APPENDIX I

WATER SYSTEMS

Introduction

This Appendix presents a description of the City of Poulsbo's existing water system and service area and a forecast of future water system demands.

The City's water system is currently operated under direction of the Public Works Department. The City currently provides water service to approximately 2,090 customers, or 3,852 equivalent residential units (ERU's) within an area of approximately 3.3 square miles. Generally the existing service area is congruent with the corporate city limits. The City's proposed future water service area boundaries include those areas within the existing City limits together with those areas included in the City's Urban Growth Area, once designated by the County.

Water supply to the City consist of both surface water and ground water supplies including three surface sources and five groundwater sources and an intertie with Kitsap County Public Utility District #1. Water treatment includes disinfection and fluoridation.

Water storage is provided by eight (8) active reservoirs and one (1) back-up reservoir with a combined capacity of 3.2 million gallons providing service to three separate pressure zones. The distribution system consists of approximately 44 miles of transmission and distribution mains ranging in size from 2 to 12 inch.

Water System Comprehensive Management Plan

The City has recently completed a draft Comprehensive Water System Plan pursuant to the requirement of WAC 246-290. The purpose of the plan is to:

To evaluate existing water demand data and project future water demands.

To analyze the existing water system to determine if it meets minimum requirements mandated by the Department of Health, the Department of Ecology, the City of Poulsbo Municipal Code and the City of Poulsbo's design and development criteria.

To identify water system improvements necessary to resolve existing system deficiencies and accommodate future needs of the system for at least 20 years into the future.

To prepare an implementation schedule of improvements that meets the goals of the City's community service needs.

EXISTING SYSTEM DESCRIPTION

Water Supply System

The City of Poulsbo's existing domestic water supplies consist of three surface water supplies and five ground water supplies for a combined total capacity of 3,116 gallons per minute or 1,893 acre feet per year.

Table I-1 Water Systems Supply

Date	Cert #	Name	Water Rights Instantaneous				Current Capacity
			A/F	CFS/GPM	GPM	GPD	GPM
Surface water supplies							
Dec-44	2115	Crystal Springs	x	1.2cfs	539	775,526	0
Jan-54	5585	Big Valley Springs	x	1cfs	448	645,120	0
Aug-62	8525	Big Valley Springs	x	.20cfs	90	129,254	0
Sub Total					**1076**	**1,549,901**	**0**
Ground water supplies							
Jul-68	6087 - A	Lincoln	x	475 gpm	475	684,000	300
Feb-69	G1 - 00643C	Finn Hill (Bus Barn)	516	100gpm	100	144,000	0
Oct-80	G1 - 23707C	Big Valley #1(USGS)	344	215 gpm	215	309,600	90
Jan-89	G1 - 25375P	Pugh Road	1893	650gpm	650	936,000	650

X = surface water supplies that have been taken off-line by the City due to water quality problems. The City is currently investigating ways to put these water rights back into use or trade for ground water rights.

The surface water supplies include two located in the Big Valley area and one located in the east Poulsbo area commonly known as the Crystal Springs. The surface water supplies represent a combined capacity of 2.4 cubic feet per second (1,076 gpm).

The ground water supplies include five wells of which two are located in the Big Valley area, two in the east Poulsbo area and one in the west Poulsbo area. The ground water supplies represent a combined capacity of 2040 gallon per minute.

Surface Water Supplies: In 1997, the City temporarily suspended use of its surface water supplies as a result of non-compliance with the surface water treatment rule promulgated as a result of the Safe Drinking Water Act. Future use of the sources will require the installation of additional treatment facilities in order to meet current water quality requirements.

Ground water Supplies: The City, based on current water supply demand requirements, primarily utilizes its existing ground water sources to meet current system demands. Water rights associated with these supplies total 2,040 gallons per minute. The total production capability based on existing equipments and hydraulics is approximately 1,640 gallons per minute as noted.

INSERT MAP I-1 EXISTING WATER SYSTEMS HERE

Storage

The water system consisting of seven storage reservoirs situated throughout the City provide water supply and system pressure to the low, middle and high service zones.

