Attachment P

Water Master Plan

City of Cornelius

February 2004

Final Report

Prepared by the Cornelius Public Works Department

and the Cornelius Public Works Committee

Adopted by Cornelius City Council, 3/1/04, Ordinance 846

Certificate of Engineer

City of Cornelius
Water Master Plan
February 2004

The material and data contained in this report were prepared under the direction and supervision of the undersigned, whose seal as a professional engineer, licensed to practice in the State of Oregon, is affixed below.

EXPIRES 12/31/05

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ADD	average day demand
AWWA	American Water Works Association
DBPR	Disinfection By Product Rule
DWCCL	Drinking Water Contaminant Candidate List
EES	Economic & Engineering Services, Inc.
EPA	Environmental Protection Agency
ERU	equivalent residential unit
HAA	Haloacetic Acids
IESWTR	Interim Enhanced Surface Water Treatment Rule
JWC	Joint Water Commission
LCR	Lead and Copper Rule
LT1ESWTR	Long Term 1 Enhanced Surface Water Treatment Rule
LT2SWTR	Long Term 2 Surface Water Treatment Rule
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
MG	million gallons
MGD	million gallons per day
MMM	multi-media mitigation
MRDLG	maximum residual disinfectant level goals
N/A	not applicable
ND	none detect
NTL	North Transmission Line
OAR	Oregon Administrative Rule
OHD	Oregon Health Division
OWRD	Oregon Water Resources Department
O&M	operation & maintenance
PDD	peak day demand
PLC	programmable logic controller
PNR	Public Notification Rule
PRV	pressure reducing valve
PVC	polyvinyl chloride
PWS	public water system
SDWA	Safe Drinking Water Act
SOC	synthetic organic contaminants
THM	Trihalomethane
UFC	Uniform Fire Code
UGB	Urban Growth Boundary
USA	Utility Services Associates
USGS	United States Geologic Service
VOC	volatile organic contaminants
WTP	water treatment plant

Section 1
Introduction and Summary

1.1 Introduction

The City of Cornelius (City) retained Economic and Engineering Services, Inc. (EES) to prepare an updated Water Master Plan outlining a program to accommodate growth, changing needs, an increasingly complex regulatory environment, and to guide system improvements. The EES effort resulted in the "Water Master Plan for the City of Cornelius, February 2002 Final Report" (EES 2002 Report). The EES 2002 Report was never adopted by the Cornelius City Council. The Cornelius Public Works Department and the Cornelius Public Works Committee have updated and modified the EES 2002 Report to produce the Water Master Plan for the City of Cornelius, February 2004, Final Report (2004 Plan). The most significant changes to the EES 2002 Report involve changes to the recommended capital improvement plan directly related to the October 20, 2003 decision of the Cornelius City Council to discontinue its participation in the regional water supply feasibility study and adoption of a water supply policy to continue purchasing water as a wholesale customer from the City of Hillsboro.

The City owns and operates a water distribution system in Washington County, Oregon. The 2004 Plan includes evaluation of the City's water system and provides recommendations to correct existing deficiencies, meet future growth requirements, and ensure compliance with Federal Safe Drinking Water Act (SDWA). The Plan has been prepared both to serve the needs of the City's customers and to conform to the requirements of the Oregon Health Division (OHD). The planning period extends to the year 2024, as required by OHD. The Plan has been developed to serve the needs of the City and clarify the City's role as a wholesale water purchaser from the City of Hillsboro.

1.2 Authorization

The 2004 Plan has been prepared under the authority of the Cornelius City Council with supervision provided by the Cornelius Public Works Committee.

1.3 Purpose of the 2004 Plan

The rules and regulations of the OHD, specifically 333-61-060 (5), require that water systems supplying more than 300 service connections must maintain a current and approved Master Plan. The purpose of this document is to fulfill this requirement.

The overall objectives of the 2004 Plan are to evaluate the existing capabilities and limitations of the system, project its future demands, and establish a schedule of system improvements necessary to provide adequate water service to existing and new customers within the City's service area. A list of improvements was developed and incorporated in a recommended water system capital improvement program (CIP) with estimated costs and an implementation schedule. Additionally, water system project costs have been broken down between operation and maintenance costs, and costs associated with development.

1.4 Scope of Work

The general scope of work for the project was to develop a Water System Master Plan. The specific scope included tasks to:

- ❑ Take existing population forecasts and develop forecasts for water demands,
- ❑ Develop planning criteria and goals to be used in evaluating the existing system and future system improvements,
- ❑ Complete an existing distribution system hydraulic model prepared by City staff,
- ❑ Prepare a map of the existing water system,
- ❑ Develop and calibrate the hydraulic model using Cybernet® software,
- ❑ Prepare maps with existing and future pressure system conditions,
- ❑ Evaluate the existing system for deficiencies based on the planning criteria, using both the hydraulic model and interview with City staff,
- ❑ Identify the system improvements needed to support anticipated growth and development and prepare a map showing the potential future service area conditions with future drinking water infrastructure,
- ❑ Review existing compliance and provide recommendations to meet future changes in State and Federal water quality regulations,
- ❑ Prepare a list of Capital Improvement Projects based on the evaluation of existing and future facilities,
- ❑ Prepare a Master Plan summarizing the work.

1.5 Water System Ownership and Operations

The water system for the City's service area is owned and operated by the City. The City purchases their water wholesale from the City of Hillsboro. This water has historically come from the Cherry Grove Slow Sand Filter Plant near Haines Falls. Following the completion of the 72-inch transmission main in 2002, all of the City's water now originates from the Joint Water Commission Water Treatment Plant (JWC WTP).

1.6 Recommended Water System Improvement Plan

A water system CIP has been developed as a part of this study. The recommended improvements to the water system are divided in the following seven categories and further divided into an implementation schedule over the next 20 years.

- ❑ Operation and Maintenance
- ❑ Supply Options
- ❑ Water Quality
- ❑ Distribution Pipelines
- ❑ Storage
- ❑ Pumping
- ❑ Recommended Studies

Section 6 provides a more detailed discussion of the recommended improvements. The following summarizes the essential objectives of the system improvement projects and policy related decisions by the City.

1.6.1 Operation and Maintenance

Based on the City's projected 2024 population of 20,000, the average day demand of the City is anticipated to grow from 1.19 million gallons per day (MGD) to 2.28 MGD by the year 2024. The peak day demand is expected to increase by 2.61 MGD to a total of 5.47 MGD. This is an increase in the overall water demand of 100 percent in 20 years. Owing to increased efficiency and water conservation efforts, water demand may not increase as substantially. However, it is difficult to determine the effects that water conservation may have on projected water demands over the 20-year planning period. Conversely, several large industrial developments may significantly increase the average per capita consumption average and actual future demand may exceed projected.

1.6.2 Supply Options

The City currently relies on the City of Hillsboro to meet their water supply needs as a wholesale water provider. The City of Hillsboro provides water to the City from the JWC WTP-owned in part by the City of Hillsboro.

It is recommended that the City perform an emergency water supply options study to review and recommend other possible emergency water supplies.

1.6.3 Water Quality

Since the City receives their water wholesale from the City of Hillsboro, it is the responsibility of Hillsboro to ensure compliance with State and Federal regulations for source water quality including inorganic, synthetic organic, volatile organic chemicals as well as radionuclides and trihalomethanes. However, it is the responsibility of the City to monitor total coliforms, chlorine residual, and lead and copper compliance.

The City has met all regulations for total coliform, chlorine residual, and lead and copper compliance. The City has had several reporting violations for routine monitoring and timeliness of consumer confidence reporting. However, these violations were minor and did not affect water quality. It is recommended that the City review their water quality-monitoring program to ensure complete compliance with their reporting programs. Operational changes are recommended to the City's Water Park reservoir to help ensure adequate water turnover and to reduce water age in the reservoir.

1.6.4 Distribution System

The City has a single pressure zone that is fed by pressure reducing stations off a 72-inch transmission main from the JWC WTP. The City has a single ground level reservoir with a booster pump station that pumps water into the distribution system during timed intervals or during emergency demand periods. The distribution system consists of approximately 32 miles of pipeline ranging from 2 to 12-inches in diameter consisting of a number of different pipe materials. Approximately one-quarter of the City's system has steel or galvanized steel pipelines that are leaking or undersized. The City also has a number of cast iron pipes in the system. However, the cast iron pipes are lined while their fittings are unlined and have tubercle growth on the inside. All remaining steel pipelines in the distribution system are targeted for replacement in CIP.

1.6.5 Storage

The storage facilities within the City's water system are currently insufficient to meet City of Hillsboro water supply contract requirements, existing system needs, or the anticipated growth of the City. A total minimum of 5.33 million gallons (MG) of storage is estimated to be needed by the end of the 20-year planning period. The City has an existing 1.5 MG of storage and needs an additional 2.0 MG of storage to meet current and near future needs. Consequently, to meet existing and projected future needs, a total minimum additional 3.83 MG will be needed by the year 2024.

It is recommend that an additional 2.0 MG of storage be constructed at the Water Park Reservoir site by 2006.

It is recommended a second 2.0 MG reservoir be constructed by 2024. Its location will depend on the City's growth patterns. It will most likely be north of Council Creek. Consequently, it is identified in the CIP as the "North Reservoir".

1.6.6 Booster Pump Station

The booster pump station associated with the Water Park Reservoir has an approximate firm capacity of 980 gpm with one pump out of service. The pump station is in relatively good shape and the pumps have had recent servicing by the factory. It is recommended that switchgear be added to the pump station so that emergency power can be connected in the event of loss of power. A second pump station will be necessary when the second reservoir is constructed at the Water Park Reservoir site.

1.6.7 Recommended Studies

Revised Water Master Plans in the years 2009, 2014, and 2019 are included in the CIP. A system wide leak detection survey is recommended now that the 72-inch transmission main and transfer to the JWC WTP for water supply is complete. An emergency water supply options study to review and recommend other possible emergency water supplies is also recommended.

1.7 Recommended Capital Improvement Program

The recommended CIP is shown in Table 1-1. The anticipated implementation schedule is also shown for each project, along with a breakdown of costs between operation and maintenance and system development charge revenue eligible.

1.8 Financial Review of CIP

A financial review of the recommended CIP is provided in Section 7.

Table 1-1
City of Cornelius
Capital Improvement Program

CIP No.	Project	Length (feet)	Diameter (inches)	Project Need	Est.Total Cost in 2004 $	O&M Costs	SDC Eligible Costs	Anticipated Implementation Period 2004	2005-2008	2009-2012	2013-2017	2018-2024
Operations / Maintenance												
M001	Meter Replacement			O&M	$80,000	$80,000	$0	$4,000	$16,000	$20,000	$20,000	$20,000
M002	PRV Backflow Device - S. 12th Avenue			O&M	$30,000	$30,000	$0	$30,000				
Distribution Pipelines												
P001	10-inch on S. Linden Rd between S. 8th Ave. and S. 10th Ave. and S. Magnolia	1,110	10	Fire flow	$111,000	$66,600	$44,400	$111,000				
P002	8-inch on N. Barlow St. between N. 10th and N. 14th Avenue	1,230	8	O&M/Fire flow	$98,400	$49,200	$49,200	$98,400				
P003	8-inch on N. Clark St. between N. 10th and N. 14th Ave.	1,230	8	O&M/Fire flow	$98,400	$73,800	$24,600		$98,400			
P004	8-inch on on N. 13th Ave. between N. Clark and N. Fremont St.	625	8	O&M/Fire flow	$50,000	$37,500	$12,500			$50,000		
P005	12-inch on N. 10th Ave. from intersection of N. Holladay south 280 feet	280	12	O&M/Fire flow	$33,600	$16,800	$16,800		$33,600			
P006	12-inch on N. 4th Ave. between N. Adair St. and N. Davis	1,000	12	Fire flow	$120,000	$60,000	$60,000	$120,000				
P007	12-inch on S. 12th Ave. from Adair to S. Dogwood St.	1,550	12	O&M/Fire flow	$186,000	$93,000	$93,000		$186,000			
P008	12-inch on S. 12th Ave from S. Dogwood St. to S. Fawn St.	510	12	O&M/Fire flow	$61,200	$30,600	$30,600		$61,200			
P009	12-inch on N. 17th from N. Barlow to N. Clark St.	480	12	O&M/Fire flow	$57,600	$19,200	$38,400		$57,600			
P010	12-inch on N. Clark and N. 16th between N. Davis and N. 17th Avenue	630	12	O&M/Fire flow	$75,600	$12,600	$63,000		$75,600			
P011	12-inch on N. Clark from Water Park to N. 17th Avenue	270	12	Fire flow	$32,400	$0	$32,400		$32,400			
P012	8-inch on N. Barlow from Water Park to N. 17th Avenue	470	8	O&M/Fire flow	$37,600	$18,800	$18,800		$37,600			
P013	12-inch on N. 19th Ave. from Holladay St. north 456 feet	1,250	12	Growth	$150,000	$0	$150,000					$150,000
P014	8-inch pipe on Baseline St. from N. 1st Ave. to N. 4th Avenue	1,040	8	O&M/Fire flow	$83,200	$41,600	$41,600					$83,200
P015	12-inch from Basco PRV to Water Park reservoir	970	12	Capacity	$116,400	$77,600	$38,800		$116,400			
P016	8-inch on Baseline St. from N. 14th Avenue to N. 19th Avenue	1,620	8	O&M/Fire flow	$129,600	$97,200	$32,400			$129,600		
P017	8-inch on N. 14th Avenue from Baseline to N. Clark St.	930	8	O&M/Fire flow	$74,400	$55,800	$18,600		$74,400			
P018	8-inch on S. Alpine from S. 8th Avenue to S. 12th Avenue	1,260	8	O&M/Fire flow	$100,800	$75,600	$25,200		$100,800			
P019	8-inch on S. Cherry from S. 12 Avenue to S. 16th Avenue	1,280	8	O&M/Fire flow	$102,400	$51,200	$51,200		$102,400			
P020	8-inch on S. 16th Avenue from S. Alpine to S. Dogwood Street	940	8	O&M/Fire flow	$75,200	$56,400	$18,800			$75,200		
P021	8-inch on S. Cherry from S. 8th Avenue to S. 12th Avenue	1,260	8	O&M/Fire flow	$100,800	$50,400	$50,400		$100,800			
P022	12-inch on S. Dogwood from S. 16th Avenue to S. 18th Avenue	480	12	O&M/Fire flow	$57,600	$28,800	$28,800		$57,600			
P023	6-inch on S. 11th Ave. from S. Dogwood St. to S. Fawn St.	510	6	O&M/Fire flow	$30,600	$20,400	$10,200			$30,600		
P024	6-inch on S. 9th and S. Fawn St. from S. Dogwood Ave. to S. 10th Ave.	770	6	O&M/Fire flow	$46,200	$30,800	$15,400			$46,200		
P025	6-inch in alley north of S. Ginger St. between S. 8th and S. 10th Avenues	560	6	O&M/Fire flow	$33,600	$22,400	$11,200			$33,600		
P026	12-inch on N. 10th Ave. from N. Holladay to N. Spiesschaert Rd.	710	12	Growth	$85,200	$0	$85,200				$85,200	
P027	12-inch on N. 29th Ave. north from Oregon Elect. Railway to Council Creek	1,560	12	Growth	$187,200	$0	$187,200				$187,200	
PO28	2-inch interim on SW 345th Ave. south from TV Hwy	1,700	2	O&M	$70,000	$70,000	$0	$70,000				
P029	12-inch on SW 345th Avenue south from TV Highway	2,240	12	Growth	$268,800	$0	$268,800				$268,800	
P030	10-inch between SW 345th Ave. and S. Dogwood	990	10	Growth	$99,000	$0	$99,000				$99,000	
P031	12-inch on S. 26th Ave. south from S. Ginger St.	1,700	12	Growth	$204,000	$0	$204,000					$204,000
P032	12-inch on S. 20th south from S. Ginger St.	1,100	12	Growth	$132,000	$0	$132,000					$132,000
P033	12-inch on N.17th from N. Adair to N. Barlow	410	12	O&M/Fire flow	$49,200	$16,400	$32,800		$49,200			
P034	8-inch on S. Fawn from S. 10th to S. 12th	700	8	O&M/Fire flow	$56,000	$42,000	$14,000		$56,000			
P035	4-inch on S. Elder Ct. from S. 15th	260	4	O&M/Fire flow	$13,000	$6,500	$6,500		$13,000			
P036	8-inch on N. 14th from N. Clark to N. Fremont	820	8	O&M/Fire flow	$65,600	$49,200	$16,400		$65,600			
P037	6-inch on N. 15th south from N. Davis	220	6	O&M	$13,200	$4,400	$8,800			$13,200		
P038	8-inch on S. 10th from S. Heather to S. Dogwood St.,	1,000	8	O&M/Fire flow	$80,000	$60,000	$20,000			$80,000		
P039	10-inch between SW 345th Ave. and S. Alpine St.	990	10	Growth	$99,000	$0	$99,000					$99,000
P040	8-inch on S. Ivy between S. 12th and S. "14-1/2"	830	8	O&M/Fire flow	$66,400	$49,800	$16,600			$66,400.00		
P041	12-inch on N. 9th Ave. from N. Adair to alley	220	12	O&M	$26,400	$26,400	$0	$26,400				
	Total	37,705			$3,577,600	$1,411,000	$2,166,600					
Storage												
S001	Water Park reservoir seismic evaluation			Safety/Emergency	$20,000	$20,000	$0		$20,000			
S002	Water Park pump station and site evalaution			Fire flow/Emergency	$25,000	$12,500	$12,500		$25,000			
S003	Water Park reservoir cleaning, external repair, and painting			Maintenance	$30,000	$30,000	$0		$30,000			
S004	2.0 MG Water Park Reservoir			Fire flow/Emergency	$1,600,000	$400,000	$1,200,000		$1,600,000			
S005	2.0 MG North Reservoir			Fire flow/Emergency	$1,600,000	$0	$1,600,000					$1,600,000
Pumping												
PS001	Install switch gear in existing Water Park PS			Emergency	$15,000	$15,000	$0	$15,000				
PS002	New Water Park Reservoir 2,300 gpm/135 HP Pump Station			Growth	$300,000	$0	$300,000			$300,000		
Recommended Studies												
R001	Water Master Plan 2009			Regulatory	$45,000	$22,500	$22,500			$45,000		
R002	Water Master Plan 2014			Regulatory	$50,000	$25,000	$25,000				$50,000	
R003	Water Master Plan 2019			Regulatory	$55,000	$27,500	$27,500					$55,000
R004	Leak Detection Surveys			O&M	$37,000	$37,000	$0	$10,000	$15,000	$6,000	$3,000	$3,000
R005	Emergency Water Supply Options Study			Growth/Emergency	$25,000	$12,500	$12,500		$25,000			
Total					**$7,489,600**	**$2,123,000**	**$5,366,600**	**$484,800**	**$3,049,600**	**$895,800**	**$713,200**	**$2,346,200**

Section 2
Existing Water System

2.1 Service Area Description

The City of Cornelius (City) is located in the Tualatin Valley approximately 20 miles west of downtown Portland in an area that has historically been characterized as primarily agricultural. In recent years, this has changed along the Highway 26 corridor and is becoming much more urban. Areas to the east, namely the City of Hillsboro, have become highly industrialized with the growth of high technology related industries. Despite these areas of high growth nearby, the City remains mostly residential in nature with some light industrial and supporting commercial businesses.

The City of Cornelius' Public Water System (Cornelius PWS) serves an estimated population of 10,450 persons in Washington County, Oregon. This number for the 2004 population is projected from a certified population census conducted on July 1, 2000 and the 2003 Portland State University estimate. Over 98 percent of the service area is within city limits and Urban Growth Boundary (UGB) of Cornelius, Oregon. Those services outside the UGB were in place prior to the establishment of the UGB or represent minor additions of services by agreement with the City of Hillsboro. The service area is roughly bounded on the north and south by Council Creek and the Tualatin River, respectively. The City of Forest Grove creates the western boundary and the City has an approximate boundary of NW 341st/331st Avenues on the east. Growth within the City has been relatively moderate compared to those cities closer to downtown Portland.

2.2 Service Area Characteristics

The service area is situated within the Tualatin sub-basin of the Willamette watershed near the east slopes of the Coastal Range and the western outskirts of the Portland metropolitan area. In general, the City is relatively flat with one pressure zone serving the entire distribution system.

The climate of the City service area is typical of the Willamette Valley. The mean annual temperature is approximately 52 degrees. Precipitation averages around 41 inches per year with a maximum rainfall approximately 7 inches in December and a low of 0.50 inches in July. While precipitation occurs throughout the year, nearly 79 percent occurs during the six-month period between October and March.

2.3 Water Supply and Distribution System

The City receives its water by wholesale purchase from the City of Hillsboro via the JWC WTP. The treatment plant facilities and City distribution system are described in this section. A map illustrating the City's primary service territory is shown in Exhibit 2-1. The City water distribution system is supplied by the new 72-inch transmission line completed in 2002.

2.4 Source of Supply and Water Rights

The City of Hillsboro supplies water to the City of Cornelius. Water rights owned by the City of Hillsboro that feed the JWC WTP are a combination of surface water rights associated with the Tualatin River and storage rights created in the upper Tualatin and Trask River basins. The instream rights are typically limited to use during non-peak periods of the water year, namely mid-September through mid-May. In the summer time, water is drawn from the Barney Project or Scoggins Reservoir. The combination of water rights are used to produce a continuous source of supply to the JWC and Cherry Grove water treatment plants, depending on the individual right, its point of diversion, and associated restrictions.

