City of Independence

WATER SYSTEM MASTER PLAN

Adopted March 28, 2023 – Ordinance No. 1606

Westech Engineering, Inc.
3841 Fairview Industrial Drive SE, Suite 100
Salem, OR 97302
(503) 585-2474

WATER SYSTEM MASTER PLAN

City of Independence, Oregon

March 2023

Prepared for
City of Independence, Oregon
555 S Main Street
Independence, OR 97351

REGISTERED PROFESSIONAL ENGINEER
56473PE
OREGON
JAN. 14, 2003
CHRISTOPHER J. BRUGATO
RENEWS: 12/31/2023

REGISTERED PROFESSIONAL ENGINEER
100308PE
OREGON
JUL. 12, 2022
E. PAYSON SMITH III
RENEWS: 6/30/2024

Prepared by
Westech Engineering, Inc.
3841 Fairview Industrial Drive SE, Suite 100
Salem, OR 97302
(503) 585-2474

J.O. 2814.4020

PUBLIC HEALTH DIVISION
Drinking Water Services
Tina Kotek, Governor

Oregon Health Authority

800 NE Oregon Street, #640
Portland, OR 97232-2162
Phone: 971-201-9794
Fax: 971-673-0694
www.healthoregon.org/DWP

March 2, 2023

Christopher J. Brugato
Westech Engineering, Inc.
Via email: cbrugato@westech-eng.com

Re: **Water System Master Plan (PR#1-2023)**
Independence Water System (PWS ID#00399)
Concurrence with Master Plan

Dear Chris:

Thank you for your submittal to the Oregon Health Authority's Drinking Water Services (DWS) of plan review information for the Water System Master Plan for Independence Water System. On December 23,2022, our office received a copy of the master plan. A plan review fee of $4,125 was received on January 3, 2023.

The Master Plan represents at least a 20-year planning horizon, out to the year 2045. The plan includes a system goals and description, future demand estimates, engineering evaluation, evaluations of options to meet future demand, financing, and a list of recommended projects and cost estimates. A seismic risk assessment and mitigation plan is required and was included. Upon review of the Master Plan, it appears the elements listed in Oregon Administrative Rules (OAR) 333-061-0060(5) have been addressed.

Please note that OAR 333-061-0060 contains plan submission and review requirements for all major water system additions or modifications. Construction plans and specifications must be submitted to and approved by DWS before construction begins.

If you have any questions, please feel free to call me at (971) 201-9794.

Sincerely,

Carrie Gentry, PE
Regional Engineer
Drinking Water Services

ec: Michelle Byrd, REHS, OHA/DWS
Gerald Fisher, PE, Public Works Director, City of Independence

TABLE OF CONTENTS

Chapter **Page**

Executive Summary 1

1 Introduction 1-1

1.1 General Overview 1-1

1.2 Need For Water System Master Plan 1-1

1.3 Purpose 1-1

1.4 Scope of Work 1-1

1.5 Planning Regulatory Compliance 1-2

Master Plan Requirements 1-2

Future Master Plan Updates 1-2

1.6 Previous Studies And Reports 1-2

2 Study Area and Planning Considerations 2-1

2.1 Study Area 2-1

2.2 Study Period 2-1

2.3 Physical Environment 2-2

2.3.1 Climate and Rainfall Patterns 2-2

2.3.2 Topography 2-2

2.3.3 Soils 2-3

2.3.4 Water Resources 2-3

2.3.5 Geologic Hazards 2-3

2.3.6 Public Health Hazards 2-4

2.3.7 Native Vegetation and Wildlife 2-4

2.3.8 Air Quality and Noise 2-4

2.3.9 Environmentally Sensitive Areas 2-4

2.3.10 Historical & Archeological Sites 2-4

2.3.11 Threatened or Endangered Species 2-5

2.4 Socioeconomic Environment 2-5

2.4.1 Economic Conditions and Trends 2-5

2.4.2 Population & Growth Projections 2-5

2.4.3 Land Use 2-6

2.4.4 Energy Production and Consumption 2-6

3 Regulatory Requirements 3-1

3.1 Introduction 3-1

3.2 Regulating Agencies 3-1

3.3 Existing Water Quality Regulations 3-1

3.3.1 Microbial Contaminants 3-2

3.3.2 Total Coliform Rule....3-3
3.3.3 Revised Total Coliform Rule....3-4
3.3.4 Surface Water Treatment Rule....3-4
3.3.5 Long Term 1 Enhanced Surface Water Treatment Rule....3-5
3.3.6 Long Term 2 Enhanced Surface Water Treatment Rule....3-5
3.3.7 Disinfectants and Disinfection Byproducts Rule....3-6
3.3.8 Lead and Copper Rule....3-7
3.3.9 Inorganic Contaminants....3-8
3.3.10 Organic Contaminants....3-8
3.3.11 Radiologic Contaminants....3-9
3.3.12 Arsenic Rule....3-9
3.3.13 Secondary Contaminants....3-10
3.3.14 Groundwater Rule....3-10
3.3.15 Filter Backwash Recycling Rule....3-12
3.4 Consumer Confidence Report Rule....3-12
3.5 Cross-Connection Control Program....3-12
3.6 Sanitary Survey....3-13
3.7 Vulnerability Assessment....3-13
3.8 Future Water Quality Regulations....3-13
3.8.1 Unregulated Contaminant Monitoring Rule....3-14
3.8.2 Radon....3-14
3.9 City Public Works Design Standards....3-14
3.10 Standards for Municipal Wells....3-15
3.10.1 Municipal Wells....3-15
3.11 Water Use Regulations & Water Rights....3-15
3.12 Water Management & Conservation Plan....3-16
4 Existing Water System....4-1
4.1 Overview....4-1
4.2 Water System Schematic & Maps....4-1
4.3 Water Rights & Sources....4-1
4.3.1 Polk Wellfield....4-6
4.3.2 South Wellfield....4-11
4.3.3 Willamette Wellfield....4-14
4.3.4 Willamette River Surface Water Rights....4-16
4.3.5 Independence-Monmouth Water System Intertie....4-17
4.3.6 Polk County Regional Water Supply Plan....4-17
4.4 Water Treatment....4-18
4.4.1 Polk Water Treatment Plant....4-18
4.4.2 South Water Treatment Plant....4-23

4.5 Water Storage 4-26
4.5.1 Polk Reservoirs 1 & 2 4-28
4.5.2 South Reservoir 4-29
4.5.3 Monmouth Street Reservoir 4-30
4.6 Pump Stations 4-30
4.6.1 Polk Pump Station 4-31
4.6.2 South Pump Station 4-32
4.6.3 Monmouth Street Pump Station 4-32
4.7 Distribution System 4-33
4.7.1 Distribution Pipe Network 4-33
4.7.2 Water Service Levels 4-34
4.7.3 Water Meters 4-35
4.8 SCADA & Telemetry System 4-36
4.9 Existing Water System Funding Mechanisms 4-36
4.9.1 Water User Fees 4-36
4.9.2 System Development Charges 4-36
4.9.3 Annual Water System Costs 4-37
4.9.4 Debt Service 4-38

5 Present and Future Water Demands 5-1

5.1 Introduction 5-1
5.2 Terms and Definitions 5-1
5.2.1 System Demand 5-1
5.2.2 Demand Variations 5-1
5.3 Population 5-2
5.3.1 Historical Municipal Population 5-2
5.3.2 Anticipated Future Development & HB 2001 5-2
5.3.3 Future Population Projections 5-3
5.4 Historical Water Demand 5-4
5.4.1 Water Production 5-4
5.4.2 Average Day Demand (ADD) 5-5
5.4.3 Peaking Factors 5-6
5.4.4 Maximum Month Demand (MMD) 5-6
5.4.5 Maximum Day Demand (MDD) 5-7
5.4.6 Peak Hour Demand (PHD) 5-7
5.4.7 Water Loss 5-7
5.4.8 Water Users by Category 5-8
5.5 Projected Water Demand 5-9
5.5.1 Projected Municipal Water Demand 5-9
5.5.2 Projected Water Demand Summary 5-9

5.6 Fire Flow....5-10

6 Water Supply Evaluation 6-1

6.1 Evaluation Criteria....6-1

6.1.1 Water Rights & Water Sources 6-1

6.1.2 Water Supply Reliability & Resiliency....6-1

6.2 Water Right & Water Source Evaluation 6-2

6.2.1 Polk Wellfield....6-2

6.2.2 South Wellfield 6-4

6.2.3 Independence-Monmouth Water System Intertie....6-4

6.2.4 Willamette Wellfield....6-5

6.2.5 Willamette River 6-6

6.2.6 Polk County Regional Water Supply Plan 6-7

6.3 Water Supply Reliability & Resiliency Evaluation 6-7

6.3.1 Total Capacity 6-7

6.3.2 Firm Capacity....6-9

6.3.3 Auxiliary Power 6-9

6.3.4 Potential Future Water Sources 6-10

6.4 Recommended Improvements 6-12

6.4.1 Recommended 20-Year Water Supply Strategy 6-12

6.4.2 Recommended Water Right Actions 6-13

6.4.3 Recommended Water Supply Improvements....6-14

6.4.4 Summary of Recommended Projects....6-19

7 Water Treatment Evaluation....7-1

7.1 Introduction....7-1

7.2 Evaluation....7-1

7.2.1 Polk Water Treatment Plant 7-1

7.2.2 South Water Treatment Plant....7-2

7.2.3 Surface Water Treatment....7-3

7.3 Water Treatment Improvement Alternatives....7-3

7.3.1 Treatment Location Alternatives....7-3

7.3.2 Treatment Technology Alternatives....7-4

7.4 Recommended Treatment System Improvements 7-8

8 Distribution System Evaluation 8-1

8.1 Introduction....8-1

8.2 Sizing and Capacity....8-1

8.2.1 System Pressure....8-1

8.2.2 Fire Protection....8-2

8.2.3 Deficiency Categories 8-2

8.3 Hydraulic Model Development 8-3
8.3.1 Model Methodology 8-3
8.3.2 Model Development 8-3
8.3.3 Model Scenarios 8-4
8.4 Distribution System Analysis 8-4
8.4.1 Recommended Distribution System Improvements 8-5
8.4.2 Recommended Miscellaneous Projects 8-12
8.4.3 Water Loss Reduction Recurring Programs 8-12
8.5 Summary of Recommended Distribution Improvements 8-14
9 Water Storage Evaluation 9-1
9.1 Introduction....9-1
9.2 Reservoir Evaluation & Design Criteria 9-1
9.2.1 Storage Volume Categories 9-1
9.2.2 System Pressure 9-3
9.2.3 Water Quality 9-3
9.2.4 Reliability of Pumped Sources & Pumped Storage 9-4
9.2.5 Redundancy 9-4
9.3 Water Storage Analysis 9-4
9.3.1 Storage Volume Assumptions & Estimates 9-4
9.3.2 Storage Volume Evaluation 9-6
9.4 Evaluation of Existing Storage Tanks 9-7
9.4.1 Polk Reservoir 1 9-7
9.4.2 Polk Reservoir 2 9-8
9.4.3 South Reservoir 9-8
9.4.4 Monmouth Street Reservoir 9-9
9.5 Recommended Improvements 9-10
9.6 Summary of Recommended Storage Improvements 9-12
10 Seismic Risk Assessment & Mitigation Plan 10-1
10.1 Introduction....10-1
10.2 Regulatory Requirements....10-1
10.3 Critical Facilities 10-3
10.4 Likelihood and Consequences of Failure 10-3
10.5 Mitigation Plan....10-1
11 Operation & Maintenance 11-1
11.1 Introduction....11-1
11.2 Water System Record Keeping 11-1
11.2.1 Water Production 11-1
11.2.2 Regulatory Record Keeping 11-2

11.2.3 Operations and Maintenance Records 11-2
11.2.4 Water System Mapping & System Inventory 11-3
11.3 Water Use Audit 11-3
11.4 Leak Detection 11-3
11.5 Distribution System Flushing Program 11-3
11.6 Valve Exercising 11-4
11.7 Cross-Connection Control Program 11-4
11.8 Master Meter Maintenance 11-5
11.9 Customer Water Meter Maintenance 11-5
11.9.1 Large & Mid-size Meters 11-5
11.9.2 Conventional Meters 11-5
11.10 Hydrant Maintenance and Replacement 11-5
11.11 Reservoir Inspection & Maintenance Program 11-6
11.12 Staffing Levels 11-6

12 Capital Improvement Plan 12-1

12.1 Introduction 12-1
12.2 Prioritized Improvements 12-1
12.2.1 Prioritization Criteria 12-1
12.2.2 Prioritization Levels 12-2
12.2.3 Prioritized Capital Improvement Projects & Estimated Project Costs 12-2
12.2.4 Environmental Impacts 12-9
12.3 Basis of Cost Estimates 12-9
12.3.1 Accuracy of Cost Estimates 12-9
12.3.2 Adjustment of Cost Estimates Over Time 12-10
12.3.3 Engineering and Administrative Costs, Contingencies 12-10
12.4 Construction Cost Estimates 12-11
12.4.1 Pipeline Improvement Costs 12-11
12.4.2 Source Improvement Costs 12-12
12.4.3 Water Treatment Improvement Costs 12-12
12.4.4 Storage Tank Improvement Costs 12-12
12.5 Funding Sources 12-12
12.5.1 Local Funding Sources 12-12
12.5.2 State and Federal Grant and Loan Programs 12-16
12.5.3 Funding Recommendations 12-18
12.6 Recommended Implementation Plan 12-18