Table I-2: Water Storage Facility

Location	Capacity (million gals)	Service Zone	Over Flow Elevation (feet)
Pugh Road Reservoir	1.000	Eastside High	514.0
Lincoln Reservoir	0.150	Eastside High	469.0
Caldart Reservoirs	0.150	Eastside Middle	396.0
Raab Reservoir	0.150	Eastside Middle	396.0
Wilderness Park Reservoir	1.000	Eastside Low	244.5
4th Ave Reservoirs	0.250	Eastside Low	244.5
Finn Hill reservoir	0.500	Westside Low	244.5
Total Storage	**3.200**		

The maximum combined storage capacity of the City's water storage facilities is 3.2 million gallons. The total amount of usable storage for operational, equalizing, standby, and fire flow purposes is reduced approximately 50 percent to 1.4 MG, due the significant amount of dead storage (i.e., non-usable storage) in the lower portion of the standpipes in the Low Zone and Middle Zone. Most of the dead storage is located in the Low Zone due to the water services that are located at the higher elevations near the Finn Hill Tank. The dead storage caused by the normally low pressures in these two areas are the result of being served by pressure zones that are not suited to provide adequate pressures at these higher elevations.

Distribution System

Transmission and Distribution Mains: The Poulsbo water service area contains more than 44 miles of water main ranging in size from 4-inches to 12-inches. The majority of the water mains in the system are cast iron and ductile iron. All new water main installations are required to use ductile iron water main in accordance with the City's development and construction standards.

Table I-3: Water Main Inventory

Diameter Inches	Length Feet	% of Total
4	23,092	9.9%
6	58,547	25.0%
8	130,744	55.9%
10	14,156	6.0%
12	7,508	3.2%
Total	**234,047**	

Water Main Inventory

The life expectancy, depending on the type of main, is generally 50 years. A significant amount of water main within the system is older than 50 years. Most of the older water mains located in the downtown area of the City are part of the original water system.

The 8-inch cast iron transmission main between the Big Valley wells and the County Pump Station is responsible for the conveyance of almost one half of the City's water supply to the system.

Pressure Reducing Stations: Pressure reducing stations are connections between adjacent pressure zones that allow water to flow from the higher-pressure zone to the lower pressure zone by reducing the pressure of the water as it flows through the station, thereby maintaining a safe range of pressure in the lower zone.

The Poulsbo water system has a total of six pressure reducing stations. One station is connected between the High Zone and Middle Zone, and the remaining five are connected between the Middle Zone and the Low Zone. Only three of the six stations are currently active, the Mesford PRV, Forest Rock PRV, and Finn Hill PRV. The remaining pressure reducing stations are currently inactive.

The function of the Mesford PRV Station is different than the other stations. The Mesford PRV Station controls the flow of water between the High Zone and Middle Zone to maintain the level in the Raab Park Tank. This is accomplished with a solenoid control valve within the station that simply opens to flow water between the zones when the water level in the Raab Park Tank drops to a low level set point and closes when the tank is full or nearly full, depending on the high level set point established by the City. This PRV station is automatically controlled with the telemetry and control equipment at the station and the Raab Park Tank.

Water System Intertie: The Poulsbo water system currently maintains an intertie between the City System and Kitsap County Public Utility District #1. The intertie is located adjacent to the Finn Hill Road and connects the City's system with the Vinland Water System, which is owned and operated by the PUD.

The primary purpose of the intertie is to provide water service to five customers located on the northwest side of Highway 3 that cannot be served by the City's system because of their location (i.e., elevations are too high to be served by the City's Low Zone). The 1995 agreement for the intertie provides for a maximum flow rate of 500 gpm and an average annual flow rate of approximately 310 gpm.

SYSTEM EVALUATION

Water Supply

Table I-4: Average Daily Demand

	Population	Annual Supply (gallons)	Average Daily Demand (gpm)	Average Demand Per Capita (gals/day/capita)
1991	5140	294,146,000	560	157
1992	5280	286,239,500	545	149
1994	5350	258,608,100	492	132
1994	5415	304,345,200	579	154
1995	5765	333,501,000	635	158
1996	6070	302,319,800	575	136
1997	6590	309,105,000	588	129
Average 1996 - 1997				133

Average Day Demand (ADD) is the total amount of water delivered to the system in a year divided by the number of days in the year. The average day demand has been determined from historical water patterns of the system and is also used to project future demand within the system. Water production records from the City's wells and previously used spring sources were reviewed to determine the system's average day demand. The system's day demand from 1991 through 1997 as shown is approximately 133 gpm per capita.