Direct water rights belonging to the City are limited to four groundwater wells located at the City Parks; Harleman Park (Certificate #68324, Permit # G5524, APLPLN G5723), Dogwood Park (Well I.D. #L 61013, Start Card # 153472), Alpine Park (Well I.D. L 64172, Start Card # W159660), and Tarrybrooke Park (Well I.D. # L 64170, Start Card # 159658). These wells are shallow, relatively low-yielding wells. Use of these wells is limited to irrigation purposes only for the city parks.

2.5 Facilities Inventory

Outlined in this section are brief descriptions of existing wholesale supply facilities providing water to the City with respect to treatment, storage and distribution. The City does not treat its water. The City's water system is served by the City of Hillsboro. The City is not responsible for ensuring compliance of the JWC WTP with current State and Federal regulations. This responsibility lies with the City of Hillsboro. The information regarding the JWC WTP is intended to be informational only.

2.5.1 Joint Water Commission Treatment and Transmission Facilities

Treatment Facilities

The JWC WTP is located along Fern Hill Road approximately 1.5 miles southwest of the City of Forest Grove. The plant operates under a conventional treatment process that includes sedimentation, coagulation, flocculation, filtration, pH adjustment, and disinfection. Since its original construction in 1976, the plant has been upgraded several times - most recently in 1999 where the plant capacity was expanded from 40 to 70 mgd. The JWC WTP is served from a raw water intake and pump station located about 0.7 miles north of the treatment plant along the Tualatin River.

Finished Water Storage

The members of the JWC own a single 20 MG reservoir located approximately ½ mile east of the JWC WTP atop Fern Hill. The facility, known as the Spring Hill Reservoir, provides equalization and peak day storage for the JWC members. The City of Hillsboro is currently designing an additional 27 MG reservoir on the same site. Construction is estimated for 2005-2007.

Finished Water Transmission

From the Fern Hill Reservoir, water is fed via gravity to the City of Hillsboro through the 45-inch south transmission main. This main runs east along Blooming-Fern Hill Road and eventually makes its way to the City of Hillsboro.

The north transmission line-Phase 2 (NTL2) was completed in 2002. The new 72-inch main provides substantially more flow capacity from the JWC water treatment plant. The pipeline originates along Fern Hill road to a point just west of the City of Forest Grove's wastewater treatment plant and continues east along S. Heather Street into the City, winding its way north along S. 10th Avenue, S. Beech Street and S. 12th Avenue to an intersection with the Tualatin Valley Highway. The pipeline then turns east a final time extending through the City and into the City of Hillsboro to a connection with the north-south intertie at the intersection of Baseline Street and SW Dennis Avenue. Along with its service into Hillsboro, the new north transmission line provides wholesale service to the City. The NTL 2 is shown in Exhibit 2-2.

2.5.2 City of Cornelius Internal Facilities

Storage and Booster Pumping

The City has a single ground level reservoir serving the distribution system. The reservoir is a 1.5 MG reinforced concrete reservoir located near the center of town. The reservoir is in Water Park on N. Clark Street between N. 17th and N. 19th Avenues. The reservoir is 100 feet in diameter and approximately 30 feet tall. Originally constructed in 1969, the reservoir helps meet peak demand needs and provides some emergency storage capacity. An altitude control valve maintains the water level in the reservoir while a pump station at the reservoir pumps water back into the distribution system. The reservoir was constructed under seismic design standards of 1969. The reservoir design should be reviewed to ensure compliance with current seismic requirements.

The pump station that serves the reservoir has a cast-in-place concrete pipe gallery with a brick ground-level structure that houses the pump motors and related controls. The pump station has three vertical turbine pumps. Two are constant speed day pumps operating on alternate days, running 12 hours per day. The third pump is a fire pump used only during high demand periods. The static head at the discharge side of the pumps is approximately 70 psi.

In 1999, the City had a pump manufacturer review the existing pumps in the station. Based upon their review, the pumps were in good shape. The following table summarizes each of the pumps.

Table 2-1 City of Cornelius Water Park Reservoir Pumps					
Pump	**Horse-power**	**Manufacturer**	**Model**	**Stages**	**Capacity (gpm)**
No. 1	15	Johnston	8AC	5	180 @ 175'
No. 2	15	Johnston	8AC	5	180 @ 175'
No. 3	40	Johnston	10DC	5	800 @ 175'
Total					**1160 @ 175'**

A PLC controls the pump station to pump water from the reservoir into the distribution system on a daily interval from Pumps No. 1 and No. 2. The daily pumping helps "turnover" the water in the reservoir to maintain water quality. Pump No. 3 is connected to a pressure sensor to turn on during high demand periods such as emergency fire flows. It is recommended that the City periodically check the operation of the fire pump to ensure that the PLC automatically controls the pumps as initially intended during emergency events.

The reservoir and pump station are in satisfactory structural condition in consideration of their age. City staff have indicated that there are areas of a failed exterior coating on the reservoir and that the reservoir exterior should be cleaned and possibly resurfaced. The reservoir site has space reserved for a future reservoir. However, it is undetermined if the existing pump station can be retrofitted to increase pumping capacity. A new pump station will likely be required if additional pumping capacity is required at the reservoir site. A preliminary site review and pumping system evaluation should be conducted before proceeding with the design of a new reservoir and pump station. The study would evaluate the existing pump station for adequate pumping capacity for the existing reservoir and provide recommended improvements for the site prior to the construction of a new reservoir.

Distribution System

The City's distribution system contains more than 32 miles of pipeline ranging in size from 2-inch to 12-inch. The pipe inventory is comprised of a range of material type, including: cast or ductile iron, lined or coated steel, asbestos cement, PVC, and other unknown types of plastic. A summary of current pipe inventory is outlined in Table 2-2.

The ductile iron and C-900 PVC (polyvinyl chloride) pipe portions of the system generally represent the highest integrity and most recently constructed elements of the network. Asbestos cement and cast iron pipe dominate the midrange of system integrity and age. Steel pipe and unknown, undocumented installations of various pipe materials represent the least reliable lines in terms of potential for unexpected capital outlays and system flow restriction due to undersized conduits in the primary network. Steel pipe and unlined cast iron may develop tubercules (growth of rust like nodes) on the inside of the pipes that can, in worst cases, significantly reduce the capacity of the pipeline. Tubercles can also potentially increase water quality problems by increasing the demands on disinfectant residual.

The City has selected cement lined ductile iron pipe as a standard for the City. Most of the cast iron pipe installed in the City is lined. However, the cast iron fittings installed with this pipe at the same time are probably unlined. The City has had problems with tubercle growth in the unlined cast iron fittings. As a matter of practice, all new ductile iron fittings are cement mortar lined and should never be an issue with new fittings. Because the cast iron pipe is lined and in good shape, replacement of the cast iron pipe and fittings is a low priority and considered impractical at this time. It is recommended that the unlined cast iron fittings be replaced if it can be accomplished with a concurrent project in the vicinity.

Table 2-2
City of Cornelius
Distribution System Mains Installed Within City Limits
(All lengths in feet)

Diameter	Ductile Iron	Cast Iron	C900-PVC	Asbestos Cement	Unknown	Steel/ Galv. Steel	Totals
2"	-	-	-	-	-	5,793	5,793
4"	699	1,873	2,806	1,211	380	6,809	13,778
6"	3,080	3,687	31,871	6,529	305	9,239	54,711
8"	7,350	1,400	30,993	5,801	1,650	0	47,194
10"	7,343	-	3,811	969	-	-	4,780
12"	18,089	260	5,605	10,761	-	-	34,715
Totals	**36,561**	**7,220**	**75,086**	**25,271**	**2,335**	**21,841**	**168,314**

The distribution system also consists of the following:

- ❑ Approximately 124 gate and butterfly valves
- ❑ Approximately 285 fire hydrants
- ❑ Approximately 2,700 metered services, sizes ¾" to 4"
- ❑ Master meters with check-valves
- ❑ Main pressure reducing valves

Pressure Reducing Valves

The City currently has three (3) existing and a fourth future pressure reducing valve (PRV) stations and one (1) altitude valve at the Water Park reservoir. The three (3) PRV stations are on the existing 72" NTL 2 transmission line from the JWC WTP. The fourth PRV station on the new JWC 72-inch NTL pipeline will be in place by the end of 2004. The PRV stations are summarized in Table 2-3.

Table 2-3
City of Cornelius
Summary of Pressure Reducing Valve Stations

PRV Location	Size	Remarks
Existing		
S. 12th & Baseline Street	3-inch Cla-Val 6-inch Cla-Val	Connects to 72" NTL 2 Line
Baseline Street & Basco's (Water Park Reservoir Feed)	3-inch Cla-Val 6-inch Cla-Val	Connects to 72" NTL 2 Line
TV Hwy & "343rd" (Valley View MHP entrance)	3-inch Cla-Val 8-inch Cla-Val	Connects to 72" NTL 2 Line
Water Park Reservoir	6-inch Clayton 206	Altitude valve that fills the reservoir
Future		
S. 10th & S. Heather Street	3-inch Cla-Val 6-inch Cla-Val	Future PRV connection to 72" NTL 2 line.

Interties

The City effectively has one intertie with the City of Hillsboro, a 12-inch pipe built in association with the completion of the new 72-inch NTL 2 line. The new 12-inch line intertie is at the same location as the TV Highway and "343rd" PRV. This intertie permits emergency service from Hillsboro in the event of disruption of flow from the NTL 2 line between the two Cities.

In addition to the 12-inch intertie, a second intertie was constructed as part of the 72-inch NTL 2 line. An 8-inch intertie was constructed on S. Heather St. between the City of Forest Grove and Cornelius. The intertie connects to an existing 6-inch line just west of the intersection of S. 1st Avenue and Heather Street and runs west to the intersection of Mt. View Drive in Forest Grove. This valved intertie remains in a closed position, but is available for actuation to receive water from the Forest Grove system in the event of a failure in the NTL 2 line.

A third emergency intertie between the City of Forest Grove and Cornelius is recommended to help serve the City in the event of an emergency. The intertie should be located on either TV Highway or N. Holladay Street.

2.5.3 Leak Detection

Leak Detection Survey

As part of an ongoing leak detection program at the City, Utility Services Associates (USA) has been retained by Cornelius to conduct periodic leak detection surveys within the mild steel pipe areas of the distribution system within the City's water service territory. Following each of these surveys, the City has pursued the identified leaks and repaired them to help reduce unaccounted for water loss. An audit of the City's water use is presented in Section 3.

A summary of the results of the leak detection surveys is presented in Table 2-4.

Table 2-4
City of Cornelius
Leak Detection Summary

Survey Period	Estimated Miles Surveyed	Leaks Found	Est. Total Loss (gpm)	Total Est. Annual Water Loss (gallons)
9-06-95 to 9-08-95	4.8	7	25.75	13,534,000
7-15-98 to 7-17-98	3.0	6	12.75	6,701,000
4-17-00 to 4-19-00	10-12	8	69.50	36,529,000
11/05/02 to 11/06/02 & 12/9/02	3.0	11	71.75	37,711,800
9/16/03 to 9/18/03	3.0	5	19	9,986,400

While each of the surveys did not cover the entire length of the distribution system (in excess of 32 miles), it did focus on areas of known problems. A summary of the size and location of the identified leaks is shown in Table 2-5.

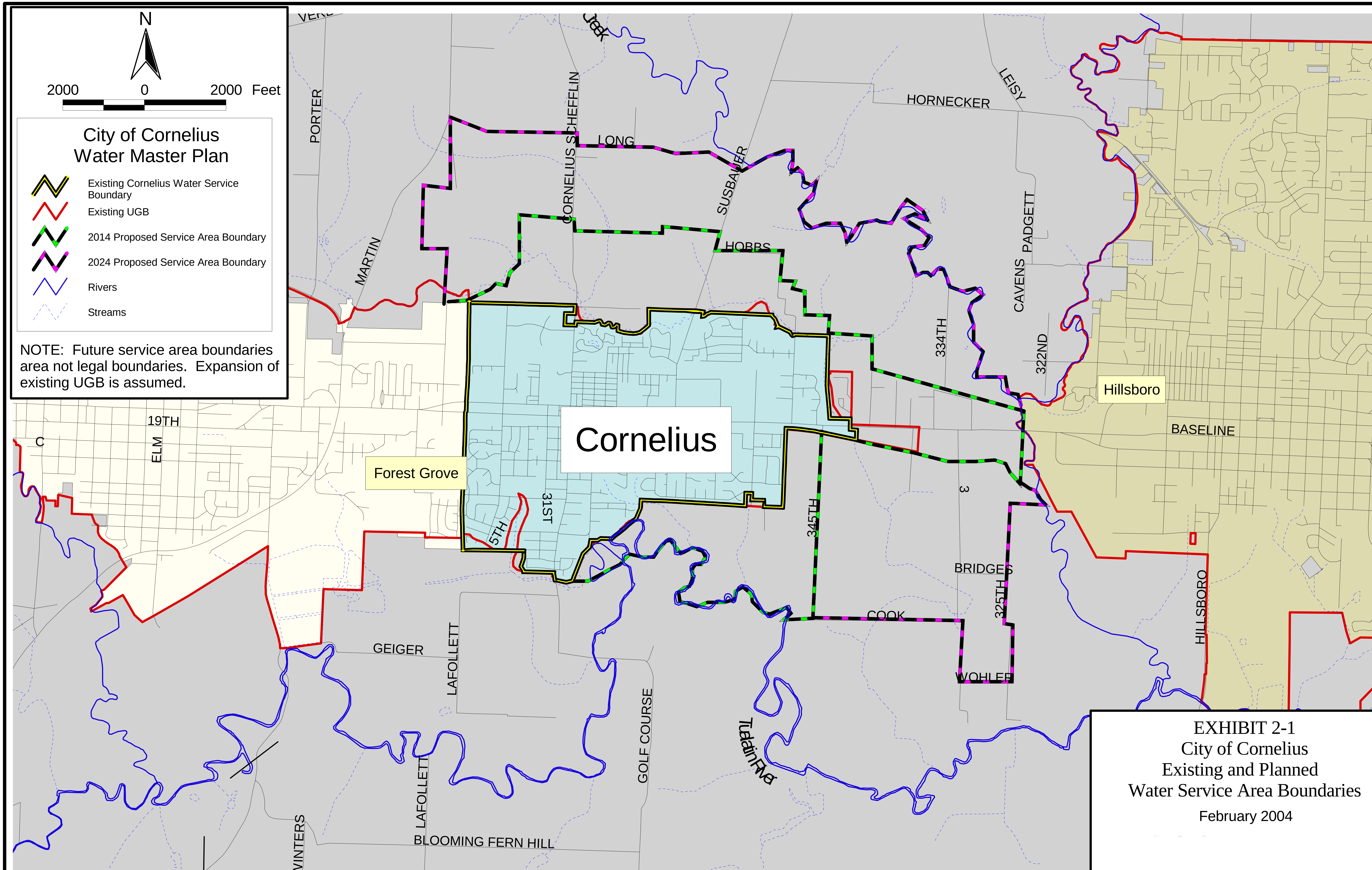
Table 2-5
City of Cornelius
Leak Detection Summary

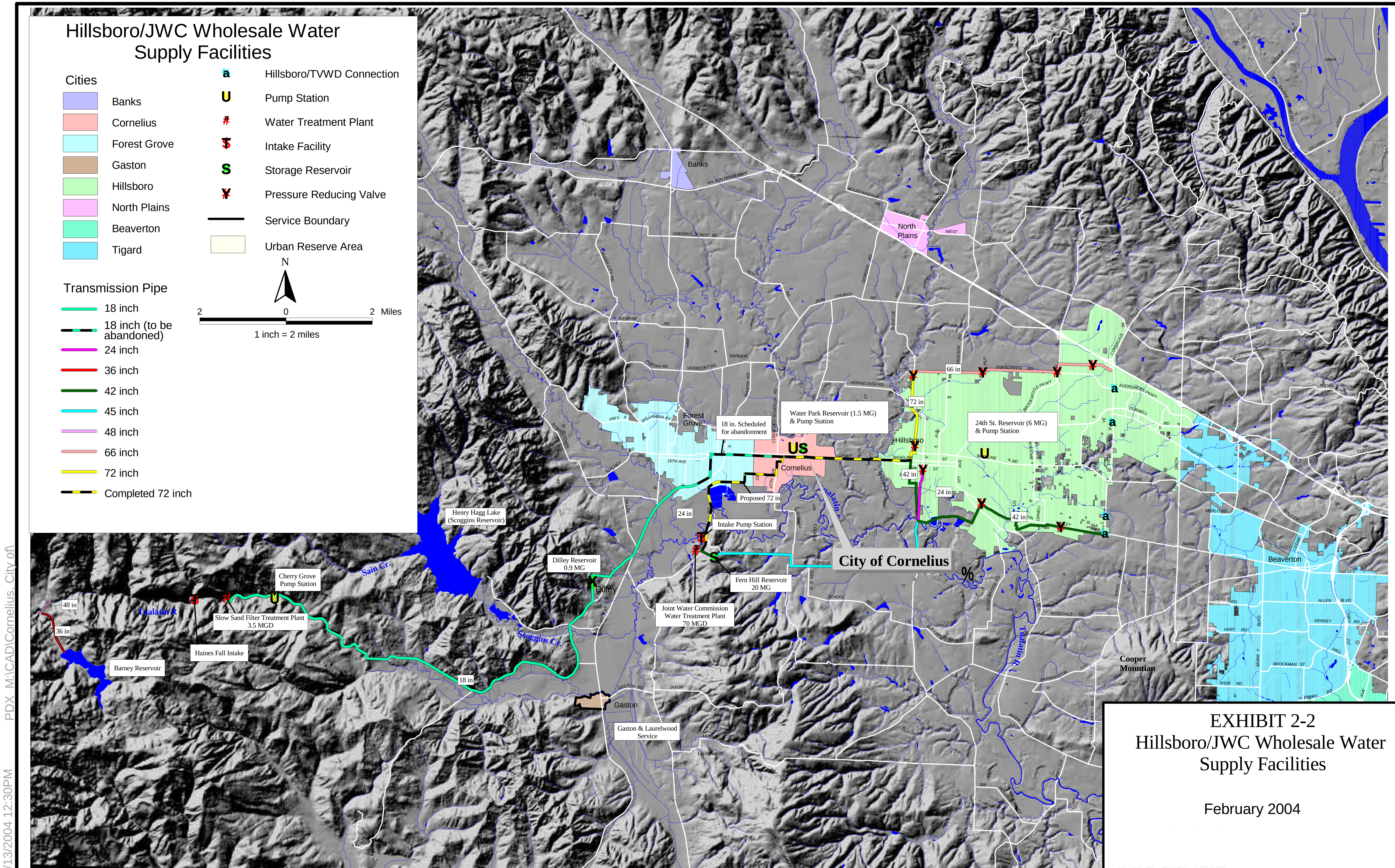
Leak #	Date	Rate (gpm)	Location	Type
1	9/07/95	0.5	S. 11th Ave & Cherry St.	hydrant
2	9/07/95	5.0	S. 11th Ave & Alpine St.	service conn.
3	9/06/95	0.25	Clark St & N. 12th Avenue	hydrant
4	9/07/95	10.0	S. 12th Ave. & Dogwood St.	main
5	9/07/95	2.0	1467 E. Elder Ct.	service conn.
6	9/08/95	4.0	1680 Dogwood St.	service conn.
7	9/08/95	4.0	N. 11th Ave. & Adair St.	main
8	7/17/98	0.5	Baseline St. & N. 14th Avenue	hydrant
9	7/17/98	2.0	N. 13th Ave & N. Barlow St.	valve
10	7/17/98	3.0	1112 N. Clark St.	service conn.
11	7/17/98	1.0	N. Adair St. & N. 12th Ave.	hydrant
12	7/17/98	0.25	S. Cherry St. & S. 11th Ave.	hydrant
13	7/17/98	6.0	S. Cherry St. & S. 16th Ave.	main
14	4/18/00	1.0	N. Barlow St. & N. 10th Avenue	valve
15	4/18/00	5.0	N. 13th Ave. & N. Barlow St.	main

Table 2-5
City of Cornelius
Leak Detection Summary (Cont'd)

Leak #	Date	Rate (gpm)	Location	Type
17	4/19/00	5.0	S. 20th Ave. & Baseline St.	main
18	4/19/00	5.0	1317 S. Ivy St.	service line
19	4/19/00	1.0	1622 S. Dogwood St.	main
20	4/19/00	2.0	S. 16th Ave. & S. Dogwood St.	main
21	4/19/00	0.5	S. 14th Ave. & S. Beech St.	hydrant
22	11/06/02	10.0	1680 S. Dogwood Street	main
23	11/06/02	1.0	N. Barlow St. & N. 13th Ave.	main
24	11/06/02	10.0	1757 N. Clark Street	service
25	11/06/02	10.0	S. Alpine St. & S. 11 Ave	main
26	12/13/02	10.0	502 S. 19th Ct.	service
27	12/09/02	2.0	1083 S. Fawn St.	valve
28	12/09/02	0.75	S. Cherry St. & 9th St.	hydrant
29	12/09/02	10.0	1459 Baseline St.	service
30	12/09/02	3.0	Corner of N. 19th and Baseline St.	main
31	12/09/02	50.0	Corner of N. 9th Ave. & Adair St.	main
32	9/18/03	5.0	N. Barlow & N. 13th Ave	main
33	9/18/03	4.0	S. Fawn St. & S. 11th Ave	main
34	9/18/03	3.0	386 S. 12th Ave.	main
35	9/18/03	5.0	250 S. Alpine St.	service
36	9/18/03	2.0	Baseline & S. 14th Ave.	main

It is recommended that the entire distribution system, where appropriate, have a leak detection survey performed now that the connection with the new JWC transmission line is complete.


