# CITY OF OREGON CITY

# WATER MASTER PLAN

WEST YOST & ASSOCIATES
OCTOBER 2004

# TABLE OF CONTENTS

**Page**

## TABLE OF CONTENTS (continued)

**Page**

## TABLE OF CONTENTS (continued)

**Page**



**LIST OF TABLES**

**TABLE OF CONTENTS** (continued)

**Page**

**TABLE OF CONTENTS** (continued)

**Page**



**LIST OF FIGURES**

**TABLE OF CONTENTS** (continued)

# CHAPTER 1

# EXECUTIVE SUMMARY

This master plan presents the results of the water distribution system planning effort conducted for the City of Oregon City. The plan summarizes the components of the existing water distribution system, analyzes local water demand patterns, evaluates the performance of the water system with respect to critical service standards, identifies the improvements necessary to remedy system deficiencies and accommodate future growth. Based on this analysis, the study recommends specific projects for inclusion in the water distribution system Capital Improvement Program (CIP). These projects will ensure that the water distribution system continues to provide adequate and reliable service to the City. Finally, the master plan presents a financing plan that will facilitate successful implementation of the recommended CIP.

**Source of Supply**

The source of supply for the City of Oregon City is surface water from the lower Clackamas River which is supplied by the South Fork Water Board (SFWB). The SFWB is a wholesale water supplier that is equally owned by the Cities of Oregon City and West Linn. The SFWB operates an intake and pumping station just to the north of the Oregon City city limits which delivers raw water to the SFWB water treatment plant located in the City's Park Place area. The Oregon City water distribution system is supplied by the SFWB at six different locations.

**Existing System**

The Oregon City water distribution system currently serves more than 5,500 acres of developed property within the city limits. The existing system is composed of approximately 140 miles of pipeline network, five booster pumping stations, four reservoirs, seventeen pressure reducing valve (PRV) stations, two altitude valves, and eight interties with other water systems. The service area contains twelve pressure zones which are summarized in Table 1-1 along with their respective static pressure ranges.

**Water Demand**

Analysis of historical water demand data illustrate the water use patterns that characterize the City of Oregon City. These water use patterns also provide the basis for estimating future water demand in the community when the urban growth boundary (UGB) has been built out. Table 1-2 summarizes existing water demand in terms of average annual, maximum month, maximum day, and peak hour demand and provides projections for the UGB build-out condition. The City has also received preliminary approval for three UGB expansion areas that would increase annual average demand by approximately 0.8 million gallons per day (mgd) for the future service area at UGB build-out.

**Table 1-1. Pressure Zone Ranges**

| Zone | Zone Bottom Elevation (feet) | Zone Top Elevation (feet) | Pressure Range (psi) |
|---|---|---|---|
| Lower Zone | 20 - 50 | 80 - 170 | 48 - 113 |
| Intermediate Zone | 80 - 170 | 320 - 380 | 45 - 178 |
| Upper Zone | 320 - 380 | 470 - 500 | 38 - 118 |
| Canemah Zone | 60 | 130 - 180 | 50 - 102 |
| Fairway Downs Zone | 470 | 530 | 49 - 85 |
| Park Place Lower Zone | 40 - 130 | 190 - 220 | 42 - 120 |
| Park Place Intermediate Zone | 190 - 220 | 410 - 430 | 49 - 156 |
| Park Place Upper Zone - CRW | 410 - 430 | 540 | 112 - 168 |
| Park Place View Manor Zone | 230 | 330 | 36 - 79 |
| Park Place Livesay Road Zone | 220 | 360 | 39 - 100 |
| Park Place Jennifer Estates | 200 | 265 | 40 - 68 |
| Paper Mill Zone | 40 | 60 | 102 - 110 |

**Table 1-2. Water Demand Summary for Oregon City**

| Description | Current Water Demand, mgd[a] | Build-Out Water Demand, mgd[a] |
|---|---|---|
| Average Annual | 3.6 | 7.2 |
| Maximum Month | 5.4 | 11 |
| Maximum Day | 7.6 | 15 |
| Peak Hour | 16.2 | 32 |

[a]mgd: millions of gallons per day

**Water Distribution System Service Standards**

The City of Oregon City maintains benchmarks for service quality that are used to measure performance of the water utility. These benchmarks include service standards for water quality, quantity, and pressure, as well as the minimum supply levels for fire protection. For example, the Oregon City water distribution system was analyzed to ensure that service pressures never fall below 40 psi during normal demand scenarios and fire flows are available without dropping system pressures below 20 psi. The service standards set forth in this master plan are derived from regulations, rules, and recommendations established by a variety of sources including the Oregon State Department of Human Services (DHS), the Environmental Protection Agency (EPA), the American Water Works Association (AWWA), the Insurance Services Office (ISO), and the Uniform Fire Code (UFC).

## Distribution System Modeling

A computer based hydraulic model of the Oregon City water distribution system was developed as part of the master planning effort to evaluate the ability of the system to meet current and projected demands. Field calibration work confirmed that the model accurately simulates operation of the water distribution system. The model was used to evaluate the existing and future water distribution system under three conditions:

- Peak hour demand
- Maximum day demand plus fire flow
- Low demand during booster pump station operation

## System Evaluation and Capital Improvement Plan Recommendations

The Oregon City water distribution system was analyzed to evaluate its performance and capacity under current and future demand conditions relative to critical service standards. This analysis identified system improvements necessary to maintain adequate performance through build-out of the UGB. These improvements were developed to either eliminate existing deficiencies in system performance or expand service to satisfy community growth. The elements of the water distribution system that were evaluated include treated water storage capacity, booster pumping capacity, and pipeline network performance. A seismic vulnerability assessment was also conducted to identify all facilities upgrades necessary to limit the potential for water system damage from earthquakes.

Table 1-3 presents the specific costs for reservoir, pump station, and pipeline projects that are targeted for implementation through build-out of the UGB. These costs account for developer participation in the financing of some pipeline expansion projects. Costs shown are the City's estimated share of the pipeline extensions and do not include the costs to be borne by developers. Figure 1-1 illustrates how the new pump stations and reservoirs will fit into the existing hydraulic profile of the water distribution system. Figure 1-2 shows the layout of the future system including new pipelines and reservoirs.

The planned timing of projects is based on the anticipated rate of growth in water demand, the City's review and prioritization of improvements, as well as the anticipated locations of developer driven system expansions. Some adjustment of timing and priorities should be expected to accommodate the eventual sequence of development.

## Financing and Implementation Plan

The development of a financing plan is a key element for successful implementation of the recommended capital improvement program (CIP). Projects in the CIP that improve the existing system but do not increase system capacity must be funded from water rates. Projects that increase water system capacity for future growth are eligible for funding from system development charges (SDCs). Financial projections were developed based on the City's historical revenue stream from water rates and SDCs. The SDC projections reflect the updated SDC which was adopted by the City Commission in June 2004. These projections indicate that available revenue streams will be adequate to fund the recommended CIP during the first and

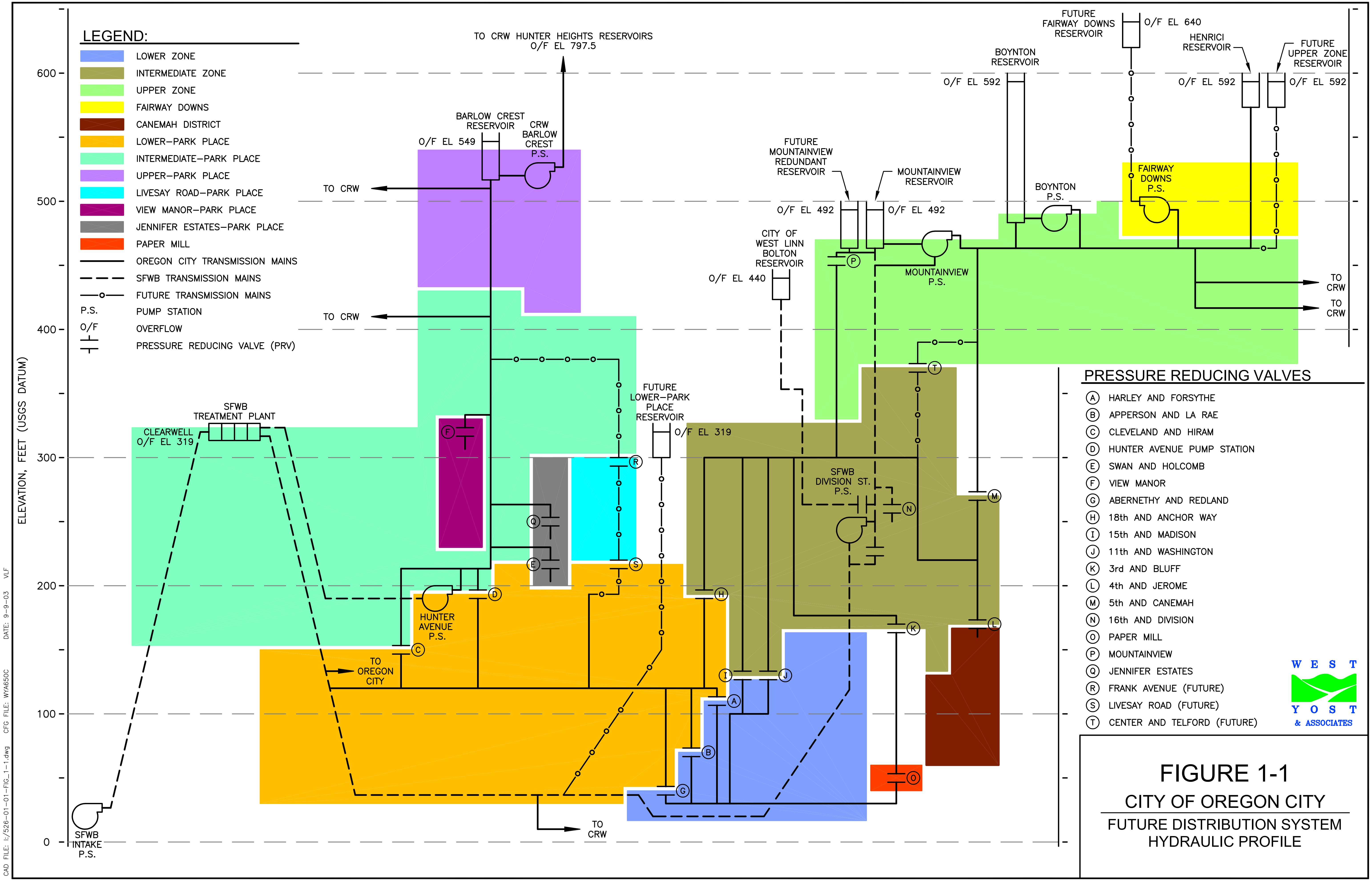



FIGURE 1-1
CITY OF OREGON CITY
FUTURE DISTRIBUTION SYSTEM HYDRAULIC PROFILE

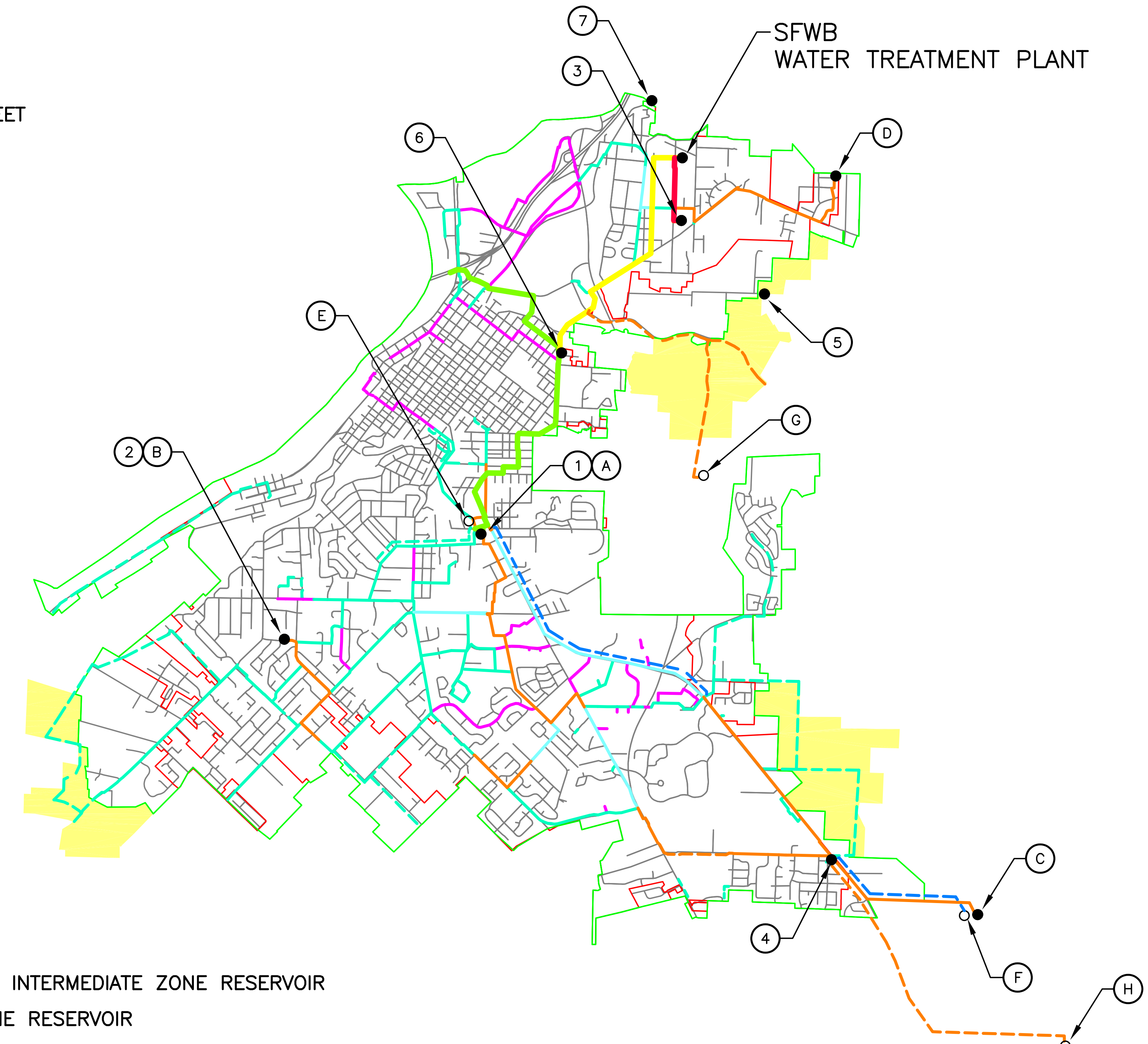
# FIGURE 1-2

## CITY OF OREGON CITY

FUTURE WATER DISTRIBUTION SYSTEM

PUMP STATIONS

1. MOUNTAINVIEW
2. BOYNTON
3. HUNTER AVENUE
4. FAIRWAY DOWNS
5. LIVESAY ROAD
6. SFWB DIVISION STREET
7. SFWB INTAKE




RESERVOIRS

A. MOUNTAINVIEW
B. BOYNTON
C. HENRICI
D. BARLOW CREST
E. FUTURE REDUNDANT INTERMEDIATE ZONE RESERVOIR
F. FUTURE UPPER ZONE RESERVOIR
G. FUTURE LOWER–PARK PLACE RESERVOIR
H. FUTURE FAIRWAY DOWNS RESERVOIR

N

0 2000 4000
SCALE IN FEET

LEGEND:

- URBAN GROWTH BOUNDARY (UGB)
- PROPOSED UGB EXPANSION AREA
- CITY LIMITS
- FUTURE PIPELINE
- 10” – OREGON CITY PIPELINES
- 12” – OREGON CITY PIPELINES
- 14” – OREGON CITY PIPELINES
- 16” – OREGON CITY PIPELINES
- 20” – OREGON CITY PIPELINES
- 24” – SFWB PIPELINES
- 30” – SFWB PIPELINES
- 42” – SFWB PIPELINES
- ● WATER SYSTEM FACILITIES
- ○ FUTURE WATER SYSTEM FACILITIES

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CAD FILE: I:/526-01-01-FIG_1-2.dwg CFG FILE: 526-01-01-FIG_2-1.CFG DATE: 9-9-03 VLF

third improvement phases, while additional financing will be necessary to complete funding for projects during the second improvement phase. To meet the projected shortfalls during the second improvement phase, the implementation plan recommends that the City acquire revenue bonds totaling approximately $8.9 million. The annual debt service on a revenue bond of this amount would require a rate increase of twelve percent. By City ordinance, the sale of revenue bonds and a rate increase greater than three percent will require a vote of the people.

**Table 1-3. Estimated Capital Costs for CIP Project**

| Recommended Improvements | Capital Cost, $1,000[a] |
|---|---|
| **Period 2004 – 2009** | |
| Treated Water Storage | 8,207 |
| Pump Stations | 534 |
| Pipelines | 5,450 |
| Total | 14,191 |
| **Period 2009 – 2014** | |
| Treated Water Storage | 283 |
| Pump Stations | 2,940 |
| Pipeline Replacement | 6,665 |
| Other | 200 |
| Total | 10,088 |
| **Period 2014 – 2024** | |
| Treated Water Storage | 2,860 |
| Pipelines | 14,493 |
| Other | 200 |
| Total | 17,553 |
| Grand Total | 41,832 |

[a] Capital costs based on an Engineering News – Record (ENR) Construction Cost Index (CCI) of $6,650.

# CHAPTER 2

# EXISTING WATER DISTRIBUTION SYSTEM

The Oregon City water distribution system currently serves more than 5,500 acres of developed property within the city limits. The existing system is composed of an extensive pipeline network, five booster pumping stations, four reservoirs, seventeen pressure reducing valve (PRV) stations, two altitude valves, and eight interties with other water systems. This chapter provides background information on the various elements of the existing system as well as an overview of system operations.

## SOURCE OF SUPPLY

The source of supply for the City of Oregon City is surface water from the lower Clackamas River (Figure 2-1) which is supplied by the South Fork Water Board (SFWB). Figure 2-2 is a map of the Clackamas River and surrounding river systems. The SFWB is a wholesale water supplier that is equally owned by the Cities of Oregon City and West Linn. The SFWB operates an intake and pumping station just to the north of the Oregon City city limits which delivers raw water to the SFWB water treatment plant located in the City's Park Place area. The treatment plant was originally constructed in 1958 and has undergone several renovations over the years. The most recent plant expansion was completed in 1986, bringing the plant's rated production capacity to 20 million gallons per day (mgd). The historical maximum day treated water production rate was 18.3 mgd on August 11, 1996. The treatment process includes flocculation and sedimentation of suspended solids, filtration of the remaining particles, and chlorination for disinfection prior to pumping into the SFWB transmission system.

**Figure 2-1. South Fork Water Board Raw Water Intake**

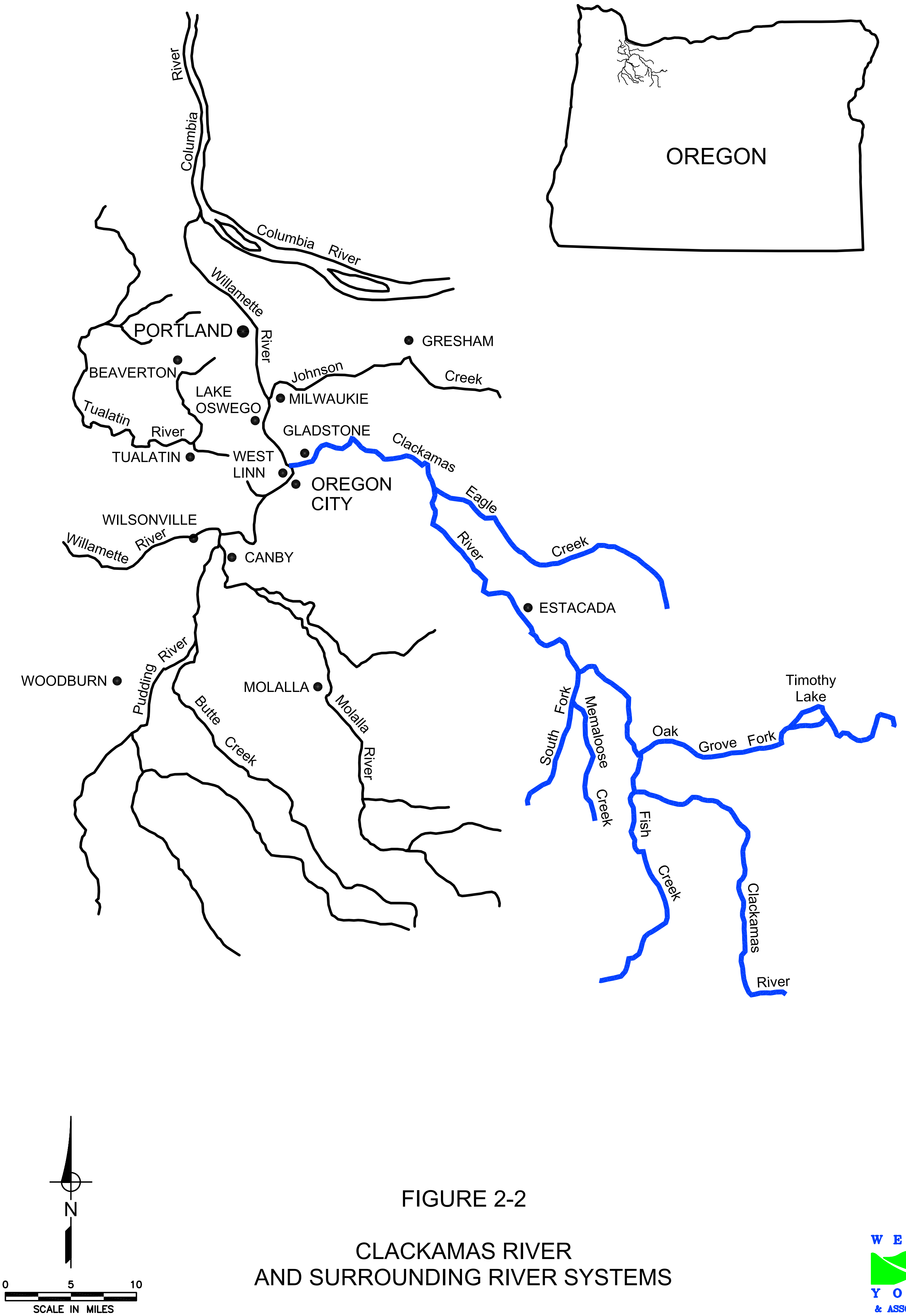


FIGURE 2-2

CLACKAMAS RIVER
AND SURROUNDING RIVER SYSTEMS

WEST YOST & ASSOCIATES

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## WATER SUPPLY RIGHTS

The SFWB holds five water rights on the Clackamas River and its tributaries which total 116 cubic feet per second (cfs) or nearly 75 mgd. However, the allowed maximum withdrawal rate for these water rights is based on available flow during summertime periods of low stream flow. As a result, it is estimated that the actual maximum withdrawal rate is 80 cfs or nearly 52 mgd. Since some of the water rights pertain to upstream locations on the South Fork of the Clackamas River and Memaloose Creek, the SFWB has taken legal steps in recent years to ensure access to these water rights at the existing water supply intake on the Lower Clackamas. Currently, the SFWB has secured rights to withdraw 42.6 mgd at the existing intake.

## REGIONAL MASTER METERING SYSTEM

The regional water supply master metering system measures the volumes of water delivered by the SFWB to its customers. The SFWB's three primary customers include the City of Oregon City, the City of West Linn, and Clackamas River Water (CRW). CRW is a domestic water supply district that serves the unincorporated rural areas surrounding Oregon City. The Oregon City water distribution system is supplied by the SFWB at six different locations, the City of West Linn is supplied at one location, and CRW is supplied at six locations. The City of Oregon City and the City of West Linn are directly supplied from the SFWB's transmission pipelines. One of the CRW connections is directly supplied by the SFWB and the other five connections are supplied through the Oregon City water distribution system. CRW also has two emergency interties with the Oregon City water distribution system. There is a master metering vault at each of these supply locations that is monitored on a monthly basis to determine delivered water volumes for billing purposes. Figure 2-3 illustrates the master metering station at Barlow Crest Reservoir. Table 2-1 summarizes important information about each of the thirteen primary master metering stations.

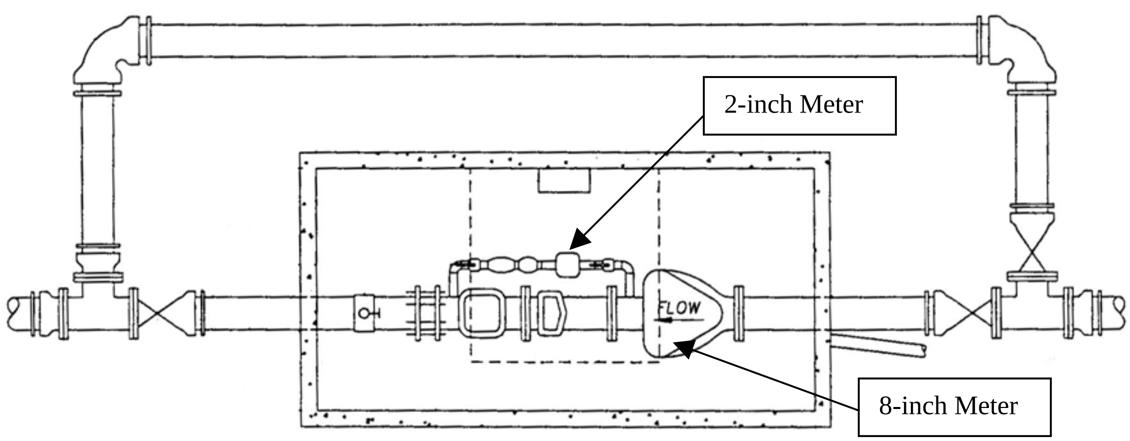


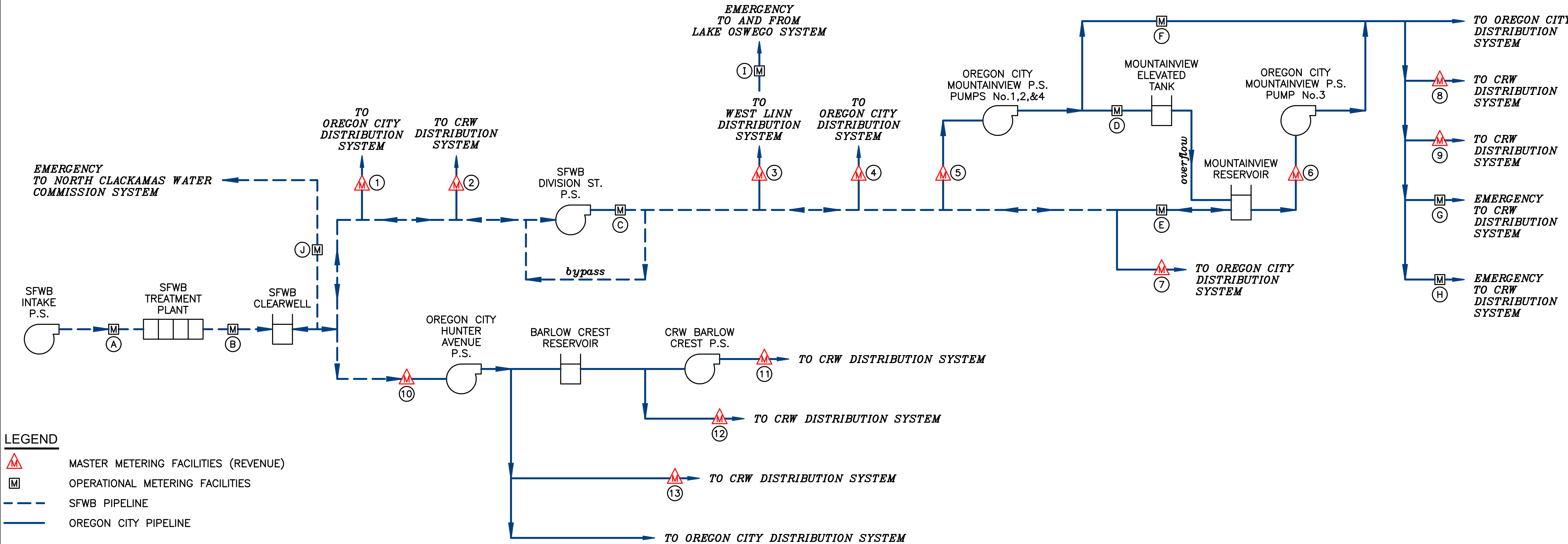

**Figure 2-3. Barlow Crest Master Meter Vault Plan**

**Table 2-1. Regional Master Meter Sites**

| Master Meter Station No. | Location | Meter Diameter and Type | Agency Served | Owner |
|---|---|---|---|---|
| 1 | Cleveland & Hiram Roads | 10-inch turbine | City of Oregon City | SFWB |
| 2 | Redland Rd. & Anchor Way | 8-inch compound | Clackamas River Water | SFWB |
| 3 | 17th & Division Street | 16-inch magnetic | City of West Linn | SFWB |
| 4 | 16th & Division Street | 8-inch compound | City of Oregon City | SFWB |
| 5 | Mountainview Pump Sta. Pump Nos. 1, 2, & 4 | 16-inch turbine | City of Oregon City | SFWB |
| 6 | Mountainview Pump Sta. Pump No. 3 | 6-inch propeller | City of Oregon City | SFWB |
| 7 | Mountainview Street | 10-inch turbine | City of Oregon City | SFWB |
| 8 | Leland & Meyers Roads | 6-inch compound | Clackamas River Water | Oregon City |
| 9 | South End & Impala Roads | 6-inch, 2-inch turbine, piston | Clackamas River Water | Oregon City |
| 10 | Hunter Ave. Pump Station | 10-inch turbine | City of Oregon City | Oregon City |
| 11 | Barlow Crest Pump Station | 6-inch magnetic | Clackamas River Water | Oregon City |
| 12 | Barlow Crest Reservoir | 8-inch, 2-inch turbine, piston | Clackamas River Water | Oregon City |
| 13 | Swan Ave. & Foresythe Rd. | 6-inch, 2-inch turbine, piston | Clackamas River Water | Oregon City |
| Secondary | Old River Rd. & Highway 43 | 12-inch magnetic | City of Lake Oswego | West Linn |
| Secondary | SFWB Treatment Plant | 24-inch magnetic | North Clackamas Water Commission | SFWB |

There are also two secondary water supply interties in the regional water system. The SFWB occasionally provides water to the City of Lake Oswego through an intertie in the City of West Linn's water distribution system and is also able to provide water to the North Clackamas Water Commission system through an intertie at the SFWB treatment plant. The Lake Oswego meter is monitored and maintained by City of West Linn staff whenever the intertie is active. The City of Lake Oswego can also pump into City of West Linn system at this location if the SFWB supply to West Linn is disrupted. The North Clackamas Water Commission intertie, which is monitored and maintained by SFWB staff, is typically active when that agency is experiencing problems with treating highly turbid water during winter flood events. Since neither of these interties is regularly in operation, the meters are not included in the monthly monitoring program. Instead, the City of West Linn and SFWB report metered water volumes to master meter billing staff as necessary. Table 2-1 also includes information on these two secondary master metering stations.

The following figures provide an overview of the master metering system. Figure 2-4 is a schematic that depicts the configuration of the master metering system, showing the primary master meters used for revenue calculations as well as the secondary flow meters that are used for operational or emergency purposes. Figure 2-5 is a map of the regional system that shows the location of each master metering station.




## MASTER METER KEY

| | | |
|---|---|---|
| 1 | Owner: | SFWB |
| | Location: | Cleveland and Hiram Roads |
| | Purpose: | Revenue |
| | Agency Served: | City of Oregon City |
| | Diameter: | 10-inch |
| | Units: | 500 cubic feet |
| | Type: | Sensus Turbo |
| 2 | Owner: | SFWB |
| | Location: | Redland Road and Anchor Way |
| | Purpose: | Revenue |
| | Agency Served: | Clackamas River Water |
| | Diameter: | 8-inch, 4-inch, & 4-inch |
| | Units: | 100 cubic feet, 100 cubic feet, & cubic feet |
| | Type: | Hersey Compound |
| 3 | Owner: | SFWB |
| | Location: | 17th and Division Street |
| | Purpose: | Revenue |
| | Agency Served: | City of West Linn |
| | Diameter: | 16-inch |
| | Units: | 1,000 gallons |
| | Type: | Magnetic |
| 4 | Owner: | SFWB |
| | Location: | 16th and Division Street |
| | Purpose: | Revenue |
| | Agency Served: | City of Oregon City |
| | Diameter: | 8-inch, 4-inch, & 4-inch |
| | Units: | 100 cubic feet, 100 cubic feet, & cubic feet |
| | Type: | Hersey Compound |
| 5 | Owner: | SFWB |
| | Location: | Mountainview Pump Station Pumps No. 1, 2, & 4 |
| | Purpose: | Revenue |
| | Agency Served: | City of Oregon City |
| | Diameter: | 16-inch |
| | Units: | 10,000 cubic feet |
| | Type: | Sensus Turbo |
| 6 | Owner: | SFWB |
| | Location: | Mountainview Pump Station Pump No. 3 |
| | Purpose: | Revenue |
| | Agency Served: | City of Oregon City |
| | Diameter: | 6-inch |
| | Units: | 1,000 gallons |
| | Type: | Propeller |
| 7 | Owner: | SFWB |
| | Location: | Mountainview Street |
| | Purpose: | Revenue |
| | Agency Served: | City of Oregon City |
| | Diameter | 10-inch |
| | Units: | 1,000 cubic feet |
| | Type: | Sensus Turbo |
| 8 | Owner: | City of Oregon City |
| | Location: | Leland and Meyers Roads |
| | Purpose: | Revenue |
| | Agency Served: | Clackamas River Water |
| | Diameter: | 6-inch, 6-inch, & 6-inch |
| | Units: | 100 cubic feet, 100 cubic feet, & 100 cubic feet |
| | Type: | Hersey Compound |
| 9 | Owner: | City of Oregon City |
| | Location: | South End and Impala Roads |
| | Purpose: | Revenue |
| | Agency Served: | Clackamas River Water |
| | Diameter: | 6-inch & 2-inch |
| | Units: | 500 cubic feet & 100 cubic feet |
| | Type: | Sensus Turbo |
| 10 | Owner: | City of Oregon City |
| | Location: | Hunter Avenue Pump Station |
| | Purpose: | Revenue |
| | Agency Served: | City of Oregon City |
| | Diameter: | 10-inch |
| | Units: | 100 cubic feet |
| | Type: | Sensus Turbo |
| 11 | Owner: | City of Oregon City |
| | Location: | Barlow Crest Pump Station |
| | Purpose: | Revenue |
| | Agency Served: | Clackamas River Water |
| | Diameter: | 6-inch |
| | Units: | 10 gallons |
| | Type: | Sensus Turbo |
| 12 | Owner: | City of Oregon City |
| | Location: | Barlow Crest Reservoir |
| | Purpose: | Revenue |
| | Agency Served: | Clackamas River Water |
| | Diameter: | 8-inch & 2-inch |
| | Units: | 500 cubic feet & 100 cubic feet |
| | Type: | Sensus Turbo |
| 13 | Owner: | City of Oregon City |
| | Location: | Swan Avenue and Forsythe Roads |
| | Purpose: | Revenue |
| | Agency Served: | Clackamas River Water |
| | Diameter: | 6-inch & 2-inch |
| | Units: | 500 cubic feet & 100 cubic feet |
| | Type: | Sensus Turbo |

## OPERATIONAL METER KEY

| | | |
|---|---|---|
| A | Owner: | SFWB |
| | Location: | Water Treatment Plant |
| | Purpose: | Operational - Raw Water Measurement |
| | Diameter: | 20-inch |
| | Type: | Propeller |
| B | Owner: | SFWB |
| | Location: | Water Treatment Plant |
| | Purpose: | Operational - Finished Water Measurement |
| | Diameter: | 20-inch |
| | Type: | Propeller |
| C | Owner: | SFWB |
| | Location: | Division Street Pump Station |
| | Purpose: | Operational - Pumping Rate Measurement |
| | Diameter: | 24-inch |
| | Type: | Sonic |
| D | Owner: | City of Oregon City |
| | Location: | Elevated Tank |
| | Purpose: | Operational - Flow to Elevated Tank |
| | Diameter: | 2-inch |
| | Type: | Sensus Turbo |
| E | Owner: | City of Oregon City |
| | Location: | Mountainview Reservoir No. 2 |
| | Purpose: | Operational - Reservoir Fill and Discharge Rate |
| | Diameter: | 10-inch |
| | Type: | Magnetic Bi-Directional |
| F | Owner: | City of Oregon City |
| | Location: | Mountainview Street |
| | Purpose: | Operational - Partial Flow to Upper Pressure Zone |
| | Diameter: | 16-inch |
| | Type: | Magnetic |
| G | Owner: | Clackamas River Water |
| | Location: | Beavercreek Road and Highway 213 |
| | Purpose: | Emergency Intertie to CRW |
| H | Owner: | Clackamas River Water |
| | Location: | Beavercreek and Glen Oak Roads |
| | Purpose: | Emergency Intertie to CRW |
| I | Owner: | City of West Linn |
| | Location: | Old River Rd and Hwy 43 |
| | Purpose: | Emergency Intertie to Lake Oswego |
| | Diameter: | 12-inch |
| | Type: | Magnetic Bi-Directional |
| J | Owner: | SFWB |
| | Location: | SFWB Treatment Plant |
| | Purpose: | Emergency Intertie to NCWC |
| | Diameter: | 24-inch |
| | Type: | Magnetic |

# FIGURE 2-4

## CITY OF OREGON CITY

### MASTER METERING SYSTEM SCHEMATIC

WEST YOST & ASSOCIATES

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# FIGURE 2-5

## METER LOCATIONS

### MASTER METERS

(1) SERVES CITY OF OREGON CITY
CLEVELAND AND HIRAM ROADS

(2) SERVES CLACKAMAS RIVER WATER
REDLAND ROAD AND ANCHOR WAY

(3) SERVES CITY OF WEST LINN
17th AND DIVISION STREET

(4) SERVES CITY OF OREGON CITY
16th AND DIVISION STREET

(5) SERVES CITY OF OREGON CITY
MOUNTAINVIEW PUMP STATION PUMPS No.1, 2, AND 4

(6) SERVES CITY OF OREGON CITY
MOUNTAINVIEW PUMP STATION PUMP No.3

(7) SERVES CITY OF OREGON CITY
MOUNTAINVIEW STREET

(8) SERVES CLACKAMAS RIVER WATER
LELAND AND MEYERS ROADS

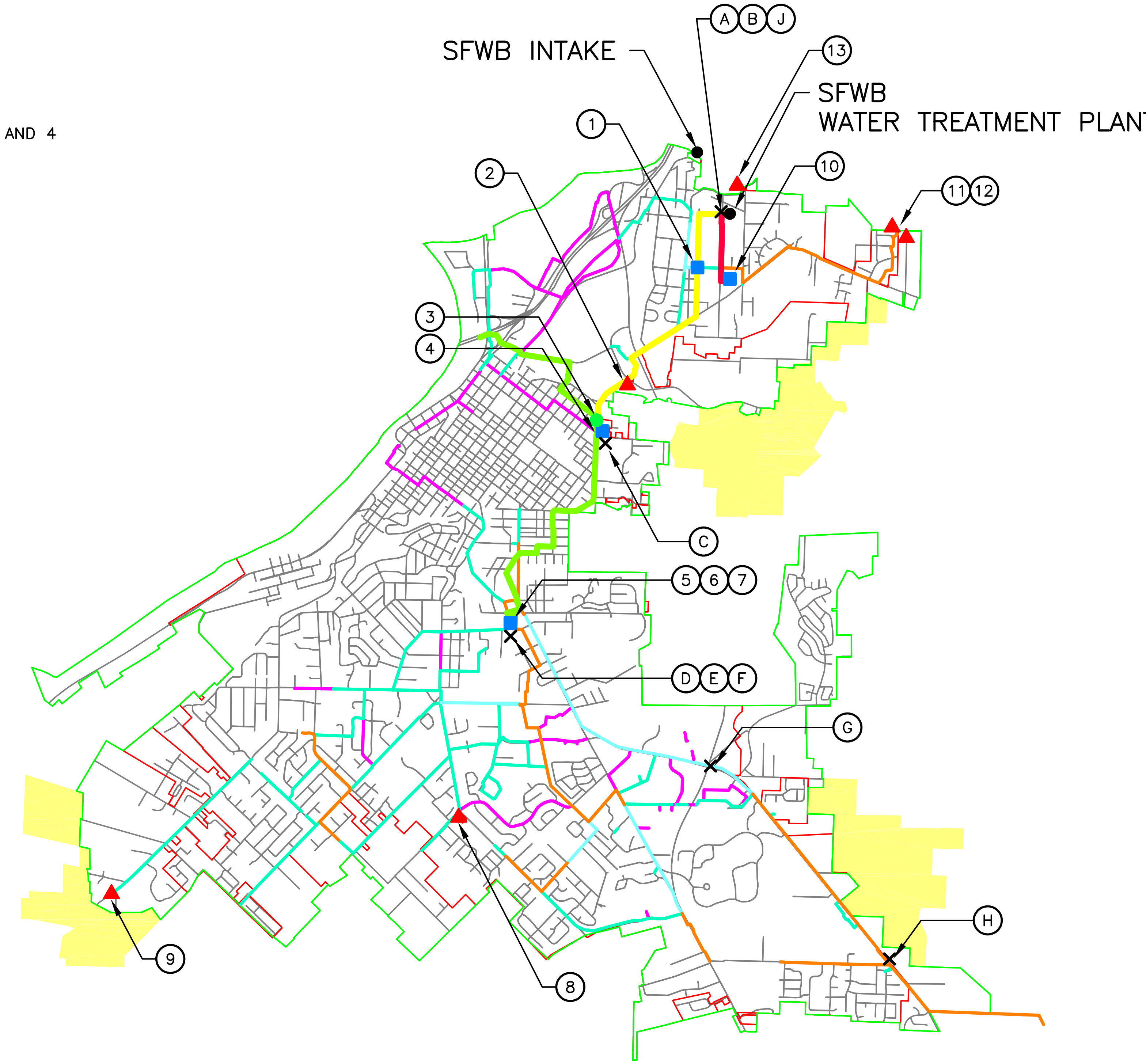
(9) SERVES CLACKAMAS RIVER WATER
SOUTH END AND IMPALA ROADS

(10) SERVES CITY OF OREGON CITY
HUNTER AVENUE PUMP STATION

(11) SERVES CLACKAMAS RIVER WATER
BARLOW CREST PUMP STATION

(12) SERVES CLACKAMAS RIVER WATER
BARLOW CREST RESERVOIR

(13) SERVES CLACKAMAS RIVER WATER
SWAN AVENUE AND FORSYTHE ROADS




N
0 2000 4000
SCALE IN FEET

### OPERATIONAL METERS

(A) RAW WATER SUPPLY
SFWB TREATMENT PLANT

(B) FINISHED WATER DELIVERED
SFWB TREATMENT PLANT

(C) PUMP STATION FLOW
DIVISION STREET PUMP STATION

(D) TANK INLET FLOW
ELEVATED TANK

(E) TANK INLET/OUTLET FLOW
MOUNTAINVIEW RESERVOIR

(F) PARTIAL PUMP STATION FLOW
MOUNTAINVIEW PUMP STATION

(G) EMERGENCY INTERTIE TO CRW
BEAVERCREEK ROAD AND HIGHWAY 213

(H) EMERGENCY INTERTIE TO CRW
BEAVERCREEK AND GLEN OAK ROADS

(I) EMERGENCY INTERTIE TO LAKE OSWEGO
OLD RIVER ROAD AND HIGHWAY 43, WEST LINN (NOT SHOWN)

(J) EMERGENCY INTERTIE TO NORTH CLACKAMAS WATER CO –
SFWB TREATMENT PLANT

### LEGEND:

- URBAN GROWTH BOUNDARY (UGB)
- PROPOSED UGB EXPANSION AREA
- CITY LIMITS
- 10" } OREGON CITY PIPELINES
- 12"
- 14"
- 16"
- 24" } SFWB PIPELINES
- 30"
- 42"
- MASTER METER TO WEST LINN
- MASTER METER TO CRW
- MASTER METER TO OREGON CITY
- × OPERATIONAL METER

WEST YOST & ASSOCIATES

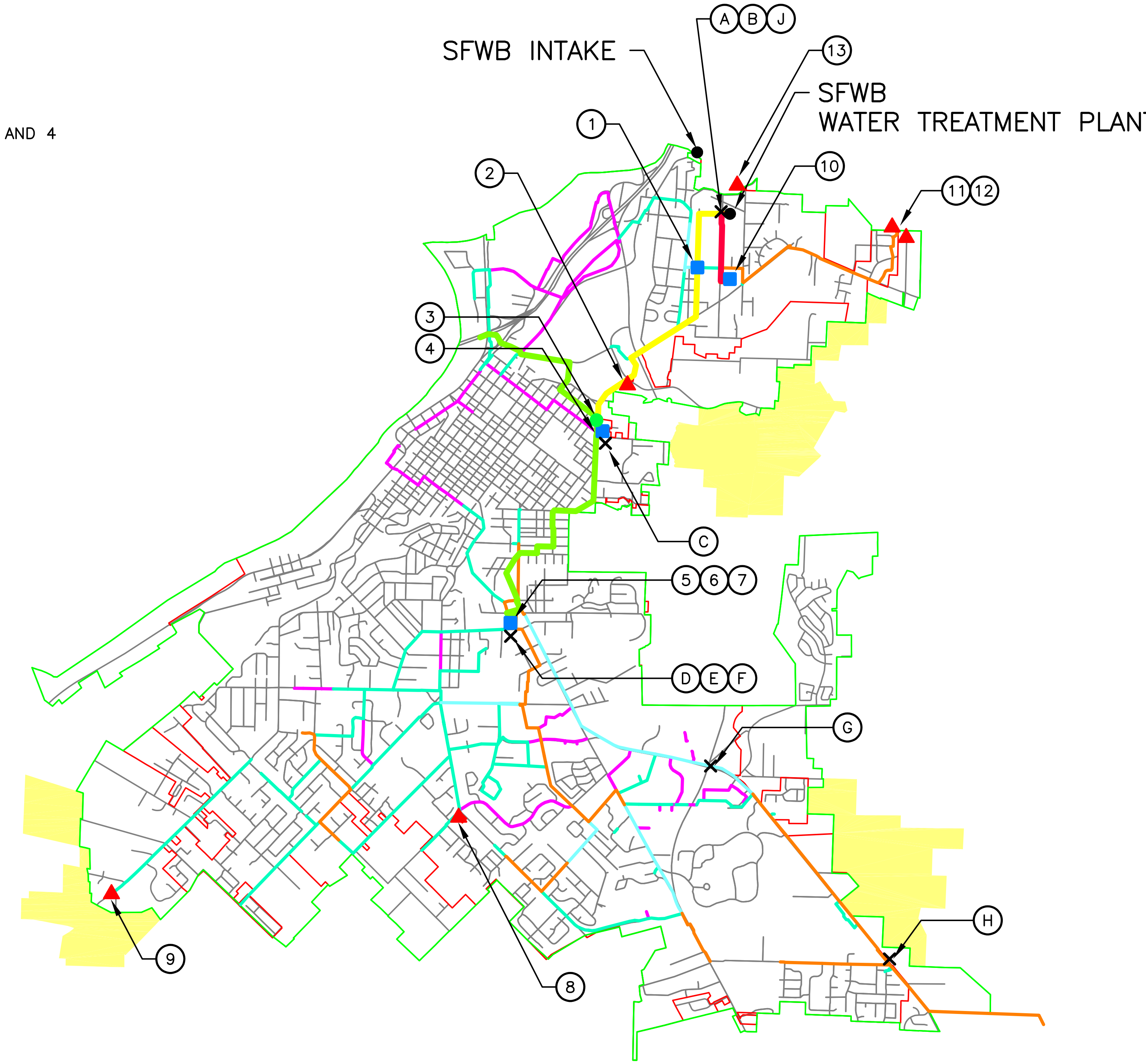
CAD FILE: I:/526-01-01-FIG_2-5.dwg CFG FILE: 526-01-01-FIG_1-2.CTB DATE: 9-17-03 VLF

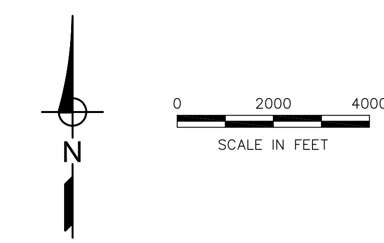
# FIGURE 2-5

## METER LOCATIONS

## MASTER METERS

1. SERVES CITY OF OREGON CITY
   CLEVELAND AND HIRAM ROADS
2. SERVES CLACKAMAS RIVER WATER
   REDLAND ROAD AND ANCHOR WAY
3. SERVES CITY OF WEST LINN
   17th AND DIVISION STREET
4. SERVES CITY OF OREGON CITY
   16th AND DIVISION STREET
5. SERVES CITY OF OREGON CITY
   MOUNTAINVIEW PUMP STATION PUMPS No.1, 2, AND 4
6. SERVES CITY OF OREGON CITY
   MOUNTAINVIEW PUMP STATION PUMP No.3
7. SERVES CITY OF OREGON CITY
   MOUNTAINVIEW STREET
8. SERVES CLACKAMAS RIVER WATER
   LELAND AND MEYERS ROADS
9. SERVES CLACKAMAS RIVER WATER
   SOUTH END AND IMPALA ROADS
10. SERVES CITY OF OREGON CITY
    HUNTER AVENUE PUMP STATION
11. SERVES CLACKAMAS RIVER WATER
    BARLOW CREST PUMP STATION
12. SERVES CLACKAMAS RIVER WATER
    BARLOW CREST RESERVOIR
13. SERVES CLACKAMAS RIVER WATER
    SWAN AVENUE AND FORSYTHE ROADS




## OPERATIONAL METERS

- A: RAW WATER SUPPLY
  SFWB TREATMENT PLANT
- B: FINISHED WATER DELIVERED
  SFWB TREATMENT PLANT
- C: PUMP STATION FLOW
  DIVISION STREET PUMP STATION
- D: TANK INLET FLOW
  ELEVATED TANK
- E: TANK INLET/OUTLET FLOW
  MOUNTAINVIEW RESERVOIR
- F: PARTIAL PUMP STATION FLOW
  MOUNTAINVIEW PUMP STATION
- G: EMERGENCY INTERTIE TO CRW
  BEAVERCREEK ROAD AND HIGHWAY 213
- H: EMERGENCY INTERTIE TO CRW
  BEAVERCREEK AND GLEN OAK ROADS
- I: EMERGENCY INTERTIE TO LAKE OSWEGO
  OLD RIVER ROAD AND HIGHWAY 43, WEST LINN (NOT SHOWN)
- J: EMERGENCY INTERTIE TO NORTH CLACKAMAS WATER CO –
  SFWB TREATMENT PLANT

## LEGEND:

- URBAN GROWTH BOUNDARY (UGB)
- PROPOSED UGB EXPANSION AREA
- CITY LIMITS
- OREGON CITY PIPELINES: 10”, 12”, 14”, 16”
- SFWB PIPELINES: 24”, 30”, 42”
- MASTER METER TO WEST LINN
- MASTER METER TO CRW
- MASTER METER TO OREGON CITY
- OPERATIONAL METER

WEST YOST & ASSOCIATES

CAD FILE: I:/526-01-01-FIG_2-5.dwg CFG FILE: 526-01-01-FIG_1-2.CTB DATE: 9-17-03 VLF

In addition to the formal master metered boundaries between agencies, there are also joint usage agreements between the City of Oregon City and CRW that govern special situations within the Oregon City distribution system. Under these agreements, CRW can serve customers directly from Oregon City pipelines that are upstream of their master meter. These joint usage areas, such as those along South End Road, typically occur where land that has been annexed into the Oregon City city limits but remains intermixed with unincorporated properties that are still served by CRW. CRW then reimburses Oregon City for the water supplied to joint usage areas based on individual customer meter summaries that are prepared each month.

## DISTRIBUTION AND STORAGE SYSTEM

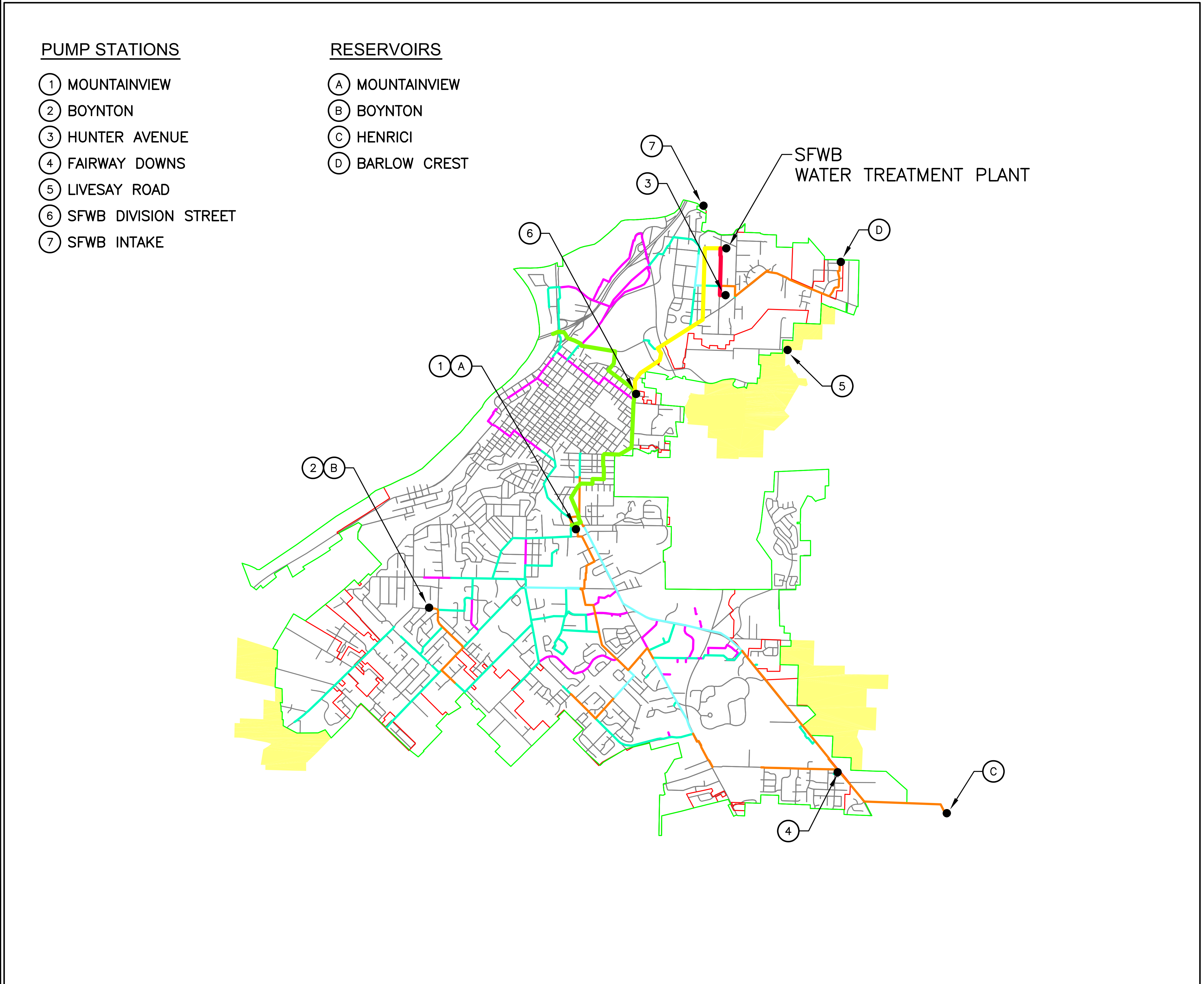
The following sections provide background information on each component of the water distribution and storage system. Figure 2-6 provides an overview of the Oregon City water distribution system, depicting the location of major facilities and all water distribution piping ten inches in diameter and larger. In addition, the figure shows facilities and transmission piping within Oregon City that are operated by the South Fork Water Board, City of West Linn, and Clackamas River Water. The figure also illustrates the existing city limits and urban growth boundary (UGB). The city limits mark the boundary of the existing service area and the UGB marks the boundary of the future service area. The City is nearing approval for three UGB expansion areas which will also be included in the future service area. Appendix A contains a wall map of the Oregon City water distribution system.

### Pipeline Network

The City's water distribution pipeline network consists of approximately 140 miles of existing pipeline. Table 2-2 details the water distribution system according to pipeline length and diameter. These pipelines are primarily made of cast iron or ductile iron and range in age up to approximately 100 years. However, there is some asbestos cement and steel pipe in the Park Place area.

**Table 2-2. Water Distribution System Pipeline Network**

| Pipe Size (inches) | Length (miles) |
|---|---|
| 2 | 2.4 |
| 4 | 7.5 |
| 6 | 41.9 |
| 8 | 49.9 |
| 10 | 8.3 |
| 12 | 15.1 |
| 14 | 3.5 |
| 16 | 8.1 |
| Total | 136.7 |




# FIGURE 2-6

## CITY OF OREGON CITY
WATER DISTRIBUTION SYSTEM

N

0 2000 4000
SCALE IN FEET

LEGEND:

- URBAN GROWTH BOUNDARY (UGB)
- PROPOSED UGB EXPANSION AREA
- CITY LIMITS
- 10" }
- 12" } OREGON CITY PIPELINES
- 14" }
- 16" }
- 24" }
- 30" } SFWB PIPELINES
- 42" }
- ● WATER SYSTEM FACILITIES

WEST YOST & ASSOCIATES

CAD FILE: I:/526-01-01-FIG_2-6.dwg CFG FILE: 526-01-01-FIG_1-2.CFG DATE: 9-15-03 VLF

### Service Pressures

The urban growth boundary (UGB) for the City of Oregon City encompasses lands of wide ranging elevations. Also, the City has annexed neighboring water distribution systems that contained independent water service pressure zones. As a result, the existing water distribution system contains twelve separate service pressure zones. Table 2-3 summarizes the service elevations and static pressure range for each pressure zone. The lower end of the pressure range is based on reservoirs at 80 percent full and the upper end is based on full reservoirs. Figure 2-7 illustrates the hydraulic profile of the Oregon City system including the SFWB facilities and Figure 2-8 illustrates the ultimate extent of each pressure zone within the Oregon City UGB. Only those areas within the present city limits are served by the existing Oregon City water distribution system. CRW is currently serving the developed areas of these pressure zones outside of the city limits as well as all of the Upper Park Place Zone.

**Table 2-3. Pressure Zone Ranges**

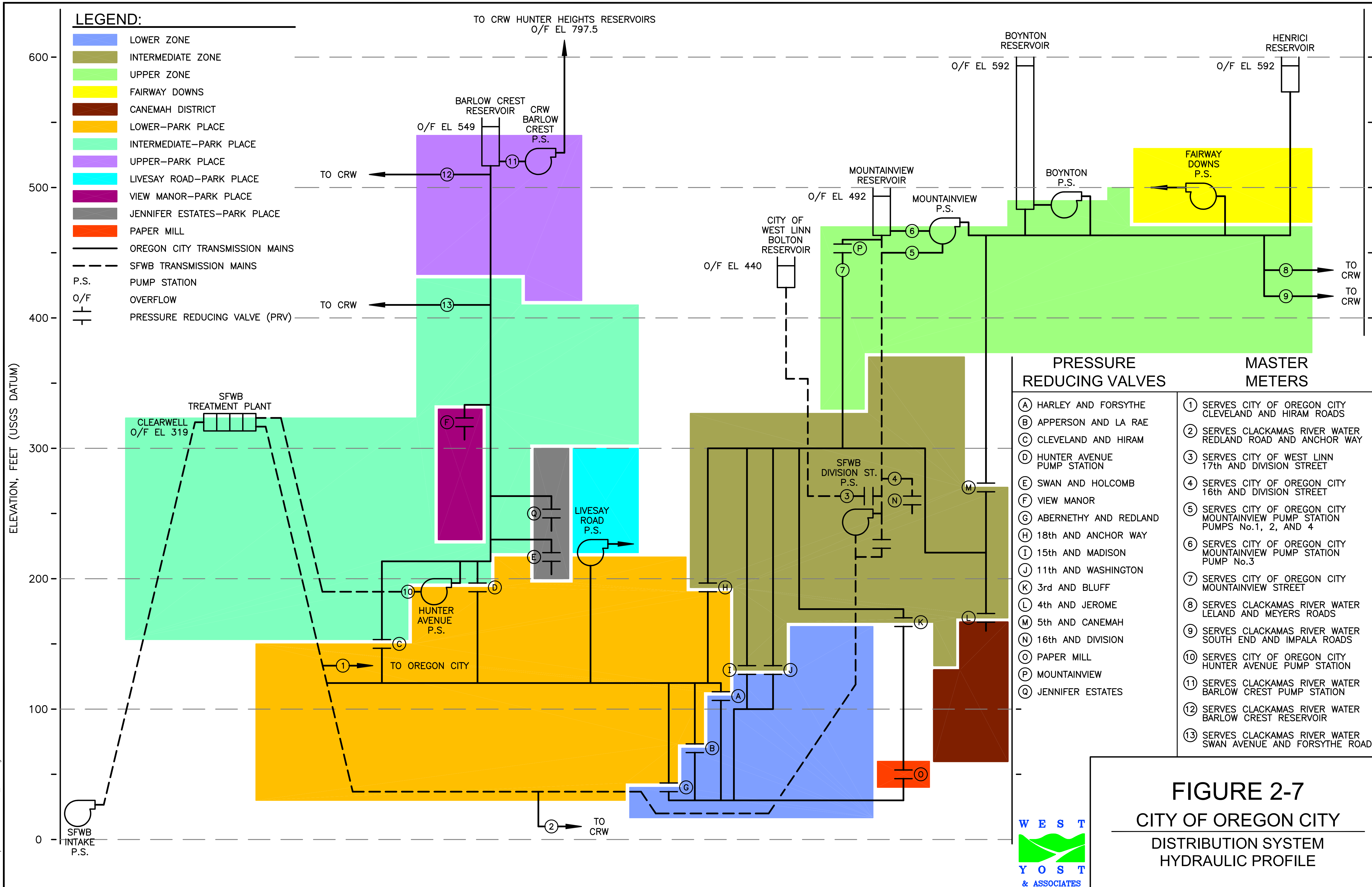
| Zone | Zone Bottom Elevation (feet) | Zone Top Elevation (feet) | Pressure Range (psi) |
|---|---|---|---|
| Lower Zone | 20 - 50 | 80 - 170 | 48 - 114 |
| Intermediate Zone | 80 - 170 | 320 - 380 | 45 - 175 |
| Upper Zone | 260 - 380 | 470 - 500 | 38 - 145 |
| Canemah Zone | 60 | 130 - 180 | 50 - 102 |
| Fairway Downs Zone | 470 | 530 | 49 - 85 |
| Park Place Lower Zone | 40 - 130 | 190 - 220 | 42 - 120 |
| Park Place Intermediate Zone | 155 - 220 | 410 - 430 | 49 - 170 |
| Park Place Upper Zone - CRW | 410 - 430 | 540 | 112 - 168 |
| Park Place View Manor Zone | 230 | 330 | 36 - 79 |
| Park Place Livesay Road Zone | 220 | 360 | 39 - 100 |
| Park Place Jennifer Estates | 200 | 265 | 40 - 68 |
| Paper Mill Zone | 40 | 60 | 102 - 110 |

### Fire Protection

Clackamas Fire District No. 1 (CFD-1) provides fire protection for properties within the City. Since the water distribution system is an integral part of the City's fire protection system, fire protection agencies have adopted and amended the 1997 Uniform Fire Code recommendations regarding minimum required fire flows for buildings within the City. These fire protection requirements are discussed in detail in Chapter 4, "Water Distribution System Service Standards."