Peak Day Demand (PDD) is the maximum amount of water used throughout the system during a 24-hour time period of a given year. Supply facilities (wells, pump stations, intertie) are typically designed to supply water at a rate that is equal to or greater than the system's peak day demand.

The City's highest peak day demand on the system was 1,155 gpm, which occurred on July 20, 1994. Since this time the City has metered the water system and demand has dropped significantly.

The demand of each customer class can also be expressed in terms of equivalent residential units (ERU's) for demand forecasting and planning purposes. One ERU is equivalent to the amount of water used by a single-family residence. The number of ERU's represented by the demand of the other customer classes is determined from the total demand of all customer class and the unit demand per ERU based on the single family residential demand data.

Demands shown are based on supply data that was computed from the consumption of each customer class and the average amount of unaccounted-for water from each year. The average daily demand per ERU from 1996 and 1997 was 227 gallons per day.

Future Water Supply Demands

Future demands were calculated from the systems per capita demand data and projected population data. Future demand projections were computed with and without conservation. The existing per capita demand of 133 gallons per day was used for all demand projections without water conservation.

Additionally for planning purposes, existing per capita demands were reduced to reflect the water use reduction goals contained in the City's Water Conservation Plan. The City's Water Conservation Plan presents a goal of 5 percent water use reduction by the year 2000 and 10 percent water use reduction by the year 2010, with 1996 as the base year. Applying these water use reduction goals to the existing per capita demand of 132 gallons per day results in projected per capita demands with conservation of 123 gallons per day in the year 2003 (6-year forecast) and 118 gallons per day in the year 2017 (20-year forecast),

Table I-5 on the following page presents the 6-year and 20-year water demand forecast for the Poulsbo water system based on existing system production capacity and existing water rights. The actual demand data from 1996 and 1997 is also shown in the table for comparison purposes. The future peak day demands were projected based on population estimates for the given years and the estimated demand per capita values. The future peak day demand projections are also shown with and without estimated reductions in water use from achieving the conservation goals described earlier.

The analysis and evaluation of the existing water system with respect to the proposed improvements presented in the Water Comprehensive Plan is based on the 20-year projected demand data ***without "conservation reductions***". This ensures that the future system improvements will be sized properly to meet all requirements, whether or not additional water use reductions from conservation are achieved.

The results of the supply capacity analysis indicate that the supply system can support up to a maximum of approximately 9944 ERU's ***without conservation***, provided the City upgrades its existing infrastructure and develops its existing water rights.

Table I-5:Future Water Demand Projections*			
	1997	2003	2017
Population	**6,590**	**9,743**	**17,101**
Capacity by Current Available Production			
Current Production Capacity (gpm)	1,650	1,650	1,650
Peak Day Demand / Without Conservation (gpm)	1,144	1,777	3,120
Surplus /Deficit / Without Conservation (gpm)	**506**	**(127)**	**(1,470)**
Current Production Capacity (gpm)	1,650	1,650	1,650
Peak Day Demand / With Conservation (gpm)	1,144	1,656	2,788
Surplus /Deficit / With Conservation (gpm)	**506**	**(6)**	**(1,138)**
Capacity by Water Rights			
Total Water Rights Capacity (gpm	3,116	3,116	3,116
Peak Day Demand / Without Conservation (gpm)	1,144	1,777	3,120
Surplus /Deficit	**1,972**	**1,339**	**(4)**
Total Water Rights Capacity (gpm	3,116	3,116	3,116
Peak Day Demand / With Conservation (gpm)	1,144	1,656	2,788
Surplus /Deficit	**1,972**	**1,460**	**328**
Capacity by Equivalent Residential Units			
Production Capacity (ERU's)	5,257	5,257	5,257
ERU's (Without conservation)	3,852	5,666	9,944
Surplus /Deficit	**1,405**	**(409)**	**(4,687)**
Water Rights (ERU's)	9,927	9,927	9,927
ERU's (Without conservation)	3,852	5,666	9,944
Surplus /Deficit	**6,075**	**4,261**	**(17)**

*Dates in table reflect water plan horizon

Storage System Evaluation

The results of the existing storage evaluation, as shown indicate that the system has a storage deficiency of approximately 1.08 MG, most of which is in the Low Zone. If the dead storage was eliminated as a result of pressure improvements, the City's existing reservoirs will be sufficient to meet the existing storage requirements of the system.

