City of
Sherwood
Oregon

WATER SYSTEM MASTER PLAN

August 2005

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WATER SYSTEM MASTER PLAN

FOR

CITY OF SHERWOOD

AUGUST 2005

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EXECUTIVE SUMMARY

Authorization

In February 2004, the firm of Murray, Smith & Associates, Inc. (MSA) was authorized by the City of Sherwood to prepare this Water System Master Plan.

Purpose

The purpose of this study is to perform a comprehensive analysis of the City of Sherwood's water distribution system, to identify system deficiencies, to determine future water distribution system supply requirements, and to recommend water system facility improvements that correct existing deficiencies and that provide for future system expansion. The planning and analysis efforts include consideration of the ultimate integration of recommended distribution system improvements with the City's long-term water source and supply decision.

Planning Period

The planning period for this master plan is approximately 20 years. Certain planning and facility sizing efforts will use estimated water demands at saturation development. Saturation development occurs when all existing developable land within the planning area has been developed. The planning period for transmission and distribution facilities is to saturation development of the City's water system planning area. This assumption allows a determination of the ultimate size of facilities. Typically, if substantial improvements are required beyond the planning period in order to accommodate water demands at saturation development, staging is often recommended for certain facilities where incremental expansion is feasible and practical. Unless otherwise noted, recommended improvements identified in this plan are sized for saturation development within the water system planning area.

Background and Study Area

The City of Sherwood's current water service area includes all areas within the current City limits. The City provides potable water to approximately 15,172 people through approximately 4,967 residential, commercial and industrial service connections. The study area of this planning effort is the entire area within the urban growth boundary (UGB), which currently encompasses a total of approximately 2,994 Acres.

In October 2000, the City of Sherwood entered into an intergovernmental agreement with the Tualatin Valley Water District (TVWD). Under the terms of the agreement, included in Appendix B of this report, the TVWD will provide a water supply and manage the City's water system. The agreement ends in September 2005 and may be renewed for two terms of five years each. The City and District recently approved renewal of the agreement for the first of the two additional five year terms provided for in the agreement.

Currently, the City's primary water supply is from four groundwater wells owned by the City and operated by TVWD. The City also supplements supply from the groundwater wells through a 24-inch diameter connection to the City of Tualatin's 36-inch diameter Tualatin-Portland supply main.

The City's water distribution system consists of three service zones supplied by two storage facilities and two pumping stations. One of the service zones is supplied through a continuous operation pump station.

Plate 1 of Appendix C illustrates the Sherwood water service area limits, supply connections, water system facilities, distribution system piping, and system interties. Plate 1 is also a digital representation of the computerized distribution system hydraulic model used for system analysis efforts.

Supply Sources

Groundwater Wells

Sherwood operates four groundwater wells within the City's water system service area limits. The wells are used year round and serve as the City's primary water supply. Well Nos. 3, 4, 5 and 6 have an existing combined production capacity of approximately 3.3 million gallons per day (mgd). The groundwater supplies are disinfected through the addition of sodium hypochlorite at each well. Table ES-1 lists the location, pump type, horsepower, year constructed, approximate depth, approximate production capacity and casing diameter for each of the City's groundwater wells. An evaluation of the hydrogeological conditions in the study area is included in Appendix D of this report.

The actual production capacity of the City's groundwater well supply system is limited to approximately 1.2 mgd due to aquifer and pumping limitations.

Portland Supply Connection

The City of Sherwood is supplied with water from the City of Portland via the City of Tualatin under an agreement with TVWD. This supply is transmitted through an approximately 4-mile long, 24-inch diameter City-owned transmission main from the City of Tualatin's system. This connection is located in the Tualatin Community Park where the Tualatin-Portland supply main connects to the City of Tualatin's distribution system. The amount of flow through the City's connection is regulated by a control valve operated by the City of Tualatin. The transmission main runs west along SW Tualatin Road and SW Herman Road and south on SW Cipole Road, SW Tualatin-Sherwood Road and SW Oregon Street to a connection to the City's distribution system at the intersection SW Oregon Street and SW

Table ES-1
Groundwater Well Summary

Well No.	Location	Pump Type	Hp	Year Constructed	Production Capacity (gpm)	Approx. Depth (feet)	Casing Dia. (inches)
1	Well Abandoned						
2	Well Abandoned						
3	Intersection of Pine and Willamette Street	Vertical Line Shaft Turbine	75	1946	890	319	12
4	17191 Smith Road	Vertical Line Shaft Turbine	60	1969	250	458	14
5	16491 Sunset Boulevard	Vertical Line Shaft Turbine	150	1984	600	800	16
6	1830 Roy Street	Vertical Line Shaft Turbine	75	1997	550[1]	889	16
Total Production Capacity (gpm):					**2,290**		
(mgd):					**3.29**		

Notes: 1. Production capacity is limited by available water rights.

Murdock Street. A pressure reducing valve (PRV) at this connection reduces the hydraulic grade of the supply to approximately 385 feet above mean sea level (msl).

The City of Tualatin currently wheels, or transmits, up to 3 mgd of water from the City of Portland to Sherwood through its distribution system from the Tualatin-Portland supply line. This supply is a portion of the Washington County Supply Line capacity owned by the TVWD. The primary water source originates in the City of Portland's Bull Run Watershed and Columbia South Shore Wellfield. The water source is disinfected through the addition of chloramines, a combination of chlorine and ammonia, by the City of Portland. The City of Portland also adjusts the pH of its water supply. The water wheeling agreement between the City of Tualatin and TVWD is included as Appendix E. This supply is not a guaranteed, firm, supply for the City, but is existing unused capacity currently available in the Washington County Supply Line system. When the owners of the supply line system require additional supply capacity then the excess capacity currently delivered to the City is likely to be reduced or completely unavailable.

Existing Water System

The City of Sherwood's existing distribution system is divided into three major service levels, or pressure zones that are usually defined by ground topography and designated by overflow elevations of water storage facilities or outlet settings of pressure reducing facilities serving the zone. The City's water system contains two reservoirs with a total combined storage capacity of approximately 5.0 million gallons (mg). The system also contains two pump stations.

The water service area water distribution system is composed of various pipe types in sizes up to 24 inches in diameter. The total length of piping in the service area is approximately 66.6 miles. The pipe types include cast iron, ductile iron, PVC, and copper. The majority of the piping in the system is cast and ductile iron piping. Table ES-2 presents a summary of pipe lengths by diameter.

Table ES-2
Distribution System Pipe Summary

Pipe Diameter	Estimated Length (miles)
4-inch or Less	1.4
6-inch	1.9
8-inch	34.8
10-inch	8.3
12-inch	13.8
14-inch	1.0
16-inch	0.3
18-inch	1.0
24-inch	4.1
Total Length	**66.6**

Existing Water Demands

Based on the most recent historical water usage patterns and historical population, the water service area's average daily demand is approximately 1.6 mgd with an average day per capita consumption ranging from approximately 100 to 120 gallons per capita per day (gpcd) since 1996. Recent maximum daily water demand usage has ranged from 2.0 times to 2.5 times the average day demand. This is equivalent to a maximum per capita usage ranging from 230 to 270 gpcd.

Water Demand Projections

Estimates of future water demands were developed from the City's present per capita water usage data, population forecasts and water demand forecasts prepared for the City through previous work. For the purposes of this plan, estimated average daily water usage is assumed to be approximately 120 gpcd. As conservation plays an increasing role in water usage patterns, it is anticipated that Sherwood's average daily per capita usage can ultimately be reduced to and maintained at 110 gpcd.

For the purposes of this study, current maximum daily per capita usage is estimated at approximately 250 gpcd. As conservation plays an increasing role in water usage patterns, it is anticipated that Sherwood's maximum daily per capita use can ultimately be reduced to and maintained at approximately 240 gpcd, even in drought years. Estimated average and maximum daily water demands are developed by multiplying the estimated per capita water usage by the anticipated population for that year. To provide an estimate of peak hourly usage, a factor of approximately 1.5 was applied to estimated maximum day demands. This is consistent with water demand patterns of similar communities in the region. Population projections and anticipated water demand, in five year increments through 2025 and for saturation development, are summarized in Table ES-3.

Table ES-3
Population Forecasts and
Estimated Water Demand Summary

Year	Population	Water Demand (mgd)		
		Average Day Demand	Maximum Day Demand	Peak Hour Demand
2005	15,800	1.9	4.0	6.0
2010	18,970	2.2	4.7	7.0
2015	22,130	2.6	5.4	8.1
2020	25,290	2.9	6.2	9.3
2025	28,450	3.2	6.9	10.4
Saturation Development	37,940	4.2	9.1	13.7

Water Supply Source

As previously described, the City's primary water supply is from City-owned groundwater wells. Based on the water demand estimates and the historical decline in aquifer levels the City's existing supply sources will not be adequate to meet future water demands, so the City is exploring several long-term water supply alternatives. In order to be considered a feasible option for the City, a long-term water supply source must meet several criteria. The criteria were developed in coordination with City staff, integrating criteria being used by other communities in the region. The criteria that will be used to evaluate the supply source options are:

- Ability to meet all, or a substantial portion, of the City's long-term water supply needs
- Potential for joint development with a partner or partners

- Ability to cost-effectively integrate source options into current distribution system
- Supply source development cost
- Estimated cost of water

Groundwater Supply Evaluation

The purpose of the hydrogeological evaluation is to assess the potential capacity and limitations of the City's groundwater supply source. Historical groundwater production rates and water level trend data were compiled and analyzed for each of the City's groundwater wells to evaluate the hydraulic response of the Columbia River Basalt Group aquifer underlying the City relative to historical and current groundwater pumping rates. From this evaluation it was observed that a distinct overall declining trend in water levels is occurring and increases in the rate of water level decline has occurred during periods of peak groundwater production by the City. From the analysis, it was determined that continued groundwater production at the current rate will soon require capital investment to maintain pumping rates and will likely result in significant loss of production capacity as groundwater levels continue to decline. Development of additional groundwater production facilities, such as the Spada well, is feasible, but additional groundwater production will result in an increased rate of water level decline and the ultimate loss of production capacity will occur sooner than under existing conditions. The rate of decline is dependant upon actual groundwater production. At the current rate of decline it is anticipated that without additional supplies the City will experience potential water shortages within the next five years. A technical memorandum documenting the complete groundwater supply evaluation is included in this report as Appendix D.

Supply Source Technical Analysis

Seven supply alternatives are considered for evaluation as long-term water supply sources for the City of Sherwood. The alternatives include the following:

1. Supply from the City's existing groundwater production facilities and the Spada well
2. Prospective use of Aquifer Storage and Recovery (ASR) using Sherwood's existing connection to the City of Tualatin that supplies City of Portland water to Sherwood
3. Supply from the City of Portland Bull Run Watershed and Columbia South Shore Wellfield (CSSWF) through the Washington County Supply Line and the City of Tualatin
4. Supply from the Joint Water Commission
5. Supply from the City of Newberg
6. Supply from the Clackamas River
7. Supply from the Willamette River Water Treatment Plant at Wilsonville.

A brief description of each supply alternative is presented below, including a discussion of existing supply facilities and capacities. Six planning level criteria were developed to evaluate the source of supply options. These criteria are:

- *Supply performance* – Water supply source options were evaluated based on their ability to provide a portion of the City's long-term water supply needs. The City's long-term water supply need is estimated to be 10 million gallons per day (mgd) for the purpose of this analysis.
- *Potential for joint development with a partner or partners* – Development of proposed water supply sources with local or regional partners may present significant opportunity for cost savings to the City. Each supply source was evaluated for potential opportunities for joint development.
- *Supply integration into existing distribution system* – Each supply source was evaluated for ability to integrate the supply option into current distribution system operations without the need for additional significant improvements.
- *Estimated cost for supply source development and cost of water* – Estimated capital costs of supply development were evaluated based on existing available information. Costs for development of new facilities and/or expansion of existing facilities were compiled and used to develop estimated cost for each supply source. Cost estimates were developed assuming that raw water, treatment and pumping facilities will be developed for 5 mgd capacity with provisions for expansion to 10 mgd capacity, and transmission facilities will be developed for 10 mgd capacity. Estimated cost of water data for each source was developed from existing available information, including current wholesale water rates and previous evaluations of proposed supply sources completed for the City and others. The cost of water estimates presented are for comparative uses only, that actual cost of water may vary and will depend on a number of factors outside the scope and control of this planning work.
- *Other Factors* – Supply option development may involve other factors that will directly impact the City's ability to fully develop the option. These unique factors will be described as they apply to each option.

Supply Source Analysis Summary

Table ES-4 presents a summary of the analysis of the long-term water supply options available to the City that can meet the City's long-term water supply needs. The City's existing groundwater wells, ASR, and the City of Newberg supply option are not shown as these options cannot meet the City's long-term needs. Based on the evaluation presented above, other options may also be removed from further consideration based on on-going evaluations.

Table ES-4
Water Supply Source Option Summary

Supply Source Options	Capacity (mgd)	Ability to Integrate into City's System	Cost Savings with Partners	Project Cost Range	Estimated Cost of Water ($ per ccf)	Key Issues/Comments
City of Portland Water System	10	Yes	Yes	$31 - 51 million	$1.05	Size, scope and cost of long-term supply system improvement uncertain
Joint Water Commission	10	Yes	Yes	$58.5 million	$0.07 to 0.90	System reliability and certainty of supply for the City of Sherwood is uncertain
Clackamas River Water Supply System	10	Yes	Yes	$29 - 31 million	$0.55 to 0.65	System reliability and certainty of supply for the City of Sherwood is uncertain
Willamette River Water Supply System	10	Yes	Yes	$24.5 - 21.6 million	$0.64 to 1.00	Political and public perception key issue. Will require a vote of approval from City residents

Supply Source Development Strategy

The hydrogeologic evaluation found that the aquifers serving as the City's current supply source are experiencing a pattern of water level declines that appear to be correlated to the historic use of these aquifers for water supply purposes. The analysis also found that these aquifers do not have the capacity to serve the City's expanding water supply needs. It is anticipated that the City will need to develop a new long-term water supply within the next 3 to 5 years.

While a number of the City's long-term water supply options presented above offer the City a reliable long-term water supply source, it is anticipated that for the near term the City's existing groundwater wells will continue to supply water as the City selects, evaluates and develops other water supply options. This need for continued reliance on groundwater in the near term and the declining aquifer levels suggests the need to develop a water supply source strategy that allows for the ultimate transition to a new source while maximizing the use of the existing groundwater wells. Under current conditions it is anticipated that the City's existing groundwater wells can consistently produce a firm production capacity of approximately 1.2 mgd. With the anticipated addition of the Spada Well and the implementation of certain water rights recommendations it is anticipated that this firm groundwater production capacity can be increased to approximately 2 mgd. Developing and maintaining this capacity will require capital investment in the City wells that may range from approximately $3.0 to 5.0 million.

The current available supply capacity from Sherwood's City of Portland supply through the City of Tualatin is 3.0 mgd. The water supply agreement supporting this supply with the Tualatin Valley Water District is currently set to expire in the year 2010. The source development strategy anticipates that the supply from the City of Portland system, as supplied by the existing transmission and supply facilities will reach capacity by the year 2010 and that this supply will not be available to the City beyond the year 2010. It is therefore anticipated that a new supply, with an initial supply increment of 5 mgd will be brought on line by the year 2010. At this point the new supply source will be relied on to serve the City's average day needs throughout most of the year and the existing ground water wells will be used to provide peak supply during the summer months. Additional source supply increments are added in the year 2025 and 2035 to meet the City's additional water supply needs.

Aquifer storage and recovery (ASR) may provide the City additional flexibility and time to develop and implement a long-term water supply source, however, as currently understood ASR will not provide the City the needed long-term water supply capacity needed to meet all of its water supply needs.

Water Quality Review

As part of the system analysis process a water quality workshop was held with City staff, Tualatin Valley Water District staff and members of the master plan development team. The workshop focused on the water quality characteristics of the City's existing groundwater supplies and of all of the City's long-term water supply options. The City's current regulatory compliance process was reviewed as were anticipated upcoming near-term and long-term water quality regulations.

The City's long-term water supply options were also reviewed for their water quality characteristics. In light of the City Council's direction to narrow the long-term water supply options to the City of Portland Bull Run Watershed/CSSWF and the Willamette River at Wilsonville, water quality discussions will focus on these sources. A brief discussion of water quality characteristics of these two source options is presented below.

City of Portland Bull Run Watershed/CSSWF Supply Option

The City of Portland is supplied water from the Bull Run Watershed and the Columbia South Shore Wellfield. The Bull Run watershed is a protected watershed west of Mt. Hood the City of Portland has historically provided finished water that meets all drinking water quality standards. The Columbia South Shore Wellfield consists of multiple wells south of the

Columbia River near and adjacent to northeast Portland. A copy of the City's 2004 Water Quality Report is presented as Appendix K.

Willamette River Supply Option

The City of Wilsonville has been supplied treated Willamette River water since April 2002. The Willamette River watershed is the largest in the state and includes a mix of forest, agricultural and urban uses. Since the water treatment plant at Wilsonville began producing drinking water the finished water supply has met all drinking water standards.
A copy of the City of Wilsonville's 2004 Water Quality Report is provided in Appendix L.

In May 2005 the Tualatin Valley Water District completed a water quality comparison of three of the region's water sources: the City of Portland supply, the Joint Water Commission supply and the Willamette River supply. The comparison tabulated a side by side comparison of all currently regulated water quality parameters and a number of currently unregulated parameters. A copy of this comparison is provided in Appendix M.

As part of the master planning work, a water quality workshop was conducted to review current water quality concerns of the City's existing wells and the long-term water supply options. An agenda and summary of this workshop session is presented in Appendix N.

Cost Estimating Data

An estimated project cost has been developed for each improvement project recommendation presented in this section. Itemized project cost estimate summaries are presented in Appendix H. This appendix also includes a cost data summary for recommended water main improvements developed on a unit cost basis. Project costs include construction costs and an allowance for administrative, engineering and other project related costs.

The estimated costs included in this plan are planning level budget estimates presented in 2005 dollars. Since construction costs change periodically, an indexing method to adjust present estimates in the future is useful. The Engineering News Record (ENR) Construction Cost Index (CCI) is a commonly used index for this purpose. For future reference, the January 2005 ENR CCI of 8,165 for the Seattle area construction market (the nearest market ENR monitors) was used for construction cost estimates in this report.

Recommended Improvements

General

Presented below are recommended water distribution system improvements for reservoirs, pump stations, distribution system water lines and other facilities. Also presented is a discussion of other recommended improvements and programs. Project cost estimates are presented for all recommended improvements and annual budgets are presented for recommended programs. The recommendations are presented by project type and discussed in order of need. As presented late in this section the City's long-term water supply source options have been narrowed to two alternatives and the City is developing an independent process for the evaluation and selection of a final option. As such, the CIP program recommendations presented as part of this master plan will include distribution system facility only. Supply source development funding and capital needs will be determined outside of this master plan.

A summary of all the recommended improvements is presented in Table ES-5. The table provides for prioritized project sequencing by illustrating fiscal year (FY) project needs for each facility or improvement category. Those improvements recommended for construction beyond FY 2025 are indicated as such. It is recommended that the City's capital improvement program (CIP) be funded at approximately $920,000 annually for storage, pumping and distribution system piping improvements. While the funding needs for certain water system improvements may exceed this amount, the proposed improvements listed in Table ES-5 are phased and sequenced so that the ultimate 20-year average annual capital requirement is approximately $920,000.

Supply Source Improvements

The seven supply source options and improvement alternatives identified in Section 5 were reviewed with City staff, City of Sherwood Planning Commission and with City Council as part of a public works session on April 5, 2005. At the conclusion of this process the City Council directed that two options be carried forward for further consideration. A copy of the City Council presentation of April 5, 2005 is provided in Appendix O. Based on this direction it is recommended that the City of Portland supply option and the Willamette River supply option be evaluated outside the scope of this master plan as part of a comprehensive source evaluation and selection program. As part of this evaluation it is recommended that a wide range of information and data be compiled for consideration and review by City policy makers and the citizens of Sherwood. Included in this information should be water quality data cost data and a long-term financial analysis of comparative capital costs and cost of water estimates.

Financial Evaluation Overview

The purpose of the financial evaluation is to provide reasonable assurance that the City of Sherwood's Water Fund has and will have the financial ability to maintain and operate the water system on an ongoing basis, plus have the financial capacity to obtain sufficient funds to construct the water system improvements identified in Section 6.

Table ES-5
Water System Master Plan
Distribution System Capital Improvement Program Summary

Category	Project Description	Project Location	Capital Improvement Schedule and Project Cost Summary by Fiscal Year																					Estimated Project Cost
			2005/2006	2006/2007	2007/2008	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014	2014/2015	2015/2016	2016/2017	2017/2018	2018/2019	2019/2020	2020/2021	2021/2022	2022/2023	2023/2024	2024/2025	2025+	
Storage Facilities	New Reservoirs	380-Foot Pressure Zone Reservoirs								380-Foot Reservoir No. 2 $ 2,350,000	$ 2,350,000											380-Foot Reservoir No. 3	$ 4,600,000	$ 9,300,000
		535-Foot Pressure Zone Reservoir	Siting and Property Needs $ 35,000	$ 35,000	Reservoir No. 1 $ 1,050,000	$ 1,050,000																		$ 2,170,000
	Reservoir Upgrades	Main Reservoir					Seismic Upgrades $ 400,000																	$ 400,000
		Sub-Total	$ 35,000	$ 35,000	$ 1,050,000	$ 1,050,000	$ 400,000	$ -	$ -	$ 2,350,000	$ 2,350,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 4,600,000	$ 11,870,000
Pumping Facilities	Pump Station Upgrades	Booster Pump Stations																						$ -
		Groundwater Wells	Well No. 3 $ 450,000	Well No. 4 $490,000																				$ 940,000
		Sub-Total	$ 450,000	$ 490,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 940,000
Distribution System Piping	Transmission Improvements	380-Foot Pressure Zone		M-33 $ 562,716	M-32 $ 522,000																			$ 1,479,396
				M-18 $ 102,180																				
				M-7 $ 292,500																				
		535-Foot Pressure Zone			B-8 $ 1,653,000	$ 1,653,000							B-1 $ 166,010										B-2 $ 158,470	$ 3,630,480
		455-Foot Pressure Zone																						$ -
	Fire Flow Improvements	380-Foot Pressure Zone	M-9 $ 33,280			M-1 $ 165,126	M-2 $ 21,060		M-19 $ 426,692			M-8 $ 41,080	M-13 $ 56,784	M-29 $ 54,390	M-20 $ 75,754	M-22 $ 15,582	M-14 $ 49,168	M-24 $ 42,826	M-16 $ 12,446	M-21 $ 55,468	M-23 $ 32,242	M-28 $ 21,854	M-3 $ 148,850	$ 1,868,536
							M-6 $ 65,390					M-10 $ 10,530		M-17 $ 15,582		M-5 $ 111,930		M-27 $ 24,108	M-30 $ 16,464	M-4 $ 43,810	M-11 $ 40,170	M-15 $ 56,336	M-12 $ 183,300	
			M-25 $ 48,314																					
		535-Foot Pressure Zone					B-4 $ 89,830											B-5 $ 19,600	B-6 $ 78,302				B-3 $ 154,180	$ 341,912
		455-Foot Pressure Zone																						$ -
	System Expansion Improvements	380-Foot Pressure Zone						M-34 $ 487,722													M-35 $ 2,175,000			$ 2,662,722
		535-Foot Pressure Zone																						$ -
		455-Foot Pressure Zone																						$ -
	Pressure Reducing Facilities		WRPS PRV $ 100,000																			SW Sherwood PRV $ 190,000		$ 290,000
	Water Main Replacement		$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 525,000
		Sub-Total	$ 206,594	$ 982,396	$ 2,200,000	$ 1,843,126	$ 201,280	$ 512,722	$ 451,692	$ 25,000	$ 25,000	$ 76,610	$ 247,794	$ 94,972	$ 100,754	$ 152,512	$ 74,168	$ 111,534	$ 132,212	$ 124,278	$ 2,272,412	$ 293,190	$ 669,797	$ 10,798,046
Other	Distribution System Interties	City of Tualatin	$ 50,000																					$ 50,000
	Pressure Relief	Murdock Sub-Zone Pressure Relief	$ 71,500																					$ 71,500
		Sub-Total	$ 121,500	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 121,500
		Total	**$ 813,094**	**$ 1,507,396**	**$ 3,250,000**	**$ 2,893,126**	**$ 601,280**	**$ 512,722**	**$ 451,692**	**$ 2,375,000**	**$ 2,375,000**	**$ 76,610**	**$ 247,794**	**$ 94,972**	**$ 100,754**	**$ 152,512**	**$ 74,168**	**$ 111,534**	**$ 132,212**	**$ 124,278**	**$ 2,272,412**	**$ 293,190**	**$ 5,269,797**	**$ 23,729,546**

Old Town Improvement Projects
Street Improvement Projects

	5 Year Total	7 Year Total	10 Year Total	15 Year Total	20 Year Total
Total	$ 9,064,896	$ 10,029,310	$ 14,855,920	$ 15,526,120	$ 18,459,746
Annual Average	$ 1,812,979	$ 1,432,759	$ 1,485,592	$ 1,035,075	$ 922,987

As discussed in Section 5, the City has explored the feasibility of several long-term water supply alternatives to meet the City's future water demands. At this point, two water supply options have been selected for further evaluation:

- Supply from the City of Portland (four capital cost scenarios, with varying treatment processes, are under evaluation) – *Preliminary capital cost estimates range from $31.0 to $51.0 million, depending upon the ultimate use and selection of a treatment process and other factors.*
- Supply from the Willamette River Water Treatment Plant in the City of Wilsonville (two capital cost scenarios, with varying transmission routing alternatives, are under evaluation) – *Preliminary capital cost estimates range from $21.6 to $24.5 million, depending upon the transmission routing.*

The ultimate cost of capital and/or water costs under each supply alternative is not currently known, as additional project details and negotiations are ongoing. The cost of water to the City may also be impacted by how needed supply capacity improvements are funded and constructed. For purposes of providing a potential range of impacts within this Section, capital costs for each alternative are amortized over a 20-year period.

As part of this effort, the City planned to have a rate study conducted to include a revenue requirement analysis, cost of service analysis, rate design, and system development charge (SDC) analysis. Since the supply alternatives are currently under evaluation, the cost of service/rate design portions of the study have been deferred until after selection of the supply source. The revenue requirement and SDC analyses have been completed to include the impacts of current operations and the water distribution system improvements identified in Section 6. Potential cost impacts integrating the City' long-term water source and supply decision will be briefly discussed.

It is anticipated that rate increases will be needed as the City implements the selected long-term water supply option. The financial evaluation did find that the water fund for recommended distribution system capital improvements is adequate. The actual need for and extent of water rate increases will vary depending on the ultimate selection and timing of a long-term water supply source.

Study Recommendations

It is recommended that the City take following actions:

1. Formally adopt this study as the City of Sherwood's Water System Master Plan.
2. Adopt the prioritized recommended system improvements described in Section 6 and specifically listed on Table ES-5 as the capital improvement plan (CIP) for the water service area.

3. Proceed with the evaluation and selection of a long-term water supply option as recommended in Section 6 and follow the recommendations generated through this process.
4. Review and update this plan within five to seven years to accommodate changed or new conditions.

Summary

Sherwood continues to experience steady population and water demand growth. This water system master plan evaluated the City water system's ability to adequately meet existing and future water needs. The ultimate completion of recommended improvement to the distribution system will ensure that the water system has adequate storage, pumping and distribution system piping capacity to meet these needs well into the future. The City faces a major decision in the selection of its long-term water supply option. Both options recommended for further study as part of this master planning effort can ultimately be developed to adequately meet the City's long-term needs. The financial evaluation found that for the recommended distribution system improvement the City currently has adequate funding resources. This financial evaluation further found that the development and implementation of a long-term water supply option must include a financial planning and analysis element to determine the ultimate impact on City rate payers and to determine overall capital funding needs.

SECTION 1
INTRODUCTION

Authorization

In February 2004, the firm of Murray, Smith & Associates, Inc. (MSA) was authorized by the City of Sherwood to prepare this Water System Master Plan.

Purpose

The purpose of this study is to perform a comprehensive analysis of the City of Sherwood's water distribution system, to identify system deficiencies, to determine future water distribution system supply requirements, and to recommend water system facility improvements that correct existing deficiencies and that provide for future system expansion. The planning and analysis efforts include consideration of the ultimate integration of recommended distribution system improvements with the City's long-term water source and supply decision.

Compliance

This plan complies with water system master planning requirements established under Oregon Administrative Rules (OAR) for Public Water Systems, Chapter 333, Division 61. A Water Management and Conservation Plan complying with OAR Division 86 is being completed concurrently by the City.

Scope

The scope of work for this study includes the following work tasks:

- ***Gather Data*** -- Compile and review existing maps, drawings, plans, studies and reports.
- ***Develop Inventory of Existing Facilities*** -- Prepare an inventory of existing water system facilities including supply, transmission and distribution piping, storage reservoirs, pumping stations, and telemetry and control systems.
- ***Develop Population and Water Demand Estimates*** -- Review information related to service area, land use, population distribution, and historical water demands. Develop population projections and water demand estimates for existing and undeveloped areas within the City's water service area.
- ***Establish System Analysis Criteria*** -- Develop system performance criteria for distribution and transmission systems and storage and pumping facilities. Develop analysis and planning criteria for pressure zone service pressure limits, for emergency

fire suppression water needs, and for water quality goals as well as for other system performance parameters.

- ***Complete and Calibrate Water System Hydraulic Model*** -- Prepare of a computerized water distribution system hydraulic network analysis model using MWHSoft, Inc.'s H2OMap hydraulic modeling software.
- ***Review Hydrogeologic Conditions*** -- Complete a review of local hydrogeologic (groundwater) conditions that are critical to the City's current short-term and long-term water supply interests.
- ***Perform Water System Analysis*** -- Perform a detailed analysis of the City's transmission and distribution system, analyze storage and pumping capacity needs, and evaluate pressure zone limits.
- ***Evaluate Unaccounted-for Water*** -- Evaluate unaccounted-for water, based upon historical City water sales, production and purchase records.
- ***Review Distribution System Water Quality Issues*** -- Evaluate the City's water quality program based on anticipated water quality regulatory requirements applicable to the City's water system.
- ***Perform a Preliminary Engineering Assessment of Well No. 5*** -- Perform a preliminary engineering assessment for Well No. 5. This effort includes a review of water quality and well production issues, wellhead access modifications, test pumping the well, preparation of design concepts for needed improvements.
- ***Develop Recommended System Improvements*** -- Develop recommended water system facilities improvements which correct existing deficiencies and that provide for future system expansion.
- ***Prepare Capital Improvement Plan*** -- Develop estimated project costs for recommended improvements, recommend project sequencing and develop a Capital Improvement Program.
- ***Complete a Water Rate and System Development Charge Study*** -- Conduct a study that will include revenue requirement analysis, cost of service analysis, rate design and system development charge (SDC) analysis.
- ***Prepare Water Distribution System Master Plan Document and System Plan Map*** -- Prepare a water distribution system master plan report that documents and describes the planning and analysis work efforts, including a color map identifying all existing and proposed water system facilities.

SECTION 2
EXISTING WATER SYSTEM

General

This section describes and inventories the City of Sherwood water service area and water distribution system facilities. Included in this section is a discussion of existing supply and transmission facilities, groundwater wells, water rights, pressure zones, storage and pumping facilities, distribution system piping, and telemetry and supervisory control systems.

Background and Study Area

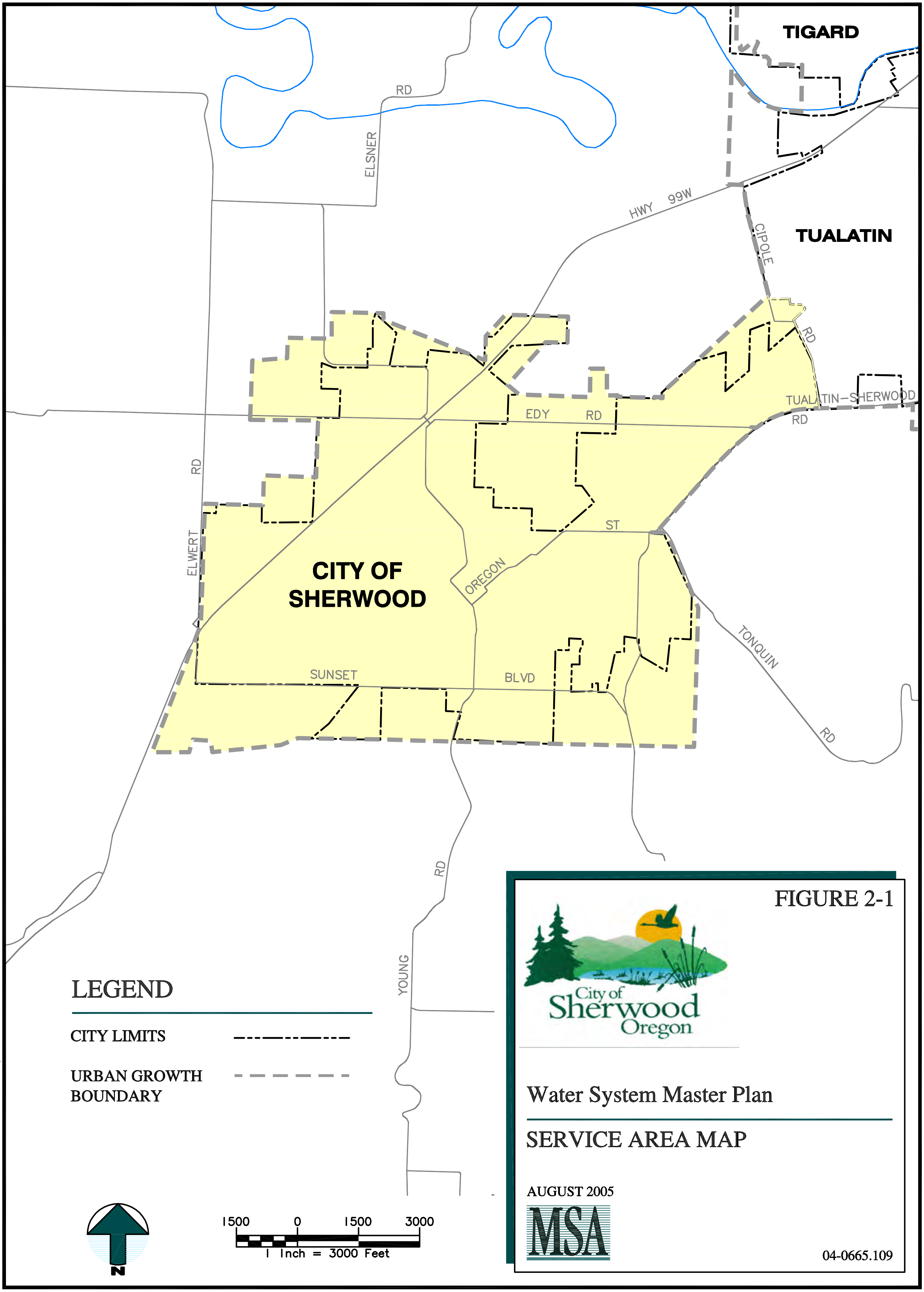
The City of Sherwood's current water service area includes all areas within the current City limits. The City provides potable water to approximately 15,172 people through approximately 4,967 residential, commercial and industrial service connections. The study area of this planning effort is the entire area within the urban growth boundary (UGB) as illustrated in Figure 2-1.

In October 2000, the City of Sherwood entered into an intergovernmental agreement with the Tualatin Valley Water District (TVWD). Under the terms of the agreement, included in Appendix B of this report, the TVWD will provide a water supply and manage the City's water system. The agreement ends in September 2005 and may be renewed for two terms of five years each. The City and District recently approved renewal of the agreement for the first of the two additional five year terms provided for in the agreement.

Currently, the City's primary water supply is from four groundwater wells owned by the City and operated by TVWD. The City also supplements supply from the groundwater wells through a connection to the City of Tualatin's 36-inch diameter Tualatin-Portland supply main.

The City's water distribution system consists of three service zones supplied by two storage facilities and two pumping stations. One of the service zones is supplied through a continuous operation pump station.

Plate 1 of Appendix C illustrates the Sherwood water service area limits, supply connections, water system facilities, distribution system piping, and system interties. Plate 1 is also a digital representation of the computerized distribution system hydraulic model used for system analysis efforts.



LEGEND

CITY LIMITS

URBAN GROWTH BOUNDARY

FIGURE 2-1

City of Sherwood Oregon

Water System Master Plan

SERVICE AREA MAP

AUGUST 2005

MSA

04-0665.109

G:\04\0665\109\CAD\FIGURE 2-1.dwg FIGURE 2-1 8.5x11 8/24/05 09:27 (hcm)

Supply Sources

Groundwater Wells

Sherwood operates four groundwater wells within the City's water system service area limits. The wells are used year round and serve as the City's primary water supply. Well Nos. 3, 4, 5 and 6 have an existing combined production capacity of approximately 3.3 million gallons per day (mgd). The actual production capacity of the City's groundwater well supply system is limited to approximately 1.2 mgd due to aquifer and pumping limitations. The groundwater supplies are disinfected through the addition of sodium hypochlorite at each well. Table 2-1 lists the location, pump type, horsepower, year constructed, approximate depth, approximate production capacity and casing diameter for each of the City's groundwater wells. An evaluation of the hydrogeological conditions in the study area is included in Appendix D of this report.

Table 2-1
Groundwater Well Summary

Well No.	Location	Pump Type	Hp	Year Constructed	Production Capacity (gpm)	Approx. Depth (feet)	Casing Dia. (inches)
1	Well Abandoned						
2	Well Abandoned						
3	Intersection of Pine and Willamette Street	Vertical Line Shaft Turbine	75	1946	890	319	12
4	17191 Smith Road	Vertical Line Shaft Turbine	60	1969	250	458	14
5	16491 Sunset Boulevard	Vertical Line Shaft Turbine	150	1984	600	800	16
6	1830 Roy Street	Vertical Line Shaft Turbine	75	1997	550*	889	16
Total Production Capacity (gpm):					**2,290**		
(mgd):					**3.29**		

* Production capacity is limited by available water rights.

Well No. 4 was taken out of service in 2003 when the well pump was removed in preparation for reconstruction of the well house and well head. A preliminary hydrogeological evaluation was performed for the well and it was determined that the well upgrades would be delayed until the full evaluation of the hydrogeology of the study area could be completed as part of this Master Plan. The District placed the well back in service using the existing well pump and re-built motor in May 2004.

City and District staff have been operating Well No. 5 at a reduced capacity by throttling the isolation valve on the well discharge pipe for several years because of "foaming" problems that occurred at higher pumping rates. A preliminary assessment was performed in December 2003 and the "foaming" was identified as entrained carbon dioxide gas. The TVWD is presently installing a new variable frequency drive at the well to manage flows at a level that does not cause the "foaming" to occur.

Portland Supply Connection

The City of Sherwood is supplied with water from the City of Portland via the City of Tualatin under an agreement with TVWD. This supply is transmitted through an approximately 4-mile long, 24-inch diameter City-owned transmission main from the City of Tualatin's system. This connection is located in the Tualatin Community Park where the Tualatin-Portland supply main connects to the City of Tualatin's distribution system. The amount of flow through the City's connection is regulated by a control valve operated by the City of Tualatin. The transmission main runs west along SW Tualatin Road and SW Herman Road and south on SW Cipole Road, SW Tualatin-Sherwood Road and SW Oregon Street to a connection to the City's distribution system at the intersection SW Oregon Street and SW Murdock Street. A pressure reducing valve (PRV) at this connection reduces the hydraulic grade of the supply to approximately 385 feet above mean sea level (msl).

The City of Tualatin currently wheels, or transmits up to 3 mgd of water from the City of Portland to Sherwood through its distribution system from the Tualatin-Portland supply line. This supply is a portion of the Washington County Supply Line capacity owned by the TVWD. The primary water source originates in the City of Portland's Bull Run Watershed and Columbia South Shore Wellfield. The water source is disinfected through the addition of chloramines, a combination of chlorine and ammonia, by the City of Portland. The City of Portland also adjusts the pH of its water supply. The water wheeling agreement between the City of Tualatin and TVWD is included as Appendix E. This supply is not a guaranteed, firm, supply for the City, but is existing unused capacity currently available in the Washington County Supply Line system. When the owners of the supply line system require additional supply capacity then the excess capacity currently delivered to the City is likely to be reduced or completely unavailable.

Water Rights Summary

Table 2-2 summarizes the existing water rights that the City holds. Sherwood holds four groundwater permits and two groundwater registration for a total of 3.82 mgd. A groundwater registration is a claim to appropriate water from a groundwater well which was in beneficial use prior to August 3, 1955. This registration has been filed with the Oregon Water Resources Department and entitles the City to a right to appropriate and apply it to beneficial use as described in the registration. The registration is not a final determination and is subject to an adjudication process. The groundwater registration has a tentative priority from the date when the construction of the well was started. A discussion of water

Table 2-2
Water Rights Summary

Well No.	Application	Permit	Certificate	Claim	Permit Rate (cfs) (gpm) (mgd)	Priority Date	Location
1	GR1161	--	--	GR1707	0.36(160) (0.23)	4/30/22	2S-1W-32-SE NW
2	GR1160	--	--	GR1706	0.49(220) (0.32)	5/12/22	2S-1W-32-SE NW
3	GR1162	--	--	GR1708	1.14 (510) (0.73)	7/25/46	2S-1W-32-SE NW
3	G9504	G9491	--	--	0.87 (390) (0.56)	11/3/80	2S-1W-32-SE NW
4	G4777	G4500	40967	--	0.83 (372) (0.54)	2/03/69	2S-1W-31-NW NE
5	G11347	G10495	--	--	1.5 (673) (0.97)	2/13/85	2S-1W-32-NW SW
6	G12155	G12546	--	--	1.23 (550) (0.79)	6/27/90	2S-1W-32-SE NE
Total Permit Rate (gpm): (mgd):					**2,875** **4.14**		

rights, their status and the need for action and recommendations is presented in Sections 5 and 6.

Pressure Zones

General

The City of Sherwood's existing distribution system is divided into three major service levels, or pressure zones. Pressure zones are usually defined by ground topography and designated by overflow elevations of water storage facilities or outlet settings of pressure reducing facilities serving the zone. A description of each of the City's pressure zones is presented below and includes a description of the service area, storage facilities, pumping facilities and groundwater sources serving the zone.

380-Foot Pressure Zone

The 300-foot pressure zone is the largest pressure zone in Sherwood, and it serves all customers below an approximate ground elevation of 250 feet above mean sea level (msl). The zone operates at an approximate hydraulic grade line (HGL) of 380 feet. The zone encompasses approximately 2,513 acres and is composed of residential, commercial and industrial land uses. The Main Reservoir serves the 300-foot pressure zone by gravity. The reservoir has an overflow elevation of approximately 380 feet and a total storage capacity of approximately 2.0 million gallons (mg). All four of the City's groundwater wells and the City's Tualatin Supply Connection supply the 300-foot pressure zone directly.

455-Foot Pressure Zone

The 455-foot pressure zone includes areas with ground elevations above 250 feet msl on the west side of the service area. The zone encompasses approximately 195 acres and is composed primarily of residential land uses and some commercial land uses. The Kruger Road Reservoir was constructed in 2001 to serve the 455-foot pressure zone by gravity. The reservoir has an overflow elevation of approximately 455 feet and a total storage capacity of approximately 3.0 mg. The Wyndham Ridge Pump Station was upgraded in 2001 to enable the station to supply water to the new reservoir from the 455-foot pressure zone and to provide continuous pumping service to the 455-foot pressure zone if the reservoir is taken out of service. A description of this pump station, including number of pump units, types and capacities, is presented later in this section.

535-Foot Pressure Zone

The 535-foot pressure zone includes areas with ground elevations above 250 feet in the southeast area of the City. The zone encompasses approximately 286 acres and is composed primarily of residential land uses. Water service to this zone is provided by continuous pumping from the Reservoir Booster Pump Station, located adjacent to the Main Reservoir. The pump station provides a static lift of approximately 155 feet, pressurizing water in this zone to an HGL of approximately 535 feet. A detailed description of the Reservoir Booster Pump Station is presented later in this section.

Storage Reservoirs

General

Sherwood's water system contains two reservoirs with a total combined storage capacity of approximately 5.0 mg. Table 2-3 presents a summary of the City's existing storage reservoirs, including capacities, overflow elevations, and pressure zones served.

Table 2-3
Reservoir Summary

Reservoir Name	General Location	Capacity (mg)	Overflow Elevation (ft)	Pressure Zone Served By Reservoir
Main Reservoir	SW Division Street east of South Pine Street	2.0	380	380-Foot Pressure Zone
Kruger Road Reservoir	SW Kruger Road west of Highway 99W	3.0	455	455-Foot Pressure Zone

2.0 MG Main Reservoir

The 2.0 mg Main Reservoir was constructed in 1972 and is located on SE Division Street just northeast of the intersection of SW Sunset Boulevard and South Pine Street at the edge of Sunset Park. The reservoir is a partially buried, cast in place, circular prestressed concrete reservoir with a diameter of approximately 105 feet and a side wall height of approximately 31 feet with an overflow elevation of 380 feet. The reservoir is supplied water from the City's four groundwater wells and the Tualatin Supply Connection. The Main Reservoir serves the Main pressure zone by gravity and supplies the Reservoir Booster Pump Station which serves the 535-foot pressure zone.

3.0 MG Kruger Road Reservoir

The 3.0 mg Kruger Road Reservoir was constructed in 2002 and is located approximately one-half mile outside of the UGB on the west side of Sherwood on SW Kruger Road. The reservoir has an overflow elevation of approximately 455 feet and a floor elevation of approximately 424 feet. The reservoir is a partially buried, cast in place, circular prestressed concrete reservoir with a diameter of approximately 130 feet and a side wall height of approximately 31 feet. The reservoir is supplied water from the Wyndham Ridge Pump Station and serves the 455-foot pressure zone.

Pump Stations

General

The City of Sherwood's water system contains two pump stations. In Table 2-4, a brief description of each station is presented, including the service zone supplied, station capacities and number, type and horsepower (hp) rating of existing pump units.

Reservoir Booster Pump Station

The Reservoir Booster Pump Station is located in Sunset Park adjacent to the Main Reservoir and houses four frame-mounted end suction centrifugal pumps. There are three 50-hp pumps each with an approximate capacity of 800 gpm and one 25-hp pump with an approximate capacity of 400 gpm. This station is a continuously operating pump station providing water to customers in the 535-foot pressure zone. The 25-hp pump is equipped with a variable frequency drive (VFD) and operates continuously to meet instantaneous demands with the other pumps operating to meet fire flow and peak demands. Pump station suction piping is connected to the Main Reservoir. The station provides a static lift of approximately 150 feet, pressurizing water in this zone to an HGL of approximately 535 feet. The pump station is equipped with a 250-kilowatt engine-generator set that provides emergency power to the pump station.

Table 2-4
Pump Station Summary

Pump Station	Unit	Hp	Capacity (gpm)	Supply To
Reservoir Booster Pump Station	1	50	800	535-Foot Pressure Zone
	2	50	800	
	3	50	800	
	4	25	400	
Wyndham Ridge Pump Station	1	40	600	455-Foot Pressure Zone
	2	40	600	
	3	10	N/A[1]	
	4	10	N/A[1]	
	5	5	N/A[1]	

Notes: 1. Pumps are not used to supply the reservoir during normal operations.

Wyndham Ridge Pump Station

The Wyndham Ridge Pump Station is located on SW Handley Street just west of Highway 99W and houses five close coupled end suction centrifugal pumps. Two 40-hp pumps supply water from the 300-foot pressure zone to the Kruger Road Reservoir in the 455-foot pressure zone. Each of these pumps has a capacity of approximately 600 gpm. The required pumping head to deliver water to the Kruger Road Reservoir and the 455-foot pressure zone is greater than the shutoff head of the two 10-hp and one 5-hp pumps at the station so these pumps are currently not utilized. The pump station is equipped with a 125-kilowatt engine-generator set that provides emergency power to the pump station.

In the event that the Kruger Road Reservoir is taken out of service, the pump station is capable of providing continuous operating pumping to serve the 455-foot pressure zone. The two 40-hp pumps are equipped with VFDs and will operate to maintain pressure and meet demands in the 455-foot pressure zone.

Distribution System

The water service area water distribution system is composed of various pipe types in sizes up to 24-inches in diameter. The total length of piping in the service area is approximately 66.6 miles. The pipe types include cast iron, ductile iron, PVC, and copper. The majority of the piping in the system is cast and ductile iron piping. Table 2-5 presents a summary of pipe lengths by diameter.

Table 2-5
Distribution System Pipe Summary

Pipe Diameter	Estimated Length (miles)
4-inch or Less	1.4
6-inch	1.9
8-inch	34.8
10-inch	8.3
12-inch	13.8
14-inch	1.0
16-inch	0.3
18-inch	1.0
24-inch	4.1
Total Length	**66.6**

Telemetry and Supervisory Control System

The telemetry and supervisory control system monitors all storage reservoirs, pump stations and well houses within the City's water distribution system and provides for manual or automatic control of certain facilities and operations. The telemetry system also collects and stores system status and performance data.

All facilities are equipped with remote telemetry units (RTUs) that monitor reservoir water surface elevations, pump station on/off status and pump station flow rates. In addition, some sites are equipped with intrusion, overflow warning and fire alarms which alert TVWD staff to unauthorized access, flooding or fire.

All signals from the RTUs are collected and transmitted to the TVWD Operations Center and to a Human-Machine Interface (HMI) located at the City's Public Works complex which enables the City to view the status of the water system. The system is also capable of automatically dialing District officials 24 hours a day in the event that one of the alarms is triggered at any of the sites. Many of the City's telemetry system facilities have recently been upgraded.

Summary

This section presents a summary of the City of Sherwood's existing water system, including the transmission and supply system, system interties, storage and pumping facilities, and distribution system piping. Also included is a discussion of existing groundwater wells, water rights, pressure zones and telemetry systems.

SECTION 3
LAND USE AND WATER REQUIREMENTS

General

This section develops population projections and estimated water demands for Sherwood's water service area. Population and water demand forecasts are developed from regional and City planning data, current land use designations, historical water demand records and previous City water supply planning efforts. Also included in this section is a description of the water service area limits and a summary of the current land use and zoning designations within the service area.

Service Area

The current water service area is the area within the existing City limits. The City limits are bounded by the Urban Growth Boundary (UGB) on all sides except for a small portion of the northeast corner which is bounded by the City of Tualatin. The City of Sherwood water system planning area, which includes all area within the current UGB encompasses a total area of approximately 2,994 acres. This total area includes the UGB expansion areas added by Metro in 2002.

Planning Period

The planning period for this master plan is approximately 20 years. Certain planning and facility sizing efforts will use estimated water demands at saturation development. Saturation development occurs when all existing developable land within the planning area has been developed. The planning period for transmission and distribution facilities is to saturation development of the City's water system planning area. This assumption allows a determination of the ultimate size of facilities. Typically, if substantial improvements are required beyond the planning period in order to accommodate water demands at saturation development, staging is often recommended for certain facilities where incremental expansion is feasible and practical. Unless otherwise noted, recommended improvements identified in this plan are sized for saturation development within the water system planning area.

Land Use

Land use and zoning classifications for Sherwood's water system planning area are established under the City's Comprehensive Plan. Table 3-1 summarizes land uses and zoning classifications for the City of Sherwood's water system planning area. Zoning classifications identified in Table 3-1 are in accordance with the Comprehensive Plan designations.

Table 3-1
Land Use Summary

Zone	Zoning Description	Area within City of Sherwood UGB (acres)
VLDR	Very Low Density Residential	105
LDR	Low Density Residential	762
MDRL	Medium Density Residential – Low	186
MDRH	Medium Density Residential – High	192
HDR	High Density Residential	161
NC	Neighborhood Commercial	1
OC	Office Commercial	17
OR	Office Retail	0
RC	Retail Commercial	97
GC	General Commercial	80
LI	Light Industrial	231
GI	General Industrial	260
IP	Institutional/Public	142
	UGB Expansion Area	370
	Existing Rights-of-Way	390
	Total	**2,994**

Population Estimates

Estimates of the existing and proposed population within the water system planning area were developed through a review of existing City of Sherwood planning data, previous water supply planning efforts, population forecast data developed by Metro for the region's water suppliers and Portland State University population forecasts. Estimates of the existing population and total number of dwelling units were developed through an analysis of City of Sherwood planning data.

Existing Population

The City of Sherwood currently supplies water to approximately 15,172 people in the water service area through approximately 4,967 service connections. Based on a review of City, Census and Metro planning data, the number of persons per dwelling unit is approximately 2.8. This results in approximately 5,400 existing dwelling units. The larger number of dwelling units relative to the number of service connections reflects single metered connections to multi-family dwelling units within the City's water service area. Table 3-2 summarizes historical and current populations within the City's water service area.

Table 3-2
Historical and Current Population Summary

Year	Population
1996	6,900
1997	8,125
1998	9,100
1999	9,855
2000	12,230
2001	12,840
2002	13,680
2003	14,050
2004	15,172

Population Forecasts

Population forecasts at saturation development for the water system planning area have been developed and summarized in Table 3-3. The anticipated saturation development population data was developed based on a detailed review of data available from the Metro Regional Land Information System (RLIS). A detailed discussion of the methodology used to develop an ultimate population projection for the service area is discussed below.

Table 3-3
Estimated Population and
Dwelling Unit Summary at Saturation Development

Pressure Zone	Total Residential Acres	Dwelling Units	Population
380-Foot Pressure Zone	1,075	10,920	30,580
455-Foot Pressure Zone	239	1,380	3,860
535-Foot Pressure Zone	308	1,250	3,500
Total	**1,622**	**13,550**	**37,940**

Population forecasts at saturation development for the City's water system planning area were developed by analyzing present zoning classifications for all developed and undeveloped residential areas within the UGB. Residential land use designations include VLDR, LDR, MDRL, MDRH and HDR as identified in Table 3-1.

The total number of residential dwelling units anticipated at saturation development was determined by multiplying the total area available for each zoning designation by the maximum density per acre for that zoning designation as defined by the City of Sherwood's Zoning and Development Code. For the Urban Growth Boundary expansion areas, approximately 270 acres were assumed to be available for residential development and a reduction factor of 20 percent was applied to this available land area to account for right-of-ways, stream corridors and open spaces. The estimated total population at saturation development was then determined by multiplying the anticipated average number of persons per household, from City, Metro and Census 2000 data, by the total number of dwelling units calculated above.

Table 3-4 presents a population forecast summary in ten year increments through 2025. The saturation development population previously developed is also presented. Based on the estimated population growth rates, it is estimated that the existing water service area will approach saturation development, or build-out conditions in approximately 2040.