### Booster Pumping Stations

Oregon City's water distribution system includes five booster pumping stations that either transfer water to the higher pressure zones or boost system pressure during emergency conditions. Two of the transfer pump stations, Mountainview and Hunter Avenue (Figure 2-9), are designed to fill reservoirs that serve the higher pressure zones. The other two transfer pump stations, Fairway Downs and Livesay Road, operate to maintain a minimum system pressure in




# FIGURE 2-7

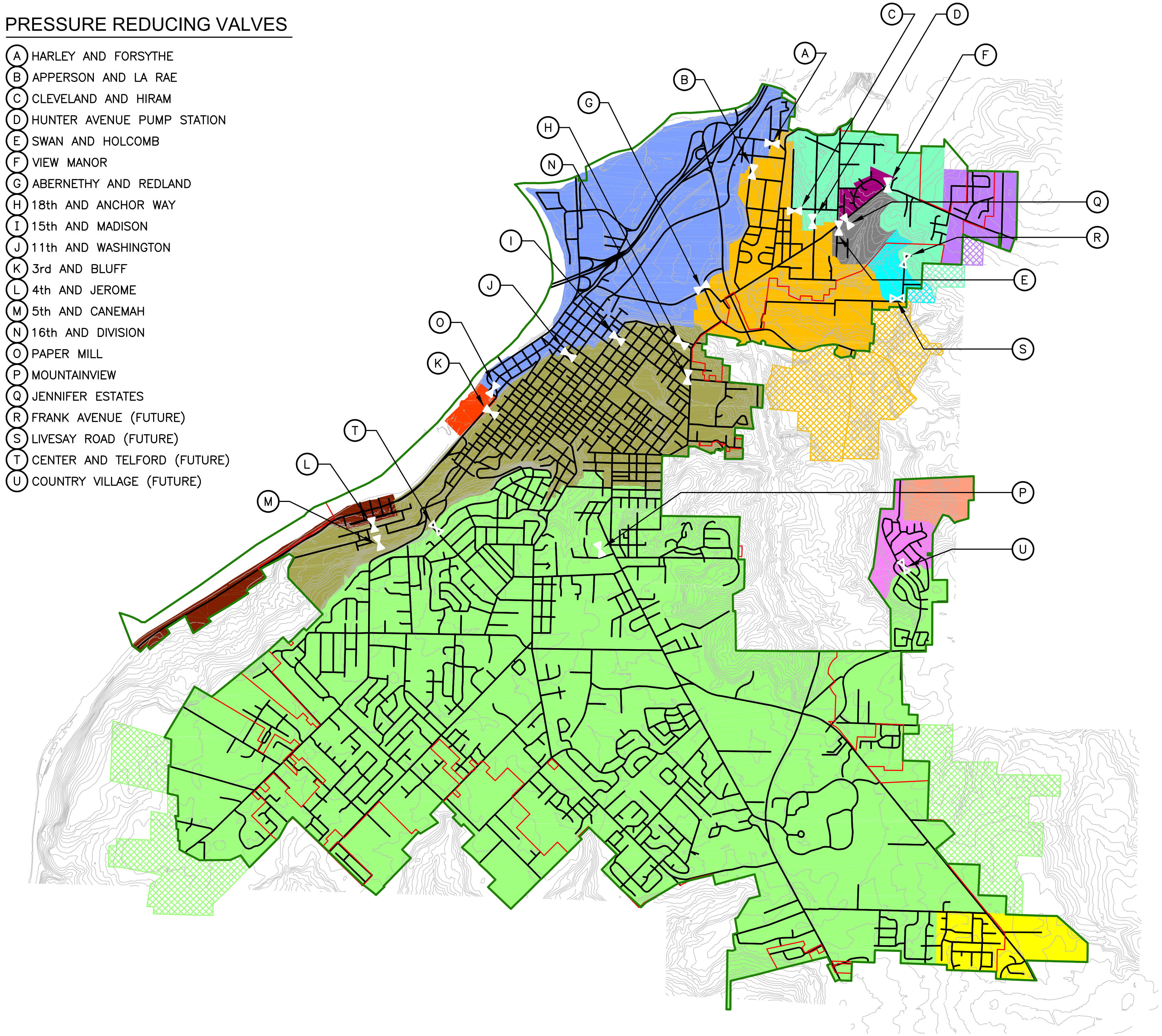
CITY OF OREGON CITY

DISTRIBUTION SYSTEM HYDRAULIC PROFILE

# FIGURE 2-8

## CITY OF OREGON CITY

ULTIMATE PRESSURE ZONE COVERAGE




LEGEND:

- URBAN GROWTH BOUNDARY (UGB)
- PROPOSED UGB EXPANSION AREA
- CITY LIMITS
- 20' CONTOURS
- LOWER ZONE
- INTERMEDIATE ZONE
- UPPER ZONE
- FAIRWAY DOWNS
- CANEMAH DISTRICT
- COUNTRY VILLAGE (CRW)
- CANYON (CRW)
- LOWER–PARK PLACE
- INTERMEDIATE–PARK PLACE
- UPPER–PARK PLACE (CRW)
- LIVESAY ROAD–PARK PLACE
- VIEW MANOR–PARK PLACE
- JENNIFER ESTATES–PARK PLACE
- PAPER MILL ZONE
- PRESSURE REDUCING VALVE STATION (FUTURE)

WEST YOST & ASSOCIATES

CAD FILE: I:/526-01-01-FIG_2-8.dwg CFG FILE:WYA650C.CTB DATE: 9-17-03 VLF areas that are not served by reservoirs. The emergency pump station located at Boynton Reservoir (Figure 2-10) is designed to increase local pressures during emergency conditions. Table 2-4 details the design data for each of the system's pumping stations and the location of each facility is shown on Figure 2-6. The Mountainview Pump Station consists of four pumps, one of which is housed in a separate building along with a back-up diesel drive system. Although there are two separate buildings, this station operates as a single facility.

**Figure 2-9. Hunter Avenue Pump Station**

**Figure 2-10. Boynton Pump Station**

**Table 2-4. Design Data for Existing Booster Pumping Stations**

| Pumping Station Name | Pressure Zone Served | Reservoirs Served | Number of Pumps | Pump Motor Size and Speed (hp/rpm) | Capacity of Each Pump (gpm) | Rated Discharge Head (feet) |
|---|---|---|---|---|---|---|
| Mountainview | Hilltop | Boynton Henrici | 4 | 125/1800<br>125/1800<br>125/1750<br>100/1770 | 1,550<br>1,700<br>2,000<br>1,800 | 214<br>214<br>214<br>156 |
| Boynton | Hilltop | -- | 2 | 75/1750<br>75/1750 | 2,300<br>2,300 | 105<br>105 |
| Hunter Avenue | Park Place Intermediate | Barlow Crest | 3 | 75/1780<br>75/1780<br>75/1780 | 900<br>900<br>900 | 250<br>250<br>250 |
| Fairway Downs | Fairway Downs | -- | 4 | 3/3500<br>15/1750<br>15/1750<br>15/1750 | 50<br>500<br>500<br>500 | 81<br>60<br>60<br>60 |
| Livesay Road | | -- | 1 | 5/3600 | 30 | 210 |

## Pressure Reducing Valve Stations

The Oregon City water distribution system relies on seventeen pressure reducing valve (PRV) stations to supply water from higher pressure zones into the lower pressure zones. These PRV stations are necessary for reducing the pressure of water that is fed from higher elevation regions of the service area. Table 2-5 lists the location of each PRV station along with its size and outlet pressure. The stations typically consist of a small PRV to supply the relatively low flows associated with normal demand conditions and a large PRV to supply the high water demand associated with a fire flow event (Figure 2-11).

**Table 2-5. Pressure Reducing Valve (PRV) Stations**

| Location | Pressure Zone Served | Elevation (feet) | Size (inches) | Outlet Pressure (psi) |
|---|---|---|---|---|
| Harley & Foresythe (south) | Lower Zone | 112 | 1.5<br>4 | Off<br>70 |
| Harley & Foresythe (north) | Lower Zone | 112 | 1.5<br>12<br>4 (relief)<br>4 (relief) | Off<br>65<br>95<br>95 |
| Apperson & La Rae | Lower Zone | 68 | 2<br>4<br>6 | 86<br>79<br>76 |
| Cleveland & Hiram | Park Place Lower Zone | 150 | 4<br>10 | Not Set<br>Not Set |
| Hunter Pump Station | Park Place Lower Zone | 195 | 3<br>6 | 45<br>40 |
| Swan & Holcomb | Park Place Lower Zone | 220 | 4<br>8 | 45<br>40 |
| Wayne Drive & Holcomb | Jennifer Estates | 250 | 4<br>8 | 51<br>46 |
| View Manor | View Manor Zone | 323 | 4<br>8 | 40<br>35 |
| Abernethy & Redland | Lower Zone | 40 | 4<br>8<br>4 (relief)<br>4 (relief) | 108<br>105<br>118<br>130 |
| 18th & Anchor Way | Park Place Lower Zone | 194 | 4<br>8<br>4 (relief) | 53<br>48<br>63 |
| 15th & Madison | Lower Zone | 132 | 1.25<br>6 | 67<br>63 |
| 11th & Washington | Lower Zone | 130 | 3<br>10 | 65<br>60 |
| 3rd & Bluff | Lower Zone | 168 | 3<br>10 | 55<br>50 |
| Paper Mill | Lower Zone<br>(bi-directional) | 54 | 12 | 95 |
| 4th & Jerome | Canemah Zone | 170 | 2<br>6 | 55<br>50 |
| 5th & Canemah | Intermediate Zone | 270 | 1.25<br>4 | 83<br>80 |
| 16th & Division | Intermediate Zone | 260 | 1.25<br>6 | 90<br>85 |
| Mountainview Street | Intermediate Zone | 474 | 10<br>6 | 2<br>2 |

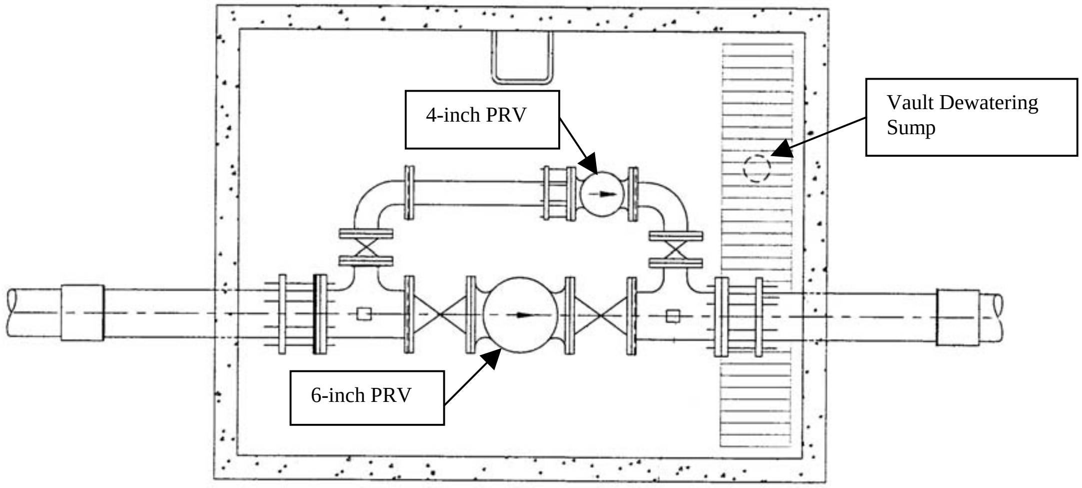



**Figure 2-11. Pressure Reducing Valve Station at View Manor**

## Reservoirs

There are six treated water storage reservoirs within the Oregon City water distribution system. However, two of these reservoirs are no longer in service. Design information for the existing reservoirs is detailed in Table 2-6 and locations are shown on Figure 2-6, presented earlier. The operating reservoirs provide a total of 16.25 million gallons of treated water storage.

**Table 2-6. Design Data for the Existing Reservoirs**

| Reservoir Name | Primary Pressure Zone Served | Year Built | Construction Materials | Capacity (mg) | Bottom Elevation (feet) | Overflow Elevation (feet) |
|---|---|---|---|---|---|---|
| **Operating Reservoirs** | | | | | | |
| Mountainview | Intermediate Lower | 1916 expanded 1952 | Concrete | 10.5 | 463.75 | 490 |
| Boynton | Upper | 1984 | Steel Standpipe | 2.0 | 484 | 592 |
| Henrici | Upper | 1994 | Steel | 2.0 | 573.5 | 592 |
| Barlow Crest | Park Place Intermediate and Lower | 1999 | Steel | 1.75 | 518 | 549 |
| **Out of Service Reservoirs** | | | | | | |
| Mountainview No. 1 | Intermediate | 1898 | Concrete (uncovered) | 1.5 | 462 | 473 |
| Mountainview Elevated Tank | Upper | 1950 | Steel | 0.1 | - | 567 |

Mountainview Reservoir (Figure 2-12) is the City's oldest operating and largest reservoir. The reservoir, constructed in 1916 with a capacity of 5 million gallons, originally served as the terminal point for the Mountain Line water supply system that brought water to Oregon City from Memaloose Creek, approximately eleven miles southeast of Estacada. The reservoir was expanded in 1952 to the current capacity of 10.5 million gallons through the addition of a vertical perimeter wall to the existing concrete basin. A roof system, consisting of laminated wood beams, plywood sheathing, and built-up roofing material supported on galvanized steel pipe columns, was installed in 1978. A 1999 report on the reservoir recommended several improvements including replacement of the built-up roofing material as well as leak repairs to the concrete basin. The results of the seismic evaluation of the reservoir also indicates the need for wall and roof retrofits to meet current seismic standards.

**Figure 2-12. Mountainview Reservoir and the Elevated Tank**

Mountainview Reservoir provides water to the Intermediate and Lower Pressure Zones and is currently supplied by the SFWB's Division Street Pump Station. The Division Street Pump Station also supplies the City of West Linn through a 24 inch transmission main. Due to a higher hydraulic grade line in the Oregon City water distribution system relative to West Linn, water can backfeed from Mountainview Reservoir into the West Linn system when the Division Street Pump Station is not operating. Also, the Division Street Pump Station is equipped with a transfer valve between the discharge and suction piping which allows for filling of the SFWB clearwell from Mountainview Reservoir when the pump station is not operating. This controlled bypassing of the Division Street Pump Station is necessary since portions of Oregon City's Park Place district and portions of the Clackamas River Water (CRW) service area rely on supply from the clearwell even when the SFWB treatment plant is not operating.

Boynton Reservoir (Figure 2-13) is a steel standpipe with a total capacity of 2.0 million gallons that serves the Upper Pressure Zone. Approximately 0.5 million gallons is available by gravity and the remainder can be boosted for fire flows and emergency flows by the manually controlled pump station located on the reservoir site. Water levels in Boynton Reservoir can be used to control pump operation at the Mountainview Pump Station.

**Figure 2-13. Boynton Reservoir**

Henrici Reservoir (Figure 2-14) is located just outside of the southeast boundary of the Oregon City UGB. This reservoir provides a second gravity supply source for the Upper Pressure Zone, allowing either Henrici or Boynton to be taken out of service for maintenance or repair without creating operational problems in the system. The location of Henrici at the southern extremity of the service area has greatly improved fire flow and peak demand condition pressures in that portion of the system. Henrici Reservoir tends to fill slowly relative to Boynton Reservoir when the Mountainview Pump Station is operating; however, this situation is expected to diminish in the future as pipeline improvements and network expansions take place in the vicinity of Henrici. As with Boynton Reservoir, water levels in Henrici Reservoir can also be used to control pump operation at the Mountainview Pump Station.

**Figure 2-14. Henrici Reservoir**

Barlow Crest (Figure 2-15) reservoir is the City's newest storage facility. The reservoir is located in the northeast corner of the Oregon City UGB and serves the Intermediate Zone of the Park Place District. The reservoir is filled by the Hunter Avenue Pump Station which is controlled by SCADA system monitoring of Barlow Crest reservoir water levels. CRW operates a pump station immediately adjacent to the reservoir. This pump station boosts water to CRW's Stoltz Reservoir which serves the Park Place Upper Zone.

**Figure 2-15. Barlow Crest Reservoir**

The open reservoir (Figure 2-16), located at the Mountainview Street water facilities site, is the City's oldest reservoir. Since this reservoir is uncovered and in poor structural condition, it was taken out of service in December of 2001. In addition to the risk of vandalism, the rapid loss of chlorine residual levels in the reservoir created operational difficulties and forced the City to use large amounts of chlorine to maintain compliance with the required minimum chlorine residual of 0.2 mg/L.

**Figure 2-16. Open Reservoir**

The elevated steel tank, located adjacent to Mountain Reservoir at the Mountainview site, was originally designed to provide equalization storage for the upper pressure zone and later provided back-up storage whenever the newer Boynton Reservoir was temporarily out of service. However, with the construction of a second upper pressure zone reservoir (Henrici) in 1994, the elevated storage tank was no longer necessary even for back-up storage and was taken out of service. This tank is scheduled to be dismantled in the near future.

## SYSTEM OPERATION

The general procedures for operation of the Oregon City water distribution system are discussed in the following sections.

### South Fork Water Board (SFWB) Water Treatment Plant

The SFWB operates their water treatment plant (Figure 2-17) to fill the main Oregon City and West Linn reservoirs. Therefore, the operating schedule varies with seasonal variations in water demand. During the low demand periods, the plant generally operates only during the evenings and night to take advantage of off-peak electrical power rates. Operational hours are extended during the high demand summer months, when the plant must operate nearly all day in order to keep the storage reservoirs full.

**Figure 2-17. SFWB Water Treatment Plant**

### Booster Pumping Stations Serving Pressure Zones With Reservoirs

Those booster pumping stations that fill storage reservoirs (Mountainview and Hunter Avenue pump stations) are automatically controlled to maintain preset water levels. When sensors show that the water level in a reservoir has fallen below a preset threshold, the lead pump will activate and begin filling the reservoir to a high water level. If water demand on the reservoir is such that a single pump cannot maintain the water level, a lag pump (or pumps) will activate as necessary until the reservoir fills to a high water level. Although Boynton Pump Station serves a pressure zone with reservoirs, it is manually operated for emergency fire flow conditions only.

### Booster Pumping Stations Serving Pressure Zones Without Reservoirs

Those booster pumping stations that serve areas without storage reservoirs (Fairway Downs and Livesay Road pump stations) are automatically controlled to maintain a minimum discharge pressure at the pumping stations. When pressure sensors show that the discharge pressure has fallen below a preset threshold, the lead pump activates and pumps until the discharge pressure exceeds a high pressure level. At the Fairway Downs Pump Station, water demand in the pump station's service area is such that a single pump cannot maintain the pressure level, a lag pump (or pumps) will activate as necessary until the system pressure is restored.

### Reservoirs

The reservoirs in the water distribution system are generally maintained between 70 and 90 percent full, although levels may be lowered during low demand periods to improve turnover and ensure adequate chlorine residual levels. The fluctuating water volume represents the operating and equalization storage caused by pump station control strategies and non-uniform demand in the system. The remaining storage is allocated to providing fire flow requirements and emergency reserves.

Altitude valves (Figure 2-18) are in place to control the flow into and out of Boynton and Henrici reservoirs. These valves are designed to close when the reservoir is full and open when the system pressure drops. The other reservoirs in the distribution system float on the system. At Henrici Reservoir, the altitude valve is currently not operating since the SCADA system is used to prevent overfilling.

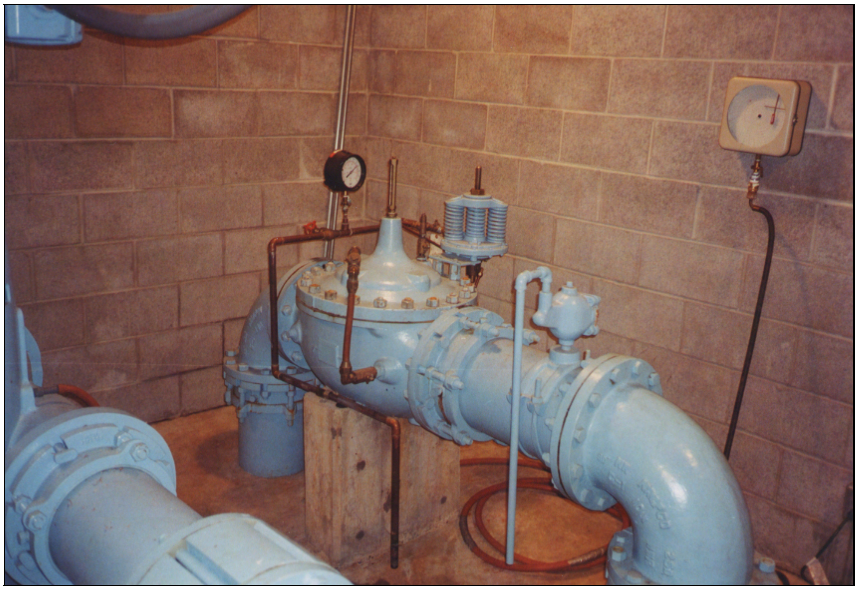


**Figure 2-18. Altitude Valve at Boynton Reservoir**

### Pressure Reducing Valves

The pressure reducing valve (PRV) stations control the flow of water from upper pressure zones to lower pressure zones. Each station contains at least two PRVs, one large and one small. The small PRV provides service during normal operating conditions and the large PRV provides higher flows during a fire flow condition.

### Supervisory Control and Data Acquisition (SCADA) System

The City's SCADA system interface is located at the Mountainview Pump Station and currently monitors reservoir levels at the Boynton Reservoir and Henrici Reservoir, views alarms, and allows for changes in pump set points according to which reservoir is in control. The South Fork Water Board maintains another SCADA system that monitors the Barlow Crest Reservoir level and controls the Hunter Avenue Pump Station.

The City is in the process of upgrading the water distribution SCADA system to allow improved monitoring and control of water operations. The new central computer system for the human-machine interface will be located at the Oregon City public works building at 122 South Center Street. Remote monitoring will also be possible through the use of a laptop computer. The new SCADA system will provide information for each pump station, reservoir, and PRV station including some or all of the following:

1. Pump Stations:
    a. Run status
    b. Total elapsed run time
    c. All possible faults
    d. pH monitoring
    e. Chlorine residual level monitoring
2. Reservoirs:
    a. Chlorine residual level monitoring
    b. pH monitoring
    c. Water elevation
    d. Hatch/Door Intrusion
3. PRVs:
    a. Upstream pressure
    b. Downstream pressure

Water operations staff will control set points for pump operation at the Mountainview and Hunter Avenue stations. The system will also monitor pump operation at Barlow Crest (a Clackamas River Water pump station) but will not control set points. The SCADA system improvements are anticipated to be completed in 2004.

**WATER QUALITY MONITORING**

The City conducts regular water quality monitoring in the distribution system to ensure the provision of safe drinking water to customers. The City's regular activities focus on ensuring compliance with federal and state regulations, monitoring the flow of water through pump stations and reservoirs, and addressing any issues of concern to water customers.

Specific water quality sampling activities include the following:

- A minimum of 30 bacteriological samples are collected each month from locations that are representative of the entire distribution system.
- Samples for disinfection by-products (regulated trihalomethanes and haloacetic acid compounds) are collected from four designated sites on a quarterly basis.
- In the limited areas where asbestos-cement pipe is still in service, asbestos sampling is required every nine years.

As a community water system, the City delivers an annual water quality report to all water customers. The City also uses these reports to update the community on improvements to the water distribution system and to answer frequently asked questions.

Additional programs that optimize water quality in the distribution system include a program for controlling and eliminating cross connections and an annual dead-end line flushing program. Further, the upgrade of the City's SCADA system will streamline pump station and reservoir monitoring, making it easier to minimize water detention time within the distribution system.

# CHAPTER 3

# WATER DEMAND ANALYSIS

This chapter presents historic data on water deliveries to the City of Oregon City from the South Fork Water Board (SFWB) as well as customer demand data from the City's billing records. These historical data define the unique patterns that characterize water use in Oregon City and provide a framework for projecting future water demand in the community. Analysis of the data also relates the various measures of water demand (maximum monthly demand, maximum daily demand, and peak hour demand) to the average annual demand through the use of peaking factors.

The projection of future water demand is based on unit demand factors that are indexed to land use categories and population levels. These future demand projections provide the basis for assessing the adequacy of the existing water distribution system and planning for future improvements.

## EXISTING WATER USE

There are several measures of water use that are important to analyze during the development of the water master plan. Following is a description of the critical water demand factors that will guide planning decisions with respect to the Oregon City water distribution system:

- Annual average demand – A measure of the average amount of water used by the community on an annual basis. The annual average demand can be compared to annual billing records to assess the unaccounted for water rate.
- Monthly average demand – A measure of the amount of water used by the community in a given month. Review of monthly average water demand illustrates seasonal variations in demand due to such factors as climate, irrigation, industrial production, and domestic use patterns.
- Maximum day demand – A measure of the maximum amount of water used by the community in a single day. The maximum daily water demand is used to size booster pumping stations that serve areas with storage reservoirs. This measure of demand is also used in conjunction with fire demands and emergency supplies to size storage reservoirs.
- Peak hour demand – A measure of the maximum amount of water used by the community in a single hour. The peak hour water demand is used to size pipelines and booster pumping stations that serve pressure zones without reservoirs.

Analysis of the water demand factors described above allows for the development of peaking factors, expressed as a ratio of each factor to the annual average demand. Historical peaking factors are useful for comparing the system-wide water use patterns in Oregon City to other communities and for projecting future water use patterns.

**Annual Average and Monthly Average Water Demand**

The City of Oregon City regularly monitors master metering stations that record the volume of water delivered by the SFWB. The City reads the meters on a monthly basis for the purpose of calculating payments to the SFWB. Although there have been errors in the master metering system in the past, the following data have been corrected to the greatest extent possible and provide an accurate representation of water demand in Oregon City. Table 3-1 presents historical delivered water data for the past five years, from 1997 to 2001. Analysis of these data allows for the identification of annual average and monthly average water demand. Based on the data presented in Table 3-1, it is also possible to identify a peaking factor between the average annual demand and the maximum monthly demand. Table 3-2 summarizes the peaking factor analysis for maximum monthly demand.

**Table 3-1. Historical Oregon City Water Use**

| Month | Monthly Average Demand (mgd[a]) | | | | |
|---|---|---|---|---|---|
| | 1997 | 1998 | 1999 | 2000 | 2001 |
| January | 2.65 | 2.85 | 2.72 | 2.81 | 2.84 |
| February | 2.40 | 3.16 | 2.77 | 2.96 | 2.76 |
| March | 2.95 | 2.98 | 2.95 | 2.80 | 2.94 |
| April | 2.61 | 2.96 | 2.82 | 2.74 | 3.21 |
| May | 2.90 | 2.95 | 2.69 | 3.40 | 3.41 |
| June | 3.48 | 3.66 | 3.89 | 2.79 | 4.03 |
| July | 4.49 | 4.93 | 4.73 | 5.75 | 5.54 |
| August | 4.73 | 5.46 | 5.21 | 5.59 | 5.20 |
| September | 3.75 | 4.63 | 4.60 | 4.13 | 4.64 |
| October | 2.93 | 3.02 | 3.11 | 3.18 | 3.46 |
| November | 2.72 | 3.05 | 2.74 | 2.90 | 3.12 |
| December | 3.25 | 3.15 | 2.62 | 2.71 | 2.66 |
| Average Annual | 3.25 | 3.57 | 3.41 | 3.49 | 3.65 |
| Maximum Month | 4.73 | 5.46 | 5.21 | 5.75 | 5.54 |

[a]mgd: millions of gallons per day

From 1997 to 2001, master metering data indicated that the average annual demand ranged from 3.25 million gallons per day (mgd) to 3.65 mgd and averaged 3.47 mgd. The highest maximum monthly water demand was 5.75 mgd in July of 2000. Analysis of these historical data indicates that the average peaking factor for the maximum monthly demand is 1.54.

**Table 3-2. Maximum Monthly Demand Peaking Factor in Oregon City**

| Year | Average Annual Demand (mgd[a]) | Maximum Monthly Demand (mgd[a]) | Maximum Month Peaking Factor |
|---|---|---|---|
| 1997 | 3.25 | 4.73 | 1.46 |
| 1998 | 3.57 | 5.46 | 1.53 |
| 1999 | 3.41 | 5.21 | 1.53 |
| 2000 | 3.49 | 5.75 | 1.65 |
| 2001 | 3.65 | 5.54 | 1.52 |
| Average | - | - | 1.54 |

[a]mgd: millions of gallons per day

### Maximum Daily Water Demand

Since the City's master meters are read on a monthly basis, historical data on the daily delivered water volumes to Oregon City are not available. However, the SFWB does maintain daily records of their overall water production volume. Since variations in the treatment plant's daily production correspond to the daily variations in demand within the served water systems, the peaking factor for the SFWB's daily production should roughly conform to the peaking factor for daily demand in the Oregon City water distribution system. Table 3-3 presents the average annual, maximum month, and maximum daily production rates for the SFWB treatment plant from 1997 to 2001. Also, shown in the table are the resulting peaking factors for the maximum monthly and maximum daily flows.

**Table 3-3. SFWB Water Production Data and Peaking Factors**

| Year | Average Annual Production (mgd[a]) | Maximum Monthly Production (mgd[a]) | Maximum Daily Production (mgd[a]) | Maximum Month Peaking Factor | Maximum Daily Peaking Factor |
|---|---|---|---|---|---|
| 1997 | 8.12 | 12.48 | 16.31 | 1.54 | 2.01 |
| 1998 | 8.33 | 14.23 | 17.58 | 1.71 | 2.11 |
| 1999 | 7.90 | 11.92 | 14.83 | 1.51 | 1.88 |
| 2000 | 8.01 | 13.55 | 17.08 | 1.69 | 2.13 |
| 2001 | 7.51 | 12.14 | 16.51 | 1.62 | 2.20 |
| Average | - | - | - | 1.60 | 2.10 |

[a]mgd: millions of gallons per day

The maximum month peaking factor for the SFWB treatment plant of 1.60 corresponds well to the maximum month peaking factor of 1.54 that was independently determined for the Oregon City water distribution system in the preceding section. It is reasonable to expect that the SFWB plant's maximum daily peaking factor of 2.1 will also correspond well to the maximum daily demand in Oregon City.

### Peak Hour Demand

The peak hour demand on a water distribution system in Western Oregon typically occurs during mid-summer when customers are heavily irrigating landscaped yards and parks. For the City of Oregon City, the peak hour demand would be expected to happen in the month of July or August during the peak day demand. An estimate of the peak hour demand is typically developed based on an analysis of hourly water level data from each of the reservoirs in the distribution system during the summertime peak demand period. In combination with data on the daily delivered water rate for that period, it is possible to analyze the reservoir data and identify the peak hour demand. Since this level of detail on system operations is currently not available from the City's SCADA system records, it was not possible to develop a customized estimate of peak hour demand for Oregon City. However, a review of the peaking factors reported by other Western Oregon communities with similar variation in seasonal demand indicates that the system-wide peak hour demand for Oregon City is likely to be 4.5 times the average annual demand. Since this is a system-wide peaking factor, local peaking factors will be higher for small areas or areas with exclusively single-family residences.

### Summary of Existing Water Demand and Peaking Factors

Table 3-4 summarizes the system-wide water demand and peaking factors for Oregon City based on analysis of data from the past five years. The maximum day demand is estimated using a peaking factor from the SFWB treatment plant and the peak hour demand is estimated using a general Western Oregon peaking factor. All of the identified peaking factor values are fairly typical for a Western Oregon community. The system-wide peaking factors for Oregon City provide a basis for projecting future water demand patterns for the community.

**Table 3-4. Existing Oregon City Demand and System-Wide Peaking Factor Summary[a]**

| Description | Current Demand (mgd[b]) | Peaking Factor |
|---|---|---|
| Average annual demand | 3.7 | 1.0 |
| Maximum month demand | 5.6 | 1.5 |
| Maximum day demand | 7.8 | 2.1 |
| Peak hour demand | 16.7 | 4.5 |

[a]The average demand multiplied by the peaking factor yields the respective demand.
[b]mgd: millions of gallons per day

### Per Capita Water Demand

Per capita water demand is also a useful demand measure that is derived from the preceding historical data. Table 3-5 presents the population for Oregon City along with the average annual demand during the past five years which allows for calculation of the average demand in gallons per capita per day (gpcd). Ranging from 133 gpcd to 158 gpcd, the average daily water demand is 144 gpcd. Note that this unit demand factor is based on water production and includes all uses: residential, commercial, industrial, institutional, and unaccounted for or lost water. The relatively higher per capita demand shown for 1997-99 relative to per capita demand in 2000-01 may reflect an underestimated Oregon City population prior to the 2000 Census. Nevertheless, variation in per capita demand from year to year is expected due to irregular water use patterns caused by unsteady weather and end user demand characteristics.

**Table 3-5. Per Capita Water Demand[a] for 1997 to 2001**

| Year | Population | Average Demand (mgd[b]) | Average Demand (gpcd[c]) |
|---|---|---|---|
| 1997 | 21,895 | 3.25 | 148 |
| 1998 | 22,560 | 3.57 | 158 |
| 1999 | 23,405 | 3.41 | 146 |
| 2000 | 26,200 | 3.49 | 133 |
| 2001 | 26,680 | 3.65 | 137 |
| Average | - | - | 144 |

[a]Demand include all uses (residential, commercial, industrial, institutional, and unaccounted).
[b]mgd: millions of gallons per day
[c]gpcd: gallons per capita per day

### High Consumption Water Customers

The City of Oregon City serves a number of high consumption water customers. In order to ensure that the high demands associated with these facilities are accounted for in the planning process, the largest customers are identified for specific modeling as point demands. Table 3-6 identifies the customers with a water demand greater than one million gallons per month (0.033 million gallons per day). In addition to providing their average water demand rates, the table also identifies their location and user category.

**Table 3-6. High Consumption Water Customers in Oregon City**

| Facility | Address | User Category | Average Water Demand (mgd[a]) |
|---|---|---|---|
| Blue Heron Paper Co. | 401 Main St | Industrial/Commercial | 0.10 |
| Clackamas Community College | 19600 S. Molalla Ave | Institutional | 0.06 |
| Pioneer Ridge Apts. | 13826 S. Meyers Rd | Multi-Family | 0.06 |
| Willamette Falls Hospital | 1400 Division St | Institutional | 0.05 |
| King's Berry Heights Apts. | 14290 Marjorie Ln | Multi-Family | 0.05 |
| Clackamas County Jail | 2206 Kaen Rd | Institutional | 0.04 |

[a]mgd: millions of gallons per day

### Unaccounted for Water

All water distribution systems experience losses of water during distribution to the end user. These losses, known as unaccounted for water, result from many situations including unmetered customers, transmission system leaks, reservoir leaks, main breaks, faulty meters, over-filling reservoirs, fire fighting activities, system flushing, and other miscellaneous hydrant uses. In addition, the City has discovered that the water circulated through the decommissioned elevated tank at Mountainview Street is also unaccounted for water. Thus, the total volume of water metered for all end users in Oregon City is expected to be less than the volume of water delivered by the SFWB.

Table 3-7 shows the estimated volume of unaccounted for water in millions of gallons (mg) and also as a percentage of total delivered water during the past five years. Although the schedules for reading the master meters are quite different than the schedules for reading customer meters, the average unaccounted for water rate over a full one-year period will be quite accurate. The five year average number will be even more accurate. A distribution system in good condition typically shows a water loss rate of 10 to 15 percent. Therefore, the calculated unaccounted for water rate of 18.2 percent indicates that the volume of under-reported water use in Oregon City is significant and warrants further attention.

Since the City of Oregon City has made significant efforts in recent years to install meters for all customers including City owned parks and facilities, unmetered customers are not expected to be a major source of unaccounted for water. Since 2000, the City is also averaging 450 old meter change outs per year, as well as more than 10,000 feet of old pipeline replacement per year. Ongoing refinement of master metering and record keeping practices is anticipated to further reduce the volume of unaccounted for water in the coming years, particularly by eliminating some past problems such as non-recording of the circulation water for the elevated tank. The City may wish to consider implementing other programs that will reduce the unaccounted for water rate such as continued replacement of old customer meters, metering of construction site water use, and improved monitoring of hydrant use for system flushing and fire fighting. In the event that a high unaccounted for water rate persists in coming years despite the comprehensive efforts, the City may also consider contracting with a leak detection service to inspect the distribution system. The leak detection effort should focus on the older, higher pressure areas of the distribution system where leaks are most to occur and are most likely to be significant.

**Table 3-7. Unaccounted for Water, 1997-2001**

| Year | Delivered Water (mg[a]) | Metered Water (mg[a]) | Unaccounted for Water (mg[a]) | Percent of Total Delivered Water |
|---|---|---|---|---|
| 1997 | 1,185 | 1,014 | 171 | 14.4 |
| 1998 | 1,303 | 1,036 | 267 | 20.5 |
| 1999 | 1,245 | 985 | 260 | 20.9 |
| 2000 | 1,273 | 1,070 | 203 | 15.9 |
| 2001 | 1,332 | 1,074 | 258 | 19.4 |
| Average | - | - | - | 18.2 |

[a]mg: millions of gallons

**Unit Demand Factors by Land Use Pattern**

The development of water demand factors related to land use patterns provides another important perspective on water demand in the community. Based on historical billing data provided by the City's Finance Department for the period between 1997 and 2001, Table 3-8 summarizes annual average water demand within three general land use pattern categories: single family residential, multi-family residential, and industrial/commercial. The single family residential designation includes the institutional land use category since the majority of churches, schools, retirement homes, etc. are located within areas zoned for residential development. As indicated in the percentage summary of annual average demand by land use, the single family residential classification accounts for nearly two-thirds of the water used in Oregon City.

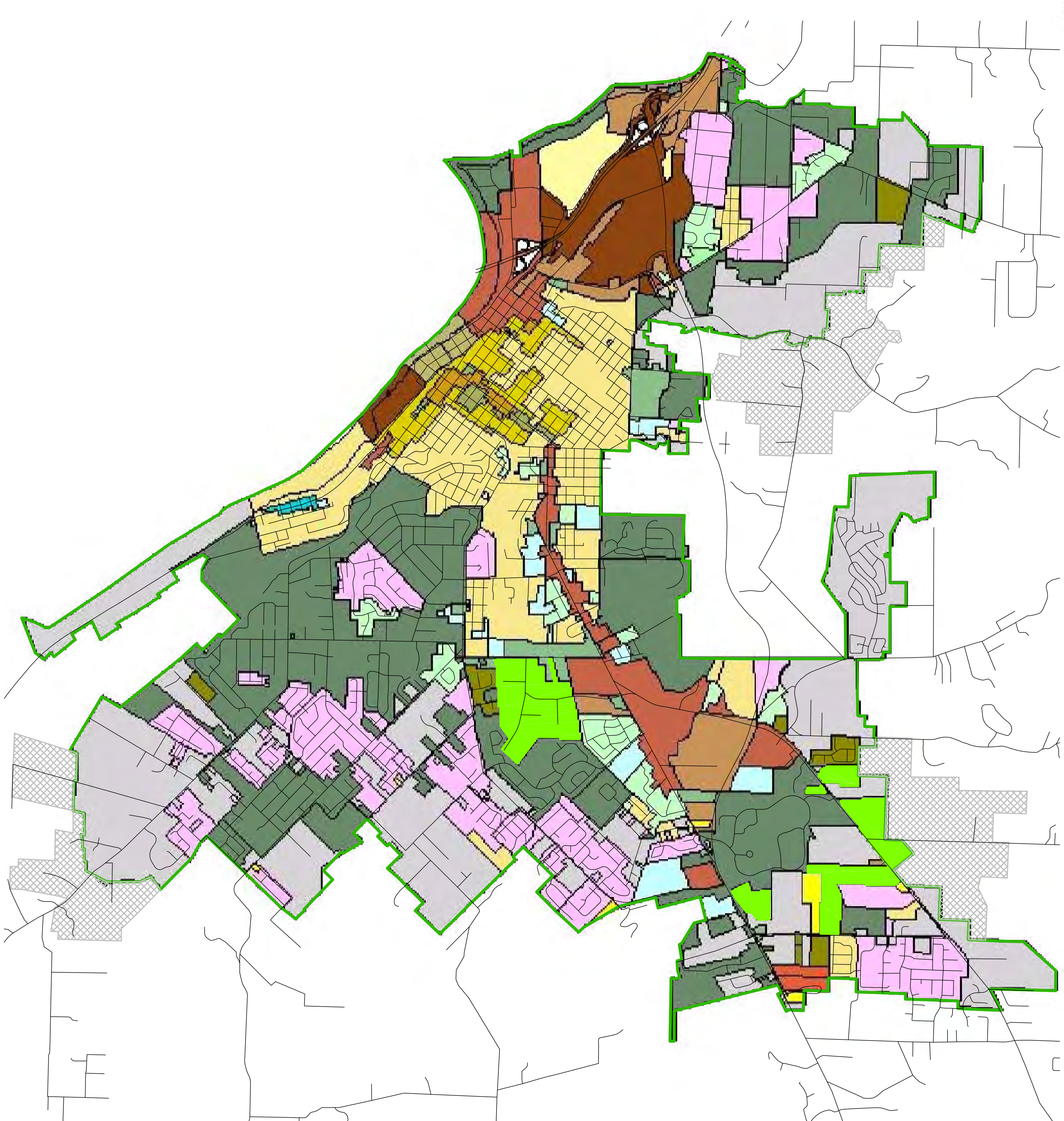
**Table 3-8. Oregon City Water Use by Customer Class, 1997-2001**

| | Demand (mgd[c]) | | | |
|---|---|---|---|---|
| Year | Single Family[a] | Multi-Family | Industrial/ Commercial | Total |
| 1997 | 1.77 | 0.48 | 0.54 | 2.78 |
| 1998 | NA[b] | NA[b] | NA[b] | NA[b] |
| 1999 | 1.69 | 0.49 | 0.52 | 2.70 |
| 2000 | 1.91 | 0.50 | 0.53 | 2.93 |
| 2001 | 1.89 | 0.53 | 0.52 | 2.94 |
| Percent of total annual average demand | 64% | 18% | 18% | 100% |

[a]The Single Family customer class includes institutional customers.
[b]NA - not available
[c]mgd: millions of gallons per day

To develop a unit demand factor for the four different land use patterns, the water demand data presented in Table 3-8 is combined with estimated areas for each of the land use categories. Figure 3-1 shows the zoning designations for all properties within the Oregon City city limits. Each zoning classification was associated with one of the three broad land use categories: single family residential, multi-family residential, and industrial/commercial. Table 3-9 summarizes the assignment of each zoning classification to a land use category.

Table 3-10 summarizes the acreages by land use category for all areas within the city limits of Oregon City. This summary was derived by overlaying the City's zoning map with a map of all developed land within the city limits. The quotient of water demand and acreage yields a unit demand factor for each land use category in gallons per acre per day (gpad), as summarized in Table 3-11. Since the billing record information presented in Table 3-8 does not include unaccounted for water, the calculation of these unit demand factors by land use includes an allowance for unaccounted for water. Based on these calculated unit demand factors, Table 3-11 also includes recommended unit demand factors for future planning. These planning level demand factors allow for more intensive water consumption patterns in the future, especially for the City's industrial/commercial land which currently exhibits relatively low levels of water demand.



# FIGURE 3-1

## CITY OF OREGON CITY

ZONING DESIGNATIONS

N

0 2000 4000
SCALE IN FEET

LEGEND:

| | | |
|---|---|---|
| | | URBAN GROWTH BOUNDARY (UGB) |
| | | PROPOSED UGB EXPANSION AREA |
| | R–10 | SINGLE FAMILY DWELLING |
| | R–8 | SINGLE FAMILY DWELLING |
| | R–6 | SINGLE FAMILY DWELLING |
| | R–6/MH | SINGLE FAMILY DWELLING |
| | RC–4 | McLOUGHLIN CONDITIONAL |
| | RD–4 | TWO FAMILY DWELLING |
| | RA–2 | MULTIFAMILY DWELLING |
| | LOC | LIMITED OFFICE CONDITIONAL |
| | LO | LIMITED OFFICE |
| | NC | NEIGHBORHOOD COMMERCIAL |
| | HC | HISTORIC COMMERCIAL |
| | LC | LIMITED COMMERCIAL |
| | C | GENERAL COMMERCIAL |
| | CBD | CENTRAL BUSINESS |
| | M–1 | LIGHT INDUSTRIAL |
| | M–2 | HEAVY INDUSTRIAL |
| | C–I | CAMPUS INDUSTRIAL |
| | TC | TOURIST |
| | COUNTY | |
| | RECENT ANNEX (FU–10) | |
| | RD4–MDP | MANUFACTURED DWELLING PARK DISTRICT |
| | FUTURE URBAN | |

WEST YOST & ASSOCIATES

CAD FILE: I:/526-01-01-FIG_3-1.dwg CFG FILE:WYA650C.CTB DATE: 6-11-03 VLF

**Table 3-9. Zoning Classification by Land Use Category**

| | Land Use Category | | |
|---|---|---|---|
| | Single Family | Multi-Family | Industrial/Commercial |
| Zoning Classifications | R-10 Single Family | RD-4 Two Family | M-1 Light Industrial/ LOC Limited Office Cond |
| | R-8 Single Family | RA-2 Multi Family | M-2 Heavy Industrial/ LO Limited Office |
| | R-6 Single Family | RD-4-MDP Manufactured Dwelling Park | C-I Campus Industrial/ NC Neighborhood Com |
| | R-6/MH Single Family | | HC Historic Commercial |
| | RC-4 McLoughlin | | LC Limited Commercial |
| | County | | C General Commercial |
| | Recent Annex | | CBD Central Business |
| | | | TC Tourist |
| | | | Future Urban |

**Table 3-10. Land Use in Acres**

| Land Use Category[a] | Served Area (acres) | Percentage (%) |
|---|---|---|
| Single Family | 2,932 | 71 |
| Multi-Family | 302 | 7 |
| Industrial/Commercial | 933 | 22 |
| Total | 4,167 | 100 |

[a]The Single Family land use category includes institutional customers of the water distribution system.

**Table 3-11. Unit Demand by Customer Class**

| Land Use Category | Average Demand[a] (mgd[b]) | Land Use Area (acres) | Calculated Unit Demand (gpad[c]) | Planning Level Unit Demand (gpad[c]) |
|---|---|---|---|---|
| Single-Family Residential | 2.36 | 2,932 | 810 | 900 |
| Multi-Family Residential | 0.65 | 302 | 2,150 | 2,200 |
| Industrial/Commercial | 0.69 | 933 | 740 | 1,000 |
| Total | 3.70 | 4,167 | - | - |

[a]The average demand estimate includes unaccounted for water.
[b]mgd: millions of gallons per day
[c]gpad: gallons per acre per day

## FUTURE WATER DEMAND

Projections of future water demand for the Oregon City water distribution system are based on the unit demand factors developed in the preceding section. The following analysis presents estimates of the City's water demand for both the 20-year planning horizon (year 2023) and for build-out of the existing UGB.

### Year 2023 Water Demand Projection

The year 2023 water demand projection is based on the anticipated rate of population growth in Oregon City over the next 20 years. Since water demand patterns in Oregon City are not anticipated to change significantly during the planning period, the projected future population provides a sound basis for estimating future water demand for the system. The most recent population projections by Metro anticipated that Oregon City would grow at an annual average rate of 2.0 percent. However, review of historical data indicates that the annual average growth rate in Oregon City was six percent during the 1990s. Since the rate of growth will determine the necessary timing of certain improvement projects, it is recommended that the City consider the possibility of faster growth rates during development of the capital improvement plan and financing plan. To allow for consideration of potentially higher rates of growth than the Metro projections, all analysis of future conditions will consider both 2.0 percent and 3.0 percent annual growth rates. At a growth rate of 2.0 percent, the City's existing population of 26,680 will grow to 41,250 by the year 2023. At a growth rate of 3.0 percent, the population will grow to 51,100 during the same period.

The future population can be translated into a future water demand using the per capita water demand factor of 144 gpcd developed earlier. Using this figure, the year 2023 average annual water demand will be 5.9 mgd at the 2.0 percent growth rate and 7.4 mgd at the 3.0 percent growth rate. Based on these estimates of the year 2023 average annual demand, the corresponding estimates of maximum month, maximum day, and peak hour demand can be estimated using the historical peaking factors. Table 3-12 summarizes the water demand projections for the year 2023 condition.

**Table 3-12. Year 2023 Water Demand Projection Summary**

| Description | Current Water Demand (mgd[a]) | Year 2023 Water Demand at 2% Growth (mgd[a]) | Year 2023 Water Demand at 3% Growth (mgd[a]) |
|---|---|---|---|
| Average Annual | 3.7 | 5.9 | 7.4 |
| Maximum Month | 5.6 | 8.9 | 11.1 |
| Maximum Day | 7.8 | 12.4 | 15.5 |
| Peak Hour | 16.7 | 26.6 | 33.3 |

[a]mgd: millions of gallons per day

### UGB Build-Out Water Demand Projection

The projection of water demand in Oregon City at build-out of the urban growth boundary is based on the land use demand factors developed earlier in conjunction with an estimate of the City's ultimate urban area. Assuming a future land use profile similar to the existing community, Table 3-13 summarizes the acreage of properties within the UGB by land use category. Using these acreages and the unit demand factors developed for these land use categories, the projected average annual water demand at Oregon City's UGB build-out condition is 7.2 mgd. Since this demand projection falls between the year 2023 estimates, it appears that Oregon City could achieve build-out of the existing UGB within 20 years.

**Table 3-13. Land Use Based Water Demand Projections for UGB Build-Out**

| Land Use Category | UGB Area (acres) | Unit Demand (gpad[a]) | Estimated Average Annual Demand, mgd[b]) |
|---|---|---|---|
| Single Family Residential | 4,985 | 900 | 4.5 |
| Multi-Family Residential | 513 | 2,200 | 1.1 |
| Industrial/Commercial | 1,586 | 1,000 | 1.6 |
| Total | 7,085 | | 7.2 |

[a]gpad: gallons per acre per day
[b]mgd: millions of gallons per day

Based on this estimate of the build-out average annual demand, the corresponding estimates of maximum month, maximum day, and peak hour demand can be estimated using the historical peaking factors. Table 3-14 summarizes the water demand projections for the UGB build-out condition.

**Table 3-14. Build-Out Water Demand Projection Summary**

| Description | Current Water Demand (mgd[a]) | Build-Out Water Demand (mgd[a]) |
|---|---|---|
| Average Annual | 3.7 | 7.2 |
| Maximum Month | 5.6 | 11.0 |
| Maximum Day | 7.8 | 15.0 |
| Peak Hour | 16.7 | 32.0 |

[a]mgd: millions of gallons per day

In addition to properties within the existing UGB, there are former urban reserve areas located adjacent to the UGB that could potentially receive urban services in the future. In late 2002, the City received preliminary approval to expand the UGB in three locations which are shown in Figure 3-1. The total area for these properties is approximately 800 acres. Assuming that these properties will ultimately develop into a similar land use profile as the existing community, the additional acreage would increase the annual average demand on the system by approximately 0.8 mgd.

### Clackamas River Water

The City of Oregon City conveys SFWB water through its distribution system for delivery to Clackamas River Water (CRW) at five different locations. Since this practice will continue for the foreseeable future, it is necessary to plan for providing adequate system capacity for these water wheeling services in addition to serving Oregon City's own customers. Table 3-15 summarizes the most recent annual average and maximum month water deliveries to CRW at each of the five delivery locations. An estimate of the maximum day demand is also provided based on a peaking factor of 3. A maximum day peaking factor greater than Oregon City's peaking factor is warranted due to the higher percentage of residential development.

**Table 3-15. Water Wheeled to CRW in 2001**

| Location | Average Annual Demand (mgd) | Maximum Month Demand (mgd) | Estimated Maximum Daily Demand (mgd) |
|---|---|---|---|
| Meyers and Leland Roads | 0.07 | 0.12 | 0.22 |
| South End & Impala Roads | 0.03 | 0.08 | 0.10 |
| Barlow Crest Pump Station | 0.17 | 0.35 | 0.51 |
| Barlow Crest Reservoir | 0.01 | 0.02 | 0.03 |
| Forsythe & Swan Roads | 0.01 | 0.02 | 0.04 |

Future demand for the areas served by CRW through the Oregon City delivery locations is uncertain. Portions of the CRW service areas are incorporated into the Oregon City system as the city limits expand toward the urban growth boundary while CRW continues to add customers outside of the UGB. Metro projections for these unincorporated areas are not available, but CRW staff feel that two percent annual growth is a reasonable estimate. Therefore, for the purpose of the master planning process, it is assumed that the CRW demands on the Oregon City system will grow at an average annual rate of two percent. Based on this growth rate, Table 3-16 summarizes CRW demands at the year 2023/build-out condition.

**Table 3-16. Projection of Future Water Wheeled to CRW
Year 2023/Build-Out**

| Location | Average Annual Demand (mgd) | Maximum Month Demand (mgd) | Estimated Maximum Daily Demand (mgd) |
|---|---|---|---|
| Meyers & Leland Roads | 0.11 | 0.17 | 0.33 |
| South End & Impala Roads | 0.05 | 0.12 | 0.14 |
| Barlow Crest Pump Station | 0.25 | 0.52 | 0.76 |
| Barlow Crest Reservoir | 0.01 | 0.02 | 0.04 |
| Forsythe & Swan Roads | 0.02 | 0.03 | 0.06 |

# CHAPTER 4

# WATER DISTRIBUTION SYSTEM SERVICE STANDARDS

As the provider of water service to the community, the City of Oregon City measures the performance of the water utility according to specific benchmarks for service quality. These benchmarks have been developed to ensure that the City provides customers with acceptable water service at all times. For instance, customers expect the City to reliably provide water at an adequate pressure for a full range of demand conditions. Also, since the water distribution network is an integral part of the fire fighting system, customers expect the City to provide adequate fire flow supplies to protect buildings and other properties within the community. The service standards recommended in this chapter provide a basis for evaluating the City's existing water distribution system and guide the planning and design of those improvements to the system that are necessary to meet future demands.

The following discussion presents service standards for water quality, quantity, and pressure, as well as the minimum supply levels for fire protection. The standards set forth in this chapter are derived from regulations, rules, and recommendations established by a variety of sources including the Oregon State Department of Human Services (DHS), the Environmental Protection Agency (EPA), the American Water Works Association (AWWA), the Insurance Services Office, Inc. (ISO), and the Uniform Fire Code (UFC).

## WATER SERVICE QUALITY STANDARDS

Water service quality standards largely pertain to protecting public health and consistently delivering a satisfactory product to the customer. Most of the water quality considerations are related to supply and treatment issues and are not the subject of this plan. In a water distribution network, a major water quality concern is maintaining compliance with the Oregon State DHS residual disinfectant requirements. The DHS requires that there is a measurable chlorine residual level throughout the system in at least 95 percent of all monthly samples and a chlorine residual of at least 0.2 mg/l where water enters the distribution system.

Attention to enhancing the reliability of the system under all conditions is another important part of maintaining high quality water service. Reliability is achieved through a number of system features including appropriately sized storage; redundant pumping, transmission, and rechlorination where required; and alternate power supplies. Reliability and water quality are also improved by designing looped water distribution pipelines and avoiding dead-end distribution mains whenever possible. Looping pipeline configurations reduce the potential for stagnant water and the associated problems of poor taste and low chlorine residuals. Proper valve placement is also necessary to maintain reliable system operation under normal and abnormal operating conditions.

## DISTRIBUTION AND STORAGE SERVICE STANDARDS

The water distribution and storage system must allow for effective service under normal operations as well as during times of system stress, such as maximum day demand, fire flows, and peak hour demand. The following performance guidelines reflect standard water system planning and design criteria which have been developed by various State agencies and other water utilities. These guidelines have been developed to ensure that a system is capable of accommodating the critical operational conditions that affect each component of the water system. As such, these standards are recommended to the City as long term performance criteria for future system improvements.

### Water Supply and Treatment Capacity

The following criteria should be used to assess the adequacy of the City's water supply and treatment capacity. Since the City of Oregon City shares its source of supply with two other water purveyors, evaluations of the water supply and treatment capacity must account for overall demand on the South Fork Water Board (SFWB) facility.

<u>Source Supply</u>. The reliable yield of all sources of supply should exceed the projected maximum day demand on the system. The definition of reliable yield of water supplies is that which can be delivered to the City during the worst drought. The worst drought conditions are estimated from historical stream flow records. The reliable yield from the SFWB's water rights is nearly 52 mgd, well in excess of the historical overall maximum day demand of 18.3 mgd.

<u>Treatment Capacity</u>. Total potable water production and supply delivery capacity should be equal to or greater than the maximum day demand. It is recommended that the total maximum production capacity be at least ten percent greater than the maximum day demand to allow for concurrent fire flow demands, meeting drinking water quality standards with difficult water, or repairing equipment. Since the overall historical maximum day demand on the system is approaching the 20 mgd treatment capacity of the SFWB plant, the SFWB's 1997 master plan called for expansion of the treatment plant and distribution facilities in the near future.

### System Pressure Requirements

Under normal operating conditions, water pressure in the distribution system should range between 40 and 100 psi. The lower end of this pressure range is intended to ensure that adequate pressure is available for the highest fixture at a service connection during maximum demand conditions. The higher end of this pressure range is intended to minimize system repairs, lower the potential for surge damage, minimize water leakage rates, and lower the expense of pipelines.

An analysis of the existing water distribution system indicates that many of the pressure zones exceed the high pressure standard while most meet the low pressure standard. The maximum pressure exceeds 170 psi in the Intermediate Pressure Zone and the Park Place Intermediate Zone, significantly higher than the service standard of 100 psi. Minimum pressures are in the upper 30s psi which is relatively close to the service standard of 40 psi. All customer service lines in the high pressure areas must be equipped with individual pressure reducing valves to keep service pressures under 80 psi as required by the Uniform Plumbing Code.

Under fire flow conditions, lower pressures in the distribution system are allowable. In accordance with DHS rules, the minimum system pressure under fire flow conditions shall be 20 psi as measured at the property line.

**Pipeline Networks**

The pipelines and transmission mains in the City's distribution system will generally be sized based on the criteria described below for average, maximum day and peak hour demand conditions.

- The minimum allowable residual pressure within a pressure zone during a fire shall be 20 psi or greater during a maximum day demand.
- The minimum residual pressure during a peak hour demand should be 40 psi.

The minimum distribution pipeline inside diameter shall be eight inches. The distribution system shall be looped at all possible locations to maintain adequate circulation and water quality. Long dead end pipelines shall be avoided whenever possible to prevent water quality problems. When unavoidable, a fire hydrant or blow-off hydrant shall be installed at the end of the line to facilitate periodic system flushing.

**System Storage Requirements**

Standards have been developed for determining treated water storage capacity needs within the individual pressure zones of a distribution system to meet diurnal operational peaks and emergency conditions. Storage requirements can generally be categorized into the following four components:

- operational storage
- equalization storage
- fire flow storage
- emergency storage

The following discussion presents design guidelines for each of these four components.

<u>Operational Storage</u>. The operational storage component allows for the continued supply of water to the system from reservoirs during temporary shutdowns of the water treatment plant or booster pump stations. The necessary volume of operational storage is determined based on the anticipated timing and duration of temporary shutdowns during the maximum demand period. Since the necessary operational storage for treatment plant shutdowns is the responsibility of the

South Fork Water Board, Oregon City's operational storage needs are solely related to the operation of its booster pumping stations. Because the City's booster pumping stations are capable of operating as long as necessary during the maximum demand period, there is not a need for dedicated operational storage within the Oregon City distribution system.

Equalization Storage. Over any 24-hour period, water demand on the distribution system will vary. Typically, water demand will be high in the morning when people are getting ready for the day, then will decline to a nominal baseline level that is dominated by the water use patterns of commercial and industrial areas. Demand will then begin to increase again in late afternoon, reaching a higher level in the early evening as people return home from work. During periods when the rate of demand exceeds the treatment plant's production rate, the excess demand is provided from equalization storage. During periods when the rate of demand is less than the treatment plant's production rate, the equalization storage is recharged. When a typical diurnal demand pattern is compared to the average daily demand, the necessary supply from equalization storage is typically equal to 25 percent of daily demand. Therefore, to ensure the availability of adequate equalization storage during a maximum day demand event, equalization storage requirements should be 25 percent of the maximum day demand.

Fire Storage. Discussions with the fire protection agencies indicates that their fire flow requirements are based on an amended version of the 1997 Uniform Fire Code (UFC). The maximum fire flows and the expected duration establish treated water storage requirements for a fire event. The UFC fire flows and associated duration to be used in this master plan are shown in Appendix B.

The City's minimum design standards for fire flow are 1,000 gallons per minute (gpm) at a domestic residence and 1,500 gpm for a commercial building. However, actual fire flow requirements are determined by the fire protection agencies and ISO on a case-by-case basis. Specific fire flow requirements are based on the size of building (in square feet) and type of construction (wood frame, metal, masonry, installation of sprinklers, *etc*.). Once the fire flow requirement is established, it is multiplied by the required duration to determine the total volume needed for fire flow storage. Recently, fire code enforcement has required that all new structures be designed for a maximum fire flow requirement of 3,000 gpm for a duration of 3 hours. Therefore, new development will have a maximum required fire flow storage volume of 540,000 gallons. However, Oregon City still must satisfy the larger fire flow requirements for older structures that were constructed under less restrictive fire protection codes.

The highest fire flow requirement in a given pressure zone determines the necessary fire flow storage that must be provided by the reservoir or reservoirs that serve that pressure zone. Since the lowest pressure zones in Oregon City are served through PRVs from the upper pressure zones, the fire flow reserves for these interconnected pressure zones are shared in common, allowing the pressure zones to be analyzed as a set. Table 4-1 identifies the primary pressure zones served by each reservoir or reservoir set as well as the largest fire flow requirement among those pressure zones. The largest fire flow requirement for Mountainview Reservoir is the paper mill at 5th and Main Street which requires 7,000 gpm for a duration of four hours; however, the paper mill has a 0.10 million gallon fire flow storage tank that slightly offsets the total volume requirement. The largest fire flow requirements for Boynton and Henrici Reservoirs are a number of commercial and institutional developments that require 5,000 gpm for a duration of four hours. The largest fire flow requirements for Barlow Crest Reservoir are school facilities which also require 5,000 gpm for a duration of four hours.

**Table 4-1. Required Fire Flow Storage by Reservoir**

| Reservoir or Reservoir Set | Pressure Zones Served | Maximum Required Fire Flow (gpm) | Required Duration (hours) | Storage Volume (gallons) |
|---|---|---|---|---|
| Mountainview | Intermediate Zone Lower Zone<br>Paper Mill Zone<br>Canemah Zone | 7,000 | 4 | 1,680,000[a] |
| Boynton Henrici | Upper Zone | 5,000 | 4 | 1,200,000 |
| Barlow Crest | Park Place Intermediate Zone<br>Park Place Lower Zone<br>View Manor Zone<br>Livesay Zone | 5,000 | 4 | 540,000 |

[a]The actual fire flow storage volume requirement for Mountainview Reservoir is 1.58 mg due to 0.10 mg available from the paper mill's own fire flow storage tank.

Note: The Park Place Upper Zone is served by Clackamas River Water, who provides the required storage for this zone.

Fire flows will be provided by storage unless a specific exception is approved by the City. Pumped fire flows can be allowed for small areas under the condition that the pump station provides an adequate firm capacity, sufficient pressure, and reliable operation. These areas would be small, isolated zones where construction of a gravity storage facility is not practical.

Emergency Storage. A reserve of treated water is also required to meet demands during emergency outage periods, when normal supply is interrupted. Such conditions may arise due to loss of the water plant during a power failure, loss of the raw water supply due to a chemical spill, a pumping equipment or pipeline failure, or the need to take facilities out of service for repair. Since the risk of an emergency situation varies from city to city, the amount of reservoir volume allocated to emergency storage varies from city to city also. The required emergency storage volume is a function of several factors including the diversity of the sources of supply, redundancy and reliability of the production facilities, and the anticipated length of the emergency outage. Review of other water system planning criteria for communities with a surface water supply shows that emergency storage volumes vary from 25 percent of maximum day demand to 150 percent of maximum day demand.

The Clackamas River is the sole source of supply for the Oregon City water system. Although the reliability and quality of the City's water supply has been excellent, it is vulnerable to temporary contamination by chemical spills into the Clackamas River. Consideration of such a scenario is useful for preparing the City to manage emergency storage supplies during an emergency event. The following scenario allows for the determination of a reasonable volume of emergency storage:

- If the Clackamas River became contaminated, it is estimated that it would take up to three days to allow the contamination to pass by the water treatment plant or to modify the process to treat the contaminated water.
- Immediately following the water treatment plant shutdown, the public would be notified and advised to adopt water rationing measures to prolong the availability of emergency storage supplies.
- If the shutdown were to occur during a period of maximum demand, it would take up to 12 hours for water rationing measures to be adopted, after which the demand might drop to one-half the annual average day demand for the remainder of the shutdown period.
- It is important to note that the response to an emergency depends on the ability of the City to reach its citizens with the necessary information. An extensive emergency curtailment plan is essential to effectively reduce water demand during an emergency.

Given this scenario, the required emergency storage would be approximately 100 percent of maximum day demand. Therefore, one maximum day demand is the recommended emergency storage requirement.

<u>Total Water Storage.</u> The minimum treated water storage capacity in the system available by gravity flow to each pressure zone shall equal the sum of the following:

- <u>Equalization</u>. The storage allocated for meeting diurnal demand peaks should be equivalent to 25 percent of the maximum day demand. This storage volume should be located within the pressure zone or available by gravity to the pressure zone.
- <u>Fire Flow</u>. The storage allocated to provide fire flows should be equivalent to the maximum fire flow in the pressure zone times the duration the flow rate must be maintained. The required volumes for each pressure zone or set of pressure zones was summarized previously in Table 4-1.
- <u>Emergency</u>. The minimum emergency storage volume allocated for providing water during periods when normal supply is interrupted should be equivalent to 100 percent of the City's maximum day demand.

A table comparing the existing storage volume in the system and the recommended storage volume is provided in Chapter 6, "Water Distribution System Evaluation."

## Reservoirs

Reservoir facilities shall be sized in accordance with the preceding discussion of system storage requirements. Reservoir inlet and outlet piping shall be designed to facilitate adequate turnover of stored water at the facility and avoid water quality problems. Reservoir management techniques such as lowering reservoir levels during periods of low demand will also ensure the freshness of the water supply and eliminate the need for rechlorination.

To ensure adequate service pressures, new reservoirs shall be placed so that the overflow elevation is 100 feet above the normal upper service elevation of the pressure zone it is serving. This arrangement will allow for fluctuations in reservoir level while maintaining system pressures within the desired range.

In addition, it is recommended that the City consider equipping reservoirs with a remote controlled shut-off valve or seismic valve to prevent drainage after a significant earthquake.

## Pump Stations

Pumping facilities that serve pressure zones with adequate gravity service storage shall be sized to supply the zone’s maximum day demand with the largest pump out of service. If a pressure zone does not have gravity service storage, the pump station shall be sized to supply peak hour demand with the largest pump out of service. The station shall also have at least two additional fire flow pumps to meet the maximum fire flow requirements for the pressure zone. The pump stations serving pressure zones without storage shall be equipped with a hydropneumatic tank to limit pump cycling. All pumping facilities shall also be equipped with an emergency generator of sufficient capacity to operate the pumping plant at its rated capacity.

## Valves

Valve location and spacing are important considerations in the design of a water distribution system. Pipelines must include an adequate number of properly located valves to allow for isolation of pipeline sections in the event of maintenance operations or new construction. ISO has developed standards for valve spacing on pipelines according to their function. These standards have been modified by the City as identified in Table 4-2. The supply pipelines that deliver water to the Oregon City system are owned and operated by the SFWB. Transmission pipelines are the high capacity mains (typically 12-inches in diameter and up) that form the framework for moving water around the system. The distribution pipelines provide the network grid from which most customer connections are served. A general guideline for locating valves in the distribution system is that smaller branch mains should be equipped with a valve so that any service problems on the branch pipeline does not require a shut-off of the major transmission line. Within the distribution grid, placement of a valve on all legs of tees and crosses will minimize the extent of a service disruption during system work. For the same reason of localizing service disruptions, system design should avoid direct service taps into transmission pipelines whenever possible.