LIST OF TABLES

Title **Page**

Table ES-1| Summary of CIP Estimated Costs....8

Table ES-2| Recommended Capital Improvement Projects by Priority....9

Table 2-1 | Approximate Areas by Land Use Zone within Current City Limits.... 2-7

Table 3-1| Secondary Maximum Contaminant Levels.... 3-10

Table 4-1| Summary of Approximate Well Yield.... 4-2

Table 4-2| Water Rights Summary.... 4-5

Table 4-3| Well Summary - Polk Wellfield.... 4-10

Table 4-4| Well Summary - South Wellfield.... 4-13

Table 4-5| Well Summary - Willamette Wellfield.... 4-16

Table 4-6| Polk Water Treatment Plant General Operating & Design Criteria.... 4-21

Table 4-7| South Water Treatment Plant General Operating & Design Criteria.... 4-25

Table 4-8| Reservoir Inventory.... 4-27

Table 4-9| Pump Station Inventory.... 4-33

Table 4-10| Distribution System Inventory.... 4-34

Table 4-11 | Current Water SDC Fees.... 4-37

Table 4-12 | Water Operating Fund Expenditures 2021/22.... 4-37

Table 4-13 | Water Utility Existing Debt.... 4-38

Table 5-1 | Historical Population.... 5-2

Table 5-2 | Municipal Population Projection.... 5-3

Table 5-3| Summary of Historical Water Production.... 5-5

Table 5-4| Summary of Historical & Estimated Water Usage Rates & Peaking Factors.... 5-6

Table 5-5| Historical Water Loss.... 5-8

Table 5-6| Water User Summary.... 5-9

Table 5-7 | Summary of Projected Water Demands.... 5-10

Table 5-8| Minimum Fire Flow Requirements.... 5-11

Table 6-1| Total Capacity Evaluation.... 6-8

Table 6-2| Recommended Water Supply Improvements.... 6-19

Table 8-1| Summary of Fire Flow Improvement Projects.... 8-6

Table 8-2| Summary of End of Service Life Replacement Projects.... 8-7

Table 8-3| Summary of Design Standards Improvement Projects.... 8-8

Table 8-4| Summary of Undeveloped Area Distribution System Projects 8-9
Table 8-5| Summary of Booster Pump Station Projects 8-12
Table 8-6| Summary of Miscellaneous Projects & Recurring Programs 8-14
Table 9-1| Reservoir Dead Storage Estimate 9-5
Table 9-2| Reservoir Effective Storage Estimate 9-5
Table 9-3| Water Storage Evaluation 9-7
Table 9-4| Recommended Treatment System Improvements 9-12
Table 11-1| General Regulatory Record Keeping Requirements 11-2
Table 12-1| Summary of CIP Estimated Costs 12-2
Table 12-2| Recommended Capital Improvement Projects by Priority 12-3
Table 12-3| Estimated Pipeline Improvement Costs 12-11
Table 12-4| Water Utility Existing Debt 12-12
Table 12-5| Current Water SDC Fees 12-13

LIST OF FIGURES

Title	Page
Figure 2-1 | Study Area Vicinity Map	2-1
Figure 2-2 | Ranked Land Uses	2-7
Figure 2-3 | Study Area	2-8
Figure 2-4 | Comprehensive Plan Designations	2-9
Figure 2-5 | Soils Map	2-10
Figure 2-6 | 100-Year Floodplain	2-11
Figure 2-7 | Wetlands Map	2-12
Figure 4-1 | Existing Water System Schematic	4-3
Figure 4-2 | Map of Water System Components	4-4
Figure 4-3 | Polk Well 1	4-7
Figure 4-4 | Polk Well 2	4-8
Figure 4-5 | Polk Well 3	4-8
Figure 4-6 | River Drive Well	4-9
Figure 4-7 | South Wells 3 and 4	4-11
Figure 4-8 | South Well 4 Piping & Adsorption Filters	4-11
Figure 4-9 | Willamette Well 1	4-15
Figure 4-10 | Willamette Well 2	4-15
Figure 4-11 | Willamette Well 3 & Willamette River	4-15
Figure 4-12 | Water System Intertie	4-17
Figure 4-13 | Polk Water Treatment Plant, Pump Station & Reservoirs	4-18
Figure 4-14 | Polk Filter Bank 1	4-18
Figure 4-15 | Polk Filter Bank 2	4-19
Figure 4-16 | South Water Treatment Plant	4-24
Figure 4-17 | Polk Reservoirs 1 & 2	4-28
Figure 4-18 | South Reservoir	4-29
Figure 4-19 | Monmouth Street Reservoir	4-30
Figure 4-20 | Polk Pump Station	4-31
Figure 4-21 | South Pump Station	4-32
Figure 4-22 | Monmouth Street Pump Station	4-32
Figure 4-23| Length of Distribution Pipe by Diameter and Material	4-34

Figure 5-1 | Population Growth Trend ... 5-3
Figure 5-2| Historical Water Production ... 5-4
Figure 5-3| Historical Water Production by Source ... 5-5
Figure 5-4| Historical Average Day Demand, Maximum Month Demand, & Maximum Day Demand ... 5-6
Figure 5-5| Projected Water Demand ... 5-10
Figure 6-1| Summary of Wellfield Capacity & Authorized Rates ... 6-3
Figure 6-2| Projected Total Water Supply Capacity ... 6-8
Figure 6-3| Conceptual Site Plan for Water Supply Improvements ... 6-18
Figure 7-1| Recommended Surface Water Treatment Process ... 7-7
Figure 7-2| Conceptual Site Plan for the Recommended Surface Water Treatment Facility ... 7-10
Figure 8-1| Map of Recommended Distribution System Improvements - North ... 8-15
Figure 8-2| Map of Recommended Distribution System Improvements - Central ... 8-16
Figure 8-3| Map of Recommended Distribution System Improvements - South ... 8-17
Figure 9-1| Reservoir Storage Volume Categories ... 9-1
Figure 10-1| Oregon State DOGAMI Map of Seismic Damage Potential ... 10-2
Figure 10-2| Water System Critical Facilities ... 10-5
Figure 12-1 | Water System Capital Improvement Priorities - North ... 12-6
Figure 12-2 | Water System Capital Improvement Priorities - Central ... 12-7
Figure 12-3 | Water System Capital Improvement Priorities - South ... 12-8
Figure 12-4| Water System Capital Improvement Priorities - New Water Source ... 12-9

LIST OF APPENDICES

APPENDIX A - City of Independence Water System Utility Maps

APPENDIX B - Independence-Monmouth Intertie Intergovernmental Agreement

APPENDIX C - Pumping Interference Calculations v2 (Polk Wellfield), GSI Water Solutions, 8/8/19

APPENDIX D - Oregon DEQ No Further Action Determination RJ Mobility Site, 12/18/2017

APPENDIX E - Independence-Monmouth Willamette Wellfield Intergovernmental Agreement

APPENDIX F - Technical Memorandum: City of Independence Willamette River Wellfield – Surface Water to Groundwater Transfer, Hydrogeologic Evaluation of Wells' Connection to River, GSI Water Solutions, 11/8/17

APPENDIX G - Cost Estimates for Recommended Capital Improvement Projects

APPENDIX H - Collector Well Feasibility Study- Cities of Independence and Monmouth, Oregon; Groundwater Solutions, Inc., 10/20/2006

FOREWORD

Using this Report

This report will be used by many people whose needs for information will differ widely. Accordingly, an Executive Summary appears at the beginning of this report. The summary provides an overview of the report and presents the main conclusions. Readers may gain a good general understanding of the report and its contents by reading the summary. Additional detailed information is presented in the body of the report.

LIST OF ABBREVIATIONS

ADD	Average Day Demand
AWWA	American Water Works Association
bgs	Below Ground Surface
cfs	Cubic Feet Per Second
CIP	Capital Improvement Plan
EDU	Equivalent Dwelling Unit
EPA	US Environmental Protection Agency
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
fps	feet per second
gpd	gallons per day
gpcd	gallons per capita per day
gpm	gallon per minute
GWR	Ground Water Rule
GWUDI	Ground Water Under the Direct Influence (of surface water)
HAA5	five haloacetic acids regulated by the EPA
HP	Horsepower
LCR	Lead and Copper Rule
MDD	Maximum Day Demand
MMD	Maximum Month Demand
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
MFTR	Manufacturer
MG	Million Gallons
MGD	Million Gallons Per Day
NAVD	North American Vertical Datum
OAR	Oregon Administrative Rule
ODOT	Oregon Department of Transportation
OHA-DWS	Oregon Health Authority Drinking Water Services
OWRD	Oregon Water Resources Department
PHD	Peak Hour Demand
PLC	Programmable Logic Controller
psi	pounds per square inch
PWDS	Public Works Design Standards
SCADA	Supervisory Control and Data Acquisition system
SDC	System Development Charge
SMCL	Secondary Maximum Contaminant Level
UGB	Urban Growth Boundary
USGS	United States Geological Survey
VFD	Variable Frequency Drive
WMCP	Water Management & Conservation Plan
WTP	Water Treatment Plant

EXECUTIVE SUMMARY

Summary Outline

Introduction
Project Objectives
Basis for Master Planning
Study Area & Planning Consideration
Regulatory Requirements
Existing Water System Inventory
Present & Future Water Demands
Water Supply & Treatment Evaluation
Distribution System Evaluation
Water Storage Evaluation
Seismic Evaluation
Recommended Capital Improvement Plan

EXECUTIVE SUMMARY

INTRODUCTION

The purpose of this study is to provide a comprehensive evaluation of the City's water system with respect to its existing and future needs, identify improvements and associated costs necessary to meet those needs, and provide the City with a framework for the provision of water service for a twenty-year planning period, from the year 2025 through 2045.

This executive summary has been prepared to provide a concise overview of the evaluations and recommendations from each chapter of the study. A summary of the capital improvement program costs appears at the end of this section, as well as in Chapter 12.

PROJECT OBJECTIVES

This master plan has been developed to provide the City with a guide for short term and long-term water system improvements and has been prepared as a reference document to assist the City as it evaluates the impacts of proposed development and land use on the water system.

This master plan accomplishes the following specific objectives:

- Establishes water system design and planning criteria
- Provides an inventory of the existing water system infrastructure
- Identifies and prioritizes current and future water system deficiencies
- Provides specific recommendations to the community and City Council for action
- Provides the City with a water system master plan that addresses the needs of both the City and regulating agencies

BASIS FOR MASTER PLANNING

The City's previous water master plan was completed in 2015, which outlined recommended improvements to the water system components including the distribution, storage, and treatment systems. A number of the improvements recommended in the previous water master plan have been addressed. This plan will replace the previous plan entirely and will serve as the City's primary planning document for the next planning period.

STUDY AREA AND PLANNING CONSIDERATIONS - CHAPTER 2

The study area of this report is the entire area within the City of Independence's Urban Growth Boundary (UGB). The improvements recommended in this plan are based on the development of land within the UGB in its present location, as well as the existing land use zoning for these areas. The City expanded the UGB in 2008 to include a relatively large area southwest of the City, known as the "Southwest Area". This document provides specific recommendations for water service in this area.

It is assumed that no significant development will occur within the study area that will require major changes to the existing zoning, and that there will be no significant expansions of the UGB within the study period. Changes in any of these assumptions could change the recommendations contained in this plan. Should significant changes in any of the above occur, this plan should be updated accordingly. Additional information regarding the study area and planning considerations is presented in Chapter 2.

The planning period for this study extends through 2045. Based on US Census data, the population in Independence in 2020 was 9,828. Based on data provided by the Portland State University (PSU) Population Research Center, the population in Independence is expected to increase to approximately to 18,636 by 2045.

This report evaluates the anticipated water supply, treatment, pumping, and storage needs for the 20-year planning period. Implementation of the recommended improvements will provide an adequate and dependable water system for the City's existing and future customers. Significant expansions of the service area, or changes to the existing zoning areas could change the recommendations of this plan. An update or reevaluation of key planning assumptions should be performed if such changes occur.

REGULATORY REQUIREMENTS - CHAPTER 3

The US Environmental Protection Agency (EPA) and Oregon Health Authority Drinking Water Services (OHA) currently enforce drinking water standards for 83 primary contaminants and 16 secondary contaminants. Primary standards regulate contaminants that pose a serious risk to public health, whereas secondary standards cover aesthetic considerations. Public water systems must sample for primary contaminants routinely to ensure that standards are met and must report the results of such sampling to the regulating agency.

The City's water system operates in compliance with the current regulatory requirements. Regulatory compliance is achieved as a function of the basic water system design, the operational modes selected by the City's licensed operators, as well as the current regulatory structure.

A more detailed discussion of existing and anticipated regulatory requirements is provided in Chapter 3.

EXISTING WATER SYSTEM INVENTORY - CHAPTER 4

The City operates and maintains the existing water system and delivers water to its consumers. The City provides for domestic uses and for fire suppression demands. The City's existing water sources are from 10 groundwater wells located in two separate wellfields. Each wellfield is associated with a water treatment plant, reservoir storage, and a booster pump station. The City has two water treatment plants, four ground storage reservoirs, and three booster pump stations. The booster pump stations distribute drinking water to customers using approximately 36.8 miles of watermains throughout the City. The City's distribution grid has an interconnection with the City of Monmouth's grid. This intertie is intended for emergency use only. An overall map of the water system is depicted in Figure 4-2.

PRESENT AND FUTURE WATER DEMANDS - CHAPTER 5

At the most fundamental level, future water demands are a product of per capita water use patterns applied to the anticipated population. The per capita use factors utilized in this report are based on typical historical use rates and do not consider the effects of future conservation programs. The development of a conservation program is encouraged and will provide additional operating margins with regard to supply and capacity.