Table 3-4
Population Forecast Summary

Year	Population
2004	15,170
2005	15,800
2010	18,970
2015	22,130
2020	25,290
2025	28,450
Saturation Development (2040)	37,940

For water system planning purposes, it is prudent to use the saturation development population forecasting methodology. This methodology provides for the most economical development of water system infrastructure improvements by assuming full occupancy at saturation development conditions allowing for actual development to progress without incurring additional costs for facility duplication.

Water Demand Estimates

General

Water demand estimates were developed from a review of historical water consumption records and data provided by the City and Tualatin Valley Water District (TVWD).

Historical Water Usage

The term "water demand" refers to all of the water requirements of the system including domestic, commercial, municipal, institutional and industrial as well as unaccounted-for water. Demands are discussed in terms of gallons per unit of time such as gallons per day (gpd), million gallons per day (mgd) or gallons per minute (gpm). Demands are also related to per capita use as gallons per capita per day (gpcd). The Tualatin Valley Water District maintains records of historical monthly water usage by City of Sherwood customers. Table 3-5 summarizes this data for the years 1996 through 2003.

Table 3-5
Historical Water Use Summary

Year	Water Service Area Population	Historical Water Demands				
		Average Day Demand (ADD)		Maximum Day Demand (MDD)		MDD:ADD
		mgd	gpcd	mgd	gpcd	
1996	6,900	0.7	101	1.7	246	2.4
1997	8,125	0.9	110	2.2	270	2.5
1998	9,100	1.1	121	2.2	242	2.0
1999	9,855	1.2	121	2.4	243	2.0
2000	12,230	1.4	114	2.8	229	2.0
2001	12,840	1.3	101	3.2	249	2.5
2002	13,680	1.4	102	3.3	241	2.4
2003	14,050	1.6	114	3.5	249	2.2

Existing Water Demands

Based on the most recent historical water usage patterns and historical population, the water service area's average daily demand is approximately 1.6 mgd with an average day per capita consumption ranging from approximately 100 to 120 gpcd since 1996. Recent maximum daily water demand usage has ranged from 2.0 times to 2.5 times the average day demand. This is equivalent to a maximum per capita usage ranging from 230 to 270 gpcd.

Water Demand Projections

Estimates of future water demands were developed from the City's present per capita water usage data, population forecasts and water demand forecasts prepared for the City through previous work. For the purposes of this plan, estimated average daily water usage is assumed to be approximately 120 gpcd. As conservation plays an increasing role in water usage patterns, it is anticipated that Sherwood's average daily per capita usage can ultimately be reduced to and maintained at 110 gpcd.

For the purposes of this study, current maximum daily per capita usage is estimated at approximately 250 gpcd. As conservation plays an increasing role in water usage patterns, it is anticipated that Sherwood's maximum daily per capita use can ultimately be reduced to and maintained at approximately 240 gpcd, even in drought years. Estimated average and maximum day water demands are developed by multiplying the estimated per capita water usage by the anticipated population for that year. To provide an estimate of peak hourly usage, a factor of approximately 1.5 was applied to estimated maximum day demands. This is consistent with water demand patterns of similar communities in the region. Population projections and anticipated water demand, in five year increments through 2025 and for saturation development, are summarized in Table 3-6.

Table 3-6
Population Forecasts and
Estimated Water Demand Summary

Year	Population	Water Demand (mgd)		
		Average Day Demand	Maximum Day Demand	Peak Hour Demand
2005	15,800	1.9	4.0	6.0
2010	18,970	2.2	4.7	7.0
2015	22,130	2.6	5.4	8.1
2020	25,290	2.9	6.2	9.3
2025	28,450	3.2	6.9	10.4
Saturation Development	37,940	4.2	9.1	13.7

To provide an indication of the anticipated ultimate water demand within each pressure zone, water demand projections identified in Table 3-6 have been further developed for individual pressure zones and summarized in Table 3-7.

Summary

This section presents a discussion of existing and projected land uses within the water service area. Estimates of the current and future population are presented along with forecasts of water demands. Section 4 outlines the planning criteria that, in conjunction with the water demand estimates developed in Section 3, are used in the system analysis efforts.

As tabulated above the City's current maximum daily water demand is approximately 4.0 mgd and the current water system master planning work forecasts a maximum daily demand of 9.1 mgd at saturation development within the City's current UGB. Very recent discussions and reviews by City staff indicates that actual growth may accelerate and that the City's potential long-term supply need may approach a maximum daily demand of at least 15.0 mgd. As currently envisioned these increases demand needs may most likely come from potential long-range UGB expansions. For the purposes of Distribution System Planning work recommendations related to monitoring actual growth and planning for accelerated growth will be presented in Section 6.

Table 3-7
Pressure Zone Water Demand Summary
at Saturation Development

Pressure Zone	Population	Water Demand (mgd)		
		Average Day Demand	Maximum Day Demand	Peak Hour Demand
380-Foot Pressure Zone	30,580	3.4	7.3	11.0
455-Foot Pressure Zone	3,860	0.4	0.9	1.4
535-Foot Pressure Zone	3,500	0.4	0.9	1.3
Total	**37,940**	**4.2**	**9.10**	**13.7**

SECTION 4
PLANNING AND ANALYSIS CRITERIA

General

This section develops and presents the planning and analysis criteria used for the water distribution system analysis. The criteria presented in this section are for water supply source, distribution system piping, service pressures, and storage and pumping facilities. Recommendations for water needs for emergency fire suppression are also presented. The water demand forecasts developed in Section 3 are used with these criteria in Section 5 for the analysis of the City of Sherwood's water distribution system.

Water Supply Source

As described in Section 2, the City's primary water supply is from City-owned groundwater wells. Given the understanding that the City's existing supply sources will not be adequate to meet future water demands, the City is exploring several long-term water supply alternatives. In order to be considered a feasible option for the City, a long-term water supply source must meet several criteria. The criteria were developed in coordination with City staff, integrating criteria being used by other communities in the region. The criteria that will be used to evaluate the supply source options are:

- Ability to meet all, or a substantial portion, of the City's long-term water supply needs
- Potential for joint development with a partner or partners
- Ability to cost-effectively integrate source options into current distribution system
- Supply source development cost
- Estimated cost of water

Distribution System

The water distribution system should be capable of operating within certain system performance limits, or guidelines, under several varying demand and operational conditions. The recommendations of this plan are based on the following performance guidelines, which have been developed through a review of State requirements, American Water Works Association (AWWA) acceptable practice guidelines, Insurance Services Office, Inc. (ISO) guidelines, operational practices of similar water providers, and discussions with City and Tualatin Valley Water District (TVWD) water system operations staff. The recommendations are as follows:

1. The distribution system should be capable of supplying the peak hourly demand while maintaining minimum service pressures of not less than approximately 85 to 90 percent of normal system pressures. Reservoirs are assumed to be approximately two-thirds full during peak hourly demand conditions.

2. The distribution system should be capable of providing the recommended fire flow to a given location while, at the same time, supplying the maximum daily demand and maintaining a minimum residual service pressure at any meter in the system of 20 pounds per square inch (psi). This is the minimum water system pressure required by the Oregon State Health Division. Reservoirs are assumed to be approximately two-thirds full at the start of fire flow events.

Proposed or new water mains should be at least 8-inches in diameter in order to supply minimum fire flows. In special cases, 6-inch diameter mains are acceptable if no fire hydrant connection is required, there are limited services on the main, the main is dead-ended, and looping or future extension of the main is not anticipated.

Service Zones Pressure

As discussed in Section 2, water distribution systems are typically separated into pressure zones or service levels to provide service pressures within an acceptable range to all customers. As previously discussed, the existing water service area distribution system is divided into three service levels, or pressure zones. Pressure zones are usually defined by ground topography and designated by overflow elevations of water storage facilities or outlet settings of pressure reducing facilities serving the zone. Typically, water from a reservoir will serve customers by gravity within a specified range of ground elevations so as to maintain acceptable minimum and maximum water pressures at individual service connections. When it is not feasible or practical to have a separate reservoir serving each pressure zone, pumping facilities or pressure reducing facilities are used to serve customers in different pressure zones from a single reservoir.

Generally, 80 psi is considered the desirable upper pressure limit and 50 psi the lower limit. Whenever feasible, it is desirable to achieve the 50 psi lower limit at the point of the highest fixture within a given building being served. Conformance to this pressure range may not always be possible or practical due to topographical relief, existing system configurations and economic considerations. Table 4-1 summarizes the service pressure criteria used in the analysis of the water system

Table 4-1
Recommended Service Pressure Criteria

Condition	Pressure (psi)
Minimum Service Pressure Under Fire Flow Conditions	20
Minimum Normal Service Pressure	50
Maximum Service Pressure	80

Storage Volume

Water storage facilities are typically provided for three purposes: operational or equalization storage, fire storage and emergency storage. A brief discussion of each storage element is provided below.

Operational Storage

Operational storage is required to meet water system demands in excess of delivery capacity from the supply source to system reservoirs. Operational storage volume should be sufficient to meet normal system demands in excess of the maximum daily demand and is generally considered as the difference between peak hour demand and maximum day demand. In other words, operational storage is the volume of water available to meet system demands when demands exceed the capacity of the supply source. For each pressure zone, operational storage in the amount of 25 percent of maximum daily demand is considered appropriate.

Fire Storage

Fire storage should be provided to meet the single most severe fire flow demand within each zone. The fire storage volume is determined by multiplying the recommended fire flow rate by the expected duration of that flow. Specific fire flow and duration recommendations are discussed later in this section.

Emergency Storage

Emergency storage is often provided to supply water from storage during emergencies such as pipeline failures, equipment failures, power outages or natural disasters. The amount of emergency storage provided can be highly variable depending upon an assessment of risk and the desired degree of system reliability. Provisions for emergency storage in other systems vary from none to a volume that would supply a maximum day's flow or higher. A reasonable volume for emergency storage for the water service area is approximately 100 percent of maximum daily demand. This amount of storage volume for emergency purposes is consistent with accepted water industry practices and guidelines.

Recommended storage in each zone is the sum of the operational, fire and emergency storage volume components.

Booster Station Pumping Capacity

Pumping capacity requirements vary depending on how much storage is available and the number of pumping facilities serving a particular pressure zone. Firm pumping capacity is defined as a station’s pumping capacity with the largest pump out of service. Back-up power is recommended for all stations in the event of power failure.

When pumping to storage facilities, a firm pumping capacity equal to the pressure zone's maximum day demand is recommended. Continuous operation pump stations supply pressure zones that have no storage facilities. It is recommended that these pump stations have the firm pumping capacity to supply peak instantaneous water demands in addition to fire flows. Peak instantaneous demands can be as much 2 times higher than normal maximum day demands.

Fire Flow Recommendations

While the water distribution system provides water for domestic uses, it is also expected to provide water for fire suppression. The amount of water recommended for fire suppression purposes is typically associated with the local building type or land use of a specific location within the distribution system. Fire flow recommendations are typically much greater in magnitude than the normal maximum day demand present in any local area. Adequate hydraulic capacity must be provided for these potential large fire flow demands.

A summary of fire flow recommendations by land use designation is presented in Table 4-2. The recommended fire flows presented in Table 4-2 were developed through a review of fire flow criteria adopted by similar communities, fire flow guidelines as developed by the AWWA and discussions with Tualatin Valley Fire and Rescue officials.

Water stored for fire suppression is typically provided to meet the single most severe fire flow demand within each zone. The recommended fire storage volume is determined by multiplying the fire flow rate by the duration of that flow. Table 4-3 summarizes fire flow durations recommended by the AWWA.

Summary

The criteria developed in this section are used to assess the system's ability to provide adequate water service with the existing distribution configuration, storage and booster pump station conditions and to guide improvements needed to provide service for future water needs. Planning criteria for the transmission and supply system, distribution system, pressure zones, and storage and pumping facilities are presented.

Table 4-2
Summary of Land Use and
Recommended Fire Flows

Zone	Zoning Description	Recommended Fire Flow (gpm)
VLDR	Very Low Density Residential	1,500
LDR	Low Density Residential	1,500
MDRL	Medium Density Residential – Low	1,500
MDRH	Medium Density Residential – High	1,500
HDR	High Density Residential	1,500
NC	Neighborhood Commercial	3,500
OC	Office Commercial	3,500
OR	Office Retail	3,500
RC	Retail Commercial	3,500
GC	General Commercial	3,500
LI	Light Industrial	3,500
GI	General Industrial	3,500
IP	Institutional/Public	3,500

Table 4-3
Fire Flow Duration Summary

Recommended Fire Flow (gpm)	Duration (hours)
Up to 2,500	2
3,000 to 3,500	3
Greater than 3,500	4

SECTION 5
WATER SYSTEM ANALYSIS

General

This section presents an analysis of the City of Sherwood's water distribution system based on the criteria developed in Section 4. The analysis includes an evaluation of supply source alternatives, an evaluation of the system's existing pressure zones and storage and pumping capacity requirements, and presents the findings of a computerized hydraulic network analysis of the water distribution system.

Through these evaluations and analysis, deficiencies are identified and improvement options developed. Section 6 presents a recommended capital improvement program that includes prioritized recommended improvements to correct deficiencies found through the analysis and which provides for system expansion.

Population forecasts and water use estimates presented in Section 3 are used to determine the need for certain improvements such as increased supply source and storage capacity, transmission system improvements and pumping capacity improvements. All improvements to storage and pumping facilities, and distribution and transmission piping, are based on estimated maximum day water demands at saturation development unless otherwise noted.

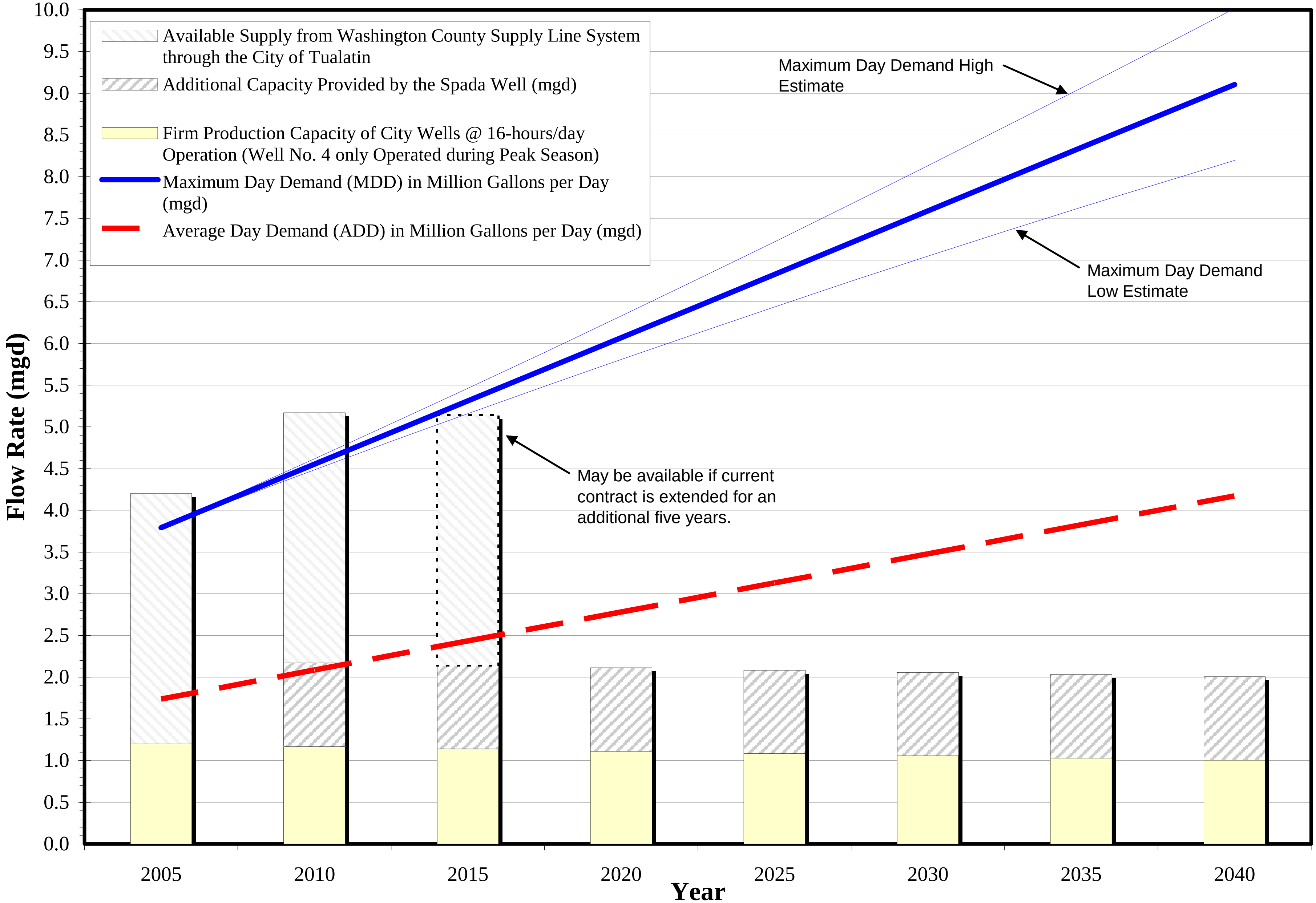
As discussed in Section 3, water demand estimates for the entire service area were developed in 5-year increments through the year 2025 and at saturation development, and were summarized in Table 3-6. These water demand estimates along with the planning criteria established in Section 4 are the basis for the analysis of the supply source, the existing system and the development of recommended system improvements.

Figure 5-1 is a graphical representation of the water demand forecast presented in Section 3. This chart illustrates the City's projected average day demand and maximum day demand through year 2040. Also shown on Figure 5-1 are the City's existing groundwater supply capacity, the estimated added capacity of the Spada well and an estimate of the existing supply capacity available through the Tualatin Supply Connection. The Tualatin Supply Connection is only included as a potential supply through the year 2010 when the City's current agreement with the Tualatin Valley Water District (TVWD) for supply through this connection expires. As described in Section 2, this agreement can be extended an additional 5 years if both parties are willing. As illustrated in this figure, it is anticipated that the City's current groundwater supply capacity will continue to decline over time. A hydrogeological analysis of the aquifers underlying the City and supplying the City's groundwater wells is summarized below.

Groundwater Supply Evaluation

The purpose of the hydrogeological evaluation is to assess the potential capacity and limitations of the City's groundwater supply source. Historical groundwater

Figure 5-1
Estimated Water Demands and Available Supply



production rates and water level trend data were compiled and analyzed for each of the City's groundwater wells to evaluate the hydraulic response of the Columbia River Basalt Group aquifer underlying the City relative to historical and current groundwater pumping rates. From this evaluation it was observed that a distinct overall declining trend in water levels is occurring and increases in the rate of water level decline has occurred during periods of peak groundwater production by the City. From the analysis, it was determined that continued groundwater production at the current rate will soon require capital investment to maintain pumping rates and will likely result in significant loss of production capacity as groundwater levels continue to decline. Development of additional groundwater production facilities, such as the Spada well, is feasible, but additional groundwater production will result in an increased rate of water level decline and the ultimate loss of production capacity will occur sooner than under existing conditions. The rate of decline is dependant upon actual groundwater production. At the current rate of decline it is anticipated that the City will experience water shortages within the next five years. A technical memorandum documenting the complete groundwater supply evaluation is included in this report as Appendix D.

Supply Source Technical Analysis

Seven supply alternatives are considered for evaluation as long-term water supply sources for the City of Sherwood. The alternatives include the following:

1. Supply from the City's existing groundwater production facilities and the Spada well
2. Prospective use of Aquifer Storage and Recovery (ASR) using Sherwood's existing connection to the City of Tualatin that supplies City of Portland water to Sherwood
3. Supply from the City of Portland Bull Run Watershed and Columbia South Shore Wellfield (CSSWF)through the Washington County Supply Line and the City of Tualatin
4. Supply from the Joint Water Commission
5. Supply from the City of Newberg
6. Supply from the Clackamas River
7. Supply from the Willamette River Water Treatment Plant at Wilsonville

A brief description of each supply alternative is presented below, including a discussion of existing supply facilities and capacities. Six planning level criteria were developed to evaluate the source of supply options. These criteria are:

- *Supply performance* – Water supply source options were evaluated based on their ability to provide a portion of the City's long-term water supply needs. The City's long-term water supply need is estimated to be 10 million gallons per day (mgd) for the purpose of this analysis.

- *Potential for joint development with a partner or partners* – Development of proposed water supply sources with local or regional partners may present significant opportunity for cost savings to the City. Each supply source was evaluated for potential opportunities for joint development.
- *Supply integration into existing distribution system* – Each supply source was evaluated for ability to integrate the supply option into current distribution system operations without the need for additional significant improvements.
- *Estimated cost for supply source development and cost of water* – Estimated capital costs of supply development were evaluated based on existing available information. Costs for development of new facilities and/or expansion of existing facilities were compiled and used to develop estimated cost for each supply source. Cost estimates were developed assuming that raw water, treatment and pumping facilities will be developed for 5 mgd capacity with provisions for expansion to 10 mgd capacity, and transmission facilities will be developed for 10 mgd capacity. Estimated cost of water data for each source was developed from existing available information, including current wholesale water rates and previous evaluations of proposed supply sources completed for the City and others. The cost of water estimates presented are for comparative uses only, that actual cost of water may vary and will depend on a number of factors outside the scope and control of this planning work.
- *Other Factors* – Supply option development may involve other factors that will directly impact the City's ability to fully develop the option. These unique factors will be described as they apply to each option.

An analysis and discussion of each of the City's supply source options using these criteria is presented below. This analysis provides a relative comparison of the supply source options available to the City and should serve as the basis for long-term water supply planning efforts by the City.

Existing Groundwater Production Facilities

The hydrogeologic evaluation of the local aquifers currently used by the City as its primary water supply found that water levels in these aquifers are declining. It was determined that if production capacities are maintained at an average daily rate of approximately 1.2 mgd from all of the City's wells, the rate of water level declines in the aquifers can be reduced. Based on current data this production capacity can be generally be maintained for the remainder of the study period. Based on this analysis it was also determined that the City's existing wells cannot provide adequate supplies to meet the City's needs. At the same time these wells can continue to serve the City as a peaking source to augment a prospective long-term supply option that can meet the City's current and future needs. For the purposes of this analysis, the City's existing groundwater wells will not be considered as a long-term supply option.

Aquifer Storage and Recovery (ASR)

General

In 1999, the City completed an analysis of developing and using aquifer storage and recovery (ASR) as a water supply management tool. The report recommended that the City pursue the development of an ASR pilot test program using the City's existing Well No. 6.

Supply Performance

The 1999 analysis found that developing ASR may possibly provide the City from 2 to 5 mgd of additional capacity during high demand periods. The findings and conclusions of the analysis were based on information available at the time of the study. Additional testing and analysis was recommended to confirm that Well No. 6 could be used for ASR purposes and to confirm the actual ultimate capacity of a City-wide ASR system. Based on current data it appears that an ASR system would not have adequate capacity to serve the City's long-term water supply needs.

Potential for Joint Development

ASR, as currently envisioned for the City of Sherwood, offers very limited or no potential for the joint development with other communities.

Estimated Project Cost and Cost of Water

The full development of an ASR system to serve the City would likely include the construction of new wells and/or the reconstruction of existing City wells. Based on current data it is estimated that developing an ASR system to supply up to 5 mgd of peak demand condition water may have project cost of $9.5 million. The ultimate value of further consideration of developing ASR for the City may be that it would allow the City additional time to develop and implement another long-term water supply option. The cost of water for this option is not currently known. Water used for injection must be purchased, stored and recovered. The actual cost of water would include all of these cost elements and would be determined as part of ASR pilot testing.

Supply Integration

A fully developed ASR system would integrate into the City's existing water system without the need for significant distribution system improvements as the contemplated well or wells would likely be located within the City's existing water distribution grid similar to the City's existing groundwater wells.

Other Factors

The ultimate performance and production capacity of an ASR system for the City of Sherwood is unknown. Additional testing and analysis is required to confirm ultimate system performance. While this option does not have adequate capacity to meet the City's long-term needs, it may offer the City a near-term peak supply option should the ultimate implementation of the final long-term option require additional time to develop.

City of Portland

General

As presented in Section 2, the City of Sherwood is supplied with water from the City of Tualatin under an agreement with the Tualatin Valley Water District. This supply is transmitted through an approximately 4-mile long, 24-inch diameter City-owned transmission main from the City of Tualatin's water system. This connection is located in the Tualatin Community Park where the Tualatin-Portland supply main connects to the City of Tualatin's distribution system. This supply connection provides up to 3 mgd of water from the City of Portland to Sherwood through its distribution system from the Tualatin-Portland supply line. This supply amount is a portion of the Washington County Supply Line capacity owned by the TVWD. The primary water source originates in the City of Portland's Bull Run Watershed and Columbia South Shore Wellfield.

Supply Performance

The existing transmission system from Powell Butte to the City of Tualatin does not have adequate capacity to meet the Sherwood's long-term water supply need of 10 mgd. Based on current understandings, should the City of Sherwood enter into a long-term water supply agreement with the City of Portland, supplies adequate to meet Sherwood's long term need would be provided and/or developed. The nature, extent and cost of improvements needed to provide this long-term supply to Sherwood is currently not known as the City of Portland is in the process of negotiating long-term water supply agreements with all of its current wholesale water users. For the purposes of this analysis it is anticipated that this supply option can meet all of the City's long-term water supply needs. It is assumed that in order to meet the City's long-term supply need, Sherwood would be expected to pay for its share of needed system improvements including transmission facilities from Powell Butte to the City.

Potential for Joint Development

This option presents a favorable opportunity for joint development with others. The City of Sherwood is presently among those water providers participating in the negotiations with the City of Portland through its association with TVWD. Based on the nature of the ongoing negotiations it is anticipated that Sherwood would achieve cost savings if the long-term supply system facilities, such as transmission, are jointly developed by Sherwood and other local partners.

Supply Integration

Supply from this source would easily integrate into the City's existing water system as it currently is configured to accept supply through its existing 24-inch diameter main in Tualatin.

Estimated Project Cost and Cost of Water

The capital costs to develop this supply for the City of Sherwood were developed anticipating that a new transmission main, generally paralleling the existing Washington County Supply Line would ultimately be constructed from Powell Butte, in southeast Portland, to the beginning of Sherwood's 24-inch diameter main in the City of Tualatin. Supply source system improvements needed to serve the City of Sherwood, in addition to other providers, were documented in the 2002 Implementation Plan for the Formation of a Proposed Bull Run Regional Drinking Water Agency, Phase II. Project cost estimates for the City of Sherwood were calculated on a proportional capacity basis based on the Sherwood's long-term water supply need of 10 mgd. It is currently uncertain if the City of Portland will build a treatment plant for the Bull Run Watershed supply. Capital cost estimates developed for this alternative include cost estimates with and without this treatment plant. Project cost estimates for the development of this supply source option range from $31 to 51 million. A summary of these needed improvements and the estimated capital cost of these improvements is presented in Appendix J.

The City of Sherwood currently pays $1.05 per one hundred cubic feet (ccf) of water supplied from the City of Portland water system. This cost includes $0.23 per ccf of system wheeling costs from the City of Tualatin. The ultimate cost of water that Sherwood would pay if the City of Portland system was the selected long-term supply option is not currently known as this cost is part of the current, ongoing, wholesale contract negotiations.

Other Factors

The ultimate cost of water to the Sherwood may also be impacted by how needed supply capacity improvements are funded and constructed. Should the City of Portland fund and complete the improvements needed to serve Sherwood it is anticipated that the rates charged to Sherwood would include these amortized improvement costs.

Based on understanding of current discussions, the City of Sherwood would not own any portion of the City of Portland water supply system that delivers water to its 24-inch diameter transmission main. As such, these capital costs cannot be included in system development capital charges for source and supply expansion needs.

Joint Water Commission (JWC)

General

The Hillsboro/Forest Grove/Beaverton/Tualatin Valley Water District Joint Water Commission (JWC) is a water source option. The JWC's source water is drawn primarily from natural surface water stream flows in the Tualatin River and the Trask River and from stored water in the Barney Reservoir on the Trask River system and the Scoggins Reservoir (Henry Hagg Lake) on Scoggins Creek.

Natural stream flows and stored water releases are withdrawn at the Springhill Pumping Plant, a Tualatin River intake facility along Fern Hill Road, approximately 1-mile south of Forest Grove. The Springhill Pumping Plant houses dedicated pumps which serve the Tualatin Valley Irrigation District irrigation transmission and distribution system and other pumps which deliver raw water through two raw water pipelines to JWC's water treatment plant further south of the river intake along Fern Hill Road. The current maximum firm water treatment capacity is considered as 60 mgd. Treated water is pumped to the JWC Fern Hill Reservoir and through transmission pipes which flow to Forest Grove, Hillsboro, the Tualatin Valley Water District and Beaverton.

With current JWC water supply facilities at capacity, the JWC has recently completed a long range 40-year Capital Improvements Plan that recommends various improvements necessary to meet short-term and long-range water supply demands under various agency participation scenarios. In addition to a raw water pipeline improvement project, this planning recommends the expansion of water treatment facilities, raw water and finished water pumping improvements and finished water storage and transmission piping system improvements, as well as participation in the prospective expansion of the Scoggins Reservoir project.

Supply Performance

The existing supply, treatment and transmission system does not have adequate capacity to meet the City of Sherwood's long-term water supply needs. However, the JWC is currently studying and is in the process of preliminary engineering and design for a raise of the dam at Scoggins Reservoir and the construction of a large diameter raw water pipeline from the reservoir to the water treatment plant. These improvements will increase the overall capacity of the JWC. For the purposes of this analysis it is anticipated that this supply option can meet all of the City's long-term water supply needs.

Based on current planning an expanded JWC system could include adequate capacity to serve the City of Sherwood's long-term water supply needs, however, system reliability is presently being evaluated.

Potential for Joint Development

The successful development of this supply option for the City Sherwood depends in large part on the willing participation of others in the development of this supply and as such the City will achieve economies of scales benefits from this option.

Supply Integration

Supply from this source would integrate into the City's existing water system with the need for significant distribution system improvements as it is anticipated that the transmission system delivering water to the City would connect directly to the City's existing 24-inch diameter Portland-Tualatin supply main.

Estimated Project Cost and Cost of Water

The capital costs for this supply for the City of Sherwood were developed anticipating that a 40-foot dam raise and raw water pipeline would be constructed. It is also anticipated that a new pump station is being considered to pump water from the Tualatin River back to Scoggins Reservoir through the raw water pipeline during periods of high river flow so as to improve the reliability of this supply source. It is also assumed that new transmission and/or reimbursement for the cost of existing transmission from the water treatment plant to the City of Sherwood will be required for this supply source. Project cost estimates for the City of Sherwood were calculated on a proportional capacity basis based on Sherwood's long-term water supply need of 10 mgd.

The City of Sherwood's proportional share of anticipated project costs for the raw water storage expansion project, the water treatment plant and pump station expansion and for transmission piping needed to deliver water to the City from JWC facilities is approximately $58.5 million, assuming that the City would participate as a partner in all contemplated project elements. A summary of these needed improvements and the estimated capital cost of these improvements is presented in Appendix J.

Based on current data the estimated cost of water to the City of Sherwood from the JWC supply system may be in the range of $0.70 to 0.90 per ccf.

Other Factors

While this supply source option can be expanded to serve the City's needs it is anticipated that over the long term, the supply capacity reliability of this alternative may be reduced as the raw water source and supply system are developed to full capacity.

City of Newberg

Discussions with City of Newberg staff indicate that the City of Newberg has adequate supplies to meet its own water needs and would not favorably consider providing water supplies to the City of Sherwood. For the purposes of this analysis this option is not considered for further evaluation.

Clackamas River

General

The Clackamas River currently supplies several municipal water providers including Clackamas River Water (CRW), North Clackamas County Water Commission (NCCWC), the South Fork Water Board (SFWB) and the Cities of Estacada and Lake Oswego. The Clackamas River watershed encompasses approximately 940 square miles southeast of the Portland metropolitan area.

Supply Performance

While current regional water supply planning work considers the Clackamas River as a potential regional water supply source for the Portland Metropolitan area, the ultimate long-term availability of this supply for the City of Sherwood is less certain. Current water rights analyses of water availability in the river indicate that under certain future conditions supply source limitations may occur.

Potential for Joint Development

While elements of this supply option can be jointly developed, the ultimate limited availability of the raw water source may in turn limit the number of potential partners and in turn limit the opportunity for the Sherwood to benefit from the resultant economies of scale.

Estimated Project Cost and Cost of Water

Estimated capital cost estimates for supply from the Clackamas River were developed for treatment, pumping and transmission on a cost per mgd basis. The cost estimates presented represent a range of potential costs for treatment, pumping facilities and transmission piping. The range of costs for development of water treatment facilities are based on previous and current transmission system analyses and water treatment expansion costs estimates. The total estimated capital cost for development of water supply on the Clackamas River is approximately $30.5 million for a 10 mgd supply capacity. A summary of these needed improvements and the estimated capital cost of these improvements is presented in Appendix J.

Based upon current understandings the estimated cost of water from a Clackamas River supply system may be in the range of $0.55 to 0.65 per ccf.

Supply Integration

Supply from this source would integrate into the City's existing water system with the need for significant distribution system improvements as it is anticipated that the transmission system delivering water to the City would connect directly to the City's existing 24-inch diameter Portland-Tualatin supply main.

Willamette River Water Treatment Plant

General

In 2002, the construction of the Willamette River Water Treatment Plant in the City of Wilsonville was completed and placed into operation. The treatment plant was constructed with an initial capacity of 15 mgd. The City of Wilsonville currently owns 10 mgd of this capacity and TVWD owns 5 mgd. The plant has the potential for expansion to more than 120 mgd capacity. Only the City of Wilsonville is presently connected to and served by the system. The Willamette River Water Coalition (WRWC), formerly the Willamette Water Supply Agency, which is made up of the Tualatin Valley Water District, the Canby Utility Board, and the Cities of Tigard, Tualatin, Gladstone and Sherwood, holds water rights for 130 mgd and has pending applications for an additional 292 mgd on the Willamette River. Sherwood has access to 10 mgd of these rights.

Supply Performance

Based on current conditions the Willamette River supply option has adequate capacity to serve Sherwood's existing and long-term water supply needs. As stated above, the City of Sherwood currently has access to a 10 mgd water right on the Willamette River at Wilsonville that would be adequate to serve the City beyond the year 2040.

Potential for Joint Development

This option presents a number of opportunities for joint development of the supply. As currently envisioned under one transmission system alternative, this option would supply the City through a connection to the 24-inch diameter Tualatin-Portland supply line if a new transmission system is constructed to supply communities north of Wilsonville from the Willamette River. Under this transmission routing alternative Sherwood would pay a proportional share of the transmission system capacity.

Another transmission system alternative would directly connect proposed City of Sherwood facilities to existing and planned City of Wilsonville transmission facilities.

Estimated Project Cost and Cost of Water

Two transmission system routing alternatives were considered as part of this alternative. The first routing alternative relies on the joint development of transmission piping intended to serve Sherwood and other communities north of Wilsonville. The conceptual level estimated project cost for this alternative is $24.5 million. Another transmission system routing alternative available to the City is supply from the City of Wilsonville's water system through piping recommended for construction to serve Sherwood's Reservoir Booster Station Pressure Zone. The estimated project costs for this option using this transmission system routing alternative is $21.6 million. A summary of these needed improvements and the estimated capital cost of these improvements is presented in Appendix J.

The December 1998 Willamette River Supply System Preliminary Engineering Report estimated a cost of water of approximately $0.64 per ccf for anticipated plant operations in the year 2007. The actual cost of water from this supply source may vary and will depend on the actual plant operations and current operating procedures and overall plant production. Recent discussions with City of Wilsonville staff indicate that the current cost of water production is approximately $1 per ccf. As this current cost includes fixed cost elements it is anticipated that the cost of water will decrease as production capacity increases.

Supply Integration

Supply from this source would integrate into the City's existing water system without the need for significant distribution system improvements as it is anticipated that the transmission system delivering water to the City would connect directly to the City's existing 24-inch diameter Portland-Tualatin supply main or through a direct connection to the City's existing Main Service Zone Reservoir through improvements recommended for the Reservoir Booster Station Zone.

Other Factors

The ultimate development of this supply option will require a public vote of approval by City of Sherwood residents.

Supply Source Analysis Summary

Table 5-1 presents a summary of the analysis of the long-term water supply options available to the City that can meet the City's long-term water supply needs. The City's existing groundwater wells, ASR, and the City of Newberg supply option are not shown as these options cannot meet the City's long-term needs. Based on the evaluation presented above, other options may also be removed from further consideration based on on-going evaluations.

Table 5-1
Water Supply Source Option Summary

Supply Source Options	Capacity (mgd)	Ability to Integrate into City's System	Cost Savings with Partners	Project Cost Range	Estimated Cost of Water ($ per ccf)	Key Issues/Comments
City of Portland Water System	10	Yes	Yes	$31 - 51 million	$1.05	Size, scope and cost of long-term supply system improvement uncertain
Joint Water Commission	10	Yes	Yes	$58.5 million	$0.70 to 0.90	System reliability and certainty of supply for the City of Sherwood is uncertain
Clackamas River Water Supply System	10	Yes	Yes	$29 - 31 million	$0.55 to 0.65	System reliability and certainty of supply for the City of Sherwood is uncertain
Willamette River Water Supply System	10	Yes	Yes	$21.6 - 24.5 million	$0.64 to 1.0	Political and public perception key issue. Will require a vote of approval from City residents

Supply Source Development Strategy

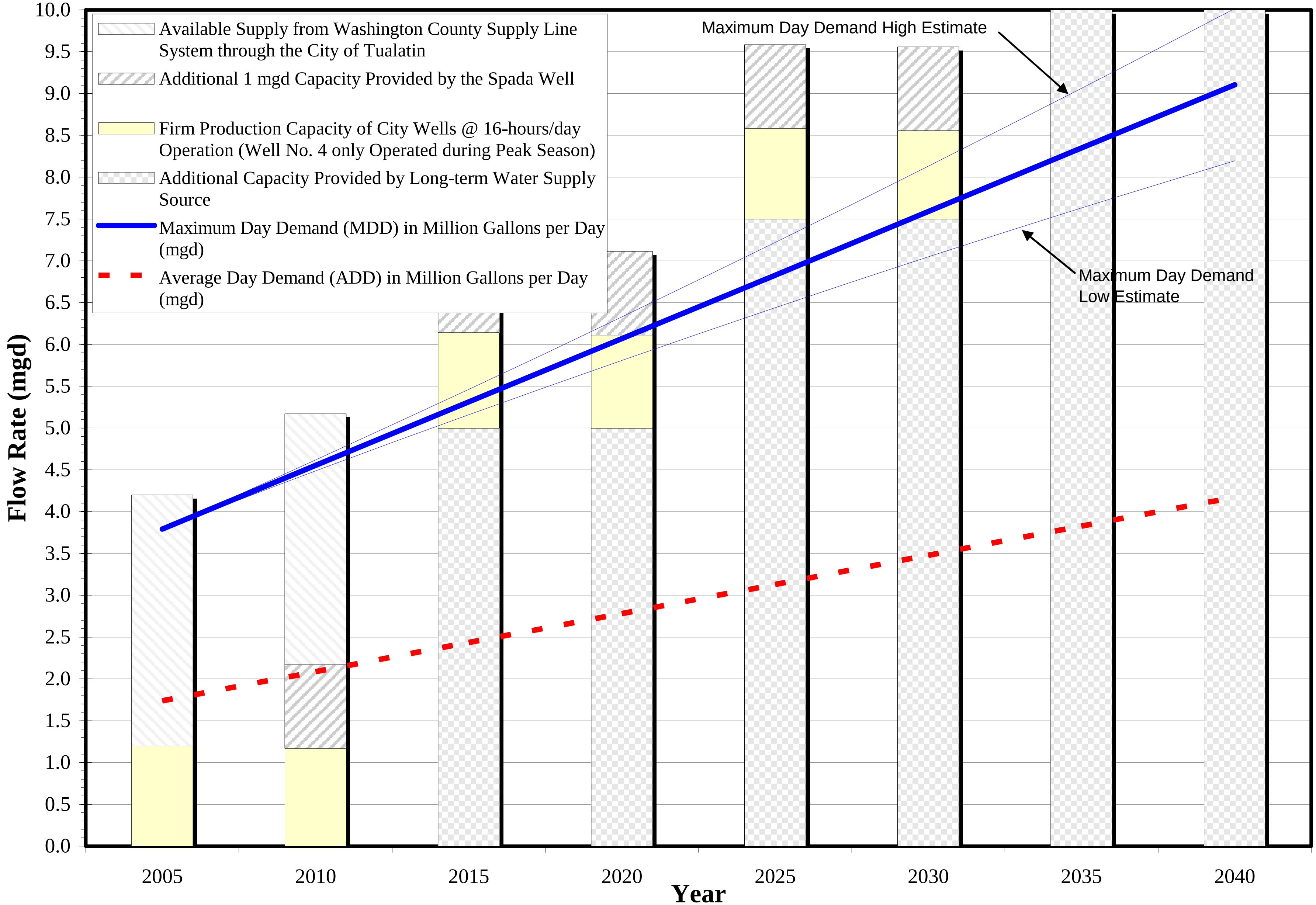
The hydrogeologic evaluation found that the aquifers serving as the City's current supply source are experiencing a pattern of water level declines that appear to be correlated to the historic use of these aquifers for water supply purposes. The analysis also found that these aquifers do not have the capacity to serve the City's expanding water supply needs. It is anticipated that the City will need to develop a new long-term water supply within the next three to five years.

While a number of the City's long-term water supply options presented above offer the City a reliable long-term water supply source, it is anticipated that for the near term the City's existing groundwater wells will continue to supply water as the City selects, evaluates and develops other water supply options. This need for continued reliance on groundwater in the near term and the declining aquifer levels suggests the need to develop a water supply source strategy that allows for the ultimate transition to a new source while maximizing the use of the existing groundwater wells. Under current conditions it is anticipated that the City's existing groundwater wells can consistently produce a firm production capacity of approximately 1.2 mgd. With the anticipated addition of the Spada Well and the implementation of certain water rights recommendations it is anticipated that this firm groundwater production capacity can be increased to approximately 2 mgd. Developing and maintaining this capacity will require capital investment in the City wells that may range from approximately $3.0 to 5.0 million.

The current available supply capacity from Sherwood's City of Portland supply through the City of Tualatin is 3.0 mgd. The water supply agreement supporting this supply with the Tualatin Valley Water District is currently set to expire in the year 2010. The source development strategy anticipates that the supply from the City of Portland system, as supplied by the existing transmission and supply facilities will reach capacity by the year 2010 and that this supply will not be available to the City beyond the year 2010. It is therefore anticipated that a new supply, with an initial supply increment of 5 mgd will be brought on line by the year 2010. At this point the new supply source will be relied on to serve the City's average day needs throughout most of the year and the existing ground water wells will be used to provide peak supply during the summer months. Figure 5-2 illustrates a graphical representation of this approach. As shown, additional source supply increments are added in the year 2025 and 2035 to meet the City's additional water supply needs.

Aquifer storage and recovery (ASR) may provide the City additional flexibility and time to develop and implement a long-term water supply source, however, as currently understood ASR will not provide the City the needed long-term water supply capacity needed to meet all of its water supply needs.

Figure 5-2
Long-Term Water Supply Strategy



Pressure Zone Analysis

As discussed in Section 2, the City of Sherwood's distribution system is currently separated into three service areas, or pressure zones. The planning criteria developed in Section 4 established acceptable service pressure limits for existing and proposed pressure zones. These criteria are used to determine optimal elevations of existing and proposed reservoirs and to evaluate existing and proposed pressure zones. Table 5-2 summarizes ground elevation service limits for pressure zones and reservoir overflow elevations assuming gravity supply to all pressure zones from storage reservoirs. A brief discussion of changes in the 535-foot pressure zone is presented below.

Table 5-2
Pressure Zone Service Elevation and Pressure Summary

Pressure Zone	Elevation Range (ft.)	Reservoir Overflow Elevation (ft.)	Approximate Static Pressure Range(psi)
380-Foot Pressure Zone	140 – 250	380	55 - 105
455-Foot Pressure Zone	250 – 300	455	65 - 85
535-Foot Pressure Zone	280 – 380	535	65 - 95

The 535-foot pressure zone serves customers in the southeast portion of the City above ground elevations of 280 feet. Currently, one subzone exists within the pressure zone where homes are served from the Murdock PRV at slightly lower pressures than the rest of the pressure zone. In order to improve service at higher elevations in the 380-foot pressure zone along the interface between the two zones, the pressure zone analysis included modifications to the current limits of this pressure zone. Specific recommendations for modification to the pressure zone boundary and distribution system operation are described in Section 6.

Storage Capacity Analysis

The storage capacity analysis evaluates existing storage capacities and determines storage volume needs for the water service area. Reservoir capacity requirements are developed based on the planning criteria presented in Sections 3 and 4. Estimated reservoir storage volume requirements are based on the sum of equalization, fire suppression and emergency storage volume needs. Table 5-3 summarizes estimated storage volume needs for each pressure zone.

Table 5-3
Storage Volume Analysis Summary

Pressure Zone	Storage Requirements (mg)			Total Storage Requirement (mg)	Existing Storage (mg)	Storage Deficit (mg)
	Operational Storage	Fire Storage	Emergency Storage			
380-Foot Pressure Zone	1.9	0.8	7.3	10.0	2	8.0
455-Foot Pressure Zone	0.2	0.8	0.9	1.9	3	-
535-Foot Pressure Zone	0.2	0.2	0.9	1.3	-	1.3

The results of the storage volume analysis indicate that the existing storage capacity of the Main Reservoir is inadequate to serve the storage capacity needs of the Main pressure zone. As indicated in Table 5-3, the recommended storage capacity needs of this zone is greater than three times the existing storage volume capacity of the Main Reservoir storage facility. The analysis results indicate that approximately 8.0 mg of additional storage will be needed to meet storage volume capacity needs of the 380-foot pressure zone. As described below, surplus storage capacity exists in the 455-foot pressure zone. This storage capacity can be used to offset the storage needs in the 380-foot pressure zone since supply from the 455-foot zone can be delivered through PRVs to the 380-foot pressure zone. An analysis of the condition of the Main Reservoir was conducted in 2004 and it was determine that seismic upgrades are necessary and that the reservoir is nearing the end of its service life. As such, it is anticipated that surplus storage from the 455-foot pressure zone will be used to offset the ultimate loss of this reservoir. A technical memorandum, documenting this investigation is included as Appendix G of this report. Section 6 includes recommendations for the rehabilitation and ultimate abandonment of this reservoir.

The results of the storage volume analysis indicate that there is sufficient storage volume capacity within the 455-foot pressure zone to accommodate water demands of the pressure zone at saturation development. Excess storage in the pressure zone can be used in the 380-foot pressure zone to meet extraordinary demands through existing and proposed PRVs between the two pressure zones.

As discussed previously, the 535-foot pressure zone presently contains no storage facilities. The analysis results indicate that in order to provide the recommended storage volume capacity needs of this service zone at saturation development approximately 1.5 million gallons of storage will be needed at an approximate overflow elevation of 535 to 545 feet.

Pumping Capacity Analysis

Existing pump station capacities were evaluated with respect to existing and future firm capacity requirements. Table 3-7 presents estimated maximum daily water demands for each service area and pressure zone at saturation development. In accordance with the pump station planning criteria presented in Section 4 these estimates are used to establish firm pumping requirements for existing and proposed pump stations. The water demand estimates developed in Table 3-7 present water demand estimates in million gallons per day (mgd). For the purposes of the pumping capacity analysis these flows have been converted to gallons per minute (gpm), where 1 mgd equals approximately 695 gpm. Table 5-4 presents a summary of estimated pumping requirements for each pump station at saturation development.

Table 5-4
Pump Station Capacity Summary

Pressure Zone	Existing Firm Capacity (gpm)	Recommended Firm Pumping Capacity (gpm)
450-Foot Pressure Zone	600	600
535-Foot Pressure Zone	2,000	560[1]

Note: 1. The recommended firm pumping capacity for the Reservoir Booster Pump Station assumes development of storage facilities to provide gravity service to the 535-foot pressure zone. Under continuous operation pumping service conditions recommended firm pump capacity would be 1,750 gpm.

A brief discussion of the pumping capacity analysis by pressure zone is presented below.

455-Foot Pressure Zone

Presently, all supply to the existing 455-foot pressure zone is from the Wyndham Ridge Pump Station which pumps water from the 380-foot pressure zone to the Kruger Road Reservoir. The pump station has five pumping units, two of which are currently operated. Each of the two identical pump units has a capacity of approximately 600 gpm. The pump station is equipped with an engine-generator to provide back-up power to the pump station.

As discussed in Section 4, firm pumping capacity is defined as the capacity of a pump station with the largest pump out of service. An analysis of existing pumping capacity to the 455-foot pressure zone evaluated the pumping capacity of the existing station with one of the pump units out of service. Applying this criterion the existing firm pumping capacity of the Wyndham Ridge Pump Station is 600 gpm. The anticipated maximum daily demand for this service zone at saturation development and the ultimate firm pumping capacity required is approximately 600 gpm. The analysis found that there is currently adequate pumping capacity to serve the 455-foot pressure zone.

535-Foot Pressure Zone

As described in Section 2, the 535-foot pressure zone is currently served from the constant pressure Booster Pump Station which pumps water from the Main Reservoir. The pump station has four pumping units. Three of these pump units are identical and have a capacity of approximately 800 gpm. The fourth pump unit has a capacity of approximately 400 gpm and is equipped with a variable frequency drive to operate at lower capacity during times of low demand in the pressure zone. The pump station is equipped with an engine-generator to provide back-up power to the pump station.

Applying the pump station capacity criteria presented in Section 4, the firm capacity of this pump station is approximately 2,000 gpm. Should the 535-foot pressure zone continue to be served by constant pressure operation of the pump station then the ultimate firm pumping capacity required of the pump station would be 1,750 gpm. As described above, it is recommended that approximately 1.5 mg of storage be provided in this pressure zone. With the construction of storage for this pressure zone, the required ultimate firm pumping capacity required for this pump station is 560 gpm. In either case, the firm pumping capacity of the pump station is adequate to serve the Reservoir Booster Station pressure zone.

Distribution System Analysis

A hydraulic network analysis computer program was used to evaluate the performance of the existing distribution system and to aid in the development of proposed system improvements. The network analysis program utilizes a digital base map of the water distribution system prepared using MWHSoft, Inc. H2OMap network analysis software. The purpose of the computer network modeling is to determine pressure and flow relationships throughout the distribution system for a variety of critical hydraulic conditions. System performance and adequacy is then evaluated on the basis of water demand estimates developed in Section 3 and planning criteria presented in Section 4.

Hydraulic Model

The hydraulic model used to complete the hydraulic analysis of this master plan was developed from the City's current distribution system map. The hydraulic model developed includes all system piping, supply sources, pump stations, reservoirs and PRVs. The hydraulic model was then used to perform the system analysis and to illustrate recommended improvements. This drawing file is presented as Plate 1 in Appendix A.

All pipes on Plate 1 are shown as "links" between "nodes" which represent pipeline junctions or changes in pipe size. Pipes and nodes are numbered to allow for easy system updating and revision. These numbers have been assigned to frozen drawing layers and have not been shown for drawing clarity. Diameter, material type and length are specified for each pipe, and an approximate ground elevation is specified for each node. For drawing clarity only pipe diameters are illustrated. Hydraulic elements such as closed valves, pressure reducing valves, pumps and reservoirs are also illustrated and incorporated into the model data base.

Model Calibration

For a computer model to provide accurate results under test conditions the model is calibrated with field conditions so that modeled conditions reflect actual system operation. Model calibration was performed using hydrant flow test data gathered by TVWD staff. Flow data from the hydrant flow tests were compared to pressure and flow results obtained from modeled flows placed at the same location. Calibration is generally considered successful when pressures measured during hydrant flow tests is within 5-10 percent of the hydraulic model. The Hazen-Williams roughness coefficients of the pipes and the distribution of demands from the nodes in the model were adjusted until the modeled flow test results fell within the range described above. Based on the calibration results, a Hazen-Williams roughness coefficient or C-Factor between 90 and 130 was used for all existing pipes throughout the modeling process.

Modeling Conditions

To simulate system operation under maximum usage conditions, it is necessary to determine the water usage anticipated for the highest water use day of the year. For this purpose the maximum daily demands at saturation development, previously presented as part of Table 3-6, were distributed throughout the system.

The computer analysis was performed with all pressure zones simultaneously in operation. In order to use the computerized hydraulic model of the water system to assess system adequacy, several system conditions were examined. The adequacy of the system's major transmission piping and the system's ability to provide recommended fire flows throughout the system were analyzed.

All fire flow modeling was performed assuming that the system must be capable of providing the recommended fire flows while maintaining a minimum system pressure of approximately 20 psi to all services within the pressure zone of the flow test.

Modeling Results

Transmission System

The results of the transmission system analysis indicate that maximum day demand conditions at saturation development will not be adequately supplied by the existing water system and supply configuration. Improvements to the transmission system are needed to improve system operation and are collocated with proposed roadway construction projects.

Fire Flow Modeling

The fire flow modeling found that under maximum day demand conditions at saturation development, improvements are required to provide recommended fire flows in the 380-foot pressure zone and the 535-foot pressure zone. Fire flows were simulated throughout the study area based on the estimated fire flow recommendations for land uses as presented in Section 4. The proposed improvements include upsizing existing distribution mains and constructing new distribution mains to reduce system head losses.

System Expansion

As discussed in Section 3, UGB expansion areas are included in the water system planning area for this analysis. These areas are illustrated on Plate 1 of Appendix A. As part of system analysis efforts, a brief evaluation was performed to identify water system infrastructure needs for these areas. Identification of proposed system improvements discussed in this section and detailed in Section 6 include improvements necessary to supply current anticipated water demand needs of these areas.

The proposed distribution system improvements are indicated on Tables H-9 and H-10 in Appendix H. Improvement sequencing and pipe sizing recommendations are present in Section 6 in addition to detailed project cost estimates.

Water Loss Evaluation

Water production and meter records were reviewed for the City's water system for the past two years. Table 5-5 summarizes the water production and unaccounted-for water losses for this period. Prior to 2002, insufficient records exist to compare water production and water sales volumes to determine unaccounted-for water quantities. As shown, the City has experienced an average annual water loss of approximately 6.4 percent during this period. The water works industry generally considers a level of unaccounted-for water of 15 percent or more to be excessive. In addition, Division 86 of the Oregon Administrative Rules requires water suppliers with leakage greater than 10 percent to put in place a leak detection program. Since the City of Sherwood's present average annual water loss is within acceptable limits, it is not recommended that the City perform a leak detection survey at this time.

Water Quality Review

As part of the system analysis process a water quality workshop was held with City staff, Tualatin Valley Water District staff and members of the master plan development team. The workshop focused on the water quality characteristics of the City's existing groundwater supplies and of all of the City's long-term water supply options. The City's current regulatory compliance process was reviewed as were anticipated upcoming near-term and long-term water quality regulations.