N
2000 0 2000 Feet
City of Cornelius
Water Master Plan
Existing Cornelius Water Service Boundary
Existing UGB
2014 Proposed Service Area Boundary
2024 Proposed Service Area Boundary
Rivers
Streams
NOTE: Future service area boundaries area not legal boundaries. Expansion of existing UGB is assumed.
Cornelius
Forest Grove
Hillsboro
PORTER
MARTIN
CORNELIUS SCHEFFLIN
LONG
SUSBAUER
HOBBS
HORNECKER
LEISY
PADGETT
CAVENS
334TH
322ND
BASELINE
19TH
C
ELM
31ST
5TH
345TH
3
BRIDGES
325TH
COOK
WOHLER
HILLSBORO
GEIGER
LAFOLLETT
GOLF COURSE
BLOOMING FERN HILL
VINTERS
EXHIBIT 2-1
City of Cornelius
Existing and Planned
Water Service Area Boundaries
February 2004



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Section 3
Planning Data

3.1 Service Area Policies and Related Plans

3.1.1 Utility Policies

Operation of the Cornelius PWS is governed by policies established by the City, the Water Supply Agreement between the City of Cornelius and the City of Hillsboro, and by rules established by the Oregon Health Division (OHD), the Oregon Water Resources Department (OWRD), METRO, and Washington County.

3.1.2 Fire Flow Requirements

The Cornelius PWS service area is served by Cornelius Fire District. The fire district follows the Uniform Fire Code (UFC) to establish fire flow requirements. The UFC was used as the guideline for establishing fire flows during the modeling portion of this study.

Fire flow requirements for the Cornelius PWS service area were determined based on the UFC. Because the service area is primarily residential in nature, a minimum fire flow requirement of 1,000 gpm (residential fire flow) for one hour with a residual pressure of 20 psi throughout the pressure zone is required. Where the area contains larger industrial buildings or schools, a fire flow of 3,000 gpm (industrial fire flow) with a 20 psi residual is required. The largest fire requirement in the City are horse stables located at the intersection of S. 10th Avenue and S. Flax Plant Road which require 4,500 gpm for 10 hours. A more complete evaluation of the distribution system's hydraulics is presented in Section 4.

3.2 Water Use Distribution and Growth

3.2.1 Population Projection

Based on certified census results on July 1, 2000, and the Portland State University 2003 estimate, the City's projected population for 2004 is 10,450. Assuming a slow to moderate growth rate yields a 2024 population of 20,000. However, to accommodate this growth, the UGB will have to extend beyond its current boundary.

The population forecast in the 20-year planning period is shown in Table 3-1. To accommodate this projected growth, expansion of the UGB is necessary between the years 2006 and 2011, as the current reserve of R-7 zoned land will be exhausted. With the assumption that the number of persons per metered account remains constant at 3.86, the City could anticipate an additional 2,550 accounts by the year 2024.

Table 3-1 City of Cornelius Population Forecast					
	2004	**2009**	**2014**	**2019**	**2024**
Population	10,450	12,000	14,000	16,500	20,000

The City anticipates expansion of the UGB within the 20-year planning period. When approved by METRO, the boundary expansions will occur on the north, south, and east sides of the existing City boundaries. The City shares a common boundary on the west with the City of Forest Grove. Residential growth is anticipated mostly on the south and east sides of the existing service area. Industrial and mixed-industrial is anticipated mostly on the north side of the City and along Baseline Street east of the current city limits. Increased commercial development also TV Highway is also expected.

3.2.2 Customer Breakdown

Cornelius PWS service area is comprised of residential customers, a number of multi-family dwellings, and commercial and industrial customers. A breakdown of the customer classification by percentage based on September 2001 information is shown in Table 3-2. Table 3-3 summarizes the meter size connections by equivalent residential unit (ERU). ERU determination is based on AWWA equivalency for a standard 5/8" x ¾" residential meter.

Table 3-2
City of Cornelius
Water System Customer Classification (Based on ERUs)
(Connections shown are from City Records for September 2001)

Customer Classification	Service Connections	Percentage
Residential (including multi-unit complexes)	2,380	94.2
Commercial Rentals	12	0.5
Schools	3	0.1
Restaurants	7	0.3
City Buildings/Parks	19	0.7
Gas Stations	6	0.2
Mobile Home Parks	13	0.5
Churches	7	0.3
Other	82	3.2
Total	**2,529**	**100.0**

Table 3-3 City of Cornelius Water System Meter Size Connections Based on ERU (ERUs shown are from City Records for September 2001)			
Meter Size	**AWWA ERU for 5/8" Meter**	**Cornelius Service Connections (2001)**	**ERUs**
5/8"	1.00	2,441	2,441
1"	2.50	38	95
1.5"	5.00	11	55
2"	8.00	38	304
3"	15.00	1	15
Total		**2,529**	**2,910**

3.2.3 Historical Water Use Patterns

Table 3-4 and Exhibit 3-1 display the annual historical water use for the Cornelius PWS. Water use is summarized in terms of the volume of water purchased by Cornelius PWS from Hillsboro and the amount of water billed by Cornelius from its meters. In fiscal year (July to June) 2000-01, total annual consumption for Cornelius PWS based on metered use was 333 million gallons. The amount of water purchased in that year from the City of Hillsboro was 423 million gallons with an average day demand (ADD) of 1.17 million gallons. Total annual water use by Cornelius PWS based on metered use increased by 37.6 percent (4.7 percent annually) from 242 million gallons in 1993-94 to 333 million gallons in 2000-01. However, the volume of water purchased wholesale from Hillsboro increased from 302 to 423 million gallons during the same period, representing a slightly larger increase of 40.1 percent (5.0 percent annually). Discussion on variations between the metered water use and wholesale water purchases occur later in this section.

Table 3-4 City of Cornelius Annual Water Purchased from City of Hillsboro			
Fiscal Year	**Annual Purchase (MG)**	**Percent Change**	**Average Day Demand (MGD)**
1993-94	302	-	0.83
1994-95	340	5.3%	0.93
1995-96	323	-5.0%	0.88
1996-97	374	15.8%	1.02
1997-98	363	-2.9%	0.99
1998-99	397	9.4%	1.09
1999-00	423	6.5%	1.15
2000-01	423	0.0%	1.17
2001-02	421	-0.47%	1.15
2002-03	431	2.38%	1.18

Historic monthly consumption for the service area between July 1993 and August 2001 is shown in Exhibit 3-2. Maximum use typically occurs in July or August. However, the peak monthly demand based on wholesale water purchase was 53.2 million gallons in July 2000 yielding an average day demand (ADD) of 1.72 MGD during that month. As Exhibit 3-2 shows, consumption by the City based on metered use and volume of water billed by Hillsboro do not always correspond. This may be in part due to the lag in monthly meter reading and billing by the City of individual meters.

3.2.4 Peak Day Demands

Daily peaking factors are determined by dividing the peak day demands by the average day demand. However, information on historical daily demands was not available for the Cornelius PWS service area. A review of information indicates for other municipalities and water districts in the area yield (daily) peaking ranging from 2.0 to 2.52. A peaking factor of 2.4 is assumed for the Cornelius PWS service area, noting that the City has a higher number of family residences and a higher incidence of lawns and gardens requiring irrigation than other more densely developed areas in the Portland Metropolitan area. The City of Hillsboro assumes a peaking factor of 2.4. However, the City of Hillsboro also has a large number of industrial users whose constant demand rates moderate the impact of peak demand periods. Using the assumed peaking factor of 2.4 and an estimated ADD of 1.19 MGD for the period 2003-2004, the peak day demand was estimated to be 2.86 MGD.

3.2.5 Water Audit

Table 3-5 shows the amount of water purchased from the City of Hillsboro and the amount of water billed to City customers. The difference between these two is unaccounted for water or water loss. This unaccounted for water can come from several sources including theft, unmetered services, firefighting, leakage, individual meter inaccuracies, and municipal uses (hydrant flushing, street cleaning, etc.) A typical target value for unaccounted for water is usually around 15-20 percent with unaccounted for water losses below 10 percent considered to be exceptional for a municipality.

Table 3-5 City of Cornelius Water Purchased/Water Billed				
Water Year	Annual Purchase from City of Hillsboro (MG)	Annual Billed to City of Cornelius Customers (MG)	Unaccounted for Water (MG)	Unaccounted for Water %
1993-94	302	242	59	20%
1994-95	340	261	79	23%
1995-96	323	166[1]	N/a	N/a
1996-97	374	282	92	25%
1997-98	363	269	94	26%
1998-99	397	302	96	24%
1999-00	423	303	120	28%
2000-01	423	333	91	21%
2001-02	421	299	122	29%
2002-03	431	303	128	30%

[1] *Incomplete records available from 1995 to 1996*

During the ten (10) years of water consumption records shown in Table 3-5, unaccounted for water ranged from 20 to 30 percent. During the fiscal year 2002-2003, the City had a total of 128 MG of unaccounted for water. At a wholesale rate of $0.97/CCF for FY 2002-2003 this resulted in a loss of approximately $166,000 during this period.

The City has identified a number of steel pipelines that have frequently been the source of leaks and that could account for a large portion of the unaccounted for water. Another probable source of water loss is the hundreds of thin-walled black poly service lines install by developers that frequently split and leak. Additionally, there are numerous copper service lines installed without inspection prior to 1996. Consequently, a CIP that both replaces the rusted and leaking mild steel main lines installed in the 1950's and 1960's, the thin walled black poly service lines install in the 1970's and 1980's, and the suspect copper service lines will be the most effective at reducing water loss.

3.3 Demand Forecast

3.3.1 Methodology

Future demand forecasting methodology involves establishing a baseline demand using currently installed water meters and relating this to the projected population growth estimate developed by the City.

Because current records on installed meters exist for each customer in the Cornelius PWS service area, water demand forecasts were based on ERUs. The predominant residential water meter is a standard 5/8 x 3/4-inch meter. The American Water Works Association (AWWA) ERU meter equivalency table was used to establish the baseline. A breakdown of the ERUs is shown on Table 3-3. To develop the water demand forecast, a growth rate was applied to the baseline ERU for the Cornelius PWS service area. The baseline was calculated to be 3.48 persons per ERU. The growth rate was then applied to the number of previously determined ERUs within the service area to forecast future water demands.

3.3.2 Projected Water Demands

Future water demand increases in the service area will be tied to growth associated with in-fill, redevelopment of existing areas, and growth into an expanded UGB. However, with the increased use of water saving fixtures in households and increased customer awareness of water conservation, a gradual decrease in the per capita consumption of water will likely result. Any substantial increases in system wide water use would likely occur if an industrial user moves into the service area. Noting that most of the area zoned for light industrial use within the City's boundaries has been developed and there are no areas within the City's boundaries for heavy industrial use, the addition of any new large industrial water users will depend on rezoning or expansion of the UGB, which is anticipated by 2006.

Taking the existing number of ERUs as established for May 2001 and projecting them according to the City's growth numbers to the year 2024 obtained normalized estimates for ERUs. The resulting projections are shown in Table 3-6.

Table 3-6
City of Cornelius
Projected Equivalent Residential Units (ERU's)
(Based on Cornelius Population Growth Projections)

	Year				
	2004	2009	2014	2019	2024
Population	10,450	12,000	14,000	16,500	20,000
ERU	2,985	3,428	4,000	4,714	5,714
% Increase		14.8%	16.7%	17.9%	21.2%

Values were then computed for the average water use per ERU from the July 1999 count of existing service connections. The historical water purchase during the period from 1999-2000, as shown in Table 3-4, was 423 million gallons or 1.15 million gallons per day resulting in a demand for Cornelius PWS of 397 gallons per day (gpd) per ERU. Using an assumed 2001 population of 10,086 persons, the average per capita water consumption in 2001 is approximately 114 gallons/person/day. This is a relatively low per capita consumption rate, which reflects the urbanized nature of the City service area.

When Cornelius PWS existing water use records are combined with the estimated population growth estimate, the resulting forecast yields the water use projections shown in Table 3-7 and Exhibit 3-3.

The final forecast numbers indicate the total service area will require a 100 percent increase in water supply by the year 2024 over the 2004 demand. The projections in Exhibit 3-3 and Table 3-7 have also been corrected for general conservation owed to improved household fixture efficiency and reduced number of projected persons per household. These final corrected values were obtained by reducing the total average day demand numbers by 2.5 percent every five years beginning in the year 2004. The revised ADD and PDD are shown to identify what impact conservation could have on the forecasted ADD and PDD numbers.

Table 3-7
City of Cornelius
Average Annual Water Demand Forecast (MGD) (1)

	Year				
	2004	**2009**	**2014**	**2019**	**2024**
Demand Forecast					
ADD	1.19	1.37	1.60	1.88	2.28
PDD(2)	2.86	3.29	3.84	4.51	5.47
Demand Forecast Reflecting Conservation					
ADD		1.34	1.52	1.80	2.24
PDD(2)		3.22	3.65	4.32	5.38

(1) Use estimated based on rate of 397 gal/day/ERU
(2) Peaking factor of 2.4 assumed

3.3.3 Summary

The suburban character and lower cost of living of the service area are key factors in the anticipated growth in the water demands of the City. Aside from uncertainties in growth numbers and social-economic impacts of changes in the regional economy, the City should experience continued growth over the 20-year planning period. Growth will likely occur through infill and development of open areas. The City is also anticipating expansion of the Urban Growth Boundary during the 20-year planning period. Increases in efficiency and customer awareness of limited resources should result in a gradual decrease in the per capita consumption of water. The average day demand in the year 2024 is anticipated to be 2.28 MGD, this compares to an average day demand of 1.19 MGD in 2004. The peak day demand is anticipated to be no more than 5.47 MGD in 2024.

3.4 Infrastructure Planning Criteria

A number of criteria were established to guide the planning efforts for this Master Plan. As part of this criteria several principle directions were developed for potential source and supply: planning should consider scenarios for future supply and seek ways to develop interties to other supply systems adjacent to Cornelius PWS area.

The infrastructure planning criteria were used in coordination with the hydraulic model developed for this master plan to identify existing and future system hydraulic and storage deficiencies throughout the system. The Water Master Plan looked at several planning horizons. Initially all existing deficiencies of the water system were identified. Then a detailed evaluation was conducted to the year 2024 at five-year increments. The specific planning criteria for each component of the water system - source, transmission and distribution pipelines, storage, pump stations, etc. - are represented below.

Planning Period

- ❑ Distribution and transmission capacity at 5 year increments to 2024
- ❑ Pumping and storage capacity at 5 year increments to 2024

Planning Area

- ❑ 2004 Cornelius PWS boundary and potential adjacent service area extensions

Service Pressure

- ❑ Minimum System Pressure 60 psi at Peak Hour Demand
- ❑ Minimum System Pressure 20 psi with Peak Day Demand plus Fire Flow Demand
- ❑ Maximum System Pressure 90 psi at Peak Hour Demand

Source

- ❑ Primary source capable of meeting projected Peak Day Demand
- ❑ Firm WTP capacity should meet projected Peak Day Demand with largest component out of service (This planning component is handled by the JWC)
- ❑ Emergency supply capable of meeting Average Day Demand for a minimum of one week

Transmission Pipelines

- ❑ Defined as 12-inch diameter and above
- ❑ Flow velocities should be less than 5.0 fps at Peak Day Demand

Distribution Pipelines

- ❑ Defined as all pipeline smaller than 12-inch diameter
- ❑ Capable of supplying peak hour demands
- ❑ Flow velocities should be less than 8 fps
- ❑ Head loss should be less than 10 ft/1,000 ft
- ❑ Minimum new pipeline diameter will be 6-inch
- ❑ 6-inch pipelines with fire hydrants should be part of a looped system, or be no more than 500 ft in length

Pressure Reducing Stations

- ❑ Supply peak hour demand within the continuous flow rating of the valve
- ❑ Fire flows should be delivered within the intermittent flow rating of the valve

Pump Stations

- ❑ Sized to supply peak day demand at firm capacity of the station

- ❑ Firm capacity is defined as capacity with largest pump out of service
- ❑ Power supplies should have two sources available, or one main source and standby/ emergency power
- ❑ Secondary power source should be sized for average day demand or fire flow demand, whichever is greater

Storage

- ❑ Equalization storage of 25% of peak day demand
- ❑ Fire storage must meet the 3,000 gpm for 3 hours fire flow volume in the City's distribution system
- ❑ Emergency Storage equal to two average day demands for the City
- ❑ Composite Storage equal to the sum of equalization storage, plus fire storage, plus emergency storage or approximately three average day demands depending on system specifics.

Fire Flows

- ❑ Residential Fire Flows of 1,000 gpm for 2 hours
- ❑ Commercial, industrial, multi-family, and public fire flows were set at 3,000 gpm for 3 hours. A specific fire flow of 4,500 gpm for 10 hours for the stables near Flax Plant Rd as required by the City of Cornelius Fire Department.

Exhibit 3-1
City of Cornelius
Total Annual Water Use By Water Year

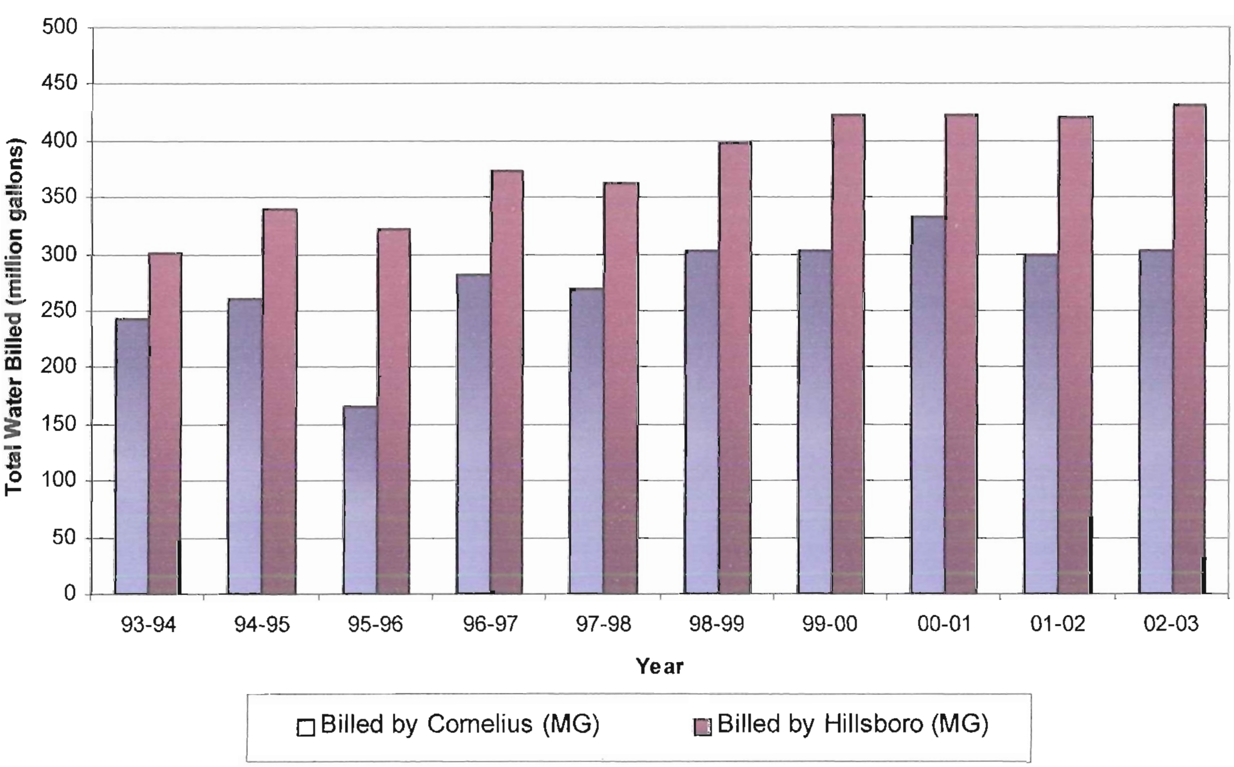


Exhibit 3-2
City of Cornelius
Historical Monthly Water Consumption

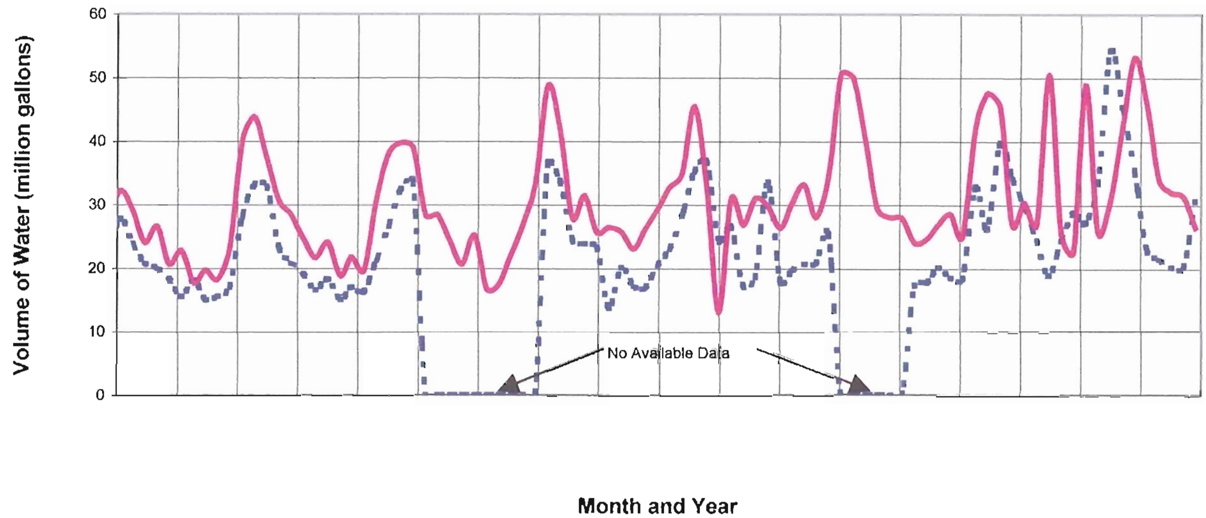


Exhibit 3-3
City of Cornelius
Demand Forecast Comaprison

Section 4
Distribution System Evaluation

4.1 Storage Requirements

The design criteria for water system storage is based on the generally accepted practice of providing effective storage for all customers. Effective storage is defined as the storage volume that can provide minimum service pressure and reserve water to all customers within the distribution system. Storage, in general, provides for three important separate and distinct aspects in the operation of the municipal water system - flow equalization during periods of peak demand, flows for fighting fires, and flows during loss of supply or other emergency condition. Following those principles, the total storage requirement has been broken into three major categories:

- ❑ Emergency Storage
- ❑ Equalization Storage
- ❑ Fire (Flow) Storage

Integrating these three criteria, a general rule of achieving three (3) average days of customer demands has been targeted.