**Table 4-2. Maximum Valve Spacing Standards**

| Pipeline Function | Maximum Spacing |
|---|---|
| Supply pipeline | 1 mile |
| Transmission pipeline | 2,000 feet (minimum)<br>1,300 feet (preferred) |
| Residential distribution pipeline | 800 feet |
| Commercial distribution pipeline | 500 feet |

### Hydrants

Fire hydrants are dispersed throughout the distribution system to provide the emergency flows required for fire protection. The requirements for spacing fire hydrants are defined in the Uniform Fire Code and have been modified by the City's development codes as shown in Table 4-3. In applying the fire code, the fire department shall determine the required fire hydrant distribution based on their judgement. In addition to the maximum spacing requirements, any building must be within 250 feet of a fire hydrant. Distances are measured along the route that the fire department will use to deploy the fire hose.

**Table 4-3. Uniform Fire Code Hydrant Distribution Requirements**

| Land Use Category | Maximum Hydrant Spacing (feet) |
|---|---|
| Residential | 500 |
| Commercial, Industrial, and Other High Value Districts | 200 - 500 |

No hydrant shall be installed on a water main with less than an 8 inch inside diameter and the hydrant shall have a minimum 6 inch inside diameter. Hydrants shall be located as close to the distribution main as possible and shall be no more than 40 feet away. To comply with this requirement, hydrants will generally be located on the same side of the street as the distribution main. In areas where required fire flows exceed 1,500 gallons per minute, the water supply must be provided by more than one hydrant.

# CHAPTER 5

# DISTRIBUTION SYSTEM MODELING

A computer based hydraulic model of the Oregon City water distribution system has been developed as part of the master planning effort to analyze the capability of the system to meet current and projected demands. Specifically, the model is used for the following types of analysis:

1. Evaluation of existing water facilities and operating strategies
2. Identification of current deficiencies in the distribution system
3. Sizing of system extensions
4. Development of recommended capital improvements

In addition to the system analysis work conducted as part of this master plan, the model will also be useful to the City in the future for a variety of purposes. The model will be a tool for evaluating system planning issues and the effects of different operating strategies. The model will also serve as a tool for assessing impacts to the water distribution system from proposed development projects. The model can also be used for the analysis of water quality issues such as chlorine residual evaluations.

**Computer Modeling Program**

The computer program $H_2O$Map by MWHSoft was used to model the distribution system. The $H_2O$Map program was specifically developed for conducting steady-state and extended period analyses of a pressure pipe network. The software is also compatible with the City's existing ArcView GIS system and is able to directly incorporate relevant background information from the City's existing GIS files. Based on comprehensive input data that define initial system conditions, the model is capable of providing the local hydraulic grade, pressure, flow rate, and velocity at any point in the system.

The $H_2O$Map computer model blends the capabilities of several types of programs (including CADD, GIS, database, and a hydraulic analysis engine) to facilitate the analysis and design of a water distribution system. The model incorporates all of the important hydraulic features of the distribution system including pipelines, pump stations, storage reservoirs, and control valves. In addition to these hydraulic features, the model also establishes junction nodes at all intersections between pipes as well as any other important locations in the distribution system. The model links a graphical representation of the water distribution system to a database that describes the physical characteristics of each hydraulic feature (i.e. length, diameter, and roughness coefficient for a pipeline) and the physical and demand conditions at junction nodes (i.e. ground elevation, water demand, diurnal variation patterns, etc.).

$H_2O$Map also includes a scenario manager feature that allows the modeler to quickly evaluate a variety of water demand and operating conditions when analyzing the system. Using this feature, the modeler can conduct a hydraulic analysis of different demand conditions, alternative system configurations, and alternative operating strategies. For example, to evaluate available fire flows in the distribution system, the modeler can create a scenario that includes the maximum day demand, an 80 percent full storage reservoir configuration, and a night-time pump station operating strategy.

**Oregon City $H_2O$Map Model**

The City of Oregon City provided an ACAD map of the existing water distribution system as the foundation for the model. West Yost & Associates (WYA) imported this drawing into $H_2O$Map, provided updates to reflect current pipeline configurations, and entered all of the necessary physical data for each element of the distribution system. The key components of the existing system model included the following:

- Non dead-end pipes 2-inches and larger in diameter.
- All system pipes 6-inches and larger in diameter.
- Pumping stations.
- Storage reservoirs.
- Pressure reducing valves.

The City also provided a GIS file showing all of the zoning designations within the Oregon City urban growth boundary which was used as a basis for allocating water demand across the water distribution system. The $H_2O$Map software was used to break the service area into individual geographical areas, each of which is associated with a junction node. These areas are characterized according to their percentage of single family residential, multi-family residential, or industrial/commercial land use. Using the acreage based demand factors developed in Chapter 3 for each land use category, an average water demand is assigned to each junction.

Each junction node and pipe link in the system has a unique identification number. The identification number corresponds to the Pressure Zone in which the node or pipe is located. For example, all identification numbers in the 1000 series are located in the Lower Pressure Zone, all identification numbers in the 2000 series are located in the Intermediate Pressure Zone, etc. Table 5-1 provides the index between pressure zone names and identification number series.

**Table 5-1. Identification Number Index**

| Pressure Zone | Identification Number Series |
|---|---|
| Lower Zone | 1000 |
| Intermediate Zone | 2000 |
| Upper Zone | 3000 |
| Lower Park Place Zone | 4000 |
| Intermediate Park Place Zone | 5000 |
| Upper Park Place Zone | 6000 |
| Canemah Zone | 7000 |
| Fairway Downs Zone | 8000 |
| View Manor Zone | 9000 |
| Swan Zone | 10000 |
| Livesay Road Zone | 11000 |
| Paper Mill Zone | 12000 |
| SFWB Transmission System | 13000 |
| CRW System | 20000 |

## Model Calibration

The purpose of calibrating the hydraulic model is to confirm that the computer model accurately represents the operation of the water distribution system. Hydrant flow testing in the field is conducted to obtain measurements of actual system pressures and flows that can be compared to model predictions. These tests are useful in evaluating pipeline friction factors (specifically Hazen Williams equation coefficients of friction or C-factors) and ensuring that the model closely represents actual conditions. The hydrant flow tests for this calibration process were performed by City water distribution personnel and WYA staff on November 21, 2002.

The baseline C-factors used in the model were selected based on the material and age of the pipelines. The majority of the pipelines in the distribution system are cast iron and ductile iron with significant amounts of steel pipe and asbestos cement pipe in areas that the City inherited from annexed water systems. C-factors can range from a low of around 40 for old unlined cast iron pipes in poor condition to a high of 140 for newly installed, cement-lined ductile iron pipe. Pipeline age and material information was used along with pipeline condition information from the City's water operation staff to assign an appropriate C-factor to each pipeline. Table 5-2 provides a general summary of the C-factors selected for each decade of pipeline installation.

**Table 5-2. Pipeline Age-Based C-Factor Summary**

| Decade of Pipeline Construction | Hazen Williams C-Factor |
|---|---|
| Pre-1920s | 40 |
| 1920s | 60 |
| 1930s | 70 |
| 1940s | 80 |
| 1950s | 90 |
| 1960s | 100 |
| 1970s | 110 |
| 1980s | 120 |
| 1990s | 130 |
| 2000s | 140 |

After developing the City's hydraulic model, WYA worked with City water operations staff to select 10 hydrant flow test sites. Selection of the hydrant test locations was based on pipeline size, age, location within the different pressure zones, and configuration of the surrounding pipeline system.

The general testing procedure for a hydrant flow test is outlined below:

- Measure the static pressures at the designated test hydrant and at each observation hydrant.
- Flow the designated test hydrant and measure the discharge flow and pressure.
- Measure the residual pressures at each observed hydrant while the test hydrant is flowing.

In addition to the field measurements taken at the flowing and observation hydrants, other important system data were recorded during the hydrant flow tests. Using the City's and the SFWB's SCADA systems, City staff monitored reservoir levels and pump station operating conditions during the test period. These data were critical for establishing the water system context within which the hydrant flow tests took place. A review of SFWB water production data also allowed for an estimate of the system demand on the flow test date. Water demand in Oregon City during the hydrant flow tests was approximately 3.7 mgd, essentially equivalent to the City's annual average demand.

**Calibration Results.** Based on the field and SCADA system data collected on November 21, 2002, each hydrant flow test was simulated using the $H_2$OMap model of the water system. $H_2$OMap predictions were then compared to the field measurements to evaluate the need for adjustments to pipeline friction coefficients or other system variables. Overall, the required adjustments to the baseline input data were very minor and calibration of the $H_2$OMap model was readily successful.

The model's ability to accurately predict head losses in the system during high flow conditions is of primary importance. This function is necessary for verifying the presence of adequate pressures in the system during critical fire flow conditions. During a hydrant flow test, head losses in the system correspond to the difference between static and residual pressures at the observed hydrants. Tables 5-3 through 5-12 summarize the static, residual, and differential pressures for both the field test data and the calibrated model predictions. The goal of our calibration effort was to achieve no greater than a 3 to 4 psi difference between the field hydrant test differential and the calibrated model differential. This goal was achieved with an average difference in differentials of 1.25 psi.

Static pressures in the system are largely related to elevation, pump operating status, reservoir levels, and PRV settings. The average difference between the measured and modeled static pressures is 2 psi. Slight pressure gauge calibration problems are the most likely explanation for discrepancies in the static measurements.

**Table 5-3. Field Test #1**

Cattle Drive near Holcomb Blvd. and Winston Drive.
8" and 16" lines in the Intermediate Park Place Pressure Zone – 2000/2001 Installation
Hydrant Test Flow Rate = 1,555 gpm

| | | Field Data | | | Modeled Data | | | Comparison Of Differential Pressures (psi) |
|---|---|---|---|---|---|---|---|---|
| Hydrant | Node | Static Pressure (psi) | Residual Pressure (psi) | Differential Pressure (psi) | Static Pressure (psi) | Residual Pressure (psi) | Differential Pressure (psi) | |
| A (F) | 5091 | 52 | | | 52 | | | |
| B | 5073 | 53 | 50 | 3 | 53 | 48 | 5 | 2 |
| C | 5089 | 53 | 51 | 2 | 53 | 51 | 2 | 0 |
| D | 5069 | 51 | 49 | 2 | 48 | 46 | 2 | 0 |

(F) Flowing hydrant

**Table 5-4. Field Test #2**

Front Street
12" line in the Lower Park Place Pressure Zone – 1993 Installation
Hydrant Test Flow Rate = 2,050 gpm

| | | Field Data | | | Modeled Data | | | Comparison Of Differential Pressures (psi) |
|---|---|---|---|---|---|---|---|---|
| Hydrant | Node | Static Pressure (psi) | Residual Pressure (psi) | Differential Pressure (psi) | Static Pressure (psi) | Residual Pressure (psi) | Differential Pressure (psi) | |
| A (F) | 4153 | 80 | | | 81 | | | |
| B | 4041 | 81 | 74 | 7 | 81 | 76 | 5 | 2 |
| C | 4155 | 82 | 77 | 5 | 81 | 78 | 3 | 2 |
| D | 4157 | 100[a] | 94[a] | 6 | 82 | 78 | 4 | 2 |

(F) Flowing hydrant
[a] This pressure gauge appears to have been losing calibration during the testing. It was replaced during the next flow test when high readings were noted again.

**Table 5-5. Field Test #3**

Agnes Avenue

10" lines in the Lower Pressure Zone – 1980 Installation

Hydrant Test Flow Rate = 2,010 gpm

| | | Field Data | | | Modeled Data | | | Comparison |
|---|---|---|---|---|---|---|---|---|
| Hydrant | Node | Static Pressure (psi) | Residual Pressure (psi) | Differential Pressure (psi) | Static Pressure (psi) | Residual Pressure (psi) | Differential Pressure (psi) | of Residual Pressures (psi) |
| A (F) | 1011 | 95-105 [a] | | | 97 | | | |
| B | 1171 | 100-110 [a] | 82 | indefinite | 102 | 84 | 18 | 2 |
| C | 1119 | 92-102 [a] | 77 | indefinite | 90 | 76 | 14 | 1 |
| D | 1173 | 105-115 [a] | 85 | indefinite | 104 | 89 | 15 | 4 |

(F) Flowing hydrant

[a] This pressure zone is fed by five PRV stations and static pressures were found to be erratic. Therefore, differential pressures for this test were indeterminate. As a result, measured versus modeled residual pressures are compared for correlation instead of differential pressures.

**Figure 5-1. Agnes Avenue Hydrant Flow Test**

**Table 5-6. Field Test #4**
Spring Street
6" line in the Intermediate Pressure Zone – 1975 Installation
Hydrant Test Flow Rate = 1,000 gpm

| | | Field Data | | | Modeled Data | | | Comparison |
|---|---|---|---|---|---|---|---|---|
| Hydrant | Node | Static Pressure (psi) | Residual Pressure (psi) | Differential Pressure (psi) | Static Pressure (psi) | Residual Pressure (psi) | Differential Pressure (psi) | Of Differential Pressures (psi) |
| A (F) | 2265 | 116 | | | 115 | | | |
| B | 2267 | 113 | 35 | 78 | 114 | 38[a] | 76 | 2 |
| C | 2525 | 119 | 77 | 42 | 115 | 74 | 41 | 1 |
| D | 2275 | 119 | 105 | 14 | 118 | 102 | 16 | 2 |

(F) Flowing hydrant
[a] To match field data, the C factor for the final reach of 6-inch pipe had to be set at 70 which is significantly rougher than anticipated for a pipe of this age. A partially closed valve within this reach is an alternative explanation for the field measurement.

**Figure 5-2. Flowing Hydrant at Spring Street**

**Table 5-7. Field Test #5**

Gilman Drive

6" and 8" lines in the Intermediate Pressure Zone – 1996 Installation

Hydrant Test Flow Rate = 1,910 gpm

| | | Field Data | | | Modeled Data | | | Comparison |
|---|---|---|---|---|---|---|---|---|
| Hydrant | Node | Static Pressure (psi) | Residual Pressure (psi) | Differential Pressure (psi) | Static Pressure (psi) | Residual Pressure (psi) | Differential Pressure (psi) | Of Differential Pressures (psi) |
| A (F) | 2527 | 114 | | | 116 | | | |
| B | 2529 | 92 | 53 | 39 | 91 | 51 [a] | 40 | 1 |
| C | 2361 | 90 | 61 | 29 | 88 | 60 [a] | 28 | 1 |
| D | 2531 | 85 | 55 | 30 | 82 | 54 [a] | 28 | 2 |

(F) Flowing hydrant

[a] This hydrant flow was primarily supplied by the PRV station at 16th and Division. The fire flow setting for the station is 85 psi. To match field data, the PRV setting had to be adjusted to 75 psi which could indicate that additional losses are incurred at the station during fire flow conditions. An alternative explanation is a closed valve in the local network.

**Figure 5-3. Hydrant Flow Test at Gilman Drive**

**Table 5-8. Field Test #6**
Barclay Hills Drive
8” lines in the Upper Pressure Zone – 1970s Installation
Hydrant Test Flow Rate = 1,740 gpm

| Hydrant | Node | Field Data Static Pressure (psi) | Field Data Residual Pressure (psi) | Field Data Differential Pressure (psi) | Modeled Data Static Pressure (psi) | Modeled Data Residual Pressure (psi) | Modeled Data Differential Pressure (psi) | Comparison Of Differential Pressures (psi) |
|---|---|---|---|---|---|---|---|---|
| A (F) | 3849 | 90 | | | 89 | | | |
| B | 3856 | 71 | 40 | 29 | 71 | 44 | 27 | 2 |
| C | 3851 | 56 | 40 | 16 | 53 | 40 | 13 | 3 |
| D | 3852 | 55 | 40 | 15 | 57 | 43 | 14 | 1 |

(F) Flowing hydrant

**Table 5-9. Field Test #7**
Clearbrook Drive
8” line in the Upper Pressure Zone – 1992 Installation
Hydrant Test Flow Rate = 1,630 gpm

| Hydrant | Node | Field Data Static Pressure (psi) | Field Data Residual Pressure (psi) | Field Data Differential Pressure (psi) | Modeled Data Static Pressure (psi) | Modeled Data Residual Pressure (psi) | Modeled Data Differential Pressure (psi) | Comparison Of Differential Pressures (psi) |
|---|---|---|---|---|---|---|---|---|
| A (F) | 3853 | 58 | | | 56 | | | |
| B | 3854 | 61 | 52 | 9 | 58 | 50 | 8 | 1 |
| C | 3855 | 57 | 49 | 8 | 52 | 45 | 7 | 1 |
| D | 3856 | 52 | 45 | 7 | 47 | 42 | 5 | 2 |

(F) Flowing hydrant

**Table 5-10. Field Test #8**
South End Road
12” line in the Upper Pressure Zone – 2001 Installation
Hydrant Test Flow Rate = 1,770 gpm

| Hydrant | Node | Field Data Static Pressure (psi) | Field Data Residual Pressure (psi) | Field Data Differential Pressure (psi) | Modeled Data Static Pressure (psi) | Modeled Data Residual Pressure (psi) | Modeled Data Differential Pressure (psi) | Comparison Of Differential Pressures (psi) |
|---|---|---|---|---|---|---|---|---|
| A (F) | 3857 | 58 | | | 58 | | | |
| B | 3858 | 60 | 54 | 6 | 59 | 53 | 6 | 0 |
| C | 3656 | 63 | 58 | 5 | 59 | 54 | 5 | 0 |
| D | 3303 | 70 | 60 | 10 | 65 | 61 | 4 | 1 |

(F) Flowing hydrant

**Figure 5-4. Hydrant Flow Test at Clearbrook Drive**

**Table 5-11. Field Test #9**
Clairmont Way
10” line in the Upper Pressure Zone – 1970s Installation
Hydrant Test Flow Rate = 1,740 gpm

| Hydrant | Node | Field Data: Static Pressure (psi) | Field Data: Residual Pressure (psi) | Field Data: Differential Pressure (psi) | Modeled Data: Static Pressure (psi) | Modeled Data: Residual Pressure (psi) | Modeled Data: Differential Pressure (psi) | Comparison Of Differential Pressures (psi) |
|---|---|---|---|---|---|---|---|---|
| A (F) | 3859 | 60 | | | 59 | | | |
| B | 3860 | 58 | 52 | 6 | 58 | 52 | 6 | 0 |
| C | 3861 | 68 | 63 | 5 | 64 | 60 | 4 | 1 |
| D | 3862 | 64 | 59 | 5 | 64 | 60 | 4 | 1 |

(F) Flowing hydrant

**Figure 5-5. Hydrant Flow Test at Clairmont Way**

**Table 5-12. Field Test #10**
Quinalt
8” line in the Upper Pressure Zone – 1995 Installation
Hydrant Test Flow Rate = 1,680 gpm

| Hydrant | Node | Field Data Static Pressure (psi) | Field Data Residual Pressure (psi) | Field Data Differential Pressure (psi) | Modeled Data Static Pressure (psi) | Modeled Data Residual Pressure (psi) | Modeled Data Differential Pressure (psi) | Comparison Of Differential Pressures (psi) |
|---|---|---|---|---|---|---|---|---|
| A (F) | 3863 | 56 | | | 57 | | | |
| B | 3864 | 60 | 52 | 8 | 60 | 54 | 6 | 2 |
| C | 3865 | 58 | 52 | 6 | 55 | 49 | 6 | 0 |
| D | 3866 | 58 | 50 | 8 | 55 | 49 | 6 | 2 |
| Fairway Downs Pump Station | | 40 | 36 | 4 | 39 | 36 | 3 | 1 |

(F) Flowing hydrant

**Calibration Conclusion.** The comparative analysis of field measurements and model predictions confirms that the calibrated $H_2$OMap model is capable of simulating operation of the existing water distribution system with an acceptable degree of accuracy. Therefore, the model can be used to analyze the adequacy of existing facilities, analyze proposed plans for system expansion and modification projects, evaluate different operational strategies, and design specific improvements to the system.

# CHAPTER 6

# WATER DISTRIBUTION SYSTEM EVALUATION

The Oregon City water distribution system has been analyzed to evaluate its performance and capacity under current and future demand conditions. Performance standards used to evaluate the system are defined in Chapter 4. This analysis identified system improvements necessary to maintain adequate performance through build-out of the urban growth boundary (UGB). These improvements are designed to either eliminate existing deficiencies in system performance or to expand service to new areas as the community grows. Each improvement project has been scheduled for implementation in one of the following three improvement phases:

Improvement Phase 1: Year 2004 to 2008
Improvement Phase 2: Year 2008 to 2014
Improvement Phase 3: Year 2014 to 2024

The identified improvements and estimated timings form the basis for the recommended capital improvement program (CIP) presented in Chapter 7.

The elements of the water distribution system evaluated in this chapter include treated water storage capacity, booster pumping station capacity, and pipeline network performance with respect to current and future demand conditions. These evaluations are based on the water demand projections presented in Chapter 3 and the results of hydraulic analyses using the computer model. As discussed in Chapter 3, water demand will most likely increase at a rate of two to three percent per year. The estimated timing for those projects that expand system capacity is based on the higher three percent annual rate of increase in water demand.

The City is in the process of obtaining approval for UGB expansions at three locations around the city. The expansion areas include the following:

- Loder Road UGB Expansion – Served from the Upper Pressure Zone.
- South End Road UGB Expansion – Served from the Upper Pressure Zone.
- Holly Lane, Livesay Road, and Holcomb UGB Expansion – Served from the Lower, Intermediate, and Upper Park Place Pressure Zones.

These locations have been approved by the Metro Council but await approval by the Land Conservation and Development Commission. Since full approval of these UGB expansions appears likely, the following assessments of the future distribution system include consideration of these areas.

## TREATED WATER STORAGE CAPACITY EVALUATION

The Oregon City water distribution system includes four treated water reservoirs serving ten pressure zones. As defined in Chapter 4, the treated water storage reservoirs serve three principal purposes in the Oregon City system:

- Fire flow storage – Storage required for fighting fires in accordance with the Uniform Fire Code.
- Equalization storage – Storage required to supply the system during periods when demand exceeds treatment plant or pump station capacities.
- Emergency storage – Storage required to supply the system during a temporary disruption of supply.

The required storage volume for these three purposes is determined individually within each pressure zone and then combined to identify the total amount of storage volume required for the overall system. The following treated water storage standards are established in Chapter 4:

1. Equalization storage equal to 25 percent of maximum day demand.
2. Emergency storage equal to 100 percent of maximum day demand.
3. Fire flow storage based on the largest fire flow requirement in the pressure zones served by each reservoir or group of reservoirs.

The combination of these three storage components yields the total storage required, which is equal to 1.25 times maximum day demand plus fire flow storage. The fire flow volume is based on the following maximum fire flow demands:

- A 5,000 gpm fire flow for a duration of 4 hours for the pressure zone served by Boynton and Henrici Reservoirs.
- A 7,000 gpm fire flow for a duration of 4 hours for the pressure zones served by Mountainview Reservoir.
- A 5,000 gpm fire flow for a duration of 4 hours for the pressure zones served by Barlow Crest Reservoir.

### Current Storage Capacity

Table 6-1 summarizes the evaluation of treated water storage requirements for current demand conditions. The existing system contains an overall treated water storage capacity of 16.25 million gallons which is ample for overall current levels of demand. The City's existing storage is primarily located in Mountainview Reservoir which accounts for 65 percent of the total available. The other reservoirs have sufficient storage to meet the equalization and fire flow storage requirements for their pressure zones, but must rely on Mountainview Reservoir for much of their emergency storage. This situation is particularly true for the Upper Pressure Zone (served by Boynton and Henrici Reservoirs) where the total required storage is nearly twice the volume available. Further, since the Upper Pressure Zone's Boynton Reservoir is a standpipe, only 0.5 million gallons of its 2.0 million gallon capacity is available by gravity. To be available at adequate pressure, the remaining 1.5 million gallons in the reservoir must be boosted into the system by the manually operated Boynton Pump Station. This station is only intended to operate during fire flow situations or other emergencies.

Another observation regarding the existing storage situation is that the Fairway Downs Pressure Zone is the only pressure zone without access to gravity supply from a reservoir. Instead, this pressure zone relies on the Fairway Downs Pump Station for supply at all times. This pump station is designed to provide both normal service and fire flow service to the pressure zone. The station also has a standby generator. Since the size of this pressure zone at build-out will be just 142 acres and a pump station is already in operation, it is a practical option for the City to continue providing only pump station service. Alternatively, if the City desires the operational advantages of having gravity supply, a reservoir could be constructed to serve the zone. Due to the topography of the surrounding area, the new reservoir would have to be either a relatively expensive elevated tank or sited at a considerable distance from the existing UGB. Depending on whether the new reservoir is sized to provide equalization, fire flow, and emergency storage for the zone or just equalization and fire flow, the required reservoir capacity would range from approximately 0.20 million gallons to 0.50 million gallons.

### Future Storage Capacity

Table 6-2 summarizes the treated water storage evaluation for future demand conditions. As the water distribution system expands toward build-out of the UGB, it will generally be possible to serve the newly incorporated areas from the existing reservoir sites. Even so, the storage available from these existing reservoirs will no longer be sufficient to satisfy the total projected need, and new reservoir construction will be necessary. Since the storage shortfall is greatest in the Upper Pressure Zone, it is recommended that the majority of future reservoir capacity be constructed to serve that zone. Although the pressure zones served by Barlow Crest Reservoir also show a local storage deficiency, the discrepancy is not as great as in the Upper Zone and the Park Place Lower Zone is partially supplied from Mountainview Reservoir. Table 6-2 shows the total storage requirements for two conditions: the first condition considers land within the existing UGB only and the second condition includes serving the proposed UGB expansion areas.

### Seismic Vulnerability of Reservoirs

The City's storage reservoirs were evaluated for seismic vulnerability issues as part of the master planning effort (see full report in Appendix C). The seismic vulnerability assessment recommended the following improvements at the City's reservoirs:

- Dismantle the elevated tank at Mountainview Street.
- Provide seismic reinforcement of the perimeter walls at Mountainview Reservoir.
- Provide seismic anchorage improvements at Boynton Reservoir.

**Table 6-1. Current Treated Water Storage Evaluation**

| Reservoir or Reservoir Set | Pressure Zones Served | Current Max Day Demand, mgd | Required Equalization Storage, mg | Required Emergency Storage, mg | Required Fire Flow Storage, mg | Required Total Storage, mg | Existing Available Storage, mg |
|---|---|---|---|---|---|---|---|
| Boynton, Henrici | Upper Zone | 5.04 | 1.26 | 5.04 | 1.20 | 7.50 | 4.00 |
| | Fairway Downs Zone | 0.08 | 0.02 | 0.08 | | 0.11 | |
| | CRW-Meyers and Leland | 0.22 | 0.06 | 0.22 | | 0.28 | |
| | CRW-South End Road | 0.10 | 0.03 | 0.10 | | 0.13 | |
| | Reservoir Set Subtotal | 5.44 | 1.36 | 5.44 | 1.20 | 8.01 | 4.00 |
| Mountainview | Lower Zone | 0.65 | 0.16 | 0.65 | 1.58[c] | 2.39 | 10.50 |
| | Intermediate Zone | 1.26 | 0.32 | 1.26 | | 1.58 | |
| | Canemah Zone | 0.06 | 0.02 | 0.06 | | 0.08 | |
| | Park Place Lower Zone[a] | 0.19 | 0.05 | 0.19 | | 0.24 | |
| | Reservoir Subtotal | 2.16 | 0.54 | 2.16 | 1.58[c] | 4.28 | 10.50 |
| Barlow Crest | Park Place Lower Zone[a] | 0.19 | 0.05 | 0.19 | 1.20 | 1.44 | 1.75 |
| | Park Place Intermediate Zone | 0.19 | 0.05 | 0.19 | | 0.24 | |
| | View Manor Zone | 0.11 | 0.03 | 0.11 | | 0.13 | |
| | Livesay Road Zone | 0.00 | 0.00 | 0.00 | | 0.00 | |
| | CRW-Barlow Crest Reservoir | 0.03 | 0.01 | 0.03 | | 0.04 | |
| | CRW-Forsythe & Swan | 0.04 | 0.01 | 0.04 | | 0.05 | |
| | Reservoir Subtotal | 0.55 | 0.14 | 0.55 | 1.20 | 1.89 | 1.75 |
| Hunter Heights (CRW) | Park Place High Zone[b] | NA[d] | NA | NA | NA | NA | NA |
| | System Total | 8.16 | 2.04 | 8.16 | 3.98 | 14.18 | 16.25 |

[a]Park Place Lower Pressure Zone demand is split between Mountainview Reservoir and Barlow Crest Reservoir.
[b]CRW's Hunter Heights Reservoir provides storage for this pressure zone of the Oregon City system, so it is not included in the analysis.
[c]Fire flow requirement reduced by 0.10 mg to account for fire storage tank owned by paper mill.
[d]NA – not applicable.

## Table 6-2. Build-Out Treated Water Storage Evaluation

| Reservoir or Reservoir Set | Pressure Zones Served | Build-out Max Day Demand, mgd | Required Equalization Storage, mg | Required Emergency Storage, mg | Required Fire Flow Storage, mg | Required Total Storage, mg | Existing Available Storage, mg |
|---|---|---|---|---|---|---|---|
| Boynton, Henrici | Upper Zone | 9.47 | 2.37 | 9.47 | 1.20 | 13.04 | 4.00 |
| | Fairway Downs Zone | 0.27 | 0.07 | 0.27 | | 0.34 | |
| | Country Village | 0.13 | 0.03 | 0.13 | | 0.16 | |
| | Canyon | 0.11 | 0.03 | 0.11 | | 0.13 | |
| | CRW-Meyers and Leland | 0.33 | 0.08 | 0.33 | | 0.41 | |
| | CRW-South End Road | 0.14 | 0.04 | 0.14 | | 0.18 | |
| | Loder Road UGB Expansion[a] | 0.53 | 0.13 | 0.53 | | 0.66 | |
| | South End Rd UGB Expansion[a] | 0.42 | 0.11 | 0.42 | | 0.53 | |
| | Reservoir Set Subtotal | 10.45 | 2.61 | 10.45 | 1.20 | 14.26 | 4.00 |
| | Reservoir Set Subtotal with UGB Expansion[a] | 11.39 | 2.85 | 11.39 | 1.20 | 15.44 | 4.00 |
| Mountainview | Lower Zone | 1.55 | 0.39 | 1.55 | 1.58[d] | 3.52 | 10.50 |
| | Intermediate Zone | 1.58 | 0.39 | 1.58 | | 1.97 | |
| | Canemah Zone | 0.15 | 0.04 | 0.15 | | 0.18 | |
| | Park Place Lower Zone[b] | 0.46 | 0.12 | 0.46 | | 0.58 | |
| | Holly Lane UGB Expansion[a] | 0.29 | 0.07 | 0.29 | | 0.37 | |
| | Reservoir Subtotal | 3.74 | 0.93 | 3.74 | 1.58[d] | 6.25 | 10.5 |
| | Reservoir Subtotal with UGB Expansion[a] | 4.03 | 1.01 | 4.03 | 1.58[d] | 6.62 | 10.5 |
| Barlow Crest | Park Place Lower Zone[b] | 0.46 | 0.12 | 0.46 | 1.20 | 1.78 | 1.75 |
| | Park Place Intermediate Zone | 0.57 | 0.14 | 0.57 | | 0.71 | |
| | View Manor Zone | 0.11 | 0.03 | 0.11 | | 0.13 | |
| | Livesay Road Zone | 0.06 | 0.02 | 0.06 | | 0.08 | |
| | CRW-Barlow Crest Reservoir | 0.03 | 0.01 | 0.03 | | 0.04 | |
| | CRW-Forsythe & Swan | 0.04 | 0.01 | 0.04 | | 0.05 | |
| | Holly Lane UGB Expansion[a] | 0.29 | 0.07 | 0.29 | | 0.37 | |
| | Livesay Rd. UGB Expansion[a] | 0.06 | 0.02 | 0.06 | | 0.08 | |
| | Reservoir Subtotal | 1.27 | 0.32 | 1.27 | 1.20 | 2.78 | 1.75 |
| | Reservoir Subtotal with UGB Expansion[a] | 1.62 | 0.41 | 1.62 | 1.20 | 3.23 | 1.75 |
| Hunter Heights (CRW) | Park Place High[c] | NA[e] | NA | NA | NA | NA | NA |
| | Total | 15.45 | 3.86 | 15.45 | 3.98 | 23.29 | 16.25 |
| | Total[a] | 17.05 | 4.26 | 17.05 | 3.98 | 25.29 | 16.25 |

[a]Includes demand from land within currently proposed UGB expansion areas.
[b]Park Place Lower Pressure Zone demand split between Mountainview Reservoir and Barlow Crest Reservoir.
[c]CRW's Hunter Heights Reservoir provides storage for this pressure zone of the Oregon City system, so it is not included in the analysis.
[d]Fire flow requirement reduced by 0.10 mg to account for fire storage tank owned by paper mill.
[e]NA – not applicable.

### Mountainview Reservoir Issues

It is important to note that Mountainview Reservoir is owned by Oregon City but effectively operates as a regional storage facility. As a result of the regional system configuration, Mountainview Reservoir's storage capacity is shared with the SFWB and City of West Linn. Given the current operating situation, the reservoir is over-allocated and only approximately half of the reservoir's capacity can be relied upon for Oregon City use. If Oregon City continues to share Mountainview Reservoir's capacity for regional storage, then the analysis shown in Table 6-1 indicates that Oregon City is in immediate need of new storage. Since Oregon City needs the entire capacity of Mountainview Reservoir to meets its existing and future storage requirements, the City is actively working with the SFWB and City of West Linn to relieve the regional system's reliance on the reservoir. Appendix D contains a technical memorandum that presents an analysis of the regional storage issues and a recommended plan.

Another issue related to Mountainview Reservoir is that there is no redundant reservoir to provide backup supply to the Intermediate Pressure Zone or the Mountainview Pump Station. As a result, it is currently impossible to take this reservoir off-line for maintenance or repair. To remedy this backup supply problem, one option is to construct a redundant reservoir adjacent to Mountainview Reservoir at the site of the now decommissioned open reservoir. However, given the strong need for new storage capacity serving the Upper Pressure Zone and the excess capacity serving the Intermediate Pressure Zone, the City would be advised to select a relatively small capacity for this redundant reservoir. If the reservoir were sized minimally to provide equalization and fire flow storage only for the Intermediate Pressure Zone at build-out, the required volume would be approximately two million gallons. Alternatively, the City might consider a joint project with the SFWB to obtain a share in a relatively large reservoir at the site.

Mountainview Reservoir also needs to be upgraded to maintain reliable service in the future. The proposed improvement projects include the following:

- Reinforce the perimeter wall of the reservoir as recommended in the seismic vulnerability assessment. The necessary reinforcement can be completed on the exterior of the perimeter wall without taking the reservoir out of service.
- Reroof the reservoir to ensure continued protection of the underlying wooden support structure and plywood sheathing.
- Repair steel structural supports for the roof.
- Provide interior lighting improvements.
- Install outlet piping improvements to improve circulation in the reservoir.

### Boynton Reservoir Circulation

Boynton Reservoir is fed by a single pipe that terminates at the bottom of the reservoir and serves as both the reservoir's inlet and outlet. This arrangement does not ensure that there is good circulation of water in this standpipe style reservoir. Although the City's regular water quality monitoring has not indicated problems during regular reservoir operation, it is possible that old water in the upper portions of the reservoir could be pumped into the system in the event of an emergency requiring operation of the Boynton Pump Station. Due to this situation, it is recommended that that the City plan to make piping improvements at the reservoir that will enhance regular turnover of the reservoir. These improvements would involve dedicating the existing feed pipe to serve as the outlet only by adding a check valve and adding a new dedicated inlet pipe (with check valve) that extends into the upper portion of the reservoir. With water entering at the top of the reservoir and exiting from the bottom, the water in the reservoir will regularly turnover.

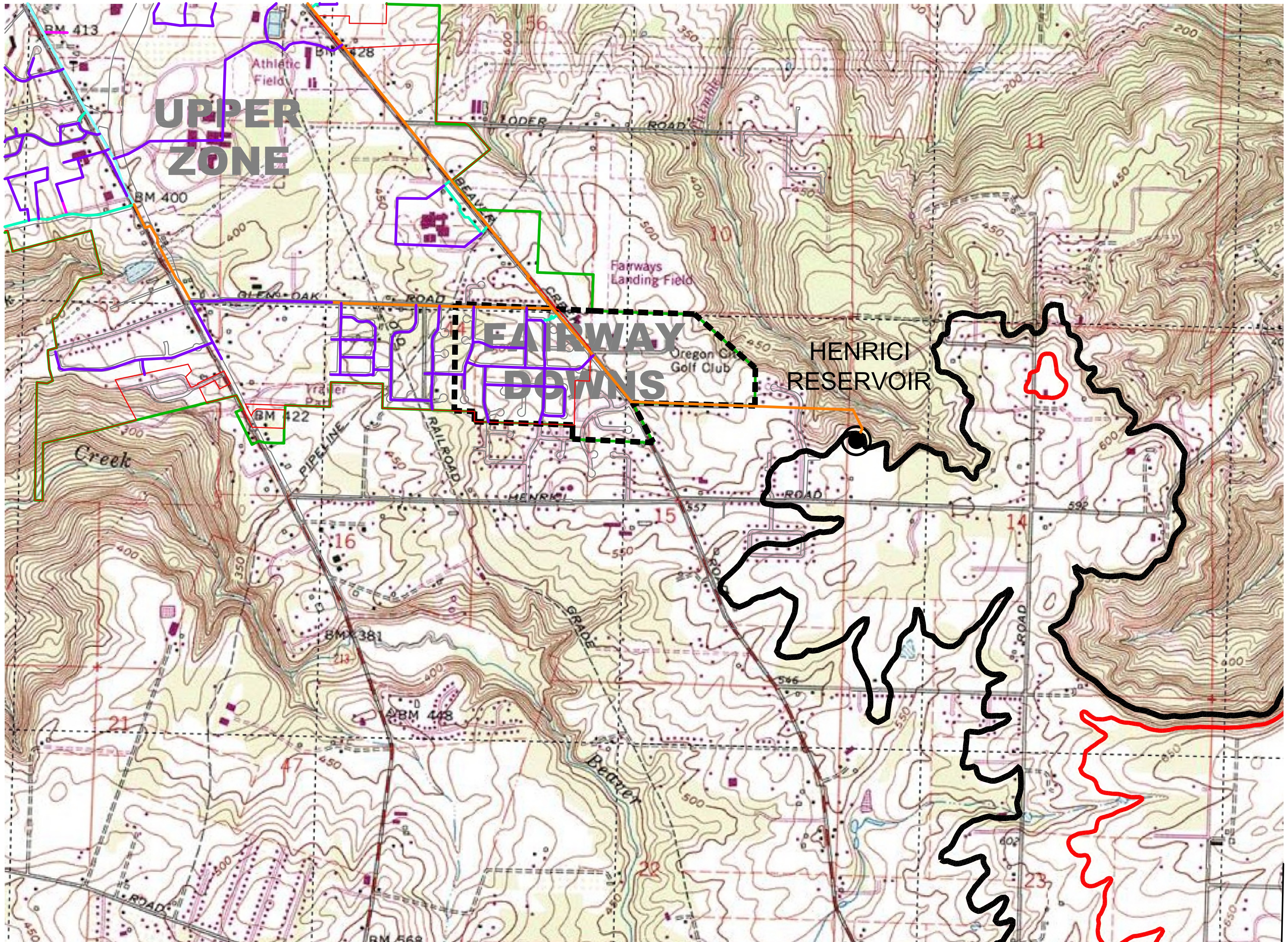
**Future Reservoir Siting Considerations**

The need for future reservoir storage capacity is the greatest in the Upper Pressure Zone. The availability of reservoir sites with proper elevation for serving Oregon City's Upper Pressure Zone is fairly limited. The ground surface elevation required for a non-elevated storage tank is approximately 570 feet and the only area meeting this criteria is located to the southeast of Oregon City, just outside of the UGB. Henrici Reservoir is sited at this location with a bottom elevation of 573.5 feet. Figure 6-1 illustrates the 570 foot elevation contour in this area along with the location of Henrici Reservoir. As a result of the topographic constraints for the Upper Pressure Zone, the southeastern area that is above elevation 570 will remain the best candidate for a future storage facility site.

A reservoir site for the Fairway Downs Pressure Zone would likewise need to be located in the area to the southeast of the Oregon City UGB. To maintain a minimum pressure of 40 psi at the top of the zone, the ground surface elevation required for a non-elevated storage tank is at least 620 feet. Figure 6-1 also shows the 620 foot elevation contour. Although the currently proposed UGB expansions do not affect the size and elevation range of this pressure zone, past UGB expansion alternatives that the City considered did affect the zone. As noted earlier, the existing Fairway Downs Pressure Zone is small enough for the City to continue providing service by pump station only. However, if future UGB expansions significantly expand the size of this pressure zone, a reservoir should be provided.

Regarding the siting of a redundant storage facility for Mountainview Reservoir, the site of the decommissioned open reservoir on Mountainview Street would be a logical location. The land is already owned by the City, required piping improvements would be minimal, and operational coordination with the existing reservoir and pump station would be relatively simple. As noted earlier, the capacity of this reservoir can be minimized since the Mountainview Reservoir provides ample storage for the pressure zones served. There may also be potential to coordinate the new reservoir project with the SFWB.

For a new reservoir serving the Lower Park Place Pressure Zone, a logical location would be along Holly Lane near the new UGB expansion area. A reservoir in this vicinity would improve fire flow availability for the higher elevation areas in this zone along Holly Lane.




# FIGURE 6-1

## POTENTIAL RESERVOIR SITES

N

0 750 1500
SCALE IN FEET

LEGEND:

- PRESSURE ZONE BOUNDARY
- URBAN GROWTH BOUNDARY
- CITY LIMITS
- 8”
- 10”
- 12”
- 14”
- 16”
- 570 FT ELEVATION
- 620 FT ELEVATION

WEST YOST & ASSOCIATES

CAD FILE: I:/526-01-01-FIG_6-1.dwg CFG FILE: 526-01-01-FIG_2-1.CTB DATE: 6-11-03 VLF

### Storage Evaluation Summary

Based on the evaluations presented above, Table 6-3 presents the estimated timing of storage facility construction or renovation projects through build-out. Some of the renovation projects for Mountainview Reservoir are relatively high priority, particularly the roof replacement. The necessary timing for construction of new storage facilities in Oregon City is dependent on population growth, the operational need for backup storage at Mountainview Reservoir, as well as the outcome of the City's ongoing work on regional storage issues. Since the City's recent high level of growth appears to be continuing for the near term future, it is recommended that the construction of new storage for the Upper Zone be planned for the latter part of the first improvement period.

**Table 6-3. Recommended Storage Improvements**

| Project | Project Phase | Years |
|---|---|---|
| Construct new 2.0 mg redundant reservoir for Intermediate Zone | 1 | 2004-08 |
| Roof replacement for Mountainview Reservoir | 1 | 2004-08 |
| Structural repair for Mountainview Reservoir Roof | 1 | 2004-08 |
| Interior lighting for Mountainview Reservoir | 1 | 2004-08 |
| Piping improvements for Mountainview Reservoir | 1 | 2004-08 |
| Seismic improvements to Mountainview Reservoir | 1 | 2004-08 |
| Demolition of elevated tank at Mountainview St. | 1 | 2004-08 |
| Construct new 5.0 mg reservoir for the Upper Zone | 1 | 2004-08 |
| Seismic improvements for Boynton Reservoir | 2 | 2008-14 |
| Piping improvements for Boynton Reservoir | 2 | 2008-14 |
| Construct new 1.5 mg reservoir for Lower Park Place Zone | 3 | 2014-24 |
| Construct new 0.5 mg reservoir for Fairway Downs Zone | 3 | 2014-24 |

## BOOSTER PUMPING CAPACITY EVALUATION

There are five booster pumping stations in the Oregon City water distribution system. The Boynton Pump Station provides local emergency and fire flow service and is adequately sized to serve this function. The other four stations perform transfer pumping service, moving water from one pressure zone to another. The planning criteria for a transfer booster pumping facility serving a pressure zone(s) with storage requires that the station have adequate firm capacity to supply the maximum day demand within all dependent pressure zones over a 24 hour period. For pressure zones without storage, the planning criteria requires that the pump station have adequate firm capacity to supply peak hour demand plus fire flow requirements within the pressure zone. The firm capacity of a pumping station is the capacity with the largest pump out of service.

## Current Pumping Capacity

Table 6-4 summarizes the booster pumping capacity requirements under current demand conditions. Current capacities for the pump stations serving pressure zones with storage, Mountainview and Hunter Avenue Pump Stations, are adequate for meeting maximum day demand. Both of the stations serving pressure zones without storage, however, have capacity issues. The Fairway Downs pump station has adequate capacity for serving the required 1,000 gpm fire flow demand, but the normal service pump's capacity of 50 gpm appears to be low relative to an estimated peak hour demand of more than 100 gpm. If the City is aware of low pressure issues during peak demand conditions, upsizing of the normal service pumps may be appropriate. With respect to the Livesay Road Pump Station, it is adequately sized for serving normal peak demands for the few houses that it serves, but lacks fire flow pumping capability. Since the Livesay Road Pressure Zone can be incorporated into the Park Place Intermediate Pressure Zone through a future system extension, it is recommended that the City plan to retire the Livesay Road Pump Station rather than upgrading the station to provide fire flow capacity.

**Table 6-4. Current Booster Pumping Capacity Evaluation**

| Pump Station | Pressure Zone Served | Current Max Day Demand[a], gpm | Existing Firm Capacity, gpm |
|---|---|---|---|
| Mountainview[b] | Upper Zone and Fairway Downs | 3,800 | 5,000 |
| Hunter Avenue[c] | Park Place Intermediate Upper, and CRW | 800 | 1,800 |
| Fairway Downs | Fairway Downs Zone | 1,100 | 1,050 |
| Livesay Road | Livesay Road Zone | 1,030 | 30 |

[a]Peak hour demand plus fire flow is used for the Fairway Downs and Livesay Road Pump Stations since they serve areas without reservoirs.
[b]Demand for the Mountainview Pump Station includes current demand from the CRW service areas that are served from the Meyer and Leland intertie and the South End Road intertie.
[c]Demand for the Hunter Avenue Pump Station includes current demand from the CRW service areas that are served at Barlow Crest Reservoir and the Forsythe and Swan intertie.

## Future Pumping Capacity

Table 6-5 shows the booster pumping capacity requirements for future demand conditions. As the community approaches build-out of the UGB, demand is expected to nearly double in the pressure zones served by the Mountainview Pump Station, creating a need for expansion of that station. Similarly, growth in the Fairway Downs pressure zone is expected to necessitate upsizing of the normal service pump for that station or providing a variable frequency drive for one of the fire flow pumps. The recently constructed Hunter Avenue Pump Station appears to have adequate capacity for the build-out demand in its service area and there is also space provided for an additional pump. Table 6-5 also shows demand for two conditions: the first condition considers land within the existing UGB only and the second condition considers the proposed UGB expansion areas as well.

**Table 6-5. Build-Out Booster Pumping Capacity Evaluation**

| Pump Station | Build-out Max Day Demand[a], gpm | Existing Firm Pumping Capacity, gpm | Necessary Capacity Expansion, gpm |
|---|---|---|---|
| Mountainview[b] | 7,300<br>7,900[c] | 5,000<br>5,000 | 2,300<br>2,900 |
| Hunter Avenue[d] | 1,500<br>1,700[c] | 1,800<br>1,800 | NA[e]<br>NA[e] |
| Fairway Downs | 1,500 | 1,050 | 450 |

[a]Peak hour demand is used for the Fairway Downs Pump station since it serves an area without storage.
[b]Demand for the Mountainview Pump Station includes future demand from the CRW service areas that are served from the Meyers and Leland intertie and the South End Road intertie.
[c]Includes demand from land within currently proposed UGB expansion areas.
[d]Demand for the Hunter Avenue Pump Station includes anticipated demand from CRW that is served at Barlow Crest Reservoir and Forsythe and Swan.
[e]Not applicable.

### Standby Power

Another important planning criteria pertains to the provision of backup power for booster pump stations in anticipation of a power outage. The criteria calls for pumping stations to be equipped with a backup energy source of sufficient capacity to operate the pumping plant at its rated capacity. Following are summaries of the backup power supply situations for each pump station:

- The Mountainview Pump Station has backup power for Pump No. 3 only, a direct diesel engine drive. Although this arrangement allows the City to maintain some service to the Upper Pressure Zone during temporary power outage situations, there could be problems in maintaining adequate service during an extended outage or during a peak demand period.
- The Hunter Avenue Pump Station has a diesel engine generator capable of operating the station at firm capacity.
- The Fairway Downs Pump Station has a natural gas engine generator capable of operating the station at firm capacity.
- The Boynton Pump Station does not have backup power. As a result, this pump station cannot provide service during emergencies that involve a power outage.
- The Livesay Road station has no backup power source, but improvements are not necessary since this station will ultimately be decommissioned.

### Seismic Vulnerability of Pump Stations

The City's pump stations were also evaluated for seismic vulnerability issues (see Appendix C). The seismic vulnerability assessment recommended the following improvements at the City's pump stations:

- Anchor miscellaneous equipment in the pump stations.
- Structurally upgrade the Mountainview Pump Stations.
- Decommission the Livesay Road Pump Station.

## Telemetry System

As noted in Chapter 2, the City is in the process of upgrading the water distribution telemetry system to allow improved monitoring and control of pump station operations as well as the City's reservoirs and PRV stations. Although these improvements are anticipated to be completed in 2004, the recommended CIP will include an allowance for additional telemetry system upgrades in the second phase of improvements.

## Pumping Evaluation Summary

Based on these evaluations, Table 6-6 summarizes the recommended type and timing of pump station construction or renovation projects through build-out. Priority projects include the backup power improvements, Fairway Downs Pump Station modifications, and decommissioning of the Livesay Road Pump Station. The necessary timing of the Mountainview Pump Station expansion is dependent on the rate of growth in the Upper Pressure Zone. This zone has shown steady growth in recent years and appears likely to achieve build-out within 20 years (annual rate of growth of nearly 4 percent). Even at this relatively high growth rate, the expansion will not be necessary until the second improvement phase. Since recent growth has been rapid for this zone, the City should monitor demand so that expansion of Mountainview Pump Station can be accelerated if necessary.

**Table 6-6. Recommended Pump Station Capacity Improvements**

| Project | Project Phase | Years |
|---|---|---|
| Backup power at Mountainview Pump Station (1,000 kW) | 1 | 2004-08 |
| Seismic upgrades at Mountainview Pump Station | 1 | 2004-08 |
| Fairway Downs Pump Station Modifications | 1 | 2004-08 |
| Decommission Livesay Road Pump Station | 1 | 2004-08 |
| Miscellaneous seismic improvements | 1 | 2004-08 |
| Mountainview Pump Station Capacity Expansion[a] | 2 | 2008-14 |
| Backup power at Boynton Pump Station (200 kW) | 2 | 2008-14 |
| Telemetry System Improvements | 2 | 2008-14 |

[a]Due to the potential for future Upper Zone UGB expansions, it is recommended that the City plan for a new 10,000 gpm pump station at Mountainview Street.

## PIPELINE NETWORK PERFORMANCE EVALUATION

The $H_2O$Map computer model was used to evaluate performance of the water distribution system pipeline network. The model was used to evaluate the system under existing and build-out conditions. The existing system model was developed to reflect the pipeline configuration as of the fall of 2002. The build-out system model includes all of the proposed pipelines necessary for solving existing system deficiencies as well as expansion of the water distribution system to serve all developable land within the urban growth boundary. A map showing all existing and proposed pipelines in the Oregon City water distribution system is included in Appendix A and a project data sheet for each pipeline project is included in Appendix E. The specific alignments of the proposed pipelines shown on this map are tentative and flexible. The actual alignments will conform to future land use, development patterns, easement acquisition issues, and topographic considerations identified during the design phase of project implementation.

The distribution system was modeled under three scenarios that simulated the critical conditions that are most demanding of pipeline network performance capabilities. The three scenarios that were modeled include:

- Peak hour demand
- Maximum day demand plus fire flow
- Low demand during booster pump station operation

### Peak Hour Demand Analysis

The peak hour demand scenario was modeled as taking place during the afternoon on a summer day when the irrigation demands are high. The booster pump stations in the system were operating at their rated capacity during the peak hour and storage reservoir levels were set at 80 percent full.

The service standard for minimum system pressure was used as the criteria for identifying deficiencies for the peak hour demand scenario. Table 6-7 summarizes the nodes in the system with pressures less than 40 psi during peak hour demand conditions. In most cases, the pressure deficiency is caused by a high elevation node near the top of the given pressure zone. Table 6-7 identifies the location, peak hour pressure estimate, and recommended corrective action for each of the deficient nodes. In addition to the identified low pressures, these nodes are also problematic with respect to available fire flows. The majority of the deficiencies are not significant problems, but can be corrected by small modifications to the local pressure zone boundary if there are customer complaints. These modifications to zone boundaries would cause significant increases in service pressures, thus requiring the installation of individual pressure reduction valves on the affected service connections.

**Table 6-7. Peak Hour Demand Deficiency Summary**

| Model Node Label | Location | Pressure Zone | Elevation (feet) | Pressure (psi) | Recommended Corrective Action | Project Phase |
|---|---|---|---|---|---|---|
| 2533 | Pearl St & Myrtle St | Intermediate | 390 | 38 | Minor problem at top of Intermed. PZ, connect into Upper PZ if complaints | 1 |
| 2263 | East St and Summit | Intermediate | 386 | 38 | Minor problem at top of Intermed. PZ, connect into Upper PZ if complaints | 1 |
| 4111 | Swan and Holcomb | Park Place Lower | 218 | 37 | Minor problem at top of Lower PP PZ, connect into Intermed. PZ if complaints | 1 |
| 4119 | Livesay Road | Park Place Lower | 218 | 39 | This area is will be absorbed into Park Place Intermed. PZ | 1 |
| 8021 | Spyglass Lane | Fairway Downs | 518 | 29 | Increase capacity of normal service pump at Fairway Downs PS | 1 |

**Maximum Day Demand Plus Fire Flow Analysis**

The fire flow scenario was modeled as taking place during a summer day when demand is at the maximum day level, transfer booster pump stations are in operation (including the SFWB's Division Street Pump Station), and water levels in the storage facilities are at 80 percent of full capacity. This scenario was modeled to verify the availability of minimum fire flows for residential areas (1,000 gpm) as well as commercial, multi-family, and public facility type land uses. In addition, specific ISO fire flow recommendations were compared to the available fire flows predicted by the model for locations identified in the latest ISO report for Oregon City.

As indicated above, minimum fire flow requirements were used to identify system deficiencies for the maximum day demand plus fire flow scenario. The available fire flow at a node is defined as the maximum flow available from a given node without reducing pressure anywhere within the same zone below 20 psi. The fire flow analysis report from the $H_2$OMap model was reviewed to identify any deficiencies with respect to minimum fire flow requirements. In general, fire flow availability is very good in Oregon City. Even so, there are a few areas in the system with extensive lengths of 6-inch or smaller diameter pipe where the model shows clusters of nodes that do not meet minimum fire flow requirements. There are also some areas with especially high fire flow requirements where availability is inadequate. Discussions with local fire officials, however, indicate that meeting fire flow requirements above 3,500 gpm is not particularly critical since deficiencies above this flow rate will not affect the City's ISO rating and 3,500 gpm has proven adequate for the vast majority of fire fighting situations. Therefore, any deficiencies where the available fire flow is still above 3,500 gpm are considered low priority. Also, in the case of the paper mill at 5th and Main, this facility has additional fire protection systems that can supplement the municipal fire flow supply. Finally, it is important to note that much of the existing CRW network within the Oregon City UGB, such as those service areas along South End Road, are small diameter systems with inadequate fire flow availability. These pipelines will require upsizing when annexed into the City in the future.

Table 6-8 identifies the location, available fire flow estimate, required fire flow, and recommended corrective action for each of the deficient areas. Although Table 6-8 identifies only one node for each problem area, many of these problem areas are actually indicated by a cluster of deficient nodes. The deficiencies identified in Table 6-8 provide the basis for the development of the recommended CIP for the existing system. Since correction of existing deficiencies is a high priority, these pipeline projects are targeted for implementation in Phase 1 unless specifically noted as a low priority.

**Low Demand With Booster Pump Operation**

The low demand, booster pump operation scenario simulated a time when the pumps were filling reservoirs while demand on the system was only at 20 percent of average day. Once again, the water level in reservoirs was set at 80 percent of full capacity.

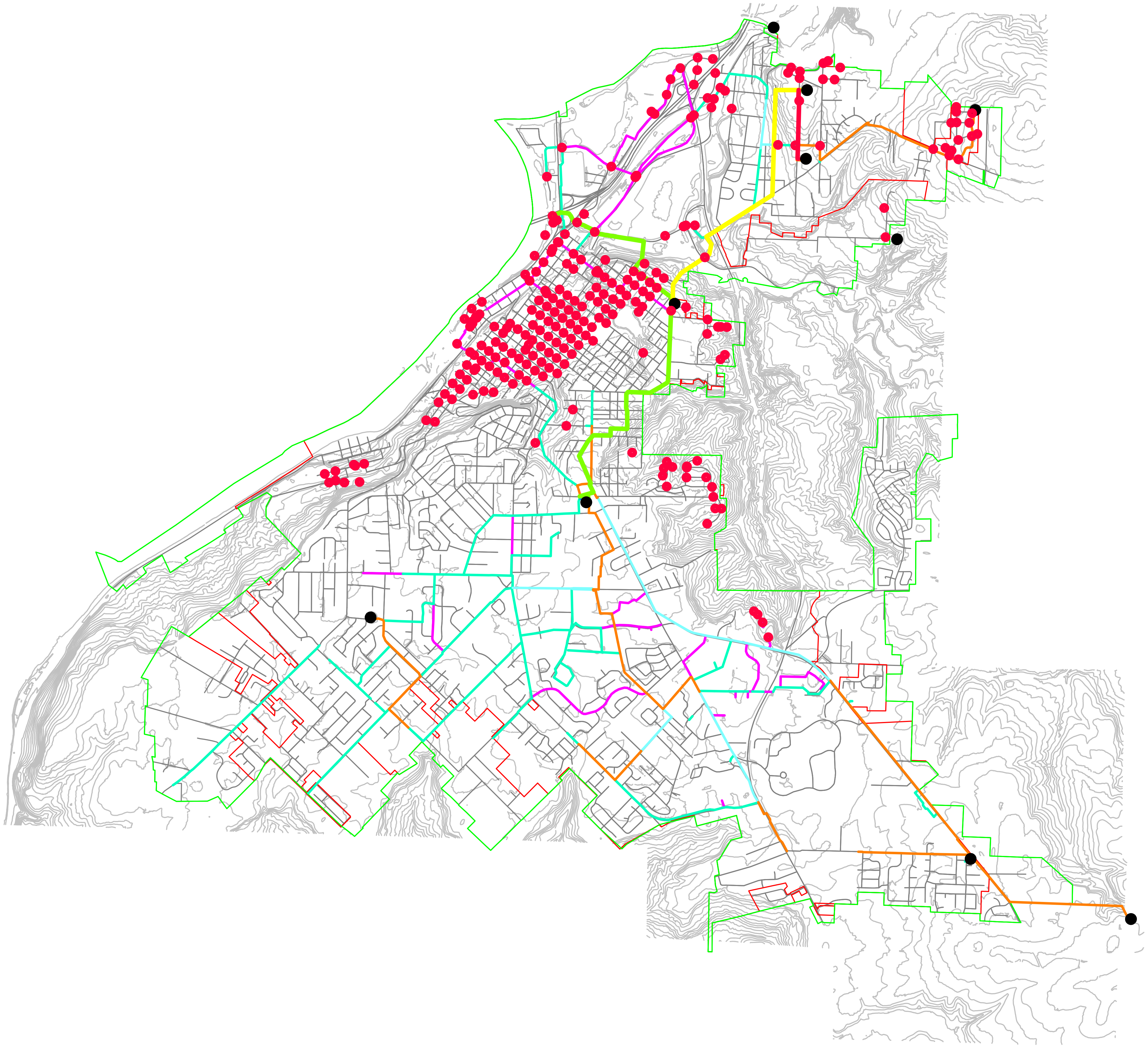
The service standard for maximum system pressure was used as the criteria for identifying deficiencies for the low demand scenario. Table 6-9 summarizes the nodes in the system with pressures over 100 psi. As noted in Chapter 2, there are areas in the Oregon City system where high pressures are inherent to the existing pressure zone system. In particular, the Intermediate Pressure Zone, Park Place Intermediate Pressure Zone, and Park Place Upper Pressure Zone span such a great range of elevations that pressures at the bottom of the zone must significantly exceed 100 psi in order to keep pressures at the top of the pressure zone above 40 psi. Although Table 6-9 identifies only the highest pressure node for each problem area, most of these problem areas are actually indicated by a cluster of excessive pressures. Figure 6-2 shows the location of all of the high pressure nodes in the Oregon City system. High pressure areas in the older parts of the system would be prime targets for leak detection activities.

In general, the recommended corrective action for existing high pressure areas is the installation of individual pressure reduction valves on service connections. If leakage problems in the very high pressure areas (upwards of 120 psi) prove to be extensive, however, this situation may warrant the consideration of reconfiguring pressure zone boundaries. Reconfigured pressure zone boundaries would be achieved through piping modifications and the addition of new pressure reduction stations. These reconfigurations would be easier in some areas of the system than others. In the Intermediate Pressure Zone, modifying pressure zone boundaries would be a challenge since it is a heavily interconnected grid. The Park Place Intermediate Zone, however appears to be an area of the distribution system with the good potential for a pressure zone boundary modification. Small pressure zones are already emerging in this area that could be linked together, restricting high pressures to the transmission main only. Similarly, if development continues such that high pressure areas along Newell Crest Drive could be connected into high pressure areas north of Beavercreek Road, there is good potential for a new pressure zone that could be fed through PRV stations from the Upper Zone.

# FIGURE 6-2

## CITY OF OREGON CITY

HIGH PRESSURE AREAS



N

0 1500 3000

SCALE IN FEET

LEGEND:

- URBAN GROWTH BOUNDARY
- CITY LIMITS
- 20' CONTOURS
- 10" } OREGON CITY PIPELINES
- 12"
- 14"
- 16"
- 24" } SFWB PIPELINES
- 30"
- 42"
- WATER SYSTEM FACILITIES
- HIGH PRESSURE NODE

WEST YOST & ASSOCIATES

CAD FILE: I:/526-01-01-FIG_6-2.dwg CFG FILE: 526-01-01-FIG_1-2.CFG DATE: 9-15-03 VLF

**Table 6-8. Maximum Day Demand Plus Fire Flow Deficiencies**

| Location and Model Node Label | Pressure Zone | Available Fire Flow, gpm | Required Fire Flow, gpm | Recommended Corrective Action | Project Phase |
|---|---|---|---|---|---|
| Residential Land Use Areas | | | | | |
| Highway 99 1025 | Lower | 740 | 1,000 | Upsize dead-end 4-inch pipeline serving hydrant. | 1 |
| Blanchard-Canemah 2069 | Intermediate | 510 | 1,000 | Cluster: Upsize 4-inch pipeline serving hydrants. | 1 |
| Center St. and Sunset 2283 | Intermediate | 560 | 1,000 | Cluster: Upsize local 6-inch pipelines or provide PRV feed from Upper Zone at Telford. | 1 |
| Third and East 2259 | Intermediate | 870 | 1,000 | Cluster: Upsize local 6-inch pipelines. | 1 |
| Caufield 3712 | Upper | 300 | 1,000 | Upsize and loop dead end 4-inch pipeline serving hydrant. | AP[a] |
| Woodfield 3300 | Upper | 970 | 1,000 | Close to required flow. No piping modification necessary if Boynton Pump Station in operation. | NA[b] |
| Rose Rd, Forest Ridge Ln, Beutel Rd CRW pipelines | Upper | 180-750 | 1,000 | CRW pipelines coming off South End Road will require upsizing when annexed. | NA[b] |
| Livesay Road 4115, 4119 | Park Place Lower | 390-970 | 1,000 | Upsize 6-inch pipeline and add feed through PRV station from Park Place Intermediate Zone. | 1 |
| Commercial and Multi-Family Land Use Areas | | | | | |
| 7th and Polk 2433 | Intermediate | 3,640 | 4,500 | Low priority. Upsize local 6-inch pipelines in future as opportunity arises. | 2 |
| Industrial, Institutions, and Public | | | | | |
| 5th and Main – Mill 12101 | Lower | 3,690 | 7,000 | Supplementary fire protection systems available. No action recommended. | NA[b] |
| Abernethy Rd. – County Shops, 1095 | Lower | 4,790 | 5,000 | Low priority. Upsize 6-inch pipeline in future as opportunity arises. | 2 |
| King Street - School 3870 | Upper | 2,350 | 5,000 | Upsize 8-inch pipeline. | 1 |

[a] AP = Already Planned (2003 replacement project)
[b] NA = Not applicable

Another important observation made during modeling of this scenario pertains to filling rates in the Upper Zone reservoirs. The model predicts that under this low demand condition with two Mountainview Pump Station pumps operating, Boynton Reservoir is filling at a rate of 3,440 gallons per minute (gpm) and Henrici Reservoir is filling at 1,170 gpm. Boynton Reservoir preferentially fills primarily due to its closer proximity to the pump station. This fill rate difference means that in order to fill the more distant Henrici Reservoir, the altitude valve at

Boynton must close, thus boosting pressures throughout the zone. To address this situation, the CIP includes pipeline improvements to increase transmission capacity between Mountainview Pump Station and the Henrici Reservoir site. These improvements will reduce the pressure rise that occurs when the Boynton Reservoir altitude valve is closed.