Table 5-5
Water Production and Losses Summary

Fiscal Year	Volume Purchased and Produced (mg)	Metered Usage (mg)	Annual Loss (mg)	Percent Loss
01-02	574	523	51	9.7%
02-03	617	599	18	3.1%
			Average Percent Water Loss	**6.4%**

Water quality issues related to the City's existing groundwater wells were reviewed and known water quality characteristics are summarized in Table 5-6. Included in this table is the existing Spada Well, an existing irrigation well, which the City may consider for development into a drinking water production well.

The City's long-term water supply options were also reviewed for their water quality characteristics. In light of the City Council's direction to narrow the long-term water supply options to the City of Portland Bull Run Watershed/CSSWF and the Willamette River at Wilsonville, water quality discussions will focus on these sources. A brief discussion of water quality characteristics of these two source options is presented below.

City of Portland Bull Run Watershed/CSSWF Supply Option

The City of Portland is supplied water from the Bull Run Watershed and the Columbia South Shore Wellfield. The Bull Run watershed is a protected watershed west of Mt. Hood the City of Portland has historically provided finished water that meets all drinking water quality standards. The Columbia South Shore Wellfield consists of several wells south of the Columbia River near and adjacent to northeast Portland. A copy of the City's 2004 Water Quality Report is presented as Appendix K.

Willamette River Supply Option

The City of Wilsonville has been supplied treated Willamette River water since April 2002. The Willamette River watershed is the largest in the state and includes a mix of forest, agricultural and urban uses. Since the water treatment plant at Wilsonville began producing drinking water the finished water supply has met all drinking water standards. A copy of the City of Wilsonville's 2004 Water Quality Report is provided in Appendix L.

Table 5-6
Groundwater Well Water Quality Summary Table

Well No./Name	Production Capacity (gpm)	Water Quality Summary
3	890	1. Radon @ 436 pCi/L (12/10/02)[3] 2. Sodium @ 15.1 mg/l (11/21/03) and @9.4 mg/l (6/14/99)[4] 3. Nitrate @ 0.6 mg/l (11/21/03)[5]
4	250	1. Radon @ 922 pCi/L (12/10/02)[3] 2. Nitrate @1.3 (6/14/99) @ 0.66 (6/18/96)[5]
5	600	1. Radon @ 750 pCi/L (12/10/02)[3] 2. Sodium @ 18.6 mg/l (11/21/03) and @13.8 mg/l (6/14/99)[4] 3. Bicarbonate and Total Akalinity @ 111 mg/l (1/28/05)[8]
6	550	1. Radon @ 332 pCi/L (12/10/02)[3] 2. Sodium @ 57.6 mg/l (11/21/03)[4], @ 64.2 mg/l (6/14/99) and @ 57.0 mg/l (1/31/97)[4] 3. Pre-filter Iron @ 0.11 mg/l. Post-filter Iron @ non-detectable levels (12/6/00)[1] 4. Pre-filter Manganese @ 0.032 mg/l. Post-filter Manganese @ non-detectable levels (12/6/00)[2].
Spada	400 – 700	1. Radon @ 590 pCi/L (12/10/02)[3] 2. Chloride @ 260 mg/l (8/4/04)[6] 3. Total dissolved solids @ 650 mg/l (8/4/60)[7]

Notes:
1. Secondary maximum contaminant level (SMCL) for Iron is 0.3 mg/l.
2. SMCL for Manganese is 0.05 mg/l.
3. No current maximum contaminant level (MCL) for Radon.
4. Recommended MCL for Sodium is 20 mg/l.
5. Recommended MCL for Nitrate is 10 mg/l.
6. SMCL for Chloride is 250 mg/l.
7. SMCL for Total Dissolved Solids is 500 mg/l.
8. No current limits for Bicarbonate, limit for Total Alkalinity suggested at 400 mg/l.

In May 2005 the Tualatin Valley Water District completed a water quality comparison of three of the region's water sources: the City of Portland supply, the Joint Water Commission supply and the Willamette River supply. The comparison tabulated a side by side comparison of all currently regulated water quality parameters and a number of currently unregulated parameters. A copy of this comparison is provided in Appendix M.

As part of the master planning work, a water quality workshop was conducted to review current water quality concerns of the City's existing wells and the long-term water supply options. An agenda and summary of this workshop session is presented in Appendix N.

As part of the review of water quality issues for the City of Sherwood's water system, an the computerized hydraulic model that was developed and calibrated for the hydraulic analysis was expanded beyond a steady state model into an extended period simulation (EPS) model. An EPS model simulates system operation over a specific time interval characterizing changes in reservoir water levels, flow directions, and other dynamic responses of the water distribution system to changing system demands.

It is anticipated that the EPS model developed for the City will be used to satisfy pending regulatory requirements related to Initial Distribution System Evaluations (IDSEs). IDSEs are studies intended to select a new compliance monitoring sites, which more accurately represent high concentrations of disinfection by-products (DBP) such as total trihalomenthane (TTHM) and the sum of five regulated haloacetic acids (HAA_5). In order to comply with the IDSE requirement, an evaluation or study of DBP formation in the distr8ibution system is required, either in the form of a system-specific study (SSS) or a standard monitoring plan (SMP).

- System-Specific Study (SSS) – There are several options in performing an SSS including the use of historical DBP data and water distribution system modeling.
- Standard Monitoring Program (SMP) – Perform one year of distribution system monitoring under a schedule and plan determined by system size, source water, and number of plants.

Based on our current understanding of the proposed regulations, the EPS model will meet the criteria for a SSS and allow the City to reduce the sampling requirements of the pending regulation.

Water Quality Compliance Strategy

The City's water quality compliance strategy depends in great part on the long-term water supply option that the City ultimately chooses. If a new supply is brought on line and the City's existing wells are used just for emergency supply conditions then secondary water quality issues, such as taste and odor characteristics related to the wells, become less of a concern and no treatment improvements at the wells may be needed. It is anticipated that any new long-term supply option will be fully compliant with current regulations and that any source will remain compliant. A final strategy and compliance plan should be developed following the selection of the long-term water supply option. At the same time the City should be prepared to comply with Disinfection By-Product Rule (DBP), Initial Distribution System Evaluation (IDSE) requirements.

Summary

This section developed and presented an analysis of the City of Sherwood water distribution system and long-term water supply options. Several long-term water supply options for the City were evaluated. This evaluation should serve as the basis for further investigation of water supply options as opportunities for development occur. The distribution system analysis found that piping and storage improvements are needed to adequately meet fire flow requirements and to provide for system expansion needs. Section 6 presents recommendations and a capital improvement plan that includes project sequencing needs, phasing requirements and project cost estimates.

SECTION 6
RECOMMEDATIONS AND CAPITAL IMPROVEMENT PLAN

General

This section presents recommended water system improvements based on the analysis and findings presented in Section 5. These improvements include proposed reservoir, pump station and water line improvements. Recommended supply source options and an implementation approach will be developed with City policymakers through a review and evaluation process with the contents and findings of this draft document. Also presented is a capital improvement program schedule for all recommended improvements. All proposed system improvements are illustrated on Plate 1 in Appendix C.

Cost Estimating Data

An estimated project cost has been developed for each improvement project recommendation presented in this section. Itemized project cost estimate summaries are presented in Appendix H. This appendix also includes a cost data summary for recommended water main improvements developed on a unit cost basis. Project costs include construction costs and an allowance for administrative, engineering and other project related costs.

The estimated costs included in this plan are planning level budget estimates presented in 2005 dollars. Since construction costs change periodically, an indexing method to adjust present estimates in the future is useful. The Engineering News Record (ENR) Construction Cost Index (CCI) is a commonly used index for this purpose. For future reference, the January 2005 ENR CCI of 8,165 for the Seattle area construction market (the nearest market ENR monitors) was used for construction cost estimates in this report.

Recommended Improvements

General

Presented below are recommended water distribution system improvements for reservoirs, pump stations, distribution system water lines and other facilities. Also presented is a discussion of other recommended improvements and programs. Project cost estimates are presented for all recommended improvements and annual budgets are presented for recommended programs. The recommendations are presented by project type and discussed in order of need. As presented late in this section the City's long-term water supply source options have been narrowed to two alternatives and the City is developing an independent process for the evaluation and selection of a final option. As such, the CIP program recommendations presented as part of this master plan will include distribution system facility only. Supply source development funding and capital needs will be determined outside of this master plan.

Table 6-1
Water System Master Plan
Distribution System Capital Improvement Program Summary

Category	Project Description	Project Location	Capital Improvement Schedule and Project Cost Summary by Fiscal Year																					Estimated Project Cost
			2005/2006	2006/2007	2007/2008	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014	2014/2015	2015/2016	2016/2017	2017/2018	2018/2019	2019/2020	2020/2021	2021/2022	2022/2023	2023/2024	2024/2025	2025+	
Storage Facilities	New Reservoirs	380-Foot Pressure Zone Reservoirs								380-Foot Reservoir No. 2 $ 2,350,000	$ 2,350,000											380-Foot Reservoir No. 3	$ 4,600,000	$ 9,300,000
		535-Foot Pressure Zone Reservoir	Siting and Property Needs $ 35,000	$ 35,000	Reservoir No. 1 $ 1,050,000	$ 1,050,000																		$ 2,170,000
	Reservoir Upgrades	Main Reservoir					Seismic Upgrades $ 400,000																	$ 400,000
		Sub-Total	$ 35,000	$ 35,000	$ 1,050,000	$ 1,050,000	$ 400,000	$ -	$ -	$ 2,350,000	$ 2,350,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 4,600,000	$ 11,870,000
Pumping Facilities	Pump Station Upgrades	Booster Pump Stations																						$ -
		Groundwater Wells	Well No. 3 $ 450,000	Well No. 4 $490,000																				$ 940,000
		Sub-Total	$ 450,000	$ 490,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 940,000
Distribution System Piping	Transmission Improvements	380-Foot Pressure Zone		M-33 $ 562,716	M-32 $ 522,000																			$ 1,479,396
				M-18 $ 102,180																				
				M-7 $ 292,500																				
		535-Foot Pressure Zone			B-8 $ 1,653,000	$ 1,653,000							B-1 $ 166,010										B-2 $ 158,470	$ 3,630,480
		455-Foot Pressure Zone																						$ -
	Fire Flow Improvements	380-Foot Pressure Zone	M-9 $ 33,280			M-1 $ 165,126	M-2 $ 21,060		M-19 $ 426,692			M-8 $ 41,080	M-13 $ 56,784	M-29 $ 54,390	M-20 $ 75,754	M-22 $ 15,582	M-14 $ 49,168	M-24 $ 42,826	M-16 $ 12,446	M-21 $ 55,468	M-23 $ 32,242	M-28 $ 21,854	M-3 $ 148,850	$ 1,868,536
							M-6 $ 65,390					M-10 $ 10,530		M-17 $ 15,582		M-5 $ 111,930		M-27 $ 24,108	M-30 $ 16,464	M-4 $ 43,810	M-11 $ 40,170	M-15 $ 56,336	M-12 $ 183,300	
			M-25 $ 48,314																					
		535-Foot Pressure Zone					B-4 $ 89,830											B-5 $ 19,600	B-6 $ 78,302				B-3 $ 154,180	$ 341,912
		455-Foot Pressure Zone																						$ -
	System Expansion Improvements	380-Foot Pressure Zone						M-34 $ 487,722													M-35 $ 2,175,000			$ 2,662,722
		535-Foot Pressure Zone																						$ -
		455-Foot Pressure Zone																						$ -
	Pressure Reducing Facilities		WRPS PRV $ 100,000																			SW Sherwood PRV $ 190,000		$ 290,000
	Water Main Replacement		$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 525,000
		Sub-Total	$ 206,594	$ 982,396	$ 2,200,000	$ 1,843,126	$ 201,280	$ 512,722	$ 451,692	$ 25,000	$ 25,000	$ 76,610	$ 247,794	$ 94,972	$ 100,754	$ 152,512	$ 74,168	$ 111,534	$ 132,212	$ 124,278	$ 2,272,412	$ 293,190	$ 669,797	$ 10,798,046
Other	Distribution System Interties	City of Tualatin	$ 50,000																					$ 50,000
	Pressure Relief	Murdock Sub-Zone Pressure Relief	$ 71,500																					$ 71,500
		Sub-Total	$ 121,500	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 121,500
		Total	**$ 813,094**	**$ 1,507,396**	**$ 3,250,000**	**$ 2,893,126**	**$ 601,280**	**$ 512,722**	**$ 451,692**	**$ 2,375,000**	**$ 2,375,000**	**$ 76,610**	**$ 247,794**	**$ 94,972**	**$ 100,754**	**$ 152,512**	**$ 74,168**	**$ 111,534**	**$ 132,212**	**$ 124,278**	**$ 2,272,412**	**$ 293,190**	**$ 5,269,797**	**$ 23,729,546**
							5 Year Total $ 9,064,896 Annual Average $ 1,812,979		7 Year Total $ 10,029,310 Annual Average $ 1,432,759			10 Year Total $ 14,855,920 Annual Average $ 1,485,592					15 Year Total $ 15,526,120 Annual Average $ 1,035,075					20 Year Total $ 18,459,746 Annual Average $ 922,987		

Old Town Improvement Projects
Street Improvement Projects

A summary of all the recommended improvements is presented in Table 6-1. The table provides for prioritized project sequencing by illustrating fiscal year (FY) project needs for each facility or improvement category. Those improvements recommended for construction beyond FY 2025 are indicated as such. It is recommended that the City's capital improvement program (CIP) be funded at approximately $920,000 annually for storage, pumping and distribution system piping improvements. While the funding needs for certain water system improvements may exceed this amount, the proposed improvements listed in Table 6-1 are phased and sequenced so that the ultimate 20-year average annual capital requirement is approximately $920,000. Figure 6-1 illustrates the hydraulic profile of the system incorporating existing and proposed reservoirs, pump stations and other features. Capital funding needs for supply source improvements will be dependent upon the selection of a recommended supply source option.

Reservoirs

It is recommended that three new reservoirs be constructed in the water service area and one reservoir be rehabilitated. Table 6-2 presents a summary listing of these recommendations and includes project cost estimates for each reservoir as well as a recommended year to begin project related efforts.

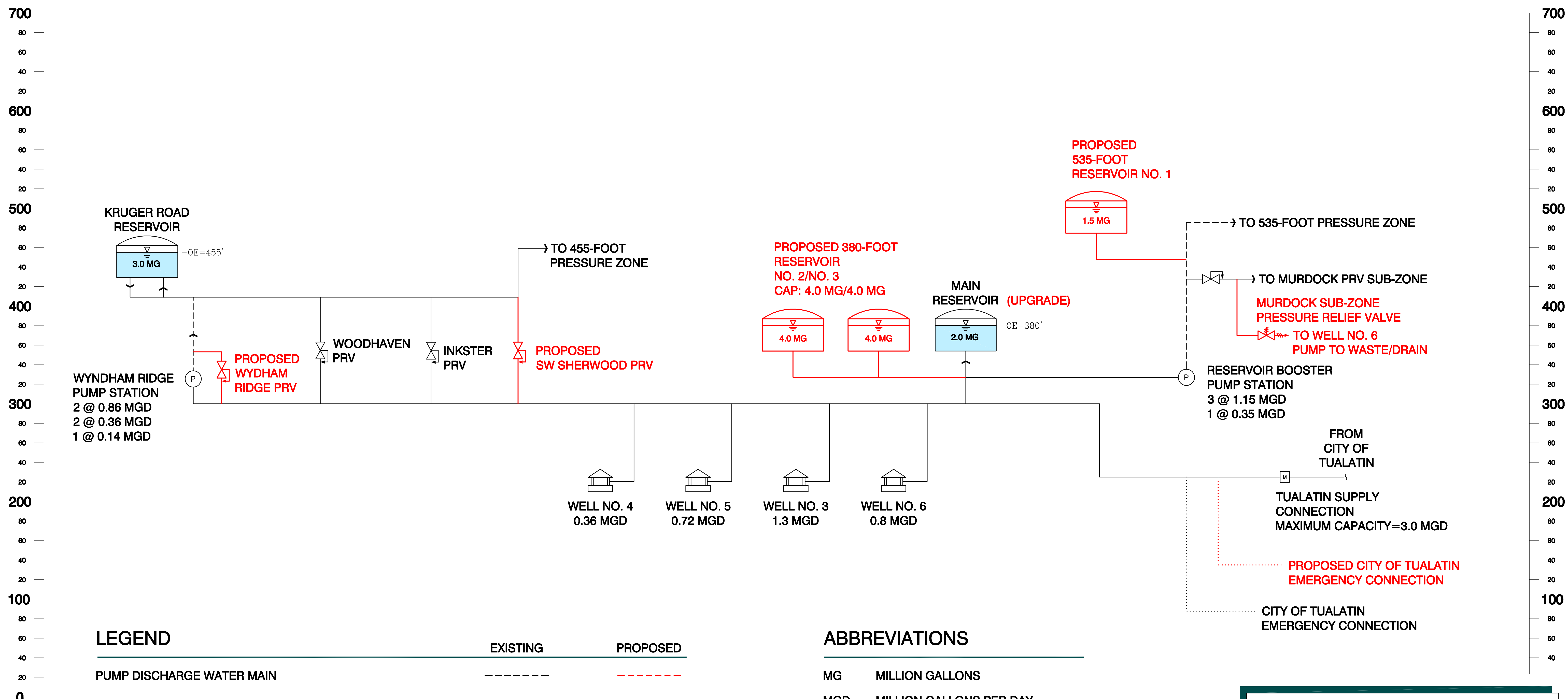
Table 6-2
Recommended Reservoir Improvement Summary

Priority	Project Start (Fiscal Year)	Project Description	Estimated Project Cost
1	2005/2006	Siting Study and Property Needs	$70,000
2	2007/2008	535-Foot Pressure Zone Reservoir No. 1	$2,100,000
3	2009/2010	Main Reservoir Seismic Upgrades	$400,000
4	2012/2013	380-Foot Pressure Zone Reservoir No. 2	$4,700,000
5	Beyond 2025	380-Foot Pressure Zone Reservoir No. 3	$4,600,000
		Total	**$12,050,000**

A brief description and summary of recommended reservoir improvement projects, reservoir siting and property needs evaluations and related programs is presented below. The projects are presented in order of recommended priority of completion.

Siting Study and Property Needs

It is recommended that efforts begin to complete a siting analysis and identify property acquisition needs for the 535-foot pressure zone Reservoir No. 1. It is further recommended that the City explore opportunities to partner with the City of Wilsonville for the acquisition and development of a site that can meet the storage needs of both cities. For the purposes of this planning effort it is recommended that approximately $35,000 be budgeted in FY 2005/2006 and FY 2006/2007 for this purpose. This budget does not include funds for property purchases.



LEGEND

	EXISTING	PROPOSED
PUMP DISCHARGE WATER MAIN		
WATER MAIN		
RESERVOIR (CAPACITY IN MG, OVERFLOW ELEVATION IN FEET)	1.0 MG OE=410'	1.0 MG OE=550'
GROUNDWATER WELL (CAPACITY IN MGD)		
PRESSURE REDUCING OR SUSTAINING VALVE		
PRESSURE RELIEF VALVE		
CLOSED VALVE		
PUMP STATION (NUMBER OF PUMPS AND CAPACITY IN MGD)	P	P
MASTER METER	M	M
DISTRIBUTION SYSTEM EMERGENCY INTERTIES		

ABBREVIATIONS

MG	MILLION GALLONS
MGD	MILLION GALLONS PER DAY
OE	OVERFLOW ELEVATION
PRV	PRESSURE REDUCING VALVE

FIGURE 6-1

City of Sherwood Oregon

Water System Master Plan

WATER DISTRIBUTION SYSTEM HYDRAULIC PROFILE

MARCH 2005

MSA

04-0665.109

535-Foot Pressure Zone Reservoir No. 1

It is recommended that a new 1.5 million gallon reservoir be constructed to serve the 535-foot pressure zone. This reservoir will serve areas presently supplied through constant pressure pumping from the Reservoir Booster Pump Station. Supply to the reservoir will be through the existing Reservoir Booster Pump Station. The recommended overflow of this reservoir is 535 feet. As described above, it is recommended that preliminary siting efforts begin immediately to identify a site and to initiate discussions with the City of Wilsonville regarding joint development of the site and facilities. For the purposes of this study the recommended start for construction activities is identified to occur in FY 2007/2008. The estimated project cost of this reservoir is $2,100,000. This estimate does not include property acquisition costs.

Main Reservoir Seismic Upgrades

It is recommended that seismic upgrades, as described in Section 5 and Appendix G be completed on the City's Main Reservoir. These improvements are necessary to extend the service life of the reservoir until additional storage facilities in the 380-foot pressure zone are constructed. It is anticipated that the Main Reservoir has a remaining service life of approximately 15 years or longer if these improvements are completed. The estimated project cost for the recommended upgrades is approximately $400,000 and the recommended start for construction activities is identified to occur in FY 2009/2010.

380-Foot Reservoir No. 2 and No. 3

The reservoir storage capacity analysis presented in Section 5 found that the 380-foot pressure zone does not have adequate storage capacity to meet anticipated future storage needs. It is recommended that an additional 8.0 million gallons of storage be constructed at Sunset Park. It is currently recommended that additional storage be constructed as two 4.0 million gallon reservoirs. This recommendation should be evaluated as part of preliminary engineering efforts for the 380-foot Reservoir No. 2, with consideration given to Sunset Park planning efforts and site constraints. For the purposes of this study the recommended start for construction activities for Reservoir No. 2 is identified to occur in FY 2012/2013. The estimated project cost of this reservoir is $4,700,000.

It is recommended that Reservoir No. 3 be considered a long-term improvement and as such is identified for construction beyond FY 2025. It is also recommended that this schedule be reevaluated as upgrades and additional investigations are completed to further determine the remaining useful life in the Main Reservoir, and as additional preliminary engineering efforts are completed for the siting of reservoir facilities at Sunset Park. The estimated project cost of this reservoir is $4,600,000.

Pump Stations

It is recommended that two groundwater pump station be upgraded. Recent and planned street improvements near Well No. 4 and Well No. 3 respectively have resulted in the need to upgrade and replacement the existing well house structures at these two wells. These improvements are planned for FY 2005/2006 for Well No. 3 and FY 2006/2007 for Well No. 4. It is anticipated that the schedule for completion of these improvement be reevaluated based on the timing of proposed street improvements. The estimated project cost for well house upgrades at Well No. 3 and Well No. 4 is $448,000 and $490,000, respectively.

As previously discussed it is anticipated that the City's existing groundwater wells will continue to serve as a City supply source until a long-term supply option can be developed and as such, these facilities should be maintained and upgraded.

Distribution System Improvements

General

The analysis found that distribution system water line improvements are needed to provide improved hydraulic transmission capacity within the distribution system, provide for improved fire flow capacities and provide for system expansion needs. For the purpose of this section recommended distribution system improvements are grouped in the following categories:

1. Waterline improvements needed to improve distribution system transmission capacity including improvements associated with planned roadway improvements and improvements related to specific proposed reservoir improvements.

2. Improvements related to improving fire flow capacities.

3. Pressure reducing station improvements.

4. Water main replacement program.

Table 6-1 presents recommended distribution system waterline improvements for each FY up to FY 2025/2026. Each improvement is identified by category and includes an estimated project cost. Certain improvements are recommended for completion within the next two years. These improvements are based on planned roadway improvements and should be coordinated with the roadway construction work. Certain improvements are recommended for completion within the next year. A brief description of these improvements is presented below. A brief summary description of recommended waterline improvements for each pressure zone is also presented below.

Wyndham Ridge Pump Station PRV

It is recommended that a PRV station and associated connection piping be constructed at the Wyndham Ridge Pump Station to serve the 380-foot pressure zone from the Kruger Road Reservoir, or 455-foot pressure zone. This improvement will provide additional hydraulic capacity to the northwesterly portion of the 380-foot pressure zone and will improve fill and draw operations at the Kruger Road Reservoir. It is recommended that this improvement be completed in FY 2005/2006. The estimated project cost of this improvement is approximately $100,000.

Murdock Sub-Zone Pressure Relief

It is recommended that a new pressure relief valve vault be constructed near the intersection of Roy Street and William Avenue. This pressure relief valve will provide protection from over pressurization for the Murdock sub-zone. The discharge for this pressure relief valve should be routed to the pump-to-waste/drain line for the City's Well No. 6 which is approximately 200 linear feet from the intersection. It is recommended that this improvement be completed in 2005/2006. The estimated project cost of this improvement is $71,500.

City of Tualatin Distribution System Intertie

It is recommended that a new distribution system intertie with the City of Tualatin be constructed in the northeast corner of the City. The location of this intertie should be coordinated with the extension of the SW Galbreath Drive waterline to the City limits where an existing City of Tualatin water main serves customers. This intertie could also be located near to Tualatin's proposed "A" level reservoir which is near to Sherwood's northeastern boundary off of SW Tualatin Sherwood Road. It is anticipated that the intertie will be configured to allow for gravity flow from the City of Sherwood's to the City of Tualatin's distribution system and for portable pump connections to supply flow from Tualatin to Sherwood. This improvement should include the construction of a concrete pad for placing a portable pumping unit at the site. It is recommended that this improvement be completed in FY 2005/2006. The estimated project cost for this improvement is $50,000.

380-Foot Pressure Zone

It is recommended that approximately 41,000 lf of distribution system transmission waterline be installed in the 380-foot pressure zone. The analysis found that, in general, the 380-foot pressure zone had adequate capacity to meet existing and projected needs. Improvements recommended in this zone are intended to provide adequate fire flows to areas which are presently inadequate, improve transmission capacity and replace aging waterlines.

445-Foot Pressure Zone

The 445-foot pressure zone has adequate capacity to meet existing and projected needs. No distribution system improvements are recommended for this pressure zone.

535-Foot Pressure Zone

It is recommended that approximately 24,370 lf of distribution system transmission waterline be installed in the 535-foot pressure zone to improve fire flow capacities and to meet future maximum daily and hourly demands.

Water Main Replacement Program

It is recommended that the City continue a waterline replacement program. This program provides for the routine replacement of leaking, damaged and older water mains throughout the water system. In most cases the existing mains have adequate capacity and will be replaced with the same diameter water mains. It is recommended that $25,000 be budgeted annually for this program.

Leak Detection Program

The unaccounted-for water analysis completed in Section 5 found that the City's historical annual average water loss rate for the past few years has been approximately 6 to 7 percent. Water loss prevention and leak detection programs are typically economical when annual water losses regularly exceed 10 percent. The City's current water loss rate is well below this level and a water loss reduction and leak detection program is not recommended at this time. It is recommended that the City continue to monitor its unaccounted-for water, repair leaks, continue ongoing meter testing and replacement programs and continue water main replacement programs as described above.

Supply Source Improvements

The seven supply source options and improvement alternatives identified in Section 5 were reviewed with City staff, City of Sherwood Planning Commission and with City Council as part of a public works session on April 5, 2005. At the conclusion of this process the City Council directed that two options be carried forward for further consideration. A copy of the City Council presentation of April 5, 2005 is provided in Appendix O. Based on this direction it is recommended that the City of Portland supply option and the Willamette River supply option be evaluated outside the scope of this master plan as part of a comprehensive source evaluation and selection program. As part of this evaluation it is recommended that a wide range of information and data be compiled for consideration and review by City policy makers and the citizens of Sherwood. Included in this information should be water quality data cost data and a long-term financial analysis of comparative capital costs and cost of water estimates.

Summary

A summary of all the recommended improvements is presented in Table 6-1. The table provides for prioritized project sequencing by illustrating fiscal year (FY) project needs for each facility or improvement category. Those improvements recommended for construction beyond FY 2025 are indicated as such. It is recommended that the District's capital improvement program (CIP) be funded at approximately $920,000 annually for storage, pumping and distribution system piping improvements.

SECTION 7
FINANCIAL EVALUATION

General

For the purposes of this plan, the financial evaluation presented in this section will analyze the capital needs for completing the distribution system improvements recommended in Section 6. Comprehensive supply source evaluation recommendations in Section 6 include a comprehensive financial analysis of the two selected supply source options.

Evaluation Overview

The purpose of the financial evaluation is to provide reasonable assurance that the City of Sherwood's (City) Water Fund has and will have the financial ability to maintain and operate the water system on an ongoing basis, plus have the financial capacity to obtain sufficient funds to construct the water system improvements identified in Section 6.

As discussed in Section 5, the City has explored the feasibility of several long-term water supply alternatives to meet the City's future water demands. At this point, two water supply options have been selected for further evaluation:

- Supply from the City of Portland (four capital cost scenarios, with varying treatment processes, are under evaluation) – *Preliminary capital cost estimates range from $31.0 to $51.0 million, depending upon the ultimate use and selection of a treatment process and other factors.*

- Supply from the Willamette River Water Treatment Plant in the City of Wilsonville (two capital cost scenarios, with varying transmission routing alternatives, are under evaluation) – *Preliminary capital cost estimates range from $21.6 to $24.5 million, depending upon the transmission routing.*

The ultimate cost of capital and/or water costs under each supply alternative is not currently known, as additional project details and negotiations are ongoing. The cost of water to the City may also be impacted by how needed supply capacity improvements are funded and constructed. For purposes of providing a potential range of impacts within this Section, capital costs for each alternative are amortized over a 20-year period.

As part of this effort, the City planned to have a rate study conducted to include a revenue requirement analysis, cost of service analysis, rate design, and system development charge (SDC) analysis. Since the supply alternatives are currently under evaluation, the cost of service / rate design portions of the study have been deferred until after selection of the supply source. The revenue requirement and SDC analyses have been completed to include the impacts of current operations and the water distribution system improvements identified in Section 6. Potential cost impacts integrating the City' long-term water source and supply decision will be briefly discussed.

In completing this financial evaluation, the historical financial performance of the Water Fund was documented; capital funding options available for water system projects identified; a capital funding strategy for the Capital Improvement Program (CIP) was developed; and revenue requirements and customer impacts considering the "total system" costs of providing water service, operating and capital, were determined. The evaluation includes the following elements:

- ***Past Financial Performance***
    - Comparative Statements of Revenue and Expenses 1999 - 2004
    - Comparative Balance Sheets 2001 - 2004
    - Debt Service Schedules
- ***Funding Sources***
- ***Fiscal Policies***
- ***Capital Financing Plan***
    - 10-year CIP with Revenue Sources 2006 - 2015
    - Total Water Distribution System Projects with Revenue Sources 2006 - 2025
- ***Projected Financial Performance***
    - 10-year Revenue Requirement Forecast 2006 - 2015
- ***Current Rate Structure and Conservation Objectives***

Historical Financial Performance

The primary function of the City's water utility is to provide potable water and irrigation services to the customers of the City of Sherwood at the lowest reasonable price, assuring reliability of source, water quality, storage and distribution.

The historical financial statements presented in the next section clearly show the financial viability of the Water Fund to continue providing a high-quality level of service.

Comparative Financial Statements

Table 7-1 shows a Statement of Revenues, Expenses, and Changes in Net Assets for the Water Fund from 1999-2004. Key points regarding the statement are discussed below.

Table 7-1
Water Fund Revenue, Expense, and Change in Net Asset Statement Summary

WATER FUND	1999	2000	2001	2002	2003	2004
Operating revenues						
Charges for services:						
Utility charges for services	$ 1,076,692	$ 1,263,014	$ 1,196,007	$ 1,285,950	$ 1,539,956	$ 1,711,570
Other charges for services	13,594	13,845	15,564	751	5,983	12,636
Infrastructure development fees:						
System development charges [1]	-	-	-	-	627,424	949,756
Utility connection fees	30,419	57,619	92,722	70,758	44,955	97,495
Other revenue	2,820	1,010	-	-	300	817
Total operating revenues	1,123,525	1,335,488	1,304,293	1,357,459	2,218,618	2,772,274
Operating Expenses						
Materials and Services:						
Professional and technical services	-	-	1,090,740	780,247	720,583	868,450
Facility and equipment	-	-	76,077	71,359	86,649	79,773
Other purchased services	-	-	-	271	19,006	21,476
Supplies	-	-	-	-	112	405
Minor equipment purchases	12,240	-	-	-	-	-
Other materials and services	246,548	311,558	-	6,545	-	13,263
Reimbursements	-	-	-	-	4,615	29,745
Depreciation	185,417	185,417	64,536	64,536	202,657	238,711
Total operating expenses	444,205	496,975	1,231,353	922,958	1,033,622	1,251,823
Operating income (loss)	679,320	838,513	72,940	434,501	1,184,996	1,520,451
Nonoperating revenue (expenses):						
Interest Earnings	50,313	33,863	44,066	45,328	52,076	52,153
Settlement of Litigaton	-	-	825,000	350,000	-	-
Interest expense	-	-	-	-	(4,352)	(3,325)
Payment for debt service	-	-	-	-	(5,692)	(7,935)
Total nonoperating revenue	50,313	33,863	869,066	395,328	42,032	40,893
Income before contributions	729,633	872,376	942,006	829,829	1,227,028	1,561,344
Capital contributions [1]	-	-	389,086	1,830,158	-	482,395
Reclass capital assets between funds		-	-	-	-	141,443
Transfers (to)/from other funds	(1,563,745)	(913,870)	(116,771)	(462,966)	-	-
Fund equity - beginning	712,856	(121,255)	1,811,797	3,026,118	7,027,104	17,832,465
Prior Period Adjustments:						
Capital assets constructed prior years				1,365,416	9,580,680	-
SDC credits from prior years				-	(2,347)	-
Fund equity - ending	$ (121,256)	$ (162,749)	$ 3,026,118	$ 6,588,555	$ 17,832,465	$ 20,017,647

[1] SDC revenues were reclassified as operating revenue in 2003

- Water service revenues have increased over the years, with more significant revenue increases occurring in 2003 and 2004, reflecting City growth, rate increases, and most likely the impact of warm dry summers.

- Operating expenses have remained relatively stable, resulting in the generation of positive net income in all years - although the significantly higher operating income shown in 2003 and 2004 is largely due to the reclassification of SDC revenues from capital contributions to operating income.

- The Water Fund's non-operating results have been very strong in the last several years, mostly due to capital contributions and revenues from settlement of litigation in 2001 and 2002.

Comparative Balance Sheets

Table 7-2 shows the Balance Sheet for the Water Fund 2001-2004. Key points regarding the balance sheets are discussed below:

- The Water Fund's current ratio (current assets divided by current liabilities) has been about 20.0, and ranged between 19.72 to 42.5 (2002). A ratio of 2:1 or higher is generally considered very good. The Water Fund has adequate liquidity as a result of accumulation of cash balances in the operating and capital accounts.
- The Water Fund has carried very little debt, with total debt relative to total assets at less than 2 percent.
- Fund equity (earned equity in the system) is growing at a faster rate than liabilities, which is also an indicator of good financial health. However, most of the equity growth has been from capital contributions and system development charge revenues not the "operating" net income.

Existing Long-term Debt

The City currently has only one outstanding debt obligation for the Water Fund – a Public Works & Fieldhouse loan obtained in 2002. The Water Fund's share of this debt obligation is five (5 %) percent. Table 7-3 shows the Water Fund's share of the outstanding debt service schedule for this loan as of June 30, 2005.

Funding Sources

The City may fund the water capital improvement program from a variety of sources. In general, these sources can be summarized as: 1) governmental grant and loan programs; 2) publicly issued debt (tax-exempt or taxable); and 3) cash resources and revenues. These sources are described below.

Government Programs

Oregon State Safe Drinking Water Financing Program

The Safe Drinking Water Fund is capitalized by annual grants from the U.S. Environmental Protection Agency (EPA) and matched with state resources. The program is managed jointly by the Department of Human Services (Drinking Water Program) and the Economic and Community Development Department (OECDD).

Table 7-2
Water Fund Balance Sheet Summary

WATER FUND	2001	2002	2003	2004
ASSETS				
Current Assets:				
Cash and cash equivalents	$ 1,495,390	$ 1,425,760	$ 1,769,539	$ 3,725,706
Receivables	70,774	544,127	61,311	69,937
Advances from other funds		-	-	274,907
Total current assets	1,566,164	1,969,887	1,830,850	4,070,550
Noncurrent assets:				
Advances from other funds	-	-	1,213,257	663,443
Capital assets:				
Land	15,150	15,150	28,868	30,118
Infrastructure	-	-	10,461,175	15,854,245
Buildings and improvements	1,046,236	1,200,066	1,533,835	45,743
Machinery and equipment	879,641	879,641	881,019	1,154,362
Licensed vehicles	-	-	-	-
Construction work in progress	-	3,041,744	3,445,186	226,528
Less accumulated depreciation	(407,047)	(471,583)	(1,476,446)	(1,818,441)
Total noncurrent assets	1,533,980	4,665,018	16,086,894	16,155,998
Total assets	$ 3,100,144	$ 6,634,905	$ 17,917,744	$ 20,226,548
LIABILITIES AND FUND EQUITY				
Current liabilities:				
Accounts payable	$ 74,026	$ 46,350	$ 81,241	$ 203,941
Other current liabilities	-	-	1,115	2,468
Total current liabilities	74,026	46,350	82,356	206,409
Noncurrent liabilities:				
Other noncurrent liabilities		-	2,923	2,492
Total liabilities	74,026	46,350	85,279	208,901
Fund equity:				
Invested in capital assets	1,533,980	4,665,018	16,086,894	16,155,998
Unrestricted	1,492,138	1,923,537	1,745,571	3,861,649
Total fund equity	3,026,118	6,588,555	17,832,465	20,017,647
Total liabilities and fund equity	$ 3,100,144	$ 6,634,905	$ 17,917,744	$ 20,226,548

Table 7-3
Long-Term Water Fund Debt Summary

Year	2002 Public Works & Fieldhouse Loan		
	Principal	Interest	Total
2005	$ 8,305	$ 3,600	$ 11,905
2006	8,694	3,211	11,905
2007	9,101	2,805	11,906
2008	9,527	2,379	11,906
2009	9,973	1,933	11,906
2010	10,439	1,466	11,905
2011	10,928	978	11,906
2012	11,439	466	11,905
2013	2,943	34	2,977
Totals	**$ 81,349**	**$ 16,872**	**$ 98,221**

The Safe Drinking Water financing program provides low-cost financing for construction and/or improvements of public and private water systems. This is accomplished through two separate programs; Safe Drinking Water Revolving Loan Fund (SDWRLF) for collection, treatment, distribution and related infrastructure, and Drinking Water Protection Loan Fund (DWPLF) for sources of drinking water prior to system intake.

The Safe Drinking Water Revolving Loan Fund (SDWRLF) lends up to $4 million per project—with a possibility of subsidized interest rate and principal forgiveness for a Disadvantaged Community.

The standard loan term is 20 years or the useful life of project assets, whichever is less, and may be extended up to 30 years under SDWRLF for a Disadvantaged Community. Interest rates are 80 percent of the state/local bond rate.

The maximum award for the Drinking Water Protection Loan Fund (DWPLF) is $100,000 per project.

Special Public Works Fund

The Special Public Works Fund program provides funding for the infrastructure that supports job creation in Oregon. Loans and grants are made to eligible public entities for the purpose of studying, designing and building public infrastructure that leads to job creation or retention.

In 2003 the rules for the Special Public Works Fund (Division 42) underwent a dramatic revision. The rules are now broken out into the following major divisions:

- Infrastructure (e.g., public infrastructure needed to support job creation)
- Community Facilities (e.g., publicly owned facilities that supports the local economy)
- Essential Community Facilities Emergency Projects (e.g., city halls, community centers)
- Railroads

Water systems are listed among the eligible infrastructure projects to receive funding. The Special Public Works Fund is comprehensive in terms of the types of project costs that can be financed. As well as actual construction, eligible project costs can include costs incurred in conducting feasibility and other preliminary studies and for the design and construction engineering.

The Fund is primarily a loan program. Grants can be awarded, up to the program limits, based on job creation or on a financial analysis of the applicant's capacity for carrying debt financing.

The total loan amount per project cannot exceed $15 million. The Department is able to offer very attractive interest rates that typically reflect low market rates for very good quality creditors. In addition, the Department absorbs the associated costs of debt issuance thereby saving applicants even more on the overall cost of borrowing. Loans are generally made for 20-year terms, but can be stretched to 25 years under special circumstances.

Water/Wastewater Fund

The Water/Wastewater Fund was created by the Oregon State Legislature in 1993. It was initially capitalized with lottery funds appropriated each biennium and with the sale of state revenue bonds since 1999. The purpose of the program is to provide financing for the design and construction of public infrastructure needed to ensure compliance with the Safe Drinking Water Act or the Clean Water Act.

Eligible activities include reasonable costs for construction improvement or expansion of drinking water, wastewater or storm water systems.

To be eligible a system must have received, or is likely to soon receive, a Notice of Non-Compliance by the appropriate regulatory agency, associated with the Safe Drinking Water Act or the Clean Water Act. Projects also must meet other state or federal water quality statutes and standards.

Criteria include projects that are necessary to ensure that municipal water and wastewater systems comply with the Safe Drinking Water Act or the Clean Water Act.

In addition, other limitations apply including:

- The project must be consistent with the acknowledged local comprehensive plan.
- The municipality will require the installation of meters on all new service connections to any distribution lines that may be included in the project.
- Recipient shall certify that a registered professional engineer will be responsible for the design and construction of the project.

The Fund provides both loans and grants, but it is primarily a loan program. The loan/grant amounts are determined by a financial analysis of the applicant's ability to afford a loan including the following criteria: debt capacity, repayment sources and other factors.

The Water/Wastewater Financing Program's guidelines, project administration, loan terms and interest rates are similar to the Special Public Works Fund program. The maximum loan term is 25 years or the useful life of the infrastructure financed, whichever is less. The maximum loan amount is $15,000,000 per project through a combination of direct and/or bond funded loans.

Loans are generally repaid with utility revenues or voter approved bond issues. A limited tax general obligation pledge may also be required. "Credit worthy" borrowers may be funded through sale of state revenue bonds.

Community Development Block Grant (CDBG)

Since the late 1980's the state of Oregon has administered the U.S. Department of Housing and Urban Development's Community Development Block Grant (CDBG) funds for the non-entitlement cities and counties of the state. The primary objective of the program is the development of viable, livable urban communities by expanding economic opportunities and providing decent housing and a suitable living environment principally for persons of low- and moderate-income. Each year the state develops an annual "Method of Distribution" which establishes how the funds will be used for that calendar year. The Method of Distribution can be found on the department's web site.

Only non-entitlement (non-metropolitan) cities and counties in rural Oregon can apply for and receive grants. Urban (entitlement) cities: Ashland; Bend; Corvallis; Eugene; Medford; Portland; Salem; and Springfield and counties: Clackamas; Multnomah; and Washington are not included in the state's 2005 Community Development Block Grant program because they receive Community Development Block Grant funds directly from the U.S. Department of Housing and Urban Development.

Under the 2005 CDBG Method of Distribution, improvements to water and wastewater systems projects are eligible for funding.

Public Debt

Revenue Bonds

Revenue bonds are commonly used to fund utility capital improvements. The debt is secured by the revenues of the issuing utility and the debt obligation does not extend to other City resources. With this limited commitment, revenue bonds typically require security conditions related to the maintenance of dedicated reserves (a bond reserve) and financial performance measures (added bond debt service coverage). In order to quality to sell revenue bonds, the City must show that the net revenue (less operating and maintenance expense) for the Water Fund (or on a combined basis with other enterprise funds, if applicable) is equal to or greater than a factor, typically 1.2 to 1.4 times the annual revenue bond debt service. This factor is commonly referred to as the coverage factor, and is applicable to revenue bonds sold on the commercial market. There is no bonding limit, except perhaps the practical limit of the utility's ability to generate sufficient revenue to repay the debt and meet other security conditions. In some cases, poor credit might make issuing bonds problematic.

Revenue bonds incur relatively higher interest rates than government programs, but due to the highly competitive nature of the low-interest government loans, revenue bonds are assumed to be a more reliability source of funding. The Water Fund's strong historical financial performance and low debt to equity ratio bodes well for reliance on this form of financing capital projects. To be conservative, the analyses presented herein assume that capital projects above the amount available from rates and cash reserves will be funded with revenue bonds. However, the City should pursue the lower-interest loans for eligible capital projects.

Water Fund Cash Resources and Revenues

Water Fund financial resources available for capital funding include rate funding, cash reserves, and system development charges.

- *Rates and Rate Funding* -- The City has a policy to transfer 12% of annual rate revenue collections to the capital account for direct rate-funding of capital projects. This policy has allowed the Water Fund to maintain a healthy level of capital reserves and reduce the level of debt issued for capital projects.

- *Cash Reserves* -- The Water Fund is projected to end 2005 with $1.9 million in the capital account as cash available for funding capital projects in 2006 and beyond. The reserves are comprised of system development charge revenues, replacement reserves, and interest earnings on available cash balances. Further, as part of the rate study, it is recommended that the City transfer operating account reserves in excess of recommended minimum balances to the capital account at year end for use in funding capital projects in the following years. It is projected that an additional $3.6 million will be available from the operating account to fund capital projects in 2007.

- *System Development Charges* -- The City imposes a system development charge (SDC) on all new connections to the water system. The current charge is $2,960 for a 5/8" meter. Revenues generated from this source are projected at $755,000 for 2006. The SDC has been updated as part of this analysis to reflect existing system development as well as eligible (growth-related) distribution system capital improvements identified in the CIP. Excluding potential water supply capital projects, the analysis indicates that an increase to roughly $3,800 per equivalent 5/8" meter is justified.

  Capital improvements for the water supply alternatives have not been incorporated into the analysis at this time. Under the City of Portland supply alternative, capital costs are not eligible for inclusion in the SDC since the City of Sherwood will not own the capacity / improvements. The capital costs associated with the Willamette River Water alternative are eligible - and it is anticipated that the SDC will increase by several thousand dollars, providing substantial revenues to help fund future capital projects or, most likely, to help pay the annual debt service incurred for funding the supply-related capital improvements.

  The SDC will be finalized following the City's selection of the supply option. A brief overview of the methodology is described below.

System Development Charges

System development charges (SDCs) are legal sources of funding provided through development and growth in customers typically used by utilities to support capital needs. The charge is intended to recover a fair share of the costs of existing and planned facilities that provide capacity to serve new growth.

Oregon Revised Statue (ORS) 223.297 – 223.314 defines SDCs and specifies how they shall be calculated, applied, and accounted for. By statue, an SDC can be constructed to include one or both of the following two components:

- *Reimbursement Fee* – Intended to recover an equitable share of the cost of facilities already constructed or under construction.

- *Improvement Fee* – Intended to recover a fair share of future, planned, capital improvements needed to increase the capacity of the system.

The reimbursement fee methodology must consider such things as the cost of existing facilities and the value of unused capacity in those facilities. The calculation must also ensure that future system users contribute no more than their fair share of existing facilities costs. Reimbursement fee proceeds may be spent on any capital improvements (or debt service repayment) related to the system for which the SDC is applied. For example, water SDCs must be spent on water improvements or water debt service.

The improvement fee methodology must include only the cost of projected capital improvements needed to increase system capacity. In other words, the cost(s) of planned projects that correct existing deficiencies, or do not otherwise increase capacity, may not be included in the improvement fee calculation. Improvement fee proceeds may be spent only on capital improvements (or related debt service), or portions thereof, that increase the capacity of the system for which they were applied.

In general, an SDC is calculated by adding the applicable reimbursement fee component to the applicable improvement fee component. Each separate component is calculated by dividing the eligible cost by the appropriate measure of growth in capacity. The unit of capacity used becomes the basis of the charge. A sample calculation is shown below.

Reimbursement Fee		**Improvement Fee**		**SDC**
Eligible cost of capacity in existing facilities	+	Eligible cost of planned capacity-increasing capital improvements	=	SDC ($ / unit)
Growth in system capacity		Growth in system capacity		

Fiscal Policies

Critical to the long-term financial health and performance of the Water Fund is the development of sound fiscal policies to guide the financial performance of the utility. The key policies incorporated into this financial evaluation include:

- Minimum operating account balance equal to 60 – 75 days of annual operating and maintenance expenses (O&M). Balances in excess of 75 days should be transferred to the capital account at year-end to help fund capital projects.

- Capital contingency reserve equal to at least one (1%) percent of water system plant assets.

- In the short term, continue the City's policy of 12% of annual rate revenues used to directly fund capital projects.

- In the long-term, consider establishing and integrating a system reinvestment strategy for the eventual replacement of deteriorating assets through additional rate funding. Annual depreciation expense can be used as the benchmark for establishing the appropriate level of funding. At a minimum, it is recommended that the annual contribution be based on "net depreciation funding" from rates, which equals the annual depreciation expense less annual debt principal payments. This benchmark is roughly equivalent to "break-even" performance from a balance sheet perspective.

Capital Financing Plan

Funding strategies were developed based on the fiscal policies outlined above, together with the projected level of resources available from rates and charges. Table 7-4 summarizes the 10-year capital funding strategy for the water distribution system capital improvements identified in Section 6. Total capital costs from 2006 through 2015 equal $14.9 million in current dollars. Costs have been escalated annually at 4 percent for a total cost of $18.2 million.

The capital-financing plan evaluates expected capital costs and available resources to determine whether funding for such projects will be required from rates, either to pay debt service or to directly fund capital projects.

As shown in the table, cash funding from rates, capital reserves (system development charge revenues), and revenue bond proceeds of roughly $3.2 million are projected to fund the water distribution system capital projects over the next 10 years. The funding analysis assumes that the City implements a revised SDC, effective in 2007, of at least $3,800 per equivalent 5/8 inch meter.

Table 7-5 shows the total capital projects from 2006 to 2025 and the anticipated funding sources by category. The total capital projects from 2006 through 2025 equal $18.5 million in current dollars and $25.5 million escalated.

Cash funding from rates and system development charge revenues are projected to fully fund the next 10 years (2016-2025) of water distribution system capital projects. No additional revenue bond proceeds are needed above the $3.2 million planned to fund projects through 2015.

It is important to note, that integration of the long-term water supply related capital costs will result in the need for significant additional funding, likely from revenue bonds. As mentioned previously, such costs could range between $21.6 million and $51.0 million, and will likely result in the need for substantial rate increases to pay annual debt service and/or water costs.

Based on a rough order-of-magnitude analysis, incremental debt service costs could range between $2 and $5 million to fund the necessary supply projects. Under the Willamette River Water alternative, SDC revenues will also increase significantly, which could potentially pay a substantial portion of the annual debt service.

Table 7-4
10-Year Capital Funding Strategy Summary

Capital Financing 2006-2015	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Capital Projects - Inflated $										
Growth-Related Capital	$ 266,760	$ 1,073,376	$ 3,627,686	$ 3,162,128	$ -	$ 617,124	$ -	$ 3,216,137	$ 3,344,783	$ -
NonGrowth-Related Capital	578,858	557,024	28,122	222,421	731,549	31,633	594,396	34,214	35,583	113,402
Total Capital Costs	**$ 845,618**	**$ 1,630,400**	**$ 3,655,808**	**$ 3,384,548**	**$ 731,549**	**$ 648,757**	**$ 594,396**	**$ 3,250,351**	**$ 3,380,366**	**$ 113,402**
Funding Sources										
Rates and Capital Reserves	$ 845,618	$ 1,630,400	$ 3,655,808	$ 2,684,257	$ 731,549	$ 648,757	$ 594,396	$ 2,882,195	$ 1,244,050	$ 113,402
Revenue Bond Proceeds	-	-	-	700,291	-	-	-	368,157	2,136,315	-
Total Funding Sources	**$ 845,618**	**$ 1,630,400**	**$ 3,655,808**	**$ 3,384,548**	**$ 731,549**	**$ 648,757**	**$ 594,396**	**$ 3,250,351**	**$ 3,380,366**	**$ 113,402**

Table 7-5
20-Year Capital Funding Strategy Summary

Capital Financing 2006-2025	Total
Capital Projects - Inflated $	
Growth-Related Capital	$ 20,562,269
NonGrowth-Related Capital	4,920,129
Total Capital Costs	**$ 25,482,397**
Funding Sources	
Rates and Capital Reserves	$ 22,277,635
Revenue Bond Proceeds	3,204,763
Total Funding Sources	**$ 25,482,397**

Projected Financial Performance

The projection of financial performance begins with the Water Fund's existing financial condition as a baseline for projecting future costs and estimating the impacts of recommended water system improvements.

Basis for Revenue Requirements

The revenue requirement analysis determines the amount of rate revenue needed in a given year to meet that year's expected financial obligations. Analytically, at least two separate conditions must be satisfied for each year of the analysis period in order for rates to be sufficient: periodic cash needs must be met, and the minimum revenue bond debt service coverage requirement (if any) must be realized.

The cash flow test identifies cash requirements for the Water Fund in the year addressed. Those requirements can include cash operating and maintenance expenses, debt service, directly funded capital outlays, capital transfers, and any projected additions to reserves. The total cash needs are then compared to projected utility revenues. Any projected shortfalls are identified and the level of rate increase necessary to make up the shortfall is estimated.

The coverage test is based on bond covenants applicable to outstanding revenue bonds, which require that a specific test of revenue sufficiency be met. This requirement typically stipulates that annual revenues must be sufficient to meet operating expenses plus a factor multiplied times annual debt service on all revenue bond debt issued. A coverage factor of 1.25 is most common; however, a 1.50 coverage factor may be more appropriate if SDC revenues are to be included in the test.

The City does not currently have any revenue bonds outstanding. Current rates generate sufficient coverage for the proposed $3.2 million in revenue bond proceeds. It is important to note that additional revenue bond issues are expected to be needed to fund the future water supply projects. As such, this test will become an important indicator in determining the ultimate rate needs for the Water Fund.

A number of forecast assumptions are used in the analysis:

- Rate revenue is calculated to increase with growth in future years, which is projected to average 3% per year 2006-2025.

- Operation and maintenance (O&M) expenses are escalated assuming general inflation of 3% per year and labor inflation of 5% per year.

- The City's franchise fee of 5% of rate revenues is applied to projected revenues throughout the analysis period.

- SDC revenues are assumed to increase to at least $3,800 per equivalent 5/8 inch meter in 2007.

- In addition to O&M expenses, the revenue requirements include debt service costs and transfers to the capital account.

- The City's fund interest earnings rate is assumed to be 2% in the next two years then increasing to 3% for the remaining study period.

Table 7-6 summarizes the financial performance and rate requirements for 2006 through 2015.

It is anticipated that rate increases will be needed as the City implements the selected long-term water supply option. The financial evaluation did find that the water fund for recommended distribution system capital improvements is adequate. The actual need for and extent of water rate increases will vary depending on the ultimate selection and timing of a long-term water supply source

As such, the integration of the water supply capital projects and related annual costs into the revenue requirement analysis may result in the need for significant rate increases. Fortunately, the City's current water rates are relatively low, thereby providing some tolerance for these increases while maintaining affordable rates for the City's customers.

Rate Structure and Conservation Objectives

The City's water rate structure consists of a monthly base rate, which includes the first 100 gallons of water usage, plus a two-tiered volume charge for residential customers and a single block volume charge for commercial customers. The base rate increases with the size of the water meter. Tables 7-7 presents a summary of this information.

After evaluation of the customer data, the findings were that approximately 83% of residential water use falls within the first block of water use. The second block is not significantly utilized, and thus is relatively weak in sending appropriate pricing signals for promoting conservation.