Water demand is defined as the sum of all water produced and delivered to the City's distribution system. It includes water consumed in all use categories and also includes water loss and unaccounted-for water. Water demand varies across seasonal periods, days of the week, and hours of the day. The establishment of an average day demand rate (ADD) serves as the baseline against which other more intensified demands are measured, such as maximum day demand (MDD), which is defined as the highest production day within the highest production month and peak hour demand (PHD), which is defined as the greatest flow occurring in any one-hour period.

Historical populations were reviewed and future populations were projected using data produced by the PSU Population Forecast Center. Based on the population estimates, this report assumes a 2045 population of 18,636. Figure 5-1 depicts the historical and projected populations based on this analysis.

Historical records of water demand provided by the City were evaluated to determine usage rates and demand variations. The roughly five-year period from 2017 through October 2021 was used as a basis to establish historical water demands. This information combined with the population data forms the basis for estimating future water demands. This report uses an ADD of 106 gallons per capita per day for additional users due to population growth. This value is equal to the existing ADD determined from data for 2017 through 2021. Table 5-4 summarizes the peaking factors used in this report to estimate MDD and PHD based on the ADD.

Future water demand for the municipal population is calculated by adding the current demand to the product of the per-capita demand, the projected additional population in the planning year in question, and a peaking factor. These results are summarized in Table 5-7 and illustrated in Figure 5-5.

WATER SUPPLY EVALUATION - CHAPTER 6

In Oregon, all water is publicly owned. The Oregon Water Resources Department (OWRD) regulates the use of both surface and groundwater throughout the state. Over the years as greater demands have been placed on limited water resources, OWRD has exercised increasing control over water use. Water rights establish a hierarchy utilized by OWRD to adjudicate water in times of water shortages. Accordingly, it is paramount the City secure and maintain suitable water rights to meet long term municipal needs.

The City currently utilizes groundwater from the City's Polk and South Wellfields as its sole source of municipal water. The City has another wellfield not in use that is co-owned with the City of Monmouth, the Willamette Wellfield. This wellfield is partially developed and is not currently viable as a water source. The City has ground water rights for the wellfields. The City also has surface water rights to the Willamette River that are not in use. This chapter evaluated the reliability of the City's water sources for meeting current and projected demands and provided recommendations to supply adequate water through the planning period.

The City's water supply capacity is affected seasonally by groundwater levels. The wells are typically 15-20% less productive in the summer months. A conservative approach is taken in this study by evaluating water supply capacity during the summer. Further recommendations in this study are also based upon securing water supply capacity during the summer months, which is also typically when demand is the highest. As shown in Figure 6-1, the capacity of the Polk Wellfield is limited to 3.41 cfs (1,530 gpm) by the total rate authorized for use by the OWRD. The South Wellfield is limited to 1.28 cfs (575 gpm) by the capacity of the wells in the summer. Therefore, the total existing capacity of the City's two water sources during summer conditions is approximately 2,105 gpm.

Section 6.3.1 provides an evaluation of the City's total water supply capacity. The total water supply required at the end of the planning period is estimated to be 2,930 gpm. This analysis is summarized in Table 6-1 and shown graphically in Figure 6-2. Based on this evaluation, the City's existing water supply will be 4% deficient by 2030. By the end of the planning period, the City's existing water supply will be deficient by 825 gpm (28%), based on the evaluation criterion for total supply capacity. Based on the total capacity evaluation in Table 6-1, this plan recommends that the City start working to develop additional water supply at the beginning of the planning period. Section 6.3.4 discusses potential future water sources that could be utilized to balance the projected deficit in water supply.

As discussed in Section 6.2, the capacity of the Polk and South Wellfields cannot be increased to a level that would balance the City's deficit in water supply through the end of the planning period. The City will need to develop an additional water source. Three alternatives for new water sources are evaluated: the Willamette Wellfield, the Willamette River, and an additional wellfield. Based on all available information and studies to date, it is extremely likely that the Willamette Wellfield will be regulated by OHA as groundwater under the direct influence of surface water, which requires water treatment to surface water standards. This issue is discussed further in Section 4.3.3.

As discussed in Section 6.3.4, developing an additional wellfield in the vicinity of the City is possible, but not expected to be successful in the planning period. Therefore, developing a new wellfield is not recommended as a long-term water supply strategy. However, it is recommended that the City conduct a groundwater availability study to look for potential opportunities to obtain groundwater rights, because a new groundwater source would likely be less costly than utilizing a surface water source. This study is described further under **Project S-11**.

Section 6.3.4 compares further developing the Willamette Wellfield to developing the Willamette River as the new water source. It is recommended that the City avoid further developing in the Willamette Wellfield and pursue the Willamette River for the new water source. Based on available information, it is not expected that the wellfield will be able to provide for the long-term needs of the City and will require a substantial investment to make it a viable water source. Two options for Willamette River intake structures are compared: an intake tower and a collector well. A preliminary engineering and feasibility study is recommended to be completed early in the planning period for a collector well (see **Project S-9**). If the collector well is not feasible, then an intake tower is recommended to be pursued. **Project S-10** provides specific recommendations for the collector well, raw water pump station, and pipeline.

This plan recommends projects to address deficiencies with the City's water rights. These are **Projects S-1, S-2, S-3, and S-4**. **Project S-2** has the potential to increase the authorized capacity of the Polk Wellfield if the water right action is permissible by the OWRD. If this water right action is successful, then the City will be able to delay sourcing water from the Willamette River from roughly the year 2028 to 2033. However, one of the City's most important water rights to the Willamette River requires at least some progress toward construction by August 2026 in order to be in compliance with provisions of the water right (Permit S-54331).

Two projects are recommended to address issues with the existing wellfields. For the Polk Wellfield, **Project S-5** includes upgrades for auxiliary power and instrumentation. This project will allow all of the wells to be operated with the existing generator. For the South Wellfield, **Project S-6** includes improvements to equipment, deteriorated yard piping, and building improvements. Also for the South Wellfield, **Project S-7** is recommended to recommission the use of two existing wells.

Project S-8 is the addition of a second water system intertie with the City of Monmouth's finished water distribution grid. This intertie will add a redundant finished water source in the event of an emergency.

Table 6-2 is a summary of the recommended water supply improvement projects and their recommended budgets. Details of particular projects are discussed in Chapter 6. Detailed cost estimates for projects are provided in **Appendix G**.

WATER TREATMENT EVALUATION - CHAPTER 7

Chapter 7 evaluates improvements to meet the City's water treatment needs during the planning period. The recommended improvements were developed by considering the projected water demands, the condition and performance of the existing facilities, regulatory requirements, and the City's objectives.

The City's existing water sources require relatively simple treatment for groundwater. The existing water treatment processes include softening, activated carbon adsorption, disinfection and fluoridation. The City is currently implementing pH adjustment improvements for the Polk Water Treatment Plant to mitigate increasing copper concentrations in the distribution system. Both the Polk Water Treatment Plant and South Water Treatment Plant have been regularly maintained and have had upgrades relatively recently. Both facilities currently produce water that consistently meets OHA standards. With typical repairs & maintenance, no capital improvements are anticipated to be needed specifically for the existing treatment plants during the planning period.

The City has historically benefitted from the availability of high-quality source water—specifically groundwater that requires very little treatment. This resource is nearing its limit as demands for drinking water increase and new groundwater sources become increasingly difficult to acquire. The City is currently approaching the maximum capacity of its available groundwater sources. As noted in Chapter 6, the City is encouraged to seek out additional high quality groundwater sources to service future demand, but ultimately this plan recommends to begin sourcing additional water from the Willamette River. The water rights held on the Willamette River satisfy the City's projected demands, but this source carries a significantly higher cost due to the associated treatment of that water.

Another challenge the City faces is the potential re-classification of some of its existing groundwater sources as groundwater under the influence of surface water (GWUDI). The OHA defines GWUDI as "any water beneath the surface of the ground with significant occurrences of insects or other macro-organisms, algae or other large-diameter pathogens such as *Giardia lamblia* or *Cryptosporidium*, or significant and relatively rapid shifts in water characteristics such as turbidity, temperature, conductivity or pH which closely correlate to climatological or surface water conditions". The geology of the Polk Wellfield aquifer and the proximity of the wells to the Willamette River classifies this groundwater resource as sensitive to influences from the surface water in the Willamette River. This is an evolving issue; and the OHA is currently reviewing water quality data from this wellfield to make a determination. If the aquifer and/or particular wells are determined to be GWUDI, the City will be required to either take those wells offline, or provide additional treatment.

The salient point from the above discussion is that the era of "easy water" is coming to a close for the City. As Chapter 6 points out, the City has adequate water resources to satisfy its water quantity needs, however the utilization of these un-tapped water resources requires a robust level of water treatment. Chapter 7 provides a discussion of the aspects and issues associated with producing finished drinking water from the Willamette River. This is currently being done by other Cities in the Willamette Valley. The City of Corvallis has utilized the Willamette as a primary source of drinking water since 1949. In 2002 the City of Wilsonville began using the Willamette as the source for their drinking water needs. Other municipalities including Tualatin, Hillsboro, and Newberg are in the process of developing the Willamette as a source.

The reader is referred to Chapter 7 for more detailed discussion of the recommended treatment objectives, processes, and components of the facility. These recommendations are a best estimate of the facility that will be needed and are based on the information available during this study. It should be expected that the treatment objectives and components of the facility will evolve as information becomes available and as public engagement is incorporated in to the planning of the facility. A graphical representation of the proposed treatment process is included in Figure 7-1.

The recommended treatment facility includes a new surface water treatment plant with a production capacity of 1.5 mgd **(Project T-1).** Based on the municipal water demand projection and supply evaluations presented in this study, this capacity will enable the City to meet the maximum day demands through the end of the planning period and have some margin to provide for growth in the following planning period. The major components of the facility include land acquisition, water treatment equipment, a building, civil site improvements, and a pump station. A conceptual site plan for the facility is shown in Figure 7-2. Figure 12-4 is a depiction of the supply, treatment, storage and distribution system projects associated with developing the new water source.

DISTRIBUTION SYSTEM EVALUATION - CHAPTER 8

The primary purpose of a water distribution system is to deliver the full range of consumer demands and fire flows at pressures suited for the particular use. To accomplish this, the distribution system utilizes a combination of large water mains and networks of smaller distribution mains. The City utilizes three booster pump stations to maintain pressure and flow in the distribution system. These are the Polk, South and Monmouth Street Booster Pump Stations. Each pump station was evaluated for necessary improvements during the planning period. **Project P-1** is recommended to address operational issues, aging electrical equipment, and auxiliary power needs at the facility. **Project P-2** includes security fencing improvements for the City's Polk Booster Pump Station, Water Treatment Plant, Reservoirs and adjacent wastewater treatment plant. **Project P-3** is recommended to address electrical issues with the South Booster Pump Station and Water Treatment Plant. **Project P-4** includes the booster pump station at the recommended Willamette Water Treatment Plant. This pump station is intended, in-part, to allow for the Monmouth Street Pump Station & Reservoir to be decommissioned. **Project P-5** is a project specifically for decommissioning the Monmouth Street Pump Station & Reservoir.

The water distribution grid was evaluated for performance under specific fire flow and demand scenarios at the beginning and end of the planning period. A computer-based numerical model was utilized for this analysis. Modeling of water distribution systems is a proven and effective method for simulating and analyzing the performance of a distribution system under a wide range of operational and hydraulic conditions. A properly constructed and calibrated model permits a robust evaluation of the distribution system and often allows the designer to replicate and evaluate hydraulic scenarios that are too difficult or costly to perform in the real world. Such scenarios are useful to determine the overall performance of a distribution system and to identify weaknesses that require improvements. The model was also used to evaluate alternatives for improvements and to make recommendations.

The recommended distribution system improvements are summarized in Table 8-1 through Table 8-6 and are shown graphically in Figure 8-1 through Figure 8-3. Waterline projects are typically recommended for four reasons: to increase fire flows, to replace facilities that are expected to reach the end of their service life during the planning period, to comply with the City's design standards, and to serve new site developments. These are project code categories A, B, C, and D, respectively.

Chapter 8 recommends two miscellaneous projects. **Project M-1** is a study to address taste & odor (T&O) issues with the City's finished drinking water quality. T&O issues in public drinking water systems can be relatively difficult problems to pinpoint, because of their highly subjective nature, the sensitivity of users, and variety of possible factors. T&O issues can develop from any part of the water system, including water sources, treatment processes, reservoirs, and distribution pipes. This project will assess the problem, evaluate causes, and develop alternatives for addressing the issue. **Project M-2** is a recommended update to the Water Master Plan roughly ten years through the planning period. Three recurring programs were also recommended in Chapter 8. These continue the City's existing efforts to track and reduce water loss.

The recommended improvements are summarized in Table 8-1 through Table 8-6 and graphically depicted in Figure 8-1 through Figure 8-3. Additional information supporting these recommendations is included in the City's water utility maps, included in **Appendix A**.

WATER STORAGE EVALUATION - CHAPTER 9

All water used in the City of Independence is stored in four ground-level storage tanks. Each reservoir has an associated pump station, which is used to maintain system pressure and to deliver all demands of the distribution system. The City presently has four finished water storage reservoirs in use for a total storage capacity of 3,478,000 gallons. The City also has an elevated water storage tank that is no longer connected to the water system. Table 4-8 provides an inventory of the City's storage reservoirs.