**Table 6-9. Excessive Pressures Under Low Demand With Booster Pump Operation**

| Model Node Label | Location | Pressure Zone | Elevation (feet) | Pressure (psi) | Recommended Corrective Action |
|---|---|---|---|---|---|
| 1117 | Clackamette Park | Lower | 28 | 114 | Individual PRVs and repair detected leaks. |
| 2209 | 12th & John Adams | Intermediate | 98 | 164 | Individual PRVs, consider boundary change only if leakage is extensive. |
| 2011 | Bean Court | Intermediate | 190 | 124 | Individual PRVs, consider boundary change only if leakage is extensive. |
| 2289 | 4th & Paquet Canemah | Intermediate | 192 | 124 | Individual PRVs, consider boundary change only if leakage is extensive. |
| 3327 | Holmes and Logus | Upper | 314 | 125 | Individual PRVs since small area. |
| 3132 | Newell Crest Drive | Upper | 260 | 152 | Individual PRVs now, future new pressure zone. |
| 3773 | North of Beavercreek | Upper | 300 | 129 | Individual PRVs now, future new pressure zone. |
| 4079 | Redland and Holcomb | Park Place Lower | 44 | 115 | Individual PRVs and repair detected leaks. |
| 5027 | Cleveland and Hiram | Park Place Intermediate | 154 | 172 | Consider linking pressure zones. |
| 5039 | Swan and Holcomb | Park Place Intermediate | 220 | 143 | Consider linking pressure zones. |
| 6005 | Winston and Holcomb | Park Place Upper | 434 | 158 | Consider pressure study if leakage rates high. |
| 6015 | Barlow Crest Reservoir | Park Place Upper | 518 | 121 | Consider pressure study if leakage rates high. |

## Fire Hydrant Coverage

The City's service standards require that all buildings be within a minimum of 500 feet of a fire hydrant. In commercial, industrial, and high-value districts, the minimum distance can be as low as 200 feet depending on the fire marshal's interpretation of the fire code. Review of the existing system indicates that there are areas that do not meet the minimum fire hydrant spacing requirements. A preliminary assessment using the City's GIS database of hydrant locations showed a current deficiency of as many as 100 hydrants system wide. These deficiencies should be field verified and the necessary remedial action clarified. In most cases, the remedy to the hydrant coverage deficiencies will be simply to connect a new hydrant to an existing water main. In a few cases, the nearest water main may be undersized for fire hydrant service and the pipeline will have to be upsized as part of a replacement project. To address these hydrant coverage issues, the CIP incorporates an allowance for fire hydrant additions into the annual allowance for pipeline replacements. This CIP item will ensure that the entire distribution system is brought into accordance with the City's service standards within the planning period.

**Seismic Vulnerability of the Pipeline Network**

The seismic vulnerability assessment reported that portions of the City's service area contain liquefiable soils. These areas are primarily in the Old Town district along the Willamette River, between I-205 and Highway 213 in the Park Place district, and along Redland Road. The seismic vulnerability assessment (see Appendix C) recommended the following actions regarding the pipeline network:

- Document and regularly exercise valves in the areas with liquefiable soils so that pipeline failures can be isolated in the aftermath of an earthquake.
- Communicate with the fire protection authorities regarding the potential for water service failures in those areas with liquefiable soils following a major earthquake.
- Anchor equipment in PRV vaults.
- Encourage the South Fork Water Board to conduct a seismic vulnerability assessment of their transmission pipelines.
- Replace steel and cast iron pipe with leaded joints, especially in those areas with liquefiable soils.

**Pipeline Condition Assessment and Replacement Requirements**

The Oregon City water distribution system contains a considerable amount of aged and small diameter pipelines. In addition, pipeline networks that the City inherited from annexed water districts largely consist of old asbestos cement and steel pipe in poor condition. The old pipes tend to contribute to leakage problems and the small lines tend to create problems with service pressures and fire flows due to excessive head losses. In addition to being in poor condition, many of the inherited steel and asbestos cement pipelines also do not meet the City's standards for fire hydrant spacing. In response to this situation, the City has actively pursued annual replacement projects to improve the overall condition of the pipeline network. In 2002, the City replaced more than 16,000 feet of old and small diameter pipe and plans to replace another 10,000 feet in 2003. It is recommended that the City plan to continue pipeline replacement activities for the duration of the 20-year planning period of this plan. To accomplish this objective, the CIP will budget sufficient funds to replace pipe at a rate of one percent of the system per year. This rate of replacement is required to completely replace the system every 100 years.

Some of the necessary pipeline replacement projects would be particularly desirable to complete in the near term future. Table 6-10 presents a listing of pipeline replacement projects that water operations staff have identified as high priority since they present ongoing maintenance problems or transmission bottlenecks in the system. Therefore, these projects will specifically be scheduled in the first phase of improvements of the recommended CIP. Following the first phase of improvements, the CIP will include an annual pipeline replacement allowance as described above. Prioritization of the remaining pipeline replacement projects should be conducted on an annual basis in accordance with the observations of operations staff regarding maintenance requirements and leak detection results. Pipelines with chronic maintenance issues or leakage problems should be selected for replacement first.

**Table 6-10. Priority Pipeline Replacement Projects**

| Location | Pressure Zone | Recommended Action | Project Phase |
|---|---|---|---|
| Highway 99 | Lower | Upsize 6-inch cast iron pipeline that crosses Highway 99 near I-205 | 1 |
| Singer Creek | Intermediate | 1) Abandon 12-inch steel pipe and complete transmission main connection down Pearl and Linn to 4th Street.<br>2) Provide second feed to Intermediate Zone via 16th and Division PRV station. | 1, AP[a] |
| Molalla at Mountainview to Beavercreek at Marjorie | Upper | Upsize remaining portion of the old Mountain Line (re-lined 16-inch steel pipeline with lead joints) to 20-inch. This project also improves Henrici filling rate. | 1, AP[a] |
| Swan Avenue | Park Place Intermediate | Upsize 6-inch steel pipe to reduce leakage and maintenance requirements. | 1 |
| Hunter Avenue | Park Place Intermediate | Upsize 6-inch steel pipe to reduce leakage and maintenance requirements. | 1, AP[a] |
| View Manor | View Manor | Upsize 6-inch cast iron pipe to reduce leakage and maintenance requirements. | 1 |
| Partlow Road | Upper | Upsize 8-inch steel pipe segment to complete 12-inch transmission main. | 1 |
| Meyers Road | Upper | Upsize 8-inch steel pipe to complete 12-inch transmission main | 1 |

[a]A portion of this project is already planned (2004 replacement project).

## PRV Stations

The existing PRV stations in the Oregon City system have generally been performing well for the City, but water operations staff have voiced concerns regarding the potential for failure of PRV stations. In recent years, a PRV failure in the Park Place District resulted in damage to private property and amplified the need to include protective features in the design of PRV stations. Although it is rare for PRV stations that receive regular maintenance and inspection to catastrophically fail, there are protective measures that can be incorporated into station design.

Available protective measures include stainless steel tubing on the valve piloting systems, the addition of surge shut-down piloting, placement of a strainer upstream of the PRVs, and placement of a pressure relief valve downstream of the PRVs. If drainage to a storm sewer is not available in the immediate vicinity of a PRV station, the pressure relief valve could be installed downstream at the nearest possible location with access to a storm sewer. An alternative to the pressure relief valve, although more expensive, is to install a redundant PRV downstream of the existing equipment. The cost for retrofitting the existing PRV stations with these protective features is included in the CIP for the City's consideration. Regardless of whether the City decides to upgrade the stations with protective features, each PRV should receive an annual inspection and all valve parts that wear or deteriorate should be replaced every five years.

**Pipeline Network Expansion**

In addition to the improvement projects designed for correcting deficiencies in the existing system, the pipeline network will also require expansion into areas within the UGB that are not yet served. In order to plan for these future expansions of the pipeline network, the computer model was used to perform sizing of the main transmission lines (12-inches and greater) that will be required to extend water service. Additional smaller pipelines (8-inch) were also modeled to ensure that fire flows in the future system would be adequate along the peripheries of the system. Pipeline expansions were also evaluated in the City's UGB expansion areas that are currently under consideration by the Department of Land Conservation and Development. Table 6-11 summarizes a list of transmission main expansion projects for pipelines 12-inches in diameter and greater. Details on these expansion projects are included in the CIP project data sheets in Appendix E. As with the previous pipeline projects, these system expansions are assigned an anticipated project timing according to improvement period.

**Table 6-11. Summary of Pipeline Network Expansion Projects for UGB Build-Out**

| Expansion Project Location | Pipe Size, inches | Project Phase |
|---|---|---|
| Leland Road from Caddis to McCord | 12 | 1 |
| McCord from Pease to Leland | 12 | 1 |
| New Upper Zone Reservoir Extension | 20 | 1 |
| Redland Road Extension | 16 | 2 |
| Holly Lane Extension | 16 | 2 |
| Beavercreek at Thayer Rd to Country Village | 12 | 2 |
| South End Road Loop Extension | 12 | 2 |
| Country Village Extension | 12 | 3 |
| Highway 99 South from Canemah | 12 | 3 |
| New Lower Park Place Reservoir Extension | 16 | 3 |
| New Fairway Downs Reservoir Extension | 16 | 3 |

### South Fork Water Board Transmission Pipelines

Hydraulic modeling of high demand conditions indicates that the SFWB will need to add transmission pipeline capacity to Oregon City as water demand increases. As an example, the UGB expansion area along Redland Road and Holly Lane will primarily receive supply from the 30-inch transmission pipeline between the SFWB plant and the SFWB's Division Street Pump Station. Modeling of the peak hour and maximum day plus fire flow demand in this area indicates excessive pressure loss in this 30-inch line during these high demand conditions.

### Water System Management and Planning Requirements

In addition to providing water service at an adequate volume and pressure, operation of the water system also requires management and planning activities. Regulatory agencies require either certification or documentation of these management and planning activities, often as conditions for maintaining permit compliance. Specific management and planning activities that the City is required to perform include a security vulnerability assessment, an emergency response plan, a water management and conservation plan, and a current water system master plan.

As part of the Bioterrorism Act of 2002, the federal government requires all communities serving more than 3,300 people to submit a Security Vulnerability Assessment to the Environmental Protection Agency. New rules adopted by the Oregon Department of Human Services Drinking Water Program in 2002 require that the results of the security vulnerability assessment be incorporated into an emergency response plan. The SFWB is currently coordinating the development of a vulnerability assessment and an emergency response plan on behalf of Oregon City, West Linn, and Clackamas River water. These documents, which will include the necessary analysis of the Oregon City water distribution system, are scheduled for completion in 2003. Since this work is being coordinated by the SFWB, the City's share of the costs will be funded through the SFWB's wholesale water supply rates.

Another planning requirement is the development of a water management and conservation plan. The Oregon Water Resources Department requires water suppliers to prepare a long term water management and conservation plan as part of the water use permitting process. The plan provides a description of the water system, water demand levels, and the water supply source and then explains how the water supplier will manage and conserve water to meet current and future demand. The plan also includes a water curtailment element that identifies stages of alert that will trigger increasingly restrictive water use requirements in response to supply shortages due to drought, contamination, or infrastructure failure. Currently, the City anticipates that the SFWB will coordinate the development of a water management and conservation plan on behalf of its customers. Again, since it is anticipated that this work will be coordinated by the SFWB, the City's share of the costs will be funded through the SFWB's wholesale water supply rates.

Finally, the City needs to maintain a current water master plan to guide improvements and expansions to the water system. Maintaining a current water master plan typically requires updating the plan every five to ten years. Costs for future master planning work that will update this report are included in the recommended CIP.

# CHAPTER 7

# CAPITAL IMPROVEMENT PROGRAM

Based on the evaluation of existing system performance and future expansion requirements presented in Chapter 6, this chapter integrates the projects into a staged Capital Improvement Program (CIP). Specific improvements are identified for each of the improvement periods of the CIP and for the full build-out of the City's service area. For each of the recommended projects, this chapter also presents cost estimates based on the unit construction costs identified below.

## UNIT CONSTRUCTION COSTS

This section presents the basis for cost estimates including the unit construction costs that are used to estimate the cost of recommended water system facility improvements. The unit costs are for construction only and do not include cost estimates for land acquisition, contingencies, engineering, legal costs, environmental, inspections and/or contract administration. These additional costs are added to the unit construction costs as a percentage mark-up to provide the City with a budgetary estimate of the total project capital cost for each proposed improvement.

These unit costs are representative of the construction cost of water system facilities under normal construction conditions. Estimation of construction costs for facilities to be constructed in areas requiring rock excavation, special foundation considerations or other special conditions should be developed based on specific unit cost data matching the expected conditions or requirements.

The unit costs were developed based on cost data supplied by manufacturers, published cost data and cost information from previous projects. All construction costs have been adjusted to reflect a year 2003 price level using the Construction Cost Index published by the Engineering News-Record (ENR). The ENR index for this master plan is 6,650. These cost data can be adjusted to reflect past or future construction costs by multiplying by the ratio of the past/future ENR to the base ENR of 6,650.

Construction cost data presented in this chapter are not intended to represent the lowest prices in the industry for each type of construction, but rather to be representative of average or typical construction costs. They are order-of-magnitude cost estimates with an expected accuracy of +50 percent to –30 percent to reflect the variability of costs according to the time of year that the work is bid, level of competition within the local economic environment, and future changes in the cost of labor and materials. As planning level unit costs, they are intended for guidance in evaluating various options and for budgetary purposes only within the context of this master planning effort.

## Pipelines

Unit costs for cement-mortar lined ductile iron water mains 8- through 36-inches in diameter are provided in Table 7-1. These costs include pipe materials, trenching, placing and jointing pipe, valves, thrust blocks, fittings, hydrants, placing imported pipe bedding, and native backfill material. The table includes costs for both new construction and pipe installations requiring asphalt pavement replacement. Asphalt replacement will be included in all cost estimates unless the proposed pipeline alignment will clearly cross unpaved ground. The cost for new or reconnected service lines from the pipeline to the property line, for average suburban residential development densities, is included in the costs for pipelines up to 18-inches in diameter. Service connection costs are not included for larger diameter pipelines which serve primarily as transmission lines. Unit costs increase if rock excavation is necessary, typically adding 50 to 200 percent or more to the baseline installation cost. The cost for any proposed pipelines within known rocky areas will be increased by a factor of 2.

**Table 7-1. Construction Costs for Water Mains**

| Pipeline Diameter, inches | Construction Cost[a,b], Dollars Per Lineal Foot New Construction | Construction Cost Including Pavement Replacement |
|---|---|---|
| 8 | 58 | 74 |
| 10 | 67 | 83 |
| 12 | 83 | 97 |
| 14 | 86 | 108 |
| 16 | 91 | 115 |
| 18 | 95 | 126 |
| 20 | 108 | 136 |
| 24 | 128 | 152 |
| 30 | 166 | 209 |
| 36 | 212 | 262 |
| 42 | 250 | 302 |

[a]Costs based on the 20-city average ENR CCI of 6,650.
[b]Costs do not include engineering, overhead, and contingency.

## Treated Water Storage Tanks

Unit costs were developed for the construction of water storage tanks in the size ranges of 0.5, 1, 2, 5, and 10 million gallons (MG). Table 7-2 lists the estimated construction cost for a ground-level pre-stressed concrete storage tank. As previously stated, these costs represent construction under normal excavation and foundation conditions and would be significantly higher for special or difficult foundation requirements. In addition to these construction costs, an allowance of $100,000 is included in the total capital cost for land acquisition at each tank site.

**Table 7-2. Construction Costs for Storage Reservoirs**

| Tank Volume, million gallons[a] | Construction Cost[b] Concrete Reservoirs, $1,000[c,d] |
|---|---|
| 0.5 | 659 |
| 1 | 903 |
| 2 | 1,358 |
| 5 | 2,890 |
| 10 | 4,523 |

[a]Costs for volumes not shown may be interpolated.
[b]Costs do not include engineering, overhead, and contingency.
[c]Costs based on the 20-city average ENR CCI of 6,650.
[d]Costs are based on prestressed concrete tank design.

## Distribution Pumping Stations

Distribution pumping station costs vary considerably, depending on such factors as architectural design, pumping head, and station capacity. Estimated average construction costs for distribution pumping stations, as shown in Table 7-3, are based on enclosed stations with architectural and landscaping treatment suitable for residential areas. Pumping station cost estimates include allowances for a standby pumping unit and auxiliary engine-generator sets.

**Table 7-3. Construction Costs for Distribution Pumping Stations**

| Pumping Station Capacity, mgd[a] | Construction Cost[b], $1,000[c] |
|---|---|
| 1 | 259 |
| 2 | 443 |
| 5 | 887 |
| 10 | 1,478 |
| 25 | 2,956 |

[a]Costs for capacities not shown may be interpolated.
[b]Costs do not include engineering, overhead, and contingency.
[c]Costs based on the 20-city average ENR CCI of 6,650.

## Engineering Markups and Contingencies

Engineering services associated with new facilities include preliminary investigations and reports, site and route surveys, foundation explorations, preparation of drawings and specifications, construction services, surveying and staking, sampling of testing material, and start-up services. For this study, engineering costs are assumed to be 10 percent of the construction cost estimates after construction contingencies have been applied.

There are also program implementation costs which cover such items as legal fees, financing expenses, administrative costs, and interest during construction. The cost of these items can also vary, but for the purpose of this study, it is assumed that these charges will equal approximately 5 percent of the construction costs after construction contingencies have been applied.

Construction Management covers such items as contract management and inspection during construction. The cost of these items can also vary, but for the purpose of this study, it is assumed that construction management charges will equal approximately 10 percent of the construction costs after construction contingencies have been applied.

It is also appropriate to allow for uncertainties unavoidably associated with the preliminary layout of projects. Such factors as unexpected construction conditions, the need for unforeseen mechanical items, and variations in final quantities are a few of the items that can increase project costs for which it is wise to make allowances in preliminary estimates. An allowance of 20 percent of the base construction cost was included to cover such contingencies.

Based on these factors, the total cost of all necessary engineering services, construction management, contingencies and program implementation is 45 percent of the base construction costs for each project. This factor is applied to the construction cost to estimate the total capital cost.

## COST OF PROPOSED IMPROVEMENTS

**Based on the unit costs and methodology described above, this section summarizes the estimated costs associated with each CIP project. The projects are divided into three categories according to their anticipated timing:**

Improvement Phase 1: Year 2004 to 2008
Improvement Phase 2: Year 2008 to 2014
Improvement Phase 3: Year 2014 to 2024

The recommended timing for projects is based on a steady population growth rate of three percent. As a result, the improvement phases correspond to the following population levels:

Improvement Phase 1: Population 29,000 to 33,000
Improvement Phase 2: Population 33,000 to 39,000
Improvement Phase 3: Population 39,000 to 53,000

In the event that population growth rates fluctuate significantly during the planning period, the timing of CIP projects can be adjusted in accordance with actual population levels.

Most of the CIP projects are displayed along with the existing water distribution system on the system map enclosed in Appendix A.

## Summary of CIP Projects

Tables 7-4 through 7-6 summarize the capital costs for each project in the set of recommended improvements according to their anticipated timing. These CIP projects are intended to satisfy the system improvement and expansion requirements through build-out of the City's urban growth boundary. The pipeline projects shown for the first improvement period focus on areas with fire flow deficiencies and high priority replacements of undesirable pipe materials with a few system expansion transmission mains. After the first improvement period, the pipeline projects focus on expansion of transmission mains and an allowance is also included for the annual replacement of 5,000 feet of pipelines and hydrant improvements. The reported capital costs account for developer participation in the financing of some system extensions. The estimated capital costs for pipelines are shown in greater detail on the project data sheets in Appendix E.

**Table 7-4. Estimated Capital Costs for CIP Projects**
**Improvement Phase 1 – Years 2004 to 2008 – ENR 6650**

| Recommended Improvements | Capital Cost, $1,000 |
|---|---|
| Reservoirs | |
| Redundant reservoir for Intermediate Zone | 2,180 |
| Roof replacement for Mountainview Reservoir | 490 |
| Structural repair for Mountainview Reservoir | 90 |
| Piping improvements for Mountainview Reservoir | 230 |
| Seismic improvements for Mountainview Reservoir | 1,015 |
| Demolition of elevated tank | 52 |
| Interior lighting for Mountainview Reservoir | 20 |
| New reservoir for Upper Zone | 4,130 |
| Subtotal | 8,207 |
| Pump Stations | |
| Diesel Generator at Mountainview Pump Station | 450 |
| Decommission Livesay Road Pump Station | 22 |
| Seismic upgrade at Mountainview Pump Station | 30 |
| Fairway Downs Pump Sta. Modifications | 22 |
| Misc. seismic improvements | 10 |
| Subtotal | 534 |
| Pipelines | |
| Leak detection (approx. 30 miles of pipeline network) | 20 |
| Leak repair | 150 |
| P-101 Highway 99 near 205 (FF[a], R[b]) | 375 |
| P-102 Blanchard – Canemah (FF) | 182 |
| P-103 Center Street and Sunset (FF- new PRV) | 292 |
| P-104 Third and East (FF) | 159 |
| P-105 Oak Tree Terrace to Livesay Road (FF – new PRVs) | 314 |
| P-106 King Street (FF) | 229 |
| P-107 Modify 16th and Division PRV Sta. (R[b]) | 29 |
| P-108 Linn to 4th Street (R) | 197 |
| P-109 Remaining Mountain Line (R) | 1,051 |
| P-110 Swan Avenue (R) | 384 |
| P-111 Hunter Avenue (R) | 128 |
| P-112 View Manor (R) | 457 |
| P-113 Partlow Road (R) | 16 |
| P-114 Meyers Road (R) | 197 |
| P-115 Livesay Road (R) | 75 |
| P-116 Leland Road from Caddis to McCord (E[c]) | 47 |
| P-117 McCord from Pease to Leland (E) | 113 |
| P-118 New Upper Zone Reservoir Extension (E) | 1,035 |
| Subtotal | 5,450 |
| Total | 14,191 |

[a]FF – Pipeline projects motivated by fire flow deficiencies.
[b]R – High priority pipeline replacement projects.
[c]E – Pipeline network expansion projects.

**Table 7-5. Estimated Capital Costs for CIP Projects**
**Improvement Phase 2 – Years 2008 to 2014 – ENR 6650**

| Recommended Improvements | Capital Cost, $1,000 |
|---|---|
| Reservoirs | |
| Piping improvements for Boynton Reservoir | 210 |
| Seismic improvements for Boynton Reservoir | 73 |
| Subtotal | 283 |
| Pump Stations | |
| Mountainview Pump Station Expansion | 2,750 |
| Diesel generator at Boynton Reservoir | 90 |
| Telemetry System Improvements | 100 |
| Subtotal | 2,940 |
| Pipelines | |
| P-201 Thayer Road and Loder Road Extension (E[a]) | 412 |
| P-202 Redland Road Extension (E) | 312 |
| P-203 Holly Lane Extension (E) | 184 |
| P-204 South End Road Loop Extension (E) | 436 |
| P-205 7th and Polk (FF[b]) | 104 |
| P-206 Abernethy Road (FF) | 217 |
| Pipeline Replacement/Hydrant Improvements | 5,000 |
| Subtotal | 6,665 |
| Other | |
| Water Master Plan | 200 |
| Total | 10,088 |

[a]E – Pipeline network expansion projects.
[b]FF – Pipeline projects motivated by fire flow deficiencies.

**Table 7-6. Estimated Capital Costs for CIP Projects**
**Improvement Phase 3 – Years 2014 to 2024 – ENR 6650**

| Recommended Improvements | Capital Cost, $1,000 |
|---|---|
| Reservoirs | |
| New reservoir for Fairway Downs Zone | 1,060 |
| New reservoir for Holly Lane | 1,800 |
| Subtotal | 2,860 |
| Pipelines | |
| P-301 Canemah – Highway 99 Extension (E[a]) | 276 |
| P-302 Country Village Extension (E[a]) | 241 |
| P-303 New Lower Park Place Reservoir Supply | 232 |
| P-304 New Fairway Downs Reservoir Supply | 1,744 |
| Pipeline Replacement | 12,000 |
| Subtotal | 14,493 |
| Other | |
| Water Master Plan | 200 |
| Total | 17,553 |

[a]E – Pipeline network expansion projects.

# CHAPTER 8

# FINANCING AND IMPLEMENTATION PLAN

The development of a financing plan is a key element for successful implementation of the recommended capital improvement program (CIP). The following chapter presents information that the City will need to make financing and implementation decisions. First, the recommended CIP projects are assessed to determine the portion of each project that should be funded from rates and the portion that should be funded from water system development charges (SDCs). The next sections summarize data on the number of rate payers as well as background information regarding historical revenues and expenses associated with the City's water fund and SDC fund. Background information on the City's rate stabilization fund and water revenue bond fund is also summarized. This historical data provides a basis for projecting future water system revenues and expenses for both the water fund and SDC fund. The availability and timing of funding from water rate and SDC sources is then compared to the funding requirements and timing of CIP projects. Review of the resulting financial demands provides a basis for evaluating alternative funding strategies and identifying the recommended financing and implementation plan.

The financing information presented in this chapter is summarized for each phase of the 20-year improvement period. This analysis anticipates that the City will adopt an updated financing plan, including an updated SDC, during fiscal year 2003/04 so that implementation of the recommended CIP will be fully underway in fiscal year 2004/05. As presented in the previous chapter, each CIP project has been assigned to one of three improvement periods:

Improvement Phase 1: Year 2004 to 2008
Improvement Phase 2: Year 2008 to 2014
Improvement Phase 3: Year 2014 to 2024

Appendix F contains tables that provide detailed financing information for each year within these improvement phases as well as specific detail related to each CIP project.

## CIP PROJECT COST ALLOCATIONS AND SCHEDULE

Cities are required to use water rates for funding projects that improve the existing system but do not expand system capacity. Projects that increase water system capacity for future growth are eligible for funding from SDCs. For projects that both increase system capacity for growth and improve existing facilities, appropriate percentages of the project cost can be assigned to each category. Table 8-1 summarizes the allocation of costs for CIP projects between the water rate funding source and the SDC funding source for each phase of the improvement period. Table F-1 in Appendix F shows the allocation between water rate funding and SDC funding for each project. Since the City's current budget for fiscal year 2003/04 includes funds for preliminary design work on high priority CIP projects, the cost allocations for these projects have been adjusted accordingly.

**Table 8-1. Funding Source Cost Allocations by CIP Project**

| Funding Source | Phase 1: 2004-2008, $ | Phase 2: 2008-2014, $ | Phase 3: 2014-2024, $ |
|---|---|---|---|
| Water Fund | 4,695,000 | 7,249,000 | 12,080,000 |
| SDC Fund | 9,496,000 | 2,839,000 | 5,473,000 |
| Total | 14,191,000 | 10,088,000 | 17,553,000 |

## RATE PAYER BASE

The water customer profile in Oregon City is dominated by single family residential rate payers but also includes a mix of multi-family, commercial, institutional, and industrial customers. In order to evaluate water revenues from all customers and evaluate rate impacts, it is useful to consider the rate payer base in terms of equivalent single family units (ESFUs). Table 8-2 presents data from the past two fiscal years that indicates the total number of existing ESFUs and the average rate of revenue per ESFU. This data indicates that each single family customer (ESFU) currently pays $323/year for water service or about $27/month. The average single family customer uses just under 1,000 cubic feet or 7,500 gallons of water per month.

**Table 8-2. Rate Payer Base**
Equivalent Single Family Units (ESFUs)

| Fiscal Year | Total Water Rate Billings, $/year | Single Family Water Rate Billings, $/year | Single Family Residential Units | Average Payment per Single Family Unit, $/SFU/year | Total System Equivalent Single Family Units ESFUs |
|---|---|---|---|---|---|
| 2000/01 | 3,662,772 | 2,160,800 | 6,584 | 328 | 11,161 |
| 2001/02 | 3,748,839 | 2,221,441 | 6,976 | 318 | 11,772 |
| Average | - | - | - | 323 | - |

Based on ESFU growth during fiscal year 2002/03, it is estimated that there will be nearly 12,400 ESFUs in the system for fiscal year 2003/04. Since the number of ESFUs served by the water system will continue to grow with overall system water demand, revenues from water rates can be expected to increase comparably over time. As discussed in Chapter 3 – Water Demand Analysis, water demand will most likely increase at an annual rate of two to three percent. For purposes of projecting future water system revenues, the ESFU growth is estimated at the lower two percent annual rate of increase.

## CITY FUNDING SOURCES

The City maintains several funds that can be used to finance capital improvement projects for the water distribution system. Each of these funding sources is described in the following sections and a baseline for projections is identified for those funds that are anticipated to finance the recommended CIP.

**Water Fund (501)**

The water fund (identified by fund number 501) is the source of funding for ongoing water operations and improvements for the existing water system. Revenues for the water fund predominantly come from rates with smaller amounts derived from miscellaneous sources such as tapping fees, hydrant draw payments, and interest. Expenses for the water fund primarily include employee salaries and benefits, materials and contract services, capital outlays for new construction and equipment, and debt service on bonds. For purposes of determining the availability of water rate funds for CIP projects, the line item titled Net Revenues without CIP Outlays is of particular interest. Table 8-3 summarizes historical revenues and expenses for the water fund during fiscal years 2000/01, 2001/02, and 2002/03 as well as the budgeted amounts for 2003/04.

**Table 8-3. Water Fund Historical and Budget Data**

| | 2000/01 Actual $ | 2001/02 Actual $ | 2002/03 Actual $[a] | 2003/04 Budgeted $ |
|---|---|---|---|---|
| Beginning Balance | 4,008,518 | 4,750,128 | 5,325,156 | 4,719,880 |
| Revenues | | | | |
| Water Rate Revenues | 3,662,772 | 3,748,839 | 4,017,400 | 4,000,000 |
| Miscellaneous Revenues[b] | 239,525 | 315,489 | 333,573 | 244,150 |
| SFWB SDC | | | 354,133 | 350,000 |
| LGIP Interest | 184,471 | 104,167 | 68,948 | 60,000 |
| Bond Interest | 72,722 | 2,006,174[c] | 20,730 | 22,000 |
| Total Revenues | 4,159,490 | 6,174,669 | 4,794,784 | 4,676,150 |
| Expenses | | | | |
| Personal Services | 547,364 | 680,734 | 730,716 | 856,467 |
| Non-CIP Material & Services[d] | 1,867,387 | 1,810,953 | 2,126,688 | 2,562,056 |
| SFWV SDC | | | 354,133 | 350,000 |
| Non-CIP Capital Outlays | 101,754 | 5,657 | 10,866 | 123,000 |
| CIP Material & Services | 0 | 36,904 | 90,362 | 100,000 |
| CIP Capital Outlays | 259,076 | 499,502 | 1,358,461 | 2,210,500 |
| Fleet Transfers, Maintenance | 57,437 | 52,358 | 156,000 | 178,500 |
| Transfer to Rate Stabilization | 0 | 0 | 0 | 100,000 |
| Debt Service | 584,863 | 2,513,533[c] | 572,834 | 573,699 |
| Total Expenses | 3,417,881 | 5,599,641 | 5,400,060 | 7,054,222 |
| Net Revenues | 741,609 | 575,028 | -605,276 | -2,378,072 |
| Net Revenues w/o CIP Outlays | 1,000,685 | 1,111,434 | 843,547 | -67,572 |
| Ending Balance | 4,750,127 | 5,325,156 | 4,719,880 | 2,341,808 |

[a]Final unaudited figures.
[b]Miscellaneous revenues include pumping charges, tapping fees, hydrant draw payments, and interest.
[c]City refinanced the debt.
[d]Includes wholesale water purchase from the South Fork Water Board.

The City currently pays debt service on two bonds through the water fund. The debt service schedule for these bonds is summarized in Table 8-4. The first bond dates from 1993 and will be paid off in fiscal year 2006/07. The second bond dates from 2002 and will be paid off in fiscal year 2014/15.

**Table 8-4. Bond Debt Service Schedule**

| Fiscal Year | Debt Service Payment, $/year |
|---|---|
| 2003/04 | 573,699 |
| 2004/05 | 568,481 |
| 2005/06 | 406,058 |
| 2006/07 | 406,045 |
| 2007/08 | 200,245 |
| 2008-2015 | 200,245 |

The historical/budget data and debt service schedule provide a basis for projecting future revenues and expenses for the water fund. Table 8-5 presents the anticipated water fund revenue and expense figures for fiscal year 2004/05 that are used as a baseline for the financial projections.

**Table 8-5. Fiscal Year 2004/05 Water Fund Baseline for Projections**

| | 2004/05 Projected $ | Basis |
|---|---|---|
| Beginning Balance | 2,341,808 | Current balance less 2003/04 budget |
| Revenues | | |
| Water Rate Revenues | 4,180,000 | Increase at 2% from 2002/03 |
| Miscellaneous Revenues | 347,049 | Increase at 2% from 2002/03 |
| SFWB SDC | 350,000 | Constant from 2003/04 budget |
| LGIP Interest | 60,000 | Constant from 2003/04 budget |
| Bond Interest | 7,500 | Declines to zero in 2015 |
| Total Revenues | 4,944,549 | |
| Expenses | | |
| Personal Services | 856,467 | Constant from 2003/04 budget |
| Non-CIP Material & Services | 2,305,850 | 90% of budgeted 2003/04, increase at 2% |
| SFWB SDC | 350,000 | Constant from 2003/04 budget |
| Non-CIP Capital Outlays | 75,000 | Constant at double the 3-year average |
| Fleet Transfers, Maintenance | 178,500 | Constant from 2003/04 budget |
| Transfer to Rate Stabilization | 100,000 | Discontinued after 2004/05 |
| Existing Debt Service | 568,481 | Per debt service schedule |
| Total Expenses | 4,434,298 | |
| Net Revenues w/o CIP Outlays | 510,251 | |

For the purpose of developing water fund financial projections, water rate and miscellaneous revenues are expected to increase over time in accordance with population growth at two percent per year. Since the major component of the material and services expense is water purchases from the South Fork Water Board, this expense item is increased at two percent per year as well. Future debt service on existing bonds is projected per the debt service schedule. Interest income is expected to decline over time. With the exception of the transfer to the rate stabilization fund which is just a temporary expense through 2004/05, all other expenses are held constant for the duration of the planning period.

**Water Revenue Bond Fund (503)**

The City is in the process of retiring the water revenue bond fund (identified by fund number 503) by transferring its remaining balance to the rate stabilization fund. An amount of $100,000 will be transferred to the rate stabilization fund in 2003/04 and the remaining funds will be transferred in 2004/05. Since this fund is being discontinued, it is not anticipated to play a role in financing the recommended CIP.

**System Development Charge Fund (511)**

The SDC fund (identified by fund number 511) is the source of funding for the planning, design, and construction of water system expansion projects necessary to accommodate growth. Revenues for the SDC fund come from the SDCs paid by new connections to the water system and interest income. Expenses for the SDC fund primarily include new construction projects with additional funds spent on related planning and design work. For purposes of determining the availability of SDC funds for CIP projects, the line item titled Net Revenues without CIP Outlays is of particular interest. Table 8-6 summarizes historical revenues and expenses for the SDC fund during fiscal years 2000/01, 2001/02, and 2002/03 as well as the budgeted amounts for 2003/04.

**Table 8-6. SDC Fund Historical and Budget Data**

| | 2000/01 Actual $ | 2001/02 Actual $ | 2002/03 Actual $[a] | 2003/04 Budgeted $ |
|---|---|---|---|---|
| Beginning Balance | 2,700,350 | 2,955,075 | 3,244,936 | 2,707,517 |
| Revenues | | | | |
| SDC Revenues | 455,616 | 476,915 | 421,276 | 400,000 |
| Interest Income | 157,484 | 78,264 | 48,301 | 45,000 |
| Total Revenues | 613,100 | 555,179 | 469,577 | 445,000 |
| Expenses | | | | |
| Non-CIP Material & Services | 59,284 | 58,694 | 53,894 | 77,600 |
| Non-CIP Capital Outlays | 0 | 0 | 0 | 0 |
| CIP Materials and Services | 5,787 | 48,178 | 69,691 | 115,000 |
| CIP Capital Outlays | 293,304 | 158,446 | 883,411 | 1,015,500 |
| Total Expenses | 358,375 | 265,318 | 1,006,996 | 1,208,100 |
| Net Revenues | 254,725 | 289,861 | -537,419 | -763,100 |
| Net Revenues w/o CIP Outlays | 553,816 | 496,485 | 415,683 | 367,400 |
| Ending Balance | 2,955,075 | 3,244,936 | 2,707,517 | 1,944,417 |

[a]Final unaudited figures.

Again, the historical and budget data provide a basis for projecting future revenues and expenses. Table 8-7 presents the anticipated SDC fund revenue and expense figures for fiscal year 2004/05 that are used as a baseline for the financial projections.

**Table 8-7. Fiscal Year 2004/05 SDC Fund Baseline for Projections**

| | 2004/05 Projected $ | Basis |
|---|---|---|
| Beginning Balance | 1,944,417 | Current balance less 2003/04 budget |
| Revenues | | |
| SDC Revenues | 451,269 | Average of historical data, increase at 2% |
| Interest Income | 45,000 | Constant from 2003/04 budget |
| Total Revenues | 496,269 | |
| Expenses | | |
| Non-CIP Material & Services | 77,600 | Constant from 2003/04 budget |
| Non-CIP Capital Outlays | 0 | Constant from 2003/04 budget |
| Total Expenses | 77,600 | |
| Net Revenues | 418,669 | |

For the purpose of developing the SDC fund financial projections, the number of new connections to the system requiring payment of an SDC is expected to increase over time in accordance with population growth at two percent per year. Interest income and expenses are held constant for the duration of the planning period.

Since the existing water system SDC was last revised in 1997, the City needed to update the fee amount so that it accurately reflects the recommended CIP projects contained in this master plan. Therefore, as part of the master planning project, an SDC evaluation was conducted and a report was prepared that recommended updated SDC amounts. The SDC report is included as Appendix G. The updated SDC amounts were adopted by the City Commission in June 2004. The updated SDC is based on various components as summarized in Table 8-8.

**Table 8-8. Water System Development Charge Summary**

| Item | Reimbursement Fee | Improvement Fee | Total Fee |
|---|---|---|---|
| Pump Stations | 44.04 | 176.10 | 220.14 |
| Storage | 0.00 | 1,347.18 | 1,347.18 |
| Distribution Mains | 677.39 | 547.04 | 1,224.43 |
| Compliance Costs | 0.00 | 31.05 | 31.05 |
| Debt Service Credit for Bonds | 0.00 | 0.00 | 0.00 |
| Total | 721.44 | 2,101.370 | 2,822.80 |

For ease of administration, the adopted SDC amount is set at $2,820. The financial projections for the SDC fund reflect the updated SDC going into effect starting in 2004/05.

**Water Rate Stabilization Fund (515)**

The water rate stabilization fund (identified by fund number 515) was established to comply with Oregon City Resolution 01-42 of December 19, 2001. The City plans to set aside funds at an amount approximately equal to the Debt Service Reserve for the Water Fund which is currently just under $500,000. The funding for the water rate stabilization fund will come from the discontinued Water Revenue Bond Fund (503) and the Water Fund (501). Since this fund is intended for stabilizing rates in the event of unanticipated expenses, it is not included as a funding source for the recommended CIP.

## WATER SYSTEM FINANCIAL PROJECTIONS

To determine the amount of financing necessary for implementation of the CIP, projections of available funding from water rate and SDC sources can be compared to the funding requirements and timing of CIP projects. Table F-1 in Appendix F shows the CIP expenditure schedule as well as funding allocations between the Water Fund (501) and the SDC Fund (511) for each year of planning period. Review of the resulting financial demands provides a basis for the recommended financing and implementation plan. These projections are based on actual dollars using an inflation rate of 2.5 percent.

**SDC Fund Financial Projections.** The availability of financing from the SDC fund for growth-related CIP projects was reviewed first because any shortfalls in SDC funding must be met through the water rate system. Table 8-9 summarizes the revenues, expenses, and anticipated balance for the SDC fund for each phase of the improvement period. The beginning SDC fund balance is derived from the current balance less net expenditures projected in the 2003/2004 budget. It is assumed in these projections that the SDC fund will maintain a minimum $500,000 balance for contingency in the future. Table F-2 in Appendix F provides detail on each year in the financial projection for the SDC fund.

**Table 8-9. SDC Fund Financial Projections**

| | Phase 1: 2004-2008, $ | Phase 2: 2008-2014, $ | Phase 3: 2014-2024, $ |
|---|---|---|---|
| Beginning SDC Fund Balance | 1,058,571 | 500,000 | 3,126,228 |
| Total Revenues | 3,664,557 | 6,844,365 | 16,256,958 |
| Total Expenses | 322,235 | 547,147 | 1,112,883 |
| Net Revenues | 3,342,321 | 6,297,217 | 15,144,075 |
| Planned CIP Outlays from SDC Fund | 4,850,180 | 8,688,960 | 7,501,106 |
| Ending SDC Fund Balance | 500,000 | 3,126,228 | 10,769,197 |
| Shortfall | 949,287 | 5,017,971 | 0 |

This analysis indicates that there will not be sufficient SDC funds to meet all costs associated with SDC eligible projects during the first and second improvement phases. As a result, the shortfall amount must be met through alternative financing. For the purposes of this financial evaluation, the full shortfall amount is transferred as an obligation for the water fund.

**Water Fund Financial Projections.** Table 8-10 summarizes the revenues, expenses, and anticipated balance for the water fund for each phase of the improvement period. This summary shows the transfer of CIP funding obligations for SDC eligible projects that cannot be covered by the SDC fund. The beginning water fund balance is derived from the current balance less net expenditures projected in the 2003/2004 budget. It is assumed in these projections that water rates will increase at 3 percent per year to keep pace with inflation and system growth. Also, the water fund will maintain a minimum $1,200,000 balance for debt service reserves and contingency in the future. Table F-3 in Appendix F provides detail on each year in the financial projection for the water fund.

**Table 8-10. Water Fund Financial Projections**

| | Phase 1: 2004-2008, $ | Phase 2: 2008-2014, $ | Phase 3: 2014-2024, $ |
|---|---|---|---|
| Beginning Water Fund Balance | 2,341,808 | 1,259,107 | 1,150,000 |
| Total Revenues | 21,172,808 | 39,868,201 | 96,675,830 |
| Total Expenses | 17,562,193 | 33,932,169 | 71,156,675 |
| Net Revenues | 3,610,615 | 5,936,032 | 25,519,155 |
| Planned CIP Outlays from Rates | 3,744,029 | 9,125,991 | 17,752,807 |
| SDC Outlays Requiring Rate Coverage | 949,287 | 5,017,971 | 0 |
| Total CIP Outlays from Rates | 4,693,316 | 14,143,961 | 17,752,807 |
| Ending Water Fund Balance | 1,259,107 | 1,150,000 | 9,007,473 |
| Shortfall | 0 | 8,098,823 | 91,125 |

This analysis indicates that implementation of the recommended CIP under the existing water rate structure and an updated SDC structure would result in significant funding shortfalls only during the second improvement phase. The following section presents a plan that addresses these projected shortfalls.

## FINANCING PLAN

The financial projections indicate that the City will be able to fund water system improvements on a pay-as-you-go basis during the first and third improvement periods. An alternate source for funding, however, will be required for the second improvement period. The sale of revenue bonds, which would be backed by the City’s ability to collect service fees from system users, is the recommended financing tool for meeting the projected funding shortfalls associated with implementation of the second phase. To sell bonds, the City would be required to reserve one year of debt service and increase rates to cover the cost of the bonds. It is important to note that since 1996, the City charter requires approval of the sale of revenue bonds by a vote of the people. For the purposes of this evaluation, it was assumed that the revenue bonds would be sold in an amount ten percent greater than the projected shortfall and that the bonds would have a five percent annual interest rate and twenty year payback period. Thus, revenue bonds totaling approximately $8.9 million would be necessary to meet the shortfall in the second improvement phase.

The impact of a revenue bond financing plan is most easily evaluated in terms of its effect on the average user rate. As noted earlier, each equivalent single family unit (ESFU) currently pays approximately $323/year for water service or almost $27/month. Table 8-11 identifies the amount of revenue bonds required for each improvement period, the resulting annual debt service payment, and the associated increase necessary in user rates to cover debt servicing. For the first and third phase of improvements, no additional debt servicing costs are necessary such that there are no rate impacts other that the regular increases necessary to keep pace with inflation. For the second phase of improvements, water rates would increase by $49/year or approximately $4/month to cover debt servicing.

**Table 8-11. Rate Impacts From New Revenue Bonds**

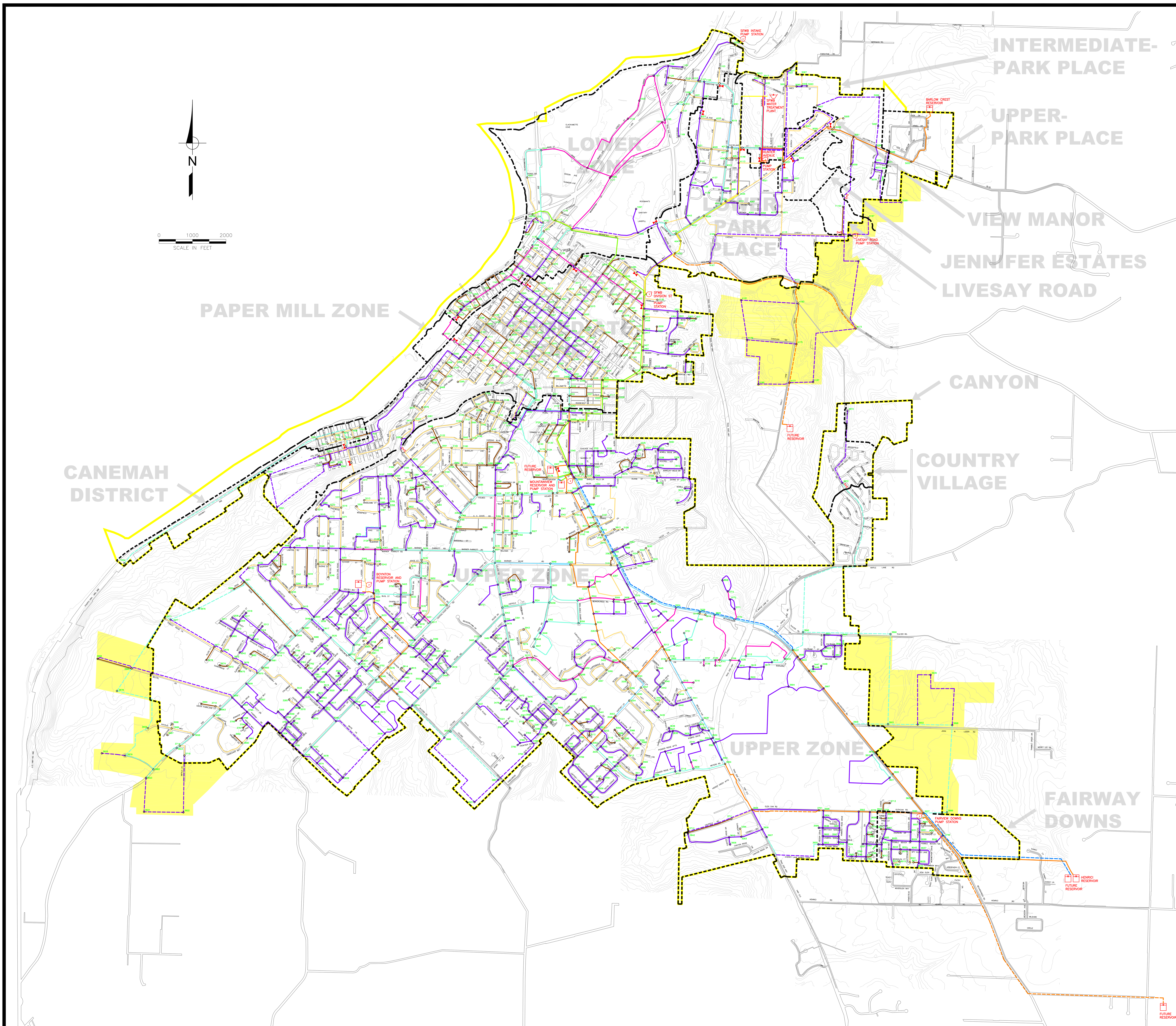
| | Phase 1: 2004-2008 | Phase 2: 2008-2014 | Phase 3: 2014-2024 |
|---|---|---|---|
| Revenue Bonds Requirement, $ | 0 | 8,900,000 | 0 |
| Annual Debt Service, $ | 0 | 714,159 | 0 |
| Rate Impact per ERU, $/year | 0 | 49 | 0 |
| Total Rate per ERU, $/year, avg. | 338 | 396 | 498 |
| Rate Impact per ERU, $/month, avg. | 0 | 4 | 0 |
| Total Rate per ERU, $/month | 28 | 33 | 42 |

The rate increase required to fund the Phase 2 improvements represents a twelve percent increase in water rates. This rate increase is greater than the three percent per year threshold which requires a vote of the people by the City charter. Therefore, the necessary rate increase would need to be included in the revenue bond measure that goes to a vote of the people.

## IMPLEMENTATION

The update of the water system SDC was a critical step forward in the implementation of the recommended CIP. Eventually, the City will also need to obtain voter approval for revenue bond financing for the second phase of improvements. Prior to the revenue bond vote, it is critical that the City Commission moves to eliminate the existing water rate regression provision that is currently in the City Charter (Section 58). If left in place, this provision will obstruct the City's ability to obtain revenue bond financing.

# Appendix A




| LEGEND | |
|---|---|
| SUPPLY SOURCE | |
| TANK | |
| JUNCTION NODE | |
| PUMP | |
| (FUTURE) | PRESSURE REDUCING VALVE STATION |
| URBAN GROWTH BOUNDARY (UGB) | |
| PROPOSED UGB EXPANSION AREA | |
| PRESSURE ZONE BOUNDARY | |
| FUTURE PIPELINE | |
| EXISTING PIPELINE | |
| CRW PIPELINE | |
| MILL | PRESSURE ZONE NAME |

| PIPELINE COLOR CODING | |
|---|---|
| 4" AND UNDER | |
| 6" | |
| 8" | |
| 10" | |
| 12" | |
| 14" | |
| 16" | |
| 18" | |
| 20" | |
| 24" | SFWB TRANSMISSION PIPELINES |
| 30" | SFWB TRANSMISSION PIPELINES |
| 42" | SFWB TRANSMISSION PIPELINES |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# SYSTEM MAP

CITY OF OREGON CITY
WATER DISTRIBUTION SYSTEM MASTER PLAN
OCTOBER 2004

# Appendix B

# Division III
# FIRE PROTECTION
# APPENDIX III-A

## FIRE-FLOW REQUIREMENTS FOR BUILDINGS

## (See UFC Section 903.3)

### SECTION 1 – SCOPE

The procedure determining fire-flow requirements for buildings or portions of buildings hereafter constructed shall be in accordance with Appendix III-A. Appendix III-A does not apply to structures other than buildings.

### SECTION 2 – DEFINITIONS

For the purpose of Appendix III-A. certain terms are defined as follows:

**FIRE AREA** is the floor area, in square feet, used to determine the required fire flow.

**FIRE FLOW** is the flow rate of a water supply, measured at 20 psi (137.9 kPa) residual pressure, that is available for firefighting.

### SECTION 3 – MODIFICATIONS

**3.1 Decreases.** Fire-flow requirements may be modified downward by the chief for isolated buildings or a group of buildings in rural areas or small communities where the development of full fire-flow requirements is impractical.

**3.2 Increases.** Fire-flow may be modified upward by the chief where conditions indicate an unusual susceptibility to group fires or conflagrations. An upward modification shall not be more than twice that required for the building under consideration.

### SECTION 4 – FIRE AREA

**4.1 General.** The fire area shall be the total floor area of all floor levels within the exterior walls, and under the horizontal projections of the roof of a building, except as modified in Section 4.

**4.2 Area Separation.** Portions of buildings which are separated by one or more four-hour area separation walls constructed in accordance with the Building Code, without openings and provided with a 30-inch (762 mm) parapet, are allowed to be considered as separate fire areas.

**4.3 Type I and Type II-F.R. Construction.** The fire area of buildings constructed of Type I and Type II-F.R. construction shall be the area of the three largest successive floors.

### SECTION 5 – FIRE-FLOW REQUIREMENTS FOR BUILDINGS

**5.1 One- and Two-Family Dwellings.** The minimum fire flow and flow duration requirements for one- and two-family dwellings having a fire area which does not exceed 3,600 square feet (344.5 $m^2$) shall be 1,000 gallons per minute (3785.4 L/min.). Fire-flow and flow duration for dwellings having a fire area in excess of 3,600 square feet (344.5 $m^2$) shall not be less than that specified in Table A-III-A-1.

> EXCEPTION: A reduction in required fire-flow of 50 percent, as approved, is allowed when the building is provided with an approved automatic sprinkler system.

**5.2 Buildings other than One- and Two-Family Dwellings.** The minimum fire-flow and flow duration for buildings other than one- and two-family dwellings shall be as specified in Table A-III-A-1.

> EXCEPTION: A reduction in required fire-flow of up to 75 percent, as approved, is allowed when the building is provided with an approved automatic sprinkler system. The resulting fire flow shall not be less than 1,500 gallons per minute (5677.5 L/min.).

**TABLE A-III-A-1—MINIMUM REQUIRED FIRE FLOW AND FLOW DURATION FOR BUILDINGS**

| FIRE AREA (square feet) x0.0929 for $m^2$ | | | | | FIRE FLOW (gallons per minute)[2] x3.785 for L/min. | FLOW DURATION (hours) |
|---|---|---|---|---|---|---|
| Type I-F.R. II-F.R.[1] | Type II One-HR III One-HR[1] | Type IV-H.I. V One-HR[1] | Type II-N III-N[1] | Type V-N[1] | | |
| 0-22,700 | 0-12,700 | 0-8,200 | 0-5,900 | 0-3,600 | 1,500 | 2 |
| 22,701-30,200 | 12,701-17,000 | 8,201-10,900 | 5,901-7,900 | 3,601-4,800 | 1,750 | |
| 30,201-38,700 | 17,001-21,800 | 10,901-12,900 | 7,901-9,800 | 4,801-6,200 | 2,000 | |
| 38,701-48,300 | 21,801-24,200 | 12,901-17,400 | 9,801-12,600 | 6,201-7,700 | 2,250 | |
| 48,301-59,000 | 24,201-33,200 | 17,401-21,300 | 12,601-15,400 | 7,701-9,400 | 2,500 | |
| 59,001-70,900 | 33,201-39,700 | 21,301-25,500 | 15,401-18,400 | 9,401-11,300 | 2,750 | |
| 70,901-83,700 | 39,701-47,100 | 25,501-30,100 | 18,401-21,800 | 11,301-13,400 | 3,000 | 3 |
| 83,701-97,700 | 47,101-54,900 | 30,101-35,200 | 21,801-25,900 | 13,401-15,600 | 3,250 | |
| 97,701-112,700 | 54,901-63,400 | 35,201-40,600 | 25,901-29,300 | 15,601-18,000 | 3,500 | |
| 112,701-128,700 | 63,401-72,400 | 40,601-46,400 | 29,301-33,500 | 18,001-20,600 | 3,750 | |
| 128,701-145,900 | 72,401-82,100 | 46,401-52,500 | 33,501-37,900 | 20,601-23,300 | 4,000 | 4 |
| 145,901-164,200 | 82,101-92,400 | 52,501-59,100 | 37,901-42,700 | 23,301-26,300 | 4,250 | |
| 164,201-183,400 | 92,401-103,100 | 59,101-66,000 | 42,701-47,700 | 26,301-29,300 | 4,500 | |
| 183,401-203,700 | 103,101-114,600 | 66,001-73,300 | 47,701-53,000 | 29,301-32,600 | 4,750 | |
| 203,701-225,200 | 114,601-126,700 | 73,301-81,100 | 53,001-58,600 | 32,601-36,000 | 5,000 | |
| 225,201-247,700 | 126,701-139,400 | 81,101-89,200 | 58,601-65,400 | 36,001-39,600 | 5,250 | |
| 247,701-271,200 | 139,401-152,600 | 89,201-97,700 | 65,401-70,600 | 39,601-43,400 | 5,500 | |
| 271,201-295,900 | 152,601-166,500 | 97,701-106,500 | 70,601-77,000 | 43,401-47,400 | 5,750 | |
| 295,901-Greater | 166,501-Greater | 106,501-115,800 | 77,001-83,700 | 47,401-51,500 | 6,000 | |
| " | " | 115,801-125,500 | 83,701-90,600 | 51,501-55,700 | 6,250 | |
| " | " | 125,501-135,500 | 90,601-97,900 | 55,701-60,200 | 6,500 | |
| " | " | 135,501-145,800 | 97,901-106,800 | 60,201-64,800 | 6,750 | |
| " | " | 145,801-156,700 | 106,801-113,200 | 64,801-69,600 | 7,000 | |
| " | " | 156,701-167,900 | 113,201-121,300 | 69,601-74,600 | 7,250 | |
| " | " | 167,901-179,400 | 121,301-129,600 | 74,601-79,800 | 7,500 | |
| " | " | 179,401-191,400 | 129,601-138,300 | 79,801-85,100 | 7,750 | |
| " | " | 191,401-Greater | 138,301-Greater | 85,101-Greater | 8,000 | |

[1]Types of construction are based upon the Building Code.
[2]Measured at 20 psi (137.9 kPa). See Appendix III-A. Section 2.

# Appendix C

ABS Consulting
EQE STRUCTURAL ENGINEERS DIVISION

*FINAL REPORT*

# Water System Seismic Vulnerability Assessment

## City of Oregon City, Oregon

**December 2002**

***Prepared for:***

**West Yost and Associates**

***Prepared by:***

**ABS Consulting**
**1411 4th Ave. Bldg, #500**
**Seattle, WA 98101**
**(206) 624-8687**

**ABS Project #1053895**

# ABS Consulting
EQE STRUCTURAL ENGINEERS DIVISION

December 30, 2002, 2002

Mr. Mark Zinniker
**WEST YOST & ASSOCIATES, LLC**
132 East Broadway, Suite 431
Eugene, OR 97401

**Subject: Transmittal of Draft Report: Water System Seismic Vulnerability Assessment, City of Oregon City, OR**

Dear Mark:

Enclosed please find seven (7) copies of the subject report. If you have any questions on this or other matters, please do not hesitate to call. It is a pleasure to be of service to the City of Oregon City and West Yost and Associates.

Sincerely yours,
**ABSG CONSULTING INC.**

Donald B. Ballantyne, P.E.

General Manager, Seattle Office

V P Lifeline Services

Enclosures

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# Table of Contents

# 1. Introduction

This report presents the findings of ABS Consulting's seismic vulnerability assessment of the Oregon City's water facilities. This vulnerability assessment was performed in accordance with the agreement between ABS Consulting and West Yost and Associates dated December 12, 2001. The assessments are based on review of available drawings, site walk-downs conducted on January 28 and 29, 2002, and performance of similar facilities in previous earthquakes.

## 1.1. Purpose

The purpose of this report is to assess the seismic vulnerability of the City's water distribution facilities. The vulnerabilities of the various facilities were projected based on the following factors: type and quality of construction, configuration, age, and condition of each structure (if such information was available), design criteria used; structural design and details; local geology and seismicity; distance from faults; site susceptibility to liquefaction and lateral spreading; and performance of similar structures in previous earthquakes.

## 1.2. Scope of Work

Seven tasks step through the vulnerability assessment project as described below. This proposal is based on evaluating five pump stations, four tanks (one 10.5-MG concrete, and three 2-MG steel), 15 PRV vaults, and the pipeline distribution system. A qualitative assessment of the pipeline distribution system is included.

The scope of work for this project included the following:

### *1.2.1. Task 1, Kickoff Meeting, Gather, and Review Information.*

ABS Consulting met with City representatives to review the project objectives and scope. We reviewed information provided by the City, including drawings for the tanks. We also obtained and reviewed hazard information from the United States Geological Survey (USGS) and Oregon State Department of Geology and Mineral Industries (DOGAMI). We visited four tanks, five pump stations, and selected PRV vaults, and observed the general layout of the service area.

### *1.2.2. Task 2, Hazard Assessment.*

ABS Consulting evaluated ground motion, soil liquefaction, and lateral spread hazards using information available from the USGS and DOGAMI, and other reports available from the City. This information was used to estimate the damage to pipelines, tanks, and pump stations. The earthquake assessment was conducted for three levels of earthquakes: 1) 72-year return period (50% probability in 50 years), 2) 475-year return period (10% probability of exceedance in 50 years), and 3) for an earthquake located on the Portland Hills Fault (PHF). An opinion of the duration of shaking for the three different earthquakes was also provided. DOGAMI has developed liquefaction susceptibility mapping for the City service area that we used to assist in evaluating pipeline vulnerability. We prepared a summary of the hazard information to be used in the project report.

### *1.2.3. Task 3, Facility Evaluation.*

ABS Consulting engineers evaluated the five pump stations, PRV vaults, and four tanks. We used the ground motion information available from the USGS. The task findings are documented in the report.

For the pump stations and PRV vaults, we reviewed the structures to identify possible deficiencies. Available drawings were reviewed. Generally small structures such as pump stations are resistant to earthquakes with the exception that they may not have adequate roof-to-wall and wall-to-foundation anchorage. We reviewed pump station equipment installations to determine anchorage. If there are deficiencies with the buildings, vaults, or equipment, we provided sketches of mitigation alternatives, and a preliminary rough-order-of-magnitude (ROM) opinion of construction cost. We provided a preliminary assessment of the electrical power reliability based on previous work in the Portland area, and observation of the transformer installations serving the pump stations. We evaluated SCADA equipment installations used by the City.

For the tanks, we performed preliminary structural calculations to determine how the tanks will perform in each of the three levels of earthquakes. The assessment considered the foundation, tank shell anchorage to the foundation, tank geometry, and shell structure/wall thickness. Impact to the tank roof from sloshing was also considered. For the tanks that are not anchored, we identified deficiencies with connecting piping. For foundation, tank, or piping deficiencies, we provided sketches of mitigation options and an ROM opinion of construction cost.

### *1.2.4. Task 4, Qualitative Pipeline Evaluation.*

ABS Consulting qualitatively evaluated the vulnerability of the pipeline distribution system. This assessment was based on observations of performance of similar pipe types in past earthquakes, and knowledge of pipe damage mechanisms. We documented the damage mechanisms for the pipe types found in the system and the earthquake hazards to which they can be subjected. We observed the relative locations between the distribution piping and soil liquefaction and landslide hazards, and developed the likely performance of the system. For example, cast iron pipe with leaded joints performs much worse than ductile iron pipe with elastomeric gaskets. Pipe performs worse in soils that liquefy than in competent soils. Mitigation recommendations are provided for identified pipeline deficiencies. The pipeline evaluation is documented in a section of the project report.

### *1.2.5. Task 5, System Evaluation.*

Based on the findings of the two previous tasks, we developed a water system damage scenario for each of the three levels of earthquakes. Each scenario describes the likely performance of the various system components, and the system as a whole. We recommended improvements so that the system can meet suggested performance objectives over the long term. The damage scenarios and recommendations are documented in a section of the report.

#### *1.2.6. Task 6, Mitigation Recommendations.*

We gathered the mitigation recommendations identified for the facilities, pipelines, and the system evaluation into a single prioritized list. Preliminary construction costs are provided. The City can use this list as input into a capital improvement plan. The mitigation recommendations are prioritized on risk to the system considering probability of occurrence and consequences of failure.

#### *1.2.7. Task 7. Report Preparation and Presentation to the City.*

ABS Consulting developed a draft report and provided the City with seven (7) copies of the report for review. We made a presentation to City representatives on the project findings and recommendations, incorporated comments into a final report, and delivered seven report copies to the City.

### 1.3. Limitations

Our professional services have been performed using the degree of care and skill ordinarily exercised, under similar circumstances, by reputable engineers practicing in the field of structural or civil engineering in this or similar localities at this time. No other warranty, expressed or implied, is made as to the professional advice included in this report. This report has been prepared for the City of Oregon City to be used solely in its evaluation of the subject facilities. The report has not been prepared for use by other parties, and may not contain sufficient information for purposes of other parties of other uses.

## 1.4. Report Outline

An overview of the City's service area and system, seismic hazards, and findings and recommendations are described in Chapter 2. Chapter 3 discusses the regional and site-specific seismic hazards. Chapter 4 provides a description of seismic vulnerabilities for the reservoirs, pump stations, and PRVs. Chapter 5 discusses the expected performance of the pipeline system. Based on the identified vulnerabilities and the system characteristics, overall system performance findings and system level upgrade recommendations are described in Chapter 6.

## 1.5. Terminology

Design Basis Earthquake (DBE) – defined to have a 10 percent chance of exceedance in 50 years (equivalent to a 475-year average return interval).

Lateral Spreading – Horizontal ground movement initiated by strong ground shaking. Lateral spreading tends to occur in liquefiable soils involving coastlines and riverbanks.

Liquefaction – occurs when saturated, cohesionless soils are strongly vibrated and soil shear strength is lost. If the liquefaction is sloped, the liquefied soils may flow (lateral spread). Soil liquefaction can allow structures to sink or allow buoyant elements such as empty pipelines to float.

Maximum Credible Earthquake (MCE) – represents a conservative upper bound on the maximum expected ground shaking that could occur at the site independent of time considerations. The MCE generally represented a worst-case scenario in regard to potential assess damage and business interruption.

Modified Mercalli Index (MMI) – A qualitative intensity scale based on observed damage. MMI intensities of I to V represent low levels of ground shaking and do not cause damage to structures. MMI intensities VI to X are characterized by increasing damage to facilities and economic loss. Intensities XI and XII only occur in the epicentral region of great earthquakes (M8+) and relate primarily to permanent ground displacement.