Following selection of the long-term water supply alternative, the City intends to update the rate study, which will include a comprehensive cost of service analysis to equitably assign costs to customers based on their demands, and a rate structure evaluation to better align the water rate structure with conservation incentives and other City goals.

Table 7-6
Revenue Requirement Summary

Revenue Requirement Summary	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Revenues										
Rate Revenues Under Existing Rates	$ 1,569,800	$ 1,628,270	$ 1,688,918	$ 1,751,824	$ 1,817,074	$ 1,873,939	$ 1,932,583	$ 1,993,063	$ 2,055,435	$ 2,119,760
Use of SDC Revenues for Debt Service	11,905	11,906	11,906	80,290	80,289	80,290	80,289	107,312	312,949	312,949
Non-Rate Revenues	110,000	67,390	72,518	75,162	79,953	82,380	84,883	87,463	91,203	100,205
Total Revenues	**$ 1,691,705**	**$ 1,707,566**	**$ 1,773,342**	**$ 1,907,276**	**$ 1,977,316**	**$ 2,036,609**	**$ 2,097,755**	**$ 2,187,839**	**$ 2,459,587**	**$ 2,532,914**
Expenses										
Operating & Maintenance Expenses	$ 1,333,010	$ 1,373,569	$ 1,415,366	$ 1,458,439	$ 1,502,827	$ 1,548,029	$ 1,594,592	$ 1,642,555	$ 1,691,960	$ 1,742,852
Routine Capital/Transfers to Capital Fund	218,376	226,292	234,497	243,001	251,814	259,651	267,732	276,064	284,655	293,514
Existing Debt Service	11,905	11,906	11,906	11,906	11,905	11,906	11,905	2,977	-	-
New Debt Service	-	-	-	68,384	68,384	68,384	68,384	104,335	312,949	312,949
Total Expenses	**$ 1,563,291**	**$ 1,611,768**	**$ 1,661,769**	**$ 1,781,730**	**$ 1,834,930**	**$ 1,887,971**	**$ 1,942,612**	**$ 2,025,931**	**$ 2,289,565**	**$ 2,349,316**
Annual Surplus / (Deficiency)	**$ 128,414**	**$ 95,799**	**$ 111,573**	**$ 125,546**	**$ 142,386**	**$ 148,639**	**$ 155,143**	**$ 161,908**	**$ 170,023**	**$ 183,599**
Annual Rate Increase	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**
Cumulative Rate Increase	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

Table 7-7
Current Water Rate Summary

Base Charge [a]

Meter Size	$ / Month
5/8"	$ 4.78
1"	5.91
1 1/2"	10.50
2"	15.28
3"	30.74
4"	52.52
6"	109.04
8"	201.83
10"	291.46

Volume Charge

Usage Block - gallons	$ / 100 gallons
Residential	
101 to 21,000	$ 0.240
Over 21,000	$ 0.370
Commercial	
Over 100	$ 0.260

[a] includes allowance 100 gallons

Water Fireline Charge

Line Size	$ / Month
4"	$ 11.47
6"	21.97
8"	32.95
10"	46.90

Affordability Test

A median household income index analysis is one way to gauge rate level affordability. To complete the test, residential water bills are compared to 1.5% of median household income for the analysis period. This analysis provides an indication of a residential connection's ability to pay the existing and projected rates. If rates exceed 1.5% of the median household income in any of the years, it suggests the system's rates may not be affordable.

The 2000 Census data shows that the median household income for the City of Sherwood in 1999 was $62,518. This amount inflated at historical and projected inflation rates (Portland-Salem CPI Urban Wage Earners and Clerical Workers) is equivalent to about $72,225 in 2006. One and a half percent of this amount is about $1083.38 annually or a maximum monthly water bill of $90.28 in 2006.

The City's average residential water monthly use is about 7,700 gallons. This results in an average residential water bill of $23.02 under existing rates, indicating that the City's water rates are currently well within the medium household income affordability index. We expect that, even given the significant impact of the water supply capital projects, the City's water rates will remain affordable to customers.

Summary

This section presented a financial evaluation of the capital funding needs of the recommendations presented in Section 6. The analysis found that in general, revenues are adequate to meet funding needs. This analysis does not include evaluation of the financial impacts of the development of a long-term water supply option. This element of the analysis will be completed as part of the selection of the long-term water supply option.

MSA

APPENDIX A

APPENDIX A
REFERENCES

Ameen, Joseph H., *Community Water System Source Book*, Fifth Edition, Technical Proceedings, 1971.

Aquifer Storage and Recovery (ASR) Phase I – Program Evaluation and Development, City of Sherwood, Oregon, Murray, Smith % Associates, Inc., 2001.

Cesario, Lee, *Modeling, Analysis and Design of Water Distribution Systems*, American Water Works Association, 1995.

Distribution Network Analysis for Water Utilities, Manual M32, First Edition, American Water Works Association, 1989.

Implementation Plan for the Formation of a Proposed Bull Run Drinking Water Agency – Phase II, Murray, Smith & Associates, Inc., 2002.

APPENDIX B

ORIGINAL

INTERGOVERNMENTAL AGREEMENT

THIS INTERGOVERNMENTAL AGREEMENT is effective this 2nd day of October, 2000, by and between Tualatin Valley Water District ("TVWD"), a domestic supply water district organized pursuant to ORS Chapter 264 and the City of Sherwood ("Sherwood"), a municipal corporation organized under the laws of the State of Oregon.

RECITALS

Sherwood owns, operates, and maintains a municipal water supply system consisting of wells, storage tanks, transmission and distribution systems. Sherwood and TVWD wish to enter into an agreement whereby TVWD will provide ongoing administration, operation, maintenance, repair and replacement of Sherwood's system, including securing other supply sources for Sherwood for the term of this agreement and for the consideration hereinafter stated.

The parties have the power to contract with each other in the performance of these services pursuant to ORS Chapter 190.003 through 190.030, and the City's Charter.

NOW, THEREFORE, the parties agree as follows:

1. Services to be Provided.

TVWD, for the consideration hereinafter set forth, agrees to provide:

A. **Supply.** TVWD will supply and manage Sherwood's system to provide water from any combination of Sherwood's wells, City of Portland, aquifer storage and recovery, or other sources available to TVWD. TVWD will obtain the consent of the cities of Portland and Tualatin for use of City of Portland water. TVWD will primarily rely upon Sherwood's wells giving due consideration to impacts on the ground water resource. Applicable commodity or wheeling charges under TVWD agreements with the cities of Portland and Tualatin will be charged to Sherwood in addition to the other payments for services rendered.

(1) Curtailment. Where TVWD supplies water from its sources, Sherwood residents will be treated as TVWD retail customers during any curtailment so that they will be reduced just as any other TVWD customer. TVWD will use Sherwood wells in conjunction with TVWD sources so that curtailment does not occur in Sherwood or is minimized.

(2) Water Quality. Water quality shall be provided to Safe Drinking Water Act (SDWA) standards.

(3) Willamette River. During the term of this contract, TVWD will not use the Willamette River as a source of water to serve the needs of Sherwood.

B. **Management of Regulatory Matters.**

(1) Water quality testing. TVWD will provide water quality sampling, testing, monitoring, and reporting according to SDWA and the Oregon Health Division (OHD) statutes, rules and regulations for municipal entities of Sherwood's size.

(2) TVWD will provide all regulatory interface with the Oregon Water Resources Department and other regulatory agencies on behalf of Sherwood.

(3) TVWD will develop a wellhead protection program in partnership with Sherwood.

C. **Backflow/Cross Connection Control Program.** TVWD will provide an ordinance for City adoption and assist in the establishment of a backflow/cross-connection control program. District staff will provide survey, notification, testing, and enforcement of backflow prevention devices.

D. **Mapping**. Sherwood will provide all available maps, drawings, as-builts, AUTOCADS and other information to enable TVWD to develop a mapping system compatible with TVWD's information system. In the ordinary course and schedule of TVWD business, TVWD will upgrade City mapping periodically.

E. **Billing**. TVWD will assume all billing and collection functions, including management of any existing agreements Sherwood may have for meter reading and other billing and collection services.

(1) TVWD will include the Sherwood water billings as part of a combined bill with the Unified Sewerage Agency.

(2) Sherwood may include a newsletter to citizens to be included in customer bills so long as it does not increase postage cost for a typical bill. If so, Sherwood must pay the additional postage or send it separately.

F. **Public Relations and Media**. TVWD will provide public relations and media services related to water, including school outreach programs.

G. **Council/City Staff Meetings.**

(1) District representatives familiar with Sherwood's system and familiar with current issues of interest to Sherwood will attend council meetings as required by Sherwood, but not less often than quarterly.

(2) The General Manager or his designee will meet with the Sherwood City Manager or his designee monthly to review water service issues.

(3) TVWD will provide such written reports as requested by Sherwood for inclusion in Council packets or for other City departments.

(4) Once each year the TVWD Board of Commissioners will hold a joint dinner meeting with the Sherwood City Council to review water service issues.

H. **Off Hours/Callouts/Emergencies.** TVWD will designate employees for off hours/callouts. TVWD will keep records of calls and, after one year, the contract may be renegotiated depending upon the volume and type of calls. Sherwood shall make personnel available in emergency events as requested by TVWD.

I. **Water Management Plan/Conservation.**

(1) In conjunction with City staff, TVWD will oversee the implementation and updating of the City's Water Management Plan and Conservation Plan with the Water Resources Department, the Water Master Plan with the Oregon Health Division and represent Sherwood at regional water providers consortium and conservation meetings.

(2) TVWD will perform water audits and leak detection, as necessary.

J. **System Operation and Maintenance.** TVWD will operate and maintain Sherwood's system, which consists of wells, reservoirs, piping, booster stations, services and meters.

(1) TVWD will install services and meters for new developments and repairs as needed in accordance with TVWD's standards.

(2) Sherwood will adopt TVWD's standards for construction as part of its City ordinances or as deemed appropriate by Sherwood and its legal counsel.

(3) TVWD will develop maintenance schedules consistent with prudent water utility practices.

(4) TVWD will be responsible for service requests and account inquiries.

K. **Capital Improvement.** Sherwood will be responsible to budget and appropriate money for capital improvements. Failure to adequately budget and appropriate will cause the scope of services to be reduced appropriately.

(1) Capital improvements shall be made according to Sherwood's Capital Improvement Plan and timing reasonably designated by Sherwood.

(2) TVWD will manage the Capital Improvement Program.

(3) All Capital Improvements shall be constructed according to TVWD construction standards.

(4) TVWD will manage the City's current water-related Capital Projects including: Kruger Reservoir and Acquifer Storage and Recovery (ASR).

(5) When a City Project involves an incidental water system improvement, the City may elect to include the improvement in its overall non-water project. In this case, the City will obtain TVWD review and coordinate with TVWD in meeting the provisions of this agreement. The associated costs will be borne by the City directly unless other arrangements have been made.

L. **Budget**. According to a schedule developed by Sherwood, TVWD will provide a draft budget for water services by January 31st of each year. Sherwood will then use that budget as the starting point for its budget processes. The scope of services will be adjusted accordingly, depending upon Sherwood's budget choices.

M. **Telemetry**. TVWD will manage, maintain, and upgrade, as necessary, the existing telemetry system. TVWD will interface with Sherwood's system. Sherwood will determine what expenditures to make to achieve that interface. Sherwood will be responsible for maintaining its telemetry radio license. TVWD will notify Sherwood when license renewal is required.

N. **Planning**. Sherwood will provide information and cooperate with TVWD to determine ultimate demand needs and water system planning in that regard.

O. **Activities in Sherwood's Right-of-Way.**

(1) Sherwood will not charge TVWD for any right-of-way permit fee for projects benefiting Sherwood.

(2) TVWD will seek the appropriate permits prior to working in Sherwood's right-of-way.

P. **Pay Stations**. Sherwood will designate publicly accessible location(s) for pay stations, which shall include City Hall and the Senior Center.

Q. **Consumer Confidence Reports**. TVWD will prepare Consumer Confidence Reports on behalf of Sherwood, commencing with the report due June 30, 2001.

R. **Landscape** and other facility maintenance at City water sites will be performed by TVWD, excepting for the reservoir located at Sydner Park where TVWD will be responsible for only the reservoir and booster station.

S. **New Development.**

(1). TVWD will review and provide comments to Sherwood on development applications. These comments will be provided within the timelines set in current land use statutes.

(2) TVWD will provide the review and approval of engineering plans for additions or modifications to Sherwood's water system.

(3) TVWD will provide inspection and final acceptance of additions and modifications to Sherwood's water system.

T. **Designated Representatives**. Sherwood and TVWD shall each designate, in writing, a person responsible for maintaining daily contact and interface of the parties.

U. **Field Office**. Sherwood shall provide an office in its public works building for the purpose of housing water system related files, the SCADA system and water system maps. The office space shall also be available for use by TVWD staff.

2. Payment by Sherwood.

In exchange for the services provided above by TVWD, Sherwood agrees to pay monthly upon invoice TVWD's actual cost of service for labor, materials and equipment, according to equipment rates adopted by TVWD and the actual cost of providing TVWD employees at their normal hourly rates, including indirect expenses, overhead, and benefits. In addition, Sherwood shall pay, upon invoice, the cost of non-Sherwood water and all costs of delivery. If TVWD determines that work would be better performed by outside contractors, TVWD shall contract for the work with the charges allocated to Sherwood. These charges shall be itemized and sent to Sherwood. Upon receipt, Sherwood shall authorize the payment of these expenses and costs and payment shall be made within 30 days following receipt of the statement. Sherwood dues for regional water activities shall be paid by TVWD and invoiced as an expense to Sherwood.

3. Term of the Agreement.

The term of this Agreement shall be for five years commencing October 2, 2000, and ending September 30, 2005, unless the Agreement is terminated for default. By mutual agreement, the contract may be renewed for two additional terms of five years each. Notice of renewal by each party must be given one year in advance of the termination date.

4. Employees & Equipment.

The parties agree that TVWD requires additional employees and equipment to manage, operate, and maintain Sherwood's water system. The parties agree that those positions and corresponding persons set forth on Exhibit A, attached hereto and incorporated by reference, shall be transferred from Sherwood to TVWD and TVWD will accept those individuals as District employees with salaries and benefits in accordance with ORS 236.610. These employees will be incorporated into TVWD's work force and assigned by TVWD to best to fit the needs of the District. If the contract terminates, the persons in the positions set forth in Exhibit A will be returned to the City in accordance with ORS 236.640. The parties further agree that the equipment set forth in Exhibit B, attached hereto and incorporated by reference shall be transferred from Sherwood to TVWD at no cost to TVWD. If the contract terminates, the equipment set forth in Exhibit B will be returned to the City in the as-is condition.

5. **Indemnity.**

To the extent permitted by Oregon law, each party agrees to indemnify and hold harmless the other, its governing body, officers, agents and employees from any and all claims, demands, damages, or liabilities of any type, including attorney's fees and costs of defense, arising solely out of the negligent act of that party. Further, the City hereby specifically assumes and agrees to pay any and all damages, judgments, costs, or settlements arising out of the pending litigation in the case of *Aurora Engineering, Inc. v. City of Sherwood, et al.*, USDC Case No. CV 991236KI and any related case.

6. **Insurance.**

Each party shall provide general liability, workers compensation and employers liability insurance in an amount not less than the monetary limits of the Oregon Tort Claims Act. Sherwood shall maintain property damage insurance on its water facilities.

7. **Notice.**

All notices and communications in connection with this Agreement shall be given in writing to:

General Manager
Tualatin Valley Water District
P.O. Box 745
Beaverton, Oregon 97075

City Manager
City of Sherwood
20 N.W. Washington Street
Sherwood, Oregon 97140

8. **Termination.**

In the event of a default or other breach of this agreement, the non-defaulting party may give written notice of termination of the agreement upon 30 days' written notice to the other party. In the event of termination, the parties shall cooperate and assist in an orderly transition of functions back to Sherwood. This agreement will terminate on the effective date of annexation of the City to TVWD pursuant to paragraph 16.

9. **Default.**

A default shall occur under this agreement if either party breaches its obligations hereunder. If the defaulting party does not remedy or commence to diligently remedy following 30 days' written notice, then the non-defaulting party may terminate the agreement and the parties shall engage in an orderly transition.

10. **Attorney's Fees.**

In the event of any suit or action to enforce the provisions of this Agreement, the parties agree the prevailing party shall receive from the other party such as the trial court may adjudge reasonable as attorney's fees to be allowed in said suit or action, and if an appeal is taken, any judgment or decree of such trial court, the parties further agree to pay such sum as the appellate court shall adjudge reasonable as prevailing party and attorney's fees on such appeal.

11. **Disputes.** If a dispute arises between the parties regarding breach of this Agreement or interpretation of any term of this Agreement, the parties shall first attempt to resolve the dispute by negotiation, followed by mediation, if negotiation fails to resolve the dispute.

Step One: (Negotiation)
Each of the disputing parties shall appoint a person to negotiate on behalf of the entity. The nature of the dispute shall be reduced to writing by the party alleging breach or seeking interpretation and shall be presented to each designated person who shall then meet and attempt to resolve the issue. If the dispute is resolved at this step, there shall be a written determination of such resolution, signed by each designated person and ratified by his or her respective Board/Council, which shall be binding upon the parties.

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

Step Three: (Litigation)
If the parties are unsuccessful at Steps One and Two, the dispute shall be resolved in the Circuit Court of the State of Oregon for the County of Washington. Upon breach of this Agreement, the nondefaulting party shall be entitled to all legal or equitable remedies available at law, including injunction, declaratory judgment, specific performance or termination.

12. **Successors and Assigns.**

All the terms and provisions contained herein shall inure to the benefit of and shall be binding upon the parties hereto and the respective legal representatives, successors, and assigns.

13. **Entire Agreement.**

This Agreement embodies the entire agreement and understanding between the parties hereto and supersedes all prior agreements and understandings relating to the subject matter hereof.

14. Assignment.

This Agreement is binding on the heirs, successors, and assigns of the parties hereto. This Agreement may not be assigned by either party without prior written consent of the other.

15. Severability.

The invalidity of any section, clause, sentence, or provision of this agreement shall not effect the validity of any other part of this agreement, which can be given effect without such invalid part or parts.

16. Annexation.

Upon mutual agreement, the City and TVWD will pass the necessary resolutions and annex to the District. The annexation will be effective at the beginning of the next succeeding fiscal year. If the parties determine to go forward with annexation, an annexation agreement detailing the transfer of liabilities, assets, debt distribution plans, employee matters and the like will be negotiated and executed.

IN WITNESS WHEREOF, the parties have, pursuant to official action of their respective governing bodies, duly authorizing the same, caused their respective officers to execute this instrument on their behalf.

CITY OF SHERWOOD

By:______________________
John N. Morgan, City Manager

Attest______________________
City Recorder

TUALATIN VALLEY WATER DISTRICT

By:______________________
Greg DiLoreto, General Manager

By:______________________
Legal Counsel

Exhibit A

Pursuant to Section 4 of this Agreement, the following persons shall be transferred from Sherwood to TVWD, and TVWD will accept these individuals as District employees pursuant to ORS 236.610.

Special Projects Manager, Lee Weislogel
Utility Billing Clerk, Michelle Caldwell
Utility Services Worker I, Jason Reed
Utility Services Worker I, Paul Visser

Exhibit B

Pursuant to Section 4 of this Agreement, the City of Sherwood agrees to provide the following equipment and materials for use by TVWD.

3	Tapping machines and accessories
All	Hydrant "gut wretches"
All	Waterworks materials currently owned by the City of Sherwood and used for the construction, operation and maintenance of the City's water system.
1	Portable Water Quality Testing Lab

D-2C

EXHIBIT "B"

Original Capital Outlay (Phase 1 & 2) 1981	4,769,102
Cost of capital outlay in 2000 $	8,379,724.33
Useful Life of asset (years)	40
Return on Capital	8.00%
Annualized cost of capital	$702,725
Projected Sherwood's water use (ccf) for FY 00-01	974,633
Projected Tualatin's water use (ccf) for FY 00-01	2,241,656
Projected Sherwood's TPWL usage %	30.30%
Projected Tualatin's TPWL usage %	69.70%
Annualized cost of capital for FY 00-01	702,725
Estimated annual O&M for FY 00-01	11,000
Total Annual Expenditure for line for FY 00-01	713,725
Sherwood's Share	216,280
Tualatin's Share	497,445
Per ccf cost (Sherwood)	0.22
Per ccf cost (Tualatin)	0.22
Based on Seattle Construction Cost Index	
Dec 1980 (3909.16) and Dec 1981 (4230.36) averaged	4069.76
March 2000	7150.92
	1.757086413

APPENDIX C


LEGEND
CITY OF SHERWOOD CITY LIMITS
URBAN GROWTH BOUNDARY
GROUND ELEVATION CONTOUR (FEET)
WASHINGTON/CLACKAMAS COUNTY LINE
PRESSURE ZONE SERVICE LIMITS FOR THE 380 FT PRESSURE ZONE
PRESSURE ZONE SERVICE LIMITS FOR THE 455 FT PRESSURE ZONE
PRESSURE ZONE SERVICE LIMITS FOR THE 535 FT PRESSURE ZONE
URBAN GROWTH BOUNDARY EXPANSION AREAS
EXISTING PRESSURE ZONE BOUNDARY
EXISTING FACILITIES
EXISTING WATER MAIN (DIAMETER IN INCHES INDICATED)
RESERVOIR CAPACITY (MILLION GALLONS) OVERFLOW ELEVATION (FEET)
PUMP STATION
PRESSURE REDUCING/FLOW CONTROL VALVE
CLOSED VALVE
MASTER METER
INTERTIE
GROUNDWATER WELL
PROPOSED FACILITIES
WATER MAIN (DIAMETER IN INCHES INDICATED)
WATER MAIN - REPLACING EXISTING MAIN (DIAMETER IN INCHES INDICATED)
RESERVOIR CAPACITY (MILLION GALLONS) OVERFLOW ELEVATION (FEET)
PUMP STATION
PRESSURE REDUCING/FLOW CONTROL VALVE
CLOSED VALVE
INTERTIE
ABBREVIATIONS
MG MILLION GALLONS
OE OVERFLOW ELEVATION
GPM GALLONS PER MINUTE
CAP CAPACITY
UGB URBAN GROWTH BOUNDARY
CITY OF SHERWOOD
TUALATIN
CITY OF TUALATIN SUPPLY CONNECTION
PROPOSED CITY OF TUALATIN EMERGENCY INTERTIE
EXISTING CITY OF TUALATIN EMERGENCY INTERTIE
EXISTING SPADA WELL
UGB EXPANSION AREA
POWER EASEMENT
BONNEVILLE POWER
SW ROY ROGERS RD
SW EDY RD
SW TUALATIN-SHERWOOD RD
PACIFIC HIGHWAY 99W
CEDAR CREEK
NE OREGON ST
N SHERWOOD BLVD
NW MEINECKE RD
SW SUNSET BLVD
SW KRUGER RD
BAKER RD
WYNDHAM RIDGE PUMP STATION
PROPOSED WYNHAM RIDGE PRV
WELL NO. 4
WELL NO. 3
WELL NO. 5
WELL NO. 6
OREGON ST PRV (CITY OF PORTLAND SUPPLY THROUGH TUALATIN)
PROPOSED MURDOCK SUB ZONE PRESSURE RELIEF
MAIN RESERVOIR CAP: 2.0MG OE: 380' (UPGRADE/ABANDON)
PROPOSED 380-FOOT PRESSURE ZONE RESERVOIR NO. 2 / NO. 3 CAP: 4.0MG / 4.0MG
RESERVOIR BOOSTER PUMP STATION
MURDOCK PRV
EXISTING MURDOCK SUB ZONE 400' HGL SERVICE
WOODHAVEN PRV
INKSTER PRV
PROPOSED SOUTHWEST SHERWOOD PRV
KRUGER ROAD RESERVOIR CAP: 3.0MG OE: 455'
WASHINGTON COUNTY
CLACKAMAS COUNTY
PROPOSED RESERVOIR SITING EVALUATION AREA
PROPOSED 535-FOOT PRESSURE ZONE RESERVOIR NO. 1 CAP: 2.0MG
SW TOOZE RD
1"=1600'
400 200 0 400 800
1 INCH = 400 FEET
PLATE 1
City of Sherwood Oregon
WATER SYSTEM MASTER PLAN
SYSTEM PLAN MAP
MSA Murray, Smith & Associates, Inc. Engineers/Planners
AUGUST 2005

APPENDIX D

Groundwater Solutions, Inc.
55 SW Yamhill Street, Suite 400 Portland, Oregon 97204
ph: 503.239.8799 fx: 503.239.8940 e: groundwatersolutions.com

TECHNICAL MEMORANDUM

City of Sherwood Groundwater Supply Evaluation

PREPARED FOR: Chris Uber, PE - Murray, Smith, & Associates
Brian Ginter, PE - Murray, Smith, & Associates

PREPARED BY: Ted Ressler - Groundwater Solutions, Inc.
Walter Burt, RG - Groundwater Solutions, Inc.

DATE: February 15, 2005

REGISTERED PROFESSIONAL OREGON WALTER C BURT G1402 GEOLOGIST
Walter C. B
Expires 08/31/05

Introduction

This memorandum presents Groundwater Solutions, Inc.'s (GSI) hydrogeologic evaluation of the City of Sherwood's (City) municipal well field and an assessment of the role of groundwater sources in meeting projected future water supply demands of the City. It is our understanding that the City is evaluating its current water system and production well field capacity to meet anticipated water supply needs.

The primary municipal water supply source for the City is groundwater produced from the aquifer hosted by basalt lava flows of the Columbia River Basalt Group (CRBG) using four production wells, Wells 3, 4, 5 and 6 (Figure 1). The overall short-term capacity of the City's well field is approximately 2,240 gallons per minute (gpm). The City holds approximately 596 gpm of undeveloped capacity on existing groundwater right permits. The City also utilizes Bull Run source water from the City of Portland via the City of Tualatin connection as a backup source. The City recently has purchased up to 3 MGD from the supply source to supplement groundwater supplies during peak demand periods. The need to augment the City's supply with an outside water source is increased in part due to constraints on how the City can operate Well 5 and Well 6. The operational rate of Well 5 recently has been reduced from approximately 550 gpm to 450 gpm because of the presence of gas exsolving from water produced in the well when pumped at rates greater than about 500 gpm. The gas has tentatively been identified as carbon dioxide. Even though the well and aquifer are capable of producing much higher rates, the operating rate of Well 6 is 550 gpm because Oregon Water Resources imposed a rate limitation on the groundwater right permit for the well since the CRBG aquifer in the area encompassing the City was designated a Groundwater Limited Area. In addition, the well produces water with high total dissolved solids (TDS), which limits the duration the City can pump the well without receiving complaints from customers.

Peak demands experienced by the City exceed the current capacity of the groundwater system, and demand is projected to continue to grow due to extensive development within the service area. Thus, the long-term goal of the City is to develop sufficient source capacity of good quality to reliably meet current and future anticipated demands. In doing so, the City also has a vested interested in fully developing unused capacity on existing water rights permits to retain the water rights into the future while utilizing the well field in a sustainable manner to ensure long-term viability of the groundwater supply.

The evaluation summarized in this memorandum is an element of an overall water master plan being completed on behalf of the City by MSA. The purpose of this evaluation is to assess the potential capacity and limitations of the City's groundwater source, and thus map out options for the role groundwater will play in the overall long-term water supply picture for the City. The objectives include the following:

1. Assess peak and long-term limitations to the capacity of the City's well field due to long-term sustainable yield constraints in the CRBG aquifer.
2. Identify options for increasing the capacity of the well field and identify advantages and disadvantages of the options.
3. Identify options for fully utilizing undeveloped capacity on existing groundwater right permits to protect the full extent of these rights in the future.

This evaluation included the following work elements:

1. Review of the hydrogeologic setting of the City's well field;
2. Pumping test of Well 5 to evaluate aquifer continuity and boundary conditions;
3. Analysis of recent and historical water level trends and groundwater withdrawals;
4. Assessment of well improvement options for increasing or maintaining the capacity of individual production wells.
5. Development of general options available to the City for future groundwater usage.

These work elements are summarized in the following sections.

Hydrogeologic Setting

The following discussion of the regional geology and hydrogeology of the area is based on information from a detailed geologic and hydrogeologic study of the region surrounding the city completed by the Oregon Water Resources Department (OWRD) (Miller et al., 1994) and previous well field and hydrogeologic assessments completed on behalf of the City (Squier, 1999 and MSA, 2001).

The City is located within the Tualatin River Valley, approximately 20 miles southwest of the Portland metropolitan area (Figure 1). The general geologic section in the vicinity of the City consists of unconsolidated alluvial sediments overlying Tertiary volcanic and marine sedimentary rocks. The unconsolidated alluvial sediments, consisting of sand, silt, clay, and gravel, increase in thickness toward the center of the valley near the Tualatin River, and may be as thick as 200 feet. The thickness of the alluvial sediments increases to as much as 700 feet towards the east, in the vicinity of the city of Tualatin. Underlying the unconsolidated alluvial sediments is a thick sequence of basalt lava flows known as the Columbia River Basalt Group (CRBG). The CRBG consist of a series of basalt flows that erupted from now inactive vents near the Oregon-Idaho border. In the vicinity of the City, the CRBG is at least 950 feet thick (based on the lithologic log from Sherwood Well 6). The individual flows of basalt comprising the CRBG have lithologic and hydraulic differences in regards to groundwater occurrence and productivity. Table 1 presents a summary of the individual units making up CRBG present in the City's well field. Each unit may consist of one or more individual flows.

Underlying the CRBG are consolidated marine sedimentary rocks consisting of siltstone, sandstone, and claystone. The marine sedimentary rocks were encountered at a depth of 1,014 feet in City Well 6. Thin sequences of alluvial sediments representing paleodrainage features that predate the CRBG are locally present on the surface of the marine sediments. These features influenced emplacement of the early basalt flows of the CRBG and the water-bearing characteristics of the flows.

Table 1
Flow units of the Columbia River Basalt Group
City of Sherwood

Flow Unit (Formation)	*CRBG Units Penetrated by City Production Wells*			
	Well 3	*Well 4*	*Well 5*	*Well 6*
Gingko Unit (Wanapum Fm)	✓			
Sentinel Bluffs (Grande Ronde Fm)	✓			✓
Winter Water (Grande Ronde Fm)	✓	✓	✓	✓
Ortley (Grande Ronde Fm)		✓	✓	✓
Umtanum (Grande Ronde Fm)		✓	✓	✓
Grouse Creek (Grande Ronde Fm)		✓	✓	✓
Wapshilla Ridge (Grande Ronde Fm)			✓	✓
Downey Gulch/Mt. Horrible (Grande Ronde Fm)				✓

The primary groundwater resource in the vicinity of the City is the CRBG. Well 3 also is open to approximately 15 feet of sandstone overlying the CRBG; however, the relative contribution of water from these sediments is unknown. Groundwater within the CRBG is most abundant in the interflow zones between the individual basalt flows. The interflow zones are the relict flow tops of the individual basalt flows that tend to be vesicular, fractured, and broken because of relatively rapid cooling compared with the interior basalt of the flow (i.e., the flow interior or intraflow). Further, if the flowing lava came into contact with water, cooling was even more rapid, resulting in formation of pillow lava structures within a shattered glassy matrix. These pillow zones tend to be highly permeable, and in some cases substantially thicker than typical flow tops. The base of the Wapshilla Ridge in the vicinity of Well 6 consists of a thick, permeable pillow zone. This feature also has been encountered in City of Tigard and City of Tualatin exploratory wells.

The individual basalt flows of the CRBG were originally deposited as near horizontal sheets; however, subsequent tectonic stresses tilted and faulted the CRBG, resulting in numerous separate fault blocks, each of which may be displaced differently relative to the other. Geologic structures have an important influence on groundwater flow in basalts. Faults and folds influence groundwater flow by promoting and/or impeding both lateral and vertical flow. The City's well field is located in a fault-bounded basin bordered by highlands comprised of CRBG. A number of faults have been mapped in the vicinity of the well field (Figure 2). Faults may limit lateral transmission of water in the basalts that can effectively create "compartments". They also may promote preferential vertical flow of water, bringing deeper water up into shallower aquifers or transmitting of water into deeper aquifers. They also may create large zones of fracturing that can enhance the transmission and storage capabilities of the basalt. The character of faults in the CRBG depends on the degree of offset, as well as healing by secondary minerals such as clays. The significance of the faults on the hydraulic characteristics of the basalts in the Sherwood area is not known with certainty at present, although evidence of hydraulic boundaries in the basalts has been observed in an aquifer test of Sherwood Well No. 6.

Groundwater Withdrawals and Water Levels

We compiled and analyzed overall groundwater production rates and historical water level trends in the City's well field to compare hydraulic responses of the CRBG aquifer to historical and current pumping stresses. This information was used to assess the sustainability of current groundwater usage, as well as to identify and assess potential future groundwater supply options for the City to consider. Sources of information included the City, Tualatin Valley Water District (TVWD), OWRD, and past consultant reports completed on behalf of the City (Bookman-Edmonsten, 1999; Squier, 1999; and MSA, 2001).

The water level (static and pumping) for each City production well and the total yearly well field production volume for the period of 1988 to 2004 are shown on Figure 3. The short periodic oscillations in the water levels are likely the results of seasonal fluctuations in the aquifer water levels, with higher water levels occurring during winter months when groundwater withdrawals are less and rainfall is providing recharge to the aquifer. Several general observations were derived from the overall water level trends and cumulative annual withdrawals shown in Figure 3, as well as the hydrographs for individual wells provided in Appendix A:

- Approximate water level elevations in Wells 5 and 6 appear to be lower than in Wells 3 and 4 (Figure 3).
- There is a distinct overall declining trend in the water levels over time
- Increases in the rate of water level decline in City production wells occur at several times during the period of record of groundwater usage by the City (Figure 3).

A possible explanation for higher water levels in Wells 3 and 4 relative to Wells 5 and 6 is that the hydraulic head in the CRBG aquifer decreases with increasing depth, suggesting a downward component to vertical flow, or recharging conditions. Since Wells 5 and 6 are open to deeper parts of the CRBG section, the hydraulic head is lower. This is consistent with observations during drilling of Sherwood 6 and with the City of Tualatin ASR exploratory well EW-1 (MSA and GSI, 2002). An implication of this observation is that deepening the shallower wells (Wells 3 and 4) could result in somewhat lower initial pumping heads.

A linear trend fit to the static water levels of each well indicates a long-term water level decline of 2 to 3 feet per year (Table 2). The observed decline in aquifer levels is likely not the result of groundwater production from any one individual well, but a result of cumulative pumping of the aquifer by all wells completed in the CRBG, and accompanying change in storage in the aquifer.

Table 2
Decline in aquifer level measured at City groundwater production wells
City of Sherwood

Well	*Water Level at Construction*		*Water Level at Present*		*Overall Water Level Trend (ft/yr)*
	DTW, bgs	*Measured on*	*DTW, bgs*	*Measured on*	
3	26	1/1/1946	106.3	11/30/2004	1.8
4	44	4/28/1969	102	9/18/2003	2.7
5	48	10/25/1984	90	11/24/2004	2.2
6	131	2/7/1997	152.3	11/30/2004	2.7

Notes:
DTW = depth to water
bgs = below ground surface

Increases in the rate of water level declines in the aquifer correlate with installation of Well 4 and Well 6, and are probably due to increased pumping at the time of or after installation of those wells. The annual rate of water level decline in the aquifer since 1998 is approximately 4.2 feet per year. This increased rate of decline correlates with increases in groundwater withdrawals from between 200 and 250 million gallons (MG) per year from 1995 to 1997, to over 400 MG pumped in 2002 and 2003. Groundwater withdrawals by the City in 2004 exceeded 500 MG.

The volume of groundwater in the CRBG aquifer, and thus water levels, represents a dynamic balance between the water entering the aquifer (recharge) less the water removed from the aquifer (discharge). The volume of groundwater in the aquifer does naturally fluctuate to some extent due to season variations in precipitation and longer-term variations in climate (e.g. drought cycles). However, groundwater withdrawals from wells represent additional discharges from the aquifer, and if the cumulative groundwater discharge from an aquifer exceeds the recharge, then the aquifer will be essentially be 'mined' of groundwater and aquifer levels will decline over the long term unless natural discharges are captured or recharge is enhanced. The timing and magnitude of water level declines in the aquifer will vary spatially depending on the location and magnitude of withdrawals relative to location of recharge and discharge areas. Past trends suggest further increases in the rate of water level declines should be expected if the recent rate of withdrawal is maintained or increased.

Because of declining water levels in the Sherwood-Wilsonville area, the OWRD has designated this region as the Sherwood-Dammasch-Wilsonville Groundwater Limited Area. Groundwater limited areas are regions where OWRD has determined that groundwater in an aquifer is over appropriated or that aquifer water levels have declined excessively, which essentially 'closes' the aquifer to additional development of new groundwater rights. The groundwater limited area designation does not immediately impact current water right holders, however, the OWRD may still intervene and request a reduction in groundwater production if OWRD determines that aquifer level declines are too severe and threaten the sustainability of the aquifer.

Well 5 Evaluation

The evaluation of Well 5 consisted of (1) conducting a pumping test of Well 5 to assess aquifer and well productivity and boundary conditions, and (2) assessing options for restoring the capacity of the well to a rate of 550 gpm, and (3) further increasing the capacity of the well.

Well 5 Pumping Test

The test consisted of pumping the well at an average rate of 450 gpm for approximately 24 hours. The recently installed SCADA systems at the City's production wells were used to collect water level measurements and flow data during the test. Representative water level data were not able to be recovered from the Well 4 SCADA system. The data indicate that the antecedent trends in water levels from all of the wells show the effects of recovery from pumping several of the production wells prior to the test. The antecedent trend obscures the responses to pumping in the observation wells, including Wells 3, 5 and 6. However, a definitive response to pumping of Well 5 was observed in the data from Well 3 after the data were corrected for the antecedent rising water level trend observed in the antecedent trend (Figure 4). A transmissivity of between 70,000 and 90,000 gallons per day per foot (gpd/ft) was calculated from the corrected data. This transmissivity is consistent with prior estimates by Squier (1999) and indicates that the portion of the basalt aquifer penetrated by Well 3 is more transmissive than the vicinity of Wells 4, 5 and even 6. It is unknown whether a portion of the relatively high calculated transmissivity could be due to water derived from approximately 15 feet of sediments overlying the basalt aquifer that are exposed in the well. The storativity calculated from the corrected data is 7×10^{-5}. The storativity value is typical of highly confined basalt aquifers.

A response in Well 6 to pumping in Well 5 could not be discerned in the corrected data; however, the lack of observable response may be a result of the resolution of the corrected data, rather than an actual lack of hydraulic connection between the two wells. Long-term water level trends in the aquifer since installation of Well 6 suggest a connection between the two wells (MSA, 2001).

Well 5 Improvement Evaluation

The current operational rate of Well 5 is limited to 450 gpm because of apparent production of carbon dioxide at higher pumping rates. Options for increasing the pumping rate in Well 5 include deepening the well to attempt to tap the pillow zone present at the base of the Wapshilla Ridge unit, and thereby either dilute it sufficiently to be acceptable or prevent production of carbon dioxide by maintaining higher pumping levels in the well. Another option is to attempt to restore the unused capacity of the well by identifying the source of the carbon dioxide and sealing it. Deepening the well to increase the capacity will entail demolishing the existing well house to access the well with a drilling rig, and carries the attendant risks that (1) the increase in capacity will not meet expectations and (2) water produced from the well will be of lower quality, as experienced in Well 6. Sealing off the source of carbon dioxide to restore the operational pumping rate to 550 gpm will require a program of zonal testing and sampling, and then overreaming and sealing of the affected zone. This likely also will entail demolition of the well house and carries the attendant risk that the source cannot be definitively identified and so an effective repair cannot be implemented. Costs for this work are discussed in the following sections.

Groundwater Supply Options

Based on our understanding of the City's historical groundwater production, and aquifer water level trends, the status of existing wells, and regulatory considerations, we have identified three general options for the City to consider when planning the future role that groundwater will have in the City's overall water supply system. These options include:

1. Continue to operate the existing wells at current production capacities
2. Increase groundwater production
3. Implement aquifer storage and recovery

For each of the three options, we evaluated the potential benefits, costs and risks, including the long-term sustainability of option. The three options are discussed below and are summarized in Table 3.

Option 1 – Continue to Use Existing Wells at Current Production Rates

In Option 1, the City would continue to use their existing groundwater production wells at the current production rates. There are several assumptions implicit in this option including that the City would perform all well maintenance and/or well modifications necessary for maintaining the current production capacity (e.g., well redevelopment, pump maintenance, pump replacement, and lowering of pump intakes).

In order to retain current capacity, available information indicates that the City will need to evaluate and implement lowering the pump in Well 3 in the near future. Available well construction records indicate that the intake depth for Well 3 is 130 ft below ground surface (bgs), which is within uncased borehole below the production casing. Recent water level measurements indicate that drawdown in Well 3 during peak production during the late summer is close to the assumed location of the pump intake. If the current rate of water level declines continues and the intake is set at 130 feet in Well 3, the City may be forced to either reduce the pumping rate in the well or lower the pump within the next 1 to 2 years. Our preliminary analysis suggests that if the pump intake in Well 3 were lowered approximately 50 feet, to a level just above the first assumed basalt interflow zone (Squier, 1999), the amount of time the current rate of groundwater production could be sustained under Option 1 is approximately 10 years. This estimate assumes that the rate of water level decline remains at the current rate of 4.2 feet per year, a minimum intake submergence of 10 feet is desirable and that little of the current production in Well 3 would be lost by drawing the water level in the well down below the Ginkgo unit of the CRBG or the uncased portion of the overlying sandstone. These assumptions would need to be verified prior to implementation of this option. Available information indicates that interflows likely would not be exposed in other wells by the additional 40 to 50 feet of water level decline that lowering the pump in Well 3 would allow. The cost to implement this option is approximately $30,000, which includes the cost for assessing the feasibility of lowering the pump in Well 3 and then lowering it approximately 50 feet.

The implications of Option 1 for the City include:

- The option would entail minor upfront capital expenditures and no major modifications of the well field.

- The maximum rate the well field can produce during peak demand periods will limited to current pumping rates, including the reduced rate due to water quality concerns at Well 5.
- Any increases in peak demands will need to be met with purchased water.
- Aquifer levels will continue to decline at a rate of up to 4 feet per year. The City will eventually begin to lose production capacity as a result of water level declines, regardless of the maintenance measures described above, because productive interflows in the aquifer will become exposed and eventually dewatered; thus individual wells will eventually lose capacity.
- OWRD could potentially intervene and object to the continued rate of groundwater production by the City because of excessive declines in aquifer levels, as occurred in the City of Wilsonville in the 1990s.

Option 2 – Increase Groundwater Production

Option 2 entails developing groundwater production capacity to meet as much of the demand peak as possible. This option would include deepening of existing wells and/or drilling of new wells to make full use of existing water rights and any purchased rights so that the City could maximize production rates.

This option assumes that the City will perform all well maintenance and/or well modifications necessary for maintaining the production capacity (e.g., well redevelopment, pump maintenance, pump replacement, and lowering of pump intake) and will fully appropriate remaining unused capacity on their existing water rights and possibly purchase additional rights. The City would deepen existing wells and/or drill new wells under this option. The City has approximately 600 gpm of undeveloped water rights on its existing permits. In addition, the operational capacity of Well 5 has been reduced from 550 to 450 gpm because of water quality issues. Consequently, the City has 700 gpm or approximately 1 million gallons per day (MGD) of unutilized capacity, 600 gpm of which has not been developed.

The City also has been exploring the purchase of a water right (Certificate No. 61886) associated with Spada Well. The water right certificate rate is 400 gpm for agricultural use and is limited to the growing season. The rate on this water right represents additional potential capacity above what the City holds on its existing permits, but this additional capacity likely would be limited to the irrigation season, which includes the peak demand months of June through September.

We have identified several options for capturing unused capacity on existing water rights and integrating the capacity on the Spada Well water right. The options, approximate costs and risks/uncertainties are listed below.

Table 3
Options for Increasing Groundwater Supply Capacity
City of Sherwood

Option	Action	Risks and Uncertainties	Approximate Project Cost
1. **Repair Well 5**	Seal off source of carbon dioxide to restore the 100 gpm of unused capacity. Other options for restoring capacity include above-ground treatment or possibly dilution from increased capacity associated with well deepening. Four to 6 months to complete, including public bidding process.	Source of carbon dioxide is not known; feasibility and efficacy of this option depends on a single localized source of the carbon dioxide being identified.	**\$48,000 - \$55,000** Does not include demolition and reconstruction of well house or any pump system modifications
2. **Deepen Well 5**	Increase capacity of the well by deepening the lower borehole by 50 to 100 feet to tap the lower pillow zone complex identified in Well 6. Four to 6 months to complete, including public bidding process	The pillow complex present in Well 6 may not be present or as productive at the location of Well 5. In addition, there is a high probability that the water present in the pillow zone will be of poorer quality than is currently produced in the well.	**\$65,000 - \$70,000** Does not include demolition and reconstruction of well house or any pump system modifications
3. **Additional New Production Well**	Drill a new production well (400 to 700 gpm) and add as a point of appropriation on all existing water right permits held by the City to develop unutilized capacity available on the permits. At least 1 year to complete, including design and completion of wellhead facilities and public bidding process.	The capacity of a new well would depend on the location and depth of the well. While the capacity of a deep well (900') would likely be greater than a shallower (<800') well, the tradeoff for increased capacity would likely be poorer water quality. Additional withdrawals from the CRBG aquifer represented by developing unutilized capacity on the permits would likely increase the rate of water level declines in the CRBG aquifer.	**\$900,000 to \$1M** Estimate range assumes an 800 to 900-feet deep well, wellhead and well house improvements. Does not include distribution system improvements or property acquisition.
4. **Spada Well Water Right and New Well**	This option includes purchasing the Spada Well water right certificate, transferring the place and type of use and replacing the Spada Well with a new production well drilled and constructed to municipal supply specifications. This option would add up to 400 gpm of capacity during the peak demand season. Between 1 and 2 years to implement including water right transfer process (assumes expedited process), public bidding process, drilling new well and design and completion of wellhead facilities.	There is some uncertainty associated with transferring the place of use and type of use from agricultural to municipal. The time of use likely would be limited to the summer season. The risks and uncertainties associated with installing a new well are the same as described above in the previous option. The water produced by the Spada Well has a relatively high total dissolved solids (TDS) concentration. Additional withdrawals from the CRBG aquifer represented by regular use of the rate of the Spada Well right may increase the rate of aquifer water level declines.	**\$900,000 to \$1.10M** Assumes water right transfer, abandonment of old Spada Well and installation of 800 to 900-feet deep well, wellhead and well house improvements. Does not include distribution system improvements or property acquisition.

The implications for the City of implementing various permutations of Option 2 described include:

- Increased production will likely accelerate the rate of water level declines in the CRBG aquifer to greater than the current rate of approximately 4.2 feet per year;
- There is a risk that deepening existing wells will not result in sufficient increases in production capacity; however, existing data do suggest the presence of a highly productive pillow zone in the deep Wapshilla Ridge unit that could be exploited.

- Water from deeper interflow zones of the CRBG aquifer tends to be of poorer water quality (e.g. Well 6); consequently, increasing production by deepening wells or drilling new deep wells will likely come at the expense of reduced water quality.
- The City will eventually begin to lose production capacity because of the limitations of existing wells and the exposure and ultimate dewatering of shallower interflow zones.
- OWRD may intervene and object to the increased rate of groundwater production by the City because of excessive declines in aquifer levels, as occurred in the City of Wilsonville.

Option 3 –Aquifer Storage and Recovery (ASR)

This option entails implementing ASR to increase capacity during peak demand periods in the summer. Implementation of ASR would entail obtaining water from another drinking water source during the winter months, injecting the water into the CRBG aquifer and recovering the water in the summer during peak demand periods. The City has completed an initial ASR feasibility study (MSA, 2001). The study identified Well 6 as being suitable for development for ASR operations and recommended initiation of a pilot testing program. The City's Well 6 appears to be capable of pumping rates of approximately 2,100 gpm, or 3 MGD. However, the current operational rate of the well is limited to 550 gpm because of conditions of the water right permit. Water from Well 6 also contains high iron, manganese and total dissolved solids (TDS) concentrations.

ASR would allow the City to utilize Well 6 at its full capacity potential while improving the quality of water produced from the well. Successful implementation of ASR at Well 6 could potentially provide the City with an additional 2 MGD of additional capacity above the current pumping capacity of the groundwater system during the peak demand season. The steps outlined by MSA (2001) for implementation of ASR at Well 6 include:

- Permitting – ASR Limited License, UIC permit and discharge permits.
- Evaluation and Retrofit of Well 6 wellhead and other infrastructure improvements
- Installation of a monitoring well
- Pilot testing

Approximate planning level costs for ASR pilot testing at Well 6, including one year of injection and recovery of 150 MG of water are provided in Table 4.

Table 3
Well 6 ASR Implementation
City of Sherwood

Description	*Unit Capital Cost*	*Unit Engineering Cost*	*Total Incremental Cost*	*Notes*
Permitting	NA	\$30,000 – \$35,000	\$30,000 – \$35,000	For first site including ASR limited license for any other sites.
Evaluation and Retrofit of Well 6	\$350,000 - \$450,000	\$80,000 - \$110,000	\$430,000 – \$560,000	Based on 3 MGD pumping capacity. Assumes new pump, motor and downhole control valve, and piping, valves, controls, and disinfection system modifications. Cost will depend on modifications necessary for upsizing piping and other infrastructure improvements to handle increased capacity and pump-to-waste. Does not include any distribution system improvements necessary.

Description	Unit Capital Cost	Unit Engineering Cost	Total Incremental Cost	Notes
Installation of Monitoring Well	$65,000 - $85,000	$12,000 - $15,000	$77,000 - $100,000	Assumes 900 foot deep monitoring well.
Pilot Testing of Well 6	NA	$130,000- $160,000	$130,000– $160,000	Pilot test of Well 6. Includes monitoring, WQ testing, geochemical compatibility analysis, well testing and analysis. Does not include labor or equipment on the part of the City or TVWD.
Rounded Totals	$475,000 - $595,000	$252,000 - $320,000	**$727,000 - $915,000**	

Source water costs are not including in the above estimates; the actual operational and maintenance costs for implementing ASR will depend greatly on source water costs. The ultimate project cost will depend on whether or not the City elects to proceed with expansion of the ASR system to include other existing wells or new wells, or just operates Well 6 as an ASR well while looking to other long-term water sources.

Development of a wellhead protection plan, though optional, also is recommended. A wellhead protection plan would cost between $30,000 and $50,000, depending on the scope.

Water Rights Strategy

Regardless of the course the City elects to follow with regard to the role groundwater supply plays in the City's overall water supply, we recommend that the City take steps to fully develop and exercise the full amount of the capacity allowed under existing water rights permits. There are several strategies for achieving this goal including:

- Add other wells as a point of appropriation to each water right permit to maximize operational flexibility and fully utilize each permitted right (Option 1).
- Modify existing wells to increase capacity and develop the remaining unutilized rights on each permit where feasible (Option 2)
- Drill an additional well or wells and add as points of appropriation on permits with unutilized capacity (Option 2)

The only method to accomplish this if the City chooses Option 1 is to add each well as a point of appropriation on other permits. This also is the simplest method for the other options.

References

Bookman-Edmonsten Engineering, Inc., 1998. City of Sherwood Water System Master Plan Update. Prepared for the City of Sherwood.

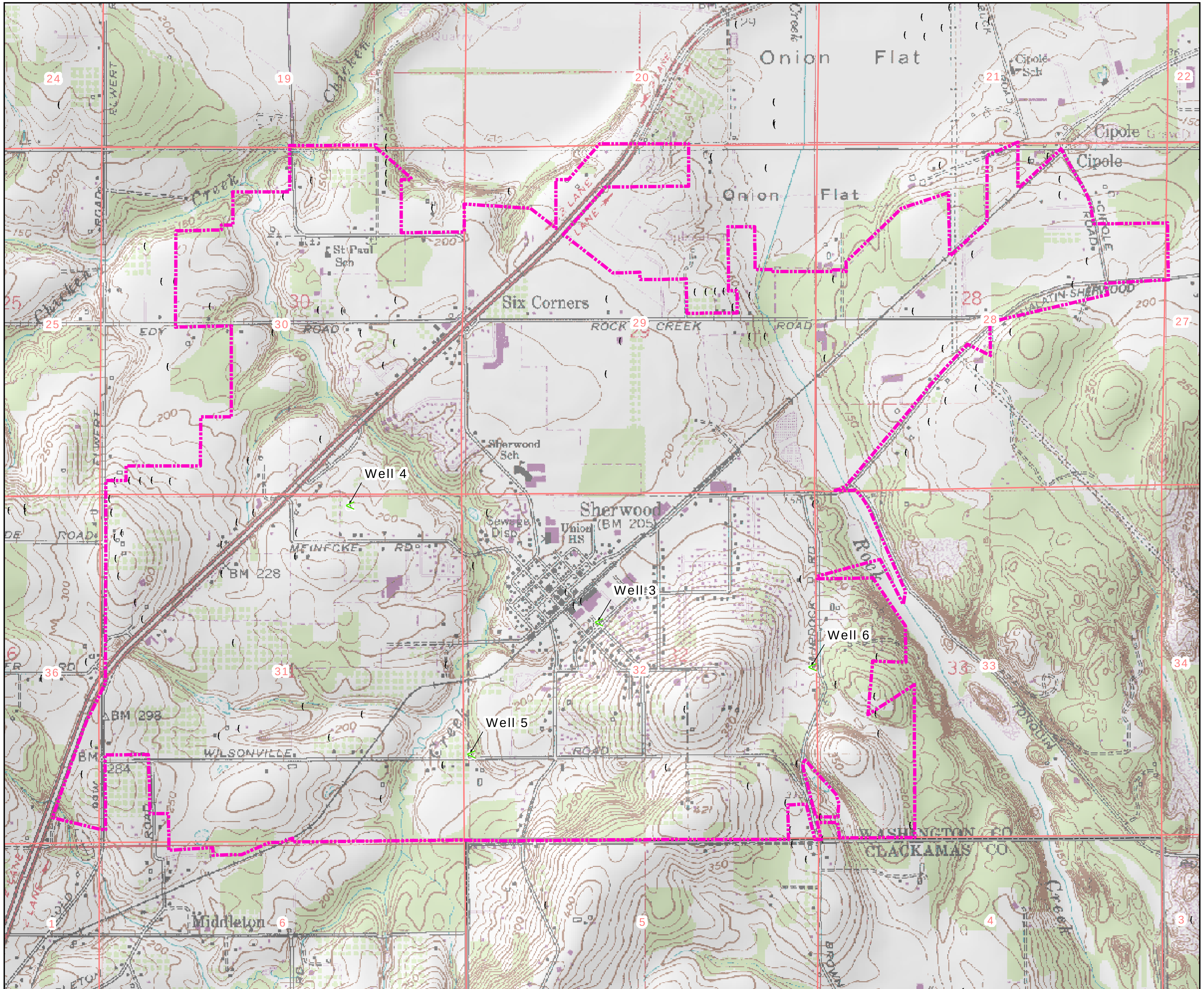
Squier and Associates, Inc., 1999. Municipal Well Field Hydrogeological Evaluation. Prepared for the City of Sherwood.