The primary function of water storage is to provide a reserve of water to equalize daily variations between supply and consumer demand, to serve fire-fighting needs, and to meet system demands during an emergency interruption of supply. The overall storage within a system can be divided into several storage categories, including operational storage, equalization storage, standby (emergency) storage, fire suppression storage, and dead storage. The analysis in Chapter 9 identifies these volumes that are currently provided by the existing storage tanks and compares them to the storage needs anticipated during the planning period.

Chapter 9 provides an evaluation of the City's existing storage tanks and a storage volume analysis. The analysis shows the existing storage tanks will not be adequate to meet the storage requirements for the remainder of the planning period. The evaluation also shows that the Monmouth Street Reservoir & Pump Station would require major capital improvements in order for these facilities to remain in service. **Project R-4** is a new 2.0-million-gallon reservoir that is recommended to be constructed in conjunction with the new water treatment plant. This will be used to balance the projected deficit in storage and to replace storage provided by the Monmouth Street Reservoir. **Projects R-1, R-2, and R-3**, are recommended seismic structural evaluations for the Polk and South water system facilities.

SEISMIC RISK ASSESSMENT & MITIGATION PLAN - CHAPTER 10

OAR 333-061-0060(5)(J) requires communities located in high hazard zones to conduct a seismic risk assessment and mitigation plan as part of a water master planning effort. Chapter 10 includes a description of the analysis and recommended mitigation plan. The critical facilities are identified along with a discussion of the consequences of failure. An overall map that identifies the City's critical water facilities is depicted in Figure 10-2**.** The recommended capital improvement plan includes several projects that mitigate the risk of water system failure as a result of a major earthquake. These includes upgrades for generators and redundancy of water supply, treatment, storage and distribution. Additionally, some critical water distribution pipes are recommended to be replaced. It is recommended that the City consider replacing these pipes with materials that are more resistant to ground motions such as HDPE or restrained joint ductile iron pipe.

OPERATION AND MAINTENANCE - CHAPTER 11

Chapter 11 includes a review of the City's operation and maintenance (O&M) activities and a general discussion of additional activities that City staff should consider. Overall, the City has good O&M practices in place for the water system. The City is already doing several of the activities that are recommended in the chapter. These activities include record keeping, water loss auditing, waterline flushing, valve exercising, cross-connection control, and meter & hydrant maintenance. It is recommended that these activities continue during the planning period. A formalized program is recommended for non-metered water use tracking, which is used for water loss audits (see **Program-1** in Section 8.4.3). A formalized program is recommended for leak detection and repairs (**Program-2**). This is identified with other distribution system water loss reduction programs in Section 8.4.3.

RECOMMENDED CAPITAL IMPROVEMENT PLAN - CHAPTER 12

As summarized in the previous sections, the water system has a number of deficiencies, which either do or will limit the City's ability to provide an adequate level of water service for the duration of the planning period. Some of these deficiencies are more critical than others as they present an immediate effect on the ability to provide adequate service. Other deficiencies will manifest as the City expands and the existing system continues to age.

A prioritizing process was developed to rank the improvement projects since the scope of the proposed improvements is large. Factors utilized in the prioritizing process included several measures of criticality (such as public health concerns, end of useful life, inadequate capacity, and City priority), as well as the cost and benefit of each project.

Priority 1 improvements are recommended to be undertaken as soon as practical. These are projects necessary to resolve existing or near-term system deficiencies, especially due to water rights or supply capacity. Priority 2 projects are needed to maintain adequate water service based on the condition of aging infrastructure, seismic risk mitigation, and to improve redundancy of water supply to users. Although not critical at this time, they should be considered as improvement projects that will be upgraded to Priority 1 prior to the end of the planning period. Priority 3 projects, while important, are not deemed critical at the present time but will eventually be needed to improve system reliability or to supply future demands. Priority 4 projects are intended to bring existing waterlines in to compliance with the City's design standards for minimum waterline size standards. These projects are not considered absolutely necessary during the planning period. Presented in the table below is a summary of the priority category totals.

Table ES-1| Summary of CIP Estimated Costs

Priority Level	Total Estimated Cost
Priority 1	$44,588,000
Priority 2	$11,630,000
Priority 3	$26,086,000
Priority 4	$12,971,000
Total	$95,275,000

Table ES-2 is a comprehensive listing of the recommended water system improvement projects. The location of many of the prioritized improvements is shown in Figure 12-1 through Figure 12-4 (in the body of the report). The reader is referred to the body of this report for more detailed descriptions of the individual projects.

Work on the Priority 1 improvements should begin as soon as feasible following approval of this plan by the Oregon Health Authority and formal adoption by the City Council. Priority 2 projects are expected to be needed within the planning period as the City desires to improve reliability and upgrade aging infrastructure. Priority 2 projects can begin as finances become available and as the need arises.

The City does not currently have the resources nor is the City's existing user fee structure sufficient to fund all of the recommended improvements; therefore, alternative funding sources must be pursued. Several potential funding sources are identified and discussed in the last portion of Chapter 12. All funding options will likely require an increase of the user rates and SDCs.

Table ES-2| Recommended Capital Improvement Projects by Priority

Project Code (1)	Project Description	Chapter	Priority	Total Estimated Project Cost (2)
S-1	Groundwater Right Development, Permit G-12134	6	1	$10,000
S-2	Groundwater Right Development, Permit G-17868	6	1	$10,000
S-4	Surface Water Right Development, Permit S-54331	6	1	$20,000
S-5	Polk Wellfield Electrical Improvements	6	1	$459,000
S-6	South Wellfield Improvements	6	1	$857,000
S-7	Recommission South Wells 4 & 5	6	1	$15,000
S-9	Collector Well Preliminary Engineering	6	1	$100,000
S-10	Collector Well & Conveyance Improvements	6	1	$5,590,000
S-11	Groundwater Availability Study	6	1	$25,000
T-1	Surface Water Treatment Facility	7	1	$19,000,000
A-7	B & 4th Street Waterline Replacement	8	1	$154,000
B-2	D Street at 12th St Waterline Replacement	8	1	$253,000
B-3	7th, D & 9th Streets Waterline Replacement	8	1	$694,000
B-4	D Street at 2nd St Steel Waterline Replacement	8	1	$189,000
B-5	E Street from 9th to 13th Waterline Replacement	8	1	$1,010,000
B-6	F Street from 9th to 3rd St Waterline Replacement	8	1	$931,000
B-9	3rd Street & E Street Waterline Replacement	8	1	$479,000
B-10	I & H Streets Waterline Replacement	8	1	$680,000
B-12	Corvallis Road Steel Waterline Replacement	8	1	$428,000
B-17	Walnut, Ash & Log Cabin Streets Waterline Replacement	8	1	$1,407,000
B-18	Monmouth St Waterline Replacement	8	1	$808,000
B-19	Copper Water Service Replacements	8	1	$6,000,000
D-6	Corvallis Road Waterline	8	1	$354,000
P-1	Polk Booster Pump Station Electrical Improvements	8	1	$852,000
P-3	South Booster Pump Station Electrical Improvements	8	1	$84,000
P-4	Willamette Water Treatment Plant Booster Pump Station	8	1	(See Project T-1)
R-1	Polk Reservoir 1 & WTP Facility Seismic Evaluation	9	1	$50,000
R-2	Polk Reservoir 2 Seismic Evaluation	9	1	$40,000
R-3	South Reservoir & WTP Facility Seismic Evaluation	9	1	$50,000
R-4	New 2.0-million-gallon Reservoir	9	1	$4,039,000
	Subtotal Priority 1			**$44,588,000**

Table ES-2| Recommended Capital Improvement Projects by Priority

Project Code (1)	Project Description	Chapter	Priority	Total Estimated Project Cost (2)
A-1	Wild Rose Ct Waterline Replacement	8	2	$181,000
A-2	12th Street & Dawn Ct Waterline Replacement	8	2	$430,000
A-3	B Street & Rhoda Ln Waterline Replacement	8	2	$636,000
A-4	17th Street Waterline Replacement	8	2	$442,000
A-5	16th Street & Talmadge Road Waterline Replacement	8	2	$535,000
A-6	9th Street Waterline Replacement	8	2	$333,000
A-8	Maple Ct Waterline Replacement	8	2	$284,000
A-9	Pine Ct Waterline Replacement	8	2	$206,000
A-10	Evergreen Dr Waterline Replacement	8	2	$273,000
B-1	Gun Club Road Waterline Replacement	8	2	$1,353,000
B-7	5th St from E to F Streets Waterline Replacement	8	2	$160,000
B-8	3rd St from F to I Streets Waterline Replacement	8	2	$410,000
B-11	River Oak Rd Waterline Replacement	8	2	$501,000
B-13	Polk & Walnut Streets Waterline Replacement	8	2	$890,000
B-14	Log Cabin Waterline Replacement	8	2	$664,000
B-15	Main Street Waterline Replacement	8	2	$1,050,000
B-16	River Drive Waterline Replacement #1	8	2	$405,000
B-20	Water Meter Replacements	8	2	$2,160,000
P-2	Polk Water & Wastewater Facility Fencing Improvements	8	2	$367,000
M-1	Taste & Odor Study	8	2	$50,000
M-2	Water Master Plan Update	8	2	$300,000
	Subtotal Priority 2			**$11,630,000**
D-1	Airport Residential & Industrial Zone Waterlines	8	3	$4,588,000
D-2	Southwest Area Residential Waterlines - North	8	3	$8,976,000
D-3	Southwest Area Residential Waterlines - South	8	3	$8,112,000
D-4	Mt. Fir Rd Waterline Replacement from Washington to 6th St	8	3	$362,000
D-5	Mt. Fir Rd Waterline	8	3	$747,000
D-7	Mt. Fir & Corvallis Road Residential Waterlines	8	3	$2,423,000
P-5	Decommission Monmouth Street Pump Station & Reservoir	8	3	$200,000
S-3	Groundwater Right Development, Permit G-17750	6	3	$10,000
S-8	New Water System Intertie	6	3	$668,000
	Subtotal Priority 3			**$26,086,000**

Table ES-2| Recommended Capital Improvement Projects by Priority

Project Code (1)	Project Description	Chapter	Priority	Total Estimated Project Cost (2)
C-1	Hyacinth St Waterline Replacement	8	4	$326,000
C-2	Williams St Waterline Replacement	8	4	$560,000
C-3	13th St Waterline Replacement	8	4	$420,000
C-4	11th & 12th St Waterline Replacements	8	4	$556,000
C-5	Randall Way Waterline Replacements	8	4	$563,000
C-6	6th & 7th St Waterline Replacements	8	4	$654,000
C-7	Freedom Estates Subdivision Waterline Replacements	8	4	$1,635,000
C-8	I St Waterline Replacement	8	4	$281,000
C-9	5th & 6th St Waterline Replacements	8	4	$549,000
C-10	6th & 7th St Waterline Replacements	8	4	$746,000
C-11	A & B St Waterline Replacements	8	4	$867,000
C-12	2nd & B St Waterline Replacements	8	4	$402,000
C-13	River Drive Waterline Replacement #2	8	4	$242,000
C-14	Independence Airpark Waterline Replacements	8	4	$5,170,000
	Subtotal Priority 4			**$12,971,000**
Recurring Annual Programs (see section 8.4.3)				
Program-1	Non-metered Water Use Tracking System	8	1	$2,000 / year
Program-2	Leak Detection and Repair Program	8	1	$55,000 / year
Program-3	Water Management & Conservation Plan Update	8	1	$6,000/ year
	Subtotal Recurring Annual Programs			**$63,000 per year**

1 Project Code Legend:
A : Distribution- Fire Flow B: Distribution- End of Service Life C: Distribution- Design Standard Improvement
D : Distribution- Undeveloped Areas
S : Water Source/Supply T : Treatment R : Reservoir/ Storage
M : Miscellaneous Program : Recurring Annual Program

2 See Section 12.3.2 for basis of project cost estimates, August 2022 ENR 20 City Construction Cost Index of 13171

3 See Appendix G for detailed project cost estimates.

CHAPTER 1

INTRODUCTION

Chapter Outline

1.1 General Overview
1.2 Need For Water System Master Plan
1.3 Purpose
1.4 Scope of Work
1.5 Planning Regulatory Compliance
1.6 Previous Studies And Reports

INTRODUCTION

CHAPTER 1

1.1 GENERAL OVERVIEW

The City of Independence is located in Polk County approximately ten miles southwest of Salem, Oregon. The City provides water service to the residents within the City Limits. The City has a comprehensive plan for the area within the City Limits. The City Limits and Urban Growth Boundary (UGB) serve as the study area for this report.

The UGB encompasses approximately 2,300 acres. Of this area, approximately 1,900 acres is currently within the City Limits. The water system currently serves approximately 2,700 user connections. The overall population of the City is approximately 10,000 people.

The City owns and operates the public drinking water system that serves the entire municipal population. The City currently sources water from two wellfields. In addition to the wellfields, the City also has water rights to source water from the Willamette River, but these rights are not currently being used. Two treatment facilities process raw water from the wells into potable drinking water that is distributed to users.

The City's population is growing relatively quickly. Additionally, the City's existing water system is aging and will need to be improved to address age-related issues.

1.2 NEED FOR WATER SYSTEM MASTER PLAN

The City adopted the previous Water Master Plan in 2015. Over the past several years, the City has been developing its long-term strategy for water sources and associated infrastructure. An updated Master Plan is being prepared at this time to assist in this process. Additionally, the City is in the process of certificating existing water rights, which requires an updated Water Management & Conservation Plan (WMCP). A WMCP and Master Plan have overlapping components and strategies. Therefore, it is reasonable to update the City's Water Master Plan at this time.