4.1.1 Emergency Storage

Emergency storage is defined as the volume of water that provides a measure of system reliability for the duration of an emergency condition. The volume stored should provide a "margin of safety" that can allow the system to operate at a reduced capacity while maintaining minimum service requirements. This storage requirement specifically addresses a failure in supplying source water to the distribution system, or in the City's case a failure in the Hillsboro transmission system. The volume specified for emergency storage has been set at one and one-half (1½) average days of customer demand.

This emergency storage level is a reflection of the City's interconnection with Hillsboro's distribution system at TV Highway and "343rd", separate from the 72" NTL2 line and Cornelius' second intertie with Forest Grove at S. Heather Street and the western city limits. The Forest Grove intertie is considered particularly valuable because Forest Grove has their own separate water supply and connections to the 72" NTL2 line.

4.1.2 Equalization Storage

Equalization or operational storage is defined as the volume of water required to supplement the production from water sources during high demand periods such as a peak hour demand. Following industry standards, this criterion is set at 25 percent of the peak day demand.

4.1.3 Fire Storage

Fire storage is defined as the quantity of water required to provide the highest risk fire flow rate and duration in the system during peak day demands. Using information provided by the City Fire Department, a prescribed minimum fire flow of 3,000 gpm for 3 hours (or 540,000 gallons) per storage facility is deemed adequate for these purposes.

4.2 Storage Evaluation

4.2.1 Storage Adequacy

Using the criteria outlined in Section 3.4 and the future water demands defined in Section 3, an evaluation was conducted to quantify the present and future storage requirements for the City. This storage analysis is consistent with AWWA recommendations and water industry practices with adjustments made for local adjacent system interties. The results of the analysis are shown in Table 4-1. Following completion of the 72-inch NTL2 line, the City receives all of their water through the City of Hillsboro from the JWC water treatment plant. The JWC has a 20 MG gravity reservoir at Fern Hill. The City has no ownership in the Fern Hill reservoir and consequently, this reservoir is not used during the storage evaluation for the City. This analysis assumes that a planned 2.0 MG reservoir at the Water Park reservoir site is constructed by the year 2006.

Table 4-1
City of Cornelius
Evaluation of Storage Adequacy

	Year				
	2004	**2009**	**2014**	**2019**	**2024**
Existing Storage Capacity (MG)					
Water Park Reservoir	1.5	1.5	1.5	1.5	1.5
Water Park Reservoir 2.0 MG Exp.		2.0	2.0	2.0	2.0
North Reservoir 2.0 MG				2.0	2.0
Total Storage	1.5	3.5	3.5	5.5	5.5
Projected Water Demands (mgd)					
Average Day Demand	1.19	1.37	1.60	1.88	2.28
Peak Day Demand	2.86	3.29	3.84	4.51	5.47
Required Storage Capacity (MG)					
Emergency Storage[1]	1.79	2.10	2.4	2.82	3.42
Equalization Storage[2]	0.72	0.83	0.96	1.13	1.37
Fire Flow Storage[3]	0.54	0.54	0.54	0.54	0.54
Total Required Storage	3.05	3.47	3.9	4.49	5.33
Future Storage Deficiency (MG)					
New Storage Needed	1.55	(0.03)	0.40	(1.01)	(0.17)

[1] *Computed as 1½ times average daily demand*
[2] *Computed as 25 percent of the peak day demand.*
[3] *Computed as 3,000 gpm for 3 hours*

The storage evaluation reveals that the City requires a significant increase in their current overall storage volume. The current total required storage is 3.05 MG, with this amount increasing to 3.9 MG by the year 2014 and 5.33 MG by year 2024. These required storage totals are much larger than the City's existing 1.5 MG of available water storage and will require substantial storage expansion over the next 20 years.

The design drawings for the City's existing reservoir at the Water Park site was originally planned for two reservoirs at this location. There is currently space for a second ground level reservoir and pump station. For planning purposes this space is considered adequate for a second 2.0 MG reservoir. Because of the substantial water storage shortfall, it is recommended that the City proceed with construction of a second reservoir at the Water Park site immediately.

The addition of a second reservoir at the Water Park site will allow the City of Cornelius to meet their current and near future water storage capacity needs. Additional storage will be required to meet the anticipated requirements of future growth.

Based on the estimated future storage needs presented in Table 4-1, an additional. 2.0 MG reservoir is recommended by 2014 if significant growth occurs north of Council Creek. This is referred to as the North Reservoir in Table 4-1. Storage requirements for years past 2009 should be carefully re-evaluated in the next master plan update in 2009. Numerous factors such as additional interties, emergency groundwater wells, shared reservoir projects, and water use pattern shifts based on new industries may reduce or significantly increase future storage needs.

4.2.2 Existing Reservoir Pumping/Water Quality

The current pumping scenario of the existing reservoir was reviewed. The existing Water Park pump station pumps from the reservoir approximately 3.5 hours per day alternating between both pumps. The capacity of the day pumps is approximately 200 gpm. This results in the pumps pumping approximately 42,000 gallons per day. This equates to a residence time of approximately 35.7 days for the water in the reservoir. Long residences generally result in lower disinfectant residuals and greater potential for microbiological contamination and disinfection by-product formation. The American Water Works Association recommends the residence time for water in a reservoir be in the range of 3 to 5 days. It is recommended that the City increase the amount of pumping from the reservoir either through increasing the amount pumped or the length of time pumped.

4.3 Hydraulic Evaluation

The hydraulic evaluation described here was completed by EES and described in their 2002 Report. It was not considered necessary to rerun or update the model for this 2004 update of the master plan. This decision was based on the described assumptions of the EES model run as compared to 2004 conditions.

4.3.1 Methodology

Hydraulic analysis for the City's distribution system was performed using the Cybernet® modeling package produced by Haestad Methods (Waterbury, Connecticut). This software provides a graphical user interface for the execution of the numerical hydraulic analysis routine. The Cybernet model is in widespread use by the public works industry and is well suited for analyzing hydraulic flows in both large and small network systems. The program can be dimensioned for thousands of pipes, subject to the limits established by available computer memory, reasonable processing time and the pipe limits of the software package purchased.

The program uses data describing the network pipes according to their length, diameter, roughness coefficients, and junctions at each end. Pipe junctions (or nodes) are further described according to elevation and demand. The model utilizes this data, along with initial assumptions, to solve the flow scheme throughout the user specified network. Hydraulic head-losses are calculated using the Hazen-Williams equation. The program returns a solution, which predicts the flows, velocities, head losses, and pressures at any point within the system. In its execution, the model can be run to assess both steady state and extended period (time-dependent) analysis.

The most current version of Cybernet® (release 3.1) links directly to AutoCAD®, sharing both data and map files. In constructing a model, the layout of the system can be prepared through the AutoCAD operating environment. From this platform, a database is developed which reflects the appropriate relational nodal and pipe system components. This data is, in turn, read directly into Cybernet along with other user specified hydraulic parameters during execution. The main database is readily updated as changes are imposed on the original AutoCAD files.

In its application here, a Cybernet model was initially created by the City from AutoCAD drawings and other information. EES received the model from the City. Utilizing the work completed by the City, the model was reviewed; demands adjusted, calibrated, and operational data for pumps and pressure reducing valves was corrected for current operating conditions.

All pipes 2-inches in diameter and greater and corresponding nodal locations shown in the drawings were entered into the model and were converted for use in the analysis. In the analysis, the system was maintained as a single pressure zone supplied through pressure reducing valves (PRVs) from the existing 18-inch transmission main. The location of Cornelius' only internal storage tank and associated pump station were identified from the supplied distribution system maps and calibrated using information supplied by the City. The system water supply (i.e. water treatment plant and Fern Hill Reservoir) was modeled as a reservoir, which Cybernet treats as an inexhaustible source. However, it should be noted that the 72-inch transmission main is modeled running through the City's distribution system but is not providing water to the City in the model. For the purposes of this master plan, calibration of the City's distribution system utilized the existing 18-inch transmission main as the source of water. However, evaluation of the City's distribution system to meet fire flows and future peak day and peak hour conditions were modeled with the 72-inch NTL pipeline in operation.

PRVs were modeled as a single valve although most PRV vaults usually consist of two valves, a 3-inch and 6 or 8-inch valve. The PRVs were calibrated based on static pressure readings taken by City personnel throughout the distribution system during the model calibration process. Closed pipes were used to model closed valves. Excluding tank elevations, all of the remaining element elevations of the system were provided in the original model by the City. It is assumed that these elevations were taken through interpretation of 7.5-minute U.S. Geological Service (USGS) Quad Maps.

Criteria were established to evaluate the acceptability for each of the computer trials, namely: (1) maintenance of adequate pressure throughout the system and (2) assurance of acceptable pipeline velocities. The Oregon Health Division (OHD) requires that system pressures be maintained in excess of 20 psi, while the City has no specific pressure goals, a minimum goal of 60 psi for all customers is assumed. Moreover, velocities above seven (7) feet per second (fps) during consistent peak day flow operations and ten (10) fps during short term peak hour flow are traditionally considered excessive, noting problems associated with increased pumping costs, reduced pipe life, and overall system safety.

4.3.2 Calibration

Background

By definition, calibration is the process of tuning the computer model to reflect operational conditions within the actual system. Calibration proceeds in an iterative manner wherein model inputs (usually estimates of pipe friction coefficient and demand distribution) are adjusted so that the predictions reflect actual observed flows and pressures within the system. The process of calibration evolves in: (1) comparison of simulated data to observed (or measured) data; and (2) modification of input data to improve agreement between predicted and observed data.

Typical comparative data consists of measured pressures and flows at various points within the system, operational status of PRVs (flow, downstream pressure, etc.), recorded water levels in storage reservoirs, and knowledge of pump operational status (on/off, total dynamic head added, flow rate, etc.). Notably, these data reflect only a "snapshot" in time for statically specified demands. Real systems are, however, largely dynamic with flows and pressures changing throughout the day. In order to capture a more robust system assessment, calibration is normally extended to include "stressed" settings through forced flowing conditions (e.g. the opening of a fire hydrant). Since the factors that are to be adjusted are usually related to pipe friction loss, the significant increase in flow permits a better evaluation of pressure drop within the area. This practice results in a wider array of head losses being tested within the calibration phase and often improves the resulting accuracy of model predictions over a broader condition of demands.

Calibration Methodology

The model was calibrated based on data taken by City staff on June 15, 2001. Distribution system nodal demands were set first. EES reviewed the nodal demands previously set by City staff. These demands appeared to be well distributed throughout the system with greater demands placed on nodes close to customers with higher average day demands. The higher demands were those closest to schools, apartments, commercial, and industrial customers, etc. The system-wide nodal demands were then globally adjusted to approximate the system during the time the model was calibrated. Unfortunately, the City does not have access to daily demand data. In the absence of this data, the average day demand during the month of June 2001 was used and then multiplied by 1.2 for higher mid-day diurnal demands for a total of 1,176 gpm for the City.

The City's Cybernet model was then calibrated to match both static and flow test (stressed) observations made on the actual water system. A total of five flow tests were performed at various locations throughout the system. Each test was conducted across a series of three hydrants along a "dead end" pipe that allowed water to approach the test site from only one direction. This affect was created artificially by closing valves within the nearby system. The first phase of the test procedure then included local pressure readings on two of the three hydrants (hydrant A and hydrant B) under static conditions. The second phase of the test involved opening the third hydrant, located downstream of hydrants A and B, and releasing a measured flow rate while additional pressure readings were taken at the other hydrants. Test locations were chosen strategically to provide a complete "picture" of the system from which an accurate flow distribution from the supply PRVs could be calibrated.

A key piece to construction of an accurate model was setting the PRV discharge pressures. Since the City's system does not "float" off of a gravity reservoir, it is difficult to know the exact hydraulic grade of the system at any given time. To determine the hydraulic grade of the system, static pressures taken during the calibration process were used to estimate the system hydraulic grade.

Table 4-2 summarizes the results of the calculated hydraulic grade of the distribution system on the day the calibration testing occurred. Static pressures were taken at the hydrant. Ground elevation readings were taken from input elevations in the hydraulic model originally provided by the City and verified with USGS 7.5 Minute Quad maps. From the results, it can be seen that the estimated hydraulic grade of the City's distribution system varied between 323 and 336 feet. This is a difference of approximately 5.6 psi. Based on similar calibration testing taken by the City of Hillsboro during a study in the last two years, it was discovered that pressure readings taken downstream of a PRV varied as much as 10 psi over a 24-hour period.

Based on the variable hydraulic grade, it was necessary to develop an average setting for all PRV's in the system. A PRV setting of 329 feet was set for all valves. Attempts were made at adjusting the PRV's with slightly different settings in different locations in the model to get modeled results closer to the static field results. However, there were no substantial improvements over a constant fixed valve setting on all PRV's.

Table 4-2
City of Cornelius
Calibration Testing
Hydraulic Grade Estimation

Hydrant (Node)	Location	Field Press. (psi)	Ground Elevation (feet)	Calc. HGL (feet)	Model Press. (psi)	Diff. (%)
625 (J-475)	N. Fremont & N. 23rd	64	182	330	65.1	1.7%
624 (J-75)	N. Fremont & N. 21st	64	178	326	65.1	1.7%
227 (J-401)	N. Davis & N. 2nd/3rd	64	180	328	64.3	-0.5%
234 (J-399)	N. Davis & N. 4th Ave.	62	184	323	63.5	2.4%
155 (J-244)	S. Nectarine & S 10th Ave.	72	158	324	72.6	0.8%
317 (J-471)	S. Beech & S. 14th Ave.	68	172	329	65.7	-3.4%
311 (J-476)	S. Beech St. & S. 12th Ave.	68	172	329	66.1	-2.8%
534 (J-457)	S. 25th & S. Alpine/Beech St.	66	184	336	63.2	-0.3%
535 (J-473)	S. Alpine & S. 23rd/25th Ave.	66	184	336	62.4	-5.4%

Other system facilities affecting both flow and pressure within the distribution system included the Water Park Reservoir and its corresponding pump station. For calibration purposes it was assumed that the reservoir was full and its intake valves were closed (i.e. no water was entering the tank through the distribution system). Moreover, it was assumed that the Water Park Reservoir pump station was not in operation and that no water was entering the distribution system from the reservoir.

Final model calibration was conducted by adjusting pipe friction coefficients to compensate for discrepancies between model simulation and field data. Accuracy limits were established based on a planning level effort, wherein requiring calibration within 10 psi at any given node.

Calibration Results

The following outlines the results for the model calibration testing. Flow volumes were determined by the City Fire Department. City staff assisted with the testing process. To aid in the calibration process, friction factors on several of the field tested pipes lengths were back calculated using estimated lengths between test locations, calculated test flows, pipe diameter, and recorded pressure drop.

Northwest Cornelius – A single flow test was performed in the northwest portion of the City's distribution system. The test was located on N. Davis Street. The flow test was monitored, while readings were taken for both static and flowing (stressed) conditions. For the N. Davis Street test, 1,162 gpm was pulled from the system at hydrant #228 near node (J-402) with pressure readings being taken at locations near nodes (J-401) and (J-399). The results for the calibration run met the established error limits for both hydrants during the static and flow tests. Simulated static pressures were within 2 psi while stressed flow conditions were within 9 psi.

Northeast Cornelius – A single calibration test was conducted in the northeast portion of City's distribution system. The test was located on N. Fremont Street between N. 21st and N. 25th Avenues. Test conditions included 1,574 gpm being released through hydrant #626 near node (J-77) with pressure readings being taken at two hydrants located near nodes (J-475) and (J-75). Pipes at the east end of N. Fremont Street were "closed" to simulate one directional flow maintained during the field-testing. The results for the calibration run met the established error limits for hydrant A during the flow test and for both hydrants during the static tests. Simulated pressures were within 2 psi of both observed static and at hydrant A during the stressed field conditions.

Southwest Cornelius – A single flow test was performed in the Southwest portion of the City's distribution system. The test was located on S. Nectarine Street west of Golf Course Road. The flow test was monitored, while readings were taken for both static and flowing (stressed) conditions. A flow of 1,114 gpm was calculated by the fire department from hydrant #164 near node (J-249) with pressure readings being recorded from nodes (J-252) and (J-244). Pipes on the west end of S. Nectarine between S. Oleander and S. Magnolia Streets were "closed" in the model to simulate one directional flow maintained during the field testing. The results for the static tests met the established error criteria, with simulated pressures being within 1 psi of the observed field results. Results under stressed conditions only met the criteria for hydrant B with results within 7 psi. Results at hydrant A were below field conditions by 14.1 psi.

Central Cornelius Area – A single calibration test was conducted in the residential area on S. Beech Street between S. 12th and S. 16th Avenues. The test was located at hydrant #316 near node (J-294) at the intersection of S. 16th Street. Test conditions included an estimated flow of 950 gpm recorded in the field. Pressure readings were taken at two hydrants located near nodes (J-471) and (J-295). Pipes were "closed" in the model on S. 16th Avenue between S. Alpine and S. Cherry Streets to simulate field-testing conditions. The modeled results under static conditions yielded results that were within 2.5 psi. Calibration results under stressed conditions yielded results that were 0.8 and 11.4 psi, respectively with the results at hydrant B just outside of the established criteria.

Southeast Cornelius – A single test was performed in the southeast portion of the City's distribution system. The readings were taken under both static and flowing (stressed) conditions along S. Alpine/ S. Beech Street. Flow tests were performed at a hydrant at the southwest corner of the intersection of S. Beech Street and S. 26th Avenue. However, flows were calculated to be 1,162 gpm. Static pressure tests were taken at hydrants near nodes (J-473) and node (J-457). The hydraulic model reported results within 4 psi of observed data under static conditions for both observation nodes. Calibration results under test conditions yielded results that were 0.7 and 13.7 psi, respectively with the results of hydrant B slightly higher that the design criteria.

With the exceptions mentioned above, results of the model calibration all lie within the acceptable error for its intended use. The remaining discrepancies result from a number of causes, which include: (1) differences between actual and model pipe friction coefficients, (2) unknown isolation valve settings, (3) lack of precision with node elevations, (4) lack of accuracy in field testing equipment, and (5) errors in testing and calculating the flows from the test hydrants. In addition, values for pipe coefficients vary greatly depending upon pipe material type and age, and wield significant influence on final model predictions. As stated previously node elevations were taken from USGS topographic maps and elevations are subject to +/- five feet of error. Summaries of the calibration results are presented in Tables 4-3a and 4-3b.

It is recommended that the City thoroughly check all distribution system valves to ensure that all are operable and the valves are fully open.

Overall, the model calibration effort was considered adequate for the level of effort required for this plan. With the above-mentioned exceptions, all results met the established criteria limits. The calibration results show that the hydraulic model accurately predicts conditions observed in the field. Moreover, the changes in pressure reflected in the model also closely mimic those in the field, providing for the indication of good model calibration. The level of calibration conducted allows the model to be used for further investigation of capital improvements and future fire flow analysis.