Miller, D. et al., 1994. Ground Water Conditions of Basalt Aquifers, Parrett Mountain, Northern Willamette Valley, Oregon. Oregon Water Resources Department Ground Water Report No. 40.

Murray Smith & Associates, Inc., 2001. Aquifer Storage and Recovery (ASR) Phase 1 – Program Evaluation and Development. Draft document prepared in association with Golder Associates for the City of Sherwood and Tualatin Valley Water District.

Murray Smith & Associates, Inc. and Groundwater Solutions, Inc., 2002. Aquifer Storage and Recovery (ASR) Exploratory Well Testing and Evaluation. Report prepared for the City of Tualatin, Oregon.

Figures



LEGEND

< City of Sherwood Production Wells

(Other Water Wells

Sherwood City Limit

Map Notes:

Map projection - Universal Transverse Mercator Zone 10. North American Datum of 1927

Scale
1:18,000

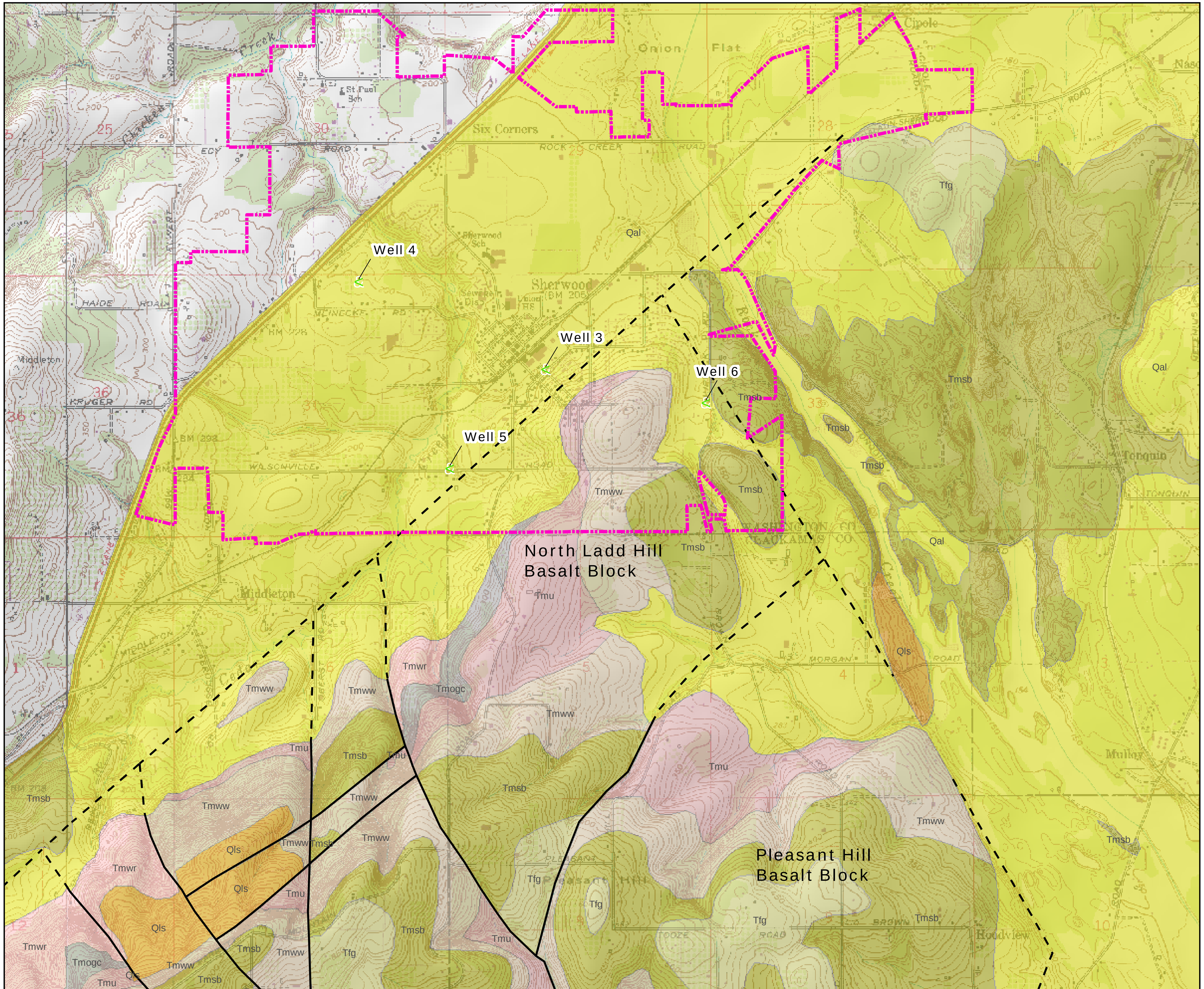
0 2000 4000
Feet

Figure 1
Site Location Map
City of Sherwood

Map Date: January 24, 2005

Groundwater Solutions Inc.

P:\124 - Sherwood (MSA)\GIS\Figure-1_Site Location.mxd



LEGEND

City of Sherwood Production Wells
Sherwood City Limit

Geologic Units

- Alluvium (Qal)
- Landslide (Qls)
- Ginko Basalt Flow (Tfg)
- Sentinel Bluffs Basalt Flow (Tmsb)
- Winter Water Basalt Flow (Tmww)
- Umtanum Basalt Flow (Tmu)
- Ortley-Grouse Creek Basalt Flow (Tmogc)
- Wapshilla Ridge Basalt Flow (Tmwr)
- Marine Sedimentary Rocks (Tos)
- Faults
- Inferred Faults

Map Notes:

Map projection - Universal Transverse Mercator Zone 10. North American Datum of 1927

Geology from Oregon Water Resources Department Groundwater Report No. 40 (Miller et. al., 1994).

Scale
1:24,000

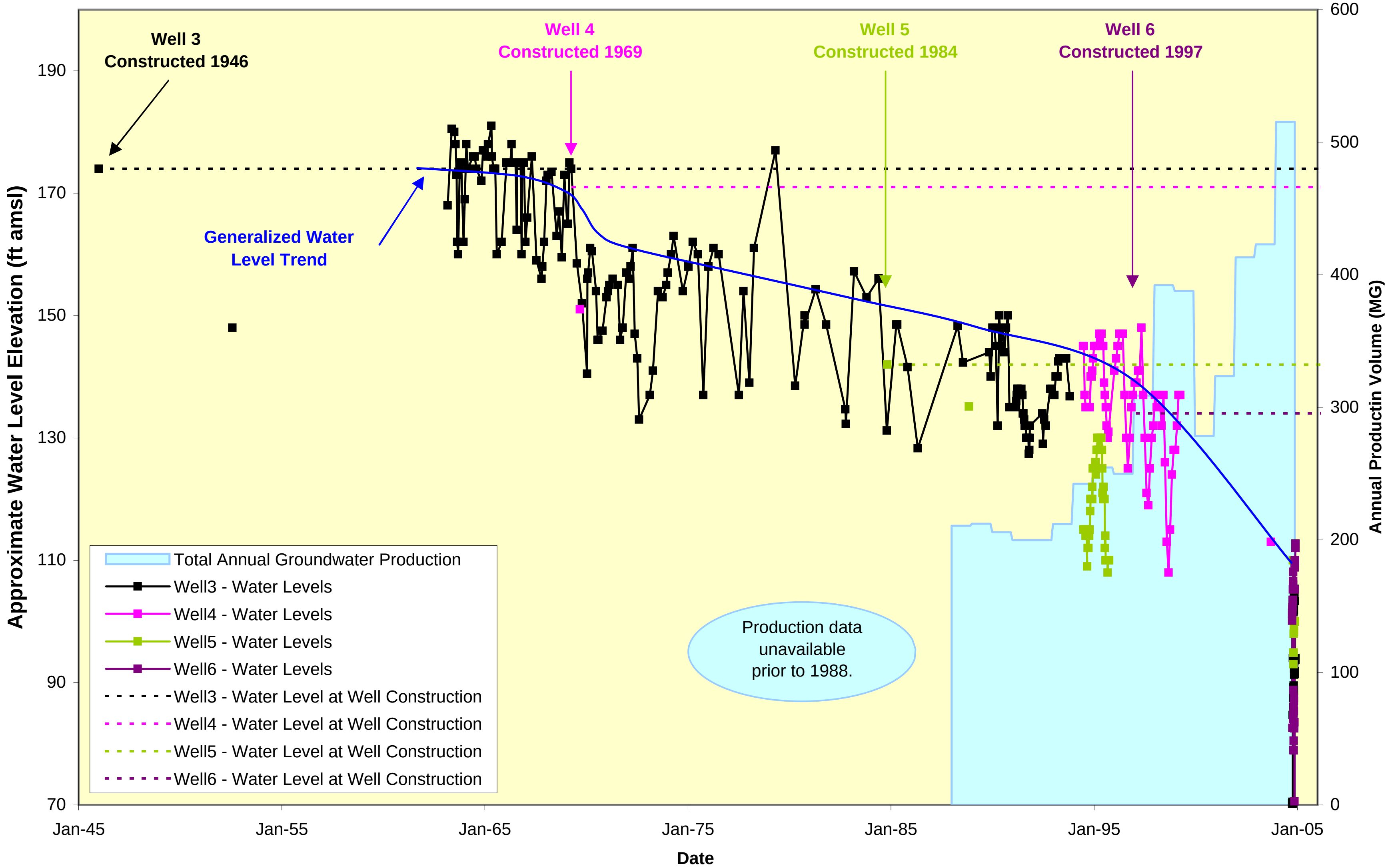
0 2000 4000
Feet

Figure 2
Geologic Map
City of Sherwood

Map Date: January 24, 2005

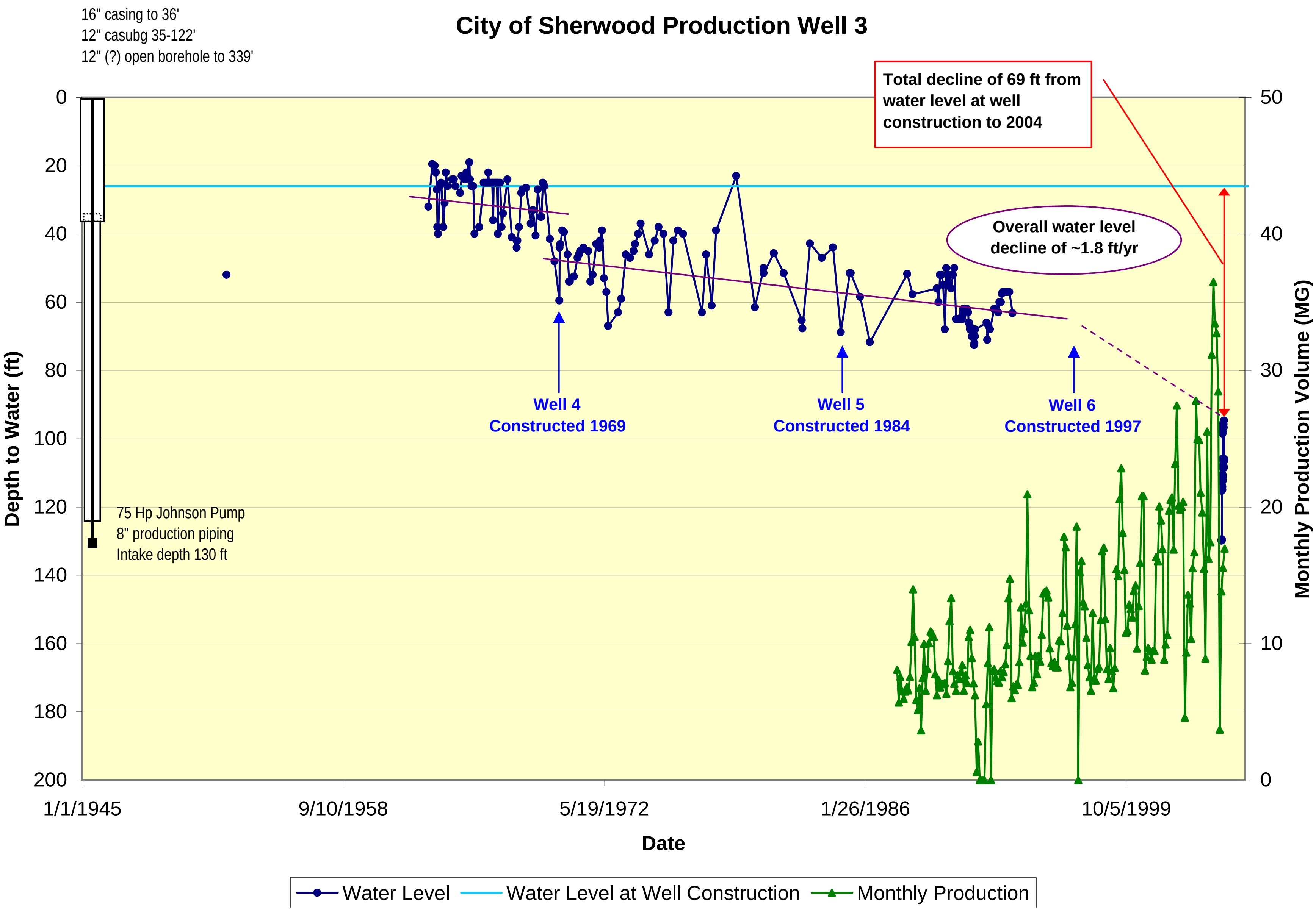
Groundwater Solutions Inc.

P:\124 - Sherwood (MSA)\GIS\Figure-2_Geology.mxd



Groundwater Solutions Inc.

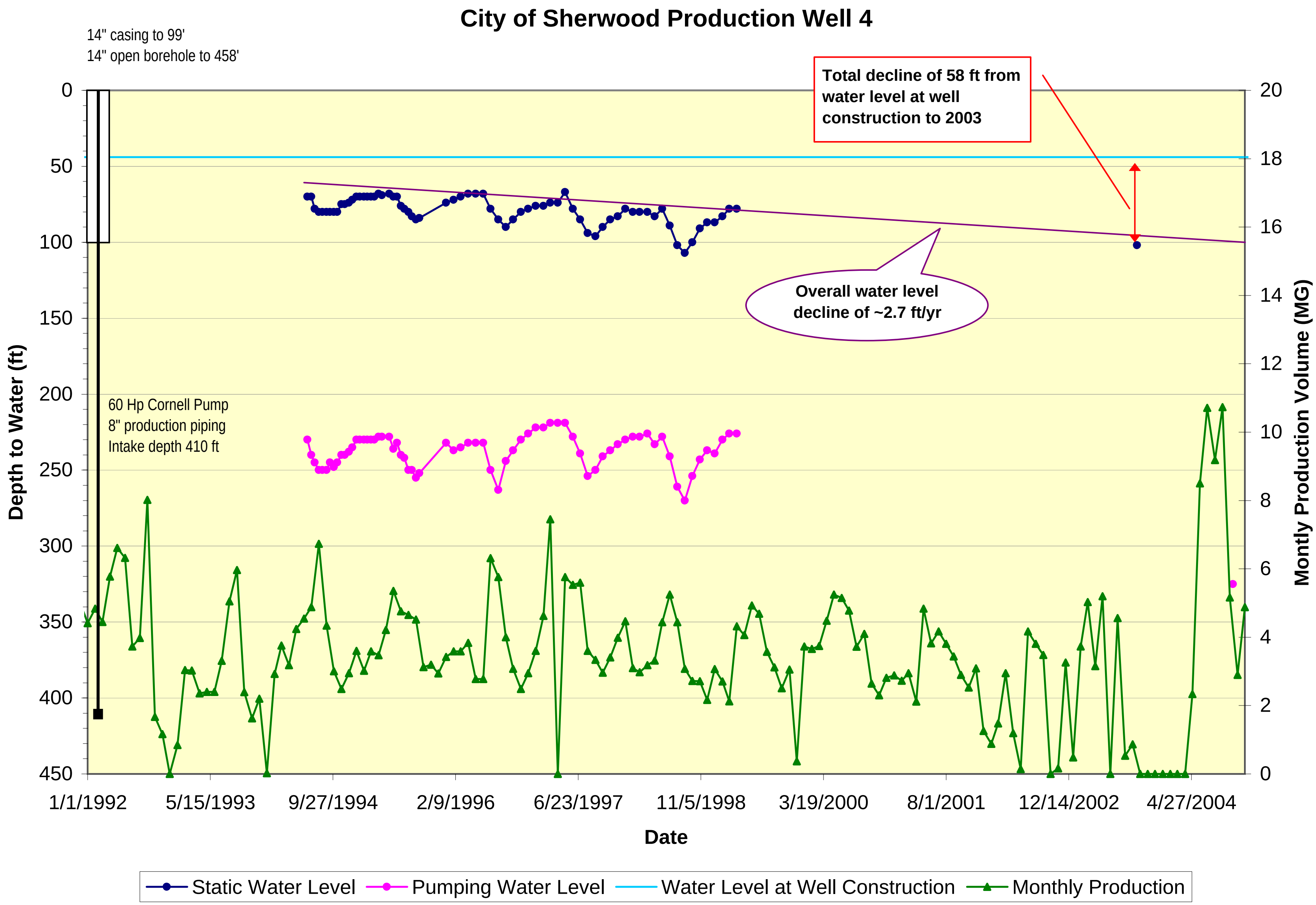
Figure 3
Well Hydrographs and Well Field Production
City of Sherwood
P:\124 - Sherwood (MSA)\003 - Well #5\Well evaluation\Q-Anual_Totals.xls



Groundwater Solutions Inc.

Appendix A - Production Well Hydrographs

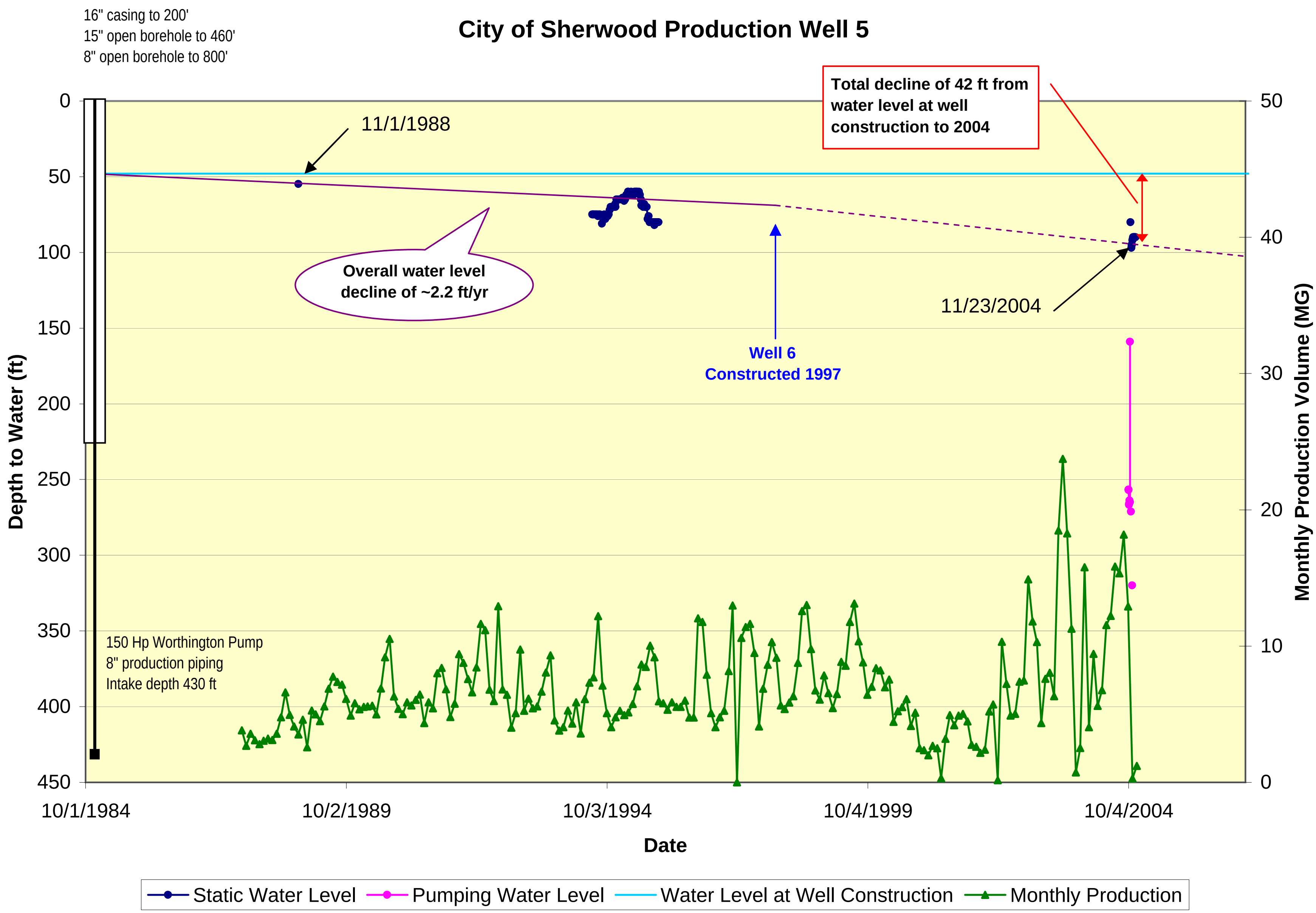
P:\124 - Sherwood (MSA)\003 - Well #5\Well evaluation\well 3 data.xls



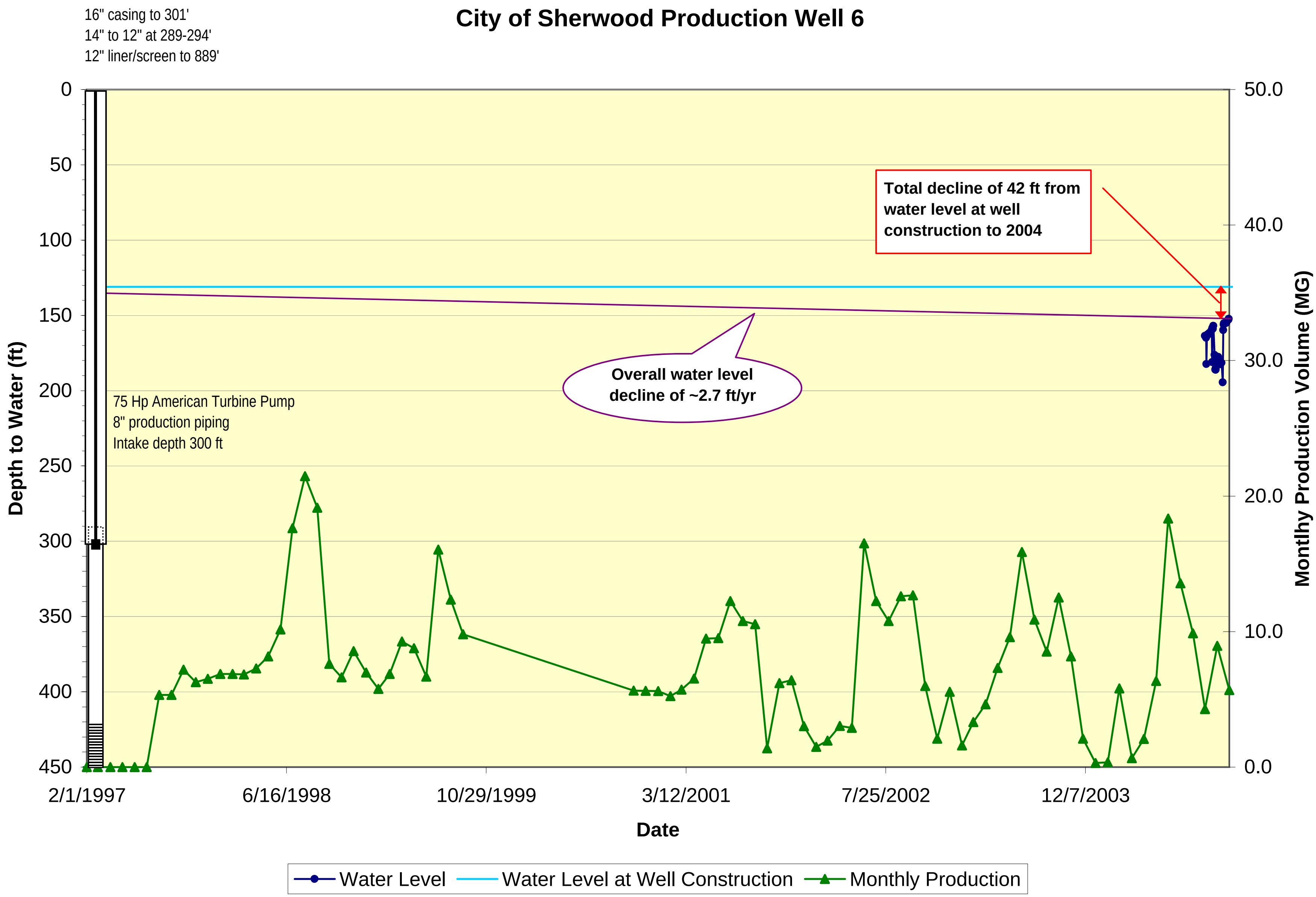
Groundwater Solutions Inc.

Appendix A - Production Well Hydrographs

P:\124 - Sherwood (MSA)\003 - Well #5\Well evaluation\well 4 data.xls


16" casing to 200'
15" open borehole to 460'
8" open borehole to 800'
City of Sherwood Production Well 5
Total decline of 42 ft from water level at well construction to 2004
11/1/1988
Overall water level decline of ~2.2 ft/yr
Well 6 Constructed 1997
11/23/2004
150 Hp Worthington Pump
8" production piping
Intake depth 430 ft
Depth to Water (ft)
Monthly Production Volume (MG)
Date
0
50
100
150
200
250
300
350
400
450
0
10
20
30
40
50
10/1/1984
10/2/1989
10/3/1994
10/4/1999
10/4/2004
Static Water Level
Pumping Water Level
Water Level at Well Construction
Monthly Production

City of Sherwood Production Well 6



Groundwater Solutions Inc.

Appendix A - Production Well Hydrographs

P:\124 - Sherwood (MSA)\003 - Well #5\Well evaluation\well 6 data.xls

APPENDIX E

WATER WHEELING AGREEMENT

This Water Wheeling Agreement ("Agreement") is made this 27 day of November, 2000, by and between the City of Tualatin, an Oregon municipal corporation ("Tualatin") and Tualatin Valley Water District, a water supply district organized pursuant to ORS Chapter 264 ("TVWD").

Recitals

A. Pursuant to ORS Chapter 190, Tualatin and TVWD are authorized to enter into Intergovernmental Agreements to provide for efficiencies and economies of scale; and

B. TVWD and the City of Sherwood have entered into an agreement whereby TVWD will provide water to Sherwood for an initial term of five years, and subject to renewal thereof for additional five-year periods as provided in the agreement. The agreement also contemplates potential annexation of the City of Sherwood into TVWD. A copy of that agreement is attached hereto as Exhibit A and incorporated by reference.

C. TVWD presently has sources of water from the City of Portland Water Bureau and the Joint Water Commission. The sources are located such that Tualatin and its 36-inch transmission from Southwest 80th and Florence Lane to Tualatin and Tualatin's distribution system is centrally placed to allow wheeling of water through Tualatin to the 24-inch water line connection with the City of Sherwood.

D. Tualatin wishes to assist TVWD and Sherwood by allowing the wheeling of water through the Tualatin facilities up to 3 million gallons per day on peak-day usage and up to 2 million gallons per day on average daily demand usage. The parties have entered into this Water Wheeling Agreement to provide for that arrangement.

E. TVWD will not purchase water from the City of Tualatin, but wheel TVWD water through City of Tualatin pipes.

F. The intent of this agreement is for Tualatin to allow TVWD to wheel TVWD water through Tualatin's 36-inch pipeline to Sherwood with no detrimental impacts on Tualatin.

G "Wheeling" is defined as Tualatin allowing TVWD to use the unused capacity portion of Tualatin's 36-inch pipe to transmit water from 80th and Florence Lane to the Sherwood connection to the 36-inch line in Tualatin.

NOW, THEREFORE, THE PARTIES AGREE AS FOLLOWS:

1. Recitals. The recitals set forth above are incorporated by reference and made a part of this Agreement.

2. Consideration. In consideration of the terms and conditions below, the parties hereby enter into this Agreement to provide for the wheeling of water obtained by TVWD through the Tualatin system to serve TVWD's customers in the City of Sherwood ("Sherwood Service Area").

3. Term. The term of this Agreement shall be for five years commencing on October 1, 2000, and as may be renewed according to the terms of the TVWD-City of Sherwood

Agreement, attached hereto as Exhibit A and incorporated by reference. The quantity of water available to TVWD and Sherwood shall reduce as Tualatin's demands increase over the present approximately 8 million gallons per day peak day demand.

4. **Tualatin's Wheeling Assets**. The Tualatin assets necessary to wheel water to the Sherwood Service Area consist of the existing 36-inch transmission line from Southwest 80th and Florence Lane to the City of Tualatin Community Park. At the Tualatin Community Park the City of Sherwood's 24-inch line connects to the City of Tualatin's 36-inch line. Tualatin agrees with coordination and cooperation from TVWD to exercise reasonable diligence and foresight to repair, replace and maintain Tualatin's transmission and distribution system so as to provide a normal volume and pressure of water at the 24-inch inter-tie, the Cipole Road connection defined in Section 6, below, or other future connection between Sherwood and Tualatin.

5. **Covenant of TVWD**. TVWD shall have full responsibility to acquire the necessary right-of-way and to design and construct those facilities it deems necessary to make a connection from the Sherwood Service Area or the TVWD Sources to the wheeling assets. Tualatin will approve the location of these facilities in Tualatin. The parties will coordinate with each other during design and construction to provide for minimal inconvenience to Tualatin.

6. **Connection, Meters, Pumps**. TVWD's connection to the Tualatin system shall be metered at such locations as designated by the parties and such expenses shall be TVWD's obligation. The meters shall be for the purpose of determining use and the wheeling charges as set forth in paragraph 7 below. TVWD shall, at all times, have access to all meters and may review and inspect water usage records upon reasonable notice. It is anticipated the water wheeled to Sherwood will be metered at Tualatin Community Park, or at Cipole Road, approximately 1,500 feet south of its intersection with Herman Road. Connection at Cipole Road shall be maintained to provide flow in both directions between the Tualatin and Sherwood Systems.

7. **Wheeling Rate**

During the first five years, on July 1st of each year, updated rates using Exhibit B will be in effect from July 1 to June 30. In February of each year Tualatin will update the rate on Exhibit B to reflect actual water usage and actual operations from the prior calendar year. This update will be for the following fiscal year. If major operational changes or maintenance needs are anticipated they may be included in the future years' rates.

If this agreement extended beyond five years, Exhibit B will be examined to determine if revisions or recalculation is necessary. If revised or recalculated the new Exhibit B will be part of the new or extended agreement.

8. **Fiscal and Operational Impacts to Tualatin.** TVWD agrees that it will hold harmless and indemnify Tualatin from fiscal or operational impacts as a result of this Wheeling Agreement. By way illustration, if Tualatin's peaking factor under its contract with the City of Portland or any other provision of the contract is affected by this Wheeling Agreement, it shall be the responsibility of TVWD to hold Tualatin harmless therefrom in a manner as if this agreement was never in existence. Tualatin agrees that, so long as no fiscal impact is passed on to Tualatin by the City of Portland under the existing contract, and so long as the water wheeling rate in Section 7 above is paid, there are no negative fiscal impacts to Tualatin. Further, TVWD agrees to negotiate modifications to this agreement as necessary to prevent any operational

impacts to Tualatin's distribution system as a result hereof. This may be necessary if wheeling water to Sherwood results in additional pumping between service levels in Tualatin.

9. Contractual Rights. TVWD and Tualatin agree that the interests acquired by TVWD in the Tualatin system as a result of this agreement is not a property ownership interest of any kind and is a contractual interest for usage subject to the terms hereof, including termination or reduction, based upon ultimate demands of Tualatin for line capacity.

10. Renewal. This Agreement may be renewed by mutual consent. TVWD will furnish notice in writing to Tualatin not later than 15 months prior to the expiration of the original or extended term of this Agreement for two additional periods of five years, so long as the TVWD-Sherwood Agreement is in effect and only to the extent that Tualatin demands are less than the 14.1 mgd capacity of the 36-inch line. Tualatin will notify TVWD within 30 days after receipt of TVWD's renewal notice whether it consents to renewal.

11. Payment of Wheeling Charges. TVWD will pay Tualatin monthly for the wheeling charges determined as described in Section 7 above. Payment will be due in 30 days from the date of invoice by Tualatin.

12. Water Quality. The quality of water delivered by TVWD through the wheeling assets shall comply with all applicable provisions of state and federal law rules and regulations. If TVWD's water does not meet these standards, then TVWD shall not supply water to its Sherwood Service Area through the wheeling assets until the matter is rectified. Sources from other than the City of Portland or Joint Water Commission shall be approved by the City Engineer in accordance with applicable City laws.

13. Dispute/Attorneys Fees. If a dispute arises between the parties regarding breach of this Agreement or interpretation of any term of this Agreement, the parties shall first attempt to resolve the dispute by negotiation, followed by mediation and arbitration.

<u>Step One</u>: The General Manager and City Manager are designated to negotiate on behalf of the parties they represent. If the dispute is resolved at this step, there shall be a written determination of such resolution, signed by each party's Manager and ratified by each governing body, if required by the governing body, which shall be binding upon the parties.

<u>Step Two</u>: If the dispute cannot be resolved within ten (10) days at Step One, the parties shall submit the matter to non-binding mediation. The parties shall attempt to agree on a mediator. If they cannot agree, the parties shall request a list of five (5) mediators from an entity or firm providing mediation services. The parties will mutually agree on a mediator from the list provided. Any common costs of mediation shall be borne equally by the parties who shall each bear their own costs and fees therefor. If the issue is resolved at this step, a written determination of such resolution shall be signed by each General Manager and approved by their respective governing bodies, if necessary.

<u>Step Three</u>: If the parties are unsuccessful at Steps One and Two, the dispute shall be resolved by arbitration proceedings. The parties shall follow the same process described in Step 2 for the selection of the arbitrator. The prevailing

party shall be entitled to its reasonable attorney's fees as may be awarded by the arbitrator.

14. Breach. If a party defaults under the terms hereof, then upon 20 days' written notice, the defaulting party shall undertake steps to commence cure of the breach. In the event there is a dispute over the amount to be paid, the undisputed amount shall be paid immediately and the Agreement shall not be termed in default while the solution to the disputed payment portion is resolved under Section 11, above. The parties understand and agree that water service is critical to each party's customers and that monetary damages may be an insufficient remedy considering the infrastructure involved. Therefore, the parties expressly agree that equitable remedies such as injunction or specific performance are specifically contemplated and allowed by this Agreement.

15. Termination. In the event of breach, this Agreement may be terminated by the nondefaulting party upon one year's written notice. Subject to Section 10, this agreement may be terminated by either party regardless of breach upon giving notice of intent not to renew, unless a shorter notice is agreed to by both parties.

16. Notices. Notices of breach, termination or renewal shall be deemed sufficient if deposited in the United States mail, first class, postage prepaid, addressed to the parties as follows:

General Manager Tualatin Valley Water District 1850 SW 170th Avenue P.O. Box 745 Beaverton, OR 97075	City Manager City of Tualatin City Offices 18880 SW Martinazzi Avenue Tualatin, OR 97062

Notices regarding ongoing operations, maintenance, repair, replacement and system operation shall be delivered as above to:

District Engineer Tualatin Valley Water District 1850 SW 170th Avenue P.O. Box 745 Beaverton, OR 97075	City Engineer City of Tualatin City Offices 18880 SW Martinazzi Avenue Tualatin, OR 97062

17. Insurance and Indemnity. To the full extent permitted by law, each party agrees to indemnify and hold harmless the other, its Board, Council, officers and employees from any and all claims, demands, damages, actions, or other harm caused by the sole negligence of that party, including any attorney's fees or other costs of defense. Further, each party agrees to maintain general liability insurance in an amount not less than Oregon Tort Claim limits applicable to public agencies as set forth in ORS 30.260 through 30.300.

18. Succession. This agreement shall be binding upon any successors to the respective parties which through merger, consolidation, or other means succeeds to the water supply and distribution functions of that party.

19. Amendment. The terms of this agreement may be amended or supplemented by mutual agreement of Tualatin and TVWD. Any amendment or supplement shall be in writing and shall refer specifically to this agreement, which shall be executed by all parties.

20. Assignment. Neither the benefits received by Sherwood nor the obligations incurred under the terms of this agreement are assignable or in any manner transferable by Sherwood without the written consent of TVWD and Tualatin.

21. Good Faith and Cooperation. TVWD and Tualatin agree and represent to each other good faith, complete cooperation, and due diligence in the performance of all obligations of the parties pursuant to this agreement.

Tualatin will bill TVWD for water delivered to Sherwood used at City of Tualatin's cost for purchase from Portland plus wheeling charge as calculated in exhibit "B"

Tualatin will determine the flow rate of water to Sherwood so Tualatin will remain in compliance with flow rate and peaking requirements set by Portland

22. Emergency Contracts; Excess Capacity Contracts. Tualatin may enter into other agreements for emergency use of capacity. Tualatin currently has emergency supply agreements with City of Tigard, City of Lake Oswego, and Rivergrove Water District. Tualatin is working with Wilsonville for an emergency supply agreement between Tualatin and Wilsonville.

At this time there are no known other requests for the use of excess capacity of Tualatin's lines. If Tualatin receives another request for use of excess capacity Tualatin will give priority to TVWD for use of excess capacity in Tualatin's lines. If others use the excess capacity other than on an emergency basis adjustment to the rate calculations in exhibit "B" will be made based on the new usage amounts of each party.

23. Prior Agreements. Tualatin, Sherwood, and TVWD have existing agreements dated November 1992, November 1995 and March1997 that address issues relating to Tualatin supplying water to Sherwood. This agreement will supercede all prior agreements in any areas where there is a conflict between agreements.

24. Tualatin Usage. If Tualatin uses more than 10.8 mgd and uses its current excess capacity for Tualatin, the amount of water available to Sherwood will be reduced by that amount over 10.8 mgd.

25. Other Approvals. Tualatin and TVWD will work with City of Portland Bureau of Water Works to receive any necessary approvals from Portland to implement this agreement.

26. Relocation. TVWD agrees to cause Sherwood to relocate any of its 24-inch line because of Tualatin's road, storm drainage, water system, or sanitary sewer improvements, modifications, repairs, or other construction that affect Sherwood's water facility within Tualatin. Sherwood, through TVWD will compensate Tualatin for inspection, services and in lieu of relocation pay additional costs of leaving the water facilities in place regarding such projects.

IN WITNESS WHEREOF, the parties have executed this Agreement on the date first above-mentioned.

CITY OF TUALATIN

Mayor

City Recorder

APPROVED AS TO FORM

City Attorney

TUALATIN VALLEY WATER DISTRICT

James Doane, Vice President

Rob Mitchell, Secretary

APPROVED AS TO FORM

District Counsel

APPENDIX F

INTERGOVERNMENTAL COOPERATIVE AGREEMENT
CREATING THE WILLAMETTE RIVER WATER COALITION

THIS INTERGOVERNMENTAL COOPERATIVE AGREEMENT is entered into by and between the following parties: Tualatin Valley Water District, a Domestic Water Supply District formed under Chapter 264 ("TVWD") Canby Utility Board, a municipal utility formed pursuant to ORS Chapter 225 ("CUB"), the City of Sherwood, a municipal corporation ("SHERWOOD"), The City of Gladstone, a municipal corporation ("GLADSTONE"), the City of Tigard, a municipal corporation ("TIGARD") and the City of Tualatin, a municipal corporation ("TUALATIN").

RECITALS:

A. WHEREAS, the parties hereto have the authority to enter into this Agreement ~~pursuant to their respective principal acts, charters, and ORS 190.003 et seq.; and~~

B. WHEREAS, the parties with the present exception of SHERWOOD and TUALATIN either hold water rights or have applications pending to appropriate water for municipal and industrial purposes on the Willamette River within that reach of the river from Lake Oswego to Wilsonville; and

D. WHEREAS, some entities may desire to develop and use the Willamette River prior to broader application of that water throughout the metropolitan region and that the entities hereto presently or in the near future will have water supply needs that could be met by the Willamette River and it may be the most economic, efficient, and available source; and

E. WHEREAS, these entities wish to create the Willamette River Water Coalition ("WRWC") under ORS Chapter 190 to study their local water demands and jointly evaluate water quality and the use of existing permitted rights and future rights and areas of usage; and being fully advised,

NOW, THEREFORE, the parties hereto agree as follows:

SECTION 1. WILLAMETTE RIVER WATER COALITION

1.1 WRWC. There is hereby created the Willamette Water Supply Agency ("WWSA") Willamette River Water Coalition ("WRWC"). The members of WRWC shall number six (6). The governing body of each party shall appoint one (1) member. Members of WRWC shall serve at the pleasure of their respective appointing bodies. The addition of new members shall require the consent of a two-thirds majority of existing members.

1.2 General Powers and Duties. WRWC shall have the following powers:

1.2.1 To adopt such bylaws, rules, regulations, and policies as it deems necessary in furtherance of the purposes of this Agreement;

1.2.2 To study the best method to develop water sources on the Willamette River between Wilsonville and Gladstone. Scope of work for specific tasks or projects/project governance and monetary responsibilities shall be negotiated on a case by case basis which may be by addendum to this Agreement;

1.2.3 To perform and exercise pursuant to the Charter or principal Acts of the parties or by Section 190.003 through 190.250 of the Oregon Revised Statutes, all powers pursuant to applicable charter, ordinance, or state or federal law which are necessary to efficiently and effectively develop water sources on the Willamette River;

1.2.4 To receive and hold existing water rights and to develop water rights on the Willamette River, and all actions necessary to preserve and protect them, to take all action necessary to design, permit, construct and operate, maintain and replace water intakes, treatment, storage, transmission and distribution facilities, equipment, and rolling stock as agreed ("the System");

1.2.5 To issue, sell or otherwise dispose of bonds, securities, or other forms of indebtedness, including the power to issue revenue bonds under ORS 288.805 to 288.945;

1.2.6 To sell water, adopt system development charges and engage in rate making pursuant to state and federal law as authorized by the members;

1.2.7 To purchase, own, hold, appropriate, and condemn land, facilities, rights of way either in its own name or in the name of the individual parties hereto to develop Willamette River rights.

1.2.8 To provide support to other entities involved in efforts to improve the health of the Willamette watershed.

1.3 Duration. Subject to Section 3 of this Agreement dealing with termination or withdrawal, the duration of this Agreement shall be perpetual.

1.4 Meetings; Manner of Acting. Meetings of WRWC shall be conducted in accordance with the provisions of the Oregon Public Meeting Law, Oregon Revised Statues Section 192.610 et seq. Four (4) members of WRWC shall constitute a quorum for the transaction of business and if only a quorum is present, a majority of those present shall be necessary to decide any issue except financial matters or new membership. Any decision of WRWC seeking financing or other financial obligation, or other forms of indebtedness, shall require an affirmative vote of the governing body of each entity that will financially participate in any project. The WRWC member may bind his/her entity without governing body approval if the amount in question is within his/her delegated contracting authority.

1.5 Officers. Annually, at the beginning of each fiscal year, WRWC shall elect from its membership a Chair and Vice-Chair who shall be officers of WRWC who shall serve a term of one (1) year. WRWC shall also appoint a Secretary who need not be a member of WRWC who shall be responsible for WRWC's records and shall keep a record of all WRWC proceedings. Officers shall serve at the pleasure of WRWC or until their successors shall be appointed and take office.

1.6 Budgeting, Accounting, Audits. WRWC shall annually prepare a work plan and an estimate for the next fiscal year and distribute it to the members by January 1 of each year. This work plan shall be referred to as general administrative. It is anticipated that each party shall budget its own staff and funds for costs or provision of in-kind services as necessary.

Each party's apportioned share of the general administration expenses shall be determined by the following formula: one half of the total administrative costs for the fiscal year shall be divided evenly among the WRWC membership, the second half of the total administrative costs for the fiscal year will be divided among the WRWC membership according to their percentage share of the total number of water meters served by the members of the WRWC as of January 1 of the preceding fiscal year. For subsequent projects, for improvements and facilities, each party's apportioned share of the expenses shall be estimated and set forth in addenda to this agreement detailing the scope of work to be performed, participants and ownership, and the amounts so estimated shall be budgeted and appropriated by the participants in accordance with local budget law. WRWC shall maintain financial reports showing its expenditures and receipts by category item for each transaction through the last working day of the preceding calendar month. If necessary, WRWC shall cause an independent audit to be performed and completed by a certified public accountant in accordance with ORS 297.405 et seq., within six (6) months following the end of each fiscal year.

SECTION 2. SURFACE WATER RIGHTS & FACILITIES.

2.1 Delegation of Powers. The functions of source management, and water treatment may be performed by WRWC, pursuant to subsequent agreements authorized by the members. Transmission and storage shall be performed by the parties using those facilities. It is the primary intent and purpose of this Agreement to allow the individual entities to develop information, participate in the study and negotiate relevant agreements regarding implementation of recommendations to design, construct, finance, own and operate facilities within their respective boundaries. WRWC may contract with any entity regarding performance of services. WRWC and each individual entity shall define the scope of individual entity contributions or individual efforts.

2.2 Contributions of Vested and Pending Water Rights. Presently permitted surface water rights to the Willamette River are held by TVWD (130 mgd) as WRD Permit No. 49240, (hereafter "existing rights"). Pending applications before the State Water Resources Department ("WRD") filed by all parties, except SHERWOOD and TUALATIN, are also set forth on Exhibit 1 (hereafter "new rights"). The existing and new rights together specify areas of usage covering the service territories of all members of WRWC. Following execution of this Agreement and formation of this entity, the parties hereto agree to execute all documents necessary to assign ownership of the existing 1973 permit to WRWC and identify WRWC as the applicant on the pending application for new rights. Thereafter WRWC shall exclusively own and manage the resources subject to this Agreement.

2.3 Allocation of Water and Diversion Point. WRWC shall become the sole holder of these rights. WRWC and its members shall each have a duty of good faith and fair dealing with each other and commitment to reasonably allocate the Willamette River water and manage the System according to an individual member's needs, considering that member's:

2.3.1 Capital contribution determined as land is acquired, facilities are constructed or cash is contributed;

2.3.2 Demand forecast for a rolling 20-year time period;

2.3.3 Development and implementation of a water system management and conservation plan consistent with the requirements or guidelines of the Regional Water Plan.

2.3.4 Other factors as agreed by separate addenda or written agreements.

2.4 Administration of Water Rights. By assignment of ownership of the Willamette River water rights, WRWC shall have the full authority to modify, combine or abandon rights and permits and seek new sources through new permits or contracting for stored water for municipal and industrial needs as the members approve.

SECTION 3. CAPITAL CONTRIBUTIONS.

3.1 Assets. Without limitation, the existing and new rights enumerated in attached Exhibit 1 (the "System") shall be employed in the System and are hereby contributed by the parties. Future agreements or addenda will identify other assets and how they are to be accounted for under this Agreement.

3.2 Effect of Membership. Each party's annual contribution towards General Administration shall entitle it to member status and each party shall own an undivided interest in the system as reflected, which shall be adjusted by capital contributions over time as set forth in Addenda or by separate written agreement. If membership status is maintained, then each party will have the right to equity participation in the construction of new or expanded facilities as they are proposed, have an option to purchase an interest in new or expanded facilities at future times, and/or to be a wholesale customer.

SECTION 4. OPERATION AND MAINTENANCE.

4.1 Generally. At such time that facilities are constructed, unless otherwise agreed in writing by the entities financially participating in the facility, the system shall be operated and maintained by WRWC, WRWC may contract with members or others to provide daily management of all or a portion of the System. Operation and maintenance will be determined at that time by the equity participants through subsequent agreement or addendum.

SECTION 5. CONSTRUCTION OF FACILITIES.

5.1 Proposal to Construct. If any member should desire to construct, expand or modify the System as now or hereafter configured, including the siting of a plant at one of the designated diversion points of 2.3 or at another location on the Willamette River, it shall notify WRWC and the other members in writing of the proposed construction, expansion or modification needs ("Project"). WRWC shall have 90 days in which to determine whether to participate in the proposed project. The notification shall include cost estimates and a reasonably detailed description of the proposed project. The members, within 90 days, shall notify the WRWC of their acceptance or rejection of participation and cost shares shall be allocated. If notice of acceptance is not received within 90 days, the proposed project shall be deemed rejected by the members failing to respond.

5.2 Individual Rights. The parties intend to provide a method of decision making by anticipated diversion points. Facilities constructed shall be in the name of WRWC but decision making shall be by the participating members as set forth in the Project Agreement. If WRWC elects not to construct, expand or modify as proposed by an individual member or members, then by separate written agreement or addenda any member or members may proceed with the 1973 rights assigned to that diversion point if the members of WRWC likely to be served by that diversion point or facility approve the technical aspects of the proposal to ensure the project will not be inconsistent with future compatibility with individual members systems. If the proposal is found inconsistent or incompatible, the member(s) may use its own water rights held outside this agreement. Under all circumstances, no such project shall impair the ability of the System to serve the other members or significantly increase the cost of usage to the other members unless the member(s) undertaking the project agrees to pay the increased unit costs to WRWC or the members which have declined to participate in the expansion. If the members likely to be served by the diversion point or facility do not approve use of the 1973 rights, then the individual entity may use other water outside this agreement or use the termination provision of Section 7. The parties agree that absent termination, only WRWC may apply for water rights to the Willamette River.

5.3 Tigard. In consideration of the abandonment of its 1995 permit application to appropriate 40 cfs, TVWD and the members of WRWC hereby allocate 40 cfs of the 1973 right at the Wilsonville diversion point to Tigard. If Tigard desires to construct a conventional treatment plant at Wilsonville to develop this right and no other members wish to participate, Tigard may proceed without further approval from WRWC or its members.

5.4 Regulatory Matters. All parties served by a facility shall share proportionately in cost if expansion or modification is necessary to meet regulatory requirements, unless subsequent agreement or addenda provides otherwise.

SECTION 6. SALE OF WATER TO OTHER ENTITIES.

6.1 WRWC. The members agree that the Willamette River water rights now existing or hereafter acquired are for regional application. The parties agree to work in good faith to accommodate other users on an ownership, wholesale, mutual aid or emergency basis. Subject to paragraph 6.2, WRWC or its members shall have the power to sell water to other non-member entities at prices determined from time to time by WRWC.

6.2 Proceeds of Sales. The proceeds attributable to the sale of water to an outside entity shall be paid to WRWC. Any distribution of these proceeds shall be as the members agree after expenses and costs of debt service, construction, operation and maintenance are met.

6.3 Transmission Line Charges. Sales to any entity which may require transmission through lines may be subject to a transmission line charge to be established by the owner. Charges for use of transmission lines shall be collected by WRWC from the user and paid to the owner of the transmission line.

6.4 Other Charges. Other charges may be established by WRWC as necessary and agreed by the parties.

SECTION 7. TERMINATION.

7.1 Notice of Election. Any party may elect to terminate this Agreement and withdraw from WRWC by giving written notice of its desire to WRWC and other member parties on or before March 1. Notwithstanding the date of notice, withdrawal shall be effective on July 1 immediately following the notice. Upon the effective date of withdrawal, unless otherwise agreed by the withdrawing party and WRWC, that party shall immediately cease membership in WRWC. The withdrawing entity shall continue to pay its share of, or be responsible for, any previously incurred joint debt, and shall hold harmless the remaining members for those financial responsibilities and obligations attributable to the withdrawing party.

7.1.1 If WRWC, after receiving the notice of termination, desires to purchase the terminating interest in the System, it shall notify the terminating member in writing of its desire to purchase the terminating member's interest at lesser of market value or depreciated book value. Such notice shall be given within 60 days of receipt of the notice of termination.

7.1.2 If WRWC declines, then the one or more remaining members may give notice within 60 days after notice of WRWC's decline of that member's intent to purchase as provided herein. Unless otherwise agreed in writing, the purchase shall be purchased equally among the buying members and their capital accounts shall be adjusted accordingly.

7.1.3 The price to be paid, whether determined by mutual agreement or arbitration, shall be paid to the terminating party in full within 12 months following the date of termination set forth in the notice of intent to terminate. If the other party fails to pay the purchase price within 12 months of the date of termination and if the parties are unable to agree upon a mutually acceptable payment schedule, then the terminating member shall have the right to sell its portion of the facility to any other entity approved by a majority of the governing boards or councils from the remaining members.

7.1.4 In the event that the WRWC or the remaining members fail to purchase the interest of the terminating member within the 12-month period, or in the event the WRWC or the remaining member(s) decline to purchase its interest, then the terminating member's rights and duties shall be those specified in this Agreement until a sale is made to some other entity or some other mutually agreeable disposition is made and the original owner shall remain responsible for all terms and conditions of this Agreement.

7.1.5 Notwithstanding anything to the contrary, because TVWD contributed the existing permitted rights (1973 rights), no withdrawing party shall be compensated for the value of those 1973 rights except TVWD. If TVWD decides to withdraw from WRWC, it may:

a) leave the entire 1973 water right with WRWC and WRWC shall purchase the right as appraised along with the entities' other assets. However, 40 cfs shall not be valued as part of this appraisal and purchased because it is allocated to TIGARD in consideration of TIGARD'S relinquishment of its 1995 permit application; or

b) leave the allocated portion of the 1973 rights which will be valued and purchased by WRWC and take the unused remainder back to its sole ownership. However, 40 cfs shall not be valued as part of this appraisal and shall be included in the portion left in WRWC as it is allocated to TIGARD in consideration of TIGARD's relinquishment of the 1995 permit application; or

c) TVWD may leave all the 1973 rights and, in lieu of monetary compensation, receive an equal amount (202 cfs) of junior rights under 7.1.6 below.

7.1.6 For the parties other than TVWD, in the event of termination, the terminating member shall be entitled to have conveyed to it by WRWC the water rights associated with the pending application the terminating member contributed to WRWC. For example, if the pending application was approved for Canby in the amount of 12.4 cfs and Canby terminates, Canby shall relinquish all rights and claims to any water allocated to its diversion point under the 1973 Permit contributed by TVWD and WILSONVILLE, and WRWC shall assign to Canby the 12.4 cfs Permit right that Canby contributed to the entity. Thereafter Canby shall rely only upon that 12.4 cfs water right and have no further right or claim to other WRWC rights.

7.1.7 The parties agree that TIGARD shall have a firm right to 40 CFS of the TVWD 1973 rights in consideration of its abandonment of its 1995 permit application.