1.3 PURPOSE

The purpose of this plan is to provide a comprehensive evaluation of the City's water system with respect to its existing and future needs, identify improvements and associated costs necessary to meet those needs, and provide the City with a framework for the provision of water service through the year 2045.

This master plan will assist the City in planning and implementing capital improvements. This plan also provides recommendations of how to serve areas within the UGB that are currently undeveloped. The plan will benefit current and future residents of the City by improving water quality, planning for growth, and providing for scheduled improvements with an equitable distribution of improvement costs.

1.4 SCOPE OF WORK

The scope of work for this master plan is to describe the City's existing and future needs, identify improvements and associated costs necessary to meet those needs, and provide the City with a planning document to guide future water system expansion. This plan accomplishes the following specific objectives:

- Establish water system design and planning criteria
- Describe existing and anticipated federal and state drinking water regulatory requirements
- Provide an inventory of the existing water system infrastructure

- Establish water demand projections based on historic and anticipated population
- Evaluate water supply quality and adequacy
- Evaluate the need for modifications to the water treatment facility
- Develop a hydraulic model of the City's water distribution system
- Evaluate the existing distribution system to determine required improvements
- Evaluate existing storage reservoirs and perform a system-wide storage analysis
- Evaluate the existing instrumentation and control system
- Develop recommendations for system-wide improvements to enhance reliability
- Develop recommendations for a prioritized Capital Improvement Plan (based on the above evaluations) to correct existing deficiencies and to serve future growth.
- Provide the City with a water system master plan that addresses the concerns of both the City and regulating agencies.

The water master plan can be used to develop specific recommendations to the community and City Council for action. This report does not include a wetland inventory or delineation, topographic or aerial surveys, on-site environmental investigations or geotechnical investigations.

1.5 Planning Regulatory Compliance

Master Plan Requirements

The Oregon Health Authority Drinking Water Services (OHA) requires community water systems with 300 or more service connections to maintain a current water master plan. This plan has been prepared to satisfy the requirements of the OHA as stipulated in OAR 333-061-0060(5).

Future Master Plan Updates

It should be recognized that projections into the future are subject to many variables and assumptions, some of which may prove inaccurate. Accordingly, it is recommended that the City review its water system at five-year intervals and update this report at 10-year maximum intervals (or more frequently if necessary).

1.6 Previous Studies And Reports

The following reports and studies were referenced in the preparation of this study.

- Technical Memorandum: Corrosion Control Strategies for Drinking Water, Westech Engineering, 1/7/20
- Technical Memorandum: City of Independence Willamette River Wellfield – Surface Water to Groundwater Transfer Hydrogeologic Evaluation of Wells' Connection to River, GSI Water Solutions, 11/8/17
- Pumping Interference Calculations v2 (Polk Wellfield), GSI Water Solutions, 8/8/19
- Technical Memorandum: City of Independence Production Well Siting Evaluation, GSI Water Solutions, 2/15/19
- City of Independence Water System Master Plan Update, 4B Engineering & Consulting, February 2015

CHAPTER 2

STUDY AREA AND PLANNING CONSIDERATIONS

Chapter Outline

2.1 Study Area

2.2 Study Period

2.3 Physical Environment

2.4 Socioeconomic Environment

STUDY AREA AND PLANNING CONSIDERATIONS

2.1 STUDY AREA

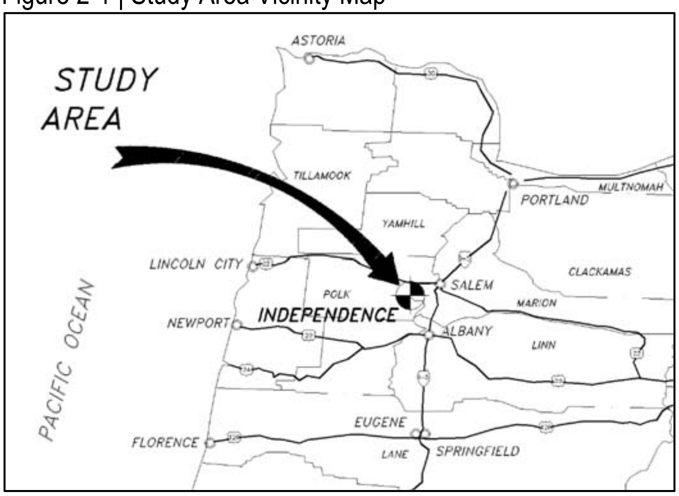
The City of Independence is located in the mid-Willamette Valley in Polk County, Oregon. The City is roughly ten miles southwest of the City of Salem, as shown in Figure 2-1. State highways 99W, 22, and 51 provide primary access to the City. Independence is located on the western bank of the Willamette River. The population of Independence is approximately 10,000 people.

The City has a defined Urban Growth Boundary (UGB) and City Limits. The UGB encompasses approximately 2,300 acres. Of this area, approximately 1,900 acres is currently within the City Limits. Eventually all of the City's UGB will be within the City Limits. Figure 2-3 is a map depicting the study area with these features. This figure and several others are presented at the end of this chapter for formatting purposes.

The study area of this report is the entire area within the City's UGB. The improvements recommended in this plan are based on the development of land within the UGB in its present location, as well as the existing land use zoning for these areas. It is assumed that no significant development will occur within the study area that will require major changes to the existing zoning, and that there will be no significant expansions of the UGB within the study period. Changes to any of these assumptions could change the recommendations contained in this plan. Should significant changes in any of the above occur, this plan should be updated accordingly.

The City's development code establishes zoning and land use restrictions for certain areas within the City. Figure 2-4 depicts these features at the end of this chapter.

Figure 2-1 | Study Area Vicinity Map



2.2 STUDY PERIOD

Choosing a "reasonable" design period for which a utility system should be designed is a somewhat arbitrary decision. If the design period is too short, the public faces the prospect of demands exceeding capacity, requiring the system to be continually upgraded or replaced. On the other hand, choosing a design period that is too long can lead to facilities with excess capacity that may never be needed if population growth does not occur at the projected rates. Such facilities can place an economic burden on the present population and may become obsolete before being fully utilized.

The Oregon Health Authority Drinking Water Services (OHA) has established 20 years as a proper planning period for water system improvements. This report will evaluate the anticipated water supply, treatment, distribution and storage needs for the 20-year planning period. Most waterline pipes are by their nature unsuited for incremental expansion without extensive capital outlays. For this reason, these facilities will be designed for the ultimate development of land within the UGB based on current land use designations. For other facilities such as treatment and storage facilities, a staged approach to expansion may be acceptable. The planning period used in this report ends in the year 2045.

It should be recognized that projections into the future are subject to many variables and assumptions, some of which may prove inaccurate. Accordingly, it is recommended that the City review its water system at 5-year intervals and update this report at 10-year maximum intervals (or more frequently if necessary).

2.3 PHYSICAL ENVIRONMENT

2.3.1 Climate and Rainfall Patterns

The study area is located in the central part of the Willamette Valley. The climate in Independence is relatively mild throughout the year, characterized by cool, wet winters and warm, dry summers. Irrigation in the summer months is common due to low precipitation.

Extreme temperatures in the study area are rare. Days with maximum temperature above 90°F occur only 5-15 times per year on average, and temperatures below 0°F occur only about once every 25 years. Mean high temperatures range from the low 80's in the summer to about 40°F in the coldest months, while average lows are generally in the low 50's in summer and low 30's in winter.

Although snow falls nearly every year, amounts are generally quite low. Willamette Valley floor locations average less than 10 inches per year, mostly during December through February. High winds occur several times per year in association with major weather systems.

Relative humidity is highest during early morning hours, and is generally 80-100 percent throughout the year. During the afternoon, relative humidity is generally lowest, ranging from 70-80 percent during winter months to 30-50 percent during summer months. Annual evaporation is about 35 inches, mostly occurring during the period April through October.

Winters are likely to be cloudy. Average cloud cover during the coldest months exceeds 80 percent, with an average of about 26 cloudy days in January. During summer, however, sunshine is much more abundant, with average cloud cover less than 40 percent. More than half of the days in July are clear.

The study area receives an average of approximately 40 inches of precipitation annually, with the majority of the rainfall occurring during the winter months. The wettest year on record likely occurred in 1996 when most Willamette Valley weather stations recorded over 70 inches of precipitation. Approximately 82% percent of the annual precipitation occurs between November 1 and May 30. The City measures daily precipitation at the wastewater treatment plant.

2.3.2 Topography

The City of Independence is located along the banks of the Willamette River and Ash Creek, which puts parts of the City within floodplains. The topography of the city is relatively flat except for the creek and river banks throughout town. The main downtown area is located on the banks of the Willamette River, which have smaller drainages and river terraces. The landscape generally drains from west to east. Ash Creek, a tributary of the Willamette River separates the northern and southern parts of the City. The lowest elevations in the City are roughly 140 feet high at the confluence of Ash Creek and the Willamette River. The highest elevations are roughly 180 feet high in the northwest and southwest edges of the UGB.

2.3.3 Soils

The soils in Independence are derived from two main parent materials: glacial flood deposits and alluvial sediments. Most of the soil properties exhibited can be attributed to these parent materials.

The glacial flood deposits from the ancient Missoula floods result in the fine silt and clay-dominated soils in the central and eastern portion of the City. These soils tend to have high water holding capacity and low infiltration. These also result in high groundwater areas and seasonal areas of flooding. USDA soil types exhibiting these characteristics include Amity, Concord, and Dayton.

Soils derived from alluvial sediments are found on the east side of the City, near the Willamette River and along Ash Creek. The waterways transport sediment from higher in the basin and deposit them in the floodplains. Over time, they result in sandy and silty soils generally with good infiltration. USDA soil types exhibiting these characteristics include Newberg, Coburg, and Malabon.

Several different soil types have been identified and mapped with the study area (see Figure 2-5 at the end of this section). Overall, soil types do not generally place limitations on development of the sanitary sewer system.

2.3.4 Water Resources

There are significant ground and surface water resources adjacent to and within the City. These are associated with the Willamette River. The Oregon Department of Water Resources regulates the use of both surface and groundwater resources. The City owns several water wells and surface water rights to the Willamette River. These are described in detail in Chapter 4.

2.3.5 Geologic Hazards

Known geologic hazards within the study area include seismic activity and flooding.

2.3.5.1 Seismic Activity

The 2008 U.S. Geological Survey (USGS) National Seismic Hazard Maps display earthquake ground motions for various probability levels across the United States. These factors are applied in the seismic provisions of building codes, insurance rate structures, risk assessments, and other public policy. A review of these maps identifies Western Oregon as having a relatively high seismic risk. The Oregon Structural Specialty Code shares this assessment and has adopted similar ground motion data as the USGS. Seismic risk factors for structures are typically influenced by a combination of factors including the geographical location, specific building and structural configurations, and local soil types. The construction and rehabilitation of significant structures recommended by this report (buildings and hydraulic structures) will require detailed geotechnical reports and site-specific seismic evaluations.

2.3.5.2 Flooding

As previously mentioned, the Willamette River is the primary stream within the study area, with Ash Creek being the only major tributary within the study area. Ash Creek enters the Willamette River near downtown Independence at approximately river mile 95. The Willamette River has a streamflow pattern typified by high flows during the winter and low flows during the summer months.

The Federal Emergency Management Agency (FEMA) has established a 100-year floodplain designation and insurance ratings for the study area. While sometimes referred to as the “100-year flood”, it is more accurate to consider it the flood having a 1-percent chance of occurrence in any year, or a 10-percent chance of occurrence during any 10-year period. A map of the 100-year floodplain is included in Figure 2-6.

During a 100-year flood (as defined by the Federal Emergency Management Association, FEMA), the Willamette River and Ash Creek rise out of their normal channels creating a large floodplain. Flood profiles and maps for those portions of the waterways adjacent to the study area are included in the Flood Insurance Study prepared for the City as follows.

- FIRM panel 41053C0402F (panel 402 of 575), December 19, 2006
- FIRM panel 41053C0404F (panel 404 of 575), December 19, 2006
- FIRM panel 41053C0410F (panel 410 of 575), December 19, 2006

It should be noted that the Floodplain and Floodway boundaries shown on the FEMA flood maps are based on flood elevations, and as such the actual boundaries may vary slightly from the location shown. Final determinations of whether property is within the floodway or floodplain must be determined based on a topographic survey of the property in question.

2.3.6 Public Health Hazards

There are no known public health hazards within the City of Independence.

2.3.7 Native Vegetation and Wildlife

Within the City boundaries there is riparian habitat with native vegetation and wildlife. These exist in the floodplains of the Willamette River and Ash Creek. These streambanks are periodically flooded and consistently moist throughout the year, leading to the diverse array of plants and animals that live there. Common tree species in this habitat include Bigleaf maple, Black cottonwood, Oregon ash, Oregon white oak, Red alder, and White alder. Common shrubs within the habitat include Douglas spirea, Snowberry, Red-osier dogwood, and willows.

These vegetation types support a variety of animals, including aquatic mammals, birds, and fish. Beaver can be commonly seen diving in and out of the stream banks. Packs of otters will roam the banks and dine on crayfish and small fish, such as smallmouth bass. Osprey and bald eagles frequently patrol the rivers and dive in for a catch.

In addition to the riparian wildlife, a variety of other species are found throughout the study area. Wildlife in the area includes squirrels, skunks, raccoons, nutrias, coyotes, opossum, deer, and a variety of reptiles and amphibians.