Table 4-3a
City of Cornelius
Comparison of Hydraulic Model with Field Verification Data
Node A

Location	Elevation	Flow[1]	Static Pressure[2] (psi)			Flow Test Pressure[3] (psi)		
Discharge Node, Node A, Node B	**(ft)**	**(gpm)**	**Hyd. A, Field**	**Hyd. A, Model**	**Difference**	**Hyd. A, Field**	**Hyd. A, Model**	**Difference**
N. Freemont St. (NE test) J-77, J-475, J-75	184	1,574	64	65.1	1.1	31	32.2	1.2
N. Davis St. (NW test) J-402, J-401, J-399	178	1,162	64	64.3	0.3	27	35.0	8.0
S. Nectarine St. (SW test) J-249, J-252, J-244	154.2	1,114	73	72.7	(0.3)	23	8.9	(14.1)
S. Beech St. (Central test) J-294, J-471, J-476	177	950	68	65.7	2.3	25	24.2	(0.8)
S. Alpine St. (SE test) J-458, J-457, J-473	182.2	1,162	66	63.2	(2.8)	25	25.7	0.7

Table 4-3b
City of Cornelius
Comparison of Hydraulic Model with Field Verification Data
Node B

Location	Elevation	Flow[1]	Static Pressure[2] (psi)			Flow Test Pressure[3] (psi)		
Discharge Node, Node A, Node B	(ft)	(gpm)	Hyd. B, Field	Hyd. B, Model	Difference (psi)	Hyd. B, Field	Hyd. B. Model	Difference (psi)
N. Freemont St. (NE test) J-77, J-475, J-75	184	1,574	64	65.1	1.1	32	47.1	15.1
N. Davis St. (NW test) J-402, J-401, J-399	178	1,162	62	63.5	1.5	28	47.1	9.1
S. Nectarine St. (SW test) J-249, J-252, J-244	154.2	1,114	72	72.6	0.6	29	35.9	6.9
S. Beech St. (Central test) J-294, J-471, J-476	177	950	68	66.1	(1.9)	36	47.4	11.4
S. Alpine St. (SE test) J-458, J-457, J-473	182.2	1,162	66	62.4	(3.6)	27	40.7	13.7

[1] *Flow refers to the rate of flow pulled during the with flow test condition.*
[2] *Static pressure refers to the flow test reading under average daily demand conditions without the additional demand of the amount listed in the "Flow " column.*
[3] *Flow Test Pressure refers to the flow test pressure reading under average daily demand conditions including the additional demand of the amount listed in the "Flow" column.*

4.3.3 Simulated Scenarios

Following calibration, model simulations were conducted under three (3) basic operational modes: 1) Average Day Demand, 2) Peak Day Demand, and 3) Peak Hour Demand Conditions. For each of the planning years, base simulations were executed using the average daily demands, peak day demands, and peak hour demands shown in Table 4-4.

Table 4-4
City of Cornelius
Modeled System Demand (mgd)

	2001	2006	2011	2021
Average Day	1.15	1.43	1.79	2.77
Peak Day	2.76	3.44	4.29	5.34
Peak Hour	4.14	5.16	6.44	9.99

Average day demands were determined from provided records, while peak day demands were estimated using a multiplication factor of 2.4 for all users. Peak hour demands were determined by applying an additional multiplication factor of 1.5 to the peak day demands. The emergency condition scenario assumed that Hillsboro's largest single water source (the JWC Treatment Facility and Fern Hill Reservoir) could not supply water to the system. All of the peak day systems demands were then met through proposed storage facilities and associated pump stations. Table 4-5 outlines the modeled water supply strategy for each of the simulated scenarios.

Table 4-5
City of Cornelius
Simulated Scenarios

Scenario	Available Sources of Water Supply				
	JWC WTP	Water Park Storage	Hillsboro & Forest Grove Interties	Ratio to Average day Demand	Notes
Average Day Demand	Yes	No	No	1	
Peak Day Demand	Yes	No	No	2.4	
Peak Hour Demand	Yes	Yes	No	3.6	Included fire flow analysis.
Emergency Conditions	No	Yes	Yes	1	Assumed ADD operating conditions.

The results for these simulations were used to determine infrastructure deficiencies in years 2001, 2006, 2011, and 2021. In general, the model simulations indicate that the current Cornelius distribution system is in relatively good operation status with a few notable exceptions. Additional larger diameter mains are necessary to meet existing and future fire flow needs in the southwest and northwest portions of the City.

4.3.4 Fire Flow Analysis

Additional simulations for fire flow were run at all of the node locations within Cornelius's service area to determine the ability of the distribution system to meet large demands in addition to peak day demands. These simulations assumed a minimum of 1,000 gpm for nodes within the residential areas, and 3,000 gpm at the point of fire within commercial land use areas with a coincident peak hour demand throughout the system. If pressures within the system remained above 20 psi, the ability to meet the fire flow was considered to be available. The fire flow analysis was conducted only for the year 2021 under peak hour demands, as that would be the "worst case" demand scenario (see Table 4-4, total peak hour). Table 4-6 indicates the locations where high fire flow demands were placed to test the capacity of the distribution system adjacent to commercial structures.

Table 4-6
City of Cornelius
Hydraulic Model Commercial and Industrial Fire Flow Tests

	Fire Flow (gpm)	Location
1	3,000	Corner of S. 9th and S. Linden (school)
2	5,000	Corner of Golf Course Rd. and Flax Plant Rd.
3	3,000	Intersection of S. 12th Ave. and S. Ivy St.
4	3,000	Court off of N. Holladay Rd.
5	3,000	Intersection of N. Adair St. and N. 17th Ave.
6	3,000	Fred Meyer
7	3,000	N. 26th Ave. just south of the Burlington Northern RR

It is important to note that the analysis only checks the distribution system capacity to deliver water of an appropriate flow rate to a fire. The amount of time that a particular flow may be sustained is dependent on the volume of internal water storage. Further provisions to accommodate fire flow duration are provided under the Cornelius storage analysis (see Section 4.1).

Under the 2021 peak hour demand conditions, the design criteria for fire flow (1,000 gpm residential, 3,000 gpm commercial, and 20 psi) are not met throughout Cornelius entire system. Several commercial locations were not able to meet the their target fire flows. This included those in the northwest and southwest quadrant of the City.

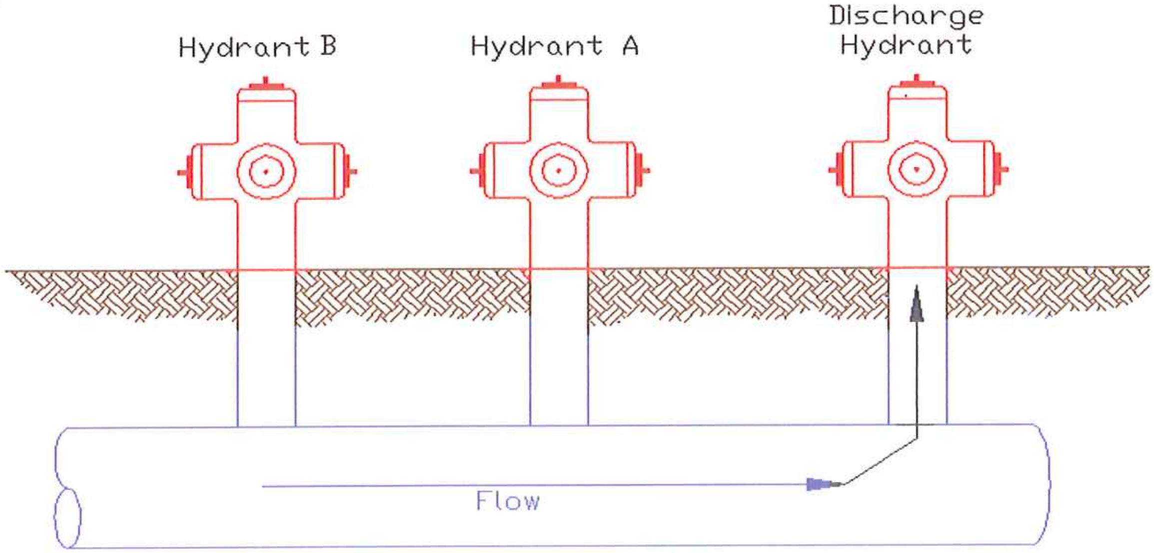
A number of residential hydrants were not able to meet the fire flow goal of 1,000 gpm. A secondary residential fire flow goal of 500 gpm (this was used by the City of Hillsboro as their minimum residential fire flow) was established to identify those with fire flows of greatest concern. Three hydrants failed to meet the 500 gpm secondary goal. Approximately 6 residential hydrants had fire flows in the test conditions in the range of 500 to 1,000 gpm. The balance of the hydrants were above the 1,000-gpm goal. Table 4-7 lists the locations of the fire hydrants that failed to meet the residential fire flow requirements. It should be noted that these hydrants failed to meet the fire flow requirements under test conditions, which included 2021 peak hour demand conditions. Most of these fire flow deficiencies can be corrected by implementing the Capital Improvement Plan presented in Section 6.

Table 4-7
City of Cornelius
Hydrants Failing to Meet Residential Fire Flow Criteria[1]

Node	Hydrant I.D.	Model Flow (gpm)	Location
J-389	431	236	N. Barlow St. and N. 13th Avenue
J-366	200	284	W. Baseline and N. 1st Avenue
J-182	427	454	Susbauer Road north of N. Holladay St.
J-313	171	631	S. Nectarine St. and S. 2nd Place
J-364	150	700	S. 1st Avenue and S. Linden Street.
J-428	301	761	S. 11th Ave and S. Cherry Street.
J-187	420	869	N. 17th Ave. and N. Barlow Street
J-233	341	884	S. Ivy St. and S. 15th Avenue
J-213	321	902	S. Fawn Ct. and S. 15th Avenue

[1] 1,000 gpm under year 2021 peak hour demand conditions.

Exhibit 4-1
Calibration Test Procedure



Calibration Test Procedure

Step 1:
Record Pressure under static conditions (no flow through Discharge Hydrant) for Hydrant A, and Hydrant B.

Step 2:
Record Pressure under stressed conditions for Hydrant A, and Hydrant B. Record flow through Discharge Hydrant.

Section 5
Regulatory Compliance

5.1 Background

The purpose of this review is to evaluate the compliance of the City's water system with state drinking water standards, as provided under Oregon Administrative Rules (OAR) 333-061. This review is also intended to make recommendations to assist the City in meeting anticipated Oregon Health Division (OHD) and U.S. Environmental Protection Agency (U.S. EPA) regulations. The Joint Water Commission Water Treatment Plant (JWC WTP) is the wholesale supplier of water to the City. Therefore, the City's compliance to OHD regulations is presented in terms of activities conducted by the City and the two treatment plants. While it is beyond the scope of this report to address treatment plant operations as a whole, treatment will be addressed on a limited basis due to the integral interconnection between treatment and distribution system water quality.

Most of the nation's drinking water quality regulations have been developed within the last 25 years and are under constant revision. Many of the regulations pertain to "contaminants" that are naturally occurring (such as turbidity) or are aggravated by natural characteristics of the water (such as corrosivity, which can lead to high lead or copper levels at consumers' taps). Other contaminants, such as nitrate or bacteria, originate from human or animal activities. Drinking water regulations are extremely complex and continue to evolve in response to improving scientific understanding of human health related issues and vastly improved methods of detection. Many utilities have found that significant budgeting and institutional changes are needed to adapt to these changing regulations. Water quality regulations are also placing a large burden on the regulatory agencies themselves, regarding review of monitoring and enforcement. As a result, more responsibility for regulatory compliance is being, and will continue to be, shifted to the various water supply agencies.

The Safe Drinking Water Act (SDWA) of 1974, along with its 1986 and 1996 amendments, establishes specific standards regarding the quality of water delivered to the public and the process by which it is produced. Under the SDWA, the U.S. EPA is authorized to develop national drinking water regulations and oversee their implementation. State governments, in turn, are expected to adopt as a minimum the federal law and accept the primary responsibility for implementation and enforcement. On a day-to-day basis, this responsibility is shifted to the water purveyor through an elaborate required monitoring program.

Following OHD definition, the City's water system is regulated as a "Community Water System," which in turn classifies it for statutory compliance as a "Public Water System."

As stipulated under Oregon Administrative Rules (OAR) 333-061-0025, an operator of a public water supply system is responsible for:

- Routinely collecting and submitting water samples for laboratory analyses at the frequencies prescribed by OAR 333-061-0036;

- Taking immediate corrective action when the results of analyses or measurements indicate that Maximum Contaminant Levels (MCLs) have been exceeded and report these results as prescribed under OAR 333-061-0040;

- Notifying all customers of the system, as well as the general public within the service area, when violations occur; moreover, notify all customers served by the system when the reporting requirements are not being met or when the operation of the system is subject to a permit or a variance;

- Maintaining monitoring and operating records and making these records available for review when the system is inspected;

- Maintaining a pressure of at least 20 pounds per square inch (psi) at all service connections at all times;

- Providing follow-up on complaints relating to water quality from users, and maintain records and reports on actions undertaken;

- Conducting an active program for systematically identifying and controlling cross connections;

- Submitting, to the OHD, plans prepared by a professional engineer registered in Oregon for review and approval before undertaking the construction of new water systems or major modifications to existing water systems, unless exempted from this requirement; and

- Assuring that the water system complies with OAR 333-061-0205 through 333-061-0295 relating to certification of water system operators.

The remaining elements of this section are directed at reviewing the current status of the City and its wholesale suppliers with regards to each of the OHD standards. In addition, recommendations are made as to future monitoring needs and/or source water protection activities.

5.1.1 Administrative Oversight

Through administrative agreement, staff at the JWC treatment plant is responsible for the water quality program for wholesale waters prior to entering the City's distribution system. The City is responsible for water quality monitoring inside the City's distribution system. For the purposes of this report, the water quality reporting requirements and results will be shown for both the JWC conventional treatment plant and the Cherry Grove slow sand filter plant (wholesale water sources), as well as distribution system water quality results. For formal reference, the two wholesale sources of water are identified as:

1. The Joint Water Commission water treatment plant - EPA Water System Number OR4100379.

2. The Cherry Grove treatment plant - EPA Water System Number OR4100985.

5.1.2 Approach Used to Evaluate Regulatory Compliance

The approach taken to assess compliance with regards to existing and future (anticipated) regulations was to:

- ❑ Review the monitoring frequency and sample numbers taken by the wholesale supplier for the source water and distribution networks of the City's system;
- ❑ Compare the sampling frequency and methods used by the City to those of the requirements stipulated under OAR 333-061;
- ❑ Contact OHD to discuss past sampling data and determine if water quality (source and distribution system) meets the current standards;
- ❑ Review the current public notification, complaint reporting and response, and consumer confidence reporting programs being used by the City;
- ❑ Review the status of the City's cross connection identification and control program;
- ❑ Discuss potential regulatory changes that may affect plant operations and outline possible future contingencies for the City.

5.2 Review of Monitoring and Regulatory Compliance

Under Oregon's Water Quality Act of 1981, regulatory guidance is established for assuring safe drinking water for all water systems that serve the public and for promoting the health standards set forth by the U.S. EPA under the federal Safe Drinking Water Act (SDWA). A list of promulgated, proposed, and anticipated regulations that affect City water system operations is provided in Table 5-1.

Table 5-1
City of Cornelius
Proposed, Promulgated and Effective Rules Under the Safe Drinking Water Act 1986 and 1996 Amendments

Rule	Parameters Regulated	Regulatory Milestone	Notes
Phase I	VOCs	Effective January 1989	
Total Coliform Rule	Bacteriological, Disinfection	Effective December 1990	
Lead and Copper Rule	Lead, Copper, water quality parameters	Effective December 1992	
Phase II, Phase V	Inorganics, VOCs, SOCs	Effective January 1993	
Information Collection Rule	Monitoring and data reporting for disinfection by-products and pathogens	May 1996	
Consumer Confidence Reports Rule	Requires annual report addressing drinking water quality	Effective September 1998	First reports due by October 1999
Stage I Disinfectants/Disinfection By-products (D/DBP) Rule	Trihalomethanes (THM), Haloacetic Acids (HAA), and Disinfectant Residuals	Effective February 1999	Revisions to Stage 1 rules published January 16, 2001. Extends use of new analytical methods for TTHM, corrects errors, and revises dates of compliance of IESWTR and Stage 1 DBPR to coincide with calendar quarters.
Public Notification Rule (PNR)	Stipulates reporting protocol for acute violations	Effective May 2002	Revises minimum notification requirements of existing 1989 PNR. Public Notification Handbook published June 2000.
Enhanced Surface Water Treatment Rule	Pathogens and Disinfection By-products	November 1998 (Stage 1) By November 2000 (Long Term 1)	
Filter Backwash Recycling Rule	Particles and Pathogens	June 2001.	Proposed April 10, 2000.
Radon	Radon	Final Rule expected early 2002	

Table 5-1
(Continued)
City of Cornelius
Proposed, Promulgated and Effective Rules Under the Safe Drinking Water Act 1986 and 1996 Amendments

Rule	Parameters Regulated	Upcoming Regulatory Milestone	Notes
Radionuclides	Radionuclides (Exclusive of radon)	Effective December 2003.	Requires sampling at each entry point.
Arsenic	Arsenic	Final Rule January 2001	
Stage II Disinfectants/ Disinfection By-products (D/DBP) Rule	THMs, HAAs, and Disinfection residuals	Proposed Rule Spring 2001, Final deadline May 2002, Agreement in Principle published December 29, 2000	Planned to Replace Stage I D/DBP Rule
Sulfate	Sulfate	Decision to regulate planned for August 2001	
Source Water Protection Rule	None	Effective August 2003	All assessments to be completed by August 2003.
Unregulated Contaminants	Organic and Inorganic Contaminants to be defined	January 11, 2001	Approves analytical methods for contaminants on List 2. Sets schedule for monitoring Aeromonas

Within this process, public water suppliers are responsible for taking all reasonable precautions to:

- Assure that the water delivered to users does not exceed the MCLs specified under OAR 333-061-0030;
- Assure that water system facilities are free of public health hazards; and
- Assure that water system operation and maintenance is performed as required under the OAR.

5.2.1 General Monitoring Requirements

Following guidance under OAR 333-061-0036, an appropriate monitoring schedule for both primary and secondary water quality criteria has been established for the City's system, and the City of Hillsboro and its wholesale suppliers. Table 5-2 defines the general long-term monitoring requirements for the service area and associated reporting frequencies.

Table 5-2
City of Cornelius
Existing OHD Monitoring Requirements for the City/JWC/Cherry Grove System

Primary Contaminants	Monitoring	Required Monitoring Frequency	Actual Monitoring Frequency
Inorganics (incl. arsenic, asbestos, and nitrate)	16 Constituents, finished water (excluding Pb & Cu)	Annually	Semi-Annually
Lead & Copper	2 Regulated Contaminants taken from point of use in "worst case" locations, 20 locations for City of Cornelius distribution system	3 Years	3 Years
Synthetic Organics	30 Regulated Contaminants, finished water	3 years	3 Years
Volatile Organics	21 Regulated Contaminants, finished water	3 years	3 Years
Radionuclides	Gross Alpha Activity, finished water	4 Years	4 Years
Total Trihalomethanes	Samples from distribution system (Not required for Cornelius)	Quarterly	Quarterly
Total Coliforms	Samples from distribution system 18 Locations City of Cornelius distribution system, 9 sampled per month in a rotation	Monthly	Monthly
Chlorine Residual	Monitored prior to entry to distribution system	Continuous	Continuous
Secondary Contaminants	**Monitoring**	**Required Monitoring Frequency**	**Actual Monitoring Frequency**
Secondary Contaminants and unregulated inorganics	40 Unregulated Contaminants, finished water	Not Required	Every 2 hours to semi-annually

The remaining subsections outline specific results for each of these monitoring criteria.

5.2.2 Regulated Inorganic Contaminants

The City of Hillsboro (through JWC and Cherry Grove treatment plants) presently monitor all 18 inorganic chemicals listed under OAR 333-061-0030(1) and 333-061-0036(2) in the finished water. The most recent sampling results for these chemicals and their comparative maximum contaminants levels (MCLs) are shown in Table 5-3.

Table 5-3
City of Cornelius
Inorganic Contaminant Standards and Finished Water Sampling Results

	JWC System		Cherry Grove		
Inorganic Contaminant	**Sample (mg/l)**	**Sample Date**	**Sample (mg/l)**	**Sample Date**	**MCL (mg/l)**
Aluminum	0.6	2/01	0.6	2/01	0.2[d]
Antimony	ND[a]	2/01	ND	2/01	0.006
Arsenic	ND	2/01	ND	2/01	0.05
Asbestos	<0.18 MFL[b]	1/93 [c]	not required	-	7.0 MFL
Barium	ND	2/01	ND	2/01	2.0
Beryllium	ND	2/01	ND	2/01	0.004
Cadmium	ND	2/01	ND	2/01	0.005
Calcium	8.4	2/01	7.49	2/01	--
Chromium	ND	2/01	ND	2/01	0.1
Cobalt	ND	2/01	ND	2/01	--
Copper	ND	2/01	ND	2/01	1.3
Cyanide	ND	1/99	ND	1/99	0.2
Fluoride	ND	2/01	ND	2/01	4.0
Iron	ND	2/01	ND	2/01	0.3[d]
Lead	ND	2/01	ND	2/01	0.015
Magnesium	2.52	2/01	1.65	2/01	--
Manganese	ND	2/01	ND	2/01	0.05[d]
Mercury	ND	2/01	ND	2/01	0.002
Molybdenum	ND	2/01	ND	2/01	--
Nickel	ND	2/01	ND	2/01	0.1
Nitrate (as N)	1.0	2/01	ND	2/01	10.0
Nitrite (as N)	ND	2/01	ND	2/01	1.0
Tot. Nitrite+Nitrate	1.0	2/01	ND	2/01	10.0
Potassium	0.5	2/01	0.3	2/01	--
Selenium	ND	2/01	ND	2/01	0.05
Silver	ND	2/01	ND	2/01	0.1[d]
Sodium	9.99	2/01	3.17	2/01	--
Thallium	ND	2/01	ND	2/01	0.002
Zinc	ND	2/01	ND	2/01	5[d]

[a] *ND = below detection limits (non-detect)*
[b] *MFL = million fibers per liter > 10 um*
[c] *Hillsboro is currently looking for a qualified laboratory to perform ongoing asbestos testing*
[d] *Suggested Secondary Contaminant Limit*

As shown, all results for inorganic chemical sampling are in compliance with respect to regulated MCLs or action levels.