7.1.8 The parties agree to cooperate to execute all documents necessary to make water right transfers and assignments.

7.2 Breach. Upon material breach of this Agreement, WRWC or an aggrieved member may seek all remedies available at law or in equity.

7.3 Dispute Resolution.

7.3.1 Method for resolving disputes. If a dispute arises between WRWC and a member or between members regarding breach of this Agreement or interpretation of any term of this Agreement, the parties shall first attempt to resolve the dispute by negotiation, followed by mediation, if negotiation fails to resolve the dispute.

Step One: (Negotiation)

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

Step Two: (Mediation)

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

7.4 Jurisdiction of Circuit Court. After exhaustion of 7.3 processes, if the parties agree, any dispute or claim shall be settled by arbitration under the jurisdiction of the Circuit Court of the State of Oregon for Clackamas County pursuant to ORS Chapter 36. In the absence of such an agreement, that same court shall have jurisdiction.

SECTION 8. AMENDMENT.

This Agreement may be amended by mutual written agreement of the parties, signed by all of the parties. Future tasks deemed necessary shall be agreed to by the parties through an addendum to this Agreement setting forth the scope of work and method of payment.

SECTION 9. GENERAL PROVISIONS.

9.1 Merger Clause. This Agreement embodies the entire agreement and understanding between the parties hereto and supersedes all prior agreements and understandings relating to the subject matter hereof.

9.2 New Members and Assignment. WRWC may accept additional government entities as participants under terms and financial conditions that WRWC deems just and equitable on a case-by-case basis and only upon an affirmative vote of two thirds of the members. Except for changes of organization through entity formation, merger, consolidation or annexation, no party shall have the right to assign its interest in this Agreement (or any portion thereof) without the prior written consent of a majority of WRWC.

9.3 Severability. In case any one or more of the provisions contained in this Agreement should be invalid, illegal, or unenforceable in any respect, the validity, legality, and enforceability of the remaining provisions contained herein shall not in any way be affected or impaired thereby.

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

Tualatin Valley Water District
Attn: General Manager
P.O. Box 745
Beaverton, Oregon 97075

Canby Utility Board
Attn: General Manager
P.O. Box 1070
Canby, Oregon 97013

City of Tigard
Attn: City Manager

P.O. Box 23397
Tigard, Oregon 97223

City of Sherwood
Attn: City Manager
20 NW Washington
Sherwood, Oregon 97140

City of Tualatin
Attn: City Manager
18880 SW Martinazzi Avenue
Tualatin, Oregon 97062

City of Gladstone
City Administrator
525 Portland Avenue
Gladstone, Oregon 977027

The parties hereto are responsible to notify each other of changes and to keep this list current.

9.5 Meetings. Regular meetings of WRWC shall be conducted at such times as WRWC may designate but shall be no less than quarterly. The chairman, upon his own motion, may, or at the request of two (2) members of WRWC, shall by giving notice to members of WRWC call a previously unannounced special meeting of WRWC for a time not earlier than twenty-four (24) hours after the notice is given, unless an emergency exists. In cases of an emergency, notice reasonable under the circumstances shall be given. Four (4) members of WRWC shall constitute a quorum. No action will be taken by WRWC unless a majority of WRWC present votes to support the action proposed, unless a greater number of votes is required.

9.6 Advisory Boards; Technical Committees. WRWC may appoint advisory boards and technical committees. The advisory boards shall meet as needed and shall review and make recommendations to WRWC on such matters as WRWC so assigns. A technical committee shall meet not less than quarterly to develop methods of coordination and functioning between WRWC and the entities.

9.7 Attorney Fees. If a dispute should arise between the parties regarding any term or portion of this Agreement, the prevailing party shall be entitled to such reasonable attorney fees as a trial court or arbitrator may award and on any appeal therefrom.

9.8 Counterparts. This Agreement may be executed in any number of counterparts and by the parties on separate counterparts, any one of which shall constitute an agreement between and among the parties.

9.9 Joint and Several Obligations. For approved WRWC activities, the parties shall be jointly and severally liable to third parties for payment of debts and costs incurred. No party to

WRWC shall be liable for damages, debts or claims caused solely by the negligent act or omission by WRWC or other members. The individual entity causing damage by its sole negligence or wrongful act shall be individually liable.

9.10 Instruments of further Assurance. From time to time at the request of any of WRWC, each member shall, without further consideration execute and deliver such additional instruments and shall take such further action as may be reasonably required to fully effectuate the purposes of this Agreement.

IN WITNESS WHEREOF, the parties have executed this Intergovernmental Cooperative Agreement by the date set forth opposite their names below.

TUALATIN VALLEY WATER DISTRICT

Date: 8/20/03, ~~2003~~

By: ______________________
Richard P. Burke, President

By: ______________________
Lisa Melyan, Secretary

CANBY UTILITY BOARD

Date: 10/2, 2003

By: Shawn Farrell

By: Barbara Benson

CITY OF TIGARD

Dated: 10/7, 2003

By: ______________________
CRAIG DIRKSEN, COUNCIL PRESIDENT

By: Catherine Wheatley
CATHERINE WHEATLEY, CITY RECORDER

Date: October 23, 2003

CITY OF SHERWOOD

By: ______________________
Mark O. Cottle, Mayor

By: ______________________
C.L. Wiley, City Recorder

Date: 10/13, 2003

CITY OF TUALATIN

By: ______________________
Lou Ogden, Mayor

By: ______________________
Steve Wheeler, City Recorder

Date: October 20, 2003

CITY OF GLADSTONE

By: Wade Byers
Wade Byers, Mayor

By: Jonathan Block
Jonathan Block, City Recorder

EXHIBIT 1

PENDING APPLICATIONS

Applicant	Amount	Priority Date	Application #
CUB	12.4 cfs	12/27/90	71072
TVWD	387 cfs	5/31/91	71651
Gladstone	12.4 cfs	9/13/91	71834
Tigard	40 cfs	3/28/95	80342

EXISTING PERMITTED RIGHTS

Applicant	Amount	Priority Date	Permit #
TVWD	202 cfs	6/19/73	49240

WILLAMETTE RIVER WATER COALITION

BYLAWS

ARTICLE 1

PURPOSE AND OBJECTIVES

The Willamette River Water Coalition ("WRWC") was created for the following general purposes:

A. To maintain the public's rights on the Willamette River for local and regional needs.

B. To study local water demands, jointly evaluate water quality of the Willamette River and ~~determine the most economic, efficient, and available source to supply short and long-term~~ demands.

C. To provide a forum for the study and discussion of water supply issues of mutual interest to members and to coordinate the responses of members to such issues;

D. To provide a forum for review and discussion of water resource related issues preliminary to any final actions by individual members, regarding issues which could be considered to relate to application of the statewide land use goals, comprehensive plans, regional plans, or land use regulations;

E. To establish an avenue for public participation and education in water supply issues in addition to public participation activities of the individual Participants;

F. It is intended that these bylaws be in compliance with the Intergovernmental Cooperative Agreement Creating the Willamette River Water Coalition, hereinafter referred to as the "WRWC Agreement".

ARTICLE 2

MEMBERSHIP

Composition

A. Current Members

The current members in the WRWC are: Tualatin Valley Water District, the Canby Utility Board, the City of Tigard, the City of Tualatin, the City of Gladstone and the City of Sherwood.

B. Additional members.

Any public entity providing drinking water wishing to join WRWC, shall so inform the Board, in writing, and shall comply with whatever standards and or financial criteria the WRWC Agreement or Board has established. The written request to join WRWC must include a statement providing the reasons the entity desires to become a member. Such entity shall then become a participant in the WRWC if two-thirds of the members vote in favor of its admission.

Withdrawal

Any member may withdraw from the WRWC at any time by giving written notice in accordance with Section 7 of the WRWC Agreement.

Membership Term

Each member shall retain a position on the Board so long as it does not withdraw or fail to pay its dues.

ARTICLE 3

WRWC BOARD

General

The Willamette River Water Coalition Board was established by the WRWC Agreement and is the entity to which these bylaws apply. This group will be addressed as the "Board" in these bylaws.

Composition

Standing Members

The Board shall be composed of one representative from the governing board, commission or council of each WRWC member. Each member shall also name an alternate Board representative from its governing board, commission or council to serve in case the primary representative cannot serve. If the Board Chair does not attend a meeting the Vice-Chair shall assume the Chair's duties.

Each governing board, commission, or council shall notify the Board Chair, and staff, in writing, of any change in their chosen Board representative and alternate.

Authority

The Board is authorized to:

1. Approve and amend the WRWC's annual work plan and budget as further described in the WRWC Agreement. This shall occur by February 1 for the upcoming fiscal year beginning July 1;

2. Set dues;

3. Set WRWC policy and carry out the powers of the WRWC Agreement;

4. Approve additional governmental entities as members;

5. Establish the terms and financial arrangements under which such new members may be accepted, or permit new members to join on a case by case basis, so long as no new member is permitted to join without two-thirds affirmative vote of the Board;

6. Recommend water supply, water planning and management and cooperative actions to member's governing boards, commissions or councils, including but not limited to actions to develop water sources;

7. Recommend to the governing boards, commissions or councils amendments to the WRWC Agreement.

8. Adopt and amend bylaws;

9. Except as provided below, assign such duties or delegate such Board authority as the Board deems advisable to any Board committee, subcommittee or to a technical committee.

10. Establish Board subcommittees and other advisory committees or bodies as the Board may deem necessary to conduct its business. Subcommittees and/or advisory committees may be created or dissolved by vote of the Board. If so created the Board shall designate the chair and membership of the committee and may establish terms of membership. The Board may also appoint advisory committees which are not solely composed of members. The Board may invite persons with special expertise or interests and lay persons to sit upon any advisory committee.

11. Approve and/or authorize funding for special studies supportive of WRWC's work;

12. Seek and accept sources of revenue other than dues and to authorize other expenditures so long as these are to be covered by identified sources of revenue; and

13. Exercise any other powers and authority granted to the WRWC in the WRWC Agreement

necessary to accomplish WRWC's purposes.

Non-Delegable Board Authority

The Board may not delegate authority to:

(1) execute intergovernmental agreements;

(2) approve the annual work plan and the budget;

(3) approve the admission of members to the WRWC; or

(4) dissolve the WRWC.

Meetings

Generally

The Board shall determine how frequently to meet, provided however, that it must meet at least quarterly.

Special Meetings

The Board may meet at times other than those regularly scheduled as deemed necessary by the Board, the Board Chair or any two Board members.

Location

The location of Board meetings shall be as determined by the Board but shall be determined with lead time sufficient to provide adequate notice.

Permitted Methods of Participation by Board Members

Board members may participate in meetings by physically attending the meeting or, if a Board member has forewarned the staff, when neither a Board member, or alternate, is physically able to attend the meeting, through electronic means which permit a "non-attending" Board member to hear and fully participate in all of the proceedings and which permits all those in the meeting room to hear the comments of the non-attending member or alternate.

Conduct of the Meetings

All Board meetings shall be conducted in accordance with the latest edition of or revision to Robert's Rules of Order or as formally modified by the Board.

Opportunities for public comment will be provided at each Board meeting in the discretion of the Board Chair.

Notice

Notice of all Board meetings shall be noticed as required by the State of Oregon's public meetings law. Notice shall be provided by the staff, if any, or such other Participant or staff person as the Board Chair directs.

Quorum

To be effective, Board actions must be approved by a vote of a majority of the Board Members present at a meeting at which a quorum of the Board is present. If the membership is an odd number, a majority shall constitute a quorum. If the membership is an even number, a quorum ~~shall consist of fifty percent of the members plus one.~~

Bylaws Adoption

The Board shall adopt bylaws within three months of its first meeting.

Voting

Each Participant member of the Board shall have one vote. Alternates in attendance may vote, in the absence of the primary representative, but voting by proxy shall not be allowed.

ARTICLE 4

OFFICERS

The Board shall have at least the following official positions:

1. Board Chair.

2. Board Vice-Chair.

The Board may elect a secretary or other officers as well. If such other officers are elected then their terms in office and duties shall be described by the Board. The Secretary shall be a staff member.

Terms of Office

The terms in office for the Chair and Vice-Chair shall be as follows:

1. Chair - one year with a possible succession of one more consecutive year if re-elected by the Board.

2. Vice-Chair - one year with a possible succession of one more consecutive year if re-elected by the Board.

Duties

The duties of the Chair are:

1. ~~Preside at all Board Meetings~~

2. Make all committee appointments assigned to the Chair in these bylaws

3. Scheduling regular and special meetings

4. Act as spokesperson for the WRWC on adopted WRWC policy deliberations and actions, and to delegate such responsibility as deemed appropriate

5. Sign Board approved contracts and intergovernmental agreements on behalf of the WRWC

6. Ensure adherence to the bylaws

7. Work with staff and any technical committee to create Board agendas

8. Review meeting minutes

9. Sign all WRWC documents which contain statements of WRWC policy

10. Delegate responsibility for signing routine and non-policy documents

11. Such other duties as the Board or the WRWC Agreement assign to the Board Chair.

The duties of the Vice-Chair are:

1. Provide whatever assistance the Board Chair requests

2. Perform the functions of the Board Chair when the Chair is not available

3. Perform such other functions as may be assigned by the Board or the WRWC Agreement.

Delegation of Duties

Whenever an officer is absent, or unwilling or unable to perform the officer's duties, the Board may appoint another participant Board member to perform the officer's duties until the officer recovers, returns or a new officer has been elected, as deemed appropriate by a majority of the Board.

Election

All officers of the Board shall be elected by a majority vote of the Board at a meeting at which there is a quorum.

Vacancies

Any vacancy occurring on the Board by reason of resignation, death or otherwise shall be filled by an alternate until official notice of a new representative is given by the affected member entity. If the alternate is appointed to serve as the primary representative, a new alternate shall also be named. These designations shall be provided to the Board Chair and staff, in writing, and shall occur within a reasonable time of the vacancy. The Vice-Chair shall take over for the Chair should that position become vacant. A new Chair will be chosen at the next Board meeting at which there is a quorum present.

When a member's representative, or alternate, no longer holds a position with the governing body, board, commission or council of that member, that person may no longer serve on the Board.

ARTICLE 5

PRESUMPTION OF ASSENT

A Board member, or a member of any committee, subcommittee or advisory committee, created by the WRWC Agreement or the Board, who is present at a meeting where action was taken and that person would have had a right to vote, is deemed to have assented to action unless his or her dissent or abstention shall be entered in the minutes of the meeting.

ARTICLE 6

FISCAL MATTERS

These matters are addressed in Section 1.6 of the WRWC Agreement and through the Board's authorization herein.

ARTICLE 7

EMPLOYMENT OF STAFF

Staff employment for the WRWC will be addressed in the annual work plan.

ARTICLE 8

ADVOCACY

On Behalf of the WRWC

Only the Board Chair, or Vice-Chair if the Chair is not available, shall be authorized to act for the WRWC. The Chair may, however, delegate this authority to other members or staff but only as to previously Board authorized positions.

Disclaimer

Any major policy or program documents issued by the WRWC shall state, if true, that the documents do not necessarily represent the views of all the members in the WRWC.

ARTICLE 9

DISPUTE RESOLUTION

The purpose of the dispute resolution process is to enable all members to resolve, in an amicable and constructive way, conflicts that are relevant and may materially affect implementation of the Plan, WRWC Agreement or Bylaws. Dispute resolution shall be in accord with the WRWC Agreement.

ARTICLE 10

DISSOLUTION

The WRWC shall be dissolved when only one member remains or the Board votes to dissolve.

ARTICLE 11

BYLAW AMENDMENT

These Bylaws may be amended by a majority vote at a Board meeting when a quorum is present. If possible, proposed Bylaw amendments should be listed in the notice of the meeting at which they will be considered.

APPENDIX G

PSE
Peterson Structural Engineers, Inc.
consulting structural engineers
Charles Gary Peterson, P.E.
Erik W.B. Peterson, P.E.
5319 sw westgate drive, suite 215
portland, oregon 97221
503/292-1635
fax: 503/292-9846

RECEIVED
NOV 10 2004
MURRAY, SMITH & ASSOCIATES, INC.

11/3/04

Eugene Thomas, P.E.
City of Sherwood
20 NW Washington St.
Sherwood OR 97140

File: Pse\99-21-25

Re: City of Sherwood Snyder Reservoir Repairs – Wall Base Investigation

Dear Gene:

The following report outlines the results and recommendations obtained from our investigation of the conditions at the base of the core wall at the Snyder Reservoir. Our reservoir condition report dated 11/10/99 identified potential overstress conditions in the seismic cables connecting the foundation to the core wall. This investigation revisits our original analysis and explores alternate analysis criteria and seismic resisting elements.

1999 REPORT FINDINGS

As stated in our 1999 report, the reservoir was constructed in 1973 on the northwest face of a hill to the southeast of downtown Sherwood, OR. The surrounding ground slopes down to the northwest. We obtained from our own files copies of the original construction drawings. They consist of ten drawings prepared by Lewis N. Powell, Engineer with Robert E. Meyer Engineers, Inc., and dated August 1972. Members of Peterson Structural Engineers, Inc. (PSE) assisted in the design and preparation of those drawings. The General Contractor was Keizer Construction Co. of Canby OR and the prestressing contractor was BBR, Inc. now DYK, Inc. of El Cajon, CA.

According to the construction drawings, the reservoir is a cylindrical prestressed concrete tank with a 105'-0" inside diameter and a 32'-11" wall height. The tank corewall is 8" thick with 1" diameter vertical post tensioning tendons at 30" on center inside the wall. The wall is wrapped with 3/8" diameter galvanized wire and coated with a layer of shotcrete to a maximum thickness of about 2". The concrete roof slab is 6" thick and supported by beams and columns on a 21'-0" square grid inside the tank. The columns are 14" square and the beams are of varying dimensions depending on location. The roof slab rests on a rubber pad and corbel constructed on the inside face of the wall. There is an 8" wide continuous curb around the roof perimeter which is an extension of the corewall. The overflow water depth is 31'-0" at the wall.

The joints at the corewall base and top were designed with flexible connections which allow the reservoir floor, wall and roof to translate independently during a seismic event. This improves the performance of structure as compared to reservoirs with fixed joints. The Snyder reservoir base joint has seismic cables to connect the corewall to the foundation. According to the original drawings, each assembly has a single 0.6" diameter cable which is cast horizontally into the wall footing and also cast into the wall with the cables angled at 30 degrees from horizontal. The cable assemblies are positioned at approximately 8'-0" on center. Note on the attached drawing of the wall base details that the base of the wall is located 9" below the top surface of the floor slab. There is a gap of indeterminate width between the corewall and raised slab which, per the original drawings, was filled with a mortar and joint sealant.

The 1999 structural evaluation of the reservoir was performed using gravity and lateral loads as specified by recent codes which include 1) the 1998 State of Oregon Structural Specialty Code (OSSC, which is based on the Uniform Building Code, 1997 Edition), 2) Building Code Requirements for Structural Concrete (ACI 318-95 by the American Concrete Institute), and 3) the American Water Works Association Standard for Wire- and Strand-wound Circular, Prestressed Concrete Water Tanks (AWWA D110-95). As of the date of issue of this report, the State of Oregon is in the process of transition from the 1998 OSSC to the 2003 OSSC (which is based on the International Building Code, 2003 Edition).

We have reviewed potential lateral loads from the 2003 International Building Code (IBC). While the AWWA code currently in force is still the design code for this type of structure, we found that IBC loads were slightly lower than those used in the original AWWA analysis. Therefore we believe that implementation of the new codes should not have considerable effect on the overall existing analysis.

ANALYSIS

Our 1999 analysis and report suggested that the cable sets were overstressed for the prescribed code level seismic loads. More specifically, we calculated that the cables were at 215% of the allowable cable stress or, in other words, each cable set would need to have 2.15 cables rather than the single cable installed. This is a result of an increase in code level seismic loads from the time of the original design to the time of the current analysis. Using the current loads, elements other than the existing seismic cables would need to be considered or installed to absorb 54% of the prescribed lateral load.

When considering the design or analysis of prestressed concrete reservoirs, only the direct mechanical connections are considered in design to resist seismic loads. Some potential seismic resisting elements such as passive soil resistance are commonly ignored. The reason for this is that soil, specifically, can shrink away from the tank sides creating a gap large enough that mechanical connectors may become overstressed from lateral motion before the surrounding soil can develop any significant contributing resistance. Another reason for ignoring soil contribution is that during a seismic event, the soil is also in motion and may move in a direction that will nullify any expected passive resistance.

That said, we may consider using a portion of soil resistance to resist lateral load based on the recommendations of a Geotechnical Engineer. This would entail having a Geotechnical firm perform a site investigation based on required structural design criteria and generate a report giving recommendations on expected soil performance around the reservoir.

As mentioned above, we have used design loads prescribed by recent codes. Concurrent with a geotechnical report on the soil performance surrounding the reservoir, the Geotechnical Engineer may also perform a site specific seismic study. Information from the results of this study will give seismic loads that can be expected from the specific reservoir site. These loads may be lower that code prescribed loads which, if we elect to use them, may decrease the overstress conditions in the wall base connection.

We have performed additional analysis on the seismic cables in the corewall base connection to determine the expected corewall horizontal deflection at the point of maximum allowable cable stress. The maximum allowable deflection was found to be 1/8". As mentioned above, the attached detail shows a gap of indeterminate width in the joint between the footing edge and the corewall. We assume at this time that the joint is very likely wider than the allowable 1/8" deflection allowed by the seismic cables. Therefore any contribution of the wall contacting the footing edge would require that the seismic cables yield or fail.

REPAIR OPTIONS AND CONSIDERATIONS

It is our understanding that, at this time, the reservoir must remain in service for supply and fire suppression. Because of this, we have divided our repair considerations into in-service and out-of-service conditions. A significant factor in making a repair to the existing reservoir is considering the desired remaining life span of the structure and the costs associated with the repair. It is our understanding that the City currently has a new master plan being developed by Murray, Smith & Associates (MSA). In generating this report, we have consulted with MSA personnel to insure, to the extent possible, that our recommendations are not in conflict with the future infrastructure.

In-service Repairs

Mechanical upgrades to the reservoir in an in-service condition would be limited to the exterior of the wall base joint. This would require excavation of the soils surrounding the exterior of the reservoir which vary between 7' and 18' in depth. Exposure of the exterior wall base would allow for the installation of a system which would either increase base connection strength or limit allowable base deflection to alleviate cable overstress.

Because the exterior of the reservoir is wrapped with prestressing wire, an exterior repair system could not be bolted to the wall because of potential wire damage. A potential repair option might be the installation of a concrete curb doweled into the footing and set 1/8" clear of the exterior of the wall. The theory behind this repair is that it would allow the wall base to move and the cables to stretch to the allowable length which maximizes allowable cable stress. Seismic loads trying to translate the wall base past 1/8" deflection would then be resisted by the newly installed curb and translated to the footing through the reinforcing dowels in the curb.

There are potential shortcomings with the exterior curb option. Excavation and reinstallation of the existing backfill may be prohibitively costly. Another difficulty would be that the exterior shotcrete on the wall likely varies in thickness by more than 1/8" making construction of the curb to a consistent 1/8" away from the wall quite difficult.

A second option would be to install additional seismic cables against the existing exterior wall and cover them with additional shotcrete. The foundation connection would likely entail some foundation demolition and/or increased foundation thickness.

Another in-service option, which is not a repair but rather an analysis consideration, is to refine the analysis loads by obtaining site specific loads from a Geotechnical Engineer. As we discussed in the analysis portion of this report, site specific loads might be lower than code prescribed loads. While a reduction of loads by the required 54% to make the wall base compliant with allowable cable stresses is not likely, the report would give a more accurate representation of the level of load expected at the site.

Preliminary construction cost estimates for in-service repair options would likely be in the range of $150,000 to $250,000 in current dollars.

Out-of-service Repairs

Mechanical upgrades to the reservoir in an out-of-service condition could be made at the wall base on the interior of the reservoir. There are various options that could be considered including installation of the same concrete curb described in the in-service repair section of this report. This curb would be configured with a positive connection to the inside face of the corewall and encase a shear can system similar to those used on the wall top connection of conventional prestressed reservoir designs. The configuration of the shear cans would allow radial expansion of the reservoir but limit lateral translation.

An alternate potential repair would consist of the installation of additional stainless steel seismic cables, bolted to inside face of the corewall and bolted to the footing or cast into an added curb. This repair would likely require a large amount of mechanical connections and be cost prohibitive compared to the curb installation.

Preliminary construction cost estimates for out-of-service repair options would likely be in the range of $80,000 to $150,000 in current dollars.

CODE LOADS VS. SITE SPECIFIC LOADS

As we have discussed above, the loads used to generate the current evaluation of the condition of the corewall base connection were obtained from building codes which were recently in force and commensurate with current codes. These codes take into account seismic zone, structure type and period as well as critical use designation to determine the magnitude of load that must be applied to a structure. Generation of the load criteria in the codes are based on known geological conditions, analytical and empirical structure performance modes, public safety considerations and probabilistic seismic return periods for various magnitude seismic events. The seismic zone factors cover a large geographic area and are thus somewhat conservative for most locations.

Historically, code level seismic loads have increased due to new scientific data and increased public interest. The existing structure was designed at a time when the local seismic zone was designated as zone 2, rather than the zone 3 used in the analysis, and seismic loads were substantially less than the current code requirements. Another example of code increases is the recent reclassification of portions of the Oregon coast from seismic zone 3 to zone 4. It is difficult to anticipate when code increases may occur and, because of the reactive nature of building codes, a significant future seismic event in the Northwest would probably result in reconsideration of the current design values.

A site specific seismic evaluation is performed to generate, through some of the same processes as the codes, an expected seismic lateral ground acceleration for the specific site location. The graphs generated by the evaluation give varying levels of ground acceleration for different structure periods. As one would expect, this evaluation may reveal ground accelerations which may be lower or higher than code level accelerations. This is based on proximity to a seismic source and the expected behavior of the soils on which the structure is founded.

When performing a structural design for a new system, site specific loads are compared to code level loads for determination of which loads will be used for the seismic design. Code requirements for new construction dictate a minimum level of load used and this minimum load may be used or increased based on the level of load anticipated for the site. For new construction the design team will often use a higher level of design load than the minimum required, partially as a conservative approach and also in anticipation of future code level load increases.

When considering existing structures, the level of seismic load used in evaluation must be weighed against the remaining usable life span the existing infrastructure contribution of the structure. The probabilistic risk an Owner is willing to accept can have a dramatic effect on the approach and costs associated with structure rehabilitation.

SUMMARY & RECOMMENDATIONS

As stated above, the wall base joint has insufficient capacity to support current code seismic loads. Failure of the wall base joint connection can lead to structural damage as well as the potential for content leakage. We therefore recommend that some form of remediation be performed in this area of the structure.

Because of the anticipated costs associated with in-service repairs plus the current need to keep the reservoir in service, we would recommend beginning the repair process by having a Geotechnical Engineer perform the aforementioned site specific seismic evaluation. We make this recommendation because we feel that scrutiny of the seismic loads would help to serve the existing evaluation of base connection as well as help to refine the level of risk expected for the structure.

We understand that a new reservoir is being considered adjacent to the existing reservoir. Information provided in a current seismic evaluation could be used in the design of a future reservoir. In view of the adoption of the IBC, we recommend that the site specific seismic survey provide response spectra for 0.5% and 5% damping for both 10% chance of exceedance in 50 years (500 year return period) as well as 2% chance of exceedance in 50 years (2,500 year return period).

It is important to note that if the site specific seismic evaluation yields loads lower than current code values, short term risk may be considered reduced. However, this area of Oregon is considered a high risk seismic zone and the theoretical determination of loads is just that, theoretical. The area is always subject to the potential for a seismic event which exceeds both code and site specific load requirements.

Evaluation of risk for the Snyder reservoir should assume that overall structure has a remaining life duration of approximately 10 to 15 more years. This is assuming the wire wrapping and other concrete reinforcing steel maintain their integrity and the reservoir is not subject to a cataclysmic event. It also assumes the structure is maintained and recommended upgrades are made. Should these elements be in good condition in 15 years time, it is very possible that the reservoir could stay in service for a considerable amount of time, possibly as long as 30 years. For the purposes of planning, however, we recommend 10 to 15 years as a realistic expectation.

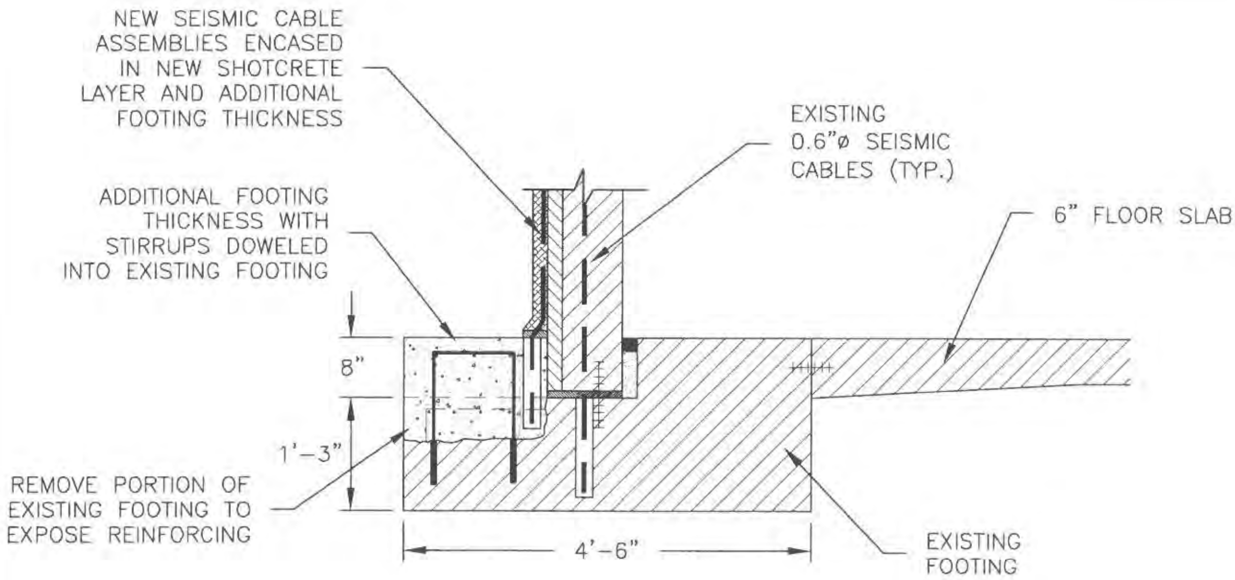
We thank the City for the opportunity to provide this report. Should design services be required for the implementation of wall base repairs, we are available to provide these services and construction documents.

Please call if you have any questions.

Sincerely,

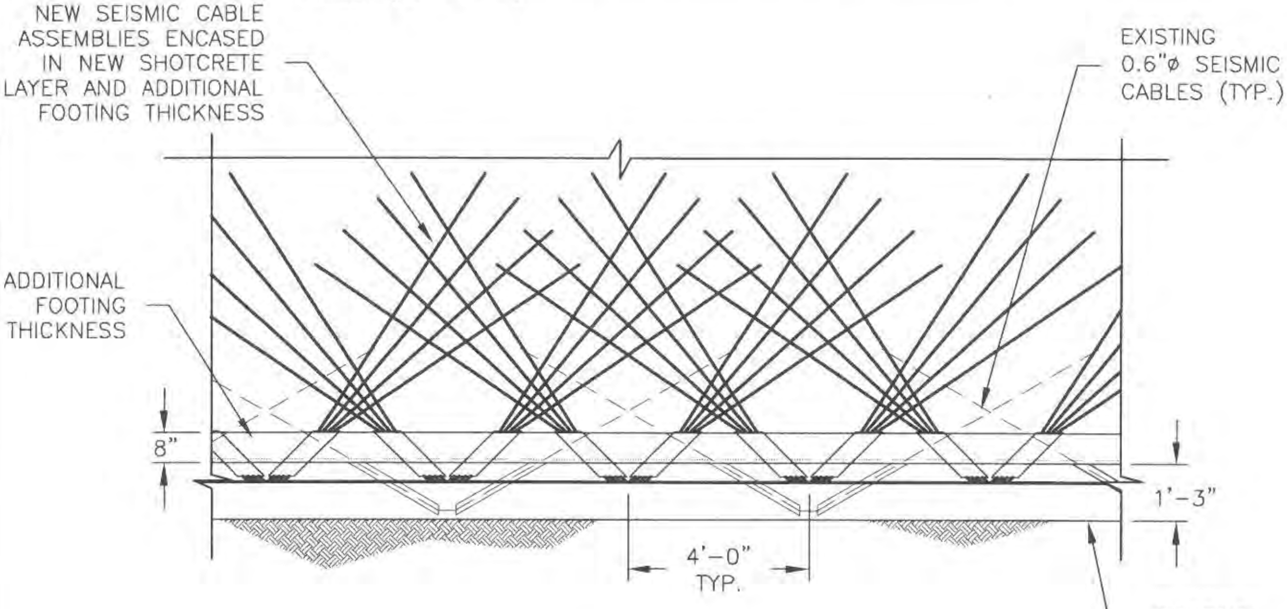
Erik Peterson, P.E.

REGISTERED PROFESSIONAL ENGINEER
56275
OREGON
JULY 9, 2001
ERIK WILLIAM PETERSON
EXPIRES 12/31/04



RETROFIT FOOTING SECTION

SCALE: 1/2" = 1'-0"



RETROFIT SEISMIC CABLE ELEVATION

SCALE: 1/4" = 1'-0"

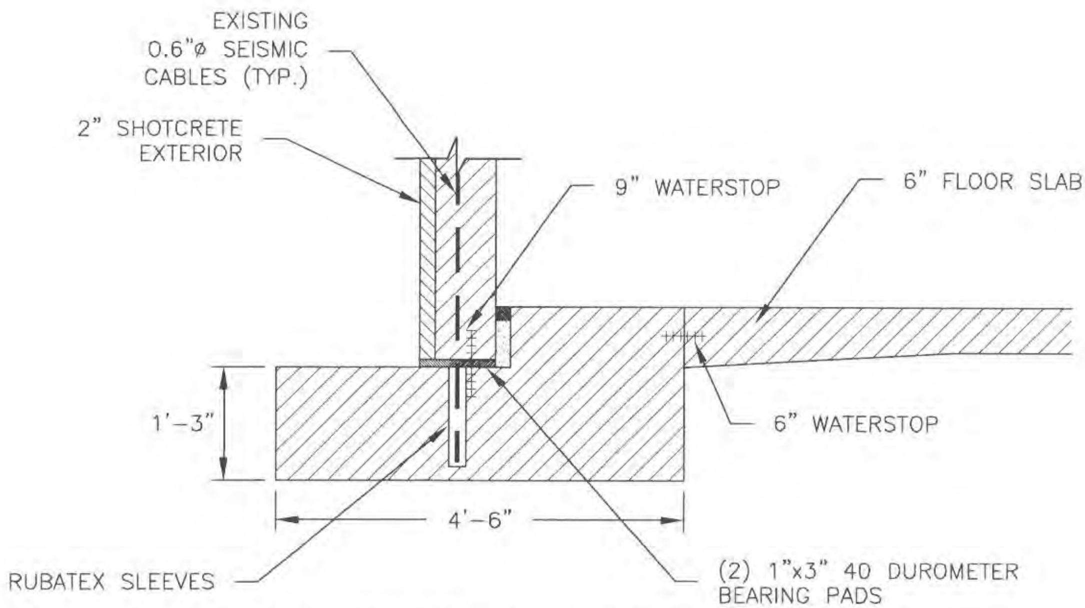
IN-SERVICE REPAIR

INSTALL ADDITIONAL SEISMIC CABLES

PRELIMINARY – NOT FOR CONSTRUCTION

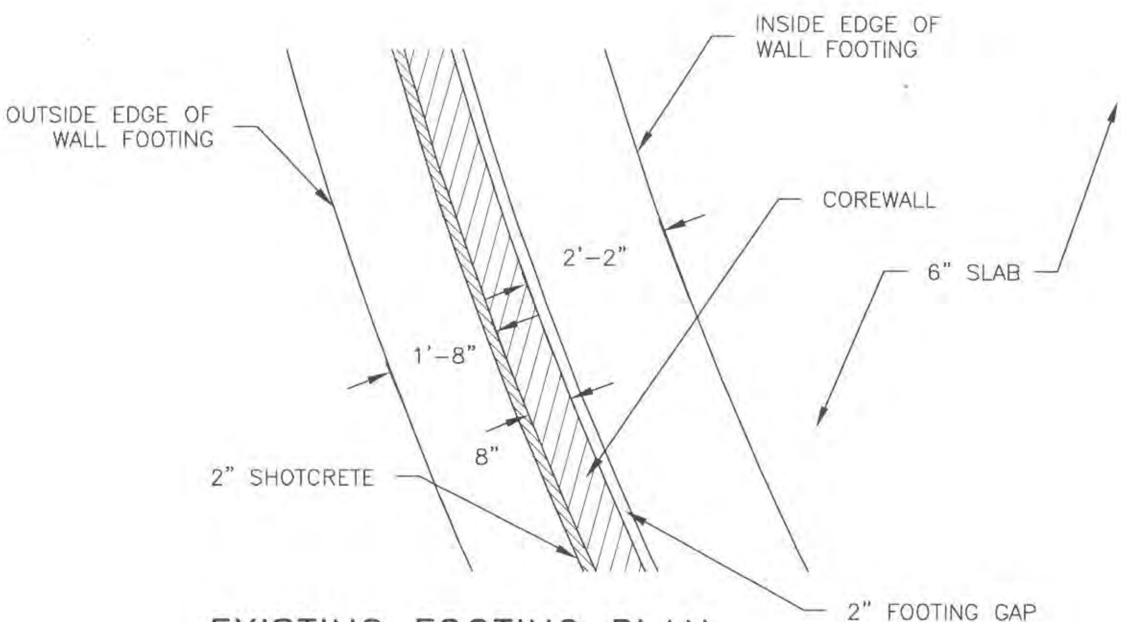
PSE
Peterson Structural Engineers, Inc.
5319 S.W. Westgate Dr., Suite 215
Portland, Oregon 97221
(503) 292-1635

SNYDER RESERVOIR RETROFIT FOOTING SECT. AND CABLE ELEVATION		
DRAWN BY:	DATE: 3/2/05	FILE
EWBP	SHEET 2 OF 4	99-21-02



EXISTING FOOTING SECTION

SCALE: 1/2" = 1'-0"



EXISTING FOOTING PLAN

SCALE: 3/8" = 1'-0"

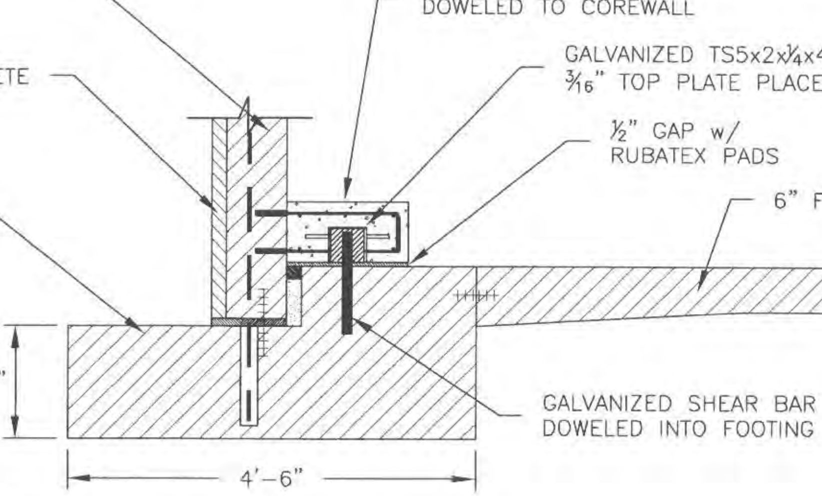
OUT-OF-SERVICE REPAIR

INSTALL INTERIOR CURB & SHEAR CANS

PRELIMINARY – NOT
FOR CONSTRUCTION

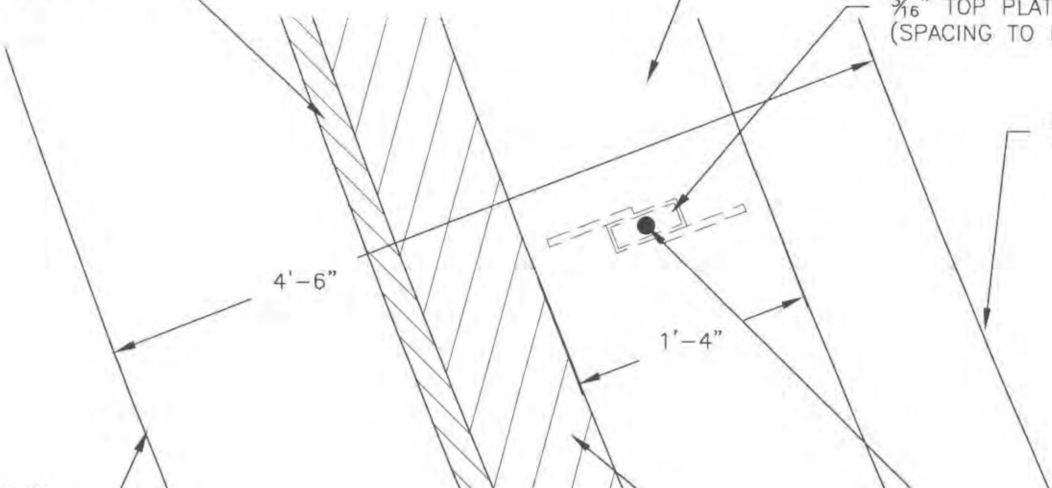
PSE
Peterson Structural Engineers, Inc.
5319 S.W. Westgate Dr., Suite 215
Portland, Oregon 97221
(503) 292-1635

SNYDER RESERVOIR EXIST. FOOTING SECTION AND FOOTING PLAN		
DRAWN BY:	DATE: 3/2/05	FILE
EWBP	SHEET 3 OF 4	99-21-02



RETROFIT FOOTING SECTION

SCALE: 1/2" = 1'-0"



RETROFIT FOOTING PLAN

SCALE: 1" = 1'-0"

OUT-OF-SERVICE REPAIR

INSTALL INTERIOR CURB & SHEAR CANS

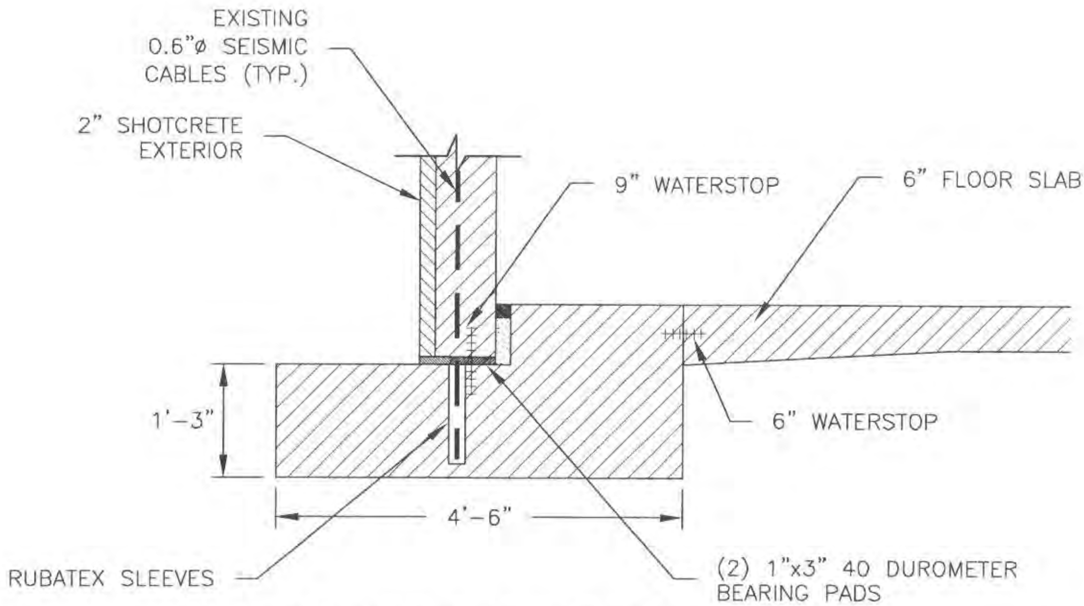
PRELIMINARY – NOT FOR CONSTRUCTION

PSE

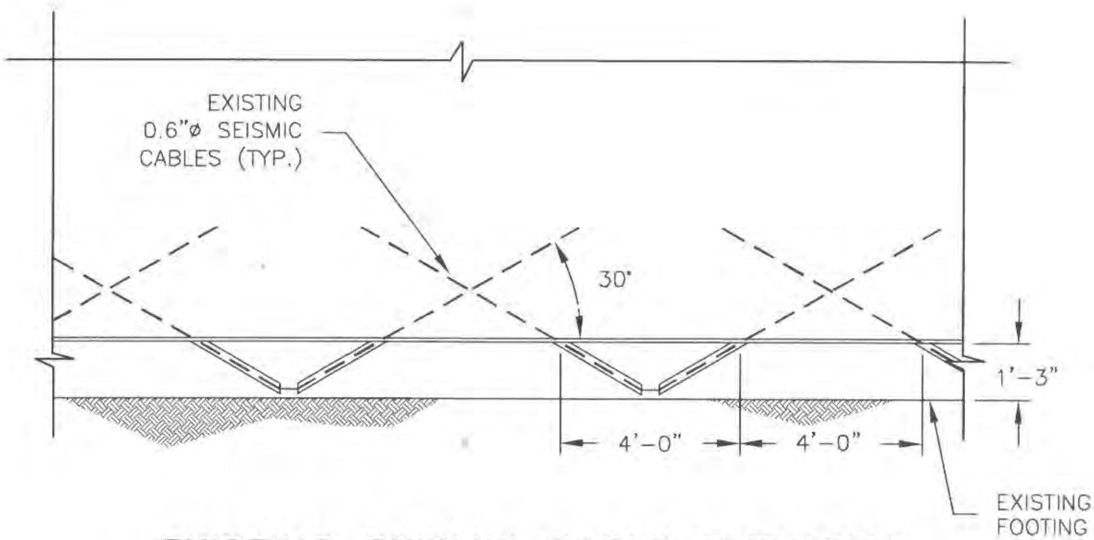
Peterson Structural Engineers, Inc.
5319 S.W. Westgate Dr., Suite 215
Portland, Oregon 97221
(503) 292-1635

SNYDER RESERVOIR
RETROFIT FOOTING SECT. AND FOOTING PLAN

DRAWN BY:	DATE: 3/2/05	FILE
EWBP	SHEET 4 OF 4	99-21-02



EXISTING FOOTING SECTION
SCALE: 1/2" = 1'-0"



EXISTING SEISMIC CABLE ELEVATION
SCALE: 1/4" = 1'-0"

IN-SERVICE REPAIR

INSTALL ADDITIONAL SEISMIC CABLES

PRELIMINARY - NOT FOR CONSTRUCTION

PSE
Peterson Structural Engineers, Inc.
5319 S.W. Westgate Dr., Suite 215
Portland, Oregon 97221
(503) 292-1635

SNYDER RESERVOIR
EXIST. FOOTING SECTION
AND CABLE ELEVATION

DRAWN BY:	DATE: 3/2/05	FILE
EWBP	SHEET 1 OF 4	99-21-02

MSA

APPENDIX H

APPENDIX H
COST ALLOCATION FOR FACILITIES AND PIPING IMPROVEMENTS

Appendix H contains cost data for recommended improvements to storage reservoirs, pump stations, pressure reducing valves and system piping. These cost estimates are based on an Engineering News Record Construction Cost Index for Seattle, Washington of 8165 (January, 2005).

Table H-1
Reservoir Project Cost Estimate Summary
535-Foot Pressure Zone Reservoir No. 1 (1.5 MG)

Reservoir project cost estimates are based on the following assumptions:

No rock excavation included.
No property acquisition costs included.
Construction by private contractors.

Item No.	Description	Estimated Project Cost[1]
1.	Reservoir Structure	$750,000
2.	Site Work	$500,000
3.	Drainage System	$20,000
4.	Geotextiles	$10,000
5.	Access/Parking	$20,000
6.	Yard Piping	$100,000
7.	Electrical	$50,000
8.	Landscaping/Fencing	$50,000
	Total Construction	$1,500,000
	40% Contingency, Administration & Engineering	$600,000
	Total Project Cost	$2,100,000
	SAY	$2,100,000

[1] The cost estimates presented are opinions of cost based on the assumptions stated and developed from information available at the time of the estimate. Final costs for all projects will depend on actual field conditions, on actual material and labor costs, final project scope, project implementation and other variables.

Table H-2
Reservoir Project Cost Estimate Summary
380-Foot Pressure Zone Reservoir No. 2 (4.0 MG)

Reservoir project cost estimates are based on the following assumptions:

No rock excavation included.
No property acquisition costs included.
Construction by private contractors.

Item No.	Description	Estimated Project Cost[1]
1.	Reservoir Structure	2,100,000
2.	Site Work	$750,000
3.	Drainage System	$60,000
4.	Geotextiles	$50,000
5.	Access/Parking	$30,000
6.	Yard Piping	$190,000
7.	Electrical	$75,000
8.	Landscaping/Fencing	$90,000
	Total Construction	$3,345,000
	40% Contingency, Administration & Engineering	$1,338,000
	Total Project Cost	$4,683,000
	SAY	$4,700,000

[1] The cost estimates presented are opinions of cost based on the assumptions stated and developed from information available at the time of the estimate. Final costs for all projects will depend on actual field conditions, on actual material and labor costs, final project scope, project implementation and other variables.

Table H-3
Reservoir Project Cost Estimate Summary
380-Foot Pressure Zone Reservoir No. 3 (4.0 MG)

Reservoir project cost estimates are based on the following assumptions:

No rock excavation included.
No property acquisition costs included.
Construction by private contractors.

Item No.	Description	Estimated Project Cost[1]
1.	Reservoir Structure	2,100,000
2.	Site Work	$650,000
3.	Drainage System	$60,000
4.	Geotextiles	$50,000
5.	Access/Parking	$30,000
6.	Yard Piping	$190,000
7.	Electrical	$60,000
8.	Landscaping/Fencing	$90,000
	Total Construction	$3,230,000
	40% Contingency, Administration & Engineering	$1,292,000
	Total Project Cost	$4,522,000
	SAY	$4,600,000

[1] The cost estimates presented are opinions of cost based on the assumptions stated and developed from information available at the time of the estimate. Final costs for all projects will depend on actual field conditions, on actual material and labor costs, final project scope, project implementation and other variables.

Table H-4
Pump Station Project Cost Estimate Summary
Well No. 3 Site Improvements

Pump station project cost estimates are based on the following assumptions:

No rock excavation included.
No property acquisition costs included.
No backup power supply.
Construction by private contractors.

Item No.	Description		Estimated Project Cost[1]
1.	Mobilization		$20,000
2.	Site Work		$75,000
3.	Structure		$100,000
4.	Yard Piping		$20,000
5.	Mechanical		$25,000
6.	Controls		$10,000
7.	Electrical		$50,000
8.	Landscaping		$20,000
	Total Construction		$320,000
	40% Contingency, Administration & Engineering		$128,000
	Total Project Cost		$448,000
		SAY	$450,000

[1] The cost estimates presented are opinions of cost based on the assumptions stated and developed from information available at the time of the estimate. Final costs for all projects will depend on actual field conditions, on actual material and labor costs, final project scope, project implementation and other variables.

Table H-5
Pump Station Project Cost Estimate Summary
Well No. 4 Site Improvements

Pump station project cost estimates are based on the following assumptions:

No rock excavation included.
No property acquisition costs included.
No backup power supply.
Construction by private contractors.

Item No.	Description	Estimated Project Cost[1]
1.	Mobilization	$25,000
2.	Site Work	$75,000
3.	Structure	$110,000
4.	Yard Piping	$20,000
5.	Mechanical	$30,000
6.	Controls	$15,000
7.	Electrical	$50,000
8.	Landscaping	$25,000
	Total Construction	$350,000
	40% Contingency, Administration & Engineering	$140,000
	Total Project Cost	$490,000
	SAY	$490,000

[1] The cost estimates presented are opinions of cost based on the assumptions stated and developed from information available at the time of the estimate. Final costs for all projects will depend on actual field conditions, on actual material and labor costs, final project scope, project implementation and other variables.

Table H-6
PRV Station Project Cost Estimate Summary
SW Sherwood PRV

PRV station project cost estimates are based on the following assumptions:

No rock excavation
No property acquisition costs included.
Construction by private contractors.

Item No.	Description	Estimated Project Cost[1]
1.	Vault	$15,000
2.	Valves	$35,000
3.	Fittings	$10,000
4.	Piping	$15,000
5.	Supports/Restraint	$10,000
6.	Excavation/Backfill/Surface Restoration	$15,000
7.	Testing/Calibration	$5,000
8.	Labor/Equipment	$30,000
	Total Construction Cost	$135,000
	40% Contingency, Administration & Engineering	$54,000
	Total Project Cost	$189,000
	SAY	$190,000

[1] The cost estimates presented are opinions of cost based on the assumptions stated and developed from information available at the time of the estimate. Final costs for all projects will depend on actual field conditions, on actual material and labor costs, final project scope, project implementation and other variables.

Table H-7
PRV Station Project Cost Estimate Summary
Wyndham Ridge Pump Station (WRPS) PRV

PRV station project cost estimates are based on the following assumptions:

No rock excavation
No property acquisition costs included.
Construction by private contractors.

Item No.	Description	Estimated Project Cost[1]
1.	Valves	$25,000
2.	Fittings	$5,000
3.	Piping	$5,000
4.	Supports/Restraint	$5,000
5.	Testing/Calibration	$5,000
6.	Labor/Equipment	$25,000
	Total Construction Cost	$70,000
	40% Contingency, Administration & Engineering	$28,000
	Total Project Cost	$98,000
	SAY	$100,000

[1] The cost estimates presented are opinions of cost based on the assumptions stated and developed from information available at the time of the estimate. Final costs for all projects will depend on actual field conditions, on actual material and labor costs, final project scope, project implementation and other variables.

Table H-8
Pressure Relief Valve Project Cost Estimate Summary
Murdock Sub-Zone Pressure Relief

Pressure Relief Valve station project cost estimates are based on the following assumptions:

No rock excavation
No property acquisition costs included.
Construction by private contractors.

Item No.	Description	Estimated Project Cost[1]
1.	Valves	$10,000
2.	Fittings	$5,000
3.	Piping	$6,000
4.	Supports/Restraint	$5,000
5.	Testing/Calibration	$5,000
6.	Labor/Equipment	$20,400
	Total Construction Cost	$51,000
	40% Contingency, Administration & Engineering	$20,000
	Total Project Cost	$71,400
	SAY	$71,500

[1] The cost estimates presented are opinions of cost based on the assumptions stated and developed from information available at the time of the estimate. Final costs for all projects will depend on actual field conditions, on actual material and labor costs, final project scope, project implementation and other variables.