Table I-6: Existing Storage

Description	Low Zone Zone	High/Middle Zone	Total
Available Existing Storage			
Maximum Storage Capacity	1.75	1.3	3.05
Dead (Non Useable Storage)	-1.57	-0.03	-1.6
Net Available Storage	**0.18**	**1.27**	**1.45**
Required Storage			
Operational Storage	0.26	0.26	0.51
Equalizing Storage	0	0.03	0.03
Standby Storage	0.25	0.48	0.74
Fire Storage	0.63	0.63	1.26
Totals	**1.14**	**1.4**	**2.54**
Surplus/Deficit	**-0.96**	**-0.12**	**-1.08**

Storage System Analysis

Future storage requirements of the system were computed for the 6-year and 20-year planning periods, based on year 2003 and 2017 demand projections. Two analyses were performed to determine the adequacy of the City's existing tanks to meet the storage requirements of the future. Both analyses are based on the completion of proposed pressure zone improvements that will eliminate all of the existing dead storage.

The result of the first analysis was based on the scenario that no additional supply sources were added to the system. Since the City will need to provide additional supply sources as growth occurs, this scenario is not likely to occur, but can be viewed as the worst-case scenario. The result of the second analysis, as noted below is based on the scenario where additional supply sources will be added to the system. This analysis assumes that approximately 650 gpm of additional supply will be available by the year 2003 and approximately 1,300 gpm of additional supply will be available by the year 2017.

Analysis of the City’s water storage facilities indicates if sufficient new supply sources were added to the system as needed in the future, would require the development of approximately 0.46 MG of storage in the year 2003 and approximately 1.22 MG of storage in the year 2017.

Table I-7: Storage System Analysis

Description	2003 Supply Area			2017 Supply Area		
	Low Zone Zone	High/Middle Zone	Total	Low Zone Zone	High/Middle Zone	Total
Available Existing Storage (MG)						
Maximum Storage Capacity	1.75	1.3	3.05	1.75	1.3	3.05
Dead (Non Useable Storage)	0	0	0	0	0	0
Net Available Storage	**1.75**	**1.3**	**3.05**	**1.75**	**1.3**	**3.05**
Required Storage (MG)						
Operational Storage	0.26	0.26	0.51	0.26	0.26	0.51
Equalizing Storage	0	0.05	0.05	0.08	0.19	0.27
Standby Storage	0.31	0.82	1.13	0.54	1.44	1.99
Fire Storage	0.63	0.63	1.26	0.63	0.63	1.26
Totals	**1.2**	**1.76**	**2.96**	**1.51**	**2.52**	**4.03**
Surplus/Deficit Storage (MG)						
Surplus/Deficit	**0.55**	**-0.46**	**0.09**	**0.24**	**-1.22**	**-0.98**

Computations based on pressure zone improvements being completed by 2003
and the addition of 650 gpm of supply added by 2003 and 1300 gpm of additional supply by 2017.
* The City's Comprehensive Water Plan's planning horizon is 2017.

The proposed storage improvements set forth in the Water Comprehensive Plan are based on the planned approach of developing sufficient new supply sources to meet future supply needs to minimize the size and number of additional storage facilities in the future.

Distribution System Evaluation

A computer-based hydraulic model of the existing water system was created using version 3.1 of the Cybernet program, developed by Haesad Methods. All water mains in the City's water system, including dead-end mains, were modeled.

The hydraulic model of the existing system contains 1997 average day demand data. The peaking factors determined from the July 20, 1994 peak day demand were used to analyze the system under peak flow demand conditions.

Supply data from the 1997 average day demand was distributed throughout the junction nodes of the model, based on allocation levels that reflect the proportionate share of total supply to each pressure zone.