5.2.3 Synthetic Organic Contaminants

The City of Hillsboro (through JWC and Cherry Grove treatment plants) presently monitors the 30 regulated Phase II and Phase V synthetic organic contaminants (SOCs) prescribed under OAR 333-061-0030(2)(a) and 333-061-0036(3). The results of recent sampling for these compounds are shown in Table 5-4, along with the required MCLs.

Measured quantities for all regulated SOCs have remained below detection limits throughout their sampling history. As such, all samples are in compliance with respect to both the MCLs and sampling frequencies.

Table 5-4
City of Cornelius
Regulated Synthetic Organic Contaminant Standards
Finished Water Sampling Results

	JWC System		Cherry Grove		
Organic Contaminant	**Sample (mg/l)**	**Sample Date**	**Sample (mg/l)**	**Sample Date**	**MCL (mg/l)**
Alachlor	ND	1/99	ND	1/99	0.002
Atrazine	ND	1/99	ND	1/99	0.003
Benzo(a)pyrene	ND	1/99	ND	1/99	0.0002
Carbofuran	ND	1/99	ND	1/99	0.04
Chlordane	ND	1/99	ND	1/99	0.002
Dalapon	ND	1/99	ND	1/99	0.2
Dibromochloropropane	ND	1/99	ND	1/99	0.0002
Dinoseb	ND	1/99	ND	1/99	0.007
Dioxin (2,3,7,8-TCDD)	N/A	*	N/A	*	0.00000003
Diquat	ND	1/99	ND	1/99	0.02
Di(2-ethylhexyl)adipate	ND	1/99	ND	1/99	0.4
Di(2-ethylhexyl)phthalate	ND	1/99	ND	1/99	0.006
Endothall	ND	1/99	ND	1/99	0.1
Endrin	ND	1/99	ND	1/99	0.002
Ethylene Dibromide	ND	1/99	ND	1/99	0.00005
Glyphosate	ND	1/99	ND	1/99	0.7
Heptachlor	ND	1/99	ND	1/99	0.0004
Heptachor epoxide	ND	1/99	ND	1/99	0.0002
Hexachlorobenzene	ND	1/99	ND	1/99	0.001
Hexachlorocyclopentadiene	ND	1/99	ND	1/99	0.05
Lindane	ND	1/99	ND	1/99	0.0002
Methoxychlor	ND	1/99	ND	1/99	0.04
Oxamyl(Vydate)	ND	1/99	ND	1/99	0.2
Picloram	ND	1/99	ND	1/99	0.5
Polychlorinated Biphenyls	ND	1/99	ND	1/99	0.0005
Pentachlorophenol	ND	1/99	ND	1/99	0.001
Simazine	ND	1/99	ND	1/99	0.004
2,4,5-TP (silvex)	ND	1/99	ND	1/99	0.05
Toxaphene	ND	1/99	ND	1/99	0.003
2,4-D	ND	1/99	ND	1/99	0.07

**No sample taken*

5.2.4 Volatile Organic Contaminants

Monitoring is also being conducted by the City of Hillsboro (through JWC and Cherry Grove treatment plants) for the 21 regulated Phase I, II and V volatile organic contaminants (VOCs) prescribed under OAR 333-061-0030(2)(c) and 333-061-0036(3). The results of recent sampling for these compounds are shown in Table 5-5, along with the required MCLs (for regulated compounds only) and sampling frequencies.

Table 5-5
City of Cornelius
Finished Water Regulated Volatile Organic Contaminants
Sampling Results

	JWC System		Cherry Grove		
Volatile Organic Contaminant	**Sample (mg/l)**	**Sample Date**	**Sample (mg/l)**	**Sample Date**	**MCL (mg/l)**
Benzene	ND	1/99	ND	1/99	0.005
Carbon tetrachloride	ND	1/99	ND	1/99	0.005
Cis-1,2-Dichloroethylene	ND	1/99	ND	1/99	0.07
Dichloromethane	ND	1/99	ND	1/99	0.005
Ethylbenzene	ND	1/99	ND	1/99	0.7
Monochlorobenzene	ND	1/99	ND	1/99	0.1
0-Dichlorobenzene	ND	1/99	ND	1/99	0.6
P-Dichlorobenzene	ND	1/99	ND	1/99	0.075
Styrene	ND	1/99	ND	1/99	0.1
Tetrachloroethylene(PCE)	ND	1/99	ND	1/99	0.005
Toluene	ND	1/99	ND	1/99	1.0
Trans-1,2-Dichloroethylene	ND	1/99	ND	1/99	0.1
Trichloroethylene (TCE)	ND	1/99	ND	1/99	0.005
Vinyl chloride	ND	1/99	ND	1/99	0.002
Xylenes (total)	ND	1/99	ND	1/99	10.0
1,1-Dichloroethylene	ND	1/99	ND	1/99	0.007
1,1,1-Trichloroethane	ND	1/99	ND	1/99	0.2
1,1,2-Trichloroethane	ND	1/99	ND	1/99	0.005
1,2-Dichloroethane	ND	1/99	ND	1/99	0.005
1,2-Dichloropropane	ND	1/99	ND	1/99	0.005
1,2,4-Trichlorobenzene	ND	1/99	ND	1/99	0.07

ND - Below Detection Limits (Non-detect)

The results for all regulated VOCs indicate contaminants levels were all below detection limits. This was also true for the 20 unregulated VOC's tested with the exception of chloroform. The detection of chloroform was related to the disinfection method.

5.2.5 Lead and Copper Monitoring

Established under the 1986 amendments to the federal Safe Drinking Water Act (SDWA), the lead and copper rule (LCR) outlines a set of enhanced monitoring criteria for corrosion control of drinking water systems. Exposure to lead through ingestion (or inhalation) also poses a potential serious health threat to sensitive portions of the population, namely young children and pregnant women. There is virtually no lead found in the finished water from the City of Hillsboro (the JWC water treatment plant or the Cherry Grove slow sand filter plant). The problem generally stems from premise (household) plumbing, for example, through use of lead solder or fixtures containing small amounts of lead.

The LCR requires treatment when lead and/or copper in drinking water exceeds specified action levels. The LCR sets forth a MCL goal (MCLG) of zero lead and 1.3 mg/L for copper. These levels represent non-enforceable health goals. The LCR, however, sets action levels of 0.015 mg/L for lead and 1.3 mg/L for copper. When the concentration of lead or copper exceeds the action levels in 10 percent of the total number of required samples, the system must carry out the water treatment requirements specified under 333-061-0034(3).

Regulations for sampling are established under a corrosion monitoring plan outlined under OAR 333-061-0036(2)(e). Under this plan, the City has completed its initial sampling and was granted a waiver for reduced monitoring. Presently, the City of Hillsboro is required to sample 20 distribution system locations within the Cornelius system every three years. The most recent round of sampling was conducted in September 1999 and reported to OHD October 1, 1999. The results of that sampling are shown below in Table 5-6. The next anticipated lead and copper sampling would occur in September 2002.

Results are well below the action levels for lead and copper for the City water system. Accordingly, the City is not presently required to perform any additional treatment for corrosion control.

Table 5-6
City of Cornelius
Lead and Copper Distribution System Sampling Results

Sampling Location	Lead (mg/l)	Copper (mg/l)
1. 155 South Heather St.	0.005	0.13
2. 2075 S. Beech St.	0.003	0.23
3. 425 N. 15th Ave.	0.003	0.19
4. 555 S. Emerald Loop	0.003	0.12
5. 399 S. 19th Ave.	0.003	0.10
6. 1290 S. Beech St.	0.002	0.16
7. 2220 S. Elder Place	0.001	0.12
8. 498 S. 23rd Ave.	0.001	0.08
9. 665 S 2nd Court	0.001	0.04
10. 1269 N. Barlow St.	0.001	0.03
11. 288 S. Ivy St.	ND	0.10
12. 356 S. 23rd Ave.	ND	0.10
13. 2310 S. Cherry St.	ND	0.10
14. 530 S. 23rd Ave.	ND	0.10
15. 630 S. Emerald Loop	ND	0.08
16. 542 S. 6th Ave.	ND	0.07
17. 1045 S. Cherry St.	ND	0.07
18. 2330 S. Cherry St.	ND	0.06
19. 475 S. 23rd Ave.	ND	0.05
20. 2234 S. Dogwood St.	ND	0.05
Action Levels (mg/l)	**0.015**	**1.3**

5.2.6 Radionuclides

For community water systems serving less than 100,000 persons, radiological monitoring is generally limited to gross alpha activity. The MCL is set at 15 pico curies per liter (pCi/l). However if levels exceed 5 pCi/l monitoring must be expanded to include

Radium-226. Moreover, if the Radium-226 is found to exceed 3 pCi/l, the monitoring must also include Radium-228. A list of recent radiological monitoring and allowable MCLs are shown in Table 5-7.

The City through the City of Hillsboro (JWC and Cherry Grove treatment plants) is in compliance with all radionuclide standards both with respect to MCLs and sampling frequencies.

Table 5-7
City of Cornelius
Finished Water Radiological Sampling Results

Radioactive Contaminant	Sample pCi/l	MCL pCi/l	Sample Date	Sampling Frequency
	JWC System			
Gross Alpha	ND	15	2/99	Every 4 years
	Cherry Grove System			
Gross Alpha	ND	15	2/99	Every 4 years

ND - Below detectable limits (non-detect)

5.2.7 Microbiological Contaminants

All public water systems are required to provide protection against microbiological contamination. As done by the JWC and Cherry Grove plants the most common means for achieving these goals are the use of approved filtration technology and chemical disinfection. Under OAR 333-061-0032(1), the treatment process is required to remove (or inactivate) at least 99.9 percent (3-log) of the Giardia lamblia cysts and at least 99.99 percent (4-log) of viruses prior to delivery to the first customer. Hillsboro's water is treated in one of two ways: (1) use of direct filtration and chlorination at the Cherry Grove plant, and (2) coagulation, settling, filtration, and chlorination at the JWC plant. Both treatment methods have been determined to meet microbiological treatment standards.

- Monitoring for potential problems within the distribution system must also be conducted with monthly sampling for total and fecal coliforms. The City samples on a weekly basis. Given the population served by the City's distribution system, three samples are collected from different locations within the system every week and analyzed for Total and Fecal Coliforms.

Within the past five years, the City has had very good records with respect to microbial contamination within its system, with the only violations related to monitoring problems where not enough repeat samples were collected following routine positives within the City's distribution system. The City has also had a violation for incomplete reporting for their consumer confidence reporting.

While the number of repeat samples did not meet the standard, enough samples were taken to show that there was no health hazard present. Moreover, the follow up samples were negative. Most recent weekly sampling events for the City finished water indicated that Total and Fecal Coliforms were consistently absent.

Table 5-8
City of Cornelius
Distribution System and Supplier Reported EPA Violations

Month/Year	System	Type of Violation	Significant
October 2000	Cornelius, OR4100218	CCR Inadequate Reporting	No
July 2000	Cornelius, OR4100218	CCR Complete Failure to Report	No
March 2000	JWC, OR4100379	Monitoring, Routine/repeat (SWTR-Filter)	No
March 2000	Cherry Grove, OR4100985	Monitoring, Routine/repeat (SWTR-Filter)	No
January 2000	Cherry Grove, OR4100985	OCCT Install. / Demonstration, Lead & Copper Rule	
January 1999	Cornelius, OR4100218	Monitoring, Routine minor	No
May 1998	Cornelius, OR4100218	Monitoring, Routine minor	No
October 1997	JWC, OR4100379	Minor, Not enough repeat sampling	No
July 1997	Cherry Grove, OR4100985	Public Education, Lead & Copper Rule	
September 1996	Cornelius, OR4100218	Monitoring, Routine major	No
March 1996	Cornelius, OR4100218	Monitoring, Routine major	No

5.2.8 Disinfection By-Products

The use of oxidative disinfectants, particularly some form of chlorine, presents the potential for forming carcinogenic compounds known as trihalomethanes (THM) within the distribution system. These compounds, along with their precursors known as haloacetic acids (HAA), are of growing concern for public health. THMs result from a complex chemical reaction of chlorine-based compounds with various forms of natural organic matter derived from the source water. This reaction depends largely on contact time and type of organic matter present. The problem is of greater concern for those systems which use surface sources because of the greater amount of organic matter in the raw water. Currently, monitoring disinfection by-products (DBP) is required for only those systems serving in excess of 10,000 persons and is limited to measurements of only total trihalomethanes (TTHM). DBP monitoring is not required for the City. However, the City benefits from the City of Hillsboro's monitoring for these compounds within the Cherry Grove distribution system as part of an extended information collection process regarding DBP potential. It is also expected that within the next 4 years monitoring for DBPs will be required for all public water systems regardless of population served. The City of Hillsboro conducts quarterly monitoring for THMs and HAAs at one site in the Cherry Grove System and at 4 sites in the JWC system. The results of recent THM sampling are shown in Table 5-9.

THMs are regulated based on annual average concentrations. The residence time of the water entering the City's distribution system is short enough that DBPs have not been a problem to date and are not expected to be a problem under future regulations. Water in parts of the Hillsboro system, particularly reservoirs, has a much greater residence time and thus tends to develop measurable concentrations of THMs and HAAs. The Hillsboro system annual average total THMs have always been well below the current standard of 100 ug/l. The last rolling annual average total THM concentration for the JWC system is also shown in Table 5-9.

Table 5-9
City of Cornelius
Quarterly and Annual Average Total THM Sampling Results for the Hillsboro System and Cherry Grove SSFP

Sampling Date	2/01	5/01	8/01	11/01	Average
Sampling Site	TTHM (ug/l)	TTHM (ug/l)	TTHM (ug/l)	TTHM (ug/l)	TTHM (ug/l)
Cherry Grove SSFP	7.1	6.5	8.7	38.1	15.1
JWC Water Treatment Plant	20.8	27.7	26.7	62.1	34.3
24th Street Reservoir	26.8	38.9	37.5	55.1	39.57
142 SE Maple	NA	35.7	35.0	56.9	42.5
229th & Bennett	23.4	36.7	39.0	51.4	37.6

ND - Below detectable limits (non-detect)
Current MCL = 100 ug/l
Phase 1 MCL = 80 ug/l
Possible Phase 2 MCL = 40 ug/l

Under Phase 1 of the Disinfectants and Disinfection Byproducts Rule the total THM MCL will drop to 80 ug/l, a HAA5 MCL will be set at 60 ug/l, a MCL for bromate will be set at 10 ug/l, and a MCL for chlorite will be set at 1 mg/l. None of the Phase 1 MCLs should pose a problem for the JWC or Cherry Grove water systems.

However, Phase 2 may drop the TTHM MCL down to 40 ug/l as well as regulate THMs, HAAs, and inorganic DBPs individually. While the Hillsboro system should be able to meet these on an annual average basis, a past quarterly sampling event has exceeded 40 ug/l TTHM. Depending on how the Phase 2 rule is written, changes to the disinfection process and/or treatment to remove THM/HAA precursor material may be required. It should be noted that at this time any discussion of Phase 2 MCLs is speculation.

Noting that the City receives its water from the City of Hillsboro before most of the sampling stations and that the formation of THMs and HAAs is a function of residence time, THMs and HAAs in the City's system should be lower than those reported by the JWC. It should be anticipated that the City should begin monitoring for THMs and HAAs as the number of customers approaches 10,000 persons. It was previously noted that the City's Water Park reservoir has low turn over rates and consequently has high residence times. The potential exists for slightly higher concentrations of THMs and HAAs in the Water Park reservoir than the balance of the distribution system without operational changes in the reservoir.

5.2.9 Secondary Contaminants

As a wholesale water supplier to the City, the City of Hillsboro also monitors the secondary contaminants listed under OAR 333-061-0030(6). It is important to note that these compounds are not presently perceived as posing a significant potential threat to public health and require only voluntary routine monitoring under Oregon law. As such, their MCLs represent reasonable goals for drinking water quality. Results of recent sampling for these secondary contaminants, along with the associated maximum contaminant level goals (MCLGs), are shown in Table 5-10.

As indicated, the water quality for secondary contaminants is well below the recommended standards.

Table 5-10
City of Cornelius
Finished Water Secondary Contaminant
Sampling Results and Standards

	JWC System		Cherry Grove System		
Inorganic Contaminant	**Sample (mg/l)**	**Sample Date**	**Sample (mg/l)**	**Sample Date**	**MCLG (mg/l)**
Color	ND	1/99	ND	1/99	15.0 color units
Corrosively	NT	-	NT	-	Noncorrosive
Foaming agents	ND	1/99	ND	1/99	0.5
pH	7.29	1/99	6.77	1/99	6.5-8.5
Hardness (as CaCO3)	26	1/99	21	1/99	250
Odor	NT	-	NT	-	3 threshold odor number
Total dissolved solids	83	1/99	39	1/99	500
Aluminum	0.015	1/99	0.005	1/99	0.05-0.2
Chloride	3.9	1/99	3.2	1/99	250.0
Copper	0.0008	1/99	0.0065	1/99	1-1.30
Fluoride	ND	1/99	ND	1/99	2.0
Iron	ND	1/99	ND	1/99	0.3
Manganese	0.0005	1/99	ND	1/99	0.05
Silver	ND	1/99	ND	1/99	0.1
Sulfate	10	1/99	1.5	1/99	250.0
Zinc	ND	1/99	0.013	1/99	5.0

NT = Not Tested, neither of these have been a problem for Hillsboro.

5.2.10 Miscellaneous Standards

Distribution System Pressure

In addition to the various water quality criteria listed above, the State requires that each distribution system be operated so as to maintain a minimum pressure of 20 psi throughout the distribution network. Cornelius currently meets this standard, wherein typically providing service within its distribution system in excess of 60 to 70 psi. The City has lowered their system pressure in recent years to lower the potential for leaks in aging steel service lines in their distribution system. Lowering system pressure may have adverse effects on fire sprinkler and irrigation systems that may have had higher operational pressures when they were designed.

Water System Operator Training and Certification

The State also requires that the treatment plant and distribution system be operated and maintained by persons who have obtained an appropriate level of professional experience and competence. Cornelius Public Works Operation staff currently consists of a 1.75 FTE operator team, a water technician, and an Operations Manager. The City staff maintain state certifications of Water Distribution Operator Level I or Level II.

The City indirectly relies upon the City of Hillsboro to provide technical operations of the water supply system. Accordingly, the City of Hillsboro employs 12 distribution system operators and another 14 water treatment plant operators which are assigned to the Joint Water Commission, Barney Commission and Hillsboro Utilities Commission facilities. The 26 member operator staff maintains state certification ranging from Water Distribution Operator Level I through Level III, and Water Treatment Plant Operator Level I through Level IV.

Consumer Confidence Report

With increased public demand governing the "right-to-know", the U.S. EPA has begun requiring all community water systems to produce and distribute annual consumer confidence reports. The contents of these reports are intended to provide public documentation of: (i) the source of water purveyed; (ii) list of important definitions; (iii) levels of detected contaminants; (iv) information on other contaminants, including microorganisms; (v) compliance status with primary drinking water standards; (vi) variances and exceptions; and (vii) additional information on water quality. The deadlines for reporting began October 1, 1999 and extends annually on July 1 in the year 2000 and thereafter. The City distributed its first periodic annual report on June 30, 2000. As indicated in Table 5-8, the City has had a violation in consumer confidence reporting. It is unclear the exact cause of this reporting violation.

Cross-connection Identification and Control Program

The City, in conjunction with the City of Hillsboro, has an active program for identifying and controlling cross-connections between potable water and sanitary water systems. The City identifies backflow requirements and cross-connection issues during construction plan review. Backflow prevention devices are inspected by the Building Department for all potable water supply connections. The City Engineering Department inspects those devices that are not hooked to potable water (such as Fire and Irrigation). The City sends yearly reminder letters concerning cross-connection requirements, followed by second and third reminders if needed. If compliance with requirements still isn't reached, an Ordinance provides the City with the authority to turn off the customer's water.

Complaint Reporting and Response Program

The City has procedures for reporting and responding to consumer complaints. The typical complaint is routed to an individual on the City's staff for response. If the staff member is unable to answer the customers question or address the complaint over the phone, a field inquiry may be requested to provide on-site assistance. These activities are recorded in a computerized database, with complaints being identified by meter/account number and cross-referenced by address. The City typically receives about 1 to 5 calls per month with customers requesting assistance on a wide array of issues.

5.3 Future Regulatory Changes

As a result of the 1996 Amendments to the federal Safe Drinking Water Act (SDWA), the EPA has been in the process of promulgating several new water quality standards and revised monitoring criteria for all community water systems. Over the years, the EPA has shifted its emphasis from the "25 contaminants every 3 years" approach established under the 1986 Amendments to a focus on microbial contaminants and improved minimization of risk-based human health criteria. Future regulations from the U.S. EPA, which may affect the monitoring requirements for the City and its wholesale suppliers, are shown in Table 5-11.

These new rules are discussed below with some of the material being taken from related EPA fact sheets.