Operating Basis Earthquake (OBE) – defined to have a 50 percent chance of exceedance in 50 years (equivalent to a 72-year average return interval).

Richter Magnitude (M) – An objective, instrumentally determined scale based on a standardized measure of the amplitude of seismic waves 100 kilometers from the earthquake epicenter. The scale is logarithmic in design with each whole number representing an increase in the measured earthquake wave amplitude and an approximate increase of 32 times in the amount of energy released.

# 2. Summary

## 2.1. Summary

The seismic vulnerability assessment of the Oregon City water system includes four tanks, five pump stations, 15 PRV vaults, and the pipeline distribution system.

The purpose of the effort was to assess the seismic vulnerability of the above facilities and develop prioritized upgrade mitigation costs. The vulnerabilities are projected based on the following factors: type and quality of construction; configuration, age, and condition of each structure (if such information was available); design criteria; structural design and details; local geology and seismicity; distance from faults; site susceptibility to soil liquefaction and lateral spreading; and performance of similar structures in previous earthquakes.

Our findings and mitigation recommendations are discussed in the following sections.

## 2.2. System Description

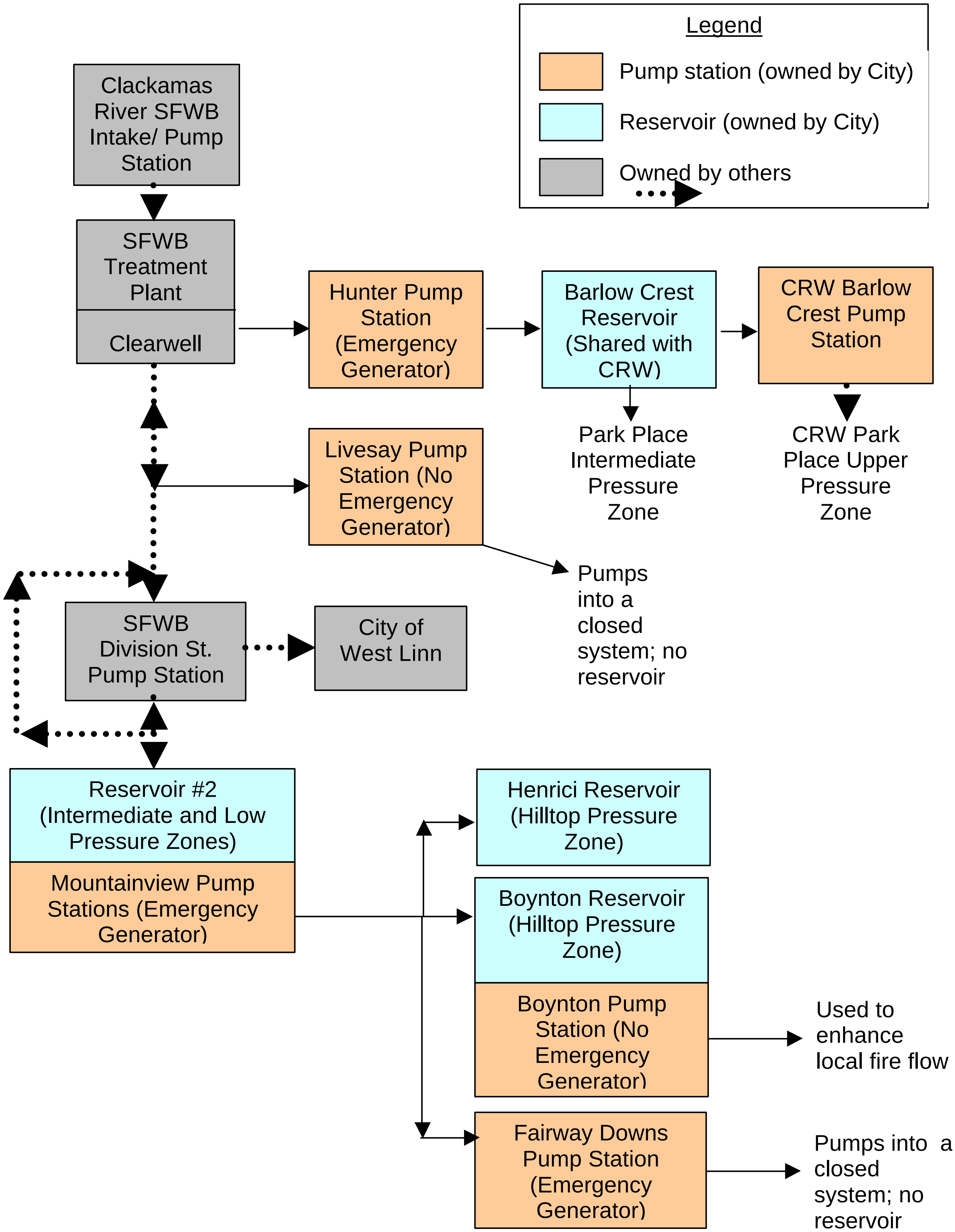
The South Fork Water Board (SFWB), an agency equally owned by the City of Oregon City and the City of West Linn, owns and operates the system backbone as shown in Figure 2-1. They pump water from the Clackamas River to the SFWB treatment plant. From there, water flows by gravity to the Division St. Pump Station that pumps it to Reservoir #2. Reservoir #2 serves the Intermediate and Low Pressure Zones, as well as supplies the City of West Linn when the SFWB is not pumping. The Mountainview Pump Stations move water from Reservoir #2 to the Upper Pressure Zone. The redundant Boynton and Henrici reservoirs float on the Upper Pressure Zone. The Boynton Pump Station is used to boost pressure for fireflows. The Mountainview Pump Stations have diesel emergency generators with adequate capacity to operate pumps to provide winter flow demands. The Boynton Pump Station does not have an emergency generator.

The Hunter Pump Station pumps water from the SFWB treatment plant clearwell to the Barlow Crest Reservoir that serves the Park Place Intermediate Pressure Zone, as well as a portion of the CRW system. The Clackamas River Water (CRW) Barlow Crest Pump Station pumps from the tank into the CRW's Park Place Upper Pressure Zone. The Livesay and Fairway Downs pump station each pump into a small pressure zone with no storage. The Hunter and Fairway Downs pump stations have emergency generators. The Livesay Pump Station does not.

Other than the two reservoirs for the Upper Pressure Zones (Boynton and Henrici), there are no redundant facilities in the system including supply, storage, and pumping. If the SFWB treatment plant is not operating, water can be backfed from Reservoir # 2, around the Division St. Pump Station, into the treatment plant clearwell, as well as to the City of West Linn.

Reservoir #1 and the Elevated Tank, both on the same site as the Mountainview Pump Stations and Reservoir #2, have been permanently removed from service. Antennas for City police, fire, and public works communications have recently been relocated from the Elevated Tank to a new communication tower across the street.

**Figure 2-1: System Schematic**



## 2.3. Earthquake Levels Evaluated

The effects of earthquake ground motions expected in an operating basis earthquake (OBE) (8 to 10 percent of gravity; 50 percent chance of occurring in 50 years), and a design basis earthquake (DBE) (15 to 20 percent of gravity; 10 percent chance of occurring in 50 years), were evaluated. Some observations are provided for expected water system performance following an event on the Portland Hills Fault that would be expected to produce ground accelerations of 50 to 60 percent of gravity. A Portland Hills Fault event is expected to occur on the average every 5,000 to 10,000 years.

## 2.4. Seismic Stability of Site Soils

Soils under all the reservoirs and pump stations are generally competent. Pockets of soil along the Willamette and Clackamas rivers are liquefiable.

## 2.5. Findings

This section summarizes findings in terms of expected performance of system components for three earthquakes, the OBE, DBE, and a Portland Hills Fault event.

The entire system is totally dependent on the SFWB supply. Our scope of work did not include evaluation of the SFWB system.

### *2.5.1. OBE Expected Performance*

For the OBE, with a recurrence interval of 72 years, the system is expected to perform relatively well. Ground motions in the order of 8 to 10 percent times gravity are expected. Minimal liquefaction is expected even in the areas that are highly susceptible.

The four tanks and five pump stations all have a low vulnerability to ground motions expected in an OBE, and minimal damage is expected. It is likely that there will be a regional loss of power that will last on the order of one day following an OBE. All of the

City pump stations have emergency generators except Livesay, but this pump station only serves three customers.

#### *2.5.2. DBE Expected Performance*

For the DBE, with a recurrence interval of approximately 475 years, significant damage is expected. The most likely source for this earthquake is a Cascadia Subduction event, with ground motions on the order of 15 to 20 percent times gravity. Soils with a high liquefaction susceptibility in the Central Business District, along I-205, and along Redland Road may liquefy in this scenario.

There is a high probability of failure of the upper wall sections of Reservoir #2. Sloshing is likely to damage the roof as well. Depending on the extent of the damage, the reservoir would likely not be usable. <u>Loss of Reservoir #2 storage capacity would impact the entire system operation.</u>

The Henrici Reservoir should perform well with the exception that sloshing may damage the roof. The redundant Boynton Reservoir is moderately vulnerable.

The Mountainview Pump Stations and Pump No. 3 House are expected to have some structural damage, but would likely remain functional. There may be some damage to unanchored/inadequately-anchored equipment at all facilities. <u>If the elevated tank is full, there is a significant potential that it may collapse and damage the adjacent Mountainview Pump Stations.</u>

Pipeline damage due to liquefaction is expected in the Central Business District, along I-205, and along Redland Road. Pipe connections to PRV vaults will likely be damaged in areas where liquefaction occurs. Damage is expected to the 16-inch-diameter cement-lined steel pipe with leaded joints transmission line serving the Henrici Reservoir, however, portions of this pipeline were replaced during the summer of 2002.

### *2.5.3. Portland Hills Fault Expected Performance*

The Portland Hills Fault event is expected to recur every 5,000 to 10,000 years. Ground motions would be expected to be four times those from a Cascadia Subduction or 475-year return earthquake, and three to four times larger than the forces that facilities were designed to resist. For this scenario, infrastructure throughout the entire region will be heavily damaged.

All four reservoirs would be expected to be damaged. Extensive structural damage is expected at the Mountainview Pump Stations, with the ability to continue operation doubtful. The modern pump stations may have limited damage. Pipeline damage would be more severe than in the DBE. Liquefaction would be more extensive, and pipe damage due to wave propagation more severe.

## 2.6. Recommendations

This section describes recommended mitigation measures for the short, medium, and long term planning scenarios.

### *2.6.1. Short-Term Mitigation (2 years) ($25,000)*

These quick-fix recommendations would enhance the emergency response following a 475-year return earthquake.

- Drain and/or remove the elevated tank at the Mountainview site. (TBD)
- Anchor miscellaneous equipment in pump stations and PRV vaults. ($5,000, potentially in-house project)
- Structurally upgrade the Mountainview Pump Stations. ($20,000)
- Document and exercise valves on pipelines in liquefiable soils in the Central Old Town district, along I-205, and Redland Road. (in-house project)
- Communicate with the jurisdiction providing fire protection about the vulnerability and potential failure of water service in these areas following a major earthquake. (incidental cost)

- If the SFWB transmission line seismic vulnerability has not been evaluated, the City should encourage that a hydraulic, structural, and condition assessment be performed. (TBD by SFWB)
- Transfer the Livesay Pump Station service area to the Barlow Crest Tank. (non-seismic related budget)

### *2.6.2. Medium-Term Mitigation (5 years) ($700,000)*

This recommendation would result in maintaining system operation following a 475-year return event.

- Seismically upgrade Reservoir #2. ($700,000)

### *2.6.3. Long-Term Mitigation (20 years) ($50,000)*

These recommendations would enhance post-earthquake recovery, particularly following a 475-year event.

- Complete replacement of the 16" steel pipe transmission line with leaded joints serving the Henrici Reservoir. (cost TBD)
- Replace the cast iron pipe with leaded joints in the Central Old Town district in liquefiable soils with ductile iron pipe with restrained joints. (cost TBD)
- Seismically upgrade the Boynton Reservoir. ($50,000).

Please note that the above costs include construction only. Approximately 40% should be added for design, inspectors, construction support, project management, contingency, permitting, and taxes.

# 3. Seismic Hazards

## 3.1. Introduction

This section addresses seismic hazards including ground motion and liquefaction.

## 3.2. Regional Seismicity and Ground Motions

Seismic hazards in the Portland area are dominated by two sources: deep earthquakes along the Cascadia subduction zone occurring at the interface between the subducting Juan de Fuca Plate and the North American Plate, and shallow crustal events within the North American Plate. The regional tectonic structure is shown in Figure 3-1.

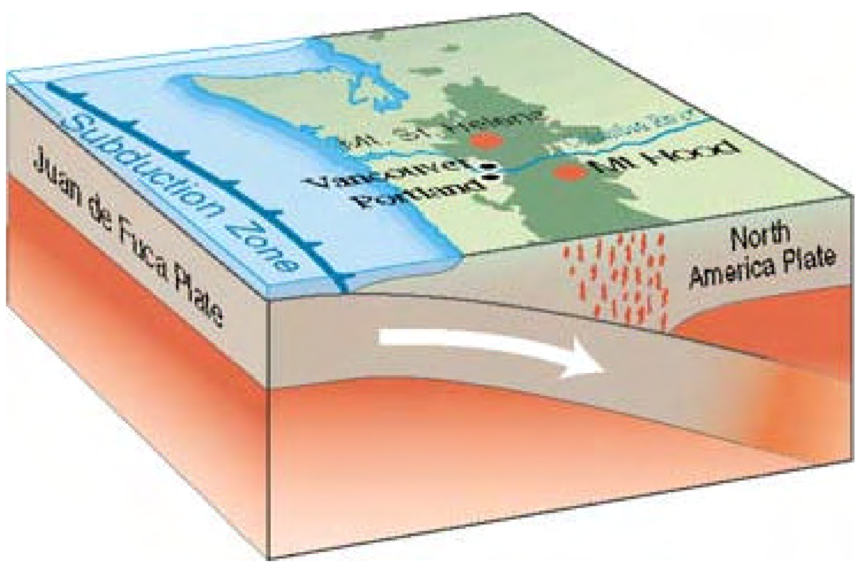



**Figure 3-1**

**Pacific Northwest Tectonic Structure (after USGS)**

There is geologic evidence that subduction earthquakes occur approximately every 500 years, the most recent being in 1700.

The USGS has included a third earthquake source zone in the Seattle area but not in the Portland area, even though the two areas arguably have a similar tectonic structure. In the USGS model, earthquakes that occur within the Juan de Fuca Plate (termed intraplate earthquakes) are not considered likely in the Portland area because of the subducting plate geometry. The 1949 magnitude 7.1, 1965 magnitude 6.5 , and 2001 M6.8 earthquakes near Seattle were intraplate events. As a result, the probabilistic earthquake ground motions in the Portland area are lower than those used for the Seattle area.

The 1993 magnitude 5.6 Scott’s Mills Earthquake, and the 1962 magnitude 5.2 Portland earthquakes were crustal events. The USGS and other researchers have identified shallow (crustal) faults and lineaments in the Portland area, the most pronounced of which is the Portland Hills Fault paralleling the Willamette River through downtown Portland. The Portland Hills Fault is modeled with a slip rate of 0.1 mm/yr, with a characteristic earthquake of magnitude 7.0 with a return period on the order of 10,000 years. Other investigators have assigned slightly higher slip rates with a corresponding return period of 5,000 years. With the low slip rate/long return periods, the fault has little effect on 475-year return probabilistic ground motions. The Portland Hills Fault runs south directly toward Oregon City, but may stop short just north of the Clackamas River. If the fault broke south, moving towards Oregon City, there could be directional effects that would result in very large ground motions. If the fault broke moving north, the ground motions would be somewhat less. Other regional faults include the Molalla-Canby Fault and the Mount Angel Fault.

### *3.2.1. Strong Ground Motion*

Strong ground motion is a significant hazard to City facilities, whose vulnerability varies depending primarily on the type of construction and the earthquake criteria to which the facility was designed.

Strong ground motion can be characterized in two ways:

- **Probabilistic**, where a hazard curve is developed for a site, expressing the probability of various levels of PGA due to all sources.
- **Scenario**, where peak ground acceleration (PGA) is determined at a site or sites given a specified earthquake occurrence; i.e., magnitude and epicentral location are uniquely defined.

Peak ground acceleration (PGA) is a measure of earthquake ground motion. It is often presented as a percent of gravity. Typically, the largest component of PGA is in the horizontal direction, with about two-thirds of the value in the vertical direction. PGA is the result of earthquake waves propagating through the ground. These waves have a range of frequencies. The highest PGAs are at frequencies of less than 1 cycle/second. Sometimes ground motion information is provided in response spectra that includes accelerations over a range of frequencies.

PGA damages structures because it effectively pushes on them laterally. Damage to vulnerable structures can occur at very low PGAs of say 5 percent times gravity. Structures can be designed to resist loads as high as 100 percent of gravity or more. Ground motion can also cause soils to consolidate/settle differentially, liquefy, spread laterally, and lurch. Structures or pipe buried in the soil can be damaged if the soil moves.

PGAs can be estimated for a specific earthquake given the earthquake magnitude and distance away from the site. Ground motion can be amplified by soft soils on the site.

Probabilistic PGAs are calculated by combining ground motions from all the possible earthquakes and weighting their contribution depending on their probability of occurrence. The probabilistic earthquake ground motion, probability of occurrence, and return period are all related. The lower the probability of occurrence within a given period, the larger the expected ground motion, and the longer the return period.

In the Oregon City area, the ground motion for an earthquake with a 50 percent probability of occurrence in 50 years is about 8 to 10 percent times gravity. Such an earthquake has a 72-year return period. Similarly, the ground motion for an earthquake with a 10 percent probability of occurrence would be about 15 to 20 percent times gravity, with a recurrence period of 475 years. The 475-year return event's primary ground motion contribution is from a subduction earthquake. These ground motions are generally consistent across the Portland area, with a slight reduction moving east away from the potential subduction earthquake source zone. The Portland Hills fault may produce a PGA in the order of 60 to 80 percent times gravity in the City.

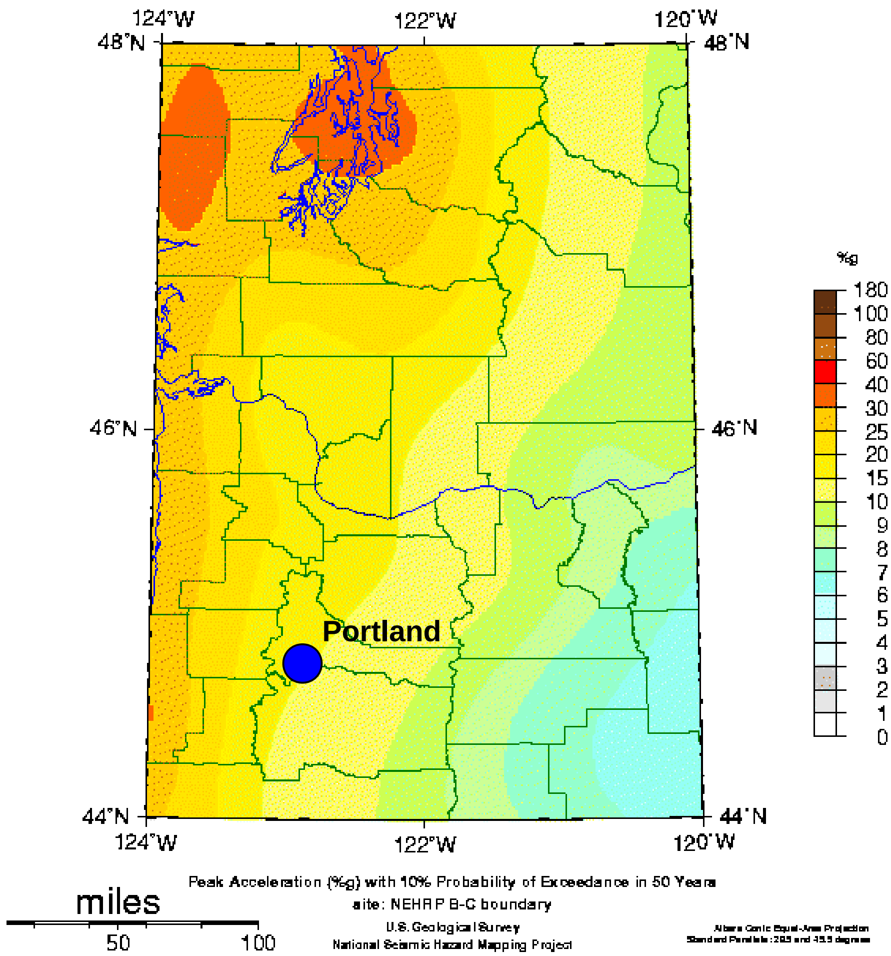



**Figure 3-2**

**Peak Acceleration With 10% Probability of Exceedance in 50 Years**

Surface faulting is not a concern in the Portland area, based on:

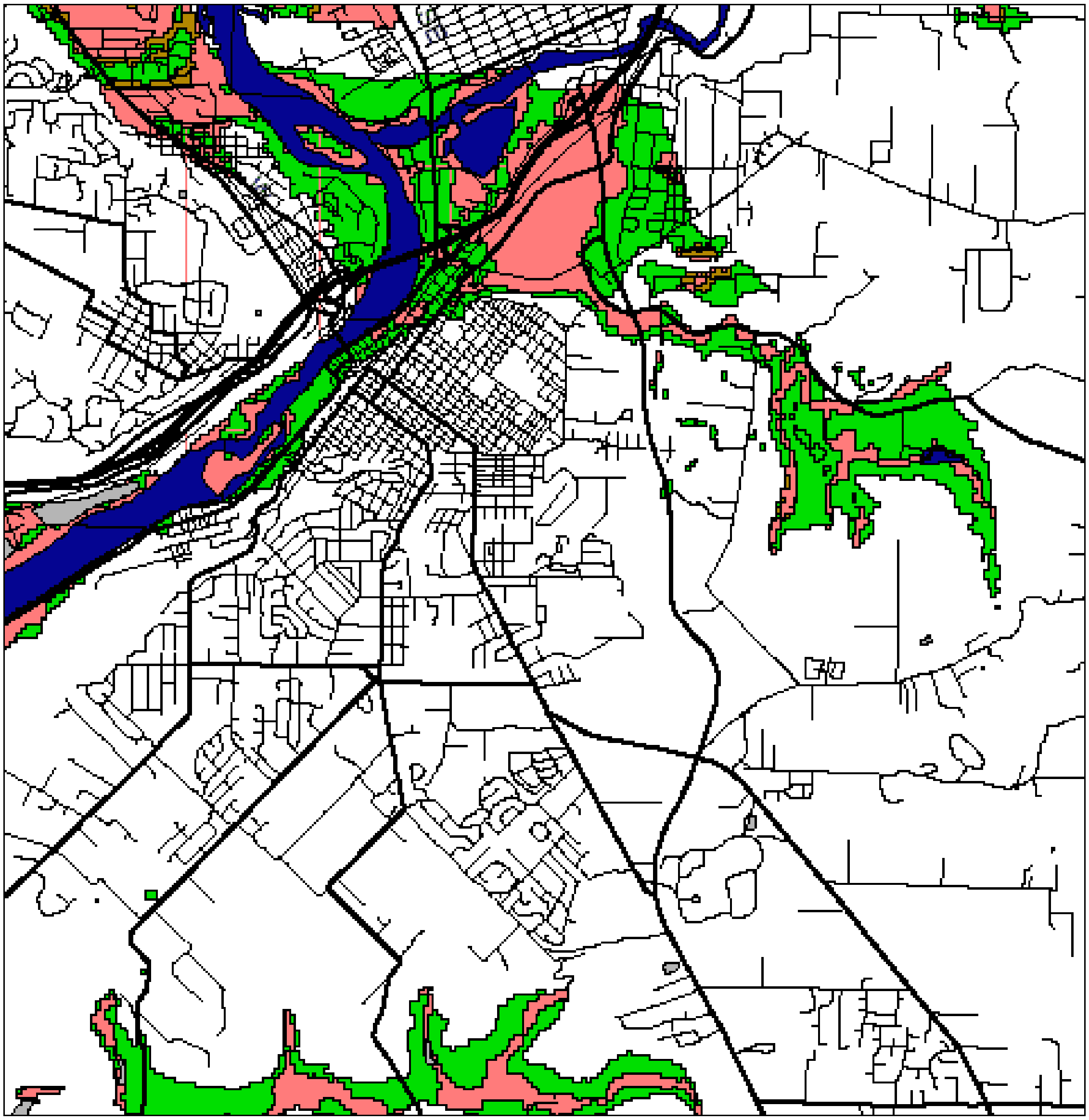
- Fault rupture associated with a subduction earthquake would be located off the Oregon coast, and should be of no consequence to City facilities.
- Thrust or reverse faults that may result from north-south crustal compression typically do not reach the surface. By comparison, the San Andreas and Hayward strike slip faults in California have a very significant surface expression, and are considered when design facilities cross them.
- There is no evidence of surface faulting in the Portland area over the last 5,000 years.

### *3.2.2. Earthquake Hazard Summary*

Probabilistic earthquake ground motions on the order of 8-10 percent gravity for a 72-year return, and 15-20 percent gravity for a 475-year earthquake can be expected in Oregon City. These will be amplified on soft soil sites. Scenario earthquake ground motions, such as from the Portland Hills Fault, may be as large as 60 to 80 percent times gravity, but these would only be expected to occur every 5,000 years.

## 3.3. Liquefaction Susceptibility

The Oregon Department of Geology and Mineral Industries (DOGAMI) has developed liquefaction susceptibility mapping for the City's service area (Figure 3-3). The pink shaded area has the highest liquefaction susceptibility. Minimal liquefaction is expected in an OBE event, whereas significant liquefaction would likely occur in a DBE event, or an event on the Portland Hills Fault. The liquefaction information is of most significance to City pipeline vulnerability, and will be discussed in that section.



Legend:
pink = high susceptibility
brown = moderate susceptibility
green = low susceptibility
white = not liquefiable

**Figure 3-3: Liquefaction Areas in Oregon City (DOGAMI).**

# 4. Facility Evaluation

## 4.1. General

The seismic vulnerability assessments for the City's water system components are presented in this chapter. The facilities included were the City's reservoirs (No. 2, Boynton, Henrici, and Barlow Crest); five pump stations and pump houses, and 15 PRVs. Assessments were made for the seismic hazards associated with the OBE and DBE and Portland Hill's Fault events defined in Chapter 3. The sites were visited by ABS Consulting engineers on January 28 and 29, 2002.

Our findings and upgrade recommendations in the event of these scenario earthquakes are discussed in the following sections. A discussion of the water system vulnerabilities and prioritized recommendations are presented in Chapter 6.

## 4.2. Criteria for Review

This assessment is based on the following:

- A review of the available civil and structural drawings for the facilities.
- A visual survey of the structures to establish their condition and the general quality of construction.
- A review of geological, fault, and earthquake data for the sites.
- An estimate of the probable ground motions at each site for three levels of earthquakes.
- Knowledge of the performance of similar facilities in past earthquakes and engineering judgment.
- Limited engineering calculations.

## 4.3. Reservoirs

The City's water reservoirs include both steel and reinforced concrete construction. Table 4-1 summarizes reservoir age, construction type, seismic risk, and applicable seismic upgrade costs. The following paragraphs summarize typical seismic vulnerabilities for these types of reservoirs.

Evaluation of the elevated tank at Mountainview is not included in the scope of work. However, if the tank collapses, it is likely to heavily damage the Mountainview Pump Stations. In the short-term, the City should either remove the tank, or drain the tank to reduce its vulnerability to collapse.

Ground-supported steel-shell reservoirs have traditionally been designed based on AWWA standards, which permit tanks to be unanchored under certain conditions. In an earthquake, the shell rigidly contains a lower portion of the liquid, while the remaining upper portion sloshes inside. The critical tank elements are: 1) the vertical shell which may buckle along the bottom due to tank rocking, 2) the welded seam between the bottom plate and the vertical shell, 3) the roof-to-shell connections, and 4) the attached piping. Typical upgrade solutions involve foundation anchors along the perimeter of the tank or flexible piping connections.

Oregon City steel reservoir descriptions and findings are included in Table 4-1. In summary, the Boynton standpipe includes a reinforced concrete mat foundation with anchor bolts at the base of the tank. The existing standpipe is adequate for the OBE scenario. The existing anchorage is inadequate to resist the DBE forces. There is potential for anchorage failure and/or shell rupture. For the PHF scenario, substantial foundation improvements would also be required.

The Henrici reservoir is relatively flat in profile. Consequently sloshing of water dominates the tank response. The tank appears to be adequately designed for the OBE scenario. In the DBE scenario there exists potential for roof damage due to sloshing. Roof damage and piping damage is likely in the PHF scenario.

The Barlow Crest is a modern steel reservoir of base anchorage which appears to be adequate for the OBE event and marginal for the DBE scenario. In the PHF scenario there is potential roof damage due to sloshing.

Historically, reinforced concrete water storage tanks have generally performed well in previous earthquakes. (There is a concern about Reservoir #2.) The primary cause of reinforced concrete tank failure can be attributed to the lack of positive connections between elements, tank deterioration, or foundation failure. The wall-to-foundation connection is the most critical in maintaining tank integrity and preventing leakage. Roofs that are not connected to the walls can slide. In addition to roof damage, interior columns may be subjected to excessive lateral forces if the roof is not anchored. Sloshing forces can also damage roofs or walls near the roof-to-wall interface. This type of damage usually occurs near or above the water level line, and these tanks are expected to remain functional after experiencing sloshing damage. Tank walls would only be expected to experience damage from inertial forces if they have deteriorated from the original design condition. Consequently, wall cracking with significant efflorescence should be investigated to determine if reinforcement corrosion has occurred. Vertical wall cracks are most significant because they may indicate a loss in hoop (tangential) stress capacity, or lead to deterioration of reinforcing designed to resist hoop stresses.

Reservoir #2 construction consists of a 1915-vintage open concrete reservoir that was modified in 1951 (concrete perimeter wall) to add storage capacity. In 1978 a wood-framed roof and interior posts were added.

The principal concern is the adequacy of the perimeter walls and roof damage due to sloshing effects. The reservoir appears to be adequate for the OBE scenario. In the DBE scenario, roof damage is possible due to sloshing. The perimeter wall is marginal if overtopped by a sloshing wave. The reservoir would likely fail in the PHF scenario.

## 4.4. Pump Stations

In general, the pump stations consist of relatively small “box-like” structures housing pumps and electrical panels. Construction consists of wood-framing or reinforced masonry units (CMU). Significant damage for these types of structures generally occurs due to a lack of wall connections at the roof or foundation level, or due to a soil failure. Table 4-2 summarizes general characteristics, findings, and recommendations for each structure.

The Mountainview Pump Stations may lack foundation anchorage. Consequently, both of these facilities are considered moderate risks and may experience severe structural damage in a DBE event. Verification of wall/roof anchorage for these structures is recommended.

Soil stability issues (landsliding and liquefaction) do not appear to be a significant issue at pump station sites.

Equipment and nonstructural issues were also noted during our walkthroughs of the pump stations. In general, the electrical panels, pumps, and motors were found to be adequately anchored to prevent damage in a major earthquake. However, a space heater and start-up batteries at the Hunter Pump Station should be properly restrained.

## 4.5. Pressure Reducing Valve Vaults

Generally, pressure-reducing valves are housed in below ground, reinforced concrete vaults. In the absence of soil failures, such structures are reliable in earthquakes. However, if liquefaction/PGD occurs, the vault may move with the surrounding soil or float. In either case the connecting piping would likely be damaged. Liquefaction susceptibility and associated pipeline vulnerability is discussed further in Chapter 5.

The piping inside the vault is generally supported at the vault wall penetrations and usually has a gravity support under the pressure-reducing valve. This should be adequate to resist lateral loading for OBE and DBE events. In a Portland Hills Fault event, piping inside the vaults could fail laterally, in bending. We noted installations where air/vacuum release valves were supported only on the small diameter threaded piping connecting them to the larger pipe. There is a significant potential for the heavy air/vacuum release valve to respond as an inverted pendulum. In a DBE it could break off where small diameter pipe is attached to the larger diameter pipe. Addition of lateral bracing is recommended.

**Table 4-1**

**RESERVOIR DESCRIPTIONS AND FINDINGS**

| Water Reservoir | Pressure Zone | Year Built | Capacity (MG) | Structural Material and System | Seismic Concerns | Scenario Seismic Risk[1] | | | Upgrade Priority | ROM Upgrade Cost (DBE) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | OBE | DBE | PH3 | | |
| No. 2 | Low and intermediate | 1915/ 1951 1978 | 10.5 | Reinforced concrete, wood-framed roof | • Concrete wall failure<br>• Wood-framed roof damage (sloshing) | Low | High | Very High | High | $700,000 |
| Boynton | Upper | 1984 | 2.0 | Steel anchored | • Inadequate foundation anchorage (DBE event)<br>• Pipe rupture<br>• Inadequate foundation (pH) | Low | Moderate | High | Moderate | $50,000 |
| Henrici | Upper | 1994 | 2.0 | Steel unanchored | • Sloshing<br>• Pipe rupture | Low | Low | Moderate | N/A | N/A |
| Barlow Crest | Low and Intermediate Park Place | 1999 | 1.75 | Steel anchored | • None (OBE event) | Low | Low | Moderate | N/A | N/A |

1. Scenarios:
   OBE = Operational Basis Earthquake
   DBE = Design Basis Earthquake
   PHF = Portland Hills Fault Earthquake

**Table 4-2**

**PUMP HOUSE DESCRIPTIONS AND FINDINGS**

| Pump House | Reservoir Served | Year Built | Structural System | Seismic Concerns | Scenario Seismic Risk | | | Upgrade Priority | ROM Upgrade Cost |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | OBE | DBE | PH | | |
| Pump House No. 3 | Henrici, Boynton | 1950s | CMU walls w/ wood-framed roof | Verify foundation and roof anchorage | Low | Moderate | High | High | $10,000 |
| Pump House No. 1, 2, 4 | Henrici, Boynton | 1960s | CMU walls w/ wood-framed roof | Verify foundation and anchorage | Low | Moderate | High | High | $10,000 |
| Boynton | local fire flow | 1984 | CMU walls w/ wood-framed roof | None observed | Low | Low | Moderate | Low | N/A |
| Fairway Downs | none | 1998 | Wood-framed roof and walls | None observed | Low | Low | Moderate | Low | N/A |
| Hunter | Barlow Crest | 1999 | CMU walls w/ wood-framed roof | Anchor suspended space heater<br>Strap start-up batteries | Low | Low | Moderate | Low | $1,000 |

1. Scenarios:
   OBE = Operational Basis Earthquake
   DBE = Design Basis Earthquake
   PHF = Portland Hills Fault Earthquake

# 5. Pipeline Evaluation

## 5.1. Introduction

In this chapter the vulnerability of the pipeline distribution system is evaluated geographically relating soils susceptible to liquefaction with City pipelines. The general vulnerability of the pipeline network to ground shaking and liquefaction is then described, and specific vulnerabilities related to liquefaction are addressed. Mitigation recommendations are provided.

## 5.2. Pipeline Vulnerability

Buried pipelines are vulnerable to ground shaking and liquefaction/lateral spreading. The failure rate for pipelines subjected to liquefaction/lateral spread is on the order of ten times that for ground shaking.

Pipelines with bell and spigot joints with elastomeric gaskets perform well when subjected to ground motion. Even asbestos cement pipe performs well when there is no permanent ground deformation because it is more flexible than cast iron. Asbestos cement pipe has a shorter laying length and has a “double” bell and spigot (coupling works as a double bell and spigot). Pipe with rigid joints and/or a weak barrel performs the worst in an earthquake-shaking environment. Cast-iron pipe installed before about 1960 (approximate) may have leaded joints. Leaded joints have brittle behavior.

Thin-walled steel pipe has performed poorly particularly when weakened by corrosion. Screwed joint pipe also has a poor track record when subjected to shaking because it has no longitudinal flexibility. That is compounded by the fact that the threads reduce the structural cross section of the pipe, and the material properties of the steel are changed when the threads are cut.

Pipe subjected to permanent ground deformation from liquefaction/lateral spreading or landslide generally does not perform well. Only strong ductile pipe with restrained joints or continuous pipe such as high-density polyethylene or steel with welded joints performs moderately well.

## 5.3. Expected Performance of City Pipelines

Expected performance of sections of the pipeline transmission and distribution system is described. The locations of concern due to liquefaction are listed below, and shown in Figure 5-1.

SFWB transmission pipeline Clackamas River to Treatment Plant (Raw Water Line), and Treatment Plant to Reservoir #2 – We understand that this is concrete cylinder pipe with bell and spigot joints. There have been joint failures in the past. The pipe generally traverses along areas of competent soil with the exception of the slope from the Clackamas River to the treatment plant, and the low point near Redland Road. We understand that the slope from the Clackamas River to the Treatment Plant has been addressed over the past few years. This is a critical pipeline. If it has not been evaluated, we recommend that the City encourage the SFWB to conduct a detailed hydraulic (transients), structural, and condition assessment of this pipeline in the short-term.

South end of system south of Warner Milne Road –It appears that this is a newer portion of the system constructed with ductile iron pipe. There are no liquefiable soils in this area, so the pipe vulnerability should be low in a DBE, and moderate in a PHF event.

Transmission line from Mountainview Pump Stations to Henrici Reservoir along Beaver Creek Road – We understand that this pipe is steel with leaded joints. Leaded joints do not perform well when subjected to earthquake wave propagation. This pipe vulnerability is Low in an OBE, Moderate in a DBE, and High in a PHF event. We understand that a portion of this transmission line was replaced in the summer of 2002.

Central Old Town portion of system north of Warner Milne Road – Much of the pipe in this area appears to be cast iron. The joint type is unknown. There are several blocks where the soil has a high susceptibility to liquefaction (see Figure 5.1). The vulnerability of cast iron pipe with leaded joints in a DBE is Moderate in competent soils, and High in liquefiable soils. If this pipeline fails, water service may be lost locally. We recommend documenting the location and regularly exercising valves required to isolate the section of pipe in liquefiable soils in the short term, and replacing it in the long-term.

Northeast section of system north of Redland Road – Much of the pipe in this area appears to be asbestos cement. The soils are competent. Asbestos cement pipe performs well in competent soils, accommodating the differential movement due to wave propagation in the gasketed joint. The pipe has a low vulnerability in a DBE, and a moderate vulnerability in a PHF event.

Northwest section of system in the area of I-205 – Much of the pipe in this area is ductile iron, but the soils are liquefiable (see Figure 5.1). If significant liquefaction and associated lateral spreading occurs, the ductile iron pipe joints could pull apart. The pipe has a moderate vulnerability in a DBE, and High vulnerability in a PHF. We recommend documenting the location and regularly exercising valves in this area that would be required to isolate the damaged pipe from the system.

Redland Road – Sections of the pipe are identified to be cast iron (joint type unknown), and is an area identified to be highly susceptible to liquefaction (DOGAMI) (see Figure 5.1). The vulnerability of cast iron pipe with leaded joints in a DBE is Moderate in competent soils, and High in liquefiable soils. If this pipeline fails, water service may be lost locally. We recommend documenting the location and regularly exercising valves required to isolate the section of pipe in liquefiable soils in the short term, and replacing it in the long-term. If this pipeline serves as a transmission line to other parts of the system, consideration should be given to replacing it in the short-term. This is the periphery of the Oregon City system; the transmission pipeline for Clackamas River Water District continues outside of the service area.

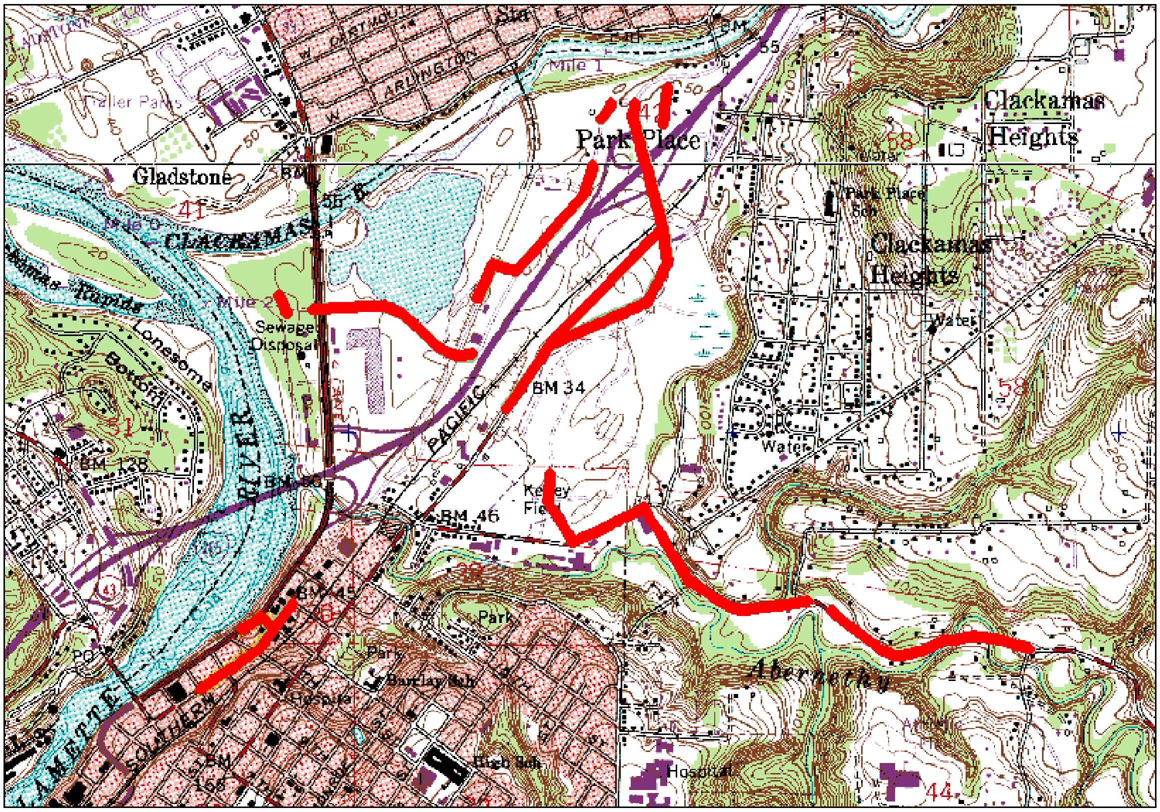



**Figure 5-1. Pipelines in the Oregon City system that are in areas susceptible to liquefaction (shown in red).**

## 5.4. Mitigation Recommendation Summary

This section summarizes recommendations to address pipeline vulnerability.

**Short-Term (2 years)** – For pipelines in liquefiable soils in Central Old Town, along I-205, and Redland Road, the City should document and exercise valves. In addition, the City should communicate with the jurisdiction providing fire protection about the vulnerability and potential failure of water service in these areas following a major earthquake. If the SFWB transmission line seismic vulnerability has not been evaluated, the City should encourage that a hydraulic, structural, and condition assessment be performed.

**Long-Term (20 years)** – The steel pipe transmission line with leaded joints serving the Henrici Reservoir should be replaced. The cast iron pipe with leaded joints in the Central Old Town in liquefiable soils should be replaced with ductile iron pipe with restrained joints.

# 6. Findings and Recommendations

## 6.1. Findings

This section summarizes findings in terms of expected performance of system components for three earthquakes, the OBE, DBE, and the PHF event.

The entire system is totally dependent on the SFWB supply. The scope of work did not include evaluation of that system.

### *6.1.1. OBE Expected Performance*

For the OBE, with a recurrence interval of 72 years, the system is expected to perform well. Ground motions in the order of 8 to 10 percent times gravity are expected. Minimal liquefaction is expected even in the areas that are highly susceptible.

The four tanks and five pump stations all have a low vulnerability to ground motions expected in an OBE, so minimal damage is expected.

It is likely that there will be a regional loss of power that will last on the order of one day following an OBE. All of the City pump stations have emergency generators except Livesay. Further, there is no storage in the Livesay service area, so service would be lost immediately on loss of power. We understand that the Livesay Pump Station service area could receive service through a new PRV from the Barlow Crest Reservoir. We recommend that this project move ahead.

### *6.1.2. DBE Expected Performance*

For the DBE, with a recurrence interval of approximately 475 years, significant damage is expected. The most likely source for this earthquake is a Cascadia Subduction event, with ground motions on the order of 15 to 20 percent times gravity. Soils with a high liquefaction susceptibility in Central Old Town, along I-205, and along Redland Road are expected to liquefy.

There is a high probability of failure of the upper wall sections of Reservoir #2. Sloshing is likely to damage the roof as well. Depending on the extent of the damage, the reservoir would likely not be usable. This could result in failure of the entire system.

The Boynton Reservoir is moderately vulnerable. Tank wall buckling would be likely, with some potential of the tank bursting a seam at the bottom. The Henrici Reservoir should perform well with the exception that sloshing, particularly from a Cascadia Subduction Earthquake, may damage the roof.

The Mountainview Pump Stations are expected to have some structural damage, but would likely remain functional. There may be some damage to unanchored/ inadequately-anchored equipment at all facilities. If the elevated tank is full, there is a significant potential that it may collapse and damage the Mountainview Pump Stations. Its collapse would also result in failure of the radio communication system as the tank supports the system antennas. Regional power outage is expected to last three days, so the Livesay Pump Station service area would be without water.

Pipeline damage due to liquefaction is expected in Central Old Town, along I-205, and along Redland Road. Pipe connections will likely be damaged to PRV vaults in areas where liquefaction occurs. Damage is expected to the steel transmission line serving the Henrici Reservoir.

#### *6.1.3. Portland Hills Fault Expected Performance*

The Portland Hills Fault event is expected to recur every 5,000 to 10,000 years. Ground motions would be expected to be four times those from a Cascadia Subduction or 475-year return earthquake, and three to four times larger than the facilities were designed to resist. With such ground motions, infrastructure throughout the entire region will be heavily damaged.

All four reservoirs would be expected to fail. Extensive structural damage is expected at the Mountainview Pump Stations, with the ability to continue operation doubtful. The modern pump stations may have little damage.

Pipeline damage would be more severe than in the DBE. Liquefaction would be more extensive, and pipe damage due to wave propagation more severe.

## 6.2. Mitigation Recommendations

This section describes recommended mitigation measures to be addressed in the short, medium, and long term.

### *6.2.1. Short-Term Mitigation (2 years) ($25,000)*

These quick-fix recommendations would enhance the emergency response following a 475-year return earthquake.

- Drain and/or remove the elevated tank at the Mountainview site. (TBD)
- Anchor miscellaneous equipment in pump stations and PRV vaults. ($5,000, potentially in-house project)
- Structurally upgrade the Mountainview Pump Stations. ($20,000) See Figure 6-1 for foundation anchorage detail.
- Document and exercise valves on pipelines in liquefiable soils in Central Old Town, along I-205, and Redland Road. (in-house project)
- Communicate with the jurisdiction providing fire protection about the vulnerability and potential failure of water service in these areas following a major earthquake. (incidental cost)
- If the SFWB transmission line seismic vulnerability has not been evaluated, the City should encourage that a hydraulic, structural, and condition assessment be performed. (TBD by SFWB)
- Transfer the Livesay Pump Station service area to the Barlow Crest Tank.

### *6.2.2. Medium-Term Mitigation (5 years) ($700,000)*

This recommendation would result in maintaining system operation following a 475-year return event.

- Seismically upgrade Reservoir #2. ($700,000) See wall upgrade concept in Figure 6-2.

### *6.2.3. Long-Term Mitigation (20 years) ($50,000)*

These recommendations would enhance post-earthquake recovery, particularly following a 475-year event.

- Replace the steel pipe transmission line with leaded joints serving the Henrici Reservoir. (cost TBD)
- Replace the cast iron pipe with leaded joints in Central Old Town in liquefiable soils with ductile iron pipe with restrained joints. (cost TBD)
- Seismically upgrade the Boynton Reservoir. ($50,000) See tank anchorage detail in Figure 6-3.

Please note that the above costs include construction only. Approximately 40% should be added for design, inspectors, construction support, project management, contingency, permitting, and taxes.

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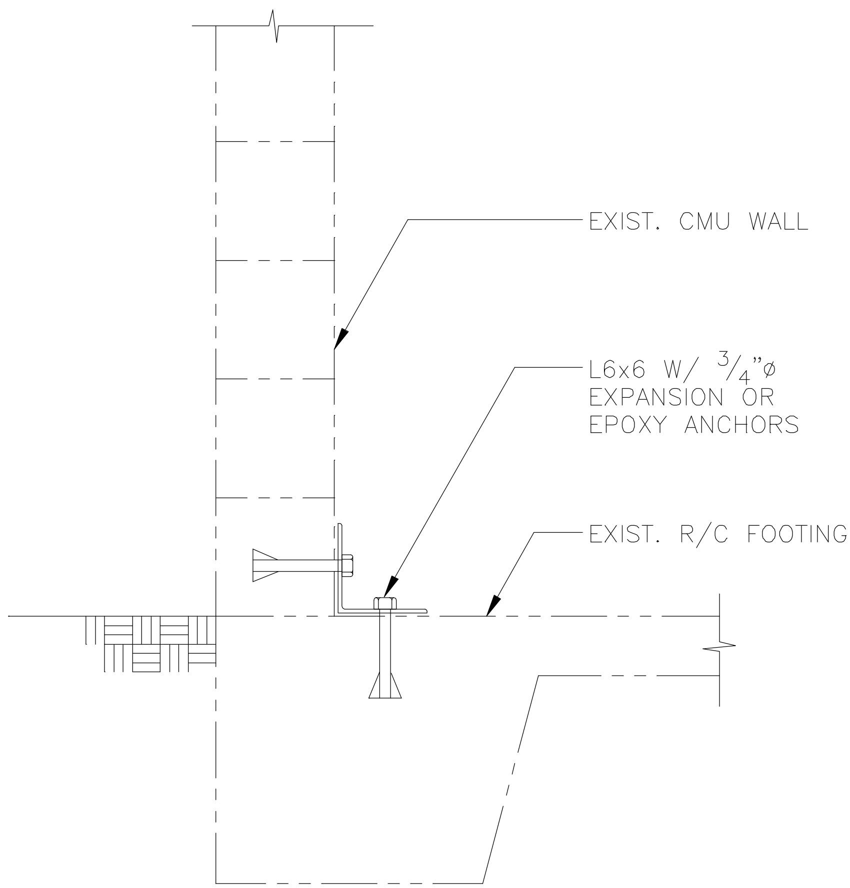
1"=1'

PRELIMINARY
NOT FOR CONSTRUCTION




WALL-TO-FOUNDATION DETAIL
N.T.S.

**Figure 6-1: Pump Station Foundation Anchorage**

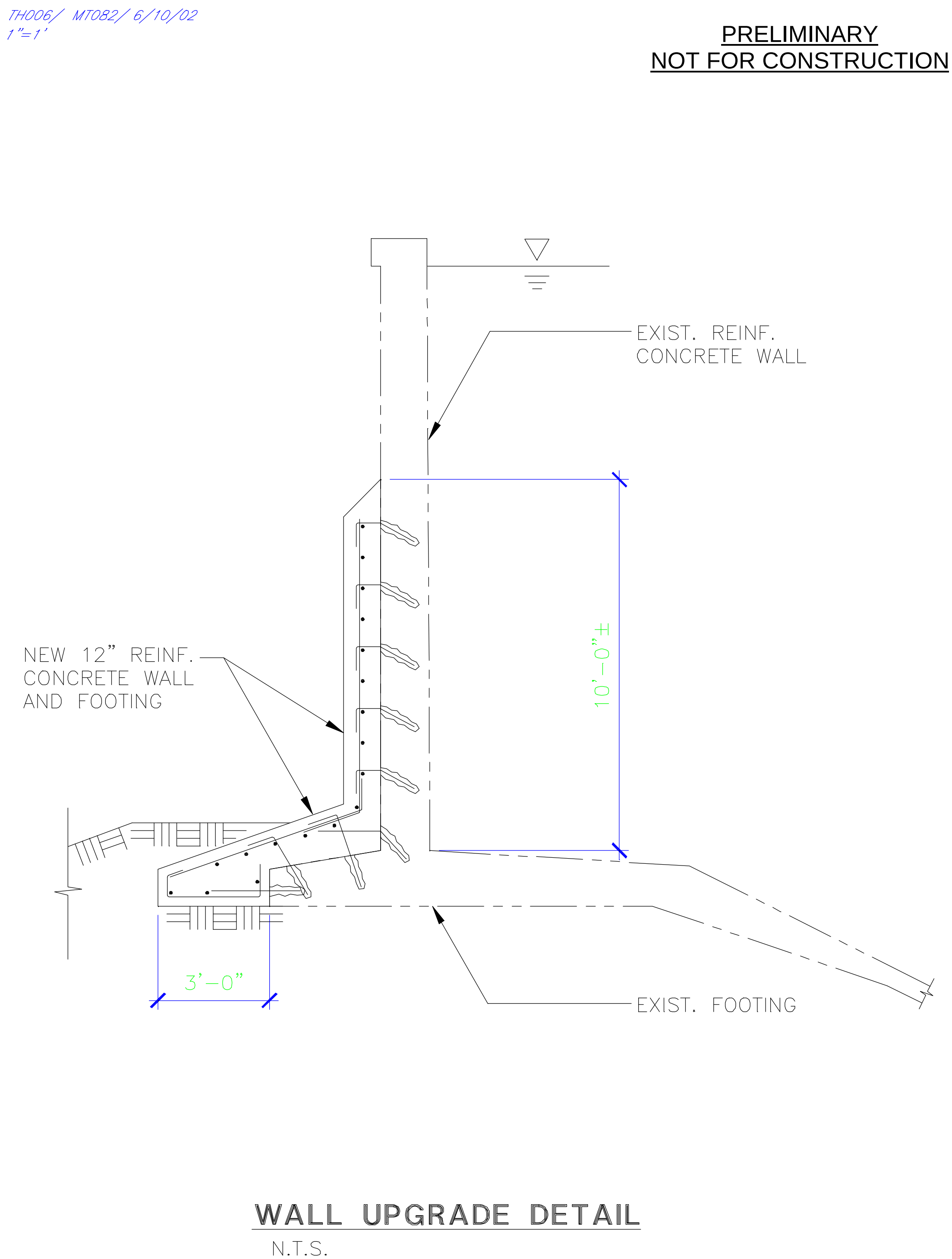



**Figure 6-2: Reservoir #2 Wall Retrofit Concept**

PRELIMINARY
NOT FOR CONSTRUCTION

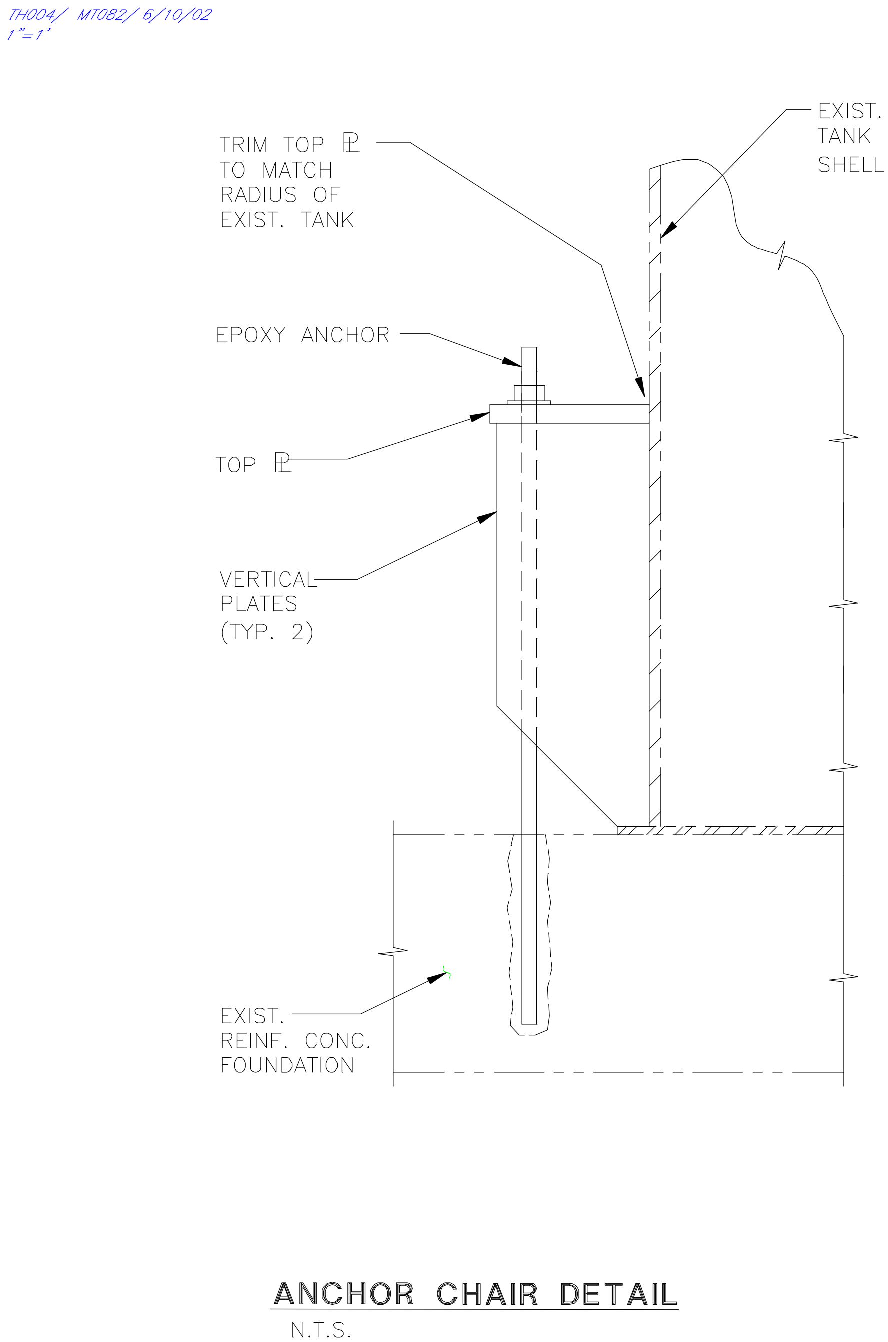



**Figure 6-3: Steel Tank Anchorage Detail**

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Yokohama, Japan

# Appendix D

# DRAFT TECHNICAL MEMORANDUM

DATE: May 8, 2003 Project No.: 526-01-01

TO: Ms. Nancy Kraushaar
City of Oregon City

FROM: Walt Meyer
Mark Zinniker

SUBJECT: Water System Storage Evaluation

This memorandum presents our evaluation of water storage requirements for the regional water systems served by the South Fork Water Board (SFWB). The regular customers of the SFWB include the City of Oregon City, the City of West Linn, and Clackamas River Water - South (CRW-S). In addition, this memorandum considers the benefits that each regional entity derives from Oregon City's Mountainview Reservoir based on an assessment of current operating conditions.

## STORAGE REQUIREMENTS

Water storage requirements are established by communities according to the following four necessary components:

- Fire flow storage – Storage required for fighting fires in accordance with the Uniform Fire Code.
- Equalization storage – Storage required to supply the system during periods when demand exceeds treatment plant or pump station capacities.
- Operational storage – Storage required to allow temporary shutdowns of the treatment plant or pump stations.
- Emergency storage – Storage required to supply the system during a temporary disruption of supply.

These components are typically additive because the need for each component of storage could occur simultaneously. The specific volume requirements for each water storage component are dependent on water demand, preferred operating strategies, as well as policy determinations that are unique to each water system operator. Table 1 summarizes the existing storage requirements as determined by each of the regional entities. The table also shows storage deficits for each entity, indicating that there is currently a regional storage deficit of 2.75 million gallons. These numbers reflect current conditions and the storage deficit will increase over time due to the higher demand caused by population growth. Figure 1 shows a schematic of the Oregon City water distribution and storage system along with each connection to the other agencys' systems.

**Table 1. Existing Water Storage Requirements**

| Entity | Existing Storage Requirement, mg | | | | Total | Available | Deficit |
|---|---|---|---|---|---|---|---|
| | Fire | Equalization | Operational | Emergency | | | |
| City of Oregon City [a] | 4 | 2 | 0 | 8 | 14 | 16.25[b] | (2.25) |
| City of West Linn [c] | 3.2 | 1.6 | 0 | 2.9 | 7.7 | 6[d] | 1.7 |
| South Fork Water Board [e] | 0 | 0 | 3.6 | 0 | 3.6 | 0 [f] | 3.6 |
| CRW-S [g] | 1.4 | 1.1 | 0 | 3 | 5.5 | 5.8[h] | (0.3) |
| Total | 8.6 | 4.7 | 3.6 | 13.9 | 30.8 | 28.05 | 2.75 |

[a] Based on data from the City of Oregon City's draft master plan update.
[b] Includes all four Oregon City reservoirs: Mountainview, Boynton, Henrici, and Barlow Crest.
[c] Based on City of West Linn Water Master Plan and Update, Montgomery Watson, April 12, 1999 and April 17, 2000.
[d] Includes all six West Linn reservoirs: Bolton, Horton, Rosemont, Bland Circle, Willamette, and View Drive.
[e] South Fork Water Board Water Master Plan, September 1997.
[f] SFWB treatment plant facilities include 1.2 million gallons of clearwell storage. Since the clearwell storage volume is needed for chlorine contact time, it is not included in the available regional storage capacity.
[g] Calculated based on Clackamas River Water Master Plan service standards.
[h] Includes all eight CRW-S reservoirs: Beavercreek No. 1, Beavercreek No. 2, Henrici No. 1, Henrici No. 2, Hunter Heights No. 1, Hunter Heights No. 2, Redland No. 1, and Redland No. 2.

The storage requirements shown for the SFWB reflect only the 3.6 million gallon operational storage component included in their master plan. With equalization storage and emergency storage included, the SFWB Master Plan indicated a total storage requirement of 12.5 million gallons. However, since the agencies served by the SFWB have established their own unique policies regarding equalization and emergency storage, the SFWB's responsibility as a water supplier could be limited to the operational storage needed to operate the water treatment plant. Therefore, the analysis shown in Table 1 identifies emergency and equalization storage requirements for the two cities and CRW-S only.

The data shown in Table 1 reflects several differences among the agencies served by the SFWB. Each water system has unique fire flow requirements according to the nature of local development and the configuration of pressure zones in their system. Also, Oregon City is planning for one peak day of demand for emergency storage while West Linn is planning for one average day of demand and CRW-S is planning for one and a half days of average demand. All three entities are providing equalization storage at 25 percent of peak day demand. Again, because the two cities and CRW-S have different needs and policies related to storage requirements, it would be appropriate that they assume responsibility for their own storage while the SFWB focuses on providing the storage required to operate the water treatment plant. Note

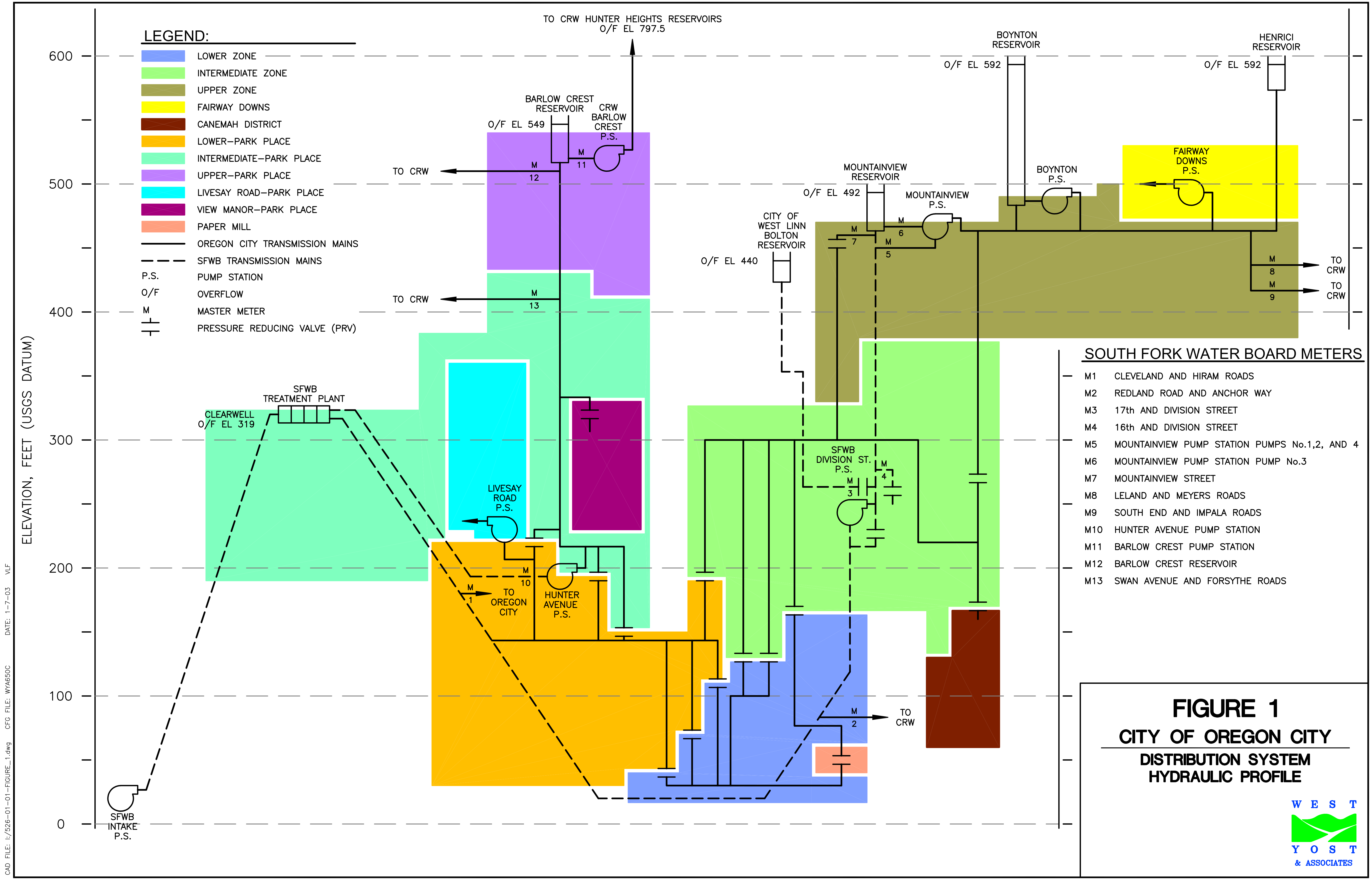



FIGURE 1
CITY OF OREGON CITY
DISTRIBUTION SYSTEM HYDRAULIC PROFILE

that the City of West Linn is considering changes to the storage criteria identified in the most recent water master plan, the effects of which are summarized as an attachment.