The hydraulic model of the proposed system also includes a 20-year demand projection for the year 2017. The distribution of demands was allocated based on estimated future demand levels in each pressure zone.

HYDRAULIC ANALYSIS RESULTS

Existing System:

The hydraulic model of the existing system contains all active existing system facilities with settings that correspond to a peak hour demand event. All wells were operating at their normal rates of supply. The Wilderness Park Pump Station was modeled as being in the off-mode, which is consistent with its current operational status. The County Pump Station was operating at its normal rate of supply, which is equal to the combined supply rate of the Big Valley wells. The reservoir levels were modeled to reflect full utilization of operational and equalizing storage, and approximately 50 percent depletion of fire flow storage, based on the maximum required fire flow storage of 630,000 gallons. All active pressure-reducing stations were modeled as being in service and at their normal set points. The intertie with PUD were modeled to provide service to only the five services along Finn Hill Road, which is consistent with its current operation.

2017 System:

The hydraulic model of the proposed system in the year 2017 contains all active existing system facilities and proposed system improvements that were identified in the Water Comprehensive Plan. All existing future wells were operating at their normal rates of supply. The County Pump Station was abandoned and the Big Valley wells supplied water directly to the Low Zone. The proposed Wilderness Park Pump Station was modeled as being in the on-mode and set to provide supply to the High Zone upon a decrease in pressure in the zone, due to a high fire flow demand. The reservoir levels were modeled to reflect full utilization of operational and equalizing storage, and approximately 50 percent depletion of fire flow storage, based on the maximum required fire flow storage of 630,000 gallons. All existing and proposed pressure-reducing stations were modeled as being in service and at their normal set points. The intertie with the PUD was modeled as being in the off-mode. The proposed High Zone reservoir near the northwest section of the service area provided supply to the High Zone and Middle Zone areas of the northwest section of the service area.

The City's existing water system analysis was evaluated based on its ability to meet the policies of design and development criteria of the City and those mandated by the Department of Health. The results of the evaluation are summarized on the following pages:

Supply

The City has sufficient water supply to meet the demands of existing customers. However, additional water supply will be required for the upgrade of the existing infrastructure in order to meet the projected demands of the system, based on the forecasted population growth.

Three of the four existing wells need improvements related to replacement of old equipment that will increase supply capacity and source protection.

Storage

The existing storage facilities provide sufficient storage to meet the requirements of the existing customers. However, pressure zone improvements are necessary to fully utilize all of the existing storage and improve pressures in two areas of the system.

Additional storage will be required in the west side high zone in the near future to serve growth in the middle and high Zones.

Pumping

The County Pump Station has adequate pumping capacity to meet the demands of the existing system. However, capacity improvements will be required in the future when additional supplies are developed in the Big Valley area. Alternatively, the pump station can be eliminated upon completion of proposed improvements to the Big Valley wells and replacement of the Big Valley transmission main.

The capacity and functionality of the Wilderness Park Pump Station is limited. Improvements to the pump station are necessary to provide supply redundancy to the High Zone and enable transferring of water from the Low Zone storage facilities to the High Zone storage facilities.

Distribution

Several areas of the system require replacement of existing water mains to resolve deficiencies related to fire flows, aging water mains, and hazardous materials.

Three of the six pressure reducing stations within the system need improvements to either replace or upgrade existing equipment to resolve deficiencies.

Some of the existing telemetry and control equipment is old, at capacity, and is in need of replacement.

Schedule of Future Capital Improvements

As previously stated, system improvements are necessary, primarily to resolve existing system deficiencies, but also to accommodate an increase in water demands from future growth. The amount of existing system deficiencies and required improvements in the Poulsbo water system is typical for most systems in the area. A list of planned improvements to the city's water system infrastructure can be found in Appendix J.

Summary

Overall water demand of the City's system is expected to increase approximately 41 to 52 percent within the next 6 years and 138 to 167 percent within the next 20 years, depending on the amount of future water use reductions from the City's conservation program.

While the City has sufficient water supply from its existing four active wells to meet near term demand requirements of the system, the City must upgrade its existing water system to ensure capacity for the City's anticipated future growth and development. The City's Comprehensive Water System Plan serves as the blueprint for these improvements necessary to serve both existing and future population growth.