5.3.1 Stage 1 Disinfection By-Product Rule (DBPR)

The final Stage 1 Disinfectants and Disinfection Byproducts Rule applies to community water systems and non-transient non-community systems, including those serving fewer than 10,000 people, that add a disinfectant to the drinking water during any part of the treatment process. The final Stage 1 Disinfectants and Disinfection Byproducts Rule includes the following key provisions:

- ❑ Maximum residual disinfectant level goals (MRDLGs) for chlorine (4 mg/L), chloramines (4 mg/L), and chlorine dioxide (0.8 mg/L);

- Maximum contaminant level goals (MCLGs) for trihalomethanes (THMs) and haloacetic acids (HAAs), including chloroform (0 mg/L), bromodichloromethane (0 mg/L), dibromochloromethane (0.06 mg/L), bromoform (0 mg/L), dichloroacetic acid (0 mg/L), trichloroacetic acid (0.3 mg/L), bromate (0 mg/L), and chorite (0.8 mg/L);

- MRDLs for three disinfectants (chlorine (4.0 mg/L), chloramines (4.0 mg/L), and chlorine dioxide (0.8 mg/L));

- Maximum contaminant levels (MCLs) for total trihalomethanes (0.080 mg/L) and haloacetic (HAA5) acids (0.060 mg/L), including individual limits on chlorite (1.0 mg/L) and bromate (0.010 mg/L); and

- A treatment technique for removal of DBP precursor material.

In Oregon, compliance with the Stage 1 DBP rule is currently set for January 2002 for systems over 10,000 customers and January 2004 for system with fewer than 10,000 customers.

Table 5-11
City of Cornelius
Anticipated Regulations, Current Schedule Targets, and Parameter(s) Under Consideration

	Action	Date	Parameter(s)	Comments
Long Term 2 ESWTR	Proposed Promulgated Effective	May 2001 May 2002 May 2005	Turbidity Cryptosporidium Giardia Viruses	Would apply only if GUI sources are utilized.
D/DBP Stage II	Proposed Promulgated Effective	Same as LT2 ESWTR	TTHMs HAA6 and HAA9 Haloacetonitriles Aldehydes Total brominated DBPs Total halogenated organics Bromodichloromethane Bromoform Bromodichloroacetic Acid Chlorate Cyanogen Chloride Formaldehyde	Possible further restriction on DBP MCLs or monitoring protocol.
Arsenic	Proposed Promulgated Effective	Jan. 2000 Jan. 2001 Jan. 2004	Arsenic	MCL expected between 0.002-0.02 mg/L
Radon	Proposed Promulgated Effective	Nov. 1999 Nov. 2000 Nov. 2003	Radon	MCL of 300 pCi/L

Table 5-11 (Cont'd)
City of Cornelius
Anticipated Regulations, Current Schedule Targets, and Parameter(s) Under Consideration

	Action	Date	Parameter(s)	Comments
Radionuclides	Promulgated Effective	Dec. 2000 Dec. 2003	Gross Alpha Particles Beta Particles Photon Emitters Radium-226, -228	
Sulfate	Decision to Regulate	Aug. 2001	Sulfate	USEPA and CDC health effects research required prior to final rule issuance.
Source Water Protection Rule	Effective	Aug. 2003	None	Requires source water boundary delineation and identification of susceptibility for contamination based on State Source Water Quality Assessment
Chemical Monitoring Reform (CMR) and Alternate Monitoring Guidelines (AMG)	*CMR* Proposed Promulgated Effective *AMG* Promulgated Effective	 Nov. 2000 April 2002 Jan. 2005 Nov. 2000 October 2003	None	Would revise monitoring requirements for Phase II and V contaminants excluding nitrate/nitrite. Both rules may be combined into single rule.

5.3.2 Interim and Long Term 1 Enhanced Surface Water Treatment Rule

Both the interim and long-term enhanced surface water treatment rules will bring forth tighter restrictions and monitoring for microorganisms and turbidity, including individual filter monitoring. This two-stage rule will include specific monitoring standards for Cryptosporidium and possibly higher percent removals for Giardia and viruses. These rules may also directly affect the JWC's treatment process and may require facility changes to accommodate increased disinfection contact times.

While the Stage 1 Disinfectants and Disinfection By-Products Rule applies to systems of all sizes, the Interim Enhanced Surface Water Treatment Rule (IESWTR) only applies to systems serving 10,000 or more people. The Long Term 1 Enhanced Surface Water Treatment Rule (LT1ESWTR), promalgated in the fall of 2001, will strengthen microbial controls for small systems i.e., those systems serving fewer than 10,000 people. The rule will also prevent significant increase in microbial risk where small systems take steps to implement the Stage 1 Disinfectants and Disinfection By-Products Rule.

EPA believes that the rule will generally track the approaches in the Interim Enhanced Surface Water Treatment Rule for improved turbidity control, including individual filter monitoring and reporting. The rule will also address disinfection profiling and benchmarking. The Agency is considering what modifications of some large system requirements may be appropriate for small systems.

5.3.3 Long Term 2 Enhanced Surface Water Treatment Rule and Stage 2 Disinfectants and Disinfection By-Products Rule

The SDWA, as amended in 1996, requires EPA to finalize a Stage 2 Disinfectants and Disinfection Byproducts Rule by May 2002. Although the 1996 Amendments do not require EPA to finalize a Long Term 2 Enhanced Surface Water Treatment Rule (LT2SWTR) along with the Stage 2 Disinfectants and Disinfection Byproducts Rule, EPA believes it is important to finalize these rules together to ensure a proper balance between microbial and DBP risks.

EPA began discussions with stakeholders in December 1998 on the direction for these rules. EPA proposed these rules in September 2000. These rules are expected to be finalized in May 2002. The intent of the rules is to provide additional public health protection, if needed, from DBPs and microbial pathogens.

Stage 2 will revise the existing MCL for TTHMs and establish new MCLs for additional DBPs, including halogenated acetic acids (HAAs), bromate, and chlorite. A list of those new standards is shown in Table 5-12.

Table 5-12
City of Cornelius
Stage 1 and 2 Disinfection By-Products (DBP) Contaminant Standards

Compound	Stage 1 MCL MCL (μg/L)	Stage 2 MCL (μg/L)	Compliance Based On
TTHM	80.00	*40.0	Annual Average
HAA5	60.00	*30.0	Annual Average
Bromate	10.00	--	Annual Average
Chlorite	1.0 mg/L	--	Monthly Average

** These values have been discussed early in the Stage 2 planning process. The final rule could vary substantially from these concentrations.*

In order to limit the possible production of DBPs, new standards have been established for disinfection residuals at the point of entry to the distribution system. A list of residual disinfection criteria is shown in Table 5-13.

Table 5-13
City of Cornelius
Residual Disinfection Criteria

Compound	MRDLs (mg/L)	Compliance Based On
Chlorine	4.0	Annual Average
Chloramines	4.0	Annual Average
Chlorine Dioxide	0.8	Daily Samples

Note: MRDL = Maximum Residual Disinfectant Level (i.e., maximum allowable level at the point of entry to the distribution system.) Not MCL, since disinfectants are not considered contaminants.

The rules will also establish enhanced coagulation requirements for precursor removal, which is not addressed by current standards. A key issue for future regulation of DBPs is the degree of control that will be possible while maintaining or strengthening disinfection processes that are necessary for protection against microbial contamination. Although the U.S. EPA has agreed that the new DBP standards are needed, microbial protection will not be compromised in order to achieve DBP reductions.

The City's interest in stage 2 DBP standards will be met by appropriate modification (if necessary) at the JWC's treatment plant. JWC, as the City's wholesale water supplier, is tracking the progress of the Stage 2 rule making process and has already started to investigate methods of reducing TTHMs.

5.3.4 Drinking Water Contaminant Candidate List

For large systems and certain smaller systems, the Unregulated Contaminant Rule requires monitoring of up to 30 unregulated contaminants for inclusion in the Drinking Water Contaminant Candidate List (DWCCL). The intent of this rule is to support identification of contaminants in the National Contaminant Occurrence Database. The new rule will include no more than 30 contaminants for required monitoring. From this list, the EPA will decide whether to regulate at least five contaminants from the DWCCL. The City of Hillsboro presently participates in the voluntary monitoring of secondary contaminants.

5.3.5 Radon and Radionuclides

The Radon Rule was proposed in November 1999. The final rule for radionuclides was adopted in December 2000 with regulation expected in early 2002. Table 5-14 summarizes the anticipated MCLs for radon and radionuclies contaminants.

Table 5-14
City of Cornelius
Anticipated Proposed Radionuclide Rule MCLs

Contaminant	MCLs
Radium – 226	5 pCi/L
Radium – 228	5 pCi/L
Radon – 222	300 pCi/L
Uranium	30 µg/L
Gross Alpha Particles	15 pCi/L
Gross Beta and Photon Emitters	4 mrem/yr

mrem/yr = millirem effective dose equivalent per year

The new rule for radon includes discussion for the preparation of "multi-media mitigation" (MMM) plans. The plans are intended to address measures for reducing the total exposure of customers to radon, including inhalation and ingestion. Under the new rule, creation of an approved MMM plan would provide a variance for the new radon-222 standard of 4000 pCi/l. The requirements for these plans are still being debated. Notwithstanding, the remaining new standard for radionuclides is not thought to pose any problems in the future.

5.3.6 Arsenic Rule

Efforts to set a revised MCL for arsenic have been ongoing for nearly twenty years. The 1996 SDWA required a proposed rule by January 2000 and a final rule one-year later. The proposed rule was presented June 2000 and the final rule was presented in January 2001. The final rule for arsenic was published in November 2001. EPA published the final MCL of 0.010 mg/L for arsenic.

5.3.7 Sulfate Rule

Currently, sulfate is listed under the Secondary Drinking Water Regulations for aesthetic reasons of taste. Under the 1996, SDWA amendments the USEPA and Centers for Disease Control are required to conduct joint sulfate health effects studies. A sulfate MCLG was last proposed in December 1994 at 500 mg/L.

Section 6
Capital Improvement Program

6.1 Capital Improvement Program

This section provides a detailed description of the Capital Improvement Program (CIP) that has been developed utilizing the hydraulic model described in Section 4 and the planning criteria from Section 3. From the model analysis, City staff experience, and distribution system improvements previously identified by City staff, a series of capital improvements have been identified to address current and future water demand conditions and to sustain system reliability. The capital improvement projects have been separated into the following categories:

- Operation / Maintenance
- Source / Intertie
- Distribution Pipelines
- Storage
- Pumping
- Recommended Studies

The recommended capital improvements included in this master plan report focus on the needs of the City water system alone. Because the City purchases water wholesale from the City of Hillsboro, capital improvements surrounding source development and water quality, unless they are distribution system specific, are the responsibility of the City of Hillsboro.

The City CIP is summarized in Table 6-7. This tabular summary provides total estimated project cost, a brief description of each project, as well as prioritizes each capital improvement based on recommended year of implementation. Project priorities should be considered flexible in order to accommodate concurrent construction during other street opening projects, budgetary constraints, specific development projects, and other factors that may affect project implementation. Along with this summary, Exhibit 6-1 identifies the location of each project.

6.2 Planning Level Opinions of Probable Cost

Planning level construction costs of the projects herein are estimated assuming a traditional public works procurement process of design, bidding, award and construction by a licensed contractor using commonly accepted means and methods. 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. Current local market bids and ENR reference data were used for cost estimates in this study. The estimated cost of the facilities should be expected to change along with the accuracy of the estimate as a project proceeds into preliminary and final design. Planning level cost estimates are typically within the range of plus 50 percent to minus 30 percent of the average of the contractors bids after adjustments for changes in the ENR index and project scope. These estimates are based on year 2004 dollars and no allowance has been made for inflation through future years so that all cost can be viewed at present worth dollars.

Total capital costs for each project are comprised of several components. These components are the directly estimated construction cost, an allowance for contingencies, and an allowance for in-house engineering, construction management, and administrative and legal costs. The allowance for contingencies covers items such as variations in the project configuration, which are developed during preliminary design and final design, unforeseen site conditions encountered during construction, and reasonable project changes during construction. The contingency allowance does not include major project scope additions or additional costs resulting from permit mitigation requirements such as wetlands enhancement.

Table 6-1 presents unit costs used in this study to develop cost estimates for each capital improvement project. These estimates involve capital and engineering costs only. Property easements or land acquisition and maintenance costs are not included in Table 6-1.

Table 6-1
City of Cornelius
Capital Improvement Program Estimated Unit Costs

Pipeline Installation	**Diameter**	**Cost per Lineal Foot**
(Assumes Class 52 ductile iron for all pipes 6-inch and larger. Cost includes pipes, valves, fittings, installation, restoration, service transfers, engineering, and contract administration.)	4-inch	$50
	6-inch	$60
	8-inch	$80
	10-inch	$100
	12-inch	$120
Reservoirs	**Capacity**	**Cost per Gallon Cap.**
(Assumes 30-ft tall concrete reservoirs set at appropriate elevation. Costs do not include land acquisition, unusual site work, transmission lines, pump stations, or pressure reducing stations.)	0.5 mil gallons	$1.10
	1.0 mil gallons	$0.90
	2.0 mil gallons	$0.80
Pump Stations	**Installed HP**	**Cost per HP**
(Assumes concrete masonry construction. Costs do not include land acquisition, unusual site work, or transmission lines.)	50	$3,000
	100	$2,500
	300	$2,000
	500	$1,800
Expand Pump Station	**Installed HP**	**Cost per HP**
(Assumes station in place and only additional pumps and minor valving being installed.)	50	$1,500
	100	$1,250
	300	$1,000
	500	$900
Pressure Reducing Valves	**Pipe Size**	**Cost per Installation**
(Assumes a concrete vault, and related piping and valves.)	8-inch	$50,000
	12-inch	$75,000
Production Well Development	**Capacity**	**Cost per Gallon**
(Assumes 1 MGD well and pump house.)	1.0 mgd	$0.30 to 0.50/gallon

It is assumed that all 6-inch and 8-inch pipelines (as well as larger) will be bid to a contractor and follow the typical design, bid, build procurement process and the opinions of probable cost reflect this.

6.3 Operations / Maintenance

The capital improvements for operations / maintenance are limited to meter replacement. Meter replacement is an ongoing program targeting a 20-year change out cycle. A strict remove and replace policy for all flow meters is in place. The cost for the meter replacement program is indicated in Table 6-2.

Table 6-2
City of Cornelius
Recommended Capital Improvement Projects - Operations / Maintenance

Project ID	Description	Opinion of Probable Project Cost
M001	Meter Replacement	$80,000
M002	PRV Backflow Device – S. 12th Avenue	$30,000

It is recommended that the City adopt an aggressive policy regarding pipeline replacement. The City has a number of cast iron, steel, and galvanized steel pipelines in place. As the system ages, unlined cast iron and steel pipelines can become hydraulically restrictive resulting in reduced capacity and operational efficiency. Most susceptible to this is small diameter galvanized pipes and unlined cast iron fittings. Most of the City's cast iron pipe is believed to be lined although the fittings on the cast iron pipe appear to be unlined.

Moreover, the aging steel pipelines in the City's distribution system are subject to high rates of corrosion and consequently are subject to leakage. Leaking steel pipelines are believed to account for a large portion of the City's unaccounted for water. All remaining steel pipelines in the City's distribution system have been identified for replacement in the pipeline section of the capital improvement plan. The high priority for the replacement of steel pipelines is being driven by fire flow capacity issues and growth needs as well as operational and maintenance issues. All pipelines are listed in Table 6-3. For funding purposes, the portion of the pipeline replacement cost attributed to direct operation and maintenance replacement is indicated as well as the costs associated with growth. For example, if a 6-inch existing steel line is replaced with a new 8-inch, the first 6-inches are assumed to be O&M replacement costs while the last two-inches are assumed to be system development costs bringing additional flows for growth and fire flow requirements. The O&M cost breakdown is shown in Table 6-7.

6.4 Source / Intertie

The City relies on the City of Hillsboro to provide water. As discussed in Section 2, with the completion of the 72-inch NTL2 line the City receives all of its water from the JWC WTP through four new pressure reducing valve stations. This provides the City with a long-term, reliable source/transmission system. However, should the 72-inch NTL2 be out of service, the City would have to utilize interties to receive water back feed from the JWC plant. As discussed in Section 2, the City has two interties now that the NTL2 line is completed. A 12-inch intertie serves the eastern portion of the City from Hillsboro and an 8-inch intertie will serve the western portion of the City from Forest Grove. A third emergency intertie is recommended on the west side of the distribution system either on TV Highway or N. Holladay Street.

An emergency water supply study is recommended to look at options for an emergency supply for the City. Options might include development of wells and purchase of existing irrigation water rights.

6.5 Distribution Pipelines

Over 7.1 miles of distribution pipeline have been identified in this CIP. The recommended distribution pipelines, described in Section 3 of the planning criteria, are needed to transport the peak day, peak hour and fire flow water demands through the City's water distribution system. The improvements in many instances replace existing pipelines subject to corrosion and reduced capacity, while meeting the need to increase capacity of the pipeline for growth or fire flow needs. The distribution system capital improvements are presented in Table 6-3 and Exhibit 6-1.

Implementation priorities for the pipeline projects are indicated in Table 6-7. The highest priority has been placed on replacement of steel pipelines first. However, this has also been balanced with the priorities of meeting required fire flows.

Although not identified as specific projects, the 12-inch mainlines on the north and south sides of TV Highway are intended to extend eastward as annexations occur and the city grows to the east. North/south cross ties to these two lines should be 8-inch and spaced 1,400-1,800 feet apart.

Table 6-3
City of Cornelius
Recommended Capital Improvement Projects - Distribution

Project ID	Description	Project Cost Estimate
P001	Replace existing 6-inch asbestos cement pipe with new 10-inch on S. Linden Rd between S. 8th Ave. and S. 10th Ave. & S. Magnolia (1110 ft)	$111,000
P002	Replace existing 4-inch steel pipe with new 8-inch on N. Barlow between N. 19th and N. 14th Avenues (1,230 feet)	$98,400
P003	Replace existing 6-inch steel pipe with new 8-inch on N. Clark St. between N. 10th and N. 14th Ave. (1,230 feet)	$98,400
P004	Replace existing 6-inch steel pipe with new 8-inch on N. 13th Ave. between N. Clark and N. Fremont St. (625 feet)	$50,000
P005	Replace existing 8-inch asbestos cement pipe with new 12-inch on N. 10th Ave. from the intersection of N. Holladay St. south (280 ft)	$33,600
P006	Replace existing 6-inch cast iron pipe with new 12-inch on N. 4th Ave. between N. Adair St. and N. Davis (1,000 feet)	$120,000
P007	Replace existing 6-inch steel pipe with new 12-inch on S. 12th Ave. from Adair to S. Dogwood St. (1,550 feet)	$186,000
P008	Replace existing 6-inch steel pipe with new 12-inch on S. 12th Ave from S. Dogwood St. to S. Fawn St. (510 feet)	$61,200
P009	Replace existing 4-inch steel with new 12-inch on N. 17th from N. Barlow to N. Clark St. (480 feet)	$57,600

Table 6-3 (continued)
City of Cornelius
Recommended Capital Improvement Projects – Distribution

Project ID	Description	Project Cost Estimate
P010	Replace existing 2-inch galvanized steel pipe with new 12-inch on N. Clark and N. 16th between N. Davis and N. 17th Avenue (630 feet)	$75,600
P011	Install new 12-inch on N. Clark from Water Park to N. 17th Avenue (270 feet)	$32,400
P012	Replace existing 4-inch steel pipe with new 8-inch on N. Barlow from Water Park to N. 17th Avenue (470 feet)	$37,600
P013	Replace existing 4-inch pipe with new 12-inch on N. 19th Ave. from Holladay Street north 456 feet (1250 feet)	$150,000
P014	Replace existing 4-inch cast iron pipe with new 8-inch pipe on Baseline St. from N. 1st Ave. to N. 4th Avenue (1,040 feet)	$83,200
P015	Replace existing 8-inch cast iron with new 12-inch from Basco PRV to Water Park reservoir (970 feet)	$116,400
P016	Replace existing 6-inch steel pipe with new 8-inch on Baseline Rd. from N. 14th Ave. to N. 19th Avenue (1,620 feet)	$129,600
P017	Replace existing 6-inch steel pipe with new 8-inch on N. 14th Avenue from Baseline to N. Clark St. (930 feet)	$74,400
P018	Replace existing 6-inch steel pipe with new 8-inch on S. Alpine from S. 8th Avenue to S. 12th Avenue (1,260 feet)	$100,800
P019	Replace existing 4-inch steel pipe with new 8-inch on S. Cherry from S. 12 Avenue to S. 16th Avenue (1,280 feet)	$102,400
P020	Replace existing 6-inch steel pipe with new 8-inch on S. 16th Avenue from S. Alpine to S. Dogwood Street (940 feet)	$75,200
P021	Replace existing 4-inch steel pipe with new 8-inch on S. Cherry from S. 8th Avenue to S. 12th Avenue (1,260 feet)	$100,800
P022	Replace existing 6-inch steel pipe with new 12-inch on S. Dogwood from S. 16th Avenue to S. 18th Avenue (480 feet)	$57,600
P023	Replace existing 4-inch steel pipe with new 6-inch on S. 11th Ave. from S. Dogwood St. to S. Fawn St. (510 feet)	$30,600
P024	Replace existing 4-inch steel pipe with new 6-inch on S. 9th and S. Fawn St. from S. Dogwood St. to S. 10th Ave. (770 feet)	$46,200
P025	Replace existing 4-inch steel pipe with new 6-inch in alley north of S. Ginger St. between S. 8th and S. 10th Ave (560 feet)	$33,600
P026	New 12-inch on N. 10th Avenue from N. Holladay to N. Spiesschaert Rd. (710 feet)	$85,200
P027	New 12-inch on N. 29th Ave. north from Oregon Electric Railway to Council Creek (1,560 feet)	$187,200
P028	Replace existing 2-inch galvanized with interim 2-inch schedule 80 PVC on SW 345th Ave. South From TV Hwy (1,700 feet)	$70,000
P029	Replace existing 2-inch schedule-80 PVC with 12-inch on SW 345th Avenue south from TV Highway (2,240 feet)	$268,800
P030	New 10-inch between SW 345th Avenue and S. Dogwood Street (990 feet)	$99,000
P031	New 12-inch on S. 26th Ave south from S. Ginger Street (1,700 feet)	$204,000
P032	New 12-inch on S. 20th Ave. south from S. Ginger St. (1,110 feet)	$132,000
P033	Replace existing 4-inch steel pipe with new 12-inch on N. 17th Avenue from N. Adair to N. Barlow St. (410 feet)	$49,200
P034	Replace existing 6-inch steel pipe with new 8-inch on S. Fawn from S. 10th to S. 12th Avenue (700 feet)	$56,000

Project ID	Description	Project Cost Estimate
P035	Replace existing 2-inch galvanized with 4-inch on S. Elder Ct. from S. 15th Avenue (260 feet)	$13,000
P036	Replace existing 6-inch steel pipe with new 8-inch on N. 14th from N. Clark to N. Fremont Street (820 feet)	$65,600
P037	Replace existing 2-inch galvanized iron pipe with new 6-inch on N. 15th south from N. Davis St. (220 feet)	$13,200
P038	Replace existing 6-inch steel pipe with new 8-inch on S. 10th from S. Heather St. to S. Dogwood St. (1000 feet)	$80,000
P039	New 10-inch between SW 345th Ave. and S. Alpine St. (990 feet)	$99,000
P040	Replace existing 6-inch cast iron pipe with new 8-inch on S. Ivy between S. 12th and S. "14-½" (830 feet)	$66,400
P041	Replace existing 12-inch asbestos cement pipe with new 12-inch on N. 9th Ave. from N. Adair to alley (220 feet)	$26,400
Sub-Total		**$3,577,600**

Table 6-3 (continued)
City of Cornelius
Recommended Capital Improvement Projects – Distribution

6.6 Storage

In potable water distribution systems, storage requirements are comprised of several different components including equalization, fire flow, and emergency storage volumes. Cornelius currently has 1.5 million gallons (MG) of storage at the Water Park reservoir site. Using the storage planning criteria and water use projections described in Section 4, the City currently requires an additional 2.0 MG of storage and an estimated total of 5.33 MG of storage by the year 2024. The construction of a second 2.0 MG reservoir and related pump station at the Water Park reservoir site is recommended immediately. Also recommended are a seismic evaluation of the existing reservoir and an evaluation of the site and existing pump station prior to the construction of a new reservoir.