Future storage requirements will depend on population growth rates in the communities and the policies established for maintaining emergency storage. For example, policy makers may decide to increase their emergency storage requirements in the future since the Clackamas River is the sole source of water supply and is vulnerable to contamination from a chemical spill.

**EXISTING OPERATIONS**

To the extent allowed by seasonal water demand levels, the SFWB operates the water treatment plant during off-peak power periods and shuts down the plant for a period of time during the day when energy costs are highest. The daily plant shut-downs are longest during the winter when regional water demand is low and shortest during the summer when demand is high. This operating strategy reduces energy costs which benefits all SFWB customers. However, this operating strategy also requires access to a large reservoir for the operational storage volume necessary to allow extended plant shut-downs during the day.

Since the SFWB supply system does not have its own storage facilities, Oregon City's Mountainview Reservoir is used as the regional water storage facility. When the water treatment plant is operational, the SFWB's Division Street Pump Station pumps water to Oregon City's Mountainview Reservoir and to West Linn's Willamette, Bolton, and Robinwood reservoirs. When the Division Street Pump Station is not operating, the hydraulic configuration of the regional system is such that Mountainview Reservoir becomes the primary source of supply. Therefore, during periods when the Division Street Pump Station is not operating, water supply to the Oregon City, West Linn, and CRW-S systems is provided from Oregon City's Mountainview Reservoir. Similarly, if an emergency condition disrupts supply from the SFWB, Mountainview Reservoir would become the primary source of supply. Therefore, under an emergency condition, the West Linn system would draw water from Mountainview Reservoir, thus reducing the amount of storage available for use by Oregon City.

**ALLOCATION OF MOUNTAINVIEW RESERVOIR UTILIZATION**

As discussed in the previous section, Mountainview Reservoir is owned by the City of Oregon City but effectively acts as a regional storage facility. The current utilization of Mountainview Reservoir storage capacity by Oregon City, West Linn, CRW-S, and SFWB can be best established by evaluating each entity's existing storage requirements and their available storage other than Mountainview Reservoir. Since any deficiency in storage capacity is supplied by the regional storage facility, the difference between required and available storage represents dependence on Oregon City's Mountainview Reservoir. This analysis is summarized in Table 2. The table also provides a utilization percentage indicating each entity's relative level of dependence on Mountainview Reservoir. Given that the volume of Mountainview Reservoir is 10.5 million gallons, the analysis in Table 2 indicates that this reservoir is over-allocated by approximately 3 million gallons. This observation is consistent with the regional storage deficit noted earlier and indicates an immediate need for new regional storage capacity.

**Table 2. Allocation of Existing Utilization for Mountainview Reservoir**

| Entity | Available Storage (without Mountainview Reservoir), mg | Required Storage, mg | Storage From Mountainview Reservoir, mg | Mountainview Reservoir Utilization, % |
|---|---|---|---|---|
| City of Oregon City | 5.75 | 14 | 8.25 | 60 |
| City of West Linn | 6 | 7.7 | 1.7 | 13 |
| South Fork Water Board | 0 | 3.6 | 3.6 | 27 |
| Clackamas River Water | 5.8 | 5.5 | 0 | 0 |
| Total | 17.65 | 30.8 | 13.55 | 100 |

In a memorandum dated October 29, 2001 by MWH, an allocation of Mountainview Reservoir utilization was proposed based on the storage deficit in West Linn's first level reservoirs only. However, storage deficits in the upper pressure zones are also relevant to the analysis since these zones are supplied from pump stations in the lower pressure zone. Therefore, West Linn's system-wide storage deficit was taken into account for the analysis presented above.

## EVALUATION

Mountainview Reservoir is an integral part of the City of Oregon City's water distribution system, providing 65 percent of the City's total treated water storage capacity. The reservoir also plays a critical function in the operation of the regional water supply system, providing operational storage for the SFWB and supplemental storage for the City of West Linn. Since Mountainview Reservoir does not have sufficient capacity to perform both of these functions, modifications to the existing system are necessary. Two alternative solutions to the Mountainview Reservoir issue have been under discussion during recent planning activities:

1. The City of Oregon City sells Mountainview Reservoir to the SFWB for continued use as a regional storage facility and builds replacement storage facilities that are dedicated to the Oregon City distribution system.
2. The SFWB and the City of West Linn construct their own storage facilities and Mountainview Reservoir is dedicated to the Oregon City distribution system.

Transferring ownership of Mountainview Reservoir to the SFWB for official use as a regional storage facility would require that the City construct a replacement reservoir or reservoirs elsewhere in the system. The minimum replacement cost for this tank is $6 million and since construction of water reservoirs often requires landscaping, land purchase, and appurtenant construction, the total replacement cost could easily exceed $7.5 million. The alternative of transferring ownership to the SFWB would only be economically feasible for the City if the combination of sale price, avoided improvement costs, and avoided operation and maintenance costs were essentially equivalent to the replacement cost. This alternative has the advantages of minimizing changes to the existing core of the regional water supply system and allowing the

SFWB to continue their existing operating practices and expansion plans. Sale of Mountainview Reservoir would also provide the City of Oregon City with an opportunity to build new storage capacity for the City's large upper pressure zone, thus better matching the location of storage to the location of demand. However, as noted, agreement on a sale price that is equal to the replacement cost of the reservoir is critical for this option to be economically viable for the City. Without such an agreement, sale of Mountainview Reservoir to the SFWB would be very costly for the City.

The alternative solution is to isolate Mountainview Reservoir from the regional system so that the City of Oregon City has exclusive use of the reservoir's storage capacity. Under this scenario, the SFWB and the City of West Linn would construct their own storage facilities. This alternative would require some level of modifications to the SFWB's regional water supply system, but Oregon City would not need to construct any new storage facilities for the near term future. An interim agreement for continued regional operation of the reservoir will be required.

Regardless of which alternative is selected as the preferred regional strategy, the City of Oregon City is entitled to compensation for the regional benefits currently provided by Mountainview Reservoir. As long as the SFWB and the City of West Linn have storage deficits and continue to rely on Oregon City's facility, it would be appropriate that the cost for operation, maintenance, and capital investments at Mountainview Reservoir be shared according to the utilization percentages shown in Table 2.

## ANNUAL COSTS FOR MOUNTAINVIEW RESERVOIR

Annual costs for Mountainview Reservoir include both the ongoing operation and maintenance costs as well as the capital costs associated with necessary improvements to the reservoir. Table 3 summarizes the current operation and maintenance costs for Mountainview Reservoir based on information from the City Water Operations Department and City Finance Department. Table 4 summarizes the planned capital improvements for the reservoir along with an improvement period duration and estimated cost for each project. The capital costs are annualized over the identified improvement period using an annual rate of 5-percent.

**Table 3. Operation and Maintenance Costs – Mountainview Reservoir**

| Operation and Maintenance (O&M) Item | Labor Hours, hours/year | Total Labor Costs[a], $/hour | Annual O&M Cost, $ |
|---|---|---|---|
| Underwater inspection and leak repair (contract) | - | - | 10,000 |
| Automatic gate maintenance | - | - | 318 |
| Exterior inspection, repair, site maintenance, and security | 600 | 68 | 40,800 |
| Residuals monitoring | 125 | 68 | 8,500 |
| Total Annual O&M Cost | | | 59,618 |

[a]Labor costs include direct labor, fringe benefits, and overhead.

**Table 4. Capital Improvement Costs – Mountainview Reservoir**

| Project | Estimated Capital Cost, $ | Improvement Period, years | Annualized Cost, $ |
|---|---|---|---|
| Automatic gate | 17,000 | 2002-2022 | 1,364 |
| Re-roofing reservoir | 490,000 | 2004-2024 | 39,319 |
| Seismic upgrades | 1,015,000 | 2004-2024 | 81,446 |
| Circulation improvements | 230,000 | 2005-2025 | 18,456 |
| Roof structural frame repair | 90,000 | 2005-2025 | 7,222 |
| Interior lighting | 20,000 | 2005-2025 | 1,605 |

The information presented in Tables 3 and 4 is combined to provide the total annual cost for Mountainview Reservoir. Table 5 summarizes total annual costs for the reservoir from the current year through 2005 expressed in 2003 dollars. After 2005, the total annual costs are expected to remain steady until the year 2022 except for unforeseen capital improvements or annual O&M cost inflation. The total annual cost shown for each year along with the utilization percentages shown in Table 2 provide the basis for allocating costs among the agencies that benefit from the reservoir.

**Table 5. Total Annual Costs for Mountainview Reservoir**

| Year | Annual O&M Costs, $ | Annualized Capital Costs, $ | Total Annual Costs, $ |
|---|---|---|---|
| 2003 | 59,618 | 1,364 | 60,982 |
| 2004 | 59,618 | 122,129 | 181,747 |
| 2005 and after | 59,618 | 149,412 | 209,030 |

## RECOMMENDATION

Since it is not likely that the City of Oregon City can negotiate a sale agreement equivalent to the true replacement value for Mountainview Reservoir, it will be most cost effective for the City to maintain ownership of the facility. In addition, since the storage capacity of Mountainview Reservoir is over-allocated as a regional facility, it is advisable for the City to request that the SFWB and the City of West Linn construct their own storage facilities so that the Mountainview Reservoir can be isolated from the regional system in the near term future. In the meantime, the City of Oregon City is entitled to compensation for the regional benefits provided by the reservoir. Therefore, until the SFWB and the City of West Linn commission new storage facilities to remedy their existing storage deficiencies, the annualized cost for reservoir operation, maintenance, and improvements should be shared according to the utilization percentage for each agency.

# ATTACHMENT

### Modified Analysis Based on Revised Storage Criteria

### for the City of West Linn

The City of West Linn is currently considering revisions to their storage criteria which would alter the analysis previously presented in this technical memorandum. West Linn may eliminate their emergency storage criteria and use their reservoir system to provide equalization and fire flow storage only. Unlike equalization storage which is necessary for accommodating diurnal fluctuations in demand and fire flow storage which is required by the Oregon Administrative Rules, emergency storage criteria are determined at a community's discretion in accordance with their risk management policy decisions. The important effect of this policy change regarding emergency storage is that West Linn would no longer have a storage deficit. A summary of the regional storage requirements that reflects West Linn's potential policy change is shown in Table A-1.

**Table A-1. Existing Water Storage Requirements**

| Entity | Existing Storage Requirement, mg | | | | Total | Available | Deficit |
|---|---|---|---|---|---|---|---|
| | Fire | Equalization | Operational | Emergency | | | |
| City of Oregon City [a] | 4 | 2 | 0 | 8 | 14 | 16.25 [b] | (2.25) |
| City of West Linn [c] | 3.2 | 1.6 | 0 | 0 | 4.8 | 6 [d] | (1.2) |
| South Fork Water Board [e] | 0 | 0 | 3.6 | 0 | 3.6 | 0 [f] | 3.6 |
| CRW-S [g] | 1.4 | 1.1 | 0 | 3 | 5.5 | 5.8 [h] | (0.3) |
| Total | 8.6 | 4.7 | 3.6 | 11.0 | 27.9 | 28.05 | (0.15) |

[a] Based on data from the City of Oregon City's draft master plan update.
[b] Includes all four Oregon City reservoirs: Mountainview, Boynton, Henrici, and Barlow Crest.
[c] Based on City of West Linn eliminating emergency storage requirements for their system.
[d] Includes all six West Linn reservoirs: Bolton, Horton, Rosemont, Bland Circle, Willamette, and View Drive.
[e] South Fork Water Board Water Master Plan, September 1997.
[f] SFWB treatment plant facilities include 1.2 million gallons of clearwell storage. Since the clearwell storage volume is needed for chlorine contact time, it is not included in the available regional storage capacity.
[g] Calculated based on Clackamas River Water Master Plan service standards.
[h] Includes all eight CRW-S reservoirs: Beavercreek No. 1, Beavercreek No. 2, Henrici No. 1, Henrici No. 2, Hunter Heights No. 1, Hunter Heights No. 2, Redland No. 1, and Redland No. 2.

Without a storage deficit, West Linn would no longer be directly reliant on the regional storage provided by Mountainview Reservoir. This change of circumstances would therefore alter the distribution of utilization percentages among the regional agencies. Table A-2 presents the utilization percentages that would result from West Linn's revised storage criteria.

**Table A-2. Allocation of Existing Utilization for Mountainview Reservoir**

| Entity | Available Storage (without Mountainview Reservoir), mg | Required Storage, mg | Storage From Mountainview Reservoir, mg | Mountainview Reservoir Utilization, % |
|---|---|---|---|---|
| City of Oregon City | 5.75 | 14 | 8.25 | 70 |
| City of West Linn | 6 | 4.8 | 0 | 0 |
| South Fork Water Board | 0 | 3.6 | 3.6 | 30 |
| Clackamas River Water | 5.8 | 5.5 | 0 | 0 |
| Total | 17.65 | 27.9 | 11.85 | 100 |

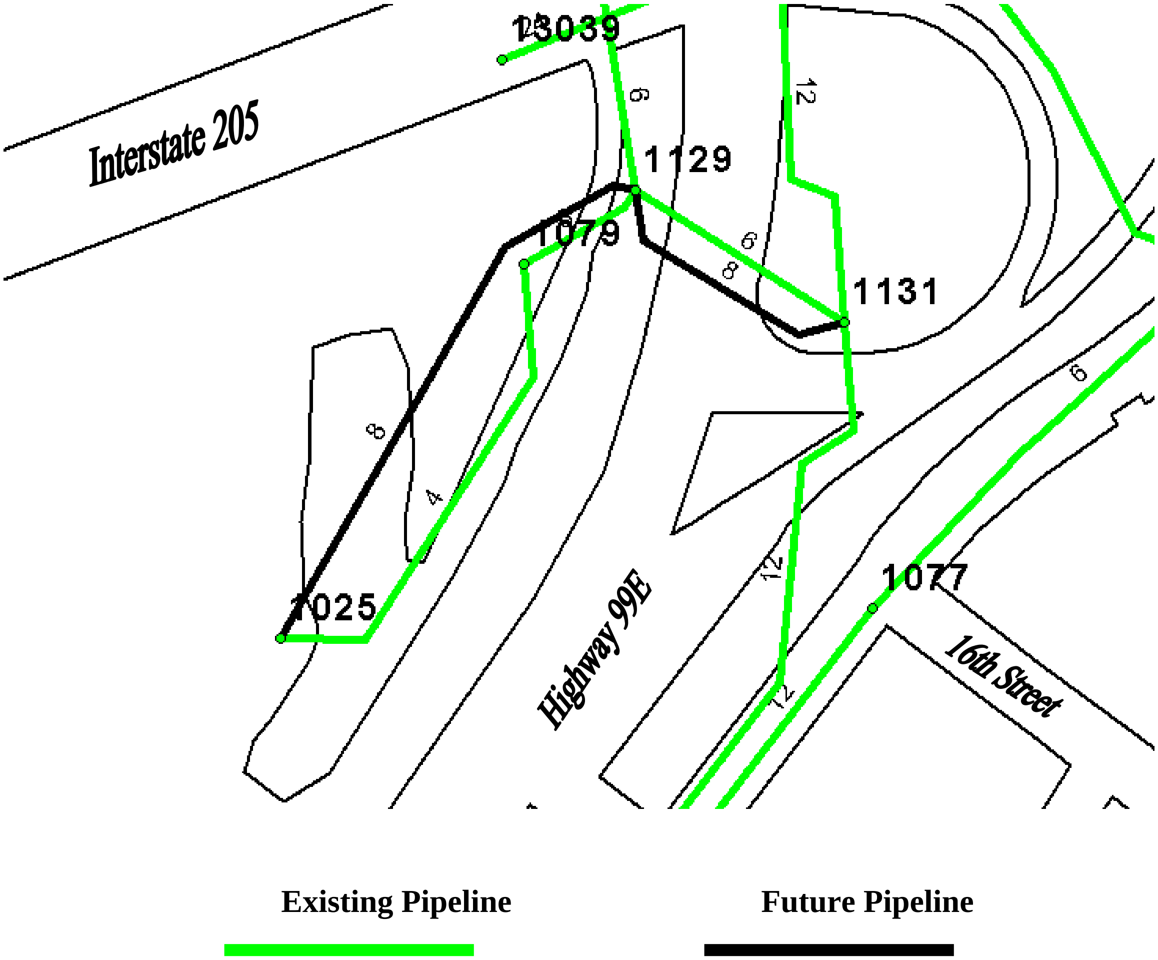
Under this scenario, West Linn would not directly participate in the utilization of Mountainview Reservoir but would continue to indirectly participate as a customer of the SFWB. Specifically, the SFWB would continue to use a portion of their operational storage in Mountainview Reservoir to supply the West Linn system when the Division Street Pump Station is not operating.

The most important ramification of the revised storage criteria is that West Linn would forego rights to Mountainview Reservoir storage supplies in the event of a failure in the SFWB supply system. Since the potential hardships and liability issues associated with lack of access to Mountainview Reservoir's emergency supplies are significant, a contingency plan for responding to a SFWB supply failure should be explicitly discussed and agreed upon among the regional agencies. Given a West Linn decision to eliminate their storage criteria, all parties would be advised to acknowledge that Oregon City would be compelled to isolate its emergency storage from the West Linn system at any time that the water supply is interrupted. Otherwise, Oregon City could not meets its own emergency needs to the level established by City policy.

# Appendix E

# APPENDIX E
# PIPELINE PROJECT DATA SHEETS

The following data sheets provide a summary of the location, sizing, length, and estimated costs for pipeline projects. The alignments of future pipeline extensions shown on the drawings are notional and actual alignments can be modified as necessary to accommodate actual development patterns.




**Pipeline Project Number:** P-101

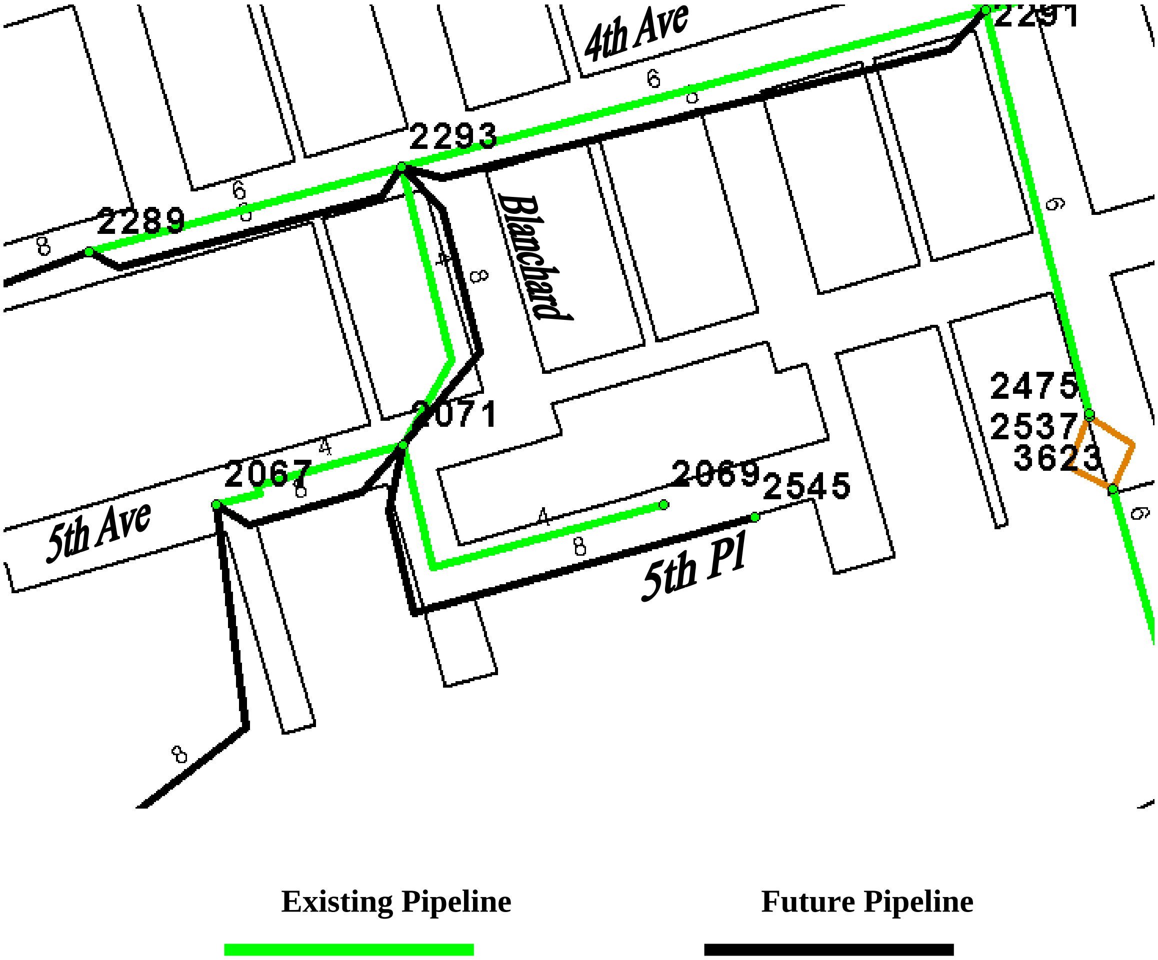
**Project Vicinity:** Highway 99E near I-205

**Project Description:** Replacement and upsizing of cast iron pipeline that has failed and provides insufficient fire flow. Crossing of Highway 99E will require trenchless construction technique.

**Project Data Table**

| Node | | Pipe Size, inches | Pipe Length, feet | Const. Cost/ft, $ | Total Const. Cost, $ | Total Capital Cost, $ |
|---|---|---|---|---|---|---|
| From | To | | | | | |
| 1131 | 1129 | 8 | 230 | 512** | 117,760 | 171,000 |
| 1129 | 1025 | 8 | 540 | 74 | 39,960 | 58,000 |
| | | Bore and Jack Pit | | | 64,000 | 93,000 |
| | | Receiving Pit | | | 37,000 | 54,000 |
| Total | | | 770 | | 258,720 | 375,000 |

**Bore and Jack allowance



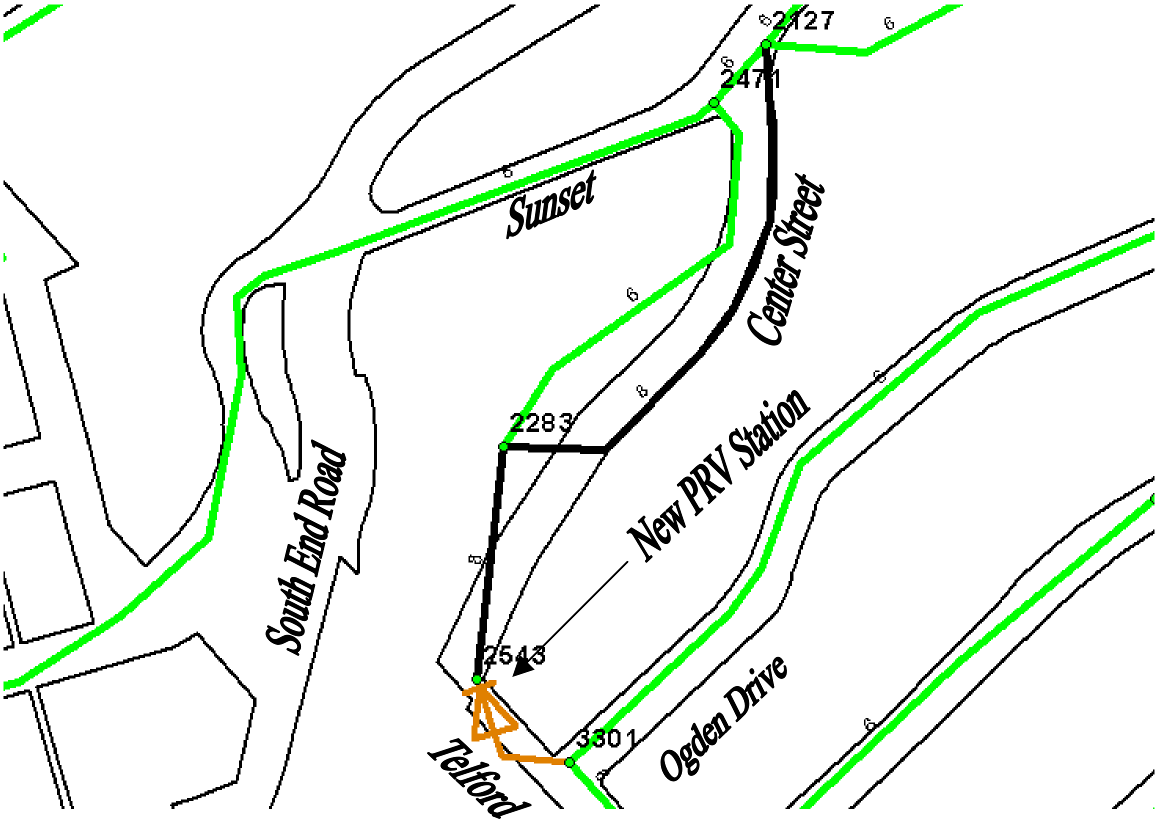

**Pipeline Project Number:** P-102

**Project Vicinity:** Blanchard - Canemah

**Project Description:** Replacement and upsizing of pipelines that provide insufficient fire flow.

**Project Data Table**

| Node | | Pipe Size, inches | Pipe Length, feet | Const. Cost/ft, $ | Total Const. Cost, $ | Total Capital Cost, $ |
|---|---|---|---|---|---|---|
| From | To | | | | | |
| 2291 | 2293 | 8 | 580 | 74 | 42,920 | 62,000 |
| 2293 | 2289 | 8 | 310 | 74 | 22,940 | 33,000 |
| 2293 | 2071 | 8 | 310 | 74 | 22,940 | 33,000 |
| 2071 | 2545 | 8 | 500 | 74 | 37,000 | 54,000 |
| Total | | | 1,700 | | 125,800 | 182,000 |




**Existing Pipeline** **Future Pipeline**

**Pipeline Project Number:** P-103

**Project Vicinity:** Center Street and Sunset

**Project Description:** Replacement and upsizing of pipelines that provide insufficient fire flow. Addition of a PRV station feed from the Upper Zone to boost local pressure in the event of a fire.

**Project Data Table**

| Node | | Pipe Size, inches | Pipe Length, feet | Const. Cost/ft, $ | Total Const. Cost, $ | Total Capital Cost, $ |
|---|---|---|---|---|---|---|
| From | To | | | | | |
| 2127 | 2283 | 8** | 760 | 148 | 112,480 | 163,000 |
| 2283 | 2543 | 8** | 400 | 148 | 59,200 | 86,000 |
| | | PRV Station | | | 30,000 | 44,000 |
| Total | | | 760 | | 201,680 | 292,000 |


**Existing Pipeline** **Future Pipeline**

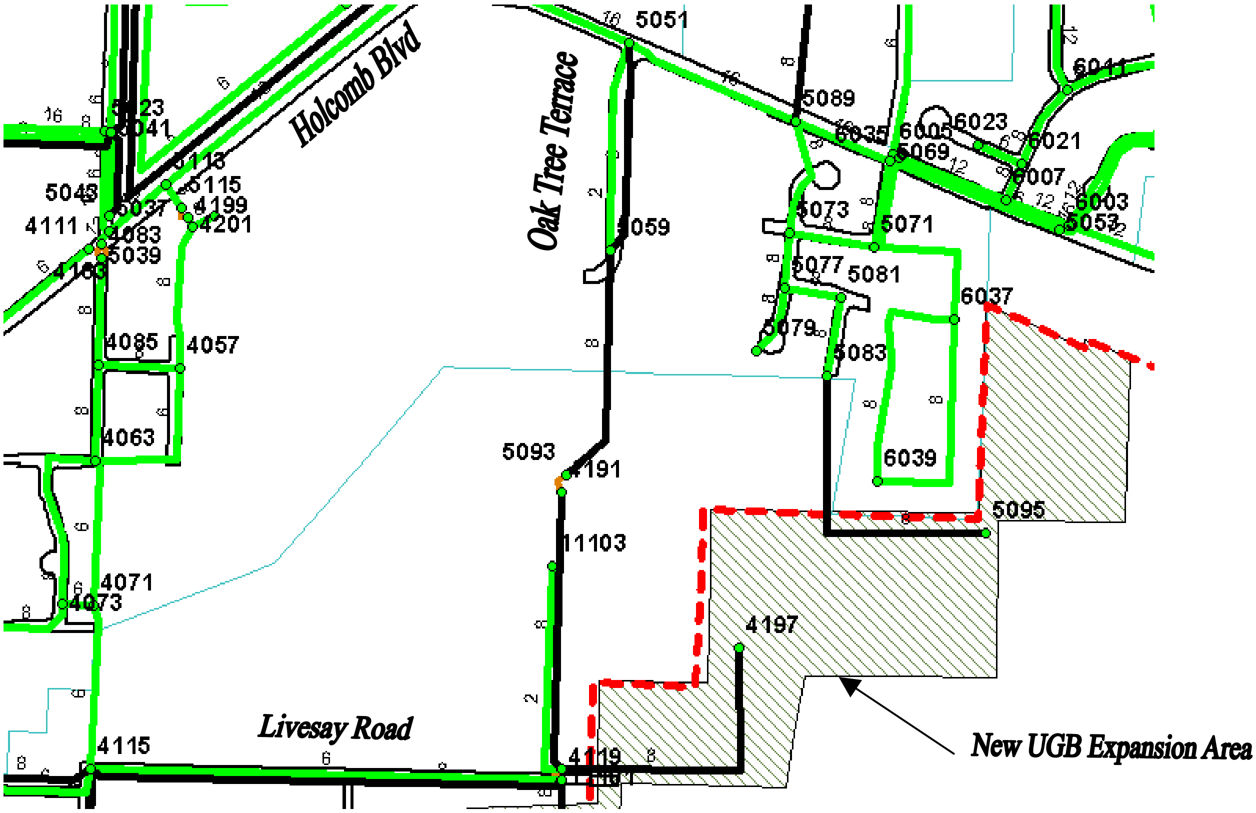
**Pipeline Project Number:** P-104

**Project Vicinity:** Third and East

**Project Description:** Replacement and upsizing of pipelines that provide insufficient fire flow.

**Project Data Table**

| Node | | Pipe Size, inches | Pipe Length, feet | Const. Cost/ft, $ | Total Const. Cost, $ | Total Capital Cost, $ |
|---|---|---|---|---|---|---|
| From | To | | | | | |
| 2053 | 2259 | 12 | 320 | 97 | 31,040 | 45,000 |
| 2259 | 2547 | 8 | 700 | 74 | 51,800 | 75,000 |
| 2547 | 2263 | 8 | 360 | 74 | 26,640 | 39,000 |
| Total | | | 1,380 | | 109,480 | 159,000 |




**Existing Pipeline** **Future Pipeline**

**Pipeline Project Number:** P-105

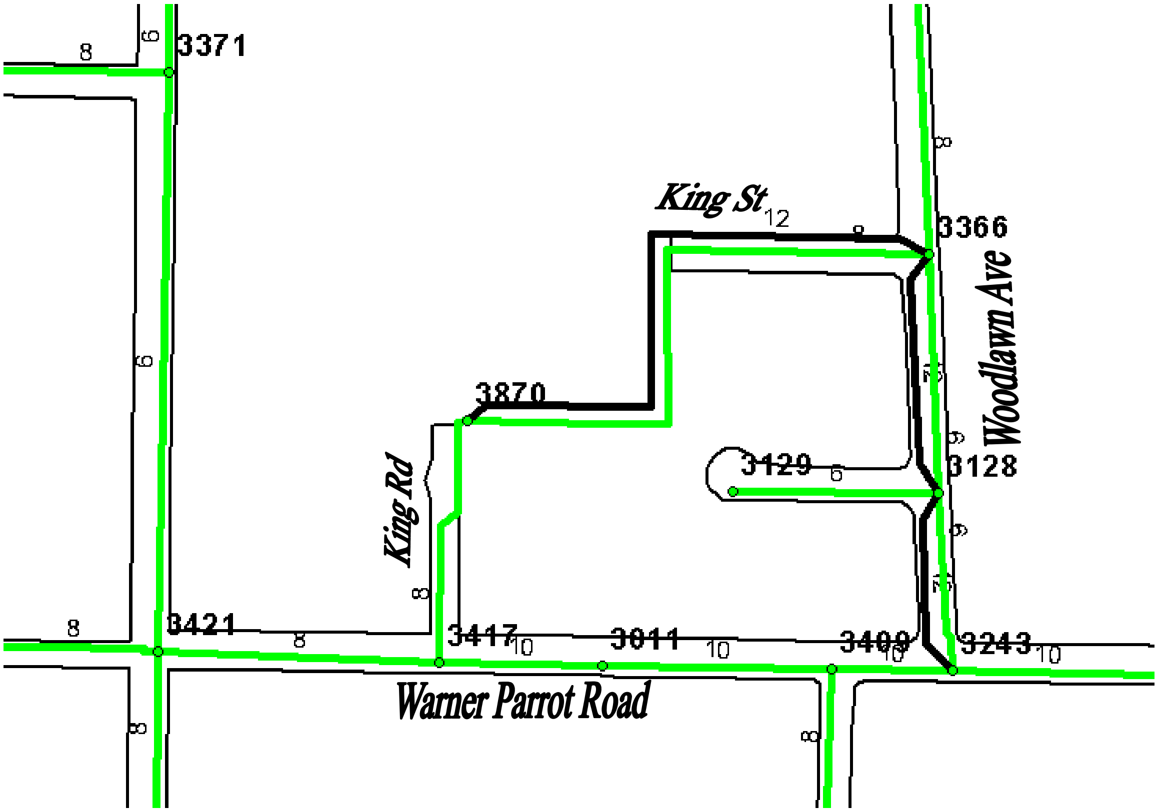
**Project Vicinity:** Livesay Road and Oak Tree Terrace

**Project Description:** This replacement, upsizing, and expansion pipeline project includes two new PRV stations and will serve the pressure zone currently fed by the Livesay Road Pump Station. Upon completion of the project, the Livesay Road Pump Station can be decommissioned.

**Project Data Table**

| Node | | Pipe Size, inches | Pipe Length, feet | Const. Cost/ft, $ | Total Const. Cost, $ | Total Capital Cost, $ |
|---|---|---|---|---|---|---|
| From | To | | | | | |
| 5051 | 5059 | 8* | 860 | 0 | 0 | 0 |
| 5059 | 5093 | 8 | 970 | 74 | 71,780 | 104,000 |
| | | PRV Station | | | 30,000 | 44,000 |
| 5093 | 4119 | 8 | 1,150 | 74 | 85,100 | 123,000 |
| | | PRV Station | | | 30,000 | 44,000 |
| Total | | | 2,980 | | 216,880 | 314,000 |

*Unit costs account for developer participation in project financing.




**Existing Pipeline** **Future Pipeline**

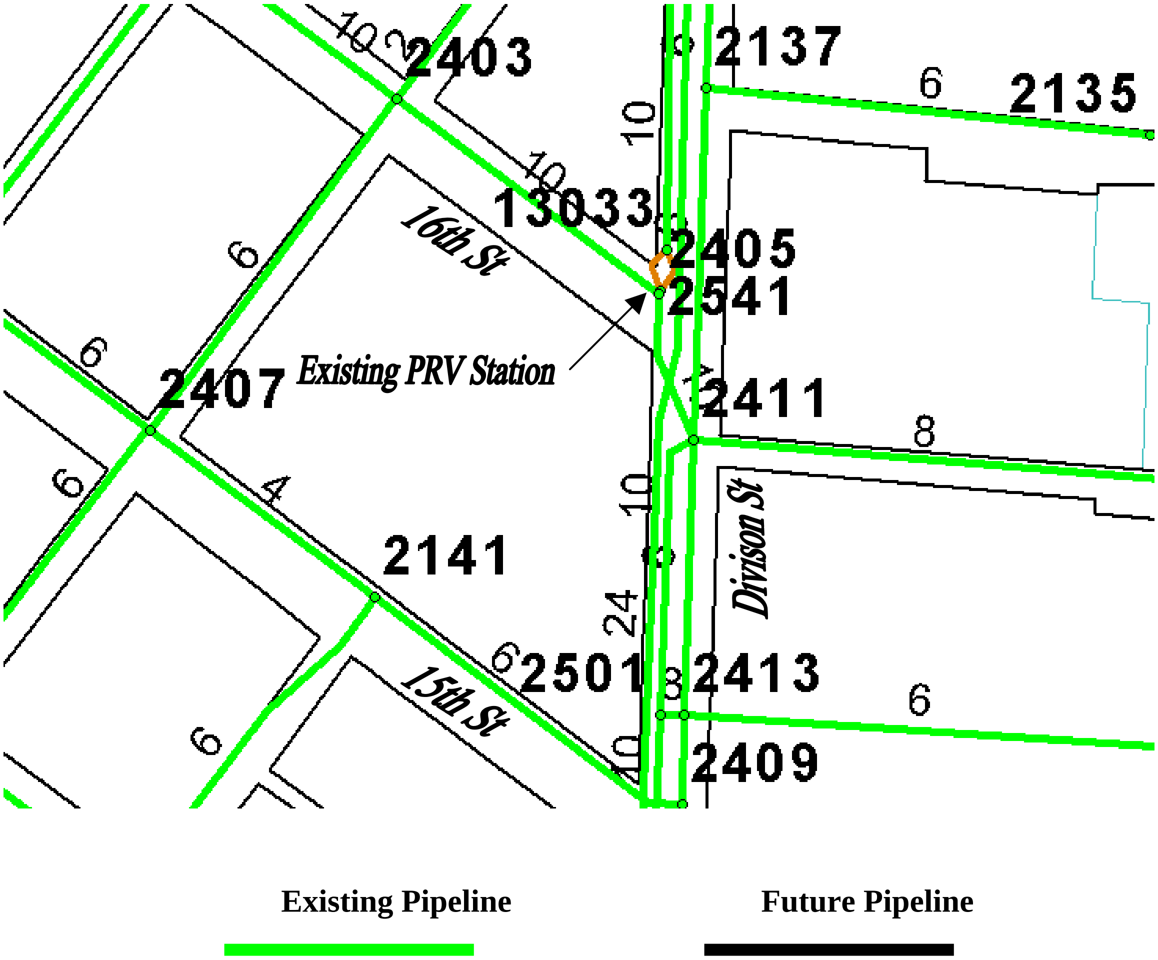
**Pipeline Project Number:** P-106

**Project Vicinity:** King Street

**Project Description:** This replacement and upsizing project is designed to improve fire flows for the nearby school. Replacement of the 6-inch bottleneck in Woodlawn and the 8-inch bottleneck in King Street is necessary to achieve required fire flows.

**Project Data Table**

| Node | | Pipe Size, inches | Pipe Length, feet | Const. Cost/ft, $ | Total Const. Cost, $ | Total Capital Cost, $ |
|---|---|---|---|---|---|---|
| From | To | | | | | |
| 3243 | 3128 | 12 | 280 | 97 | 27,160 | 39,000 |
| 3128 | 3366 | 12 | 370 | 97 | 35,890 | 52,000 |
| 3366 | 3870 | 12 | 980 | 97 | 95,060 | 138,000 |
| Total | | | 1,630 | | 158,110 | 229,000 |




**Pipeline Project Number:** P-107

**Project Vicinity:** 16th and Division

**Project Description:** This project involves modification of the existing PRV station at 16th and Division to provide a new major supply point for the Intermediate Pressure Zone. The existing PRV station consists of a 1.25-inch valve for normal service and a 6-inch valve for fire flow service. With the current design, the station supplies little water during normal demand conditions. The small valve should be upsized or augmented to provide continuous supply to the zone.

**Project Data Table**

| Node | | Pipe Size, inches | Pipe Length, feet | Const. Cost/ft, $ | Total Const. Cost, $ | Total Capital Cost, $ |
|---|---|---|---|---|---|---|
| From | To | | | | | |
| | | PRV Station | | | 20,000 | 29,000 |
| Total | | | 240 | | 20,000 | 29,000 |

*Pipe allowance


**Existing Pipeline** **Future Pipeline**

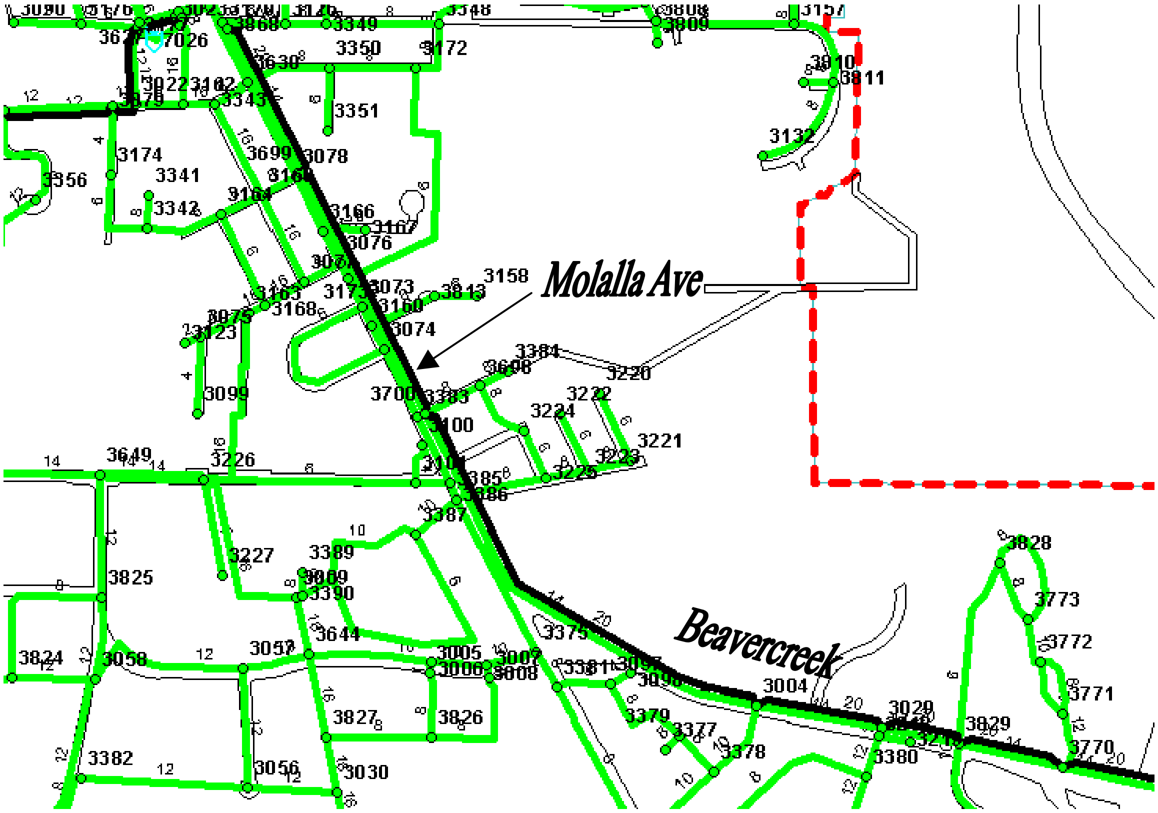
**Pipeline Project Number:** P-108

**Project Vicinity:** Linn to 4th Street

**Project Description:** This project involves replacement of the remaining 12-inch steel pipeline along Linn and 4th between Pearl Street and JQ Adams.

**Project Data Table**

| Node | | Pipe Size, inches | Pipe Length, feet | Const. Cost/ft, $ | Total Const. Cost, $ | Total Capital Cost, $ |
|---|---|---|---|---|---|---|
| From | To | | | | | |
| 2553 | 2053 | 12 | 410 | 97 | 39,770 | 58,000 |
| 2053 | 2055 | 12 | 310 | 97 | 30,070 | 44,000 |
| 2055 | 2119 | 12 | 450 | 97 | 43,650 | 63,000 |
| 2119 | 2003 | 12 | 230 | 97 | 22,310 | 32,000 |
| Total | | | 1,400 | | 135,800 | 197,000 |




**Existing Pipeline** **Future Pipeline**

**Pipeline Project Number:** P-109

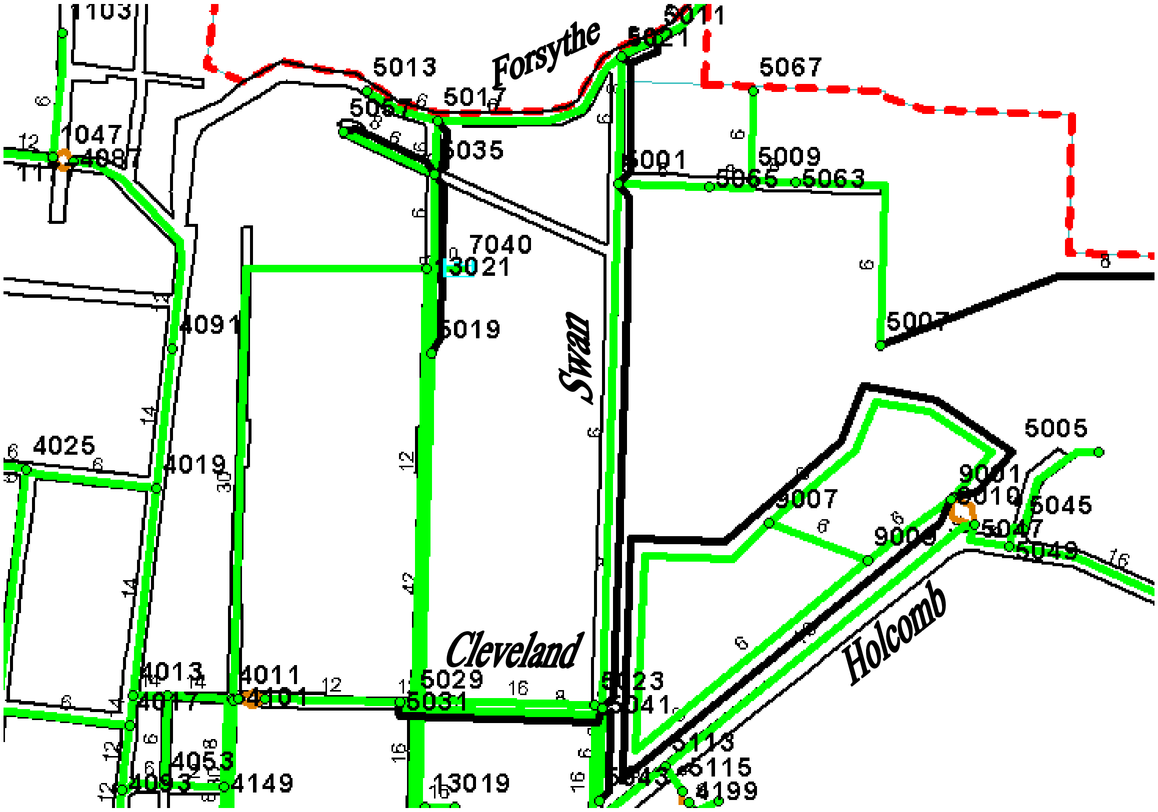
**Project Vicinity:** Beavercreek Road and Molalla Avenue

**Project Description:** This project involves replacement and upsizing of the remaining 16-inch steel Mountain Line along Beavercreek Road and Molalla Avenue between Fir Street and Barclay Hills Drive.

**Project Data Table**

| Node | | Pipe Size, inches | Pipe Length, feet | Const. Cost/ft, $ | Total Const. Cost, $ | Total Capital Cost, $ |
|---|---|---|---|---|---|---|
| From | To | | | | | |
| 3868 | 3699 | 20 | 940 | 136 | 127,840 | 185,000 |
| 3699 | 3700 | 20 | 1,280 | 136 | 174,080 | 252,000 |
| 3700 | 3004 | 20** | 2,680 | 118 | 316,240 | 459,000 |
| 3004 | 3029 | 20* | 730 | 62 | 45,260 | 66,000 |
| 3029 | 3829 | 20 | 450 | 136 | 61,200 | 89,000 |
| Total | | | 6,080 | | 724,620 | 1,051,000 |

*Unit costs account for developer participation in project financing.
**Developer participation for 25% of length.




**Existing Pipeline** **Future Pipeline**

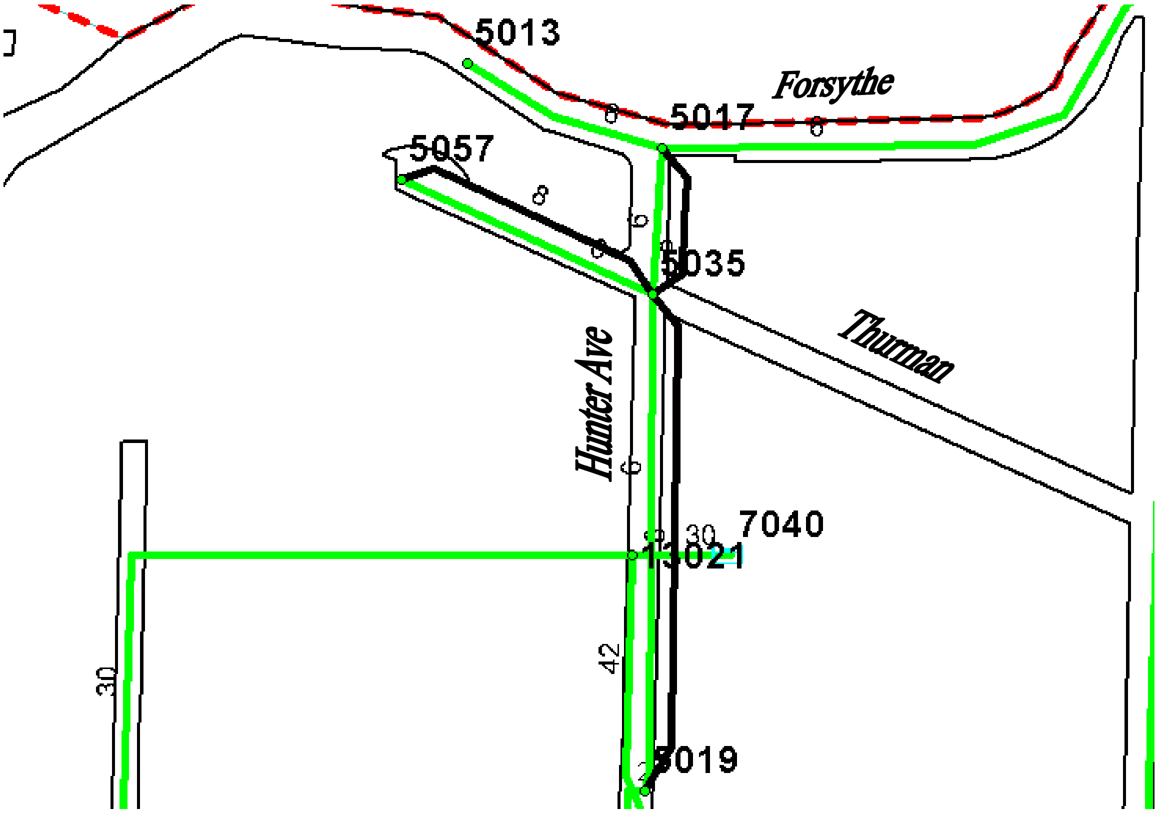
**Pipeline Project Number:** P-110

**Project Vicinity:** Swan Avenue

**Project Description:** This project involves replacement and upsizing of the steel pipeline in Swan Avenue between Holcomb Boulevard and Forsythe Road. The project also includes a steel line in Cleveland Street between Hunter Avenue and Swan Avenue.

**Project Data Table**

| Node | | Pipe Size, inches | Pipe Length, feet | Const. Cost/ft, $ | Total Const. Cost, $ | Total Capital Cost, $ |
|---|---|---|---|---|---|---|
| From | To | | | | | |
| 5031 | 5041 | 8 | 760 | 74 | 56,240 | 82,000 |
| 5041 | 5043 | 8 | 340 | 74 | 25,160 | 36,000 |
| 5041 | 5001 | 8 | 1,870 | 74 | 138,380 | 201,000 |
| 5001 | 5021 | 8 | 460 | 74 | 34,040 | 49,000 |
| 5021 | 5011 | 8 | 150 | 74 | 11,100 | 16,000 |
| Total | | | 3,580 | | 264,920 | 384,000 |




**Existing Pipeline** **Future Pipeline**

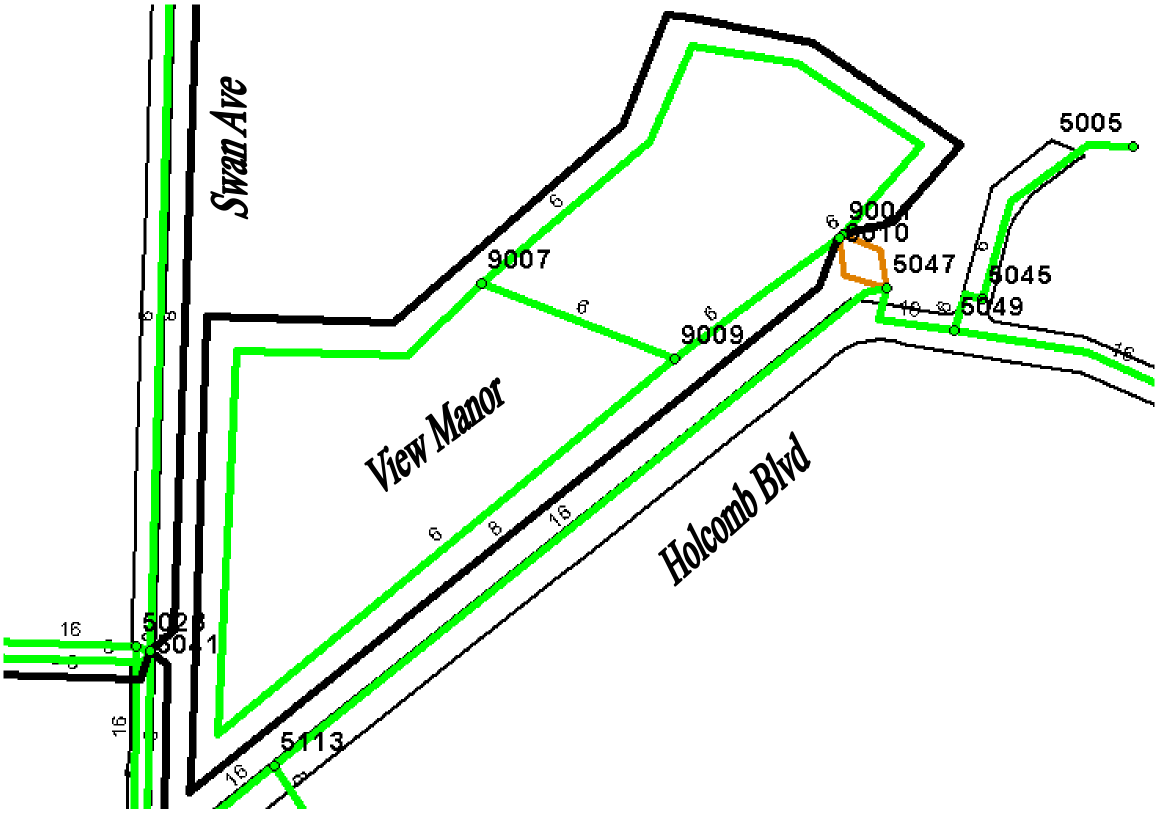
**Pipeline Project Number:** P-111

**Project Vicinity:** Hunter Avenue

**Project Description:** This project involves replacement and upsizing of the steel pipeline in Hunter Avenue from just south of the SFWB treatment plant to Forsythe Road. The project also includes a steel line in Thurman Street.

**Project Data Table**

| Node | | Pipe Size, inches | Pipe Length, feet | Const. Cost/ft, $ | Total Const. Cost, $ | Total Capital Cost, $ |
|---|---|---|---|---|---|---|
| From | To | | | | | |
| 5019 | 5035 | 8 | 640 | 74 | 47,360 | 69,000 |
| 5035 | 5057 | 8 | 360 | 74 | 26,640 | 39,000 |
| 5035 | 5017 | 8 | 190 | 74 | 14,060 | 20,000 |
| Total | | | 1,190 | | 88,060 | 128,000 |




**Existing Pipeline** **Future Pipeline**

**Pipeline Project Number:** P-112

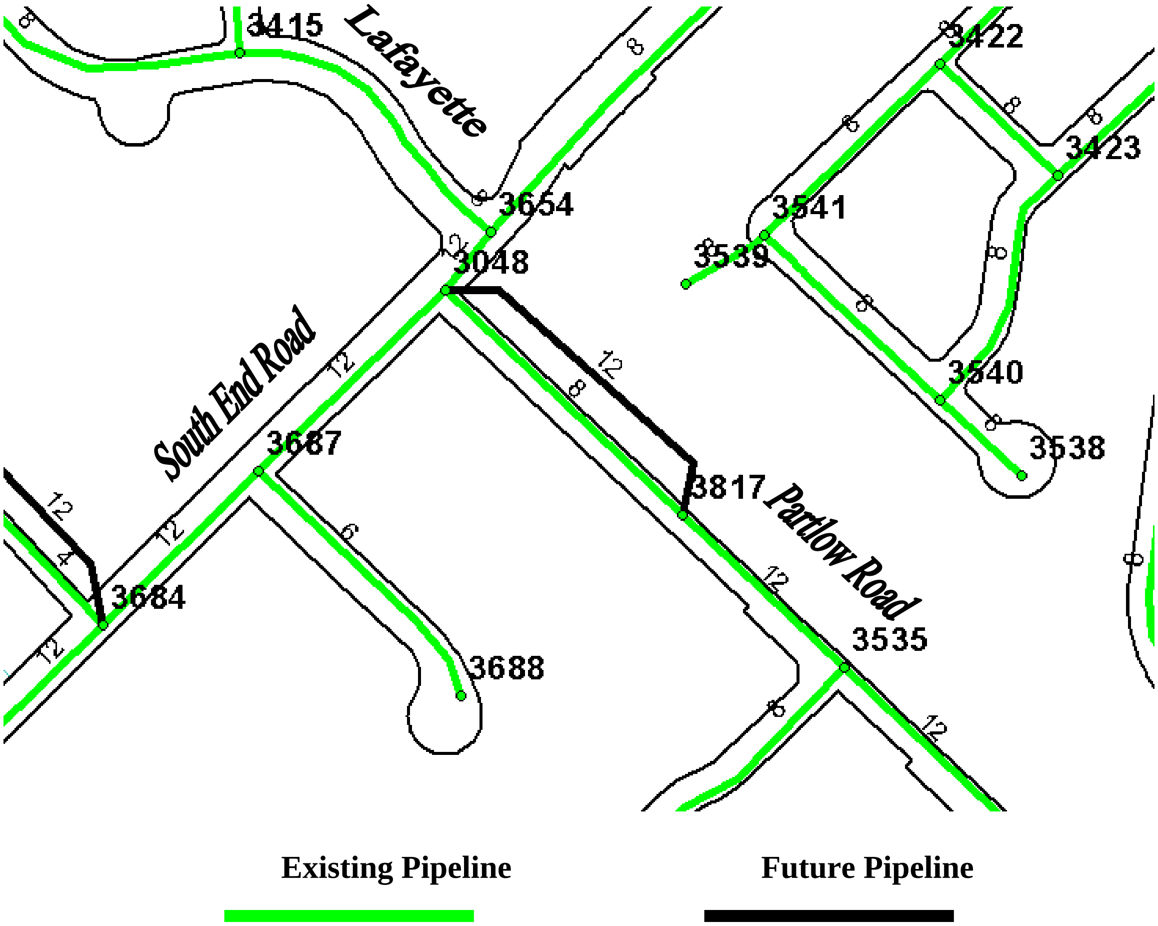
**Project Vicinity:** View Manor

**Project Description:** This project involves replacement and upsizing of the cast iron pipelines in the View Manor development. Since the existing pipelines are not within the roadway, the configuration of the pipeline network will also be modified.

**Project Data Table**

| Node | | Pipe Size, inches | Pipe Length, feet | Const. Cost/ft, $ | Total Const. Cost, $ | Total Capital Cost, $ |
|---|---|---|---|---|---|---|
| From | To | | | | | |
| 9001 | 9007 | 8 | 1,260 | 74 | 93,240 | 135,000 |
| 9007 | 9009 | 8 | 2,250 | 74 | 166,500 | 241,000 |
| 9009 | 9010 | 8 | 370 | 74 | 27,380 | 40,000 |
| 9007 | 9009 | 8 | 380 | 74 | 28,120 | 41,000 |
| Total | | | 4,260 | | 315,240 | 457,000 |

*Unit costs account for developer participation in project financing.




**Pipeline Project Number:** P-113

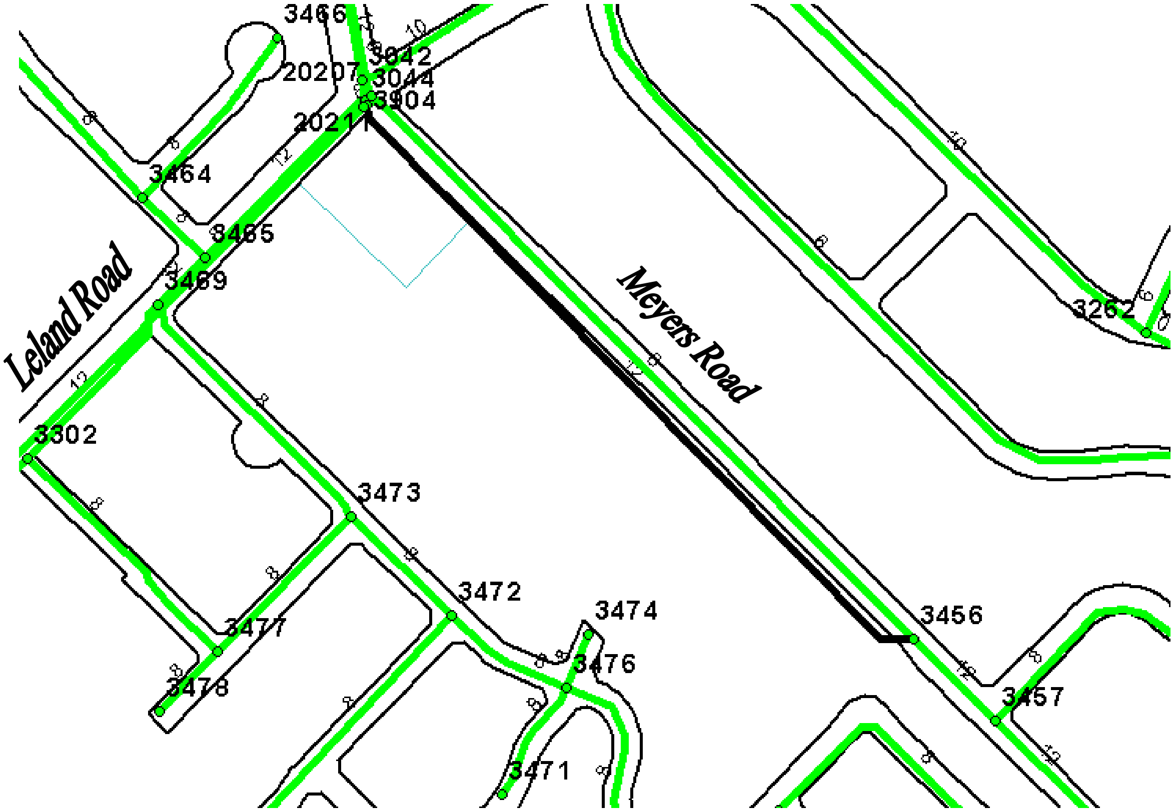
**Project Vicinity:** Partlow Road

**Project Description:** This project involves replacement and upsizing of the remaining reach of steel pipeline in Partlow Road. Intersection of Partlow Road with South End Road is expected to be realigned with Lafayette.

**Project Data Table**

| Node | | Pipe Size, inches | Pipe Length, feet | Const. Cost/ft, $ | Total Const. Cost, $ | Total Capital Cost, $ |
|---|---|---|---|---|---|---|
| From | To | | | | | |
| 3048 | 3817 | 12* | 470 | 23 | 10,810 | 16,000 |
| Total | | | 470 | | 10,810 | 16,000 |

*Unit costs account for developer participation in project financing.