Table H-9
Distribution Piping Unit Project Cost[1]
Summary

Pipe Diameter	Cost per Linear Foot
8-inch	$98
10-inch	$112
12-inch	$130
16-inch	$174
18-inch	$195
20-inch	$217
24-inch	$261

Basic Assumptions:

No rock excavation
No dewatering
No property or easement acquisitions
No specialty construction included
A 35% contingency, administration and engineering allowance included
Construction by private contractors
An Engineering News Record (ENR) construction cost index CCI for Seattle, Washington of 7951 (4/12/04).
Add an additional 60% for construction with rock excavation the entire depth of trench

[1] The cost estimates presented are opinions of cost based on the assumptions stated and developed from information available at the time of the estimate. Final costs for all projects will depend on actual field conditions, on actual material and labor costs, final project scope, project implementation and other variables.

Table H-10
Piping Improvement Project Cost Estimate Summary
380-Foot Pressure Zone

No.	Location	Size (inches)	Length (feet)	Unit Cost ($/lf)	Estimated Project Cost[1]
M-1	Pine Street	16	949	174	$ 165,126
M-2	Regal Cinemas	12	162	130	$ 21,060
M-3	Langer Drive & Albertson's Parking Lot	12	1,145	130	$ 148,850
M-4	Albertson's Parking Lot	12	337	130	$ 43,810
M-5	Tualatin-Sherwood Road	12	861	130	$ 111,930
M-6	SW Gerda Lane	12	503	130	$ 65,390
M-7	SW Galbreath Drive Extension	12	2,250	130	$ 292,500
M-8	SW Cipole Road Stub-Out	12	316	130	$ 41,080
M-9	First Street, Pine Street to Washington	12	256	130	$ 33,280
M-10	Highway 99W Crossing	12	81	130	$ 10,530
M-11	SE Roy Street	12	309	130	$ 40,170
M-12	SW Eucalyptus & Willow Drive	12	1,410	130	$ 183,300
M-13	Highway 99W Stub-Out	10	507	112	$ 56,784
M-14	Langer Drive Stub-Out South No. 1	10	439	112	$ 49,168
M-15	Langer Drive Stub-Out South No. 2	10	503	112	$ 56,336
M-16	Sandhill Lane Stub-Out	8	127	98	$ 12,446
M-17	Roy Rogers Road Stub-Out	8	159	98	$ 15,582
M-18	Wapato Street Loop	8	1,088	98	$ 106,624
M-19	Gleneagle Improvements	8	4,354	98	$ 426,692
M-20	N Sherwood Boulevard Stub-Out No. 1	8	773	98	$ 75,754
M-21	Highway 99W Frontage	8	566	98	$ 55,468
M-22	N Sherwood Boulevard Stub-Out No. 2	8	159	98	$ 15,582
M-23	N Sherwood Boulevard Stub-Out No. 3	8	329	98	$ 32,242
M-24	Saxon Place	8	437	98	$ 42,826
M-25	Second Street & Ash Street	8	493	98	$ 48,314
M-26	Not Used				
M-27	Nottingham Court	8	246	98	$ 24,108
M-28	Culver Court	8	223	98	$ 21,854
M-29	SW Sunset Court	8	555	98	$ 54,390
M-30	Myrica Court	8	168	98	$ 16,464
M-31	Not Used				
M-32	Adams Street Extension North	16	3,000	174	$ 522,000
M-33	Adams Street Extension South	16	3,234	174	$ 562,716
M-34	NW UGB Expansion Area	16	2,803	174	$ 487,722
M-35	Oregon Street (Adams Street to Old Town)	12	786	130	$ 102,180
Total			**40,940**		**$ 3,942,278**

[1] The cost estimates presented are opinions of cost based on the assumptions stated and developed from information available at the time of the estimate. Final costs for all projects will depend on actual field conditions, on actual material and labor costs, final project scope, project implementation and other variables.

Table H-11
Piping Improvement Project Cost Estimate Summary
535-Foot Pressure Zone

No.	Location	Size (inches)	Length (feet)	Unit Cost ($/lf)	Estimated Project Cost[1]
B-1	Pine Street	12	1,277	130	$ 166,010
B-2	SW Sunset Boulevard	12	1,219	130	$ 158,470
B-3	Aldergrove Avenue	12	1,186	130	$ 154,180
B-4	Highpoint Drive	12	691	130	$ 89,830
B-5	SE April Court	8	200	98	$ 19,600
B-6	SE Cochran and Meadow Court	8	799	98	$ 78,302
B-7	Not Used				
B-8	535-Foot Reservoir Transmission	16	19,000	174	$ 3,306,000
	Total		**24,372**		**$ 3,972,392**

[1] The cost estimates presented are opinions of cost based on the assumptions stated and developed from information available at the time of the estimate. Final costs for all projects will depend on actual field conditions, on actual material and labor costs, final project scope, project implementation and other variables.

APPENDIX I

APPENDIX I
OREGON ADMINISTRATIVE RULES (OAR)

Appendix I includes Oregon Administrative Rules (OAR) Public Water Systems, Chapter 333, Division 61.

333-061-0060

Plan Submission and Review Requirements

(1) Plan Submission:

(a) Construction and installation plans shall be submitted to and approved by the Department before construction begins on new systems or major additions or modifications, as determined by the Department, are made to existing systems. Plans shall be drawn to scale;

(b) Preliminary plans, pilot studies, master plans and construction plans shall be prepared by a Professional Engineer registered in Oregon, and submitted to the Department unless exempted by the Department (See OAR 333-061-0060(4));

(c) Plans shall set forth the following:

(A) Sufficient detail, including specifications, to completely and clearly illustrate what is to be constructed and how those facilities will meet the construction standards set forth in these regulations. Elevation or section views shall be provided where required for clarity;

(B) Supporting information attesting to the quality of the proposed source of water;

(C) Vicinity map of the proposed project relative to the existing system or established landmarks of the area;

(D) Name of the owner of the water system facilities during construction and the name of the owner and operator of the facilities after completion of the project;

(E) Procedures for cleaning and disinfecting those facilities which will be in contact with the potable water.

(d) Prior to drilling a well, a site plan shall be submitted which shows the site location, topography, drainage, surface water sources, specifications for well drilling, location of the well relative to sanitary hazards, dimensions of the area reserved to be kept free of potential sources of contamination, evidence of ownership or control of the reserve area and the anticipated depth of the aquifer from which the water is to be derived. The Department will review well reports from the area and in consultation with the local watermaster and the well constructor as appropriate will recommend the depth of placement of the casing seal. After the well is drilled, the following documents shall be submitted to the Department for review and approval: Well driller's report, report of the pump test which indicates that the well has been pumped for a sufficient length of time to establish the reliable yield of the well on a sustained basis, including data on the static water level, the pumping rate(s), the changes in drawdown over the duration of the test, the rate of recovery after the pump was turned off, reports on physical, chemical and microbiological quality of the well water, performance data on the well pump, a plan of the structure for protecting above-ground controls and appurtenances, and a plan showing how the well will be connected to the water system. (See OAR 333-061-0050(2).)

(e) Any community water system or non-transient noncommunity water system that treats surface water or groundwater under the influence of surface water that desires to make a significant change to the disinfection treatment process and is required to develop a disinfection profile according to OAR 333-061-0030(2)(b)(C) through (E) must consult with the Department prior to making such a change. The water system must develop a disinfection profile for Giardia lamblia (and, if necessary, viruses), calculate a disinfection benchmark, describe the proposed change in the disinfection process, and analyze the effect(s) of the proposed change on current levels of disinfection according to the USEPA Disinfection Profiling and Benchmarking Guidance Manual and/or the USEPA LT1-ESWTR Disinfection Profiling and Benchmarking Technical Guidance Manual and submit the information to the Department for review and approval. Significant changes to the disinfection treatment process include:

(A) Changes to the point of application:

(B) Changes to the disinfectants used in the treatment process;

(C) Changes to the disinfection process;

(D) Any other modification identified by the Department.

(f) A water system subject to paragraph (1)(e) of this rule must calculate a disinfection benchmark using the following procedure:

(A) From data collected to develop the disinfection profile, determine the average Giardia lamblia inactivation for each calendar month by dividing the sum of all Giardia lamblia inactivations for that month by the number of values calculated for that month.

(B) Determine the lowest monthly average value out of the twelve values. This value becomes the disinfection benchmark.

(g) A water system that uses either chloramines, chlorine dioxide or ozone for primary disinfection must also calculate the disinfection benchmark for viruses using a method approved by the Department in addition to the disinfection profile for Giardia lamblia. This viral benchmark must be calculated in the same manner as is used for the Giardia lamblia disinfection benchmark described in paragraph (1)(f) of this rule.

(2) Plan review:

(a) Upon receipt of plans, the Department shall review the plans and either approve them or advise that correction or clarification is required. When the correction or clarification is received, and the item(s) in question are resolved, the Department shall then approve the plans;

(b) Upon completion of a project, a professional engineer registered in Oregon shall submit to the Department a statement certifying that the project has been constructed in compliance with the approved plans and specifications. When substantial deviations from the approved plans are made, as-built plans showing compliance with these rules shall be submitted to the Department;

(c) Plans shall not be required for emergency repair of existing facilities. In lieu of plans, written notice shall be submitted to the Department immediately after the emergency work is completed stating the nature of the emergency, the extent of the work and whether or not any threats to the water quality exists or existed during the emergency.

(3) Plan review fees: Plans submitted to the Department shall be accompanied by a fee as indicated in Table 31. Those plans not accompanied by a fee will not be reviewed. [Table not included. See ED. NOTE.]

(4) Plan review exemptions:

(a) Water suppliers may be exempted from submitting plans of main extensions, providing they:

(A) Have provided the Department with a current master plan; and

(B) Certify that the work will be carried out in conformance with the construction standards of these rules; and

(C) Submit to the Department an annual summary of the projects completed; and

(D) Certify that they have staff qualified to effectively supervise the projects.

(b) Those water suppliers certifying that they have staff qualified to effectively plan, design and supervise their projects, may request the Department for further exemption from this rule. Such requests must be accompanied by a listing of staff proposed to accomplish the work and a current master plan. To maintain the exemption, the foregoing must be annually updated;

(c) At the discretion of the Department, Community, Transient and Non-Transient Non-Community and State Regulated water systems may be exempted from submitting engineered plans. They shall, however, submit adequate plans indicating that the project meets the minimum construction standards of these rules.

(5) Master plans:

(a) Community water systems with 300 or more service connections shall maintain a current master plan. Master plans shall be prepared by a professional engineer registered in Oregon and submitted to the Department for review and approval.

(b) Each master plan shall evaluate the needs of the water system for at least a twenty year period and shall include but is not limited to the following elements:

(A) A summary of the overall plan that includes the water quality and service goals, identified present and future water system deficiencies, the engineer's recommended alternative for achieving the goals and correcting the deficiencies, and the recommended implementation schedule and financing program for constructing improvements.

(B) A description of the existing water system which includes the service area, source(s) of supply, status of water rights, current status of drinking water quality and compliance with regulatory standards, maps or schematics of the water system showing size and location of facilities, estimates of water use, and operation and maintenance requirements.

(C) A description of water quality and level of service goals for the water system, considering, as appropriate, existing and future regulatory requirements, nonregulatory water quality needs of water users, flow and pressure requirements, and capacity needs related to water use and fire flow needs.

(D) An estimate of the projected growth of the water system during the master plan period and the impacts on the service area boundaries, water supply source(s) and availability, and customer water use.

(E) An engineering evaluation of the ability of the existing water system facilities to meet the water quality and level of service goals, identification of any existing water system deficiencies, and deficiencies likely to develop within the master plan period. The evaluation shall include the water supply source, water treatment, storage, distribution facilities, and operation and maintenance requirements. The evaluation shall also include a description of the water rights with a determination of additional water availability, and the impacts of present and probable future drinking water quality regulations.

(F) Identification of alternative engineering solutions, environmental impacts, and associated capital and operation and maintenance costs, to correct water system deficiencies and achieve system expansion to meet anticipated growth, including identification of available options for cooperative or coordinated water system improvements with other local water suppliers.

(G) A description of alternatives to finance water system improvements including local financing (such as user rates and system development charges) and financing assistance programs.

(H) A recommended water system improvement program including the recommended engineering alternative and associated costs, maps or schematics showing size and location of proposed facilities, the recommended financing alternative, and a recommended schedule for water system design and construction.

(I) If required as a condition of a water use permit issued by the Water Resources Department, the Master Plan shall address the requirements of OAR 690-086-0120 (Water Management and Conservation Plans).

(c) The implementation of any portion of a water system master plan must be consistent with OAR 333-061 (Public Drinking Water Systems, DHS), OAR 660-011 (Public Facilities Planning, DLCD) and OAR 690-086 (Water Management and Conservation Plans, WRD).

[ED. NOTE: Tables referenced are available from the agency.]

Stat. Auth.: ORS 448.131
Stats. Implemented: ORS 431.110, 431.150, 448.131, 448.150, 448.273 & 448.279
Hist.: HD 106, f. & ef. 2-6-76; HD 4-1980, f. & ef. 3-21-80; HD 17-1981(Temp), f. & ef. 8-28-81; HD 4-1982, f. & ef. 2-26-82; Renumbered from 333-042-0220; HD 2-1983, f. & ef. 2-23-83; HD 13-1985, f. & ef. 8-1-85; HD 9-1989, f. & cert. ef. 11-13-89; HD 3-1994, f. & cert. ef. 1-14-94; HD 11-1994, f. & cert. ef. 4-11-94; HD 1-1996, f. 1-2-96, cert. ef. 1-5-96; HD 14-1997, f. & cert. ef. 10-31-97; OHD 4-1999, f. 7-14-99, cert. ef. 7-15-99; OHD 7-2000, f. 7-11-00, cert. ef. 7-15-00; OHD 23-2001, f. & cert. ef. 10-31-01; OHD 17-2002, f. & cert. ef. 10-25-02; PH 16-2004(Temp), f. & cert. ef. 4-9-04 thru 10-5-04; PH 20-2004, f. & cert. ef. 6-18-04; PH 33-2004, f. & cert. ef. 10-21-04

APPENDIX J

APPENDIX J
SUPPLY SOURCE COST DATA

Table J-1
City of Portland
10 Year Source Development Cost Estimate Summary

Project	Estimated Total Project Cost	Estimated Project Cost for Sherwood
Groundwater Improvements	$ 27,300,000	$ 910,000
Conduit Vulnerability Reduction Improvements	18,600,000	890,000
Repair and Replacement Program	30,000,000	1,450,000
System Meter Improvements	2,400,000	120,000
Conduit Vulnerability Reduction Improvements	26,700,000	1,300,000
Powell Butte Reservoir No. 2	68,700,000	3,300,000
Water Treatment Plant [1]	242,000,000	9,700,000
Conduit No. 5, Gresham Section	25,200,000	1,200,000
Repair and Replacement Program	30,000,000	1,400,000
Endangered Species Act Impacts	18,000,000	900,000
Total for City of Portland Supply System w/ Treatment Plant	***$ 498,900,000***	***$ 21,170,000***
Total for City of Portland Supply System without Treatment Plant	***$ 256,900,000***	***$ 11,470,000***
City of Sherwood Transmission Main Cost		$ 20,000,000 to $ 30,000,000
Total Estimated Project Cost for City of Sherwood		**$ 31,000,000 to $ 51,000,000**

Notes:

1. This cost estimate assumes a membrane technology water treatment plant. Current planning also includes the consideration of alternate technology, such as ultraviolet disinfection, which may result in lower capital costs.
2. Sherwood's share of total project cost developed using a proportion of capacity basis. Total capacity is estimated at 210 mgd, except for the Groundwater Improvements which are based on a system capacity of 300 mgd and Water Treatment Plant which is based on a total capacity of 250 mgd.

Table J-2
Joint Water Commission Project Cost Summary

Item	Estimated Project Cost for Sherwood
Dam Raise/Raw Water Pipe/Raw Water Pump Station[1]	$20,000,000
Water Treatment Plant Expansion (10 mgd capacity)	14,500,000
Finished Water Pump Station Expansion/Upgrade	2,000,000
Finished Water Transmission	22,000,000
Total Estimated Project Cost for City of Sherwood	**$58,500,000**

Notes:
1. Sherwood share based on expected yield of 52,000 acre-feet – 16,943 mg, Sherwood's share equal to 1,533 mg and a total cost of $220 million.
2. Treatment plant expansion costs assume a unit cost of $1/gallon and a 45 percent contingency.

Table J-3
Clackamas River Supply Project Cost Summary

Item	Estimated Project Cost for Sherwood
Raw Water Pump Station Expansion/Upgrade, Water Treatment Plant Expansion (10 mgd capacity)[1]	$14,500,000
Finished Water Pump Station Expansion/Upgrade	1,000,000
Finished Water Transmission	16,000,000
Total Estimated Project Cost for City of Sherwood	**$29,000,000 to $31,000,000**

Notes:
1. Treatment plant expansion costs assume a unit cost of $1/gallon and a 45 percent contingency.

Table J-4
Willamette River Water Treatment Plant Project Cost Summary

Item	Estimated Project Cost for Sherwood
Raw Water Pump Station Expansion/Upgrade	$1,000,000
Water Treatment Plant Expansion (10 mgd capacity)	14,500,000
Finished Water Pump Station Expansion/Upgrade	1,000,000
Finished Water Transmission – Routing Alternative No. 1	8,000,000
Finished Water Transmission – Routing Alternative No. 2	5,100,000
Total Estimated Project Cost for City of Sherwood (Routing Alternative No. 1)	**$24,500,000**
Total Estimated Project Cost for City of Sherwood (Routing Alternative No. 2)	**$21,600,000**

Notes:
1. Treatment plant expansion costs assume a unit cost of $1/gallon and a 45 percent contingency.

MSA

APPENDIX K

2004 Drinking Water Quality Report

City of Portland, Oregon

Letter from the Mayor

I am pleased to share the annual monitoring results for Portland's drinking water system. It is important that the city's drinking water customers know that they, their families and businesses receive high quality drinking water.

Monitoring and treatment are key methods by which Portland protects the public water supply. The city also protects the water supply and delivery system through investment and long-range planning. The city continuously evaluates and implements programs and projects that maintain the Portland drinking water system and strengthen it against vulnerabilities such as age, earthquakes and contamination.

The city's Bull Run water source and backup groundwater facilities constitute one of Portland's most important resources. Protecting this essential resource is a vital public service and will always be a top priority. The City of Portland is committed to maintaining healthy drinking water for its customers.

Tom Potter

Tom Potter
Mayor

Letter from the Water Bureau's Administrator

This report includes critical information about the quality of drinking water in your homes and businesses.

The most important information contained in the report is that ***Portland's drinking water quality continues to meet all state and federal regulations.***

This report also contains water quality test results; definitions; information on our sources of water supply; how to reduce exposure to lead in drinking water; and a special notice for immuno-compromised persons.

If you have further questions or comments about this report, please call City of Portland Utilities Customer Services at 503-823-7770. We welcome your interest in Portland's water system.

Morteza A

Morteza Anoushiravani, P.E.
Administrator

If this information looks familiar, it should. The city has mailed similar information to customers each year since 1997. Why every year? It's the law. Drinking water regulations require the city to produce and mail this information every year.

Most of the language is also required - Congress and the EPA want to be sure people know what is in their drinking water.

The city agrees. So the Portland Water Bureau takes the effort to make this complex information readable at a low cost. The Water Bureau produced and mailed this report for 27 cents each.

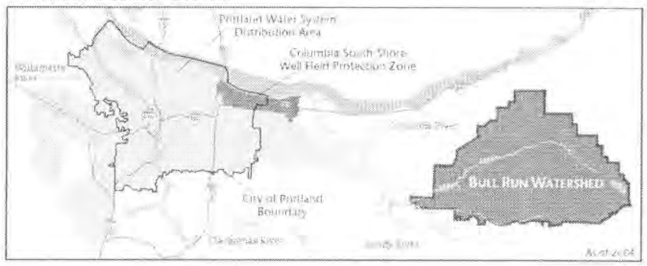
Portland's Drinking Water

Portland's Water Sources

The Bull Run watershed is a surface water supply located in the Mt. Hood National Forest. A geological ridge separates the watershed from Mt. Hood. Current regulations allow Portland to meet federal drinking water standards without filtering this high quality water supply. The watershed has an area of 102 square miles, and typically receives 80-170 inches of rainfall a year. The heaviest rains occur from late fall through spring. Two reservoirs store water for use year-round, particularly during the dry summer months.

The watershed is reserved solely for producing drinking water. Federal laws restrict human entry. No recreational, residential, or industrial uses occur within its boundaries. The Portland Water Bureau carefully monitors water quality and quantity. The Oregon Department of Human Services - Drinking Water Program regularly inspects the watershed and related treatment and distribution facilities.

Portland's Water System



The Water Bureau has completed a Source Water Assessment for the Bull Run water supply to comply with the 1996 Safe Drinking Water Act amendments. The only known contaminants of concern for the Bull Run water supply are naturally occurring microbial contaminants such as *Giardia lamblia*, *Cryptosporidium*, fecal coliform bacteria, and total coliform bacteria. These organisms are found in virtually all freshwater ecosystems and are present in the Bull Run supply at very low levels. The Bull Run supply consistently complies with all applicable state and federal regulations for source water, including the 1989 Surface Water Treatment Rule filtration-avoidance criteria. The Source Water Assessment report is available at www.portlandonline.com/water and by calling 503-823-7404.

The Columbia South Shore Well Field provides high quality water from production wells located in four different aquifers. In 2004 the city supplemented the Bull Run supply with groundwater beginning on January 29 for four days due to turbidity in Bull Run and to augment the summer water supply for 29 days beginning on July 27. The summer supplement to the Bull Run supply provided more than 1 billion gallons of water during the summer, allowing the Water Bureau to provide water in support of Bull Run River fish recovery in the Sandy River Basin.

Portland actively protects its drinking water wells and manages programs to prevent groundwater pollution. Details about Portland's wellhead protection program are available at www.portlandonline.com/water and by calling 503-823-7404.

The City of Lake Oswego, the Powell Valley Road Water District and the Sunrise Water Authority provide drinking water for a few Portland customers who live near service area boundaries. Customers who receive water from these sources receive a detailed water quality report about these sources in addition to this report.

Drinking Water Treatment

The Water Bureau treats Portland's water with chloramination. This process starts with chlorine to disinfect the water. Next the city adds ammonia to ensure that disinfection remains adequate throughout the distribution system. New federal regulations are being developed by the Environmental Protection Agency and may require additional treatment processes by 2013.

The city also adds sodium hydroxide to increase the pH of the water to reduce corrosion of plumbing systems. This treatment helps control lead and copper levels at customers' taps should these metals be present in the customers' home plumbing.

Water Testing

The Water Bureau monitors for approximately 200 regulated and unregulated contaminants in drinking water, including pesticides and radioactive contaminants. All monitoring data in this report are from 2004 unless otherwise indicated. The Portland Water Bureau received a reporting violation in 2004 for the late submission of arsenic test results for the Bull Run entry point. There was no arsenic detected in the sample and no health risk associated with this violation. **If a health related contaminant is not listed in this report, the Water Bureau did not detect it in Portland's drinking water.**

Public Involvement Opportunities

The Portland Water Bureau sponsors a variety of public involvement opportunities related to projects and programs. The bureau posts public meeting times online. If you have questions about meetings, projects, or programs, please call John Donovan, Community Relations Manager, at 503-823-7613 or visit the Water Bureau's website at www.portlandonline.com/water.

Definitions

Maximum Contaminant Level Goal or MCLG
The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety.

Maximum Contaminant Level or MCL
The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to the MCLGs as feasible using the best available treatment technology.

Maximum Residual Disinfectant Level Goal or MRDLG
The level of a drinking water disinfectant below which there is no known or expected risk to health. MRDLGs do not reflect the benefits of the use of disinfectants to control microbial contaminants.

Maximum Residual Disinfectant Level or MRDL
The highest level of a disinfectant allowed in drinking water. There is convincing evidence that addition of a disinfectant is necessary for control of microbial contaminants.

Treatment Technique
A required process intended to reduce the level of a contaminant in drinking water.

Action Level
The concentration of a contaminant which, if exceeded, triggers treatment or other requirements which a water system must follow.

Part Per Million
One part per million corresponds to one penny in $10,000 or approximately one minute in two years. One part per million is equal to 1000 parts per billion.

Part Per Billion
One part per billion corresponds to one penny in $10,000,000 or approximately one minute in 2000 years.

Picocuries
Picocurie is a measurement of radioactivity. One picocurie is a trillion times smaller than one curie.

What the EPA Says About Drinking Water Contaminants

Drinking water, including bottled water, may reasonably be expected to contain at least small amounts of some contaminants. The presence of contaminants does not necessarily indicate that water poses a health risk. More information about contaminants and potential health effects can be obtained by calling the Environmental Protection Agency's (EPA) Safe Drinking Water Hotline at 800-426-4791 or at www.epa.gov/safewater/.

The sources of drinking water (both tap water and bottled water) include rivers, lakes, streams, ponds, reservoirs, springs, and wells. As water travels over the surface of the land or through the ground, it dissolves naturally occurring minerals and, in some cases, radioactive material, and can pick up substances resulting from the presence of animals or from human activity.

Contaminants in Drinking Water Sources May Include

- **Microbial contaminants**, such as viruses and bacteria, which may come from wildlife or septic systems.
- **Inorganic contaminants**, such as salts and metals, which can occur naturally or result from urban stormwater runoff, industrial or domestic wastewater discharges, or farming.
- **Pesticides and herbicides**, which may come from a variety of sources such as farming, urban stormwater runoff, and home or business use.
- **Organic chemical contaminants**, including synthetic and volatile organic chemicals, which are byproducts of industrial processes, and can also come from gas stations, urban stormwater runoff, and septic systems.
- **Radioactive contaminants**, which can occur naturally.

In order to ensure that tap water is safe to drink, EPA has regulations that limit the amount of certain contaminants in water provided by public water systems and require monitoring for these contaminants. Food and Drug Administration regulations establish limits for contaminants in bottled water, which must provide the same protection for public health.

Special Notice for Immuno-Compromised Persons

Some people may be more vulnerable to contaminants in drinking water than the general population. Immuno-compromised persons such as persons with cancer undergoing chemotherapy, persons who have undergone organ transplants, people with HIV/AIDS or other immune system disorders, some elderly, and infants can be particularly at risk from infections. These people should seek advice about drinking water from their health care providers. Environmental Protection Agency/Centers for Disease Control and Prevention guidelines on appropriate means to lessen the risk of infection by *Cryptosporidium* and other microbial contaminants are available from the **Safe Drinking Water Hotline at 800-426-4791.**

Results of Monitoring for Unregulated Contaminants

Notes on Unregulated Contaminants

Unregulated contaminant monitoring helps EPA to determine where certain contaminants occur and whether it needs to regulate those contaminants in the future.

	Contaminant	Minimum Detected	Average Detected	Maximum Detected	Source of Contaminant
Entry Points to Distribution System*	Radon**	25 picocuries per liter	25 picocuries per liter	25 picocuries per liter	Erosion of natural deposits in groundwater aquifers
	Sodium	3.3 parts per million	7.7 parts per million	12 parts per million	Added to water during treatment; Erosion of natural deposits

Radon

Radon is a naturally occurring radioactive gas that you cannot see, taste, or smell. Radon has never been detected in the Bull Run supply. It is detected at varying levels in the city's wells. For information about radon, call the EPA's Radon Hotline at 800-SOS-RADON or visit www.epa.gov/safewater/radon.html.

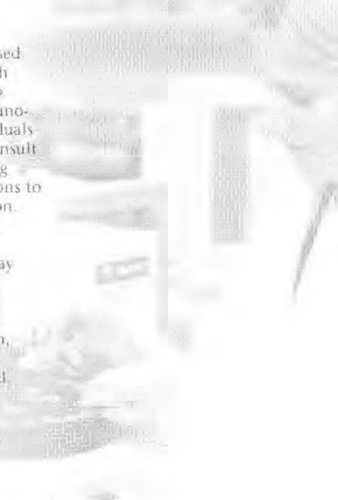
Sodium

There is currently no drinking water standard for sodium. Sodium is an essential nutrient. At the levels found in drinking water, it is unlikely to significantly contribute to adverse health effects.

Cryptosporidium

Cryptosporidium is a microorganism (protozoan) naturally present in bodies of surface water throughout the world. Surface water supplies are particularly vulnerable if they receive runoff or are exposed to human or animal wastes. Since wildlife inhabit the Bull Run watershed, the Water Bureau regularly monitors for *Cryptosporidium* and has done so for more than ten years. Occasionally, the Water Bureau finds *Cryptosporidium* at low levels. No *Cryptosporidium* oocysts were detected in water samples in 2004. EPA is in the process of developing new national standards to further reduce the risks of illness from *Cryptosporidium*. These standards may require additional treatment processes for unfiltered water systems by 2013.

Symptoms of *Cryptosporidium* infection include nausea, diarrhea, and abdominal cramps. Most healthy individuals are able to overcome the disease within a few weeks. However, immuno-compromised people have more difficulty and are at greater risk of developing severe, life threatening illness. Please read the "Special Notice for Immuno-Compromised Persons" above which describes people who may be at risk. Immuno-compromised individuals are encouraged to consult their doctor regarding appropriate precautions to take to avoid infection. *Cryptosporidium* must be ingested for it to cause disease, and may be spread through means other than drinking water. For more information, visit www.epa.gov/safewater/crypto.html.



Results of Monitoring for **Regulated Contaminants**

Detected in 2004 (unless otherwise indicated*)

	Regulated Contaminant	Minimum Detected	Maximum Detected	Maximum Contaminant Level (MCL) or Treatment Technique	Maximum Contaminant Level Goal (MCLG)	Sources of Contaminant
Source Water from Bull Run Watershed	Turbidity	0.20 NTU	3.38 NTU	5 NTU	Not Applicable	Erosion of natural deposits
	Giardia	Not Detected	One sample of 50 liters had 1 cyst.	Treatment technique required: Disinfection to inactivate 99.9% of cysts	Not Applicable	Animal wastes
	Total Coliform Bacteria	Not Detected	One sample had 16 colonies. (100% of samples had 100 or fewer bacterial colonies per 100 milliliters of water.)	At least 90% of samples measured during the previous six months must have 100 or fewer bacterial colonies per 100 milliliters of water.	Not Applicable	Found throughout the environment
	Fecal Coliform Bacteria	Not Detected	Four samples had 4 colonies each. (100% of samples had 20 or fewer bacterial colonies per 100 milliliters of water.)	At least 90% of samples measured during the previous six months must have 20 or fewer bacterial colonies per 100 milliliters of water.	Not Applicable	Animal wastes
Entry Points to Distribution System — from Bull Run and the groundwater well field	*NUTRIENTS*					
	Nitrate Nitrogen	0.01 parts per million	1.0 parts per million	10 parts per million	10 parts per million	Erosion of natural deposits; animal wastes
	Nitrite Nitrogen*	Not Detected	0.005 parts per million	1 part per million	1 part per million	
	METALS					
	Arsenic*	Not Detected	1 part per billion	50 parts per billion (MCL will be 10 parts per billion in 2006.)	No current MCLG (MCLG will be zero parts per billion in 2006.)	Erosion of natural deposits in groundwater aquifers
	Barium*	Not Detected	0.008 parts per million	2 parts per million	2 parts per million	
	Chromium*	Not Detected	2 parts per billion	100 parts per billion	100 parts per billion	
	RADIOACTIVE CONTAMINANTS					
	Uranium*	Not Detected	0.05 picocuries per liter	30 picocuries per liter	Zero picocuries per liter	
	MINERALS					
	Fluoride*	Not Detected	0.11 parts per million	4 parts per million	4 parts per million	
Distribution System of Reservoirs, Tanks and Mains	*MICROBIAL CONTAMINANTS*					
	Total Coliform Bacteria	Not Detected	Four samples in January (1.4%) had detectable coliform bacteria.	Must not detect coliform bacteria in more than 5.0% of samples in any month	0% of samples with detectable coliform bacteria	Found throughout the environment
	E. coli Bacteria	Not Detected	One sample in June had 1 *E. coli* bacterial colony.	A routine sample and a repeat sample are total coliform positive and one is also fecal coliform or *E. coli* positive	No samples with detectable *E. coli* bacteria	Animal wastes
	DISINFECTION BYPRODUCTS					
	Total Trihalomethanes					
	Running Annual Average of all sites	15 parts per billion	19 parts per billion	80 parts per billion.	Not Applicable	Byproduct of drinking water disinfection
	Single result at any one site	8.6 parts per billion	35 parts per billion	Not Applicable		
	Haloacetic Acids					
	Running Annual Average of all sites	25 parts per billion	30 parts per billion	60 parts per billion	Not Applicable	
	Single result at any one site	20 parts per billion	40 parts per billion	Not Applicable		
	Regulated Contaminant	**Minimum Detected**	**Maximum Detected**	**Maximum Residual Disinfectant Level (MRDL)**	**Maximum Residual Disinfectant Level Goal (MRDLG)**	**Sources of Contaminant**
	Total Chlorine Residual	Not Detected	2.2 parts per million	4 parts per million	4 parts per million	Chlorine and ammonia are used to disinfect water

*[illegible]

Notes on Regulated Contaminants

Turbidity

Bull Run is an unfiltered surface water supply. Rules for public water systems have strict standards for unfiltered surface water supplies. Turbidity levels in unfiltered water must not exceed 5 NTU (Nephelometric Turbidity Units). The typical cause of turbidity is tiny particles of sediment in the water during storm events. During large storm events the Water Bureau may shut down the Bull Run system and serve water from the Columbia South Shore Well Field. Turbidity can interfere with disinfection and provide a medium for microbial growth.

Giardia

Wildlife in the watershed may be hosts to *Giardia lamblia*, the organism that causes giardiasis. Chlorine is effective in killing *Giardia*.

Total Coliform Bacteria

Total coliform bacteria are naturally present in the environment. Their presence is an indicator that other potentially harmful bacteria may be present. The Water Bureau uses chlorine to control these bacteria. Total coliform samples are collected from both the source water and the distribution system.

Fecal Coliform and *E. coli* Bacteria

The presence of fecal coliform and *E. coli* bacteria in source water indicates that water may be contaminated with animal wastes. The Water Bureau uses chlorine to control these bacteria.

Nitrates and Nitrites

These nutrients can support microbial growth (bacteria and algae). Nitrate and nitrite levels exceeding the standards can contribute to health problems.

Arsenic, Barium, Chromium, Uranium, and Fluoride

Metals are a group of similar elements that occur in the earth's crust. Metals (arsenic, barium, chromium, and uranium) and other minerals (fluoride) can dissolve into water that is in contact with soil or in groundwater aquifers.

Disinfection Byproducts

During disinfection, certain byproducts form as a result of chemical reactions between chlorine and naturally occurring organic matter in the water. These byproducts can have negative health effects. The disinfection process is carefully controlled to remain effective, while keeping byproduct levels low. Monitoring in Portland's system detected Trihalomethanes and Haloacetic Acids, regulated disinfection byproducts.

Total Chlorine Residual

Chlorine residual is necessary to maintain disinfection throughout the distribution system. Adding ammonia to chlorine results in a more stable disinfectant and helps to minimize the formation of disinfection byproducts. Total chlorine residual is a measure of free chlorine and combined chlorine and ammonia in our distribution system.

Frequently Asked Questions About Water Quality

Is my water treated by filtration?

No, Bull Run is currently not filtered. The Bull Run source meets the filtration avoidance criteria of the Surface Water Treatment Rule. The state approved Portland's compliance with these criteria in 1992.

Does Portland add fluoride to drinking water?

Portland does not add fluoride to the water. No fluoride is detected in Bull Run water, but it is a naturally occurring trace element in groundwater. At low levels, fluoride helps prevent dental cavities. The US Public Health Service and the Centers for Disease Control and Prevention (CDC) consider the fluoride levels in Portland's water sources to be lower than optimal for helping to prevent dental decay. You may want to consult with your dentist about fluoride treatment to help prevent tooth decay, especially for young children.

Is Portland's water soft or hard?

Portland's water is very soft. Hardness of Bull Run water is typically 6-11 parts per million (approximately 1/2 a grain of hardness per gallon). Portland's groundwater hardness is approximately 86 parts per million (about 5 grains per gallon), which is considered moderately hard.

What is the pH of Portland's water?

In the distribution system, pH typically ranges from 7.2 to 8.2.

How can I get my water tested?

Call the LeadLine at 503-988-4000 for information about free lead in water testing. For more extensive testing, private laboratories can test your tap water for a fee. Not all labs are accredited to test for all contaminants. For information about accredited labs, call the Oregon Department of Human Services, Oregon Environmental Laboratory Accreditation Program at 503-229-5505 or visit www.oregon.gov/DHS/ph/orelap.

CITY OF PORTLAND OREGON
PORTLAND WATER BUREAU
MAYOR TOM POTTER
Mort Anoushiravani, P.E., Administrator
1120 S.W. 5th Avenue
Portland, Oregon 97204

2004 Drinking Water Quality Report

Important Information About Lead in Drinking Water

Easy steps to avoid possible exposure to lead from plumbing.

- Never use water from the hot water tap for making baby formula.
- Use only ***cold, fresh*** water from the cold water tap for drinking or cooking.
- Avoid using water that has been standing in the pipes. When a faucet is not used for more than six hours, run the cold water tap until the water feels noticeably colder (about 30 seconds to 2 minutes). This flushes standing water out of the pipes, replacing it with fresh water.
- Use only lead-free solder when making plumbing repairs. It's the law.
- Consider using a filter. Check whether it removes lead – not all filters do. Be sure to maintain and replace a filter in accordance with the manufacturer's instructions to protect water quality.
- Look for faucets and filters which are NSF-certified to limit contaminants to acceptable drinking water levels. For more information, contact NSF International at 877-867-3435 or at www.nsf.org.

Call the LeadLine at 503-988-4000 or visit www.leadline.org for information about lead hazards, free lead in water testing, and free childhood blood lead testing.

Lead was not detected in Portland's source waters. Portland has removed all known lead service connections from its distribution system.

Exposure to lead through drinking water is possible if materials in a building's plumbing contain lead. The level of lead in water can increase when water stands in contact with lead-based solder and brass faucets containing lead. Infants and children are typically more vulnerable to lead in drinking water than the general population.

People are exposed to lead in many ways. **In the Portland area, dust from paint in homes built before 1978 is the most common source of exposure to lead.** Other sources include soil, pottery, traditional folk medicines or cosmetics, some sports equipment such as fishing weights and ammunition, and some occupations and hobbies.

Lead and Copper Sampling at Residential Water Taps

	90th Percentile Values	Number of Sites Exceeding Action Levels	Action Level*	Maximum Contaminant Level Goal (MCLG)	Source of Contaminant
Lead	15 parts per billion	Nine of 111 samples exceeded the Action Level of 15 parts per billion	Exceeds Action Level if more than 10% of the homes tested have lead levels greater than 15 parts per billion	Zero parts per billion	Corrosion of household and commercial building plumbing systems
Copper	0.42 parts per million	No samples exceeded the Action Level	Exceeds Action Level if more than 10% of the homes tested have copper levels greater than 1.3 parts per million	1.3 parts per million	

Corrosion Treatment

The Water Bureau's corrosion treatment reduces corrosion in plumbing by increasing the pH of the water. Comparison of monitoring results with and without pH adjustment shows over 50 percent reduction in lead at the tap with pH adjustment.

Water Testing

Call the LeadLine for information about free lead in water testing. The program targets testing the water in households most at risk from lead in water, including pregnant women or children age six or younger who live in homes built between 1970 and 1985.

The LeadLine

The Water Bureau provides funding for Multnomah County's LeadLine, a phone line for resources about lead hazards. This program provides information about potential sources of lead in the home (including water, paint, dust, soil, pottery, and folk remedies), information on free childhood blood lead testing and lead poisoning prevention, and referrals to services to reduce lead hazards in eligible homes in the Portland metropolitan region.

Contact Information
Portland Water Bureau
1120 SW Fifth Avenue
Portland, Oregon 97204
www.portlandonline.com/water
Public Water System #4100657

City of Portland
Utilities Customer Services
503-823-7770
TTY 503-823-6868

For Additional Information
Oregon Department of Human Services — Drinking Water Program
503-731-4317
www.dhs.state.or.us/publichealth/dwp

To obtain a copy of this report in alternate format, including Braille, please call 503-823-7770.

Spanish
503-823-7770

Russian
503-823-7770

Vietnamese
503-823-7770

APPENDIX L

City of Wilsonville
2004 Annual Water Quality Report
(May 2005)

Three years ago, Wilsonville started up its new water treatment plant on the Willamette River. The plant's treatment systems meet year-round demand and have the capacity to serve growth in the future. In addition, the City has five enclosed reservoir tanks located throughout town to store water for fires or other emergencies.

Wilsonville's former water supply (eight local wells) is also available for use in emergencies. These wells tap a large groundwater formation called the Columbia River Basalt Aquifer. Aside from weekly inspections, it has not been necessary to turn on any of the wells since the water treatment plant came on line. All of Wilsonville's storage tanks and wells are covered, and all have security systems in place.

The quality of Wilsonville's drinking water is superb, as documented in the following pages. Extensive monitoring shows the water provided by the City of Wilsonville to you, our customers, is far better than required by drinking water standards.

Something You May Not Realize…

The City of Wilsonville and Tualatin Valley Fire and Rescue (TVF&R) are continually conducting inspections and maintenance on the City's fire hydrant system. This project involves operating, cleaning, and, if necessary, repairing the City's fire hydrants.

Residents can assist with this ongoing project by making sure their landscape improvements do not block access to or interfere with the operation of fire hydrants. Landscaping should not block the three caps on the side of the hydrant, which in an emergency are removed to connect fire hoses. Also, the top of the hydrant should be free of landscaping so the hydrant can be turned on without interference. To meet these requirements, the City of Wilsonville and TVF&R require that landscaping on the sides of the caps be lower than the caps and no landscaping be within three feet of the entire hydrant. The City of Wilsonville and TVF&R realize the importance and value of landscapes, but fire hydrants must be easily accessible and visible upon approach to firefighters in an emergency.

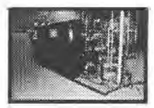
If you have further questions regarding fire hydrant maintenance contact the Public Works Department at (503) 682-4092.

Water Treatment Process

Here is a brief description of the step-by-step process used in Wilsonville's multi-barrier water treatment facility. If you would like a tour of the facility, call (503) 570-1542.

Intake Screens: to protect fish and to prevent debris from entering the treatment facility. The screens are located off the bottom of the river (to avoid bringing sediments into the treatment plant) and below the surface (to avoid bringing oils or other floating materials into the treatment plant).

Enhanced Sedimentation: to remove materials that are small enough to pass through the intake screens. Conventional chemicals called coagulants cause the suspended materials to adhere to one another forming larger, heavier "floc," which settles out of the water. By adding very fine sand to the mixture, the weight of the "floc" is increased, thereby causing the settling process to occur more quickly and more completely than conventional water treatment. The sand is then cleaned, recycled, and reused.



Ozonation: serves multiple functions including disinfection, breakdown of organic chemicals, breakdown of taste/odor causing compounds, and enhanced removal of organic material by the filters. After bubbling through the water, the ozone quickly decomposes into harmless oxygen gas.

Granular Activated Carbon: charcoal filters (6 feet thick) further remove turbidity and pathogens, remove organic chemicals, and remove taste/odor compounds to assure consistently high quality of the treated water.

Sand Filter: a "polishing" step to improve particle removal.

Secondary Disinfection: addition of chlorine to prevent bacterial contamination as the treated water flows through the distribution system to customers.

The treatment facility is "over-designed" in the sense that drinking water standards can be met without such extensive treatment. Nonetheless, the plant is operated using all these steps at all times - whether or not they are all needed to meet drinking water standards. In addition, the treatment plant has redundant (i.e., back-up) systems for all of these processes.

According to the Environmental Protection Agency…

Drinking water, including bottled water, may reasonably be expected to contain at least small amounts of some contaminants. The presence of contaminants does not necessarily indicate that water poses a health risk. More information about contaminants and potential health effects can be obtained by calling the Environmental Protection Agency's Safe Drinking Water Hotline (800-426-4791).

Some people may be more vulnerable to contaminants in drinking water than the general population. Immuno-compromised persons such as persons with cancer undergoing chemotherapy, persons who have undergone organ transplants, persons with HIV/AIDS or other immune system disorders, some elderly, and infants can be particularly at risk from infections. These people should seek advice about drinking water from their health care providers. EPA/CDC guidelines on appropriate means to lessen the risk of infection by Cryptosporidium and other microbial contaminants are available from the Safe Drinking Water Hotline (800-426-4791).

Source Water Assessments

The 1996 Amendments to the Safe Drinking Water Act require that all states conduct Source Water Assessments for public water systems within their boundaries. The assessments consist of (1) identification of the Drinking Water Protection Area, i.e., the area at the surface that is directly above that part of the aquifer that supplies groundwater to our wells, (2) identification of potential sources of pollution within the Drinking Water Protection Area, and (3) determining the susceptibility or relative risk to the well water from those sources. The delineation has been accepted by the Oregon Department of Human Service's Drinking Water Program as meeting all requirements. A map showing this area is on file/display at the City's offices.

For Further Information…

If you have any questions about this report or would like additional information, please contact Jeff Bauman, the City of Wilsonville's Public Works Director, at 503-682-4092. You may also learn more by attending meetings of the Wilsonville City Council. These meetings occur regularly at 7:00 p.m. on the first and third Mondays of each month. The Council meets at the Wilsonville Community Center (located behind City Hall) at 7965 SW Wilsonville Road.

Important Contact Information

Water bill questions - (503) 682-1011
Report a water leak - (503) 682-4092
EPA Hotline (*free*) - (800) 426-4791
State of Oregon Drinking Water Program: www.ohd.hr.state.or.us/dwp
City of Wilsonville on the web: www.ci.wilsonville.or.us

City of Wilsonville
30000 SW Town Center Loop E.
Wilsonville, OR 97070

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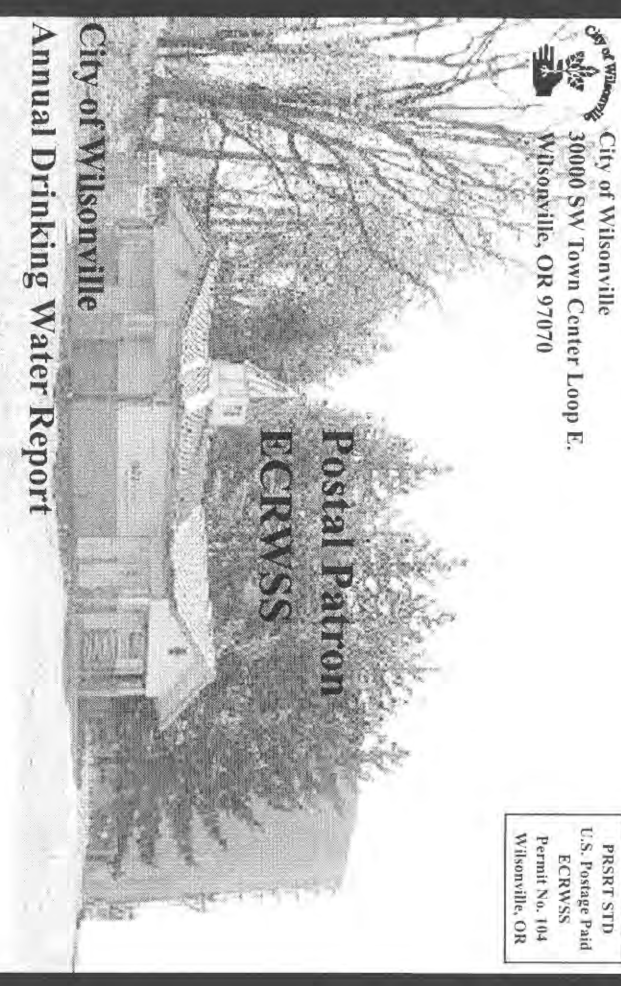

City of Wilsonville
Annual Drinking Water Report

Results of Water Quality Monitoring

Federal and State drinking water standards require monitoring and reporting of numerous specific water quality parameters. For each parameter, limits called "maximum contaminant level" are established. The U.S. Environmental Protection Agency (EPA) has determined that drinking water is safe at these levels. The EPA also specifies the laboratory methods which must be followed by certified water labs when analyzing the water. The City of Wilsonville monitors its drinking water far more extensively and far more frequently than required by Federal and State regulations.

Although various levels of these contaminants are permitted in drinking water,
NONE HAVE BEEN DETECTED IN WILSONVILLE'S DRINKING WATER.

Microbes:

Indicators of potential disease-causing contaminants

- total coliform bacteria
- fecal coliform bacteria
- giardia
- cryptosporidium

Inorganic Contaminants:

Chemicals that occur naturally and may be in water by means of erosion and leaching mineral deposits

- aluminum
- antimony
- arsenic
- beryllium
- boron
- cadmium
- chromium
- cyanide
- mercury
- nickel
- nitrite
- selenium
- thallium

Volatile Organics:

Chemical compounds such as cleaning fluids, degreasers, and plastics

- 1,1,1,2-tetrachloroethane
- 1,1,1-trichloroethane
- 1,1,2,2-tetrachloroethane
- 1,1,2-trichloroethane
- 1,1-dichloroethane
- 1,1-dichloroethelene
- 1,1-dichloropropene
- 1,2,4-trichlorobenzene
- 1,2-dichloroethane
- 1,2-dichloropropane
- 1,3-dichloropropane
- 2,2-dichloropropane
- benzene
- bromobenzene
- bromomethane
- carbon tetrachloride
- chlorobenzene
- chloroethane
- chloromethane
- cis-1,2- dichloroethelene
- cis-1,3-dichloropropene
- dibromomethane
- dichloromethane
- ethylbenzene
- m-dichlorobenzene
- o-chlorotoluene
- o-dichlorobenzene
- p-chlorotoluene
- p-dichlorobenzene
- styrene
- tetrachloroethylene
- toluene
- trans-1,2-dichloroethelene
- trans-1,3-dichloropropene
- trichloroethylene
- vinyl chloride
- xylenes

Synthetic Organics:

Chemical compounds that include insecticides and herbicides.

- 1,2,3-trichloropropane
- 2,4,5-TP
- 2,4-D
- 3-hydroxycarbofuran
- alachlor
- aldicarb
- aldicarb sulfone
- aldicarb sulfoxide
- aldrin
- atrazine
- benzo(a)pyrene
- butachlor
- carbaryl
- carbofuran
- chlordane
- dalapon
- di(2-ethylhexyl)adipate
- di(2-ethylhexyl)phthalate
- dibromochloro-propane
- dicamba
- dieldrin
- dinoseb
- dioxin
- diquat
- endothall
- endrin
- ethylene dibromide
- glyphosate
- heptachlor
- heptachlor epoxide
- hexachlorobenzene
- hexachlorocyclopentadine
- lindane
- methomyl
- methoxychlor
- metolachlor
- metribuzin
- oxamyl (vydate)
- PCBs
- pentachlorophenol
- phthalate
- picloram
- propachlor
- simazine
- toxaphene

Other:

- 2,4-dinitrotoluene
- 2,6- dinitrotoluene
- 4,4'-DDE
- acetochlor
- bromate
- DCPA
- EPTC
- molinate
- MTBE
- nitrobenzene
- perchlorate
- terbacil

In reading the following table, please note these definitions:

Maximum contaminant level goal (MCLG) - the level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety.

Maximum contaminant level (MCL) - the highest level of a contaminant that is allowed in drinking water. MCLs are set as close to the MCLGs as feasible using the best available treatment technology. MCLs are set at very stringent levels. To understand the possible health effects described for many regulated constituents, a person would have to drink two liters of water every day at the MCL level for a lifetime to have a one-in-a-million chance of having the described health effect.

Nephelometric turbidity units (NTU) - a measure of light-scattering particulate in the water, or how clear the water is.

n/a = not applicable

ND = not detected

ppm = parts per million (or milligrams per liter). One part per million is the equivalent of one minute over the span of nearly two years.

ppb= parts per billion (or micrograms per liter). One part per billion is equivalent to one minute over the span of more than 19 centuries.

pCi/l = picocuries per liter (a measure of radioactivity)

AL = action level. The concentration of a contaminant, which, if exceeded, triggers a treatment or other requirement which a water system must follow. For lead and copper, a water supply is in compliance with the drinking water standards if 90% of the samples are less than or equal to the "action level."

Contaminant	*Date Tested*	*Unit*	*Maximum Amount Detected (Range)*	*Maximum Contaminant Level (MCL)*	*Maximum Contaminant Level Goal (MCLG)*	*Potential Source(s) of Contamination*	*Violation*
Inorganic Contaminants							
nitrate and nitrite	quarterly	ppm	0.8 (0.2 – 0.8)	10	10	runoff from fertilizer use; leaching from septic tanks; erosion of natural deposits.	**NO**
fluoride	quarterly	ppm	0.35 (ND – 0.35)	4	4	erosion of natural deposits; discharge from fertilizer and aluminum factories	**NO**
barium	quarterly	ppm	0.005 (0.004 – 0.005)	2	2	discharge of drilling wastes; discharge from metal refineries; erosion of natural deposits	**NO**
turbidity	daily	NTU	0.09 (0.03 – 0.09)	0.3	n/a	soil runoff	**NO**
Volatile Organic Contaminants							
total trihalomethanes	quarterly	ppb	37 (7 – 37)	80	0	by-product of drinking water disinfection	**NO**
total haloacetic acids	quarterly	ppb	8 (2 – 8)	60	0	by-product of drinking water disinfection	**NO**
Radioactive Contaminants							
alpha particles	9/30/02	pCi/l	1.2	15	0	erosion of natural deposits	**NO**
beta particles	9/30/02	pCi/l	5	50	0	decay of natural and man-made deposits	**NO**
radium 226/228	9/30/02	pCi/l	0.9	5	0	erosion of natural deposits	**NO**
uranium	9/30/02	ppb	0.01	30	0	erosion of natural deposits	**NO**
Lead and Copper Corrosion							
Lead	Summer 2003	ppb	8 (ND – 8)*	AL = 15	0	Corrosion of household plumbing systems; erosion of natural deposits	**NO**
* (Note: The 90th percentile lead level was 2 ppb. All levels detected were below the action level of 15 ppb.)							
Copper	Summer 2003	ppm	0.08 (ND – 0.08)**	AL = 1.3	1.3	Corrosion of household plumbing systems; erosion of natural deposits; leaching from wood preservatives)	**NO**
**(Note: The 90th percentile copper level was 0.07 ppm. All levels detected were below the action level of 1.3 ppm.)							