For future estimated growth north of Council Creek, a new 2.0 MG reservoir, denoted: "North Reservoir", is recommended by 2014. The actual need for this reservoir will depend on if estimated growth actually occurs.

Table 6-4
City of Cornelius
Recommended Capital Improvement Projects – Storage

Project ID	Description	Project Cost Estimate
S001	Water Park Reservoir seismic evaluation	$ 20,000
S002	Water Park pump station and site evaluation	25,000
S003	Water Park reservoir cleaning, external repair, and painting	30,000
S004	2.0 MG Water Park Reservoir	1,600,000
S005	2.0 MGD North Reservoir	1,600,000
Sub-Total		**$ 3,275,000**

6.7 Pumping

The only pump station present in the Cornelius distribution system is at the existing Water Park reservoir. These pumps were inspected by a representative from the pump manufacturer in 1999 and appear to be in relatively good shape. However, it is recommended that the pump station be modified with a switch gear so that emergency power can be easily connected in the event of an extended power outage. It is also recommended that local PLC controls be modified to make the pump station completely automatic such that all pumps will turn on during emergency demand periods (such as large fires). It is recommended that the City increase the amount of pumping from the station into the distribution system with either increased pumping duration or increased volume during the same period of time to increase the turnover of water in the reservoir. This can be accomplished with operational changes to existing equipment in the pump station.

Since the recommended 2.0 MG reservoir at the Water Park site will be a ground level reservoir, a pump station will be necessary to boost this water back into the distribution system. The pump station is recommended with a similar configuration as the existing pump station – two (2) day pumps and one (1) fire pump. The day pumps should be rated at 20 percent of the capacity of the reservoir during the current pumping period (12 hours). Thus, the two (2) day pumps should be capable of 400 gpm each and the fire pump should be capable 1,500 gpm at a total dynamic head of 175 feet. The total horsepower requirements are approximately 135 HP. The new pump station should be equipped for connection to an emergency power source.

Table 6-5
City of Cornelius
Recommended Capital Improvement Projects – Pumping

Project ID	Description	Project Cost Estimate	
PS001	Install switch gear in existing Water Park PS.	$	15,000
PS002	New Water Park Reservoir 2,500 gpm/135 HP Pump Station		300,000
Sub-Total		$	**315,000**

6.8 Recommended Studies

The Oregon Health Division requires that each water system have a current water master plan. The OHD does not specify what this period is to maintain a current master plan. However, the State of Washington requires their systems to have their plan updated every 5 years. Using this as a guide, a revised master plan is anticipated in the years 2009, 2014, and 2019.

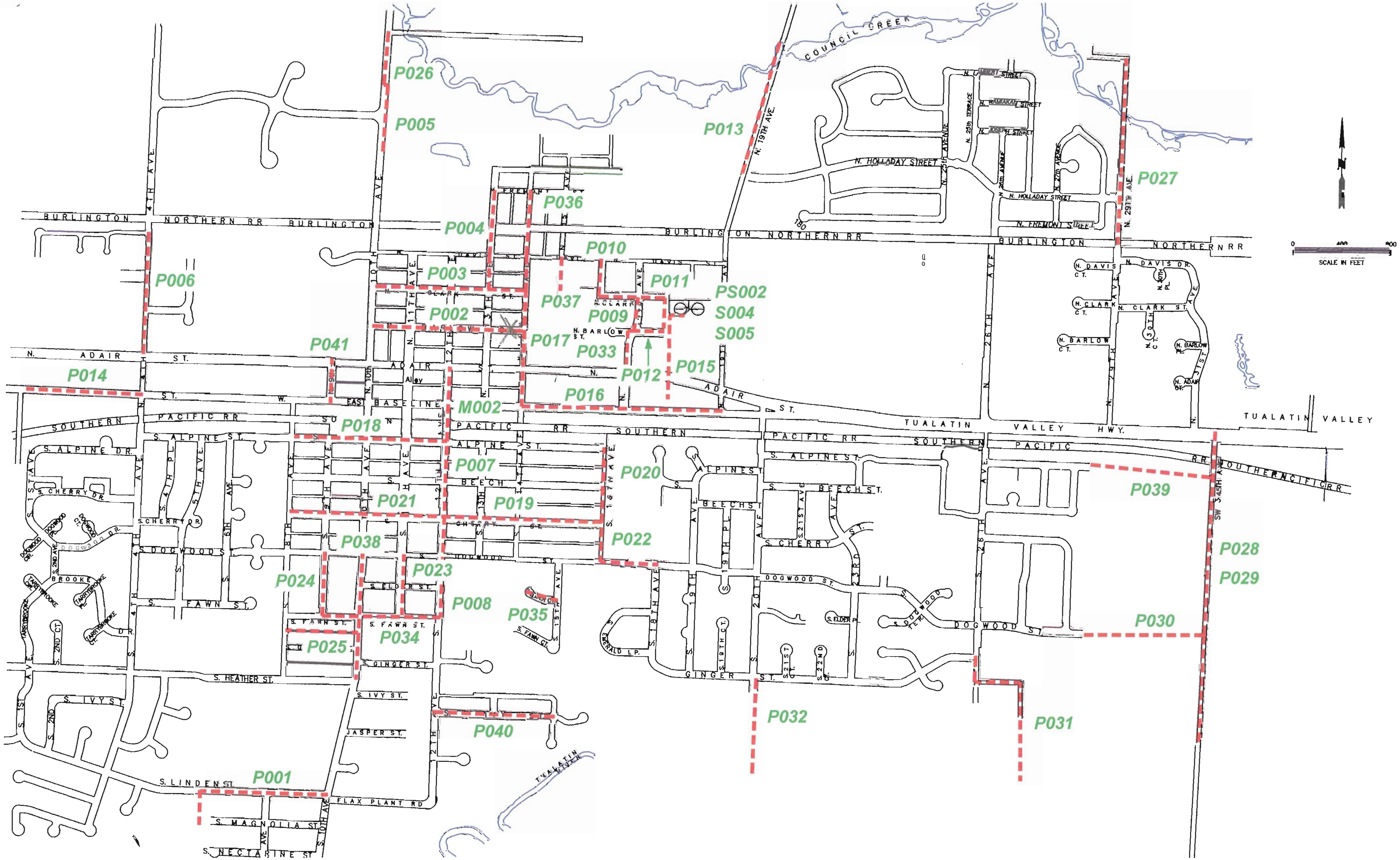
To reduce lost and un-accounted for water, a thorough leak detection survey of the distribution system is recommended. An alternative water supply study is recommended to investigate other potential water supply sources. These studies are summarized in Table 6-6.

Table 6-6
City of Cornelius
Recommended Capital Improvement Projects – Studies

Project ID	Description	Project Cost Estimate
R001	Water Master Plan 2009	$ 45,000
R002	Water Master Plan 2014	50,000
R003	Water Master Plan 2019	55,000
R004	Leak Detection Surveys	37,000
R005	Emergency Water Supply Options Study	25,000
Sub-Total		**$ 212,000**

Table 6-7
City of Cornelius
Capital Improvement Program

CIP No.	Project	Length (feet)	Diameter (inches)	Project Need	Est.Total Cost in 2004 $	O&M Costs	SDC Eligible Costs	Anticipated Implementation Period				
								2004	2005-2008	2009-2012	2013-2017	2018-2024
Operations / Maintenance												
M001	Meter Replacement			O&M	$80,000	$80,000	$0	$4,000	$16,000	$20,000	$20,000	$20,000
M002	PRV Backflow Device - S. 12th Avenue			O&M	$30,000	$30,000	$0	$30,000				
Distribution Pipelines												
P001	10-inch on S. Linden Rd between S. 8th Ave. and S. 10th Ave. and S. Magnolia	1,110	10	Fire flow	$111,000	$66,600	$44,400	$111,000				
P002	8-inch on N. Barlow St. between N. 10th and N. 14th Avenue	1,230	8	O&M/Fire flow	$98,400	$49,200	$49,200	$98,400				
P003	8-inch on N. Clark St. between N. 10th and N. 14th Ave.	1,230	8	O&M/Fire flow	$98,400	$73,800	$24,600		$98,400			
P004	8-inch on on N. 13th Ave. between N. Clark and N. Fremont St.	625	8	O&M/Fire flow	$50,000	$37,500	$12,500			$50,000		
P005	12-inch on N. 10th Ave. from intersection of N. Holladay south 280 feet	280	12	O&M/Fire flow	$33,600	$16,800	$16,800		$33,600			
P006	12-inch on N. 4th Ave. between N. Adair St. and N. Davis	1,000	12	Fire flow	$120,000	$60,000	$60,000	$120,000				
P007	12-inch on S. 12th Ave. from Adair to S. Dogwood St.	1,550	12	O&M/Fire flow	$186,000	$93,000	$93,000		$186,000			
P008	12-inch on S. 12th Ave from S. Dogwood St. to S. Fawn St.	510	12	O&M/Fire flow	$61,200	$30,600	$30,600		$61,200			
P009	12-inch on N. 17th from N. Barlow to N. Clark St.	480	12	O&M/Fire flow	$57,600	$19,200	$38,400		$57,600			
P010	12-inch on N. Clark and N. 16th between N. Davis and N. 17th Avenue	630	12	O&M/Fire flow	$75,600	$12,600	$63,000		$75,600			
P011	12-inch on N. Clark from Water Park to N. 17th Avenue	270	12	Fire flow	$32,400	$0	$32,400		$32,400			
P012	8-inch on N. Barlow from Water Park to N. 17th Avenue	470	8	O&M/Fire flow	$37,600	$18,800	$18,800		$37,600			
P013	12-inch on N. 19th Ave. from Holladay St. north 456 feet	1,250	12	Growth	$150,000	$0	$150,000					$150,000
P014	8-inch pipe on Baseline St. from N. 1st Ave. to N. 4th Avenue	1,040	8	O&M/Fire flow	$83,200	$41,600	$41,600					$83,200
P015	12-inch from Basco PRV to Water Park reservoir	970	12	Capacity	$116,400	$77,600	$38,800		$116,400			
P016	8-inch on Baseline St. from N. 14th Avenue to N. 19th Avenue	1,620	8	O&M/Fire flow	$129,600	$97,200	$32,400			$129,600		
P017	8-inch on N. 14th Avenue from Baseline to N. Clark St.	930	8	O&M/Fire flow	$74,400	$55,800	$18,600		$74,400			
P018	8-inch on S. Alpine from S. 8th Avenue to S. 12th Avenue	1,260	8	O&M/Fire flow	$100,800	$75,600	$25,200		$100,800			
P019	8-inch on S. Cherry from S. 12 Avenue to S. 16th Avenue	1,280	8	O&M/Fire flow	$102,400	$51,200	$51,200		$102,400			
P020	8-inch on S. 16th Avenue from S. Alpine to S. Dogwood Street	940	8	O&M/Fire flow	$75,200	$56,400	$18,800			$75,200		
P021	8-inch on S. Cherry from S. 8th Avenue to S. 12th Avenue	1,260	8	O&M/Fire flow	$100,800	$50,400	$50,400		$100,800			
P022	12-inch on S. Dogwood from S. 16th Avenue to S. 18th Avenue	480	12	O&M/Fire flow	$57,600	$28,800	$28,800		$57,600			
P023	6-inch on S. 11th Ave. from S. Dogwood St. to S. Fawn St.	510	6	O&M/Fire flow	$30,600	$20,400	$10,200			$30,600		
P024	6-inch on S. 9th and S. Fawn St. from S. Dogwood Ave. to S. 10th Ave.	770	6	O&M/Fire flow	$46,200	$30,800	$15,400			$46,200		
P025	6-inch in alley north of S. Ginger St. between S. 8th and S. 10th Avenues	560	6	O&M/Fire flow	$33,600	$22,400	$11,200			$33,600		
P026	12-inch on N. 10th Ave. from N. Holladay to N. Spiesschaert Rd.	710	12	Growth	$85,200	$0	$85,200				$85,200	
P027	12-inch on N. 29th Ave. north from Oregon Elect. Railway to Council Creek	1,560	12	Growth	$187,200	$0	$187,200				$187,200	
PO28	2-inch interim on SW 345th Ave. south from TV Hwy	1,700	2	O&M	$70,000	$70,000	$0	$70,000				
P029	12-inch on SW 345th Avenue south from TV Highway	2,240	12	Growth	$268,800	$0	$268,800				$268,800	
P030	10-inch between SW 345th Ave. and S. Dogwood	990	10	Growth	$99,000	$0	$99,000				$99,000	
P031	12-inch on S. 26th Ave. south from S. Ginger St.	1,700	12	Growth	$204,000	$0	$204,000					$204,000
P032	12-inch on S. 20th south from S. Ginger St.	1,100	12	Growth	$132,000	$0	$132,000					$132,000
P033	12-inch on N.17th from N. Adair to N. Barlow	410	12	O&M/Fire flow	$49,200	$16,400	$32,800		$49,200			
P034	8-inch on S. Fawn from S. 10th to S. 12th	700	8	O&M/Fire flow	$56,000	$42,000	$14,000		$56,000			
P035	4-inch on S. Elder Ct. from S. 15th	260	4	O&M/Fire flow	$13,000	$6,500	$6,500		$13,000			
P036	8-inch on N. 14th from N. Clark to N. Fremont	820	8	O&M/Fire flow	$65,600	$49,200	$16,400		$65,600			
P037	6-inch on N. 15th south from N. Davis	220	6	O&M	$13,200	$4,400	$8,800			$13,200		
P038	8-inch on S. 10th from S. Heather to S. Dogwood St.,	1,000	8	O&M/Fire flow	$80,000	$60,000	$20,000			$80,000		
P039	10-inch between SW 345th Ave. and S. Alpine St.	990	10	Growth	$99,000	$0	$99,000					$99,000
P040	8-inch on S. Ivy between S. 12th and S. "14-1/2"	830	8	O&M/Fire flow	$66,400	$49,800	$16,600			$66,400.00		
P041	12-inch on N. 9th Ave. from N. Adair to alley	220	12	O&M	$26,400	$26,400	$0	$26,400				
	Total	37,705			$3,577,600	$1,411,000	$2,166,600					
Storage												
S001	Water Park reservoir seismic evaluation			Safety/Emergency	$20,000	$20,000	$0		$20,000			
S002	Water Park pump station and site evalaution			Fire flow/Emergency	$25,000	$12,500	$12,500		$25,000			
S003	Water Park reservoir cleaning, external repair, and painting			Maintenance	$30,000	$30,000	$0		$30,000			
S004	2.0 MG Water Park Reservoir			Fire flow/Emergency	$1,600,000	$400,000	$1,200,000		$1,600,000			
S005	2.0 MG North Reservoir			Fire flow/Emergency	$1,600,000	$0	$1,600,000					$1,600,000
Pumping												
PS001	Install switch gear in existing Water Park PS			Emergency	$15,000	$15,000	$0	$15,000				
PS002	New Water Park Reservoir 2,300 gpm/135 HP Pump Station			Growth	$300,000	$0	$300,000			$300,000		
Recommended Studies												
R001	Water Master Plan 2009			Regulatory	$45,000	$22,500	$22,500			$45,000		
R002	Water Master Plan 2014			Regulatory	$50,000	$25,000	$25,000				$50,000	
R003	Water Master Plan 2019			Regulatory	$55,000	$27,500	$27,500					$55,000
R004	Leak Detection Surveys			O&M	$37,000	$37,000	$0	$10,000	$15,000	$6,000	$3,000	$3,000
R005	Emergency Water Supply Options Study			Growth/Emergency	$25,000	$12,500	$12,500		$25,000			
Total					**$7,489,600**	**$2,123,000**	**$5,366,600**	**$484,800**	**$3,049,600**	**$895,800**	**$713,200**	**$2,346,200**



NOTE: SEE TABLE 6-7 FOR PROJECT CIP LISTING

Exhibit 6-1
City of Cornelius
Capital Improvements Projects
February 2004

Section 7
Financial Review of CIP

7.1 Current Rates and Charges

The City currently maintains a water fund (Fund #06) and a water system development charges (SDC) fund (Fund #26) for its water system. The water Fund #06 is the City's main account for tracking the operations of its water system. Revenue sources for this fund include the City's rates and charges for water service as well as other miscellaneous funds. Personal services, materials and services, and capital outlays are expenditures accounted for in the water Fund #06.

The City also maintains a water system development charges Fund #26. The source of funding for this account is from the collection of system development charges. The fund is used to pay for capital outlay programs that are growth related.

7.2 Recommended Capital Improvements Program (CIP)

The Water Master Plan CIP is described in detail in Section 6 of this report. Many needed improvements were defined in the CIP, with the bulk of the capital outlays in storage and distribution. The capital improvements have been separated between those that are renewal and replacement and hence are paid for through monthly user rates and those which are growth related which can be funded via system development charges. A summary of the CIP for financial planning purposes is provided in Table 7-1.

Table 7-1
City of Cornelius
Capital Improvements Program Summary
(For Financial Planning Purposes)

Project Type	2004	2005-2008	2009-2012	2013-2017	2018-2024
Operations Related Costs					
O & M	$ 34,000	$ 16,000	$ 20,000	$ 20,000	$ 20,000
Distribution	272,200	718,300	378,900	0	41,600
Storage	0	462,500	0	0	0
Pumping	15,000	0	0	0	0
Recommended Studies	10,000	27,500	28,500	28,000	30,500
Total Operations Related	**$331,200.00**	**$1,224,300.00**	**$427,400.00**	**$48,000.00**	**$92,100.00**
Growth Related Costs					
O & M	$ 0	$ 0	$ 0	$ 0	$ 0
Distribution	153,600	600,300	145,900	640,200	626,600
Storage	0	1,212,500	0	0	1,600,000
Pumping	0	0	300,000	0	0
Recommended Studies	0	12,500	22,500	25,000	27,500
Total Growth Related	**$153,600.00**	**$1,825,300.00**	**$468,400.00**	**$665,200.00**	**$2,254,100.00**
Total CIP	**$484,800.00**	**$3,049,600.00**	**$895,800.00**	**$713,200.00**	**$2,346,200.00**

The complete recommended CIP recommends $484,800 for the FY 2004-2005 and an annual average of $762,400 for FY 2005-2006 through FY 2008-2009. For FY 2009-2010 through FY 2024-2025, the annual average is $263,680. It is important to note that these CIP annual averages are split between rate funded (O&M) and growth funded (SDC's). Both monthly water rates and water SDC fees will need to be increased to fund the recommended water system CIP.

7.3 Comprehensive Utility Rate Study

To determine the best options to fund the recommended water system CIP, a comprehensive utilities rate study for water, sewer, and storm drainage is scheduled for late Summer 2004. This comprehensive study will evaluate utility system Master Plans, utility Operational and Equipment Plans, and the ability to fund these plans at current monthly user rates and SDC rates All three utilities, water, sewer, and storm drainage, will be evaluated at the same time. Where rates are insufficient, the study will recommend various financial alternatives for the City Council's consideration.