**Existing Pipeline** **Future Pipeline**

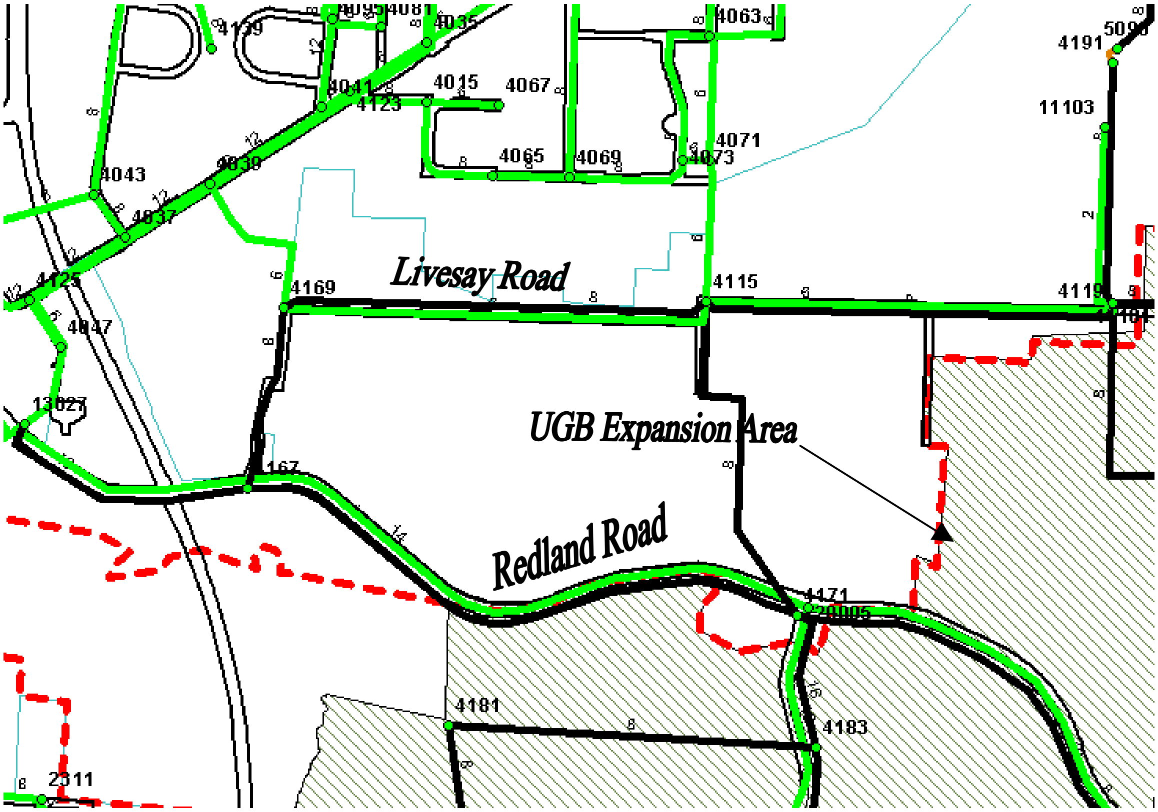
**Pipeline Project Number:** P-114

**Project Vicinity:** Meyers Road

**Project Description:** This project involves replacement and upsizing of a steel pipeline in Meyers Road.

**Project Data Table**

| Node | | Pipe Size, inches | Pipe Length, feet | Const. Cost/ft, $ | Total Const. Cost, $ | Total Capital Cost, $ |
|---|---|---|---|---|---|---|
| From | To | | | | | |
| 3904 | 3456 | 12 | 1,400 | 97 | 135,800 | 197,000 |
| Total | | | 1,400 | | 135,800 | 197,000 |




**Existing Pipeline** **Future Pipeline**

**Pipeline Project Number:** P-115

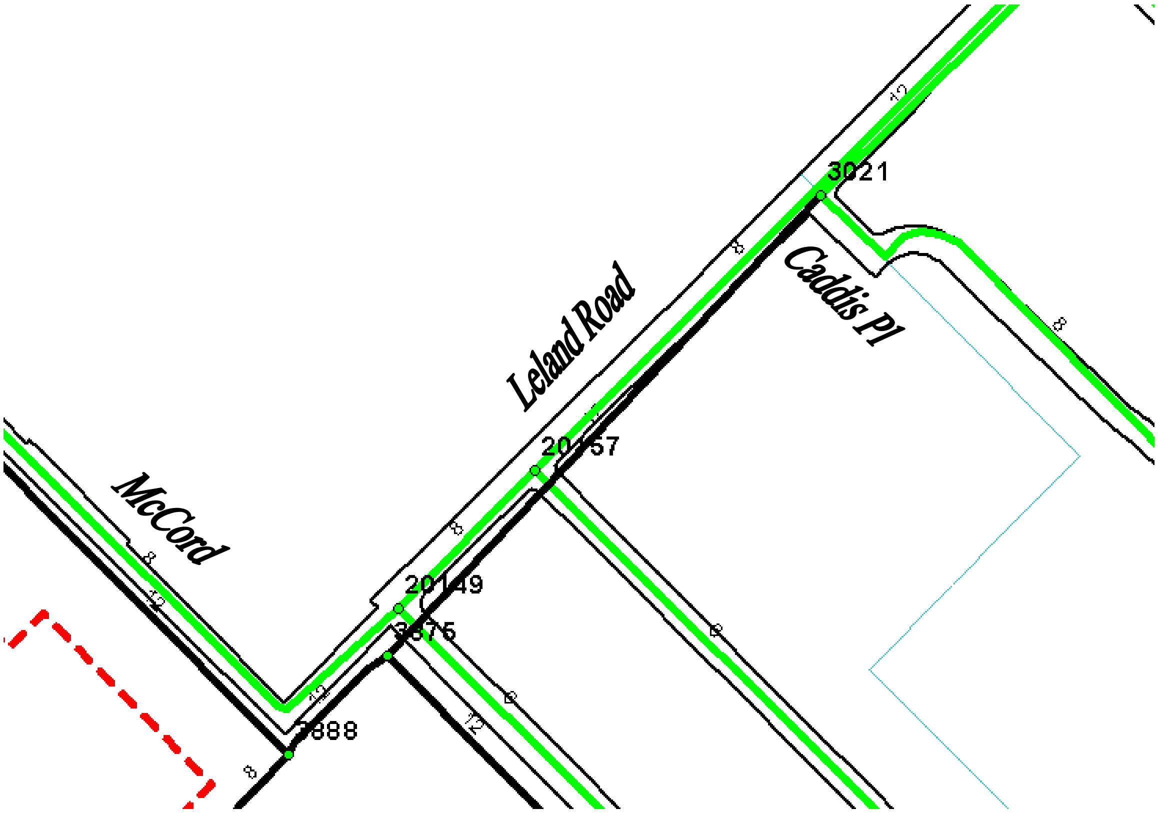
**Project Vicinity:** Redland Road to Livesay Road

**Project Description:** This project involves providing a new supply source from Redland Road for the Livesay Road neighborhood. This project involves a new supply to Oregon City from the SFWB transmission main at Redland Road and replacement/upsizing of the existing asbestos cement pipelines in Livesay Road. The existing pipeline along Redland Road is owned by CRW. The 8-inch replacements and new grid will be built by developers.

**Project Data Table**

| Node | | Pipe Size, inches | Pipe Length, feet | Const. Cost/ft, $ | Total Const. Cost, $ | Total Capital Cost, $ |
|---|---|---|---|---|---|---|
| From | To | | | | | |
| 13027 | 4167 | 16* | 1,260 | 41 | 51,660 | 75,000 |
| Total | | | 1,260 | | 51,660 | 75,000 |

*Unit costs account for developer participation in project financing.




**Existing Pipeline** **Future Pipeline**

**Pipeline Project Number:** P-116

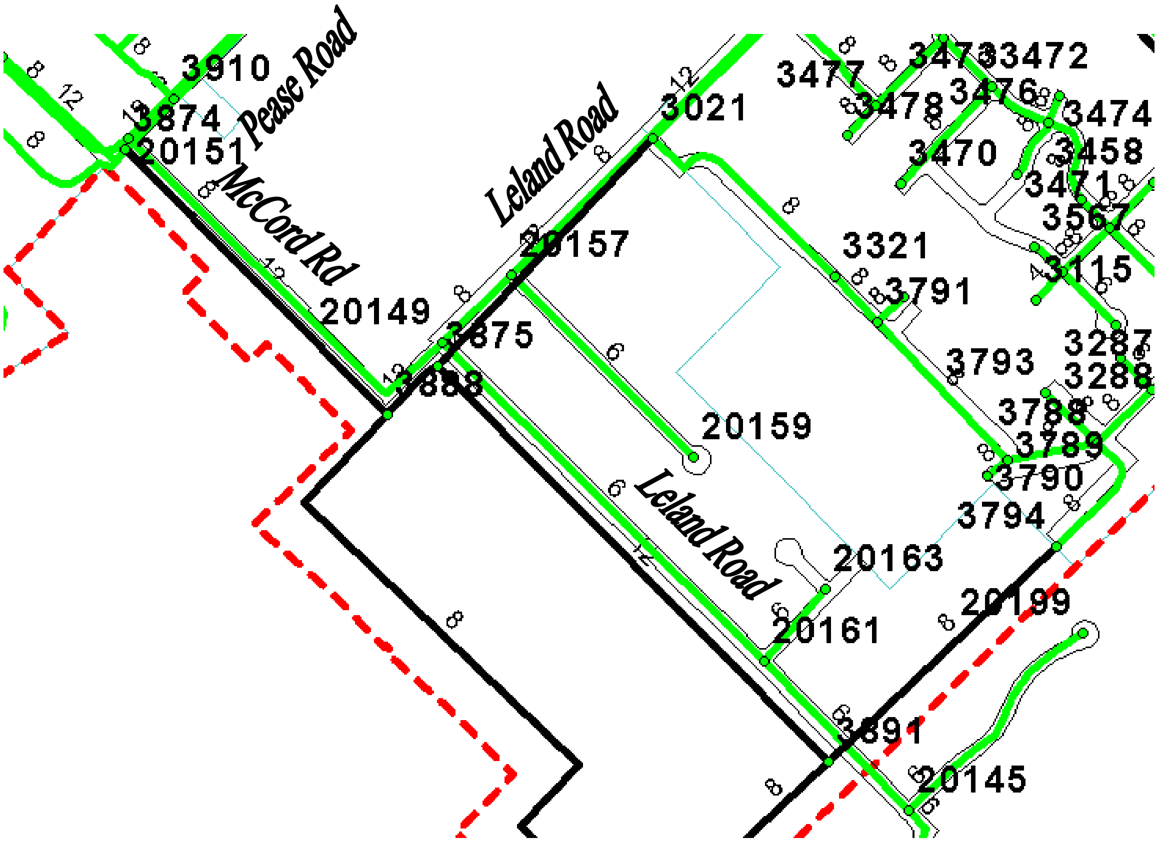
**Project Vicinity:** Leland Road

**Project Description:** This project involves extension of the existing pipeline network along Leland Road between Caddis and McCord. Many existing pipes in the area are owned by CRW.

**Project Data Table**

| Node | | Pipe Size, inches | Pipe Length, feet | Const. Cost/ft, $ | Total Const. Cost, $ | Total Capital Cost, $ |
|---|---|---|---|---|---|---|
| From | To | | | | | |
| 3021 | 3875 | 12* | 1,140 | 23 | 26,220 | 38,000 |
| 3875 | 3888 | 12* | 260 | 23 | 5,980 | 9,000 |
| Total | | | 1,400 | | 32,200 | 47,000 |

*Unit costs account for developer participation in project financing where applicable.




**Existing Pipeline** **Future Pipeline**

**Pipeline Project Number:** P-117

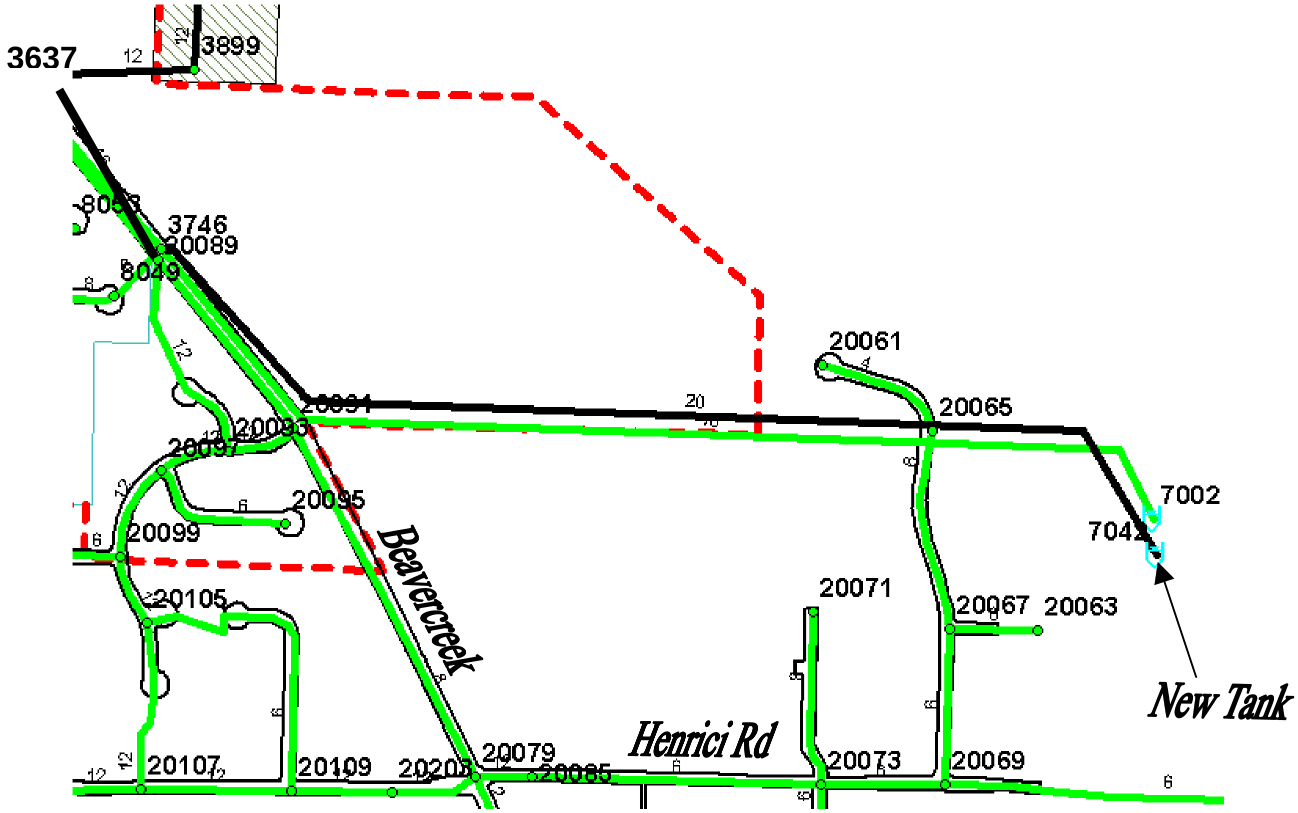
**Project Vicinity:** McCord Road

**Project Description:** This project involves extension of the existing system along McCord Road between Pease Road and Leland Road, as well as along the remainder of Leland to the UGB. Many existing pipes in the area are owned by CRW.

**Project Data Table**

| Node | | Pipe Size, inches | Pipe Length, feet | Const. Cost/ft, $ | Total Const. Cost, $ | Total Capital Cost, $ |
|---|---|---|---|---|---|---|
| From | To | | | | | |
| 3874 | 3888 | 12* | 1,360 | 23 | 31,280 | 45,000 |
| 3875 | 3891 | 12* | 2,030 | 23 | 46,690 | 68,000 |
| Total | | | 3,390 | | 77,970 | 113,000 |

*Unit costs account for developer participation in project financing where applicable.




**Existing Pipeline** **Future Pipeline**

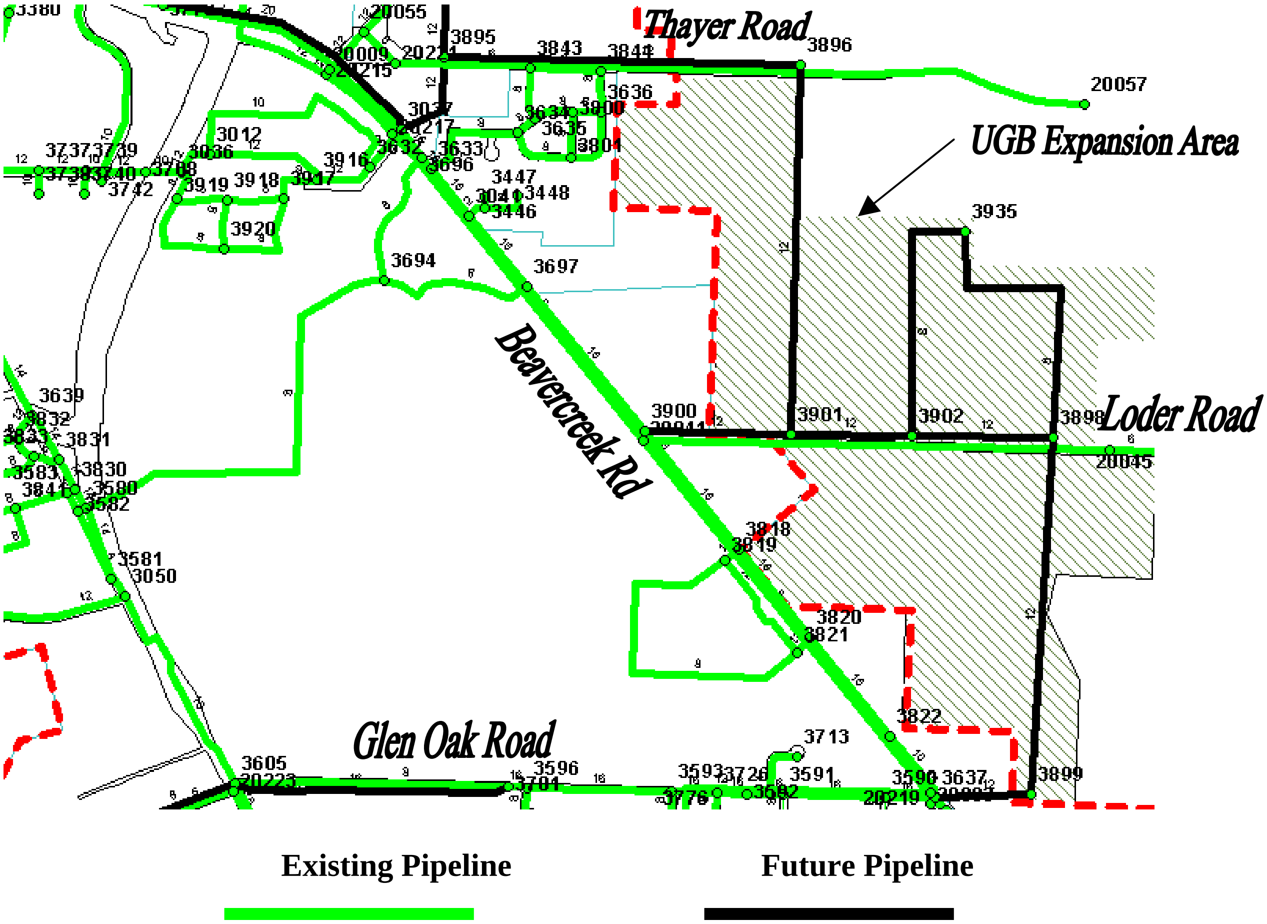
**Pipeline Project Number:** P-118

**Project Vicinity:** Henrici Reservoir

**Project Description:** This project involves extension of a new supply pipeline for the proposed new reservoir that will serve the Upper Pressure Zone from the existing Henrici Reservoir site. Many existing pipes in this area are owned by CRW.

**Project Data Table**

| Node | | Pipe Size, inches | Pipe Length, feet | Const. Cost/ft, $ | Total Const. Cost, $ | Total Capital Cost, $ |
|---|---|---|---|---|---|---|
| From | To | | | | | |
| 3637 | 3746 | 20 | 900 | 136 | 122,400 | 177,000 |
| 3746 | Tank | 20 | 4,350 | 136 | 591,600 | 858,000 |
| Total | | | 4,350 | | 714,000 | 1,035,000 |




**Pipeline Project Number:** P-201

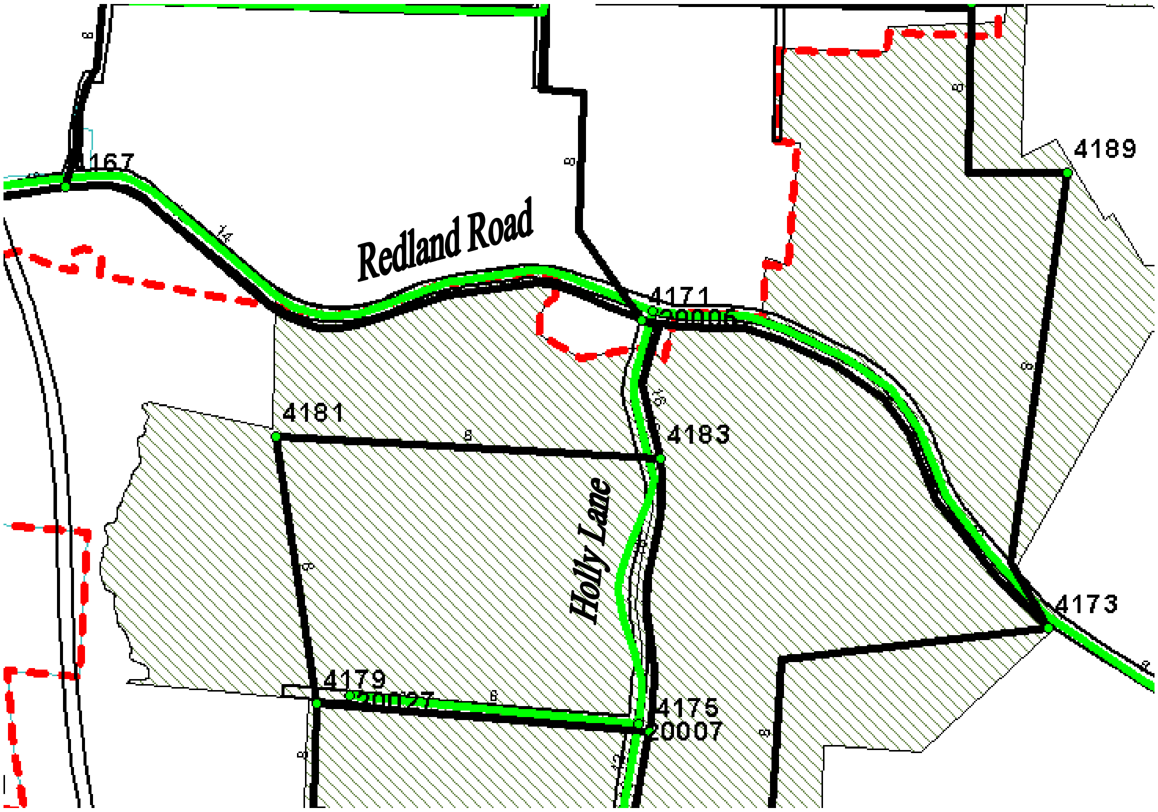
**Project Vicinity:** Thayer Road and Loder Road

**Project Description:** This project involves extension of the existing system into land to the east of Beavercreek Road, much of which is included within the proposed UGB expansion. Many existing pipes in the area are owned by CRW.

**Project Data Table**

| Node | | Pipe Size, inches | Pipe Length, feet | Const. Cost/ft, $ | Total Const. Cost, $ | Total Capital Cost, $ |
|---|---|---|---|---|---|---|
| From | To | | | | | |
| 3037 | 3895 | 12* | 720 | 23 | 16,560 | 24,000 |
| 3895 | 3896 | 12* | 2,620 | 23 | 60,260 | 87,000 |
| 3896 | 3901 | 12* | 2,700 | 23 | 62,100 | 90,000 |
| 3900 | 3901 | 12* | 1,070 | 23 | 24,610 | 36,000 |
| 3901 | 3902 | 12* | 890 | 23 | 20,470 | 30,000 |
| 3902 | 3898 | 12* | 1,030 | 23 | 23,690 | 34,000 |
| 3898 | 3899 | 12* | 2,620 | 23 | 60,260 | 87,000 |
| 3899 | 3637 | 12* | 700 | 23 | 16,100 | 23,000 |
| Total | | | 12,350 | | 284,050 | 412,000 |

*Unit costs account for developer participation in project financing where applicable.




**Existing Pipeline** **Future Pipeline**

**Pipeline Project Number:** P-202

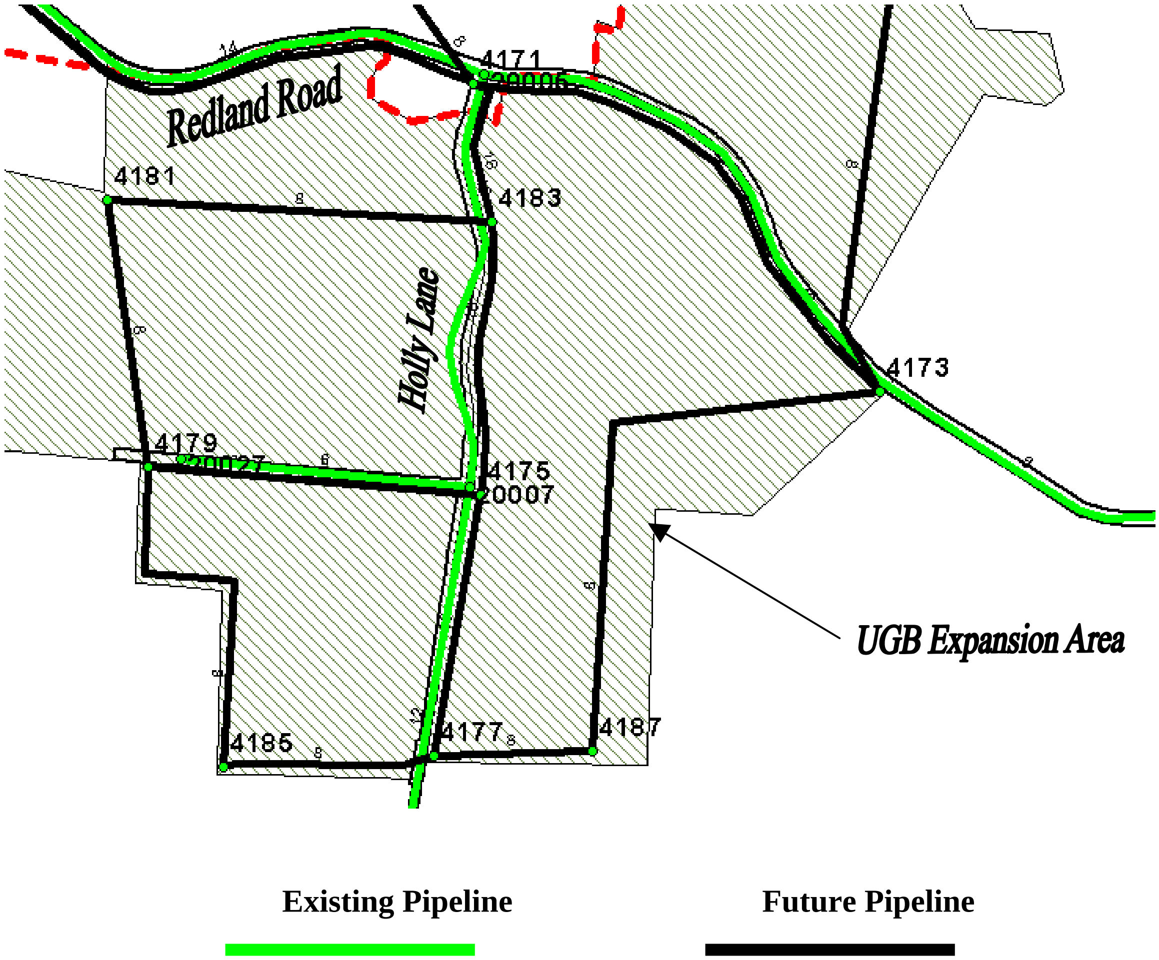
**Project Vicinity:** Redland Road Extension

**Project Description:** This project involves extension of the existing system to serve land to the north and south of Redland Road, much of which is included within the proposed UGB expansion. Since CRW already has transmission pipelines along Redland Road, this project should be coordinated with their operational planning and may include relocation of their master metering station.

**Project Data Table**

| Node | | Pipe Size, inches | Pipe Length, feet | Const. Cost/ft, $ | Total Const. Cost, $ | Total Capital Cost, $ |
|---|---|---|---|---|---|---|
| From | To | | | | | |
| 4167 | 4171 | 16* | 2,820 | 41 | 115,620 | 168,000 |
| 4171 | 4173 | 16* | 2,420 | 41 | 99,220 | 144,000 |
| Total | | | 5,240 | | 214,840 | 312,000 |

*Unit costs account for developer participation in project financing where applicable.



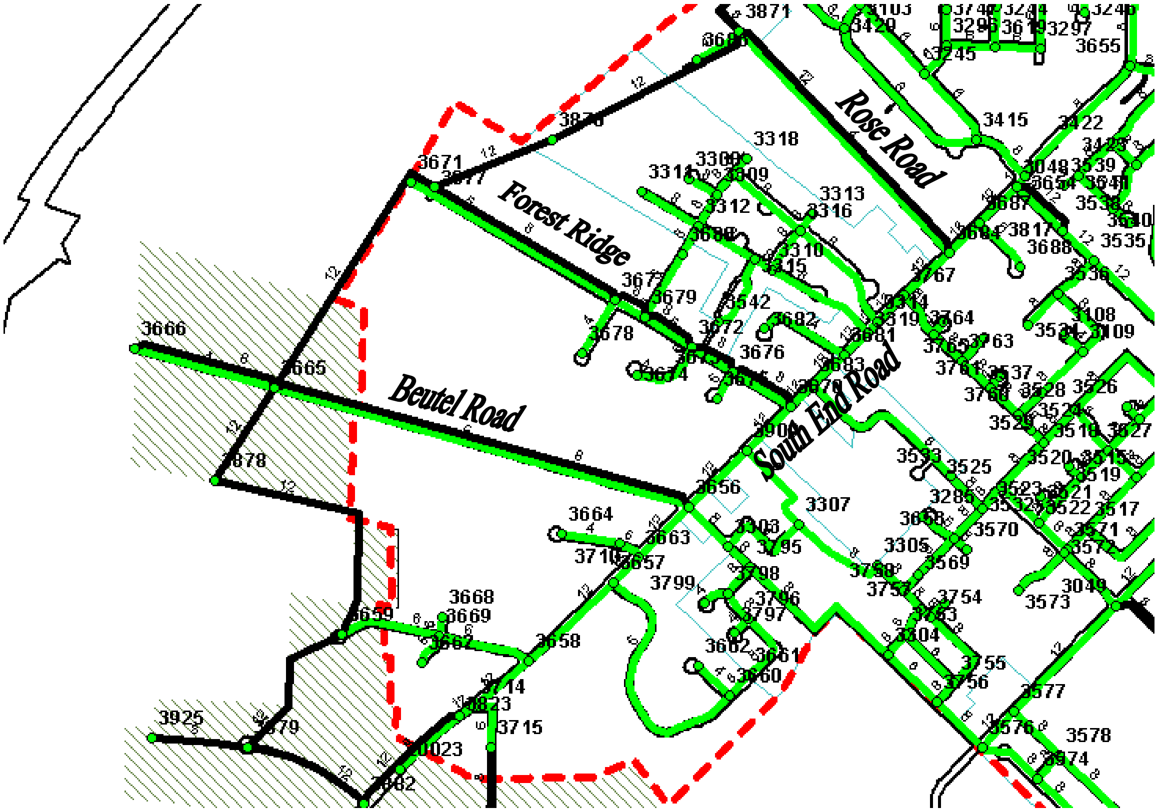

**Pipeline Project Number:** P-203

**Project Vicinity:** Holly Lane Extension

**Project Description:** This project involves extension of the existing system to serve land to the east and west of Holly Lane, which is included within the proposed UGB expansion. Existing pipes in this area are owned by CRW.

**Project Data Table**

| Node | | Pipe Size, inches | Pipe Length, feet | Const. Cost/ft, $ | Total Const. Cost, $ | Total Capital Cost, $ |
|---|---|---|---|---|---|---|
| From | To | | | | | |
| 4171 | 4183 | 16* | 690 | 41 | 28,290 | 41,000 |
| 4183 | 4175 | 16* | 1,220 | 41 | 50,020 | 73,000 |
| 4175 | 4177 | 16* | 1,180 | 41 | 48,380 | 70,000 |
| Total | | | 3,090 | | 126,690 | 184,000 |




**Existing Pipeline** **Future Pipeline**

**Pipeline Project Number:** P-204

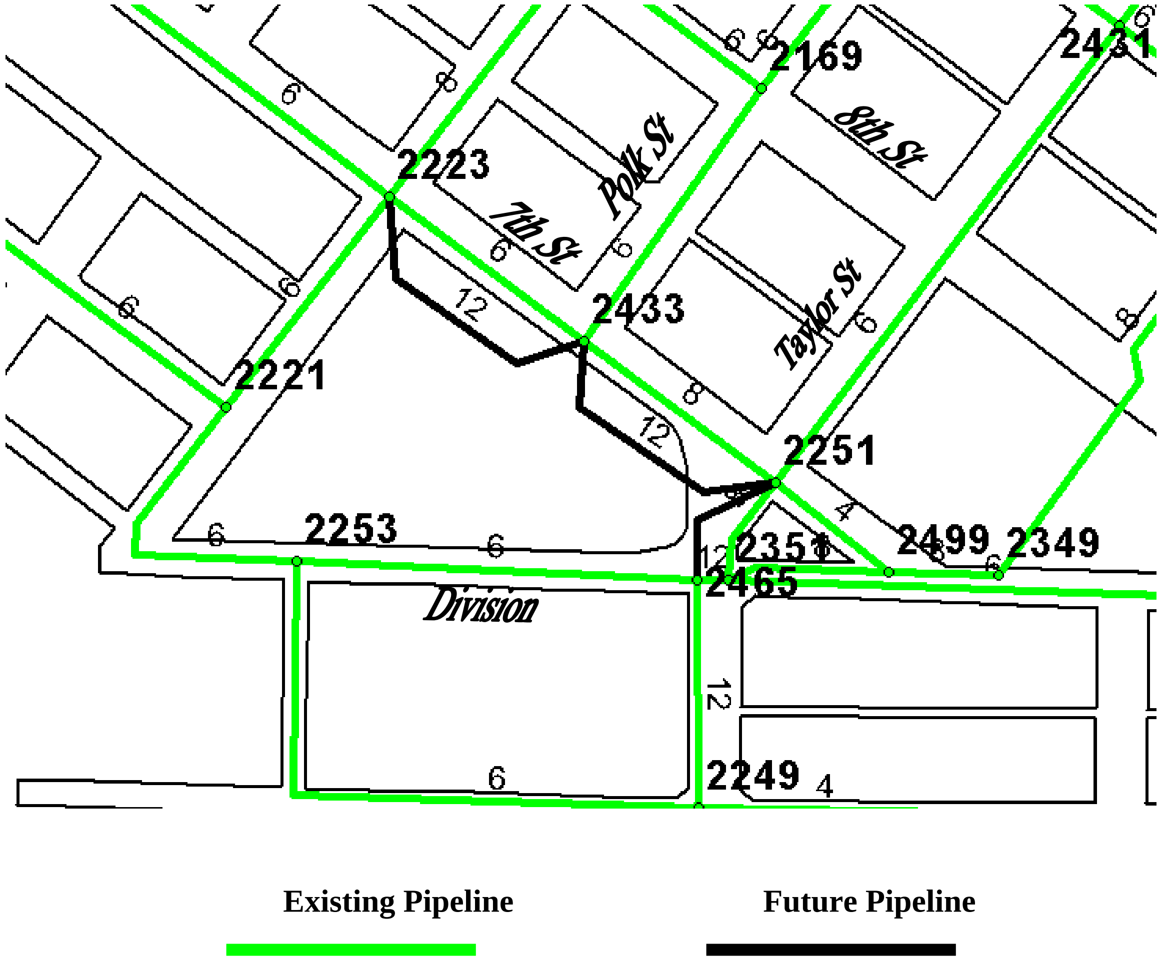
**Project Vicinity:** South End Road Loop Extension

**Project Description:** This project involves extension of the existing system to serve land to the west of South End Road. Part of this area is currently served by CRW and another part is included in the new UGB expansion area.

**Project Data Table**

| Node | | Pipe Size, inches | Pipe Length, feet | Const. Cost/ft, $ | Total Const. Cost, $ | Total Capital Cost, $ |
|---|---|---|---|---|---|---|
| From | To | | | | | |
| 3684 | 3871 | 12* | 2,590 | 23 | 59,570 | 86,000 |
| 3871 | 3876 | 12* | 1,610 | 23 | 37,030 | 54,000 |
| 3874 | 3877 | 12* | 920 | 23 | 21,160 | 31,000 |
| 3877 | 3665 | 12* | 2,050 | 23 | 47,150 | 68,000 |
| 3665 | 3878 | 12* | 800 | 23 | 18,400 | 27,000 |
| 3878 | 3659 | 12* | 1,970 | 23 | 45,310 | 66,000 |
| 3659 | 3879 | 12* | 1,180 | 23 | 27,140 | 39,000 |
| 3879 | 3882 | 12* | 960 | 23 | 22,080 | 32,000 |
| 3882 | 3823 | 12* | 980 | 23 | 22,540 | 33,000 |
| Total | | | 13,060 | | 300,380 | 436,000 |

*Unit costs account for developer participation in project financing where applicable.



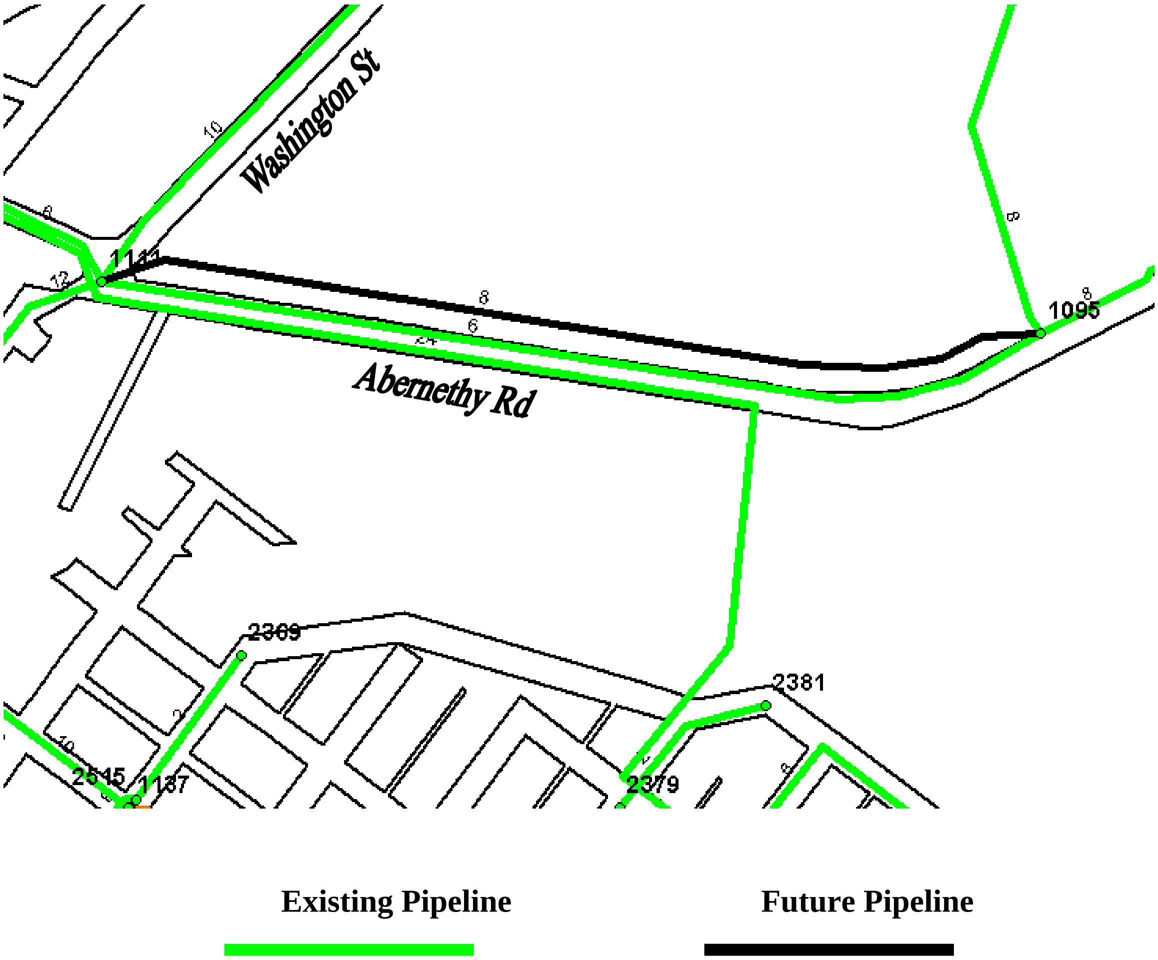

**Pipeline Project Number:** P-205

**Project Vicinity:** 7th and Polk

**Project Description:** This project involves upsizing pipelines to improve fire flow availability in the vicinity of 7th and Polk. This is a lower priority fire flow project since availability is greater than 3,500 gpm but below the 4,500 gpm recommended by the Insurance Services Office.

**Project Data Table**

| Node | | Pipe Size, inches | Pipe Length, feet | Const. Cost/ft, $ | Total Const. Cost, $ | Total Capital Cost, $ |
|---|---|---|---|---|---|---|
| From | To | | | | | |
| 2351 | 2251 | 12 | 170 | 97 | 16,490 | 24,000 |
| 2251 | 2433 | 12 | 280 | 97 | 27,160 | 39,000 |
| 2433 | 2223 | 12 | 290 | 97 | 28,130 | 41,000 |
| Total | | | 740 | | 71,780 | 104,000 |



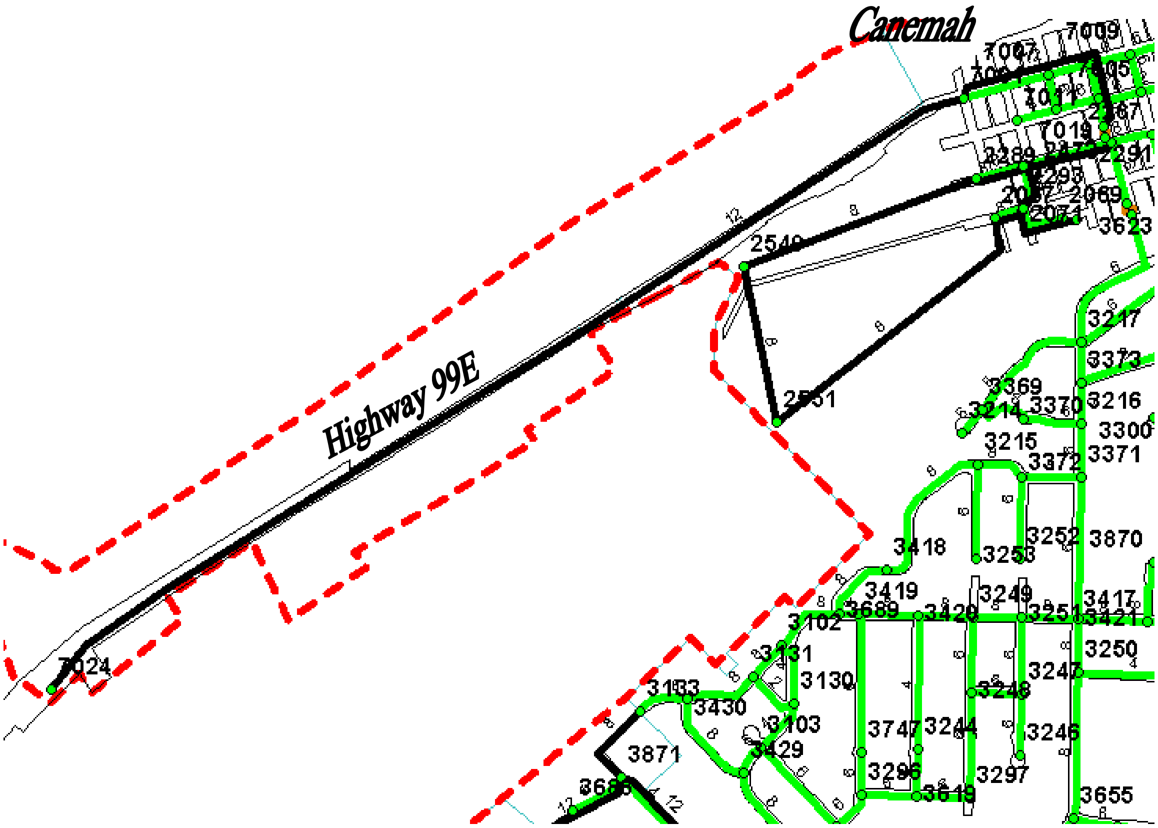

**Pipeline Project Number:** P-206

**Project Vicinity:** Abernethy Road

**Project Description:** This project involves upsizing a 6-inch pipeline to improve fire flow availability in the vicinity of the County Shops on Abernethy Road. This is a lower priority fire flow project since availability is nearly 4,800 gpm but below the 5,000 gpm recommended by the Insurance Services Office.

**Project Data Table**

| Node | | Pipe Size, inches | Pipe Length, feet | Const. Cost/ft, $ | Total Const. Cost, $ | Total Capital Cost, $ |
|---|---|---|---|---|---|---|
| From | To | | | | | |
| 1095 | 1111 | 8 | 2,020 | 74 | 149,480 | 217,000 |
| Total | | | 2,020 | | 149,480 | 217,000 |




**Existing Pipeline** **Future Pipeline**

**Pipeline Project Number:** P-301

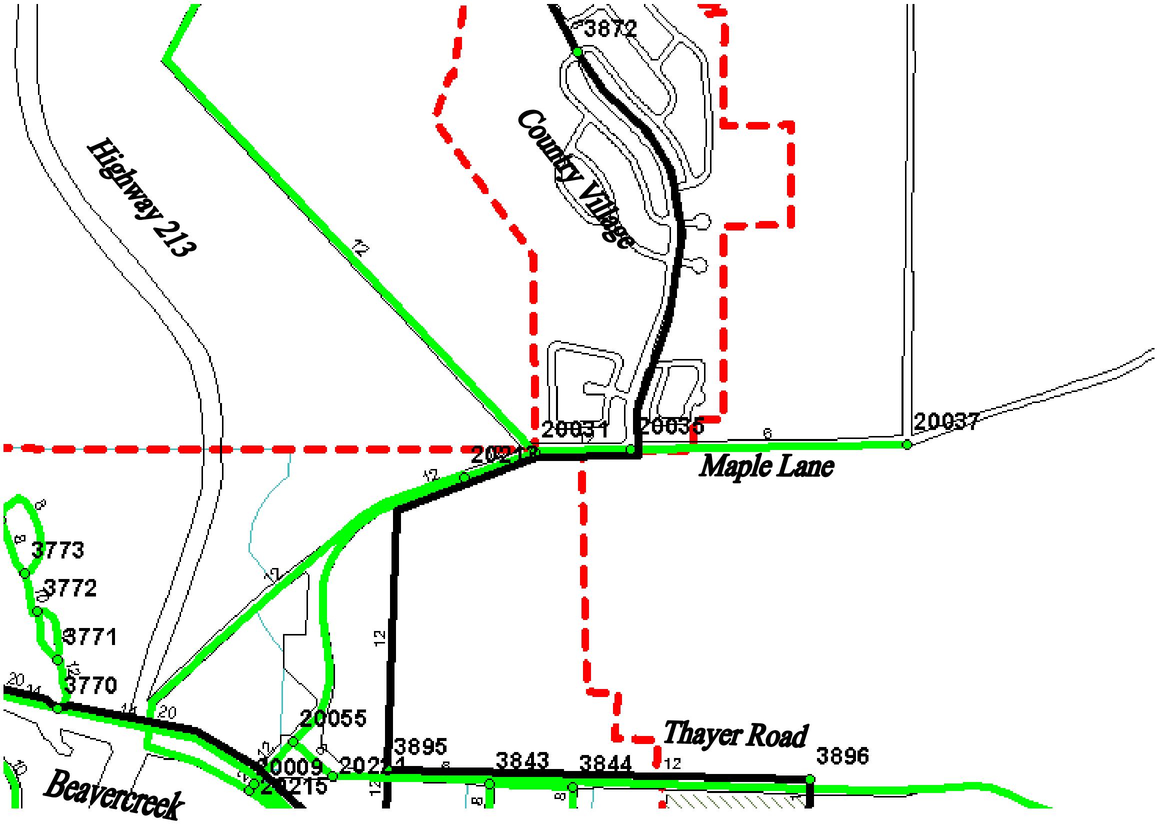
**Project Vicinity:** Canemah – Highway 99E

**Project Description:** This project involves extension of the existing system along Highway 99E from the Canemah area.

**Project Data Table**

| Node | | Pipe Size, inches | Pipe Length, feet | Const. Cost/ft, $ | Total Const. Cost, $ | Total Capital Cost, $ |
|---|---|---|---|---|---|---|
| From | To | | | | | |
| 7019 | 7001 | 12* | 1,400 | 23 | 32,200 | 47,000 |
| 7001 | 7024 | 12* | 6,870 | 23 | 158,010 | 229,000 |
| Total | | | 8,270 | | 190,210 | 276,000 |

*Unit costs account for developer participation in project financing where applicable.




**Existing Pipeline** **Future Pipeline**

**Pipeline Project Number:** P-302

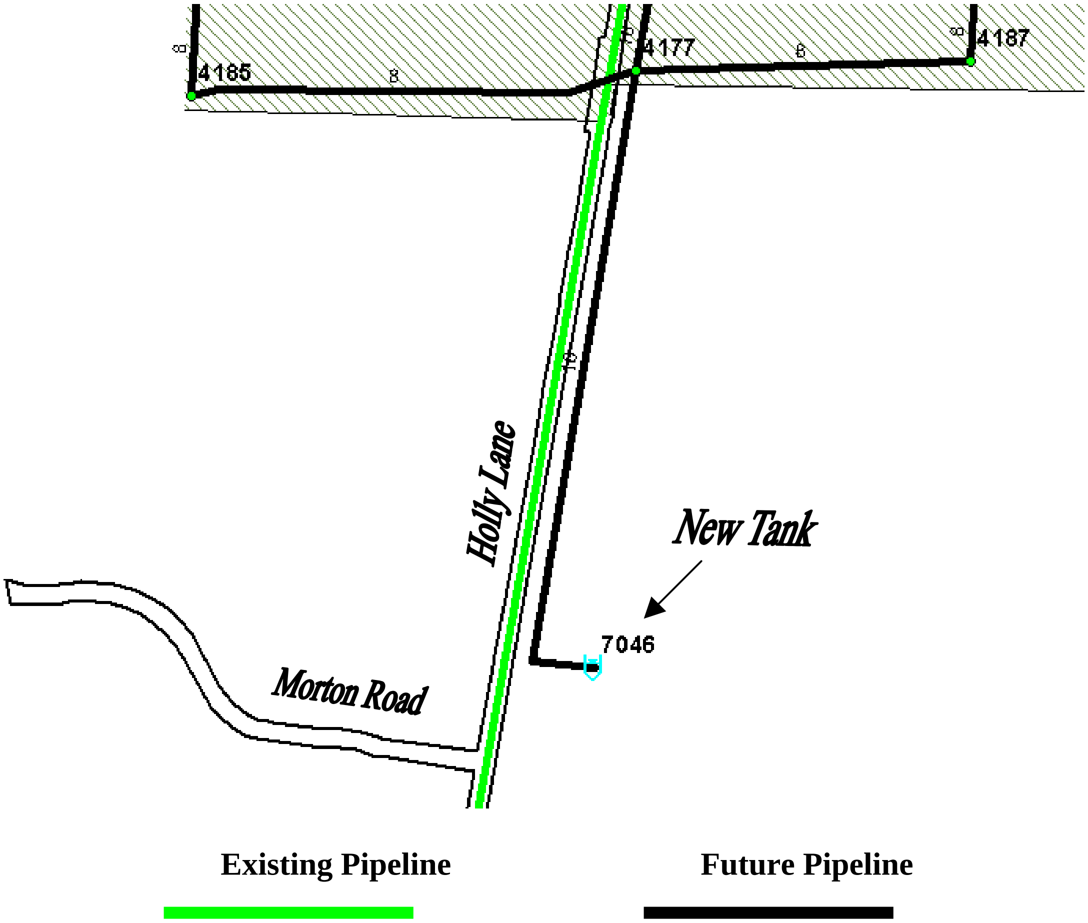
**Project Vicinity:** Country Village

**Project Description:** This project involves extension of the existing system along Maple Lane to serve the Country Village development. Most of the existing pipes in this area are owned by CRW. There may be potential for joint usage in this area as the Oregon City system expands, although many of the CRW lines are steel or cast iron and will likely require replacement.

**Project Data Table**

| Node | | Pipe Size, inches | Pipe Length, feet | Const. Cost/ft, $ | Total Const. Cost, $ | Total Capital Cost, $ |
|---|---|---|---|---|---|---|
| From | To | | | | | |
| 3895 | 3872 | 12* | 5,930 | 23 | 136,390 | 198,000 |
| | | PRV Station | | | 30,000 | 44,000 |
| Total | | | 5,930 | | 166,390 | 242,000 |

*Unit costs account for developer participation in project financing.



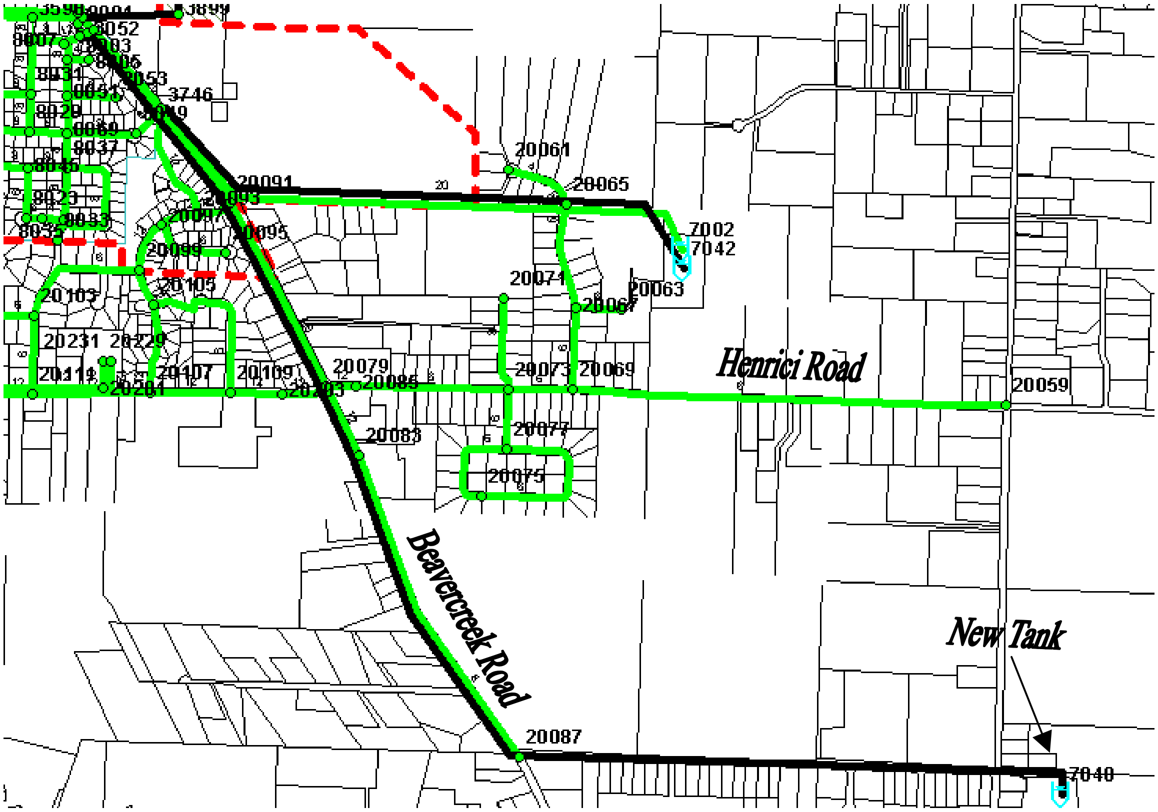

**Pipeline Project Number:** P-303

**Project Vicinity:** New Lower Park Place Zone Reservoir Extension

**Project Description:** This project involves extension of a new supply pipeline for the proposed new reservoir that will serve the Lower Park Place Pressure Zone along Holly Lane. Existing pipes in this area are owned by CRW.

**Project Data Table**

| Node | | Pipe Size, inches | Pipe Length, feet | Const. Cost/ft, $ | Total Const. Cost, $ | Total Capital Cost, $ |
|---|---|---|---|---|---|---|
| From | To | | | | | |
| 4177 | Tank | 16 | 1,390 | 115 | 159,850 | 232,000 |
| Total | | | 1,390 | | 159,850 | 232,000 |




**Existing Pipeline** **Future Pipeline**

**Pipeline Project Number:** P-304

**Project Vicinity:** New Fairway Downs Zone Reservoir Extension

**Project Description:** This project involves extension of a new supply pipeline for the proposed new reservoir that will serve the Fairway Downs Zone. Many of the existing pipes in this area are owned by CRW.