APPENDIX M

Tualatin Valley Water District

Memo

To: Those Interested in Water Quality Comparisons of the Bull Run, the Joint Water Commission and the Willamette River Water Treatment Plant

CC: Greg DiLoreto, P.E., General Manager

From: TVWD Management Team

Date: August 24, 2005

Re: Water Quality Comparisons

Attached to this memo is a chart showing the water quality results for the three sources of interest to the District. Unless otherwise noted, all of the results are for finished water. The results for the City of Portland's Bull Run and Columbia South Shore system have been verified by Yone Aggai, P.E., of the Portland Water Bureau. The results for the JWC have been submitted by JWC staff. The data for the Willamette River Water Treatment Plant at Wilsonville is the result of the testing program that TVWD undertook and supplemented with data supplied by City of Wilsonville. The additional Willamette data provide by the City of Wilsonville was included at the request of the Portland Water Bureau. Dean Fritzke, TVWD Water Quality Coordinator together with other TVWD staff prepared this table and reviewed all the results. We believe that this represents an accurate comparison between the three sources.

TVWD Water Supplies: Water Quality Comparisons

Inorganic Chemicals (Results Measured In PPM)

Contaminant (ppm – mg/L)	MCL	Portland Water Supply (Aug. 2003)			Willamette Water Supply				JWC (Aug. 2004)	
		MRL	Bull Run	Columbia Wellfield	MRL	October 2003	April 2004	June 2004	MRL	Results
Antimony Total	0.006	0.003	<0.003	<0.003	0.0005	ND at MRL	ND at MRL	ND at MRL	0.001	ND at MRL
Arsenic	0.05	0.001	<0.001	<0.001	0.0005	ND at MRL	ND at MRL	ND at MRL	0.002	ND at MRL
Barium	2.0	0.002	<0.002	0.012	0.0002	0.0043	0.0045	0.0046	0.05	ND at MRL
Beryllium Total	0.004	0.0005	<0.0005	<0.0005	0.0005	ND at MRL	ND at MRL	ND at MRL	0.0005	ND at MRL
Bromate	---	---	---	---	0.05	ND at MRL	ND at MRL	0.12	---	ND: ARBL (Jan. 1999)
Cadmium	0.005	0.001	<0.001	<0.001	0.0002	ND at MRL	ND at MRL	ND at MRL	0.001	ND at MRL
Chromium	0.1	0.001	<0.001	<0.001	0.001	ND at MRL	ND at MRL	ND at MRL	0.002	ND at MRL
Cyanide	0.2	0.02	<0.025	<0.02	0.005	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL (Aug. 2003)
Fluoride	4.0	0.05	<0.05	0.12	0.2	ND at MRL	ND at MRL	ND at MRL	0.5	ND at MRL
Lead	0.015	0.001	<0.001	<0.001	0.0002	0.0003	0.0005	0.0005	0.001	ND at MRL
Mercury	0.002	0.001	<0.001	<0.001	0.0004	ND at MRL	ND at MRL	ND at MRL	0.0002	ND at MRL
Nickel	0.1	0.002	<0.002	<0.002	0.01	ND at MRL	ND at MRL	0.0005	0.004	ND at MRL
Nitrate	10.0	0.01	0.01	0.60	0.1	0.3	0.3	0.3	0.5	0.6
Nitrate-Nitrite	10.0	0.01	0.01	0.60	0.1	0.3	0.3	0.3	---	0.6 (Feb. 2004)
Nitrite	1.0	0.005	<0.005	<0.005	0.1	ND at MRL	ND at MRL	ND at MRL	0.01	ND at MRL
Selenium	0.05	0.001	<0.001	<0.001	0.005	ND at MRL	ND at MRL	ND at MRL	0.002	ND at MRL
Sodium	---	0.01	12	12	2.0	11	7.0	1.0	0.05	8.75
Sulfate	250	1.0	<1.0	4.2	0.5	10	9.6	9.8	5	13
Thallium Total	0.002	0.0002	<0.0002	<0.001	0.0002	ND at MRL	ND at MRL	ND at MRL	0.0006	ND at MRL
Total Organic Carbon	---	0.1	2.0	0.46	0.8	ND at MRL	ND at MRL	ND at MRL	0.5	0.83

Regulated Volatile Organic Chemicals (Results Measured In PPM)

Contaminant (ppm – mg/L)	MCL	Portland Water Supply (Aug. 2003)			Willamette Water Supply				JWC (Feb. 2004)	
		MRL	Bull Run	Columbia Wellfield	MRL	Oct. 2003	April 2004	June 2004	MRL	Results
1,1 - Dichloroethylene	0.007	0.0005	<MRL	<MRL	0.0005	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
1,1,1 - Trichloroethane	0.2	0.0006	<MRL	<MRL	0.0005	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
1,1,2 - Trichloroethane	0.005	0.0005	<MRL	<MRL	0.0005	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
1,2 Dichloroethane	0.005	0.001	<MRL	<MRL	0.0005	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
1,2 Dichloropropane	0.005	0.0005	<MRL	<MRL	0.0005	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
1,2,4 – Trichlorobenzene	0.07	0.001	<MRL	<MRL	0.0005	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Benzene	0.005	0.0005	<MRL	<MRL	0.0005	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Carbon Tetrachloride	0.005	0.0005	<MRL	<MRL	0.0005	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Cis – 1,2 – Dichloroethylene	0.07	0.001	<MRL	<MRL	0.0005	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Dichloromethane	0.005	0.0005	<MRL	<MRL	0.0005	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL (Jan. 1999)

MRL (Method reporting limit): The lowest level of a contaminant that can be reliably and consistently reported by the laboratory. MRLs vary with the analytical test method and the established reporting convention of the laboratory.
MCL (Maximum Contaminant Level): The highest level of a contaminant allowed in drinking water.
ND at MRL: The contaminant was not detected at a level equal to or above the laboratory's method reporting limit.
ND: ARBL: Not detected as reported by lab. These values were reported as non-detected, but TVWD doesn't know the MRL.
<: Less than
---: The contaminant was not tested or was not reported to TVWD.

1 ppm means that one part of a particular contaminant is present for every 1 million (1,000,000) parts of water. 1 ppm is equivalent to 1 minute in 2 years, 1 cent in $10,000 and 1 inch in 16 miles.
1 ppb = .001 ppm, which means that one part of a particular contaminant is present for every 1 billion (1,000,000,000) parts of water. 1 ppb is equivalent to 1 second in 32 years, 1 cent in $10 million and 1 inch in 16,000 miles.

Contaminant (ppm – mg/L)	MCL	Portland Water Supply (Aug. 2003)			Willamette Water Supply				JWC (Feb. 2004)	
		MRL	Bull Run	Columbia Wellfield	MRL	Oct. 2003	April 2004	June 2004	MRL	Results
Ethylbenzene	0.7	0.0005	<MRL	<MRL	0.0005	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Monochlorobenzene	0.1	0.0005	<MRL	<MRL	0.0005	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL (Jan. 1999)
O-Dichlorobenzene	0.6	0.0006	<MRL	<MRL	0.0005	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL (Jan. 1999)
P-Dichlorobenzene	0.075	0.0005	<MRL	<MRL	0.0005	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL (Jan. 1999)
Styrene	0.1	0.001	<MRL	<MRL	0.0005	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Tetrachloroethylene	0.005	0.0006	<MRL	<MRL	0.0005	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Toluene	1.0	0.0005	<MRL	<MRL	0.0005	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Total Xylenes	10	0.0005	0.0005	0.0005	0.001	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Trans – 1,2 – Dichloroethylene	0.1	0.0007	<MRL	<MRL	0.0005	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Trichloroethylene	0.005	0.005	<MRL	<MRL	0.0005	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Vinyl Chloride	0.002	0.002	<MRL	<MRL	0.0005	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL

Unregulated Volatile Organic Chemicals (Results Measured In PPM)

Contaminant (ppm – mg/L)	MCL	Portland Water Supply (Aug. 2003)			Willamette Water Supply				JWC (Feb. 2004)	
		MRL	Bull Run	Columbia Wellfield	MRL	Oct. 2003	April 2004	June 2004	MRL	Results
Bromobenzene	---	0.0005	<MRL	<MRL	0.0005	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Bromodichloro Methane	---	0.0005	<MRL	<MRL	0.0005	0.0025	0.0026	0.002	---	0.0021
Bromoform	---	0.0005	<MRL	<MRL	0.0005	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Bromomethane	---	0.006	<MRL	<MRL	0.0005	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Chloroethane	---	0.001	<MRL	<MRL	0.0005	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Chloroform	---	0.0005	0.010	0.005	0.0005	0.0054	0.0037	0.0048	---	0.011
Chloromethane	---	0.0005	<MRL	<MRL	0.0005	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
2 - Chlorotoluene	---	0.0005	<MRL	<MRL	0.0005	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
4 - Chlorotoluene	---	0.0005	<MRL	<MRL	0.0005	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Dibromochloro Methane	---	0.0012	<MRL	<MRL	0.0005	0.001	0.0006	0.0008	---	ND: ARBL
Dibromomethane	---	0.001	<MRL	<MRL	0.0005	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
1,3 - Dichlorobenzene	---	0.0005	<MRL	<MRL	0.0005	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
1,1 - Dichloroethane	---	0.001	<MRL	<MRL	0.0005	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
1,3 - Dichloropropane	---	0.0012	<MRL	<MRL	0.0005	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
2,2 - Dichloropropane	---	0.0005	<MRL	<MRL	0.0005	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
1,1 - Dichloropropene	---	0.0005	<MRL	<MRL	0.0005	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
cis-1,3 - Dichloropropene	---	0.0005	<MRL	<MRL	0.0005	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
1,1,1,2 - Tetrachloroethane	---	0.0005	<MRL	<MRL	0.0005	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
1,1,2,2 - Tetrachloroethane	---	0.001	<MRL	<MRL	0.0005	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
1,2,3 – Trichlorobenzene	---	0.0006	<MRL	<MRL	---	---	---	---	---	---
1,2,3 – Trichloropropane	---	0.0006	<MRL	<MRL	0.0005	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL

MRL (Method reporting limit): The lowest level of a contaminant that can be reliably and consistently reported by the laboratory. MRLs vary with the analytical test method and the established reporting convention of the laboratory.

MCL (Maximum Contaminant Level): The highest level of a contaminant allowed in drinking water.
ND at MRL: The contaminant was not detected at a level equal to or above the laboratory's method reporting limit.
ND: ARBL: Not detected as reported by lab. These values were reported as non-detected, but TVWD doesn't know the MRL.
<: Less than
---: The contaminant was not tested or was not reported to TVWD.

1 ppm means that one part of a particular contaminant is present for every 1 million (1,000,000) parts of water. 1 ppm is equivalent to 1 minute in 2 years, 1 cent in $10,000 and 1 inch in 16 miles.
1 ppb = .001 ppm, which means that one part of a particular contaminant is present for every 1 billion (1,000,000,000) parts of water. 1 ppb is equivalent to 1 second in 32 years, 1 cent in $10 million and 1 inch in 16,000 miles.

Synthetic Organic Chemicals (Results Measured In PPM)

Contaminant (ppm – mg/L)	MCL	Portland Water Supply (Aug. 2003)			Willamette Water Supply				JWC (July 2002)	
		MRL	Bull Run	Columbia Wellfield	MRL	Oct. 2003	April 2004	June 2004	MRL	Results
2,4 – D	0.07	0.0002	<MRL	<MRL	0.0008	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
2,4,5 – TP Silvex	0.05	0.0004	<MRL	<MRL	0.0002	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Adipates	0.4	0.001	<MRL	<MRL	0.001	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Alachlor (Lasso)	0.002	0.004	<MRL	<MRL	0.0003	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Atrazine	0.003	0.002	<MRL	<MRL	0.0001	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Benzo(A)Pyrene	0.0002	0.00004	<MRL	<MRL	0.000005	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
BHC – gamma (Lindane)	0.0002	0.00002	<MRL	<MRL	0.00001	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Carbofuran	0.04	0.001	<MRL	<MRL	0.001	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Chlordane	0.002	0.004	<MRL	<MRL	0.0004	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Dalapon	0.2	0.002	<MRL	<MRL	0.003	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Dibromo chloropropane	0.0002	0.00002	<MRL	<MRL	0.00001	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Dinoseb	0.007	0.0004	<MRL	<MRL	0.0004	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Diquat	0.02	0.0004	<MRL	<MRL	0.0008	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Endothall	0.1	0.01	<MRL	<MRL	0.02	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Endrin	0.002	0.00002	<MRL	<MRL	0.00001	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Ethylene Dibromide (EDB)	0.00005	0.00001	<MRL	<MRL	0.00001	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Glyphosate	0.7	0.01	<MRL	<MRL	0.01	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Heptachlor Epoxide	0.0002	0.00002	<MRL	<MRL	0.00001	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Heptachlor	0.0004	0.00004	<MRL	<MRL	0.00001	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Hexachlorobenzene (HCB)	0.001	0.0001	<MRL	<MRL	0.00001	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Hexachloro cyclolpentadiene	0.05	0.0002	<MRL	<MRL	0.0001	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Methoxychlor	0.04	0.0002	<MRL	<MRL	0.00001	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Pentachlorophenol	0.001	0.00008	<MRL	<MRL	0.0002	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Phthalates	0.006	0.0013	<MRL	<MRL	0.001	ND at MRL	ND at MRL	ND at MRL	---	---
Picloram	0.5	0.0002	<MRL	<MRL	0.0002	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Polychlorinated Biphenyls	0.0005	0.0001	<MRL	<MRL	0.0002	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Simazine	0.004	0.0001	<MRL	<MRL	0.0001	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Toxaphene	0.003	0.001	<MRL	<MRL	0.0006	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Vydate (Oxymyl)	0.2	0.002	<MRL	<MRL	0.001	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL

Unregulated Synthetic Organic Chemicals (Results Measured In PPM)

Contaminant (ppm – mg/L)	MCL	Portland Water Supply (Aug. 2003)			Willamette Water Supply				JWC (July 2002)	
		MRL	Bull Run	Columbia Wellfield	MRL	Oct. 2003	April 2004	June 2004	MRL	Results
Butylbenzyl phthalate	---	0.0005	<MRL	---	0.001	ND at MRL	ND at MRL	ND at MRL	---	---
Di-n-butyl phthalate	---	0.0005	<MRL	---	0.001	ND at MRL	ND at MRL	ND at MRL	---	---

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Contaminant (ppm – mg/L)	MCL	Portland Water Supply (Aug. 2003)			Willamette Water Supply				JWC (July 2002)	
		MRL	Bull Run	Columbia Wellfield	MRL	Oct. 2003	April 2004	June 2004	MRL	Results
Di-n-octylphthalate	---	0.0001	<MRL	---	0.001	ND at MRL	ND at MRL	ND at MRL	---	---
Diethyl phthalate	---	0.0005	<MRL	---	0.001	ND at MRL	ND at MRL	ND at MRL	---	---
Dimethyl phthalate	---	0.0005	<MRL	---	0.001	ND at MRL	ND at MRL	ND at MRL	---	---
Butachlor	---	0.001	<MRL	<MRL	0.0003	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Metolachlor	---	0.002	<MRL	<MRL	0.0003	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Metribuzin	---	0.001	<MRL	<MRL	0.0002	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Aldrin	---	0.0001	<MRL	<MRL	0.00001	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Dieldrin	---	0.0001	<MRL	<MRL	0.00006	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Propachlor	---	0.001	<MRL	---	0.06	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Dicamba	---	0.0005	<MRL	<MRL	0.002	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
3 – Hydroxycarbofuran	---	0.004	<MRL	<MRL	0.001	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Aldicarb	---	0.002	<MRL	<MRL	0.001	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Aldicarb sulfone	---	0.001	<MRL	<MRL	0.0007	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Aldicarb sulfoxide	---	0.003	<MRL	<MRL	0.001	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Carbaryl	---	0.004	<MRL	<MRL	0.001	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Methiocarb	---	0.002	<MRL	---	0.001	ND at MRL	ND at MRL	ND at MRL	---	---
Methomyl	---	0.004	<MRL	<MRL	0.001	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Paraquat	---	0.002	<MRL	---	0.002	ND at MRL	ND at MRL	ND at MRL	---	---

Microscopic Examination

	Portland Water Supply (Aug. 2003)				Willamette Water Supply (Treated Water)						JWC (Treated Water, August 2003)	
	Bull Run (Untreated Water)		Columbia Wellfield		Oct. 2003		April 2004		June 2004			
	Giardia	Crypto sporidium oocysts	Giardia	Crypto sporidium oocysts	Giardia	Crypto sporidium oocysts	Giardia	Crypto sporidium oocysts	Giardia	Crypto sporidium oocysts	Giardia	Crypto sporidium oocysts
Empty Cysts (no internal structure)	---	---	---	---	ND: ARBL	ND: ARBL	ND: ARBL	ND: ARBL	ND: ARBL	ND: ARBL	ND: ARBL	ND: ARBL
Cysts/oocysts (amorphous internal structure (E)	---	---	---	---	ND: ARBL	ND: ARBL	ND: ARBL	ND: ARBL	ND: ARBL	ND: ARBL	ND: ARBL	ND: ARBL
Cysts/oocysts (identifiable internal structure (F)	---	---	---	---	ND: ARBL	ND: ARBL	ND: ARBL	ND: ARBL	ND: ARBL	ND: ARBL	ND: ARBL	ND: ARBL
Total Cysts/ oocysts in sample	<2	<2	---	---	ND: ARBL	ND: ARBL	ND: ARBL	ND: ARBL	ND: ARBL	ND: ARBL	ND: ARBL	ND: ARBL
Positive Internal Staining (B)	---	---	---	---	0	0	0	0	0	0	0	0
Positive Nuclei Staining (C)	---	---	---	---	0	0	0	0	0	0	0	0

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Microbiological

Contaminant	MCL	Portland Water Supply (Aug. 2003)		Willamette Water Supply			JWC (Continual)
		Bull Run	Columbia Wellfield	Oct. 2003	April 2004	June 2004	Results
E. coli	Absent	Absent	Absent	1.0	Absent	Absent	Absent
Total Coliform	No more than 1 detected sample per month	Absent	Absent	1.0	Absent	Absent	Absent

Dioxin (Results Measured In PPM)

MCL	Portland Water Supply (1993)		Willamette Water Supply			JWC
0.000000003	Bull Run	Columbia Wellfield	Oct. 2003	April 2004	June 2004	---
	0.0000000007	---	The dioxin of concern for drinking water was not detected.	The dioxin of concern for drinking water was not detected.	The dioxin of concern for drinking water was not detected.	---

Disinfection By-products (Results Measured In PPB)*

Contaminant (ppb)	MCL	Portland Water Supply (Running average for 2004)	Willamette Water Supply (March 2005)	JWC (Running average for 2004)
		Meter Vault	Entry to Wilsonville Water System	Cornelius Pass
TTHMs	80 ppb	32.225 ppb (0.032225 mg/L)	5.62 ppb (0.00562 mg/L)	28.075 ppb (0.028075 mg/L)
HAAs	60 ppb	24.55 ppb (0.02455 mg/L)	ND	30.05 ppb (0.03005 mg/L)

* Portland and JWC Disinfection By-products were measured by TVWD at entry points to TVWD's water system. Willamette Disinfection By-products were measured at the entry point to the Wilsonville water system. TTHMs (Total Trihalomethanes) include Chloroform, Bromodichloromethane, Dibromochloromethane and Bromoform. HAAs (Haloacetic Acids) include Dibromoacetic Acid, Dichloroacetic Acid, Monobromoacetic Acid, Monochloroactic Acid and Trichloroactic Acid.

Secondary Contaminants (Results Measured In PPM)

Contaminant (ppm – mg/L)	MCL	Portland Water Supply		Willamette Water Supply	JWC
		Lusted Hill Treatment Facility (Aug. 2004)	Groundwater Pump Station (July 2004)	Jan. 2005	Hillsboro Treatment Plant Finished Water (Aug. 2004)
Chloride	250	1.3	---	---	4
Hardness	250	7.9	66	23.2 – 28.2	26
Aluminum	0.05-0.20	0.030	---	0.946	ND
Iron	0.3	0.092	0.052	ND	ND
Manganese	0.05	0.032	<0.01	0.038	ND
Silver	0.1	<0.001	---	ND	ND
Zinc	5	<0.10	---	ND	ND

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--- means the contaminant was not tested or was not reported to TVWD

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Radionuclides*

Contaminant (pCi/L)	MCL	Portland Water Supply (Groundwater Pump Station, July 2003)	Willamette Water Supply (Sept. 2002)	JWC (Feb. 2003)
Gross Alpha	15	ND	1.2	ND
Combined Radium (226/228)	5	ND	0.9	ND
Combined Uranium	30	0.05	0.01	ND
Radon	---	25	---	---

* Radionuclides were measured in Picocuries per liter (pCi/L), a measure of radioactivity.

Extractable Organics (Results Measured In PPM)

Contaminant (ppm – mg/L)	MCL	Portland Water Supply (Aug. 2003)			Willamette Water Supply				JWC	
		MRL	Bull Run	Columbia Wellfield	MRL	Oct. 2003	April 2004	June 2004	MRL	Results
Azinphos-methyl	---	---	---	---	0.001	ND at MRL	ND at MRL	ND at MRL	---	---
Bolstar	---	---	---	---	0.0006	ND at MRL	ND at MRL	ND at MRL	---	---
Chlorpyrifos	---	---	---	---	0.0006	ND at MRL	ND at MRL	ND at MRL	---	---
Coumaphos	---	---	---	---	0.0006	ND at MRL	ND at MRL	ND at MRL	---	---
Demeton O-S	---	---	---	---	0.0006	ND at MRL	ND at MRL	ND at MRL	---	---
Diazinon	---	---	---	---	0.0006	ND at MRL	ND at MRL	ND at MRL	---	---
Dichlorvos	---	---	---	---	0.0006	ND at MRL	ND at MRL	ND at MRL	---	---
Dimethoate	---	---	---	---	0.0006	ND at MRL	ND at MRL	ND at MRL	---	---
Disulfoton	---	---	---	---	0.0006	ND at MRL	ND at MRL	ND at MRL	---	---
EPN	---	---	---	---	0.0006	ND at MRL	ND at MRL	ND at MRL	---	---
Ethoprop	---	---	---	---	0.0006	ND at MRL	ND at MRL	ND at MRL	---	---
Fensulfothion	---	---	---	---	0.0006	ND at MRL	ND at MRL	ND at MRL	---	---
Fenthion	---	---	---	---	0.0006	ND at MRL	ND at MRL	ND at MRL	---	---
Malathion	---	---	---	---	0.0006	ND at MRL	ND at MRL	ND at MRL	---	---
Merphos	---	---	---	---	0.0006	ND at MRL	ND at MRL	ND at MRL	---	---
Mevinphos	---	---	---	---	0.0006	ND at MRL	ND at MRL	ND at MRL	---	---
Naled	---	---	---	---	0.0006	ND at MRL	ND at MRL	ND at MRL	---	---
Parathion ethyl	---	---	---	---	0.0006	ND at MRL	ND at MRL	ND at MRL	---	---
Parathion methyl	---	---	---	---	0.0006	ND at MRL	ND at MRL	ND at MRL	---	---
Phorate	---	---	---	---	0.0006	ND at MRL	ND at MRL	ND at MRL	---	---

MRL (Method reporting limit): The minimum amount detected by the testing equipment
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ND at MRL = means the contaminant was not detected at the method reporting limit
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Contaminant (ppm – mg/L)	MCL	Portland Water Supply (Aug. 2003)			Willamette Water Supply				JWC	
		MRL	Bull Run	Columbia Wellfield	MRL	Oct. 2003	April 2004	June 2004	MRL	Results
Ronnel	---	---	---	---	0.0006	ND at MRL	ND at MRL	ND at MRL	---	---
Stirofos	---	---	---	---	0.0006	ND at MRL	ND at MRL	ND at MRL	---	---
Sulfotepp	---	---	---	---	0.0006	ND at MRL	ND at MRL	ND at MRL	---	---
Tokuthion	---	---	---	---	0.0006	ND at MRL	ND at MRL	ND at MRL	---	---
Trichloronate	---	---	---	---	0.0006	ND at MRL	ND at MRL	ND at MRL	---	---

Unregulated Contaminants (Results Measured In PPB)

Contaminant (ppb – ug/l)	Portland Water Supply (Jan. 2003)			Willamette Water Supply				JWC (Jan. 2003)	
	MRL	Bull Run	Columbia Wellfield	MRL	Oct. 2003	April 2004	June 2004	MRL	Results
Perchlorate	4.0	<MRL	---	4.0	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
2,4 – Dinitrotoluene	2.0	<MRL	---	2.0	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
2,6 – Dinitrotoluene	2.0	<MRL	---	2.0	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
4,4' – DDE	0.8	<MRL	---	0.8	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Acetochlor	2.0	<MRL	---	2.0	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
EPTC	1.0	<MRL	---	1.0	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Molinate	0.9	<MRL	---	0.9	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Terbacil	2.0	<MRL	---	2.0	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
DCPA (di-acid degradate)	1.0	<MRL	---	1.0	ND at MRL	ND at MRL	ND at MRL	---	---
DCPA (mono-acid degradate)	---	<MRL	---	1.0	ND at MRL	ND at MRL	ND at MRL	---	---
Total DCPA	---	---	---	1.0	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL
Methyl Tert-Butyl Ether	5.0	<MRL	---	5.0	ND at MRL	ND at MRL	ND at MRL	---	ND: ARBL (August 2003)
Nitrobezene	10.0	<MRL	---	10.0	ND at MRL	ND at MRL	ND at MRL	---	---
Diuron	---	---	---	1.0	ND at MRL	ND at MRL	ND at MRL	---	---
Linuron	---	---	---	1.0	ND at MRL	ND at MRL	ND at MRL	---	---
2 – Methylphenol (o-Cresol)	---	---	---	1.0	ND at MRL	ND at MRL	ND at MRL	---	---
2,4 – Dichlorophenol	---	---	---	1.0	ND at MRL	ND at MRL	ND at MRL	---	---
2,4 – Dinitrophenol	---	---	---	5.0	ND at MRL	ND at MRL	ND at MRL	---	---
2,4,6 – Trichlorophenol	---	---	---	1.0	ND at MRL	ND at MRL	ND at MRL	---	---
1,2 – Diphenylhydrazine	---	---	---	0.05	ND at MRL	ND at MRL	ND at MRL	---	---
Diazinon	---	---	---	0.05	ND at MRL	ND at MRL	ND at MRL	---	---
Disulfoton	---	---	---	0.05	ND at MRL	ND at MRL	ND at MRL	---	---
Fonofos	---	---	---	0.05	ND at MRL	ND at MRL	ND at MRL	---	---
Nitrobenzene	---	---	---	0.05	ND at MRL	ND at MRL	ND at MRL	---	---
Prometon	---	---	---	0.05	ND at MRL	ND at MRL	ND at MRL	---	---
Terbufos	---	---	---	0.05	ND at MRL	ND at MRL	ND at MRL	---	---

MRL (Method reporting limit): The minimum amount detected by the testing equipment
MCL (Maximum Contaminant Level): The highest level of a contaminant allowed in drinking water
ND at MRL = means the contaminant was not detected at the method reporting limit
--- means the contaminant was not tested or was not reported to TVWD

1 ppm means that one part of a particular contaminant is present for every 1 million (1,000,000) parts of water. 1 ppm is equivalent to 1 minute in 2 years, 1 cent in $10,000 and 1 inch in 16 miles.
1 ppb = .001 ppm, which means that one part of a particular contaminant is present for every 1 billion (1,000,000,000) parts of water. 1 ppb is equivalent to 1 second in 32 years, 1 cent in $10 million and 1 inch in 16,000 miles.

Other Common Characteristics

Contaminant	MCL	Portland Water Supply		Willamette Water Supply	JWC
		Lusted Hill Treatment Facility (Aug. 2004)	Groundwater Pump Station (July 2004)	Range Of Samples Taken In 2004	Hillsboro Treatment Plant Finished Water (Aug. 2004)
Turbidity (NTU)	5	0.47 - 0.78 (Taken at Bull Run before treatment)	0.55	0.03 – 0.09	0.039
pH (Standard Units)	6.5 – 8.5	7.9	7.8	7.67 – 8.11	7.33
Total Dissolved Solids (ppm)	500	29	---	53.0 – 76.8	60
Color (Standard Units)	15	10	5	Never exceeded 0	ND
Specific Conductance/Concutivity (µmhos/cm)	---	32	179	79.5 – 115.2	89
Water Temperature (°C)	---	15.7	15.7	4.6 – 24.5	---
Suspended Solids (ppm)	---	1.0	---	---	ND
Total Solids (@ 180° C)	---	30	140	---	60

MRL (Method reporting limit): The minimum amount detected by the testing equipment
MCL (Maximum Contaminant Level): The highest level of a contaminant allowed in drinking water
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APPENDIX N

Murray, Smith & Associates, Inc.
Engineers/Planners
121 S.W. Salmon, Suite 900 ■ Portland, OR 97204 ■ PHONE: 503-225-9010 ■ FAX: 503-225-9022

TOPIC: City of Sherwood – Water System Master Plan, Water Quality Workshop, Meeting Discussion Summary
DATE: February 22, 2005
LOCATION: City of Sherwood Public Works Shops
TIME: 1:00 pm – 4:00 pm

1. Introductions – **All**

2. Review existing water quality at wells – **Uber**
   a. Well No. 3
   b. Well No. 4
   c. Well No. 5
   d. Well No. 6
   e. Spada Well

   Discussion: See attached summary of well data. pH of existing wells ranges from 7.0 to 7.5. At Well No. 5 a control valve is being installed to control flow as a measure to deal with CO2 problem. When Well No. 6 is operated as primary supply there are occasional taste and odor complaints. If Spada well is brought on line it may be necessary to treat for TDS, BAT is RO, could be expensive ($2.0 m?) It may be a good idea to do flavor profiling with this well if it is brought on line.

3. Review water demand needs – **Ginter**

   Discussion: See attached water demand table.

4. Review current compliance with regulations – **Fritzke**
   a. Wells
   b. Distribution system

Discussion: Coliform monitoring: 20 per month. VOC/SOC – Non-detect. Lead and Copper: 1 sample on Portland program. DBP – Low 30s to 40s. Radon: No regulation yet, include as possible cost for future treatment.

5. Review anticipated new regulations – **Kreft**
   a. Short-term
   b. Long-term

Discussion: The City's current regulatory compliance program is a mix of groundwater monitoring and surface water (from City of Portland). Key issue for groundwater are Radon and possible treatment of Spada wells. Lead and Copper compliance continues in coordination with Portland. If Sherwood selects another surface water source, they may have to develop or participate in a new/other program. PH2 DBP rule, IDSE, is on the horizon, the City's development of an EPS model will put them in a good position to economically comply

6. Review water quality issues related to source options – **Uber/Fritzke/Kreft**
   a. Supply from the City's existing groundwater production facilities and the Spada well. **Uber**

   b. Supply from the City of Portland through the Washington County Supply Line and the City of Tualatin. **Fritzke**

Discussion: Ongoing compliance with existing wells. Deal with CO2 concerns at Well No., though this is a secondary(or nuisance) concern w/rt to water quality. If Spada comes on line there will need to be addressing of the secondary water quality issues as well. If Radon rule is promulgated then an MMM or treatment may be needed. The rule is in draft form now and it may be 2011 before it is promulgated, if then. Radon is primarily an air quality concern that may be regulated through water system. If new source (other than wells) is developed the public may become more aware of water quality (taste and odor) variances in the wells and new supply. . Groundwater Rule: Currently changing and will require disinfection, the City is already doing this. LTSWT: Compliance is tied to water supplier, right now no surface water supplier in this area is at risk for this. Portland will have to provide Crypto and Giardia inactivation. This will take a capital investment, it is currently not in the Portland's 5 year CIP. The consensus is that while this may be delayed, ultimately it will need to be done.

TVWD will chlorinate JWC water if the District stays with the Portland supply. Occasional low residuals and taste and odor problems.

Sherwood's compliance in step with City of Portland programs. Chloramine mixing with free chlorine from City's existing wells is ongoing concern. If selected as long-term supply and wells are used as emergency, the issue will become less of a concern.

c. Supply from the Wilsonville Willamette River Water Treatment Plant. **Kreft**

Discussion: No water quality concerns to date. The WTP has been in operation since April 2002 and has been producing water that exceeds all water quality regulations. The recent water quality testing comparison completed by TVWD shows that the drinking water produced from the WTP is of very high quality. The plant's treatment processes were designed in anticipation of future regulations. If added to Sherwood's supply with wells the waters will mix ok, since both are free chlorine.

d. Prospective use of Aquifer Storage and Recovery (ASR) using Sherwood's existing connection to the City of Tualatin that supplies City of Portland water to Sherwood. **Uber**

Discussion: This could be an issue with respect to Radon which will be taken up by the injected water. Source water disinfection (chloramination or free chlorine) could also be an issue. If Well No. 6 is used there may be an issue with iron and manganese. There is speculation that multiple injection and recovery cycles may buffer and ultimate reduce this problem.

e. Supply from the Joint Water Commission. **Kreft/Fritzke**

Discussion: No water quality concerns. Free chlorine disinfection. Would be ok for ASR use.

f. Supply from the City of Newberg. **Kreft**

Discussion: Water quality issues are being dealt with through treatment. Free chlorine disinfection. Capacity and willingness of Newberg to supply Sherwood are greater issues.

g. Supply from the Clackamas River. **Kreft**

Discussion: No major water concerns. Seasonal taste and odor issues related to algae blooms do occur. Free chlorine disinfection.

7. Develop water quality compliance strategy and recommendations for inclusion in water system master plan

Discussion: A compliance strategy depends in great part on the long-term water supply option that the City ultimately chooses. If a new supply is brought on line and the wells are used just for emergencies then secondary issues related to the wells become less of a concern. It is anticipated that any new long-term supply option will be fully compliant with current regulations and that any source will remain compliant. A final strategy and compliance plan should be developed following the selection of the long-term water supply option. At the same time the City should be prepared to comply with DBP IDSE requirements. As mentioned above this is being accomplished through the development of an EPS model.

With the wells the City will need to deal with CO2 problems at Well No. 5, most likely have to treat Spada and deal with Radon. Well No. 6 treatment facilities must be maintained. If ASR is used at Well No. 6 then treatment capacity will need to be expanded.

For a Portland supply, Sherwood would remain under Portland's lead and copper compliance program. Sherwood may need to chloraminate wells of not use wells with Portland water.

A Willamette supply should work with existing wells, both use free chlorine. It may end up being most cost efficient to use 100% Willamette and use the wells only as emergency. The public may demand this due to the wide variation in water quality from the wells. The Willamette will end a very consistent supply.

For ASR, chloramination may be needed at the wells if the source water is from Portland.

The JWC may have chloramination issues if treatment changes. Sherwood will have compliance partners with JWC, as with other options like the Clackamas and Newberg. Newberg is considered a groundwater source and may have less water quality issues.

Groundwater Well Water Quality Summary Table

Well No./Name	Production Capacity (gpm)	Water Quality Summary
3	890	1. Radon @ 436 pCi/L (12/10/02)[3] 2. Sodium @ 15.1 mg/l (11/21/03) and @9.4 mg/l (6/14/99)[4] 3. Nitrate @ 0.6 mg/l (11/21/03)[5]
4	250	1. Radon @ 922 pCi/L (12/10/02)[3] 2. Nitrate @1.3 (6/14/99) @ 0.66 (6/18/96)[5]
5	600	1. Radon @ 750 pCi/L (12/10/02)[3] 2. Sodium @ 18.6 mg/l (11/21/03) and @13.8 mg/l (6/14/99)[4] 3. Bicarbonate and Total Akalinity @ 111 mg/l (1/28/05)[8]
6	550	1. Radon @ 332 pCi/L (12/10/02)[3] 2. Sodium @ 57.6 mg/l (11/21/03)[4], @ 64.2 mg/l (6/14/99) and @ 57.0 mg/l (1/31/97)[4] 3. Pre-filter Iron @ 0.11 mg/l. Post-filter Iron @ non-detectable levels (12/6/00)[1] 4. Pre-filter Manganese @ 0.032 mg/l. Post-filter Manganese @ non-detectable levels (12/6/00)[2].
Spada	400 – 700	1. Radon @ 590 pCi/L (12/10/02)[3] 2. Chloride @ 260 mg/l (8/4/04)[6] 3. Total dissolved solids @ 650 mg/l (8/4/60)[7]

Notes:
1. Secondary maximum contaminant level (SMCL) for Iron is 0.3 mg/l.
2. SMCL for Manganese is 0.05 mg/l.
3. No current maximum contaminant level (MCL) for Radon.
4. Recommended MCL for Sodium is 20 mg/l.
5. Recommended MCL for Nitrate is 10 mg/l.
6. SMCL for Chloride is 250 mg/l.
7. SMCL for Total Dissolved Solids is 500 mg/l.
8. No current limits for Bicarbonate, limit for Total Alkalinity suggested at 400 mg/l.

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APPENDIX O

Draft Water System Master Plan

Presentation to:
City of Sherwood
City Council

April 5, 2005

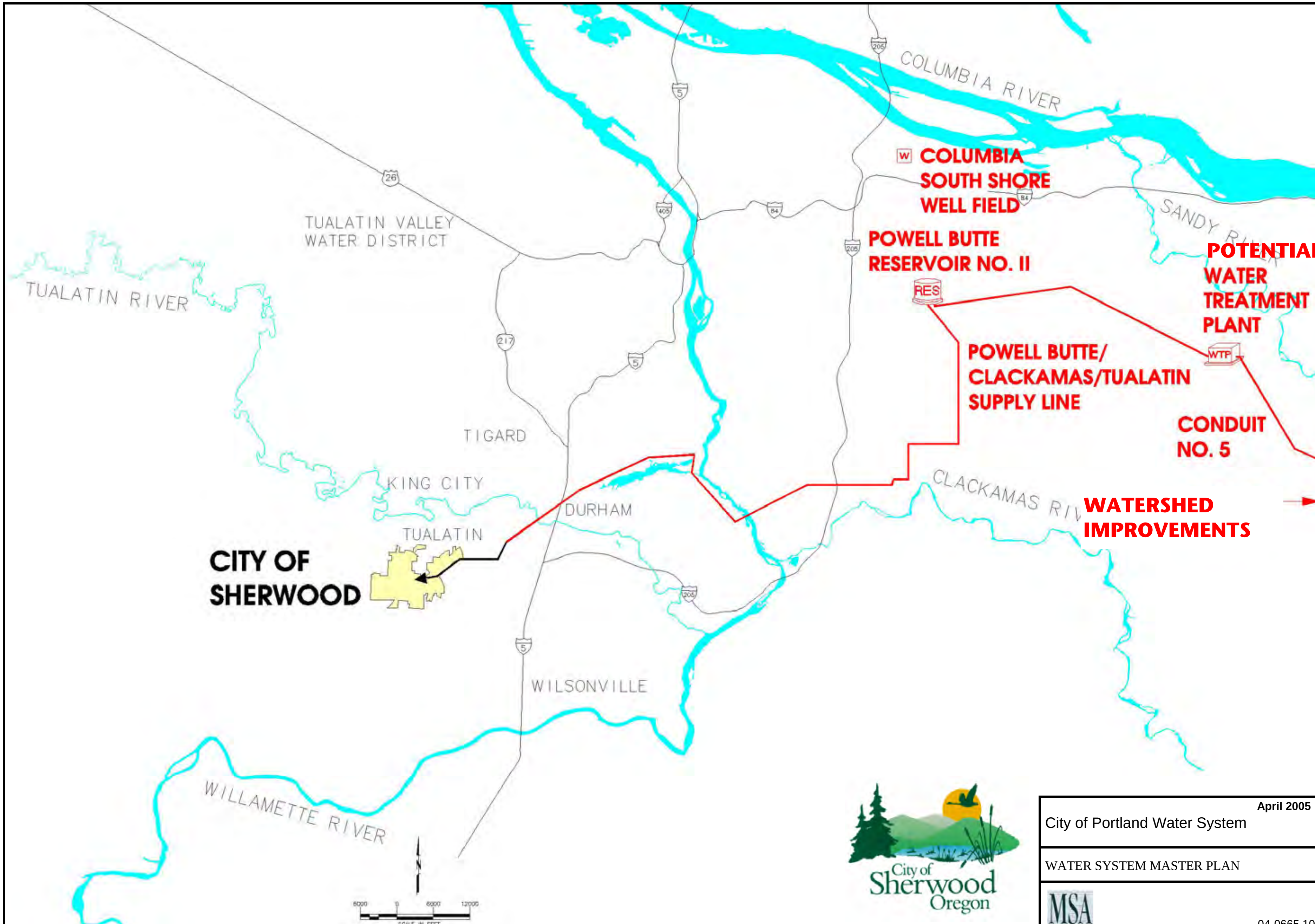
Presented by:
Chris Uber, P.E., Vice President
Brian Ginter, P.E., Staff Engineer

Sherwood's Long-term Water Supply Options and Initial Screening

- Options:
  - The City's Existing Groundwater Production Facilities
  - Aquifer, Storage and Recovery (ASR)
  - City of Portland Supply
  - Joint Water Commission
  - City of Newberg
  - Clackamas River Supply
  - Willamette River Supply
- Options capable of supplying 10 mgd
  - City of Portland
  - Joint Water Commission
  - Clackamas River Supply
  - Willamette River Supply
- Consider further narrowing of options

Basic Cost Assumptions

- Project costs are conceptual, order of magnitude estimates
- Developed using existing data from previous and ongoing engineering studies and projects
- Actual costs may vary
- Direct partnering discussions have not been opened on any option. Cost savings may be realized as agreements are reached and project details finalized.
- All proposed supply alternatives, except Newberg and a variant of a Willamette River supply option, connect to Sherwood's existing 24-inch diameter supply line.
- Supply strategy options:
  - Maximize the use of the City's existing groundwater supply wells
  - Initially size treatment capacity to 5 mgd and other facilities to 10 mgd
  - Incrementally increase treatment capacity as demands increase
  - Economic and water quality considerations may affect operational use of supplies


COLUMBIA RIVER
COLUMBIA SOUTH SHORE WELL FIELD
SANDY RIVER
TUALATIN VALLEY WATER DISTRICT
TUALATIN RIVER
POWELL BUTTE RESERVOIR NO. II
RES
POTENTIAL WATER TREATMENT PLANT
WTP
POWELL BUTTE/ CLACKAMAS/TUALATIN SUPPLY LINE
CONDUIT NO. 5
TIGARD
KING CITY
CLACKAMAS RIVER
WATERSHED IMPROVEMENTS
DURHAM
TUALATIN
CITY OF SHERWOOD
WILSONVILLE
WILLAMETTE RIVER
26
405
5
84
205
217
City of Sherwood Oregon
April 2005
City of Portland Water System
WATER SYSTEM MASTER PLAN
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04-0665.109

City of Sherwood Oregon

City of Portland Water System

Source

- The Bull Run watershed is on the slopes of Mt. Hood
- Columbia South Shore Well Field
- Existing watershed reservoirs
  No. 1 and No. 2 store approximately 16.7 billion gallons
- Capacity to meet Sherwood's needs can be developed

Required Infrastructure Improvements

- Possible water treatment plant and watershed source improvements may be needed
- Powell Butte Reservoir No. 2
- Conduit No. 5
- Transmission from Powell Butte

Regional Partnering Opportunities

- City of Tigard
- City of Tualatin
- Tualatin Valley Water District
- Others

Estimated Capital Costs

- $31 - $51 million

Issues

- Source development risk
- Actual infrastructure needs
- Source vulnerability and distance
- Project permitting
- Governance
- Schedule
- No SDC Credit

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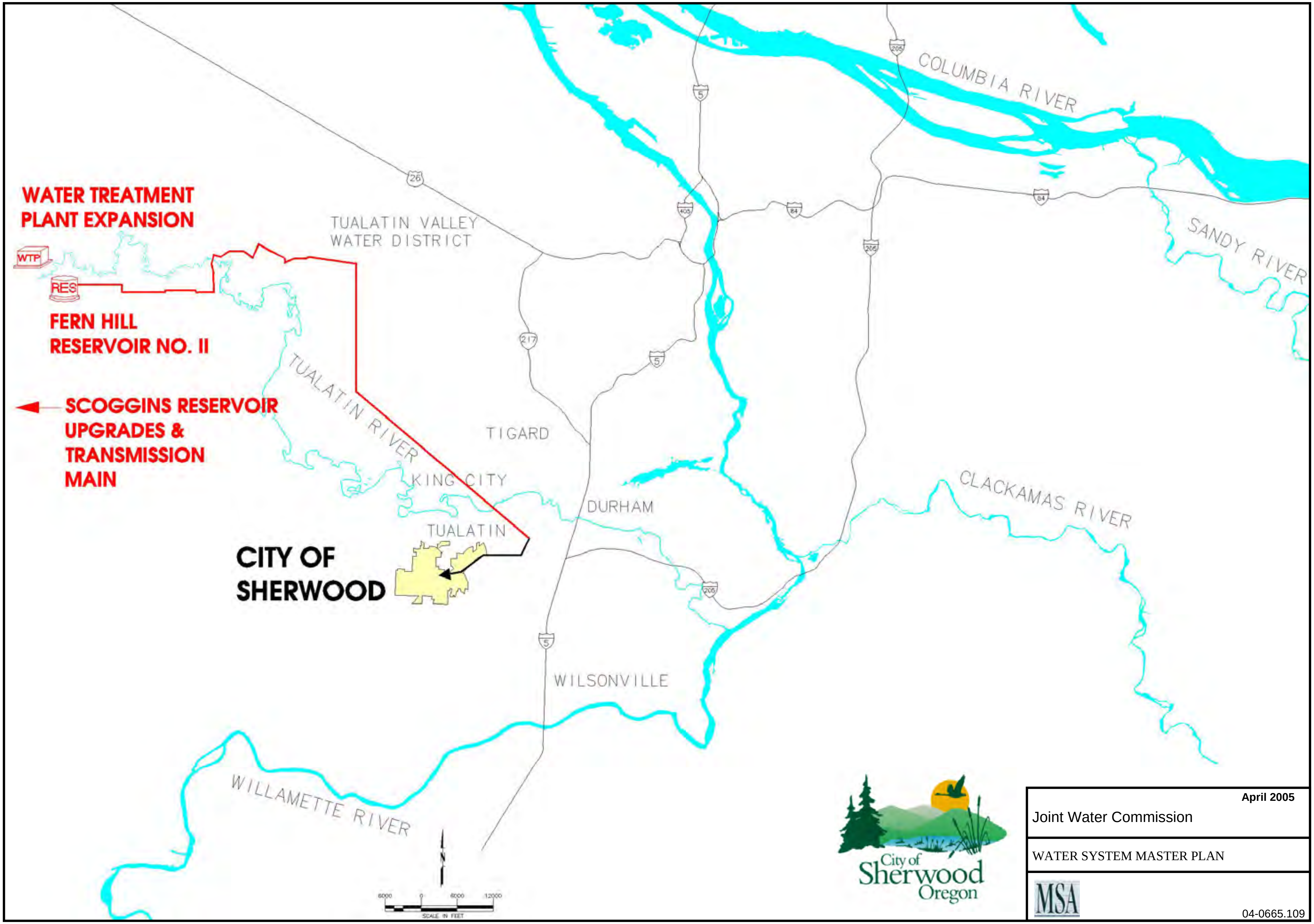
WATER TREATMENT PLANT EXPANSION
WTP
RES
FERN HILL RESERVOIR NO. II
SCOGGINS RESERVOIR UPGRADES & TRANSMISSION MAIN
TUALATIN VALLEY WATER DISTRICT
COLUMBIA RIVER
SANDY RIVER
TUALATIN RIVER
TIGARD
KING CITY
DURHAM
TUALATIN
CLACKAMAS RIVER
CITY OF SHERWOOD
WILSONVILLE
WILLAMETTE RIVER
SCALE IN FEET
City of Sherwood Oregon
April 2005
Joint Water Commission
WATER SYSTEM MASTER PLAN
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Joint Water Commission

Source	Required Infrastructure Improvements	Regional Partnering Opportunities	Estimated Capital Costs	Issues
• Trask and Tualatin Rivers and Scoggins Creek • Raw water stored at Hagg Lake and Barney Reservoir • The water is discharged into the Tualatin River, withdrawn and treated	• Raw water reservoir upgrades, including dam raise and spillway improvements • Water treatment plant upgrades • New Fern Hill Reservoir • Pump station upgrades • New transmission line	• City of Tigard • City of Tualatin • Tualatin Valley Water District • Clean Water Services • JWC Members • Others	• $54 million	• Source development risks and limitations • Water availability • Water rights • Project permitting needs • Governance • Schedule • System Reliability being evaluated

April 2005

Clackamas River Water System

WATER SYSTEM MASTER PLAN

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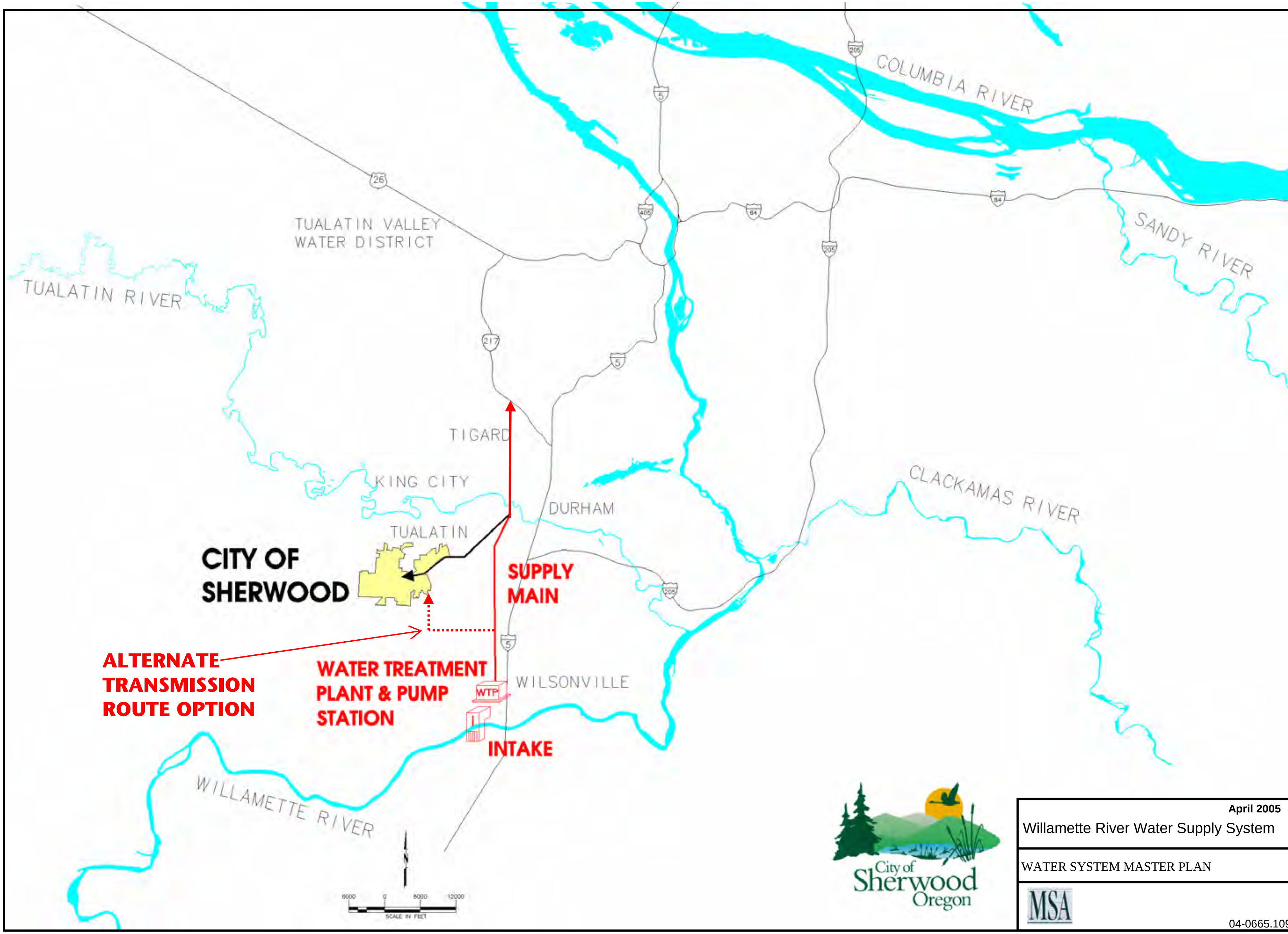
Clackamas River Water Supply System

Source	Required Infrastructure Improvements	Regional Partnering Opportunities	Estimated Capital Costs	Issues
• The Clackamas River watershed covers over 940 square miles • Timothy Lake and runoff from the Ollalie Butte make up the headwaters of the Clackamas River	• New intake • Water treatment plant • Pump station • New transmission line	• City of Tigard • Lake Oswego • City of Tualatin • Others	• $29 - $31 million	• Water rights availability • Political considerations • Ownership • Buy-in opportunities vs. wholesale • Project permitting • Schedule • Potentially limited supply capacity for Sherwood


COLUMBIA RIVER
SANDY RIVER
TUALATIN VALLEY
WATER DISTRICT
TUALATIN RIVER
TIGARD
KING CITY
DURHAM
TUALATIN
CLACKAMAS RIVER
CITY OF
SHERWOOD
SUPPLY
MAIN
ALTERNATE
TRANSMISSION
ROUTE OPTION
WATER TREATMENT
PLANT & PUMP
STATION
WTP
WILSONVILLE
INTAKE
WILLAMETTE RIVER
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City of
Sherwood
Oregon
April 2005
Willamette River Water Supply System
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Willamette River Water Supply System

Source	Required Infrastructure Improvements	Regional Partnering Opportunities	Estimated Capital Costs	Issues
• The Willamette River basin • Approximately 11,000 square miles and containing 13 major sub-basins in all or parts of ten counties	• Raw water pump station expansion • Water treatment plant expansion • High service pump station expansion • Finished water transmission main from Wilsonville to Tualatin	• City of Tigard • City of Tualatin • Tualatin Valley Water District • Others	• 21.6 - $24.5 million	• Political considerations • Public acceptance of source water • Ownership • Governance • Public vote of acceptance needed

City of Sherwood Oregon

Supply Option Comparison

Supply Source Options	Estimated Capital Cost	Cost Savings with Partners	Possible Relative Political Contention	Possible Relative Reliability Concerns	Key Issues/Comments
City of Portland Water System	$31.0 - $51.0 million	Yes	No	No	Size, scope and cost of long-term supply system improvements uncertain
Joint Water Commission	$54.0 million	Yes	No	Yes	System reliability and certainty of supply is under evaluation
Clackamas River Water Supply System	$29.0 - $31.0 million	Yes	Yes	Yes	System reliability and certainty of supply for the City of Sherwood is uncertain
Willamette River Water Supply System	$21.6 - $24.5 million	Yes	Yes	No	Political and public perception key issue. Will require a vote of approval from City residents

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Next Steps

- Draft Document Review
- Council Presentation – Narrowing of Options
- Complete Water System Financial Evaluation
- Finalize Water System Master Plan and Draft Water Management and Conservation Plan Documents
- City Adopts Plans
- Final Plan Submittals
  - WSMP submitted to Oregon DHS – Drinking Water Program
  - WMCP submitted to Oregon Water Resources Department

Summary

- Question and Answer Session

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