2.3.8 Air Quality and Noise

Air quality in the study area is generally good. Significant non-natural noise sources within the study area are limited to traffic on local streets and Monmouth-Independence Highway and construction.

2.3.9 Environmentally Sensitive Areas

The riparian areas and wetlands adjacent to the various natural waterways that run through the study area are considered to be environmentally sensitive areas. Figure 2-7 included at the end of this chapter shows the locations of designated wetlands within the study area. Not all wetland areas within the study area are shown in this figure and detailed wetland investigations may be required prior to the implementation of the recommended improvements.

2.3.10 Historical & Archeological Sites

There are no known archaeological sites that will be disturbed or impacted by the proposed improvements. However, since the mouths and banks of rivers are well known to have been centers of Native American life. It should be noted that archaeological or cultural deposits including artifact middens, burial sites, village sites, etc. could be located within the project boundaries. As such, a detailed archaeological assessment may need to be performed prior to implementation of the recommended improvements.

2.3.11 Threatened or Endangered Species

A comprehensive inventory for threatened or endangered species under the Endangered Species Act (ESA) within the study area has not been completed. However, the Oregon Department of Fish and Wildlife maintains an inventory of both state and federally-listed threatened and endangered species. Project specific biological assessments may be required for those capital improvements that include work in existing undeveloped areas.

2.4 SOCIOECONOMIC ENVIRONMENT

Growth within the study area will depend on socioeconomic conditions. The following section contains a general discussion of economic conditions, trends, population, land use, and public facilities relating to the both the study area and the City.

2.4.1 Economic Conditions and Trends

Economics in Independence has historically been based around manufacturing, natural resources, quarrying, and agriculture. In the past decade, substantial employment has been gained from retail, and healthcare. With the redevelopment of the downtown area, the new hotel, and expansion of residential development, economic activity is expected to be further supported by retail and tourism.

The Urban Growth Boundary (UGB) was last modified in 2008 when the City added area to the southwestern and northwestern parts of town. Most of this new area is intended for residential development, but some is zoned industrial. Independence is home to several manufacturers that provide numerous jobs to citizens. Many residents of Independence are employed in the neighboring Salem-Keizer metropolitan area.

2.4.2 Population & Growth Projections

Between 2000 and 2010, the population within the Independence UGB grew at an average annual rate of 3.4%, which was a relatively high growth rate compared to Polk County overall. During this same period, the number of housing units in Independence increased by 45% (1,003 units), the largest increase of any UGB in Polk County. This growth slowed after the 2008 recession. However, recent years have shown a pickup in development in Independence from new subdivisions and redevelopment to the expanded downtown.

In June of 2017, population projections for Polk County were prepared by the Portland State University Population Research Center. Independence’s population in 2017 was estimated to be approximately 9,326. The 2020 U.S. Census measured the population in Independence to be 9,828. The Portland State University Population Forecast Center (PSU) forecasts from 2017 through 2035 population within the Independence UGB will grow at a rate of 2.2%. PSU forecasts from 2035 through 2067 population within the UGB will grow at a rate of 1.4%. Polk County is expected to grow more slowly during these same time periods at rates of 1.5% and 1.1% respectively.

The PSU Population Research Center estimates the 2045 population within the Independence UGB to be 16,276. This value is known as the “county coordinated population projection” and will be used for planning purposes in order to conform to state-wide planning goals.

A more in-depth discussion of population projections is presented in Chapter 5 - Present and Future Water Demands.

2.4.3 Land Use

The City's Comprehensive Plan includes an urban growth boundary (UGB) that encompasses approximately 2,300 acres with approximately 1,900 acres within the current City Limits.

Eventually the entire area within the UGB will be part of Independence and will be served by the City's utility systems. The planning area is made up of land in two general categories, namely land inside of City limits and land outside of the City limits, all of which is inside the Urban Growth Boundary. Land use zoning in Independence is comprised primarily of residential uses, although the Comprehensive Plan sets aside large areas for industrial and commercial development. Total areas under each zoning designation are listed in Table 2-1. Total area of land use categories are ranked in Figure 2-2. A map showing the UGB, City limits and land use zoning areas appears on Figure 2-4 at the end of this chapter.

The majority of the land within the City limits is currently developed or partially developed. All of the land inside the UGB, but outside the City limits, is undeveloped except for some rural residential properties.

House Bill 2001

In 2019, the Oregon Legislature passed House Bill 2001 (HB 2001). The legislation requires local governments to permit property owners to develop additional housing units in residential zones. The law establishes different requirements for cities depending on their population. Medium Cities are those with a population between 10,000 and 25,000. Independence is expected to be classified as a Medium City during the planning period. All Medium Cities are required to allow the development of duplexes on each property zoned for residential use that allows for detached single-family dwellings. Properties are subject to these requirements regardless of the zoning, districting (e.g., historic), title record, or any homeowner's association covenants, conditions, or restrictions (CC&R's).

HB 2001 is anticipated to cause infill, redevelopment and increased density. This places additional demand on public infrastructure, such as water mains, sewers, and streets. Cities are required to identify and remediate deficiencies in existing infrastructure that are caused by HB 2001. Additionally, Cities are required to provide adequate infrastructure for future residential subdivisions that could redevelop as allowed by HB 2001. Cities and developers are expected to pay for new infrastructure and improvements to existing infrastructure that are needed as a result of HB 2001.

2.4.4 Energy Production and Consumption

Electricity is provided to the community by Pacific Power. Natural gas service is provided to the City by NW Natural. There are no grid-scale power generation facilities within the City.

Table 2-1 | Approximate Areas by Land Use Zone within Current City Limits

Land Use Zone		Area (acres)	Area (% of Total)
Low-Density Residential	RS	298	17%
Medium-Density Residential	RM	313	18%
High-Density Residential	RH	106	6%
Residential Single-Family Airpark Overlay	RSA	109	6%
Mixed Residential	MX	143	8%
Mixed-Use Pedestrian Friendly Commercial	MUPC	81	5%
Downtown Riverfront Zone	DRZ	10	1%
Light Industrial	IL	107	6%
Heavy Industrial	IH	125	7%
Industrial Park	IP	44	3%
Airport District	AD	101	6%
Agricultural	AG	20	1%
Public Service	PS	284	16%
	Total	1,741	100%

Figure 2-2 | Ranked Land Uses

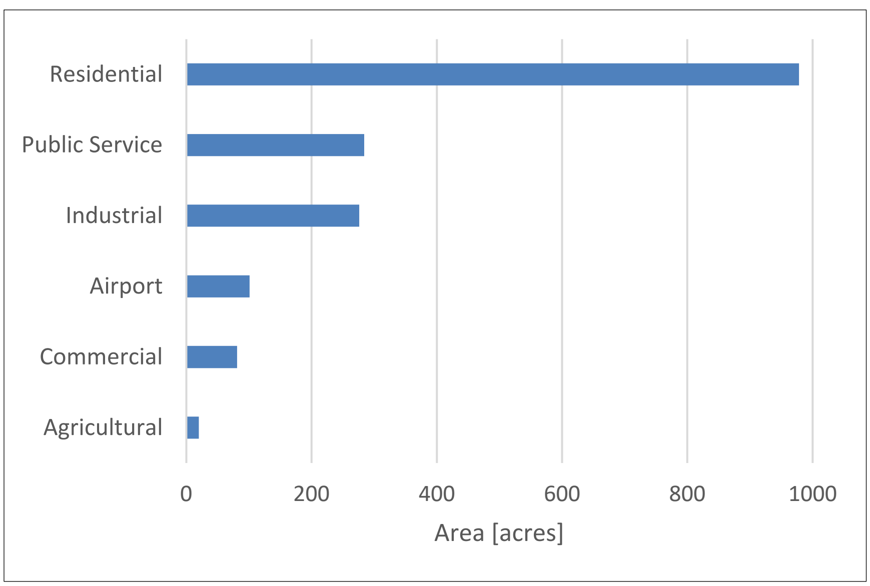


Figure 2-3 | Study Area

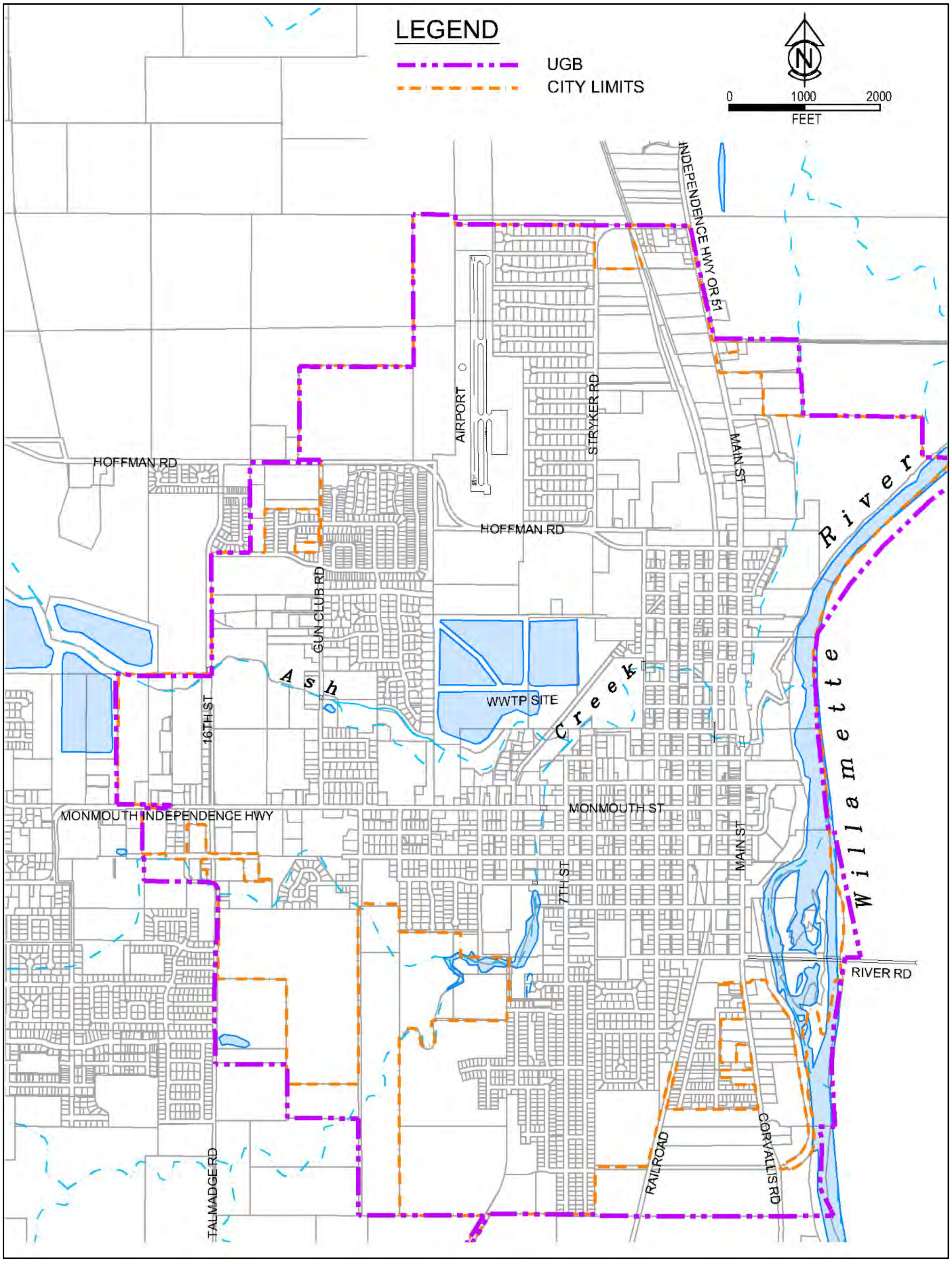


Figure 2-4 | Comprehensive Plan Designations

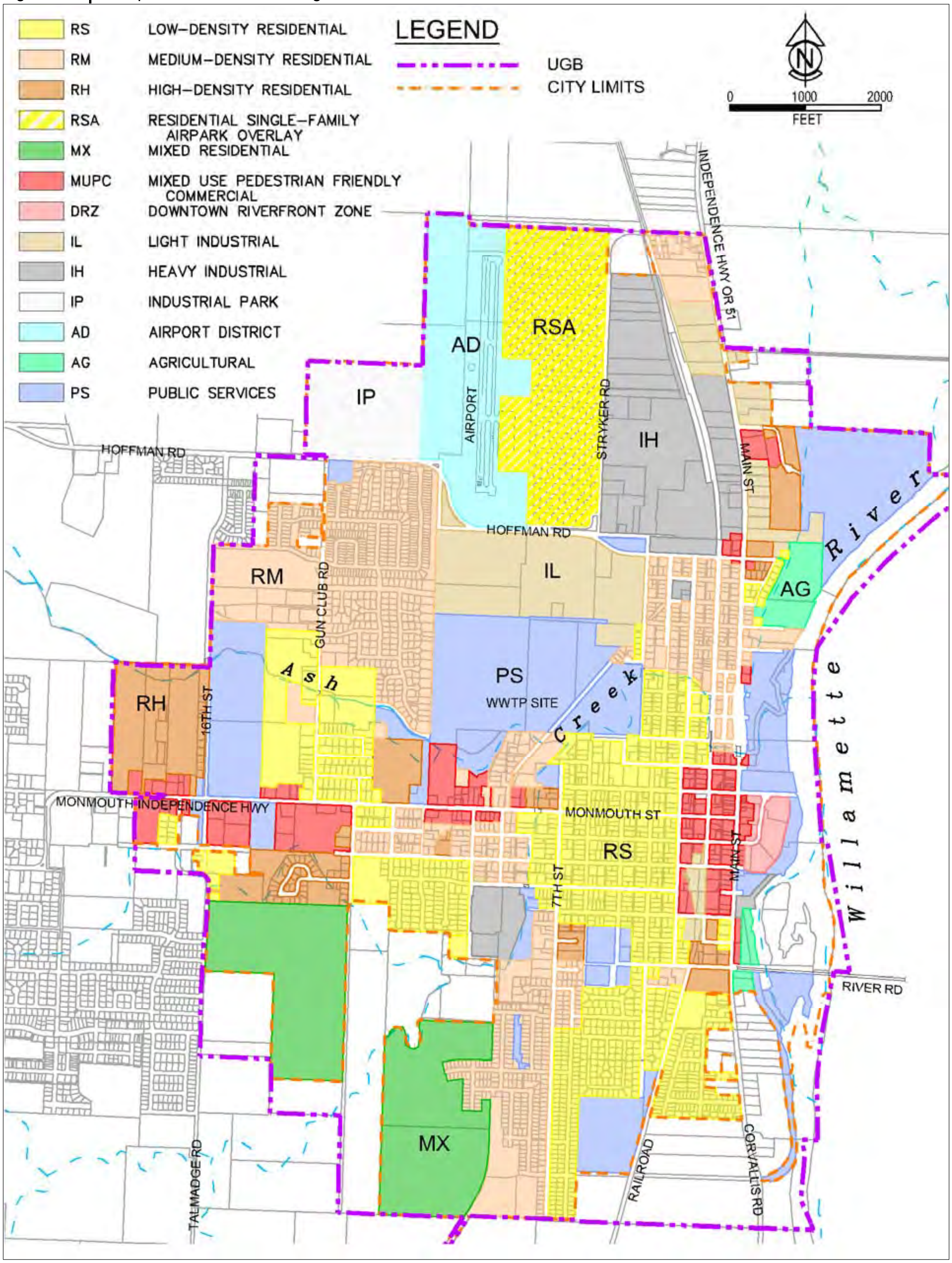


Figure 2-5 | Soils Map

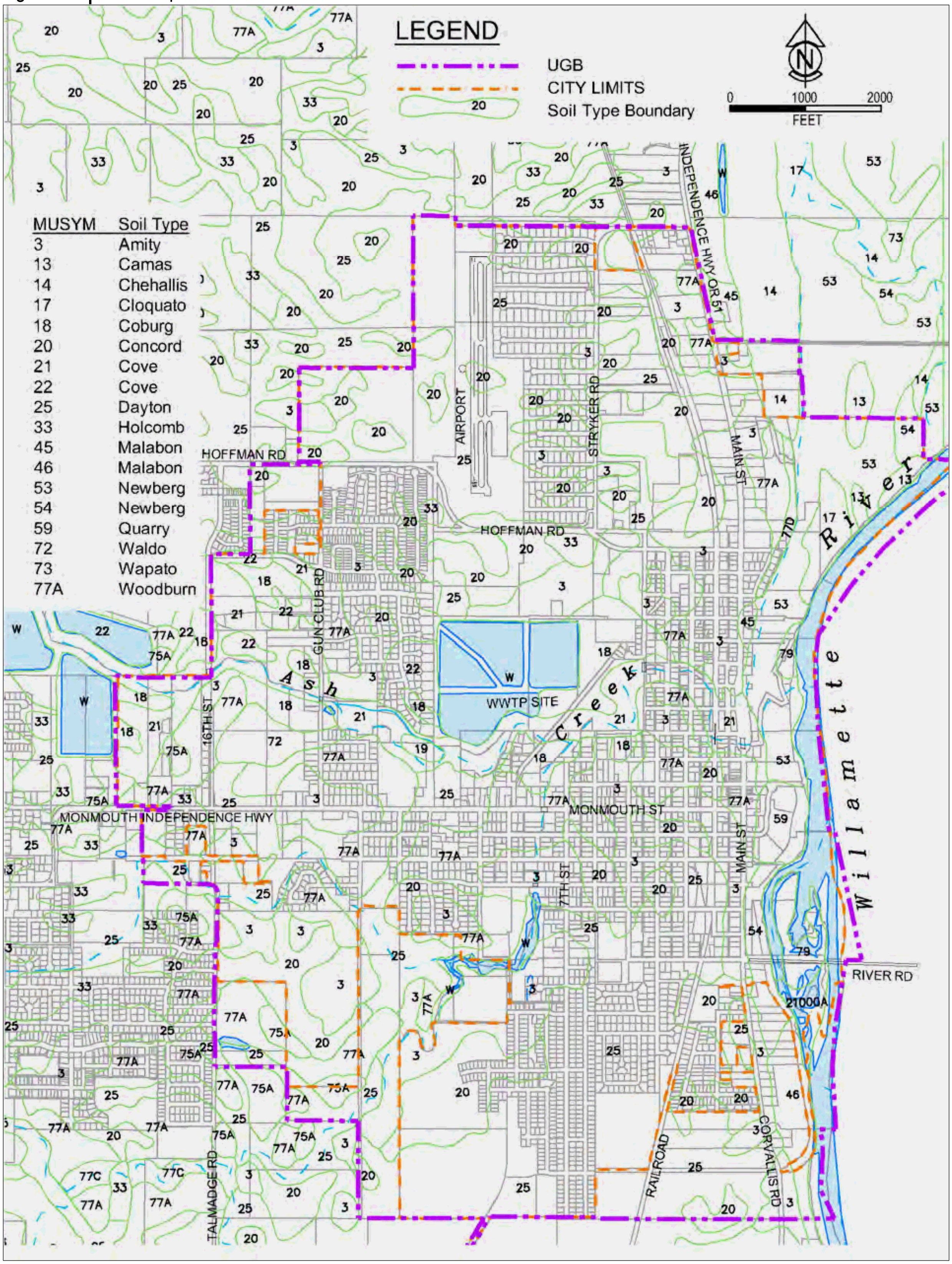


Figure 2-6 | 100-Year Floodplain

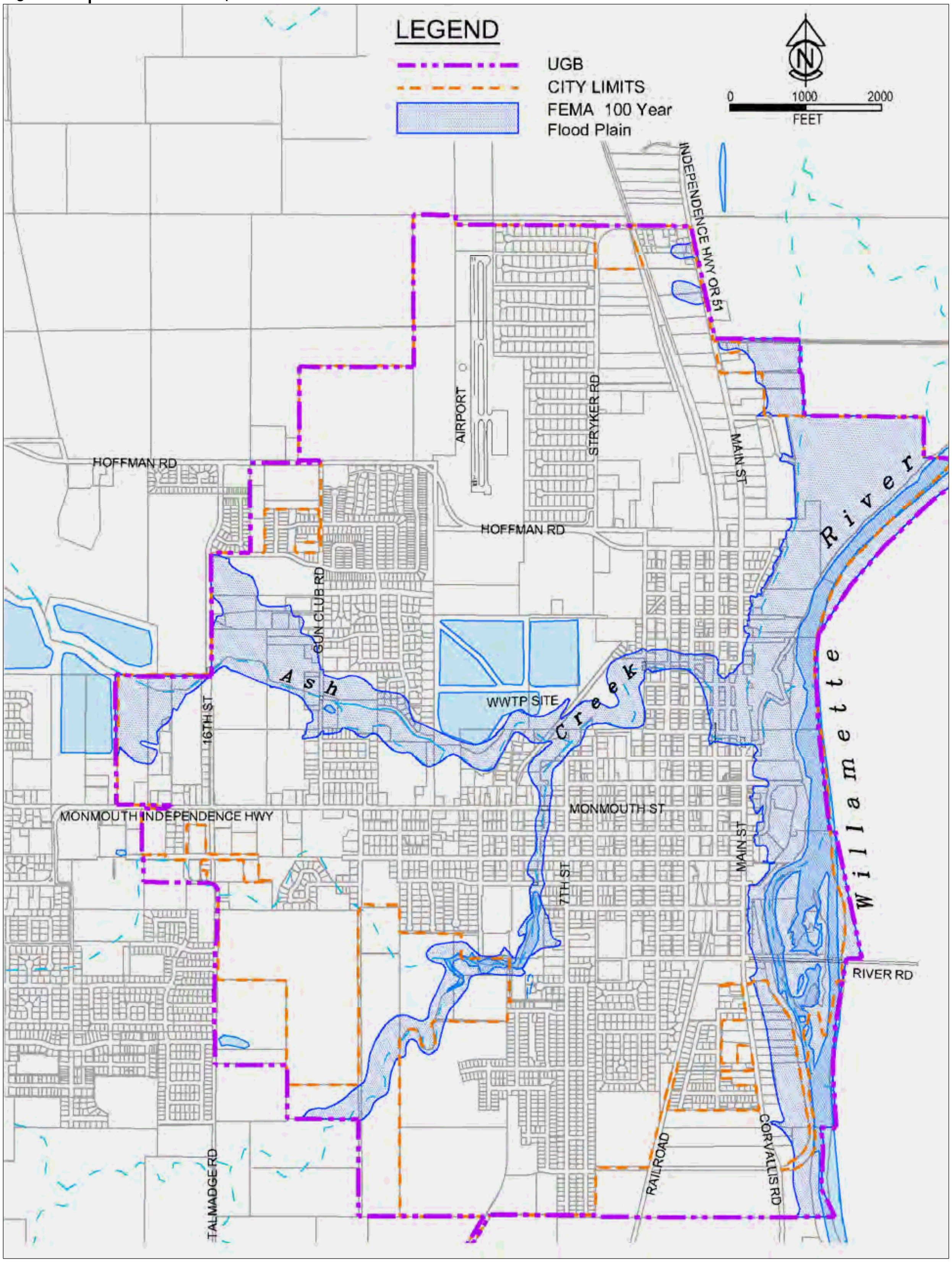
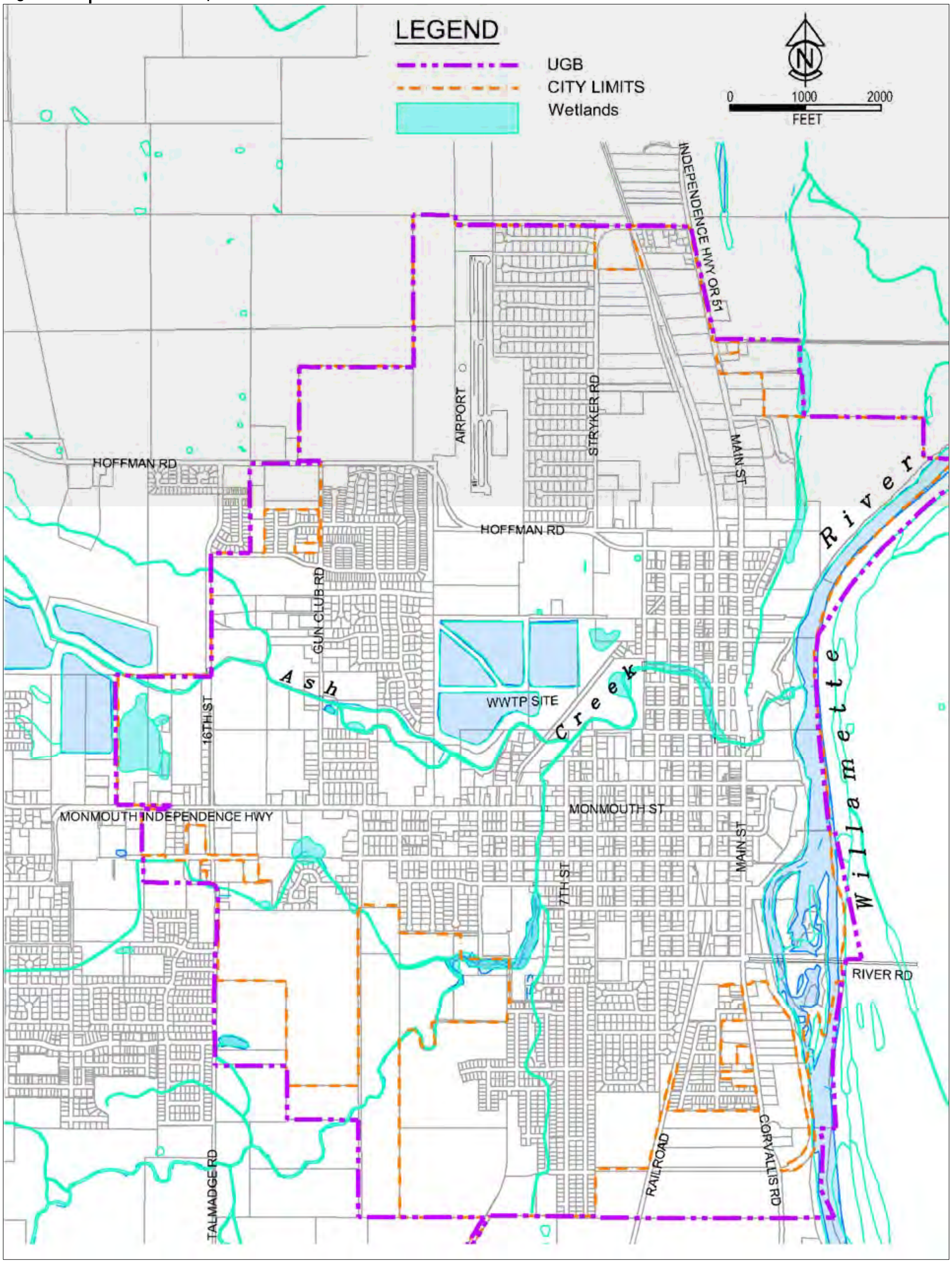


Figure 2-7 | Wetlands Map



CITY OF INDEPENDENCE
Water System Master Plan
Independence, Oregon

CHAPTER 3

REGULATORY REQUIREMENTS

Chapter Outline

3.1 Introduction
3.2 Regulating Agencies
3.3 Existing Water Quality Regulations
3.4 Consumer Confidence Report Rule
3.5 Cross-Connection Control Program
3.6 Sanitary Survey
3.7 Vulnerability Assessment
3.8 Future Water Quality Regulations
3.9 City Public Works Design Standards
3.10 Standards for Municipal Wells
3.11 Water Use Regulations & Water Rights
3.12 Water Management & Conservation Plan

REGULATORY REQUIREMENTS

3.1 INTRODUCTION

This chapter provides a summary of the key regulatory requirements and standards that govern the operation of the City's water system, which form a basis of the master planning effort. These regulations include both water quality and water use standards. This overview is for general reference only and may not include all requirements.

3.2 REGULATING AGENCIES

The Oregon Health Authority Drinking Water Services (OHA) is the primary regulating agency for water quality standards related to public drinking water systems in the State. Rules relating to public water systems are contained in the Oregon Administrative Rules (OAR 333-061). Water rights and water use regulations are administered by the Oregon Water Resources Department (OWRD).

The City's water system is registered with OHA as a community water system and Public Water System ID OR41-00399. Based on the most recent OHA Sanitary Survey, the City meets the criteria of an Outstanding Performer.

3.3 EXISTING WATER QUALITY REGULATIONS

Congress passed the original Title XIV of the Public Health Service Act, commonly known as the Safe Drinking Water Act (SDWA), in 1974. The SDWA and subsequent amendments are federal water quality regulations affecting all public water purveyors. Regulations under the SDWA at the federal level are promulgated by the US Environmental Protection Agency (EPA). The requirements of the SDWA and amendments are implemented by the State of Oregon under the Oregon Drinking Water Quality Act of 1981 (ORS 448 as amended). This legislation allowed the State to gain primacy for enforcing the federal rule requirements and the responsibility of maintaining and enforcing a drinking water program.

The OHA currently enforces drinking water standards for 83 primary and 16 secondary contaminants (OAR 333-061-0030/0031). Primary standards regulate contaminants that pose a serious risk to public health whereas secondary standards cover aesthetic considerations. Public water systems must sample for primary contaminants routinely to ensure that standards are met, and report results of that sampling to the regulating agency.

Primary contaminants can be grouped into the following general groups. A discussion of each will be presented in this section.

- Microbial contaminants
- Disinfectants and disinfection byproducts
- Inorganic chemicals
- Organic chemicals
- Radiologic contaminants
- Control of each contaminant is administered through a prescribed list of standards or limits that take several forms.

- *Maximum Contaminant Level Goal (MCLG)* — The level of a contaminant in drinking water below which there is no known or expected risk to health, allowing for a margin of safety. All regulated contaminants have an MCLG, although the MCLG is not enforceable.
- *Maximum Contaminant Level (MCL)* — The highest level of a contaminant allowed in drinking water, set as close to the MCLG as feasible using the best available treatment technologies.
- *Treatment Technique (TT)* — A required treatment process intended to reduce the level of a contaminant in drinking water. Contaminants for which testing or monitoring is not economically or technically feasible are regulated by the establishment of a treatment technique. Treatment techniques represent a requirement to install and operate a treatment process that has a proven efficacy for contaminant reduction.
- *Performance Standards (PS)* are used to determine whether or not a water system is meeting a specific treatment technique requirement and consist of measurements of water quality parameters such as turbidity, disinfectant residual, pH, or alkalinity.
- *Action Level (AL)* — The concentration of a contaminant, which when exceeded, triggers treatment or other requirements that a water supplier must follow.

Water systems that use groundwater sources are governed by a different set of water quality regulations than those that use surface water sources. A third category of source water, regulated under the same standards as surface water, is groundwater under the direct influence of surface water (GWUDI). The OHA defines GWUDI as “any water beneath the surface of the ground with significant occurrences of insects or other macro-organisms, algae or other large-diameter pathogens such as *Giardia lamblia* or *Cryptosporidium*, or significant and relatively rapid shifts in water characteristics such as turbidity, temperature, conductivity or pH which closely correlate to climatological or surface water conditions”. An evaluation of surface water influence can involve geological assessments or water quality analysis, depending on the determination of the OHA. Such investigations or re-evaluations can be made at any time based on changing conditions. If sources that are determined to be potentially GWUDI cannot be upgraded to preclude surface water influence, those sources will be regulated by GWUDI water quality standards.

3.3.1 Microbial Contaminants

Pathogenic microorganisms in drinking water can be divided into three groups: bacteria, protozoa, and viruses. Pathogenic microorganisms have a number of specific properties which distinguish them from chemical contaminants; they are living organisms and are not dissolved in water, although they will coagulate or attach to colloids and solids in water.

Regulatory inactivation or removal of these three groups of microorganisms is predominantly determined by the nature of the water source. In general, municipalities using surface water or GWUDI sources are required to inactivate or remove all three sources, while those using groundwater are required to provide for inactivation of viruses.

- *Bacteria*

Coliforms are a broad class of bacteria which live in the digestive tracts of humans and many animals. Although many types of coliform bacteria are harmless, some cause gastroenteritis, a general category of health problems that includes diarrhea, cramps, nausea, and vomiting. Gastroenteritis is not usually serious for a healthy person, but can cause serious problems for people with weakened immune systems such as the very young, elderly, or immune-compromised. Outside the colon, coliforms only survive for approximately 48 hours. Common bacteriological pathogens responsible for waterborne disease include *Escherichia coli (E. coli), Legionella, Salmonella typhi, Shigella*, and *Vibro cholerae*.

- *Protozoa*

Protozoa are single-cell organisms. They have a complex metabolism and feed on solid nutrients, algae, and bacteria present in multiple-cell organisms, such as humans and animals. To survive harsh environmental conditions, some species can secrete a protective covering and form a resting stage called a cyst, a condition that can protect some protozoa from conventional chlorine disinfection. Common examples of parasitic protozoa are *Giardia lamblia* and *Cryptosporidium*.

- *Viruses*

Unlike bacteria and parasitic protozoa, viruses can only replicate in living host cells and are inactive for periods outside of the host organism. Due to their small size, viruses can pass through conventional filtration processes and are accordingly typically inactivated with chlorine. Common examples of waterborne viruses include hepatitis A, rotavirus and Norwalk virus.

3.3.1.1 Microbial Contaminant Regulations

Several regulations have been promulgated over the years to prevent microbial contamination of drinking water supplies. These include the Total Coliform Rule (TCR), the surface water treatment rule (SWTR), the Long Term 1 Enhanced Surface Water Treatment Rule (LT1ESWTR), and the Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR).

3.3.2 Total Coliform Rule

Initially published in 1989 the Total Coliform Rule (TCR) applies to all public water systems and establishes health goals—in the form of maximum contaminant level goals (MCLGs), and legal limits—in the form of maximum contaminant levels (MCLs) for total coliform levels in drinking water. The goal of the TCR is to maintain microbial quality in finished and distributed drinking water supplies. Therefore, it primarily applies to the distribution system. It requires systems to sample for coliform bacteria, unless the City is complying with treatment technique under the Revised Total Coliform Rule. Total coliform are used as an indicator of whether a water system is vulnerable to pathogens. Coliforms were also selected because they are easily detected in water.

In promulgating the TCR, the EPA set the maximum contaminant health goal (MCLG) for total coliforms at zero. The OHA stipulates the total number of water samples a PWS must test each month and limits the number of "coliform-present" samples within this routine collection set. The number of routine samples is dependent on population.

The City is required to collect ten (10) monthly samples. Samples must be taken from an approved set of locations throughout the distribution grid, and the number of "coliform-present" results is limited to a single sample.

If a sample tests positive for coliforms, the system must collect a set of repeat samples within 24 hours. A "coliform-present" test result on either a routine or repeat sample constitutes a non-acute violation and requires additional testing for fecal coliforms and *E. coli*. A positive result for either fecal coliform or *E. coli* constitutes an acute MCL violation. Public notification is conducted in accordance with OAR 333-061-0042, which outlines a tiered approach commensurate with the prescribed risk level of a given violation.

Compliance for the TCR is based on a monthly cycle measured on two levels: submitting the prescribed number of samples, as well as successful test results for the absence of total coliforms in a given test cycle.

For this study, the last ten years of coliform data was reviewed. In that time, twenty-one samples collected by the City have been "coliform-present." In each case, four repeat samples were taken and all reported negative for coliform.

3.3.3 Revised Total Coliform Rule

The Total Coliform Rule (TCR) was initially published in 1989 and was revised in February, 2013. The Revised Total Coliform Rule (RTCR) applies to all public water systems and establishes health goals- in the form of maximum contaminant level goals (MCLSs), and legal limits- in the form of maximum contaminant levels (MCLs) for *E. coli* in drinking water. The goal of the RTCR is to maintain microbial quality in finished and distributed drinking water supplies. Therefore, it primarily applies to the distribution system. It requires systems to sample for *E. coli* bacteria which are used as an indicator of whether a water system is vulnerable to pathogens.

In promulgating the RTCR, the USEPA set the MCLG and MCL for *E. coli* at zero (0), and eliminated the MCLG and MCL of zero for total coliform (TCR), replacing it with a treatment technique for coliform that requires assessment and corrective action. *E. coli* is a more specific indicator of fecal contamination and potential harmful pathogens than total coliform (many of the organisms detected by total coliform methods are not of fecal origin and do not have any direct public health implications).

Under the newly adopted treatment technique for coliform, total coliform serves as an indicator of a potential pathway of contamination into the distribution system. A public water system that exceeds a specified frequency of total coliform occurrence must conduct an assessment to determine if any sanitary defects exist and, if found, correct them. In addition, a water system that incurs an *E. coli* MCL must conduct an assessment and correct any sanitary defects found.

3.3.4 Surface Water Treatment Rule

The SWTR was promulgated in 1989. It applies to all public water systems using surface water or GWUDI. The City currently does not use either of these sources, so the SWTR rule does not apply. However, the regulations may apply to the City for development of future water sources. The following information is provided for reference.

The primary purpose of the SWTR is to provide public health protection from microbial contaminants including bacteria, protozoa, and viruses. Specific provisions of the SWTR include the following.

- All systems that use surface water or GWUDI must disinfect water before discharging into the distribution system.
- All systems that use surface water or GWUDI must filter unless avoidance criteria can be met.
- All systems that use surface water or GWUDI must reliably achieve 3-log (99.9%) removal and/or inactivation of *Giardia lambia.*
- All systems that use surface water or GWUDI must reliably achieve 4-log (99.99%) removal and/or inactivation of viruses.
- Establishes turbidity performance standards for combined filter effluent.
- Establishes a minimum disinfectant residual of 0.2 mg/L at the entry point to the distribution and requires that minimum detectable levels of disinfectant must be maintained at all locations in the distribution system.

Since it is not practical to measure concentrations of *Giardia lambia* and viruses on a regular basis, the SWTR established performance standards to ensure the removal requirements for these contaminates are achieved. Different treatment technologies are assigned a log removal credit for *Giardia lambia*. For instance, a conventional filtration system may be granted a 2.5-log removal credit for *Giardia lambia.* An additional 0.5 log removal must be provided by another treatment process, such as a chlorine disinfection system, to meet the total 3-log removal credit for *Giardia lambia.*

Pathogen deactivation of a disinfectant is measured based on CT values, which is the disinfectant's concentration multiplied by the time the disinfectant is in contact with the water. The EPA published tables of minimum CT required to achieve various log removal credits. Water treatment systems are required to compare the CT required from the tables to the CT provided on a daily basis to ensure compliance with the SWTR. The EPA also has published tables of CT required to provide 4-log removal of viruses. The CT times for a 4-log virus removal are all lower than the CT times for the 1-log removal of *Giardia lambia.* Therefore, as long as the disinfection system is operated to provide 1-log inactivation of *Giardia lambia,* the 4-log virus removal requirement will also be met.

For some water systems, the SWTR also requires that effluent turbidity from the filters does not exceed 0.5 nephelometric turbidity units (NTU) in 95% of the samples collected with no single result greater than 5 NTU.

3.3.5 Long Term 1 Enhanced Surface Water Treatment Rule

The Long Term 1 Enhanced Surface Water Treatment Rule (LT1ESWTR) was promulgated in 2002. This rule builds on the SWTR by providing improved public health protection against *Cryptosporidium*, while addressing risk tradeoffs with disinfection by-products. The City currently does not use surface water or GWUDI, so the LT1ESWTR rule does not apply. However, the regulations may apply to the City for development of future water sources. The following information is provided for reference.

Specific provisions of the LT1ESWTR include the following.

- Maximum contaminant level goal (MCLG) of zero for *Cryptosporidium*
- 2-log (99%) *Cryptosporidium* removal requirement for systems that use filters.
- Strengthened combined filter effluent turbidity performance standards for systems using conventional and direct filtration.
- Individual filter turbidity monitoring provisions for systems using conventional and direct filtration

Treatment plants that use conventional filtration (consisting of coagulation, sedimentation, and filtration) are generally assumed to meet the 99% *Cryptosporidium* removal requirement as long as they comply with the LT1ESWTR turbidity requirements and existing