**Project Data Table**

| Node | | Pipe Size, inches | Pipe Length, feet | Const. Cost/ft, $ | Total Const. Cost, $ | Total Capital Cost, $ |
|---|---|---|---|---|---|---|
| From | To | | | | | |
| 8001 | Tank | 16 | 10,460 | 115 | 1,202,900 | 1,744,000 |
| Total | | | 10,460 | | 1,202,900 | 1,744,000 |

# Appendix F

Table F-1. Funding Source Cost Allocation and Project Scheduling

| | Capital Cost, $1,000 | SDC Portion, % | SDC Funds | Rate Funds | Phase 1: 2004 to 2008 | | | | | | | | | | Phase 2: 2008 - 2014 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2003-2004 | | 2004-2005 | | 2005-2006 | | 2006-2007 | | 2007-2008 | | 2008-2009 | | 2009-2010 | | 2010-2011 | | 2011-2012 | | 2012-2013 | | 2013-2014 | |
| | | | | | SDC Funds | Rate Funds | SDC Funds | Rate Funds | SDC Funds | Rate Funds | SDC Funds | Rate Funds | SDC Funds | Rate Funds | SDC Funds | Rate Funds | SDC Funds | Rate Funds | SDC Funds | Rate Funds | SDC Funds | Rate Funds | SDC Funds | Rate Funds | SDC Funds | Rate Funds |
| **Phase 1: Years 2004 to 2008** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ***Reservoirs*** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Redundant reservoir for Intermediate Zone | 2,180 | 100 | 2,180 | 0 | | 210 | 1420 | | 550 | | | | | | | | | | | | | | | | | |
| Roof replacement for Mountainview Reservoir | 490 | 40 | 196 | 294 | | 105 | 196 | 189 | | | | | | | | | | | | | | | | | | |
| Structural repair for Mountainview Reservoir | 90 | 40 | 36 | 54 | | | 36 | 54 | | | | | | | | | | | | | | | | | | |
| Piping improvements for Mountainview Reservoir | 230 | 40 | 92 | 138 | | | 92 | | | 138 | | | | | | | | | | | | | | | | |
| Seismic improvements for Mountainview Reservoir | 1,015 | 40 | 406 | 609 | | | | | | | 406 | 609 | | | | | | | | | | | | | | |
| Demolition of elevated tank | 52 | 0 | 0 | 52 | | | | 52 | | | | | | | | | | | | | | | | | | |
| Interior lighting for Mountainview Reservoir | 20 | 40 | 8 | 12 | | | 8 | 12 | | | | | | | | | | | | | | | | | | |
| New reservoir for Upper Zone | 4,130 | 100 | 4,130 | 0 | | | | | | | | | 620 | | 3510 | | | | | | | | | | | |
| *Subtotal Reservoirs* | 8,207 | | 7,048 | 1,159 | | | | | | | | | | | | | | | | | | | | | | |
| ***Pump Stations*** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Diesel Generator at Mountainview Pump Station | 450 | 50 | 225 | 225 | | | | | | | 225 | 225 | | | | | | | | | | | | | | |
| Decommission Livesay Road Pump Station | 22 | 0 | 0 | 22 | | | | | | | | | | 22 | | | | | | | | | | | | |
| Seismic upgrade at Mountainview Pump Station | 30 | 0 | 0 | 30 | | | | | | | | 30 | | | | | | | | | | | | | | |
| Fairway Downs Pump Sta. Modifications | 22 | 33 | 7 | 15 | | | | | | | 7 | 15 | | | | | | | | | | | | | | |
| Misc. seismic improvements | 10 | 0 | 0 | 10 | | | | | | | | 10 | | | | | | | | | | | | | | |
| *Subtotal Pump Stations* | 534 | | 232 | 302 | | | | | | | | | | | | | | | | | | | | | | |
| ***Pipelines*** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Leak detection | 20 | 0 | 0 | 20 | | | | 20 | | | | | | | | | | | | | | | | | | |
| Leak repair | 150 | 0 | 0 | 150 | | | | 150 | | | | | | | | | | | | | | | | | | |
| P-101 Highway 99 near 205 | 375 | 0 | 0 | 375 | | 317 | | 58 | | | | | | | | | | | | | | | | | | |
| P-102 Blanchard – Canemah | 182 | 0 | 0 | 182 | | | | | | 182 | | | | | | | | | | | | | | | | |
| P-103 Center Street and Sunset | 292 | 0 | 0 | 292 | | | | | | 292 | | | | | | | | | | | | | | | | |
| P-104 Third and East | 159 | 0 | 0 | 159 | | | | | | 159 | | | | | | | | | | | | | | | | |
| P-105 Oak Tree Terrace to Livesay Road | 314 | 100 | 314 | 0 | | | | | | | | | 314 | | | | | | | | | | | | | |
| P-106 King Road | 229 | 0 | 0 | 229 | | | | | | | | | | 229 | | | | | | | | | | | | |
| P-107 Modify 16th and Division PRV Sta. | 29 | 0 | 0 | 29 | | 29 | | | | | | | | | | | | | | | | | | | | |
| P-108 Linn to 4th Street | 197 | 0 | 0 | 197 | | | | | | | | | | 197 | | | | | | | | | | | | |
| P-109 Remaining Mountain Line | 1,051 | 50 | 526 | 526 | | | | | | | | | | 200 | 526 | 325 | | | | | | | | | | |
| P-110 Swan Avenue | 384 | 0 | 0 | 384 | | 384 | | | | | | | | | | | | | | | | | | | | |
| P-111 Hunter Avenue | 128 | 0 | 0 | 128 | | | | | | 128 | | | | | | | | | | | | | | | | |
| P-112 View Manor | 457 | 0 | 0 | 457 | | | | 457 | | | | | | | | | | | | | | | | | | |
| P-113 Partlow Road | 16 | 50 | 8 | 8 | | | | | | | 8 | 8 | | | | | | | | | | | | | | |
| P-114 Meyers Road | 197 | 50 | 99 | 99 | | | | 99 | 98 | | | | | | | | | | | | | | | | | |
| P-115 Livesay Road | 75 | 100 | 75 | 0 | | | | | | | | | | | 75 | | | | | | | | | | | |
| P-116 Leland Road from Caddis to McCord | 47 | 100 | 47 | 0 | | | | | | | 47 | | | | | | | | | | | | | | | |
| P-117 McCord from Pease to Leland | 113 | 100 | 113 | 0 | | | | | | | 113 | | | | | | | | | | | | | | | |
| P-118 New Upper Zone Reservoir Extension | 1,035 | 100 | 1,035 | 0 | | | | | | | | | 430 | | 605 | | | | | | | | | | | |
| *Subtotal Pipelines* | 5,450 | | 2,216 | 3,234 | | | | | | | | | | | | | | | | | | | | | | |
| ***Other - Projects for 2003/04*** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Water Master Plan/Public Works Facilities Plan/Comp Plan | 125 | 64 | 80 | 45 | 80 | 45 | | | | | | | | | | | | | | | | | | | | |
| SCADA System | 550 | 45.45 | 250 | 300 | 250 | 300 | | | | | | | | | | | | | | | | | | | | |
| Pipeline Replacements | 800 | 37.5 | 300 | 500 | 300 | 500 | | | | | | | | | | | | | | | | | | | | |
| Beavercreek Rd - Fir to Marjorie | 325 | 46.1 | 150 | 175 | 150 | 175 | | | | | | | | | | | | | | | | | | | | |
| Glen Oak - Highway 213 to Heider Dr | 270 | 46.3 | 125 | 145 | 125 | 145 | | | | | | | | | | | | | | | | | | | | |
| SDC Update | 20 | 100 | 20 | 0 | 20 | | | | | | | | | | | | | | | | | | | | | |
| Phase 2 Molalla Ave Water Line | 91 | 100 | 91 | 0 | 91 | | | | | | | | | | | | | | | | | | | | | |
| *Subtotal Other* | 2,181 | | 1,016 | 1,165 | | | | | | | | | | | | | | | | | | | | | | |
| ***Total Phase 1*** | 16,372 | | 10,512 | 5,860 | | | | | | | | | | | | | | | | | | | | | | |
| **Phase 2: Years 2008 to 2014** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ***Reservoirs*** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Piping improvements for Boynton Reservoir | 210 | 0 | 0 | 210 | | | | | | | | | | | | | | | | 210 | | | | | | |
| Seismic improvements for Boynton Reservoir | 73 | 0 | 0 | 73 | | | | | | | | | | | | | | | | 73 | | | | | | |
| *Subtotal Reservoirs* | 283 | | 0 | 283 | | | | | | | | | | | | | | | | | | | | | | |
| ***Pump Stations*** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mountainview Pump Station Expansion | 2,750 | 50 | 1,375 | 1,375 | | | | | | | | | | | | | 1375 | 1375 | | | | | | | | |
| Diesel generator at Boynton Reservoir | 90 | 0 | 0 | 90 | | | | | | | | | | | | | | | | 90 | | | | | | |
| Telemetry System Improvements | 100 | 0 | 0 | 100 | | | | | | | | | | | | | | | | | | 100 | | | | |
| *Subtotal Pump Stations* | 2,940 | | 1,375 | 1,565 | | | | | | | | | | | | | | | | | | | | | | |
| ***Pipelines*** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| P-201 Thayer Road and Loder Road Extension | 412 | 100 | 412 | 0 | | | | | | | | | | | | | | | 412 | | | | | | | |
| P-202 Redland Road Extension | 312 | 100 | 312 | 0 | | | | | | | | | | | | | | | 312 | | | | | | | |
| P-203 Holly Lane Extension | 184 | 100 | 184 | 0 | | | | | | | | | | | | | | | | | 184 | | | | | |
| P-204 South End Road Loop Extension | 436 | 100 | 436 | 0 | | | | | | | | | | | | | | | | | 436 | | | | | |
| P-205 7th and Polk | 104 | 0 | 0 | 104 | | | | | | | | | | | | | | | | | | | | 104 | | |
| P-206 Abernethy Road | 217 | 0 | 0 | 217 | | | | | | | | | | | | | | | | | | | | | | 217 |
| Pipeline Replacement/Hydrant Improvements | 5,000 | 0 | 0 | 5,000 | | | | | | | | | | | | | | 1000 | | 1000 | | 1000 | | 1000 | | 1000 |
| *Subtotal Pipelines* | 6,665 | | 1,344 | 5,321 | | | | | | | | | | | | | | | | | | | | | | |
| ***Other*** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Water Master Plan | 200 | 60 | 120 | 80 | | | | | | | | | | | | | | | 120 | 80 | | | | | | |
| ***Total Phase 2*** | 10,088 | | 2,839 | 7,249 | | | | | | | | | | | | | | | | | | | | | | |
| **Phase 3: Years 2014 to 2024** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ***Reservoirs*** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| New reservoir for Fairway Downs Zone | 1,060 | 100 | 1,060 | 0 | | | | | | | | | | | | | | | | | | | | | | |
| New reservoir for Holly Lane | 1,800 | 100 | 1,800 | 0 | | | | | | | | | | | | | | | | | | | | | | |
| *Subtotal Reservoirs* | 2,860 | | 2,860 | 0 | | | | | | | | | | | | | | | | | | | | | | |
| ***Pipelines*** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| P-301 Canemah – Highway 99 Extension | 276 | 100 | 276 | 0 | | | | | | | | | | | | | | | | | | | | | | |
| P-302 Country Village Extension | 241 | 100 | 241 | 0 | | | | | | | | | | | | | | | | | | | | | | |
| P-303 New Lower Park Place Reservoir Supply | 232 | 100 | 232 | 0 | | | | | | | | | | | | | | | | | | | | | | |
| P-304 New Fairway Downs Reservoir Supply | 1,744 | 100 | 1,744 | 0 | | | | | | | | | | | | | | | | | | | | | | |
| Pipeline Replacement | 12,000 | 0 | 0 | 12,000 | | | | | | | | | | | | | | | | | | | | | | |
| *Subtotal Pipelines* | 14,493 | | 2,493 | 12,000 | | | | | | | | | | | | | | | | | | | | | | |
| ***Other*** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Water Master Plan | 200 | 60 | 120 | 80 | | | | | | | | | | | | | | | | | | | | | | |
| ***Total Phase 3*** | 17,553 | | 5,473 | 12,080 | | | | | | | | | | | | | | | | | | | | | | |
| **TOTAL CAPITAL COSTS** | 44,013 | | 18,824 | 25,189 | 1,016 | 2,210 | 1,752 | 1,091 | 648 | 899 | 806 | 897 | 1,364 | 648 | 4,716 | 325 | 1,375 | 2,375 | 844 | 1,453 | 620 | 1,100 | 0 | 1,104 | 0 | 1,217 |
| **TOTAL CAPITAL COSTS INCLUDING INFLATION** | | | | | 1,016 | 2,210 | 1,796 | 1,118 | 681 | 945 | 868 | 966 | 1,506 | 715 | 5,336 | 368 | 1,595 | 2,754 | 1,003 | 1,727 | 755 | 1,340 | 0 | 1,379 | 0 | 1,558 |

Table F-1. Funding Source Cost Allocation and Project Scheduling

| | Phase 3: 2014 - 2024 | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2014-2015 | | 2015-2016 | | 2016-2017 | | 2017-2018 | | 2018-2019 | | 2019-2020 | | 2020-2021 | | 2021-2022 | | 2022-2023 | | 2023-2024 | |
| | SDC Funds | Rate Funds | SDC Funds | Rate Funds | SDC Funds | Rate Funds | SDC Funds | Rate Funds | SDC Funds | Rate Funds | SDC Funds | Rate Funds | SDC Funds | Rate Funds | SDC Funds | Rate Funds | SDC Funds | Rate Funds | SDC Funds | Rate Funds |
| **Phase 1: Years 2004 to 2008** | | | | | | | | | | | | | | | | | | | | |
| ***Reservoirs*** | | | | | | | | | | | | | | | | | | | | |
| Redundant reservoir for Intermediate Zone | | | | | | | | | | | | | | | | | | | | |
| Roof replacement for Mountainview Reservoir | | | | | | | | | | | | | | | | | | | | |
| Structural repair for Mountainview Reservoir | | | | | | | | | | | | | | | | | | | | |
| Piping improvements for Mountainview Reservoir | | | | | | | | | | | | | | | | | | | | |
| Seismic improvements for Mountainview Reservoir | | | | | | | | | | | | | | | | | | | | |
| Demolition of elevated tank | | | | | | | | | | | | | | | | | | | | |
| Interior lighting for Mountainview Reservoir | | | | | | | | | | | | | | | | | | | | |
| New reservoir for Upper Zone | | | | | | | | | | | | | | | | | | | | |
| *Subtotal Reservoirs* | | | | | | | | | | | | | | | | | | | | |
| ***Pump Stations*** | | | | | | | | | | | | | | | | | | | | |
| Diesel Generator at Mountainview Pump Station | | | | | | | | | | | | | | | | | | | | |
| Decommission Livesay Road Pump Station | | | | | | | | | | | | | | | | | | | | |
| Seismic upgrade at Mountainview Pump Station | | | | | | | | | | | | | | | | | | | | |
| Fairway Downs Pump Sta. Modifications | | | | | | | | | | | | | | | | | | | | |
| Misc. seismic improvements | | | | | | | | | | | | | | | | | | | | |
| *Subtotal Pump Stations* | | | | | | | | | | | | | | | | | | | | |
| ***Pipelines*** | | | | | | | | | | | | | | | | | | | | |
| Leak detection | | | | | | | | | | | | | | | | | | | | |
| Leak repair | | | | | | | | | | | | | | | | | | | | |
| P-101 Highway 99 near 205 | | | | | | | | | | | | | | | | | | | | |
| P-102 Blanchard – Canemah | | | | | | | | | | | | | | | | | | | | |
| P-103 Center Street and Sunset | | | | | | | | | | | | | | | | | | | | |
| P-104 Third and East | | | | | | | | | | | | | | | | | | | | |
| P-105 Oak Tree Terrace to Livesay Road | | | | | | | | | | | | | | | | | | | | |
| P-106 King Road | | | | | | | | | | | | | | | | | | | | |
| P-107 Modify 16th and Division PRV Sta. | | | | | | | | | | | | | | | | | | | | |
| P-108 Linn to 4th Street | | | | | | | | | | | | | | | | | | | | |
| P-109 Remaining Mountain Line | | | | | | | | | | | | | | | | | | | | |
| P-110 Swan Avenue | | | | | | | | | | | | | | | | | | | | |
| P-111 Hunter Avenue | | | | | | | | | | | | | | | | | | | | |
| P-112 View Manor | | | | | | | | | | | | | | | | | | | | |
| P-113 Partlow Road | | | | | | | | | | | | | | | | | | | | |
| P-114 Meyers Road | | | | | | | | | | | | | | | | | | | | |
| P-115 Livesay Road | | | | | | | | | | | | | | | | | | | | |
| P-116 Leland Road from Caddis to McCord | | | | | | | | | | | | | | | | | | | | |
| P-117 McCord from Pease to Leland | | | | | | | | | | | | | | | | | | | | |
| P-118 New Upper Zone Reservoir Extension | | | | | | | | | | | | | | | | | | | | |
| *Subtotal Pipelines* | | | | | | | | | | | | | | | | | | | | |
| ***Other - Projects for 2003/04*** | | | | | | | | | | | | | | | | | | | | |
| Water Master Plan/Public Works Facilities Plan/Comp Plan | | | | | | | | | | | | | | | | | | | | |
| SCADA System | | | | | | | | | | | | | | | | | | | | |
| Pipeline Replacements | | | | | | | | | | | | | | | | | | | | |
| Beavercreek Rd - Fir to Marjorie | | | | | | | | | | | | | | | | | | | | |
| Glen Oak - Highway 213 to Helder Dr | | | | | | | | | | | | | | | | | | | | |
| SDC Update | | | | | | | | | | | | | | | | | | | | |
| Phase 2 Molalla Ave Water Line | | | | | | | | | | | | | | | | | | | | |
| *Subtotal Other* | | | | | | | | | | | | | | | | | | | | |
| ***Total Phase 1*** | | | | | | | | | | | | | | | | | | | | |
| **Phase 2: Years 2008 to 2014** | | | | | | | | | | | | | | | | | | | | |
| ***Reservoirs*** | | | | | | | | | | | | | | | | | | | | |
| Piping improvements for Boynton Reservoir | | | | | | | | | | | | | | | | | | | | |
| Seismic improvements for Boynton Reservoir | | | | | | | | | | | | | | | | | | | | |
| *Subtotal Reservoirs* | | | | | | | | | | | | | | | | | | | | |
| ***Pump Stations*** | | | | | | | | | | | | | | | | | | | | |
| Mountainview Pump Station Expansion | | | | | | | | | | | | | | | | | | | | |
| Diesel generator at Boynton Reservoir | | | | | | | | | | | | | | | | | | | | |
| Telemetry System Improvements | | | | | | | | | | | | | | | | | | | | |
| *Subtotal Pump Stations* | | | | | | | | | | | | | | | | | | | | |
| ***Pipelines*** | | | | | | | | | | | | | | | | | | | | |
| P-201 Thayer Road and Loder Road Extension | | | | | | | | | | | | | | | | | | | | |
| P-202 Redland Road Extension | | | | | | | | | | | | | | | | | | | | |
| P-203 Holly Lane Extension | | | | | | | | | | | | | | | | | | | | |
| P-204 South End Road Loop Extension | | | | | | | | | | | | | | | | | | | | |
| P-205 7th and Polk | | | | | | | | | | | | | | | | | | | | |
| P-206 Abernethy Road | | | | | | | | | | | | | | | | | | | | |
| Pipeline Replacement/Hydrant Improvements | | | | | | | | | | | | | | | | | | | | |
| *Subtotal Pipelines* | | | | | | | | | | | | | | | | | | | | |
| ***Other*** | | | | | | | | | | | | | | | | | | | | |
| Water Master Plan | | | | | | | | | | | | | | | | | | | | |
| ***Total Phase 2*** | | | | | | | | | | | | | | | | | | | | |
| **Phase 3: Years 2014 to 2024** | | | | | | | | | | | | | | | | | | | | |
| ***Reservoirs*** | | | | | | | | | | | | | | | | | | | | |
| New reservoir for Fairway Downs Zone | | | | | | | 1060 | | | | | | | | | | | | | |
| New reservoir for Holly Lane | 1800 | | | | | | | | | | | | | | | | | | | |
| *Subtotal Reservoirs* | | | | | | | | | | | | | | | | | | | | |
| ***Pipelines*** | | | | | | | | | | | | | | | | | | | | |
| P-301 Canemah – Highway 99 Extension | | | 276 | | | | | | | | | | | | | | | | | |
| P-302 Country Village Extension | | | | | 241 | | | | | | | | | | | | | | | |
| P-303 New Lower Park Place Reservoir Supply | 232 | | | | | | | | | | | | | | | | | | | |
| P-304 New Fairway Downs Reservoir Supply | | | | | | | 1744 | | | | | | | | | | | | | |
| Pipeline Replacement | | 1200 | | 1200 | | 1200 | | 1200 | | 1200 | | 1200 | | 1200 | | 1200 | | 1200 | | 1200 |
| *Subtotal Pipelines* | | | | | | | | | | | | | | | | | | | | |
| ***Other*** | | | | | | | | | | | | | | | | | | | | |
| Water Master Plan | | | | | | | 120 | 80 | | | | | | | | | | | | |
| ***Total Phase 3*** | | | | | | | | | | | | | | | | | | | | |
| **TOTAL CAPITAL COSTS** | 2,032 | 1,200 | 276 | 1,200 | 241 | 1,200 | 2,924 | 1,280 | 0 | 1,200 | 0 | 1,200 | 0 | 1,200 | 0 | 1,200 | 0 | 1,200 | 0 | 1,200 |
| | 2,666 | 1,575 | 371 | 1,614 | 332 | 1,654 | 4,132 | 1,809 | 0 | 1,738 | 0 | 1,781 | 0 | 1,826 | 0 | 1,872 | 0 | 1,918 | 0 | 1,966 |

## Table F-2. SDC Fund Financial Projections

| | | |
|---|---|---|
| Assumed SDC Revenue Growth with ERUs | 0.02 | |
| Annual SDC Charge Escalation | 0.025 | |
| Assumed Inflation Rate (expenses and misc. income) | 0.025 | |
| SDC Update Factor | 1.8 | per SDC update study |

| | 2004-2005 | 2005-2006 | 2006-2007 | 2007-2008 | 2008-2009 | 2009-2010 | 2010-2011 | 2011-2012 | 2012-2013 | 2013-2014 |
|---|---|---|---|---|---|---|---|---|---|---|
| Revenues | | | | | | | | | | |
| System Development Charges | 812,284 | 849,243 | 887,884 | 928,282 | 970,519 | 1,014,678 | 1,060,846 | 1,109,114 | 1,159,579 | 1,212,340 |
| Misc. Income | 45,000 | 46,125 | 47,278 | 48,460 | 49,672 | 50,913 | 52,186 | 53,491 | 54,828 | 56,199 |
| Total Revenue | 857,284 | 895,368 | 935,162 | 976,742 | 1,020,191 | 1,065,591 | 1,113,032 | 1,162,605 | 1,214,407 | 1,268,539 |
| Expenses | | | | | | | | | | |
| Non-CIP Materials and Services | 77,600 | 79,540 | 81,529 | 83,567 | 85,656 | 87,797 | 89,992 | 92,242 | 94,548 | 96,912 |
| Net Revenues | 779,684 | 815,828 | 853,633 | 893,176 | 934,535 | 977,794 | 1,023,040 | 1,070,363 | 1,119,859 | 1,171,627 |
| Beginning SDC Fund Balance | 1,058,571 | 500,000 | 635,023 | 620,683 | 500,000 | 500,000 | 500,000 | 519,789 | 834,742 | 1,954,601 |
| Contingency | 500,000 | 500,000 | 500,000 | 500,000 | 500,000 | 500,000 | 500,000 | 500,000 | 500,000 | 500,000 |
| Funds Available for CIP Capital Outlays | 1,338,255 | 815,828 | 988,656 | 1,013,858 | 934,535 | 977,794 | 1,023,040 | 1,090,152 | 1,454,601 | 2,626,228 |
| Planned Capital Outlays | 1,795,800 | 680,805 | 867,974 | 1,505,601 | 5,335,721 | 1,594,578 | 1,003,251 | 755,410 | 0 | 0 |
| Remaining Available SDC Fund Balance | 0 | 135,023 | 120,683 | 0 | 0 | 0 | 19,789 | 334,742 | 1,454,601 | 2,626,228 |
| Capital Outlay Funds Required from Rates | 457,545 | 0 | 0 | 491,742 | 4,401,186 | 616,784 | 0 | 0 | 0 | 0 |
| Ending SDC Fund Balance | 500,000 | 635,023 | 620,683 | 500,000 | 500,000 | 500,000 | 519,789 | 834,742 | 1,954,601 | 3,126,228 |

| | 2014-2015 | 2015-2016 | 2016-2017 | 2017-2018 | 2018-2019 | 2019-2020 | 2020-2021 | 2021-2022 | 2022-2023 | 2023-2024 |
|---|---|---|---|---|---|---|---|---|---|---|
| Revenues | | | | | | | | | | |
| System Development Charges | 1,267,501 | 1,325,172 | 1,385,468 | 1,448,507 | 1,514,414 | 1,583,320 | 1,655,361 | 1,730,679 | 1,809,425 | 1,891,754 |
| Misc. Income | 57,604 | 59,044 | 60,520 | 62,033 | 63,584 | 65,173 | 66,803 | 68,473 | 70,185 | 71,939 |
| Total Revenue | 1,325,105 | 1,384,216 | 1,445,988 | 1,510,540 | 1,577,998 | 1,648,493 | 1,722,163 | 1,799,152 | 1,879,610 | 1,963,693 |
| Expenses | | | | | | | | | | |
| Non-CIP Materials and Services | 99,335 | 101,818 | 104,363 | 106,972 | 109,647 | 112,388 | 115,198 | 118,078 | 121,030 | 124,055 |
| Net Revenues | 1,225,770 | 1,282,398 | 1,341,624 | 1,403,567 | 1,468,351 | 1,536,105 | 1,606,966 | 1,681,075 | 1,758,580 | 1,839,638 |
| Beginning SDC Fund Balance | 3,126,228 | 1,685,838 | 2,597,047 | 3,606,451 | 878,482 | 2,346,833 | 3,882,938 | 5,489,904 | 7,170,979 | 8,929,559 |
| Contingency | 500,000 | 500,000 | 500,000 | 500,000 | 500,000 | 500,000 | 500,000 | 500,000 | 500,000 | 500,000 |
| Funds Available for CIP Capital Outlays | 3,851,998 | 2,468,237 | 3,438,672 | 4,510,018 | 1,846,833 | 3,382,938 | 4,989,904 | 6,670,979 | 8,429,559 | 10,269,197 |
| Planned Capital Outlays | 2,666,160 | 371,189 | 332,221 | 4,131,535 | 0 | 0 | 0 | 0 | 0 | 0 |
| Remaining Available SDC Fund Balance | 1,185,838 | 2,097,047 | 3,106,451 | 378,482 | 1,846,833 | 3,382,938 | 4,989,904 | 6,670,979 | 8,429,559 | 10,269,197 |
| Capital Outlay Funds Required from Rates | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ending SDC Fund Balance | 1,685,838 | 2,597,047 | 3,606,451 | 878,482 | 2,346,833 | 3,882,938 | 5,489,904 | 7,170,979 | 8,929,559 | 10,769,197 |

| | Phase 1 | Phase 2 | Phase 3 |
|---|---|---|---|
| Total Revenues | 3,664,557 | 6,844,365 | 16,256,958 * |
| Total Expenses | 322,235 | 547,147 | 1,112,883 * |
| Net Revenues | 3,342,321 | 6,297,217 | 15,144,075 * |
| Planned CIP Outlays from SDCs | 4,850,180 | 8,688,960 | 7,501,106 * |
| Beginning SDC Fund Balance | 1,058,571 | 500,000 | 3,126,228 * |
| Ending Balance (maintain min balance for contingency and undesigr | 500,000 | 3,126,228 | 10,769,197 * |
| Shortfall | 949,287 | 5,017,971 | 0 * |

Table F-3. Water Fund Financial Projections

| | |
|---|---|
| ERU Rate of Increase | 0.02 |
| Misc. Revenues Rate of Increase | 0.02 |
| Personal Services Rate of Increase | 0.00 |
| Material and Services Rate of Increase | 0.02 |
| Non-CIP Capital Outlays Rate of Increase | 0.00 |
| Transfers to Fleet Rate of Increase | 0.00 |
| Inflation Rate | 0.025 |
| Annual Rate of Water Rate Increase | 0.030 |
| Misc. Revenues Fee Increase | 0.020 |

| | 2004-2005 | 2005-2006 | 2006-2007 | 2007-2008 | 2008-2009 | 2009-2010 | 2010-2011 | 2011-2012 | 2012-2013 | 2013-2014 |
|---|---|---|---|---|---|---|---|---|---|---|
| Equivalent Single Family Units (ESFUs) | 12,929 | 13,187 | 13,451 | 13,720 | 13,994 | 14,274 | 14,560 | 14,851 | 15,148 | 15,451 |
| Water Rate, $/ESFU | 323 | 333 | 343 | 353 | 364 | 375 | 386 | 398 | 410 | 422 |
| Revenues | | | | | | | | | | |
| Rate Revenues | 4,180,000 | 4,391,508 | 4,613,718 | 4,847,172 | 5,092,439 | 5,350,117 | 5,620,833 | 5,905,247 | 6,204,052 | 6,517,977 |
| Misc. Revenues | 347,049 | 361,070 | 375,657 | 390,834 | 406,623 | 423,051 | 440,142 | 457,924 | 476,424 | 495,671 |
| SFWB SDC | 350,000 | 350,000 | 350,000 | 350,000 | 350,000 | 350,000 | 350,000 | 350,000 | 350,000 | 350,000 |
| LGIP Interest | 60,000 | 60,000 | 60,000 | 60,000 | 60,000 | 60,000 | 60,000 | 60,000 | 60,000 | 60,000 |
| Debt Interest | 7,500 | 6,800 | 6,100 | 5,400 | 4,700 | 4,000 | 3,300 | 2,600 | 1,900 | 1,200 |
| Total Revenues | 4,944,549 | 5,169,378 | 5,405,475 | 5,653,406 | 5,913,763 | 6,187,168 | 6,474,275 | 6,775,771 | 7,092,376 | 7,424,849 |
| Expenses | | | | | | | | | | |
| Personal Services | 856,467 | 877,879 | 899,826 | 922,321 | 945,379 | 969,014 | 993,239 | 1,018,070 | 1,043,522 | 1,069,610 |
| Non-CIP Material and Services | 2,305,850 | 2,410,766 | 2,520,456 | 2,635,137 | 2,755,036 | 2,880,390 | 3,011,447 | 3,148,468 | 3,291,724 | 3,441,497 |
| SFWB SDC | 350,000 | 350,000 | 350,000 | 350,000 | 350,000 | 350,000 | 350,000 | 350,000 | 350,000 | 350,000 |
| Non-CIP Capital Outlays | 75,000 | 76,875 | 78,797 | 80,767 | 82,786 | 84,856 | 86,977 | 89,151 | 91,380 | 93,665 |
| Transfers to Fleet Reserve, Maint. | 178,500 | 182,963 | 187,537 | 192,225 | 197,031 | 201,956 | 207,005 | 212,180 | 217,485 | 222,922 |
| Transfer to Rate Stabilization | 100,000 | | | | | | | | | |
| Existing Debt Service | 568,481 | 406,058 | 406,045 | 200,245 | 199,345 | 198,052 | 196,318 | 199,138 | 201,393 | 198,179 |
| New Debt Service | 0 | 0 | 0 | 0 | 714,159 | 714,159 | 714,159 | 714,159 | 714,159 | 714,159 |
| Total Expenses | 4,434,298 | 4,304,540 | 4,442,660 | 4,380,695 | 5,243,735 | 5,398,426 | 5,559,146 | 5,731,167 | 5,909,663 | 6,090,032 |
| Net Revenues | 510,251 | 864,837 | 962,815 | 1,272,711 | 670,027 | 788,741 | 915,129 | 1,044,603 | 1,182,714 | 1,334,817 |
| Beginning Water Fund Balance | 2,341,808 | 1,276,239 | 1,196,565 | 1,193,409 | 1,259,107 | 1,150,000 | 1,150,000 | 1,150,000 | 1,150,000 | 1,150,000 |
| Debt Coverage, Debt Reserve, and Contingency | 1,150,000 | 1,150,000 | 1,150,000 | 1,150,000 | 1,150,000 | 1,150,000 | 1,150,000 | 1,150,000 | 1,150,000 | 1,150,000 |
| Funds Available for CIP Expenses | 1,702,059 | 991,077 | 1,009,380 | 1,316,120 | 779,134 | 788,741 | 915,129 | 1,044,603 | 1,182,714 | 1,334,817 |
| Planned CIP Expenses from Rates | 1,118,275 | 944,512 | 965,971 | 715,271 | 367,708 | 2,754,272 | 1,727,160 | 1,340,243 | 1,378,745 | 1,557,863 |
| SDC Expenses Requiring Rate Coverage | 457,545 | 0 | 0 | 491,742 | 4,401,186 | 616,784 | 0 | 0 | 0 | 0 |
| Total CIP Expenses Requiring Rate Coverage | 1,575,820 | 944,512 | 965,971 | 1,207,013 | 4,768,894 | 3,371,056 | 1,727,160 | 1,340,243 | 1,378,745 | 1,557,863 |
| Remaining Available Water Fund Balance | 126,239 | 46,565 | 43,409 | 109,107 | 0 | 0 | 0 | 0 | 0 | 0 |
| Shortfall | 0 | 0 | 0 | 0 | 3,989,760 | 2,582,315 | 812,031 | 295,640 | 196,031 | 223,046 |
| Ending Water Fund Balance | 1,276,239 | 1,196,565 | 1,193,409 | 1,259,107 | 1,150,000 | 1,150,000 | 1,150,000 | 1,150,000 | 1,150,000 | 1,150,000 |
| Phase 1 Bond Service | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Phase 2 Bond Service | | | | | 714,159 | 714,159 | 714,159 | 714,159 | 714,159 | 714,159 |
| Phase 3 Bond Service | | | | | | | | | | |
| Total New Debt Service | 0 | 0 | 0 | 0 | 714,159 | 714,159 | 714,159 | 714,159 | 714,159 | 714,159 |
| Total Expenses with new debt service | 4,434,298 | 4,304,540 | 4,442,660 | 4,380,695 | 5,957,894 | 6,112,585 | 6,273,305 | 6,445,326 | 6,623,822 | 6,804,191 |
| Phase 1 Bond Rate Impact | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Phase 2 Bond Rate Impact | | | | | 51 | 50 | 49 | 48 | 47 | 46 |
| Phase 3 Bond Rate Impact | | | | | | | | | | |

| | 2014-2015 | 2015-2016 | 2016-2017 | 2017-2018 | 2018-2019 | 2019-2020 | 2020-2021 | 2021-2022 | 2022-2023 | 2023-2024 |
|---|---|---|---|---|---|---|---|---|---|---|
| Equivalent Single Family Units (ESFUs) | 15,760 | 16,075 | 16,397 | 16,724 | 17,059 | 17,400 | 17,748 | 18,103 | 18,465 | 18,834 |
| Water Rate, $/ESFU | 435 | 448 | 461 | 475 | 489 | 504 | 519 | 534 | 550 | 567 |
| Revenues | | | | | | | | | | |
| Rate Revenues | 6,847,787 | 7,194,285 | 7,558,316 | 7,940,767 | 8,342,569 | 8,764,703 | 9,208,197 | 9,674,132 | 10,163,643 | 10,677,924 |
| Misc. Revenues | 515,697 | 536,531 | 558,207 | 580,758 | 604,221 | 628,631 | 654,028 | 680,451 | 707,941 | 736,542 |
| SFWB SDC | 350,000 | 350,000 | 350,000 | 350,000 | 350,000 | 350,000 | 350,000 | 350,000 | 350,000 | 350,000 |
| LGIP Interest | 60,000 | 60,000 | 60,000 | 60,000 | 60,000 | 60,000 | 60,000 | 60,000 | 60,000 | 60,000 |
| Debt Interest | 500 | 0 | | | | | | | | |
| Total Revenues | 7,773,984 | 8,140,816 | 8,526,522 | 8,931,525 | 9,356,790 | 9,803,335 | 10,272,225 | 10,764,583 | 11,281,584 | 11,824,465 |
| Expenses | | | | | | | | | | |
| Personal Services | 1,096,350 | 1,123,759 | 1,151,853 | 1,180,649 | 1,210,165 | 1,240,420 | 1,271,430 | 1,303,216 | 1,335,796 | 1,369,191 |
| Non-CIP Material and Services | 3,598,085 | 3,761,798 | 3,932,960 | 4,111,909 | 4,299,001 | 4,494,606 | 4,699,110 | 4,912,920 | 5,136,458 | 5,370,167 |
| SFWB SDC | 350,000 | 350,000 | 350,000 | 350,000 | 350,000 | 350,000 | 350,000 | 350,000 | 350,000 | 350,000 |
| Non-CIP Capital Outlays | 96,006 | 98,406 | 100,867 | 103,388 | 105,973 | 108,622 | 111,338 | 114,121 | 116,974 | 119,899 |
| Transfers to Fleet Reserve, Maint. | 228,495 | 234,207 | 240,063 | 246,064 | 252,216 | 258,521 | 264,984 | 271,609 | 278,399 | 285,359 |
| Transfer to Rate Stabilization | | | | | | | | | | |
| Existing Debt Service | 199,485 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New Debt Service | 722,183 | 722,183 | 722,183 | 722,183 | 722,183 | 722,183 | 722,183 | 722,183 | 722,183 | 722,183 |
| Total Expenses | 6,290,605 | 6,290,354 | 6,497,925 | 6,714,194 | 6,939,539 | 7,174,352 | 7,419,046 | 7,674,049 | 7,939,811 | 8,216,799 |
| Net Revenues | 1,483,379 | 1,850,462 | 2,028,597 | 2,217,330 | 2,417,251 | 2,628,982 | 2,853,180 | 3,090,534 | 3,341,773 | 3,607,667 |
| Beginning Water Fund Balance | 1,150,000 | 1,150,000 | 1,386,595 | 1,760,979 | 2,169,703 | 2,848,996 | 3,696,572 | 4,723,810 | 5,942,753 | 7,366,146 |
| Debt Coverage, Debt Reserve, and Contingency | 1,150,000 | 1,150,000 | 1,150,000 | 1,150,000 | 1,150,000 | 1,150,000 | 1,150,000 | 1,150,000 | 1,150,000 | 1,150,000 |
| Funds Available for CIP Expenses | 1,483,379 | 1,850,462 | 2,265,192 | 2,828,309 | 3,436,954 | 4,327,979 | 5,399,752 | 6,664,343 | 8,134,526 | 9,823,813 |
| Planned CIP Expenses from Rates | 1,574,504 | 1,613,867 | 1,654,213 | 1,808,606 | 1,737,958 | 1,781,407 | 1,825,942 | 1,871,590 | 1,918,380 | 1,966,340 |
| SDC Expenses Requiring Rate Coverage | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total CIP Expenses Requiring Rate Coverage | 1,574,504 | 1,613,867 | 1,654,213 | 1,808,606 | 1,737,958 | 1,781,407 | 1,825,942 | 1,871,590 | 1,918,380 | 1,966,340 |
| Remaining Available Water Fund Balance | 0 | 236,595 | 610,979 | 1,019,703 | 1,698,996 | 2,546,572 | 3,573,810 | 4,792,753 | 6,216,146 | 7,857,473 |
| Shortfall | 91,125 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ending Water Fund Balance | 1,150,000 | 1,386,595 | 1,760,979 | 2,169,703 | 2,848,996 | 3,696,572 | 4,723,810 | 5,942,753 | 7,366,146 | 9,007,473 |
| Phase 1 Bond Service | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Phase 2 Bond Service | 714,159 | 714,159 | 714,159 | 714,159 | 714,159 | 714,159 | 714,159 | 714,159 | 714,159 | 714,159 |
| Phase 3 Bond Service | 8,024 | 8,024 | 8,024 | 8,024 | 8,024 | 8,024 | 8,024 | 8,024 | 8,024 | 8,024 |
| Total New Debt Service | 722,183 | 722,183 | 722,183 | 722,183 | 722,183 | 722,183 | 722,183 | 722,183 | 722,183 | 722,183 |
| Total Expenses with new debt service | 7,012,788 | 7,012,537 | 7,220,108 | 7,436,378 | 7,661,722 | 7,896,536 | 8,141,229 | 8,396,233 | 8,661,994 | 8,938,982 |
| Phase 1 Bond Rate Impact | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Phase 2 Bond Rate Impact | 45 | 44 | 44 | 43 | 42 | 41 | 40 | 39 | 39 | 38 |
| Phase 3 Bond Rate Impact | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |

| | | |
|---|---|---|
| Bond Interest Rate | 0.05 | years |
| Term | 20 | |

| | Phase 1 | Phase 2 | Phase 3 |
|---|---|---|---|
| Total Revenues | 21,172,808 | 39,868,201 | 96,675,830 |
| Total Expenses | 17,562,193 | 33,932,169 | 71,156,675 |
| Net Revenues | 3,610,615 | 5,936,032 | 25,519,155 |
| Planned CIP Outlays from Rates | 3,744,029 | 9,125,991 | 17,752,807 |
| SDC Outlays Requiring Rate Coverage | 949,287 | 5,017,971 | 0 |
| Total CIP Outlays Requiring Rate Coverage | 4,693,316 | 14,143,961 | 17,752,807 |
| Beginning Water Fund Balance | 2,341,808 | 1,259,107 | 1,150,000 |
| Ending Water Fund Balance | 1,259,107 | 1,150,000 | 9,007,473 |
| Net Shortfall for Period | 0 | 8,098,823 | 91,125 |
| Bond Requirement (Shortfall plus 10%) | 0 | 8,900,000 | 100,000 |
| Rate Impact per ERU, $/yr | 0 | 49 | 1 |
| Rate Impact per ERU, $/month | 0 | 4.0 | 0.0 |
| Total Rate per ERU, $/yr | 338 | 396 | 498 |
| Total Rate per ERU, $/month | 28 | 33 | 42 |

# Appendix G

Report for

# City of Oregon City, Oregon

# Water System Development Charge Report

May 2004




Presented By


Economic and Engineering Services, Inc.
111 SW 5th Avenue, Suite 1670
Portland, Oregon 97204
(503) 223-3033

# Contents

## Executive Summary



## 1 Introduction



## 2 System Development Charges in Oregon



## 3 Development of the City's Water System Development Charges

# Tables

# Appendices

## Water System Development Charges

# Executive Summary

## Introduction

The City of Oregon City (City) retained Economic and Engineering Services, Inc. (EES) to review and update the City's water system development charges (SDCs). The objective of this study is to calculate cost-based charges for new customers connecting to the City. By establishing cost-based SDCs, the City will help to have "growth pay for growth" and shelter the City's existing utility customers from the effects of growth.

## Overview of the City's System

The City currently services a population of approximately 28,000 people with water service. The City is located in a growing area. Overall growth in the study area for the master plan period between 2003 and 2023 is approximately ninety-two (92%) percent.

> ***"The objective of this study is to calculate cost-based charges for new customers connecting to the City. By establishing cost-based SDCs, the City will help to have "growth pay for growth" and shelter the City's existing utility customers from the effects of growth."***

The City obtains one hundred percent of its water supply from the South Fork Water Board (South Fork). South Fork is an ORS 190 owned by the City and the City of West Linn. South Fork operates a conventional water treatment plant with a capacity of approximately 20 mgd. Water is supplied through a series of transmission mains and a pump station. South Fork collects a separate SDC for the cost of supplying treated water to the City and hence, the South Fork assets are not included in the City's SDC. The City also has four storage reservoirs with a total capacity of 16.25 million gallons. The capital improvement plan calls for construction of four (4) new storage reservoirs to serve new growth areas and a number of new distribution pipelines in order to provide increased capacity for growth.

## Present System Development Charges

The City's present SDCs are shown in Table ES-1 for the water system.

Table ES-1
City of Oregon City
Present Water System Development Charges

| Meter Size | Meter Equivalent | SDC |
|---|---|---|
| 5/8" x ¾" | 1 | $1,623 |
| ¾" | 1.5 | 2,435 |
| 1" | 2.5 | 4,058 |
| 1-½" | 5 | 8,116 |
| 2" | 8 | 12,985 |
| 3" | 16 | 25,970 |
| 4" | 25 | 40,578 |
| 6" | 50 | 81,156 |
| 8" | 80 | 129,849 |
| 10" | 115 | 186,658 |

*(1) American Water Works Association (AWWA) safe operating capacity ratings for displacement type meters.*

As can be seen above, the City's water SDCs increase by meter size.

Based on our review of the City's costs, system characteristics and Oregon law, EES has determined new SDCs for connection to the water system.

## Proposed System Development Charges

The SDCs for the City's water system were calculated based on the City's existing assets and future capital improvements. Future capital improvements were provided by the City and the planning information from the master plan entitled, "City of Oregon City Water Master Plan", prepared by West Yost & Associates, Inc. dated September, 2003 (the "Master Plan"). Other financial and accounting information has been provided by the City.

The SDCs for the City's water system are calculated based on an equivalent residential unit (ERU) basis. A weighting factor of one (1) is assigned to a meter size of 5/8 inch. Other meter sizes are weighted based on American Water Works Association (AWWA) safe operating capacity ratings for displacement type meters.

Presented in Table ES-2 are the proposed SDCs for the City's water system. These are the maximum charges allowed under Oregon law and are presented by meter size.

| Table ES-2<br>City of Oregon City<br>Allowable Water System Development Charges | |
|---|---|
| **Plant Component** | **SDC Calculation Results** |
| Pump Stations | $220.14 |
| Storage | 1,347.18 |
| Distribution Mains | 1,224.43 |
| Compliance Costs | 31.05 |
| Debt Service Credit for Bonds | 0.00 |
| **Total** | $2,822.80 |
| **Net System Development Charge** | **$2,820** |

| | System Development Charges | | |
|---|---|---|---|
| **Meter Size** | **ERU Weighting Factor** (1) | **SDC** | |
| 5/8" x ¾" | 1 | $2,820 | |
| 3/4 | 1.5 | 4,230 | |
| 1 | 2.5 | 7,050 | |
| 1 1/2 | 5 | 14,100 | |
| 2 | 8 | 22,560 | |
| 3 | 16 | 45,120 | |
| 4 | 25 | 70,500 | |
| 6 | 50 | 141,000 | |
| 8 | 80 | 225,600 | |
| 10 | 115 | 324,300 | |
| Reimbursement Fee | | $721 | per ERU |
| Improvement Fee | | 2,101 | per ERU |

*(1) AWWA safe operating capacities for displacement type meters.*

The SDC has increased from $1,623 per ERU to $2,820 ERU. This is an increase of $1,197/ERU. This increase has been brought about by a number of different factors. These include increased costs associated with construction of infrastructure, new infrastructure built by the City since the calculation of the SDC and identification of new assets from the Master Plan that will be required to serve additional growth.

## Summary Recommendations

Based on its review and analysis in the determination of SDCs for the City, EES makes the following recommendations:

- The City establish SDCs for new hookups for water that are no greater than the SDCs set forth in this report.

- The City update the actual calculations for SDCs based on the methodology as approved by the resolution or ordinance setting forth the methodology for SDCs at such time when a new capital improvement plan, public facilities plan, master plan or a comparable plan is approved or updated by the City.
- The City provide for increases in the SDCs annually based on changes in the Engineering News Record Construction Cost Index.

## Implementation

The methodology used to calculate the system development charge takes into account the cost of money or interest charges and inflation. Therefore, EES would recommend that the City examine the SDC each year to determine the effect of interest costs and inflation on the calculation. The charge should be increased by an escalation factor each year to reflect the cost of borrowing and/or inflation. This method for escalation of the charge can be used for a four-year to five-year period. After this, EES would recommend that the City update the charge based on the actual cost of infrastructure and new facilities based on the master plan or capital improvement plan.

# Section 1
# Introduction

## 1.1 Introduction

*To mitigate the cost of financing new facilities and ultimately the cost of rates to customers, many utilities have implemented system development charges (SDCs) or impact fees for new development.*

Water systems experiencing customer growth can be initially burdened by the cost of financing capital improvements to serve new customers. The cost of developing new sources of supply, storage, transmission facilities and treatment requirements under the Safe Drinking Water Act can be quite large. To mitigate the cost of financing these new facilities and ultimately the cost of rates to customers, many utilities have implemented system development charges (SDCs) or impact fees for new development. SDCs provide the means of balancing the cost requirements for new utility infrastructure to meet customer growth between existing customers and new customers. New hook-ups, under SDCs, are required to "buy-in" to the system in terms of both existing capacity and future capacity requirements in order to mitigate customer growth effects on existing customers.

## 1.2 Scope of Services

Economic and Engineering Services, Inc. (EES) was retained by West Yost & Associates, Inc. as a subcontractor to determine SDCs for the City of Oregon City (City) water system. As part of the process, EES has determined cost-based SDCs for the City that are fair and equitable for both existing and new customers.

## 1.3 Organization of Report

This report is divided into four sections. The first section provides an executive summary of our findings and recommendations. Section 1 is this introduction. Section 2 of this report provides an overview of the requirements under Oregon law for determining SDCs. In addition, it provides a discussion of economic theory behind SDCs. Section 3 of this report provides the calculations used to determine the water SDCs for the City.

## 1.4 Disclaimer

EES, in its calculation of the system development charges presented in this report, has used generally accepted engineering and ratemaking principles. This should not be construed as a legal opinion with respect to Oregon law. EES recommends that the City have its legal counsel review the SDCs as set forth in this report to ensure compliance with Oregon law.

# Section 2
# System Development Charges in Oregon

## 2.1 Introduction

The 1989 Oregon Legislative session passed House Bill No. 3224 Chapter 449, Laws codified as ORS 223.297 through 223.314 (Oregon Law) which sets forth the requirements for calculation of system development charges (SDCs) and the use of funds collected through SDCs. Oregon law also requires the establishment of administrative review procedures for the adoption of the methodology used in the calculation of SDCs and the collection and expenditures of funds. The law applies to SDCs collected after July 1, 1991.

## 2.2 System Development Charges in Oregon

The imposition of regulations on SDCs in Oregon is not a new concept. A similar version of House Bill 3224 was first introduced in the 64$^{th}$ Legislative Assembly at the request of the Oregon Homebuilders Association. While the bill was approved by the legislature, the Governor ultimately vetoed it. In vetoing the bill, the Governor requested that the League of Oregon Cities and the Oregon State Homebuilders Association attempt to reach a settlement agreement as to the form and content of appropriate law. As a consequence of the settlement negotiations, House Bill 3224 was introduced in the 65$^{th}$ Oregon Legislative Assembly by the League of Oregon Cities, Oregon State Homebuilders Association and the Oregon Builders Association of Metro Portland, and it was passed and approved.

A summary of the legal requirements under Oregon law as defined in House Bill 3224 and subsequent amendments is provided in this section. It is meant to be a brief summary of Oregon law. It in no way constitutes a legal interpretation of Oregon law by EES.

The purpose of Oregon law for the enactment of SDCs is to provide a uniform framework for the imposition of SDCs by local governments for specified purposes, and to establish that such fees be used only for capital improvements. Capital improvements as defined under the law are as follows:

- water supply, treatment and distribution;
- wastewater collection, transmission, treatment and disposal;
- drainage and flood control;
- transportation;
- parks and recreation.

The particular parts of a water system, which are allowed to be included in the calculation of SDCs, are water mains, water pump stations, water reservoirs, water treatment plants and the water distribution system with the exception of meters and services.

An SDC means a reimbursement fee, an improvement fee, or a combination thereof. As defined under Oregon law, "improvement fee" means a fee for the costs associated with capital improvements to be constructed. "Reimbursement fee" means a fee for costs associated with capital improvements already constructed or under construction.

As defined under Oregon law, the methodology setting forth the calculations for reimbursement fees and improvement fees must make the following considerations:

> *"Reimbursement fees shall be established by ordinance or resolution, setting forth a methodology that considers the cost of existing facility or facilities, prior contributions by existing users, the value of unused capacity, rate making principles employed to finance publicly owned capital improvements and other relevant factors identified by the local government imposing the fee. The methodology shall promote the objective of future system users contributing no more than an equitable share to the cost of existing facilities. The methodology for establishing such fees shall be available for public inspection."*
>
> *"Improvement fees shall be established by ordinance or resolution setting forth a methodology that considers the cost of projected capital improvements needed to increase the capacity of the systems to which the fee is related. The methodology for establishing such fees shall be available for public inspection."*

In addition to the definitive requirements of the establishment of an SDC as an improvement fee and/or reimbursement fee, other requirements under Oregon law are as follows:

- The SDC must be based on an approved capital improvement plan, public facilities plan, master plan, or comparable plan which lists the capital improvements that may be funded with the improvement fee revenues and the estimated costs and timing for each improvement.
- Proper administrative review procedures must be followed in the enactment of an SDC resolution or ordinance.
- SDC funds must be spent only on facilities for which they were collected.
- A proper accounting system must be established which provides for an annual accounting of SDCs showing the total amount of revenue collected and the projects that were funded.

## 2.3 Economic Theory and SDCs

System development charges are generally imposed as a condition of service. The objective of an SDC is not merely to generate money for the City, but to ensure that all customers seeking to connect to the City's water system shall bear their equitable share of the cost of both the existing and future systems. Through the implementation of fair and equitable SDCs, future customers will not be unduly burdened with the cost of new development.

By establishing cost-based SDCs, the City will be taking an important step in assuring adequate infrastructure to meet growth-related needs, but more importantly, providing this required infrastructure to new customers in a cost-based, fair and equitable manner.

## 2.4 Summary

This section of the report reviewed the legal basis for establishing system development charges in Oregon. At the same time, a brief discussion of the economic theory behind the establishment of cost-based SDCs was provided. The next section of the report will discuss the development of the water system development charges for the City.

# Section 3
# Development of the City's Water System Development Charges

## 3.1 Introduction

This section of the report presents the calculation of the water system development charge. The calculation of the water SDCs presented in this section are based on the City's fixed asset records, planning data and future capital improvements as identified in the City's water master plan, entitled "City of Oregon City Water Master Plan", prepared by West Yost & Associates, Inc., dated September, 2003 (the "Master Plan"). Other financial and accounting information was provided by the City.

To the extent that the cost and timing of future capital improvements change, then the SDC presented in this section should be updated to reflect the cost of these adjustments.

## 3.2 Water Equivalent Units

The number of equivalent residential units (ERUs) was determined based on the planning criteria from the Master Plan. The Master Plan assumes 144-gallons/capita/day average daily flow. This was multiplied by 2.5 persons per ERU. A peaking factor of 2.1 was assumed per the master plan for peak day demand per ERU. This was subsequently divided by the peak day demand to determine the total number of ERUs.

The storage capacity was developed based on the total storage in 2020 divided by the total number of ERUs in 2023. The number of ERUs added during each year of the study period was made based on the growth rates as set forth in the Master Plan. A summary of the ERUs for 2004 and the ERU conversion factors is presented in Table 3-1. Details of the determination of water ERUs are provided in Exhibit 1.

Table 3-1
City of Oregon City
Water Equivalent Residential Units

| Description | ERUs | |
|---|---|---|
| Equivalent Residential Units - 2004 | 8,609 | |
| ERU Average Day Demand (1) | 360.00 | Gallons/Day/ERU |
| ERU Peak Day Demand (2) | 756.00 | Gallons/Day/ERU |
| ERU Storage Capacity (3) | 1,231.53 | Gallons/ERU |

*(1) Average demand (gpcd) from 1997-2001 multiplied by a factor of 2.5 for ERU conversion.*
*(2) Peaking Factor of 2.1 based on system usage in 2001.*
*(3) Total storage divided by 2023 ERUs.*

## 3.3 Pump Stations

The City currently has two main pump stations at Mountainview and Hunter Avenue. In addition, the city has a booster pump station at Fairway Downs and a small pump station in the Livesay area. Future improvements are to provide increased reliability and an expansion of the Mountainview pump station to serve growth. Given the cost of existing pump stations and the portion of future capital improvement related to results in an SDC for pump stations of $220.14 per ERU. Details of the calculation are provided in Exhibit 2.

## 3.4 Distribution Storage

The City currently has four main reservoirs with a total capacity of 16.25 MG. The City's capital improvement plans calls for construction of four (4) new storage reservoirs for with total capacity of capacity of 9.0 MG and gain the use of 4.1 MG from the Mountainview Reservoir. The cost of new storage is approximately $11.9 million. This results in a cost per gallon of $1.09 per gallon. Applying this to the storage requirement per ERU results in an SDC for distribution storage and pump stations of $1,347.18 per ERU. Details of the calculation are provided in Exhibit 3.

## 3.5 Distribution Mains

The City's distribution network consists of numerous lines of 3-inch, 4-inch, 6-inch, 8-inch, 10-inch, 12-inch, 16-inch mains and 24-inch diameter mains. To determine the SDC for distribution, an inventory of the existing system was undertaken as well as those planned improvements identified in the capital improvement program. The historical investments of the City were adjusted for interest charges up to a maximum of ten years. These were subsequently divided by 2020 ERUs to determine the cost per ERU. Future capital improvements were reviewed to determine the percentage that would serve new development for the planning horizon from 2003 to 2023 and were then divided by the number of new ERUs added over the planning horizon.

Based on the cost incurred by the City, the SDC for existing distribution mains is $677.39 per ERU. For future distribution mains, the SDC is $547.04 per ERU. This results in a total SDC for distribution mains of $1,224.43 per ERU.

For future distribution plant, an item-by-item analysis was done to determine the percentage cost of these facilities that would serve new development. Water main replacements were excluded since these are not growth related and should be paid for through rates. Details of the calculation are provided in Exhibit 4.

## 3.6 Compliance Cost

As allowed under Oregon law, compliance costs were calculated as part of the overall SDC. The compliance cost for the next five years were determined and divided by the total number of ERUs over the next five years. This results in a compliance cost SDC of $31.05 per ERU. Details of the analysis are provided in Exhibit 5.

## 3.7 SDC Credits

Two types of credits are applicable to the calculation of the water SDCs for the City. The first type of credit is for payment on debt service for the City's outstanding bonds. The City currently has two outstanding revenue bond issues. The second credit is for plant contributed to the City by developers.

In the determination of the debt service credit it was assumed that SDC funds could be used to pay for debt service and hence the total debt paid by rates was netted out against the amount of SDC funds. The remaining debt service was divided by the total number of ERUs to determine the debt service per ERU. This was then discounted back to 2004 dollars to reflect the fact that a credit was being given for payments in the future.

Based on the annual debt service and number of ERUs under each year for which debt service payments will be made, the credit for debt service payments is zero. Details of the calculation are provided as Exhibit 6.

The second credit applicable to the City is for contributed plant. In the development of the SDC for distribution plant, those assets that were contributed by developers to the City were excluded form the inventory of existing assets. Therefore, a credit for contributed plant is included in the calculation of the distribution plant SDC.

## 3.8 Net Water System Development Charge

Based on the sum of the component costs calculated for the SDC as detailed in this memorandum, the net Water SDC is determined. The recommended SDC is calculated for a 5/8"x ¾" meter. The SDC for larger meter sizes are determined by multiplying the SDC for a 5/8"x ¾" meter by AWWA's weighting factors. The weighting factors are based on AWWA safe operating capacities for displacement type meters. Details of the net SDC for the City are provided in Table 3-2. The detail of the calculation of the reimbursement fee and improvement fee is provided in Table 3-3.

**Table 3-2**
**City of Oregon City**
**Allowable Water System Development Charges**

| Plant Component | SDC Calculation Results |
|---|---|
| Pump Stations | $220.14 |
| Storage | 1,347.18 |
| Distribution Mains | 1,224.43 |
| Compliance Costs | 31.05 |
| Debt Service Credit for Bonds | 0.00 |
| **Total** | $2,822.80 |
| **Net System Development Charge** | **$2,820** |

| | System Development Charges | |
|---|---|---|
| **Meter Size** | **ERU Weighting Factor** (1) | **SDC** |
| 5/8" x ¾" | 1 | $2,820 |
| 3/4 | 1.5 | 4,230 |
| 1 | 2.5 | 7,050 |
| 1 1/2 | 5 | 14,100 |
| 2 | 8 | 22,560 |
| 3 | 16 | 45,120 |
| 4 | 25 | 70,500 |
| 6 | 50 | 141,000 |
| 8 | 80 | 225,600 |
| 10 | 115 | 324,300 |

*(1) AWWA safe operating capacities for displacement type meters.*

**Table 3-3**
**City of Oregon City**
**Water System Development Charge Summary**

| Item | Reimbursement | Impovement | Total |
|---|---|---|---|
| Pump Stations | $44.04 | $176.10 | $220.14 |
| Storage | 0.00 | 1,347.18 | 1,347.18 |
| Distribution Mains | 677.39 | 547.04 | 1,224.43 |
| Compliance Costs | 0.00 | 31.05 | 31.05 |
| Debt Service Credit for Bonds | 0.00 | 0.00 | 0.00 |
| **Total** | $721.44 | $2,101.37 | $2,822.80 |

Based on the above calculations, the SDC calculated for a 5/8 x ¾" meter is $2,822.80. This is the maximum charge the City can utilize. For ease of administration, the recommended charge is

$2,820. The charge is weighted by meter size to account for the capacity requirements of the customer. The use of a weighting based on AWWA safe operating capacities for displacement type meters reflects the costs incurred by the City in providing the service.

## 3.9 Key Assumptions

In the development of the SDC for the City's water system, a number of different assumptions were utilized. These are as follows:

- The interest rate used for calculating interest on existing investments was 5.5% percent.
- The maximum years of interest utilized was ten (10) years.
- The base year for the CIP was assumed at 2004.

## 3.10 Summary

The water SDC developed and presented in this section of the report is based on the engineering design criteria of the City's water system, existing assets, future capital improvements and "generally accepted" ratemaking principles. Finally, the SDC presented in this section is cost-based, and is recommended for adoption by the City.

# WATER SYSTEM DEVELOPMENT CHARGES

# Exhibit 1
# Development of ERUs

**City of Oregon City**
**System Development Charges - Water**
**Determination of ERUs**
**Exhibit 1**



| | | |
|---|---|---|
| ERU Average Day Demand (1) | 360.00 | Gallons/Day/ERU |
| ERU Peak Day Demand (2) | 756.00 | Gallons/Day/ERU |
| ERU Storage Capacity (3) | 1,231.53 | Gallons/ERU |

*(1) Average demand (gpcd) from 1997-2001 multiplied by a factor of 2.5 for ERU conversion.*
*(2) Peaking Factor of 2.1 based on system usage in 2001.*
*(3) Total storage divided by 2023 ERUs.*

| **Year** | **Peak Day (mgd)** (1) | **Total ERUs** | **Additional ERUs** |
|---|---|---|---|
| 2003 | 8.60 | 11,376 | |
| 2004 | 8.86 | 11,716 | 340 |
| 2005 | 9.12 | 12,066 | 350 |
| 2006 | 9.39 | 12,427 | 361 |
| 2007 | 9.68 | 12,798 | 371 |
| 2008 | 9.96 | 13,181 | 383 |
| 2009 | 10.26 | 13,575 | 394 |
| 2010 | 10.57 | 13,980 | 405 |
| 2011 | 10.89 | 14,398 | 418 |
| 2012 | 11.21 | 14,829 | 431 |
| 2013 | 11.55 | 15,272 | 443 |
| 2014 | 11.89 | 15,728 | 456 |
| 2015 | 12.25 | 16,199 | 471 |
| 2016 | 12.61 | 16,683 | 484 |
| 2017 | 12.99 | 17,181 | 498 |
| 2018 | 13.38 | 17,695 | 514 |
| 2019 | 13.78 | 18,224 | 529 |
| 2020 | 14.19 | 18,769 | 545 |
| 2021 | 14.61 | 19,330 | 561 |
| 2022 | 15.05 | 19,908 | 578 |
| 2023 | 15.50 | 20,503 | 595 |

*(1) From City of Oregon City demand summary (Water Master Plan).*

# Exhibit 2
# SDC – Pump Stations

**City of Oregon City**
**System Development Charges - Water**
**Pump Stations SDC**
**Exhibit 2**



| Year | | Original Cost | Cost $2004 | Percent SDC Eligible | SDC Eligible |
|---|---|---|---|---|---|
| **Pump Station Assets** | | | | | |
| 1973 | Pump House Building | $10,690 | $18,260 | 100% | $18,260 |
| 1973 | Pumps | 10,230 | 17,474 | 100% | 17,474 |
| 1973 | Centrifugal Pump | 5,115 | 8,737 | 100% | 8,737 |
| 1992 | Mtn View Pump Station | 90,830 | 155,151 | 100% | 155,151 |
| 1995 | Hunter Ave. Pump Station | 434,458 | 703,428 | 100% | 703,428 |
| **Total Existing Pump Station Assets** | | $551,323 | $903,051 | | $903,051 |
| 2023 ERUs | | | | | 20,503 |
| **Existing Pump Station SDC per ERU** | | | | | **$44.04** |
| **Future Plant** | | | | | |
| 2004-08 | Diesel Generator at Mountainview Pump Station | | $450,000 | 50% | $225,000 |
| 2004-08 | Decommission Livesay Road Pump Station | | 22,000 | 0% | 0 |
| 2004-08 | Seismic upgrade at Mountainview Pump Station | | 30,000 | 0% | 0 |
| 2004-08 | Fairway Downs Pump Sta. Modifications | | 22,000 | 33% | 7,260 |
| 2004-08 | Misc. Seismic Improvements | | 10,000 | 0% | 0 |
| 2008-14 | Mountainview Pump Sta. Expansion | | 2,750,000 | 50% | 1,375,000 |
| 2008-14 | Diesel generator at Boynton Reservoir | | 90,000 | 0% | 0 |
| 2008-14 | Telemetry System Improvements | | 100,000 | 0% | 0 |
| **Total Future Plant** | | | $3,474,000 | | $1,607,260 |
| ERUs 2003 to 2023 | | | | | 9,127 |
| **Future Pump Station SDC per ERU** | | | | | **$176.10** |
| **Total Pump Station SDC per ERU** | | | | | **$220.14** |

Exhibit 3

SDC – Storage Plant

**City of Oregon City**
**System Development Charges - Water**
**Storage Plant SDC**
**Exhibit 3**



| Year Constructed | | Original Cost | Cost $2004 | Percent SDC Eligible | SDC Eligible |
|---|---|---|---|---|---|
| **Future Plant** | | | | | |
| 2004-08 | Intermediate Zone Redundancy | | $2,180,000 | 100% | $2,180,000 |
| 2004-08 | Mountainview Res. Roof Replacement | | 490,000 | 40% | 196,000 |
| 2004-08 | Mountainview Res. Structural repair | | 90,000 | 40% | 36,000 |
| 2004-08 | Mountainview Res. Piping Improvements | | 230,000 | 40% | 92,000 |
| 2004-08 | Mountainview Res. Seismic Improvements | | 1,015,000 | 40% | 406,000 |
| 2004-08 | Elevated Tank demolition | | 52,000 | 0% | 0 |
| 2004-08 | Mountainview Res. Interior Lighting | | 20,000 | 40% | 8,000 |
| 2004-08 | Upper Zone New Reservoir | | 4,130,000 | 100% | 4,130,000 |
| 2008-14 | Boynton Res. Piping Improvements | | 210,000 | 0% | 0 |
| 2008-14 | Boynton Res. Seismic Improvements | | 73,000 | 0% | 0 |
| 2014-24 | Fairway Downs Zone New Reservoir | | 1,060,000 | 100% | 1,060,000 |
| 2014-24 | Holly Lane - New Reservoir | | 1,800,000 | 100% | 1,800,000 |
| 2014-24 | New Lower Park Place Res. Supply | | 232,000 | 100% | 232,000 |
| 2014-24 | New Fairway Downs Res. Supply | | 1,744,000 | 100% | 1,744,000 |
| **Total Future Plant** | | | $13,326,000 | | $11,884,000 |
| Capacity (million gallons) (1) | | | | | 13.00 |
| **Cost per Gallon** | | | | | **$1.09** |
| Storage Requirement per ERU (2) | | | | | 1,231.53 |
| **Storage Plant SDC ($/ERU)** | | | | | **$1,347.18** |

*(1) From City of Oregon City Water Master Plan for new reserviors plus 4 million gallons for Mountain View.*
*(2) See Exhibit 1*

# Exhibit 4
# SDC Distribution Mains

**City of Oregon City**
**System Development Charges - Water**
**Transmission and Distribution Plant SDC**
**Exhibit 4**



| Year | | Original Cost | Cost $2004 | Percent SDC Eligible | SDC Eligible |
|---|---|---|---|---|---|
| **Transmission/ Distribution Plant** | | | | | |
| 1989 | Transmission/ Distribution (incl. all pre-'89 assets) | $2,115,004 | $3,612,732 | 100% | $3,612,732 |
| 1991 | Transmission/ Distribution | 20,962 | 35,807 | 100% | 35,807 |
| 1992 | Transmission/ Distribution | 257,503 | 439,852 | 100% | 439,852 |
| 1993 | Transmission/ Distribution | 654,454 | 1,117,902 | 100% | 1,117,902 |
| 1994 | Transmission/ Distribution | 1,305,609 | 2,230,169 | 100% | 2,230,169 |
| 1995 | Transmission/ Distribution | 14,101 | 22,831 | 100% | 22,831 |
| 1998 | Transmission/ Distribution | 156,444 | 215,712 | 100% | 215,712 |
| 1999 | Transmission/ Distribution | 1,705,444 | 2,228,946 | 100% | 2,228,946 |
| 2000 | Transmission/ Distribution | 1,105,598 | 1,369,642 | 100% | 1,369,642 |
| 2001 | Transmission/ Distribution | 166,481 | 195,489 | 100% | 195,489 |
| 2002 | Transmission/ Distribution | 535,131 | 595,614 | 100% | 595,614 |
| 2003 | Transmission/ Distribution | 1,728,761 | 1,823,843 | 100% | 1,823,843 |
| **Total Existing Transmission/Distribution Plant** | | $9,765,492 | $13,888,540 | | $13,888,540 |
| 2023 ERUs | | | | | 20,503 |
| **Existing Transmission/Distribution Plant SDC per ERU** | | | | | **$677.39** |
| **Future Plant** | | | | | |
| 2004-08 | Leak Detection | | $20,000 | 0% | $0 |
| 2004-08 | Leak Repair | | 150,000 | 0% | 0 |
| 2004-08 | Fire Flow Pipeline projects | | 1,049,500 | 0% | 0 |
| 2004-08 | P-105 Oak Tree Terrace to Livesay Road | | 314,000 | 100% | 314,000 |
| 2004-08 | Pipeline Replacements | | 1,382,500 | 0% | 0 |
| 2004-08 | P-109 Remaining Mountain Line | | 1,051,000 | 50% | 525,500 |
| 2004-08 | P-113, 114 Partlow Road, Meyers Road | | 213,000 | 50% | 106,500 |
| 2004-08 | P-115 Livesay Road | | 75,000 | 100% | 75,000 |
| 2004-08 | Network Expansion projects | | 1,195,000 | 100% | 1,195,000 |
| 2003-04 | SCADA System | | 550,000 | 45% | 249,975 |
| 2003-04 | Pipeline Replacements | | 800,000 | 38% | 300,000 |
| 2003-04 | Beavercreek Rd - Fir to Marjorie | | 325,000 | 46% | 149,825 |
| 2003-04 | Glen Oak - Hwy 213 to Heider Dr. | | 270,000 | 46% | 125,010 |
| 2003-04 | Phase 2 Molalla Ave. Water Line | | 91,000 | 100% | 91,000 |
| 2008-14 | Network Expansion projects | | 1,344,000 | 100% | 1,344,000 |
| 2008-14 | Fire Flow Pipeline projects | | 321,000 | 0% | 0 |
| 2008-14 | Pipeline Replacements/ Hydrant Improvements | | 5,000,000 | 0% | 0 |
| 2014-24 | Network Expansion projects | | 517,000 | 100% | 517,000 |
| 2014-24 | Pipeline Replacements | | 12,000,000 | 0% | 0 |
| **Total Future Plant** | | | $26,668,000 | | $4,992,810 |
| Additional 2003-2023 ERUs | | | | | 9,127 |
| **Future Transmission/Distribution Plant SDC per ERU** | | | | | **$547.04** |
| **Total Transmission/Distribution Plant SDC per ERU** | | | | | **$1,224.43** |

Exhibit 5

SDC – Compliance Costs

**City of Oregon City**
**System Development Charges - Water**
**Compliance Costs**
**Exhibit 5**



| Year | Amount | Amount $2004 | Additional ERUs |
|---|---|---|---|
| 2004 | $15,000 | $15,000 | 456 |
| 2005 | 15,375 | 14,573 | 456 |
| 2006 | 15,759 | 14,159 | 456 |
| 2007 | 16,153 | 13,756 | 456 |
| 2008 | 16,557 | 13,365 | 456 |
| **Total** | **$78,845** | **$70,854** | **2,282** |
| **Compliance Cost SDC per ERU** | | | **$31.05** |

# Exhibit 6
# SDC – Debt Service Credit

**City of Oregon City**
**System Development Charges - Water**
**Credit for Debt Service Payments**
**Exhibit 6**



| | Existing Debt | | Total | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | Refunding 1993 | Refunding 2002 | Existing Debt | New Debt | Total Debt Service | SDC Revenue | Net Debt Service | ERUs | Debt/ERU | Debt/ERU (2004$) |
| 2004 | $379,216 | $194,483 | $573,699 | $0 | $573,699 | $959,752 | $0 | 11,716 | $0.00 | $0.00 |
| 2005 | 372,980 | 195,501 | 568,481 | 0 | 568,481 | 1,017,619 | 0 | 12,066 | 0.00 | 0.00 |
| 2006 | 204,950 | 201,108 | 406,058 | 0 | 406,058 | 1,081,090 | 0 | 12,427 | 0.00 | 0.00 |
| 2007 | 205,100 | 200,945 | 406,045 | 0 | 406,045 | 1,144,368 | 0 | 12,798 | 0.00 | 0.00 |
| 2008 | 0 | 200,245 | 200,245 | 0 | 200,245 | 1,216,824 | 0 | 13,181 | 0.00 | 0.00 |
| 2009 | 0 | 199,345 | 199,345 | 0 | 199,345 | 1,289,325 | 0 | 13,575 | 0.00 | 0.00 |
| 2010 | 0 | 198,052 | 198,052 | 0 | 198,052 | 1,365,081 | 0 | 13,980 | 0.00 | 0.00 |
| 2011 | 0 | 196,318 | 196,318 | 0 | 196,318 | 1,451,166 | 0 | 14,398 | 0.00 | 0.00 |
| 2012 | 0 | 199,138 | 199,138 | 0 | 199,138 | 1,541,186 | 0 | 14,829 | 0.00 | 0.00 |
| 2013 | 0 | 201,393 | 201,393 | 0 | 201,393 | 1,631,619 | 0 | 15,272 | 0.00 | 0.00 |
| 2014 | 0 | 198,179 | 198,179 | 0 | 198,179 | 1,729,885 | 0 | 15,728 | 0.00 | 0.00 |
| 2015 | 0 | 199,485 | 199,485 | 0 | 199,485 | 1,840,393 | 0 | 16,199 | 0.00 | 0.00 |
| **Debt Service Credit** | | | | | | | | | | **$0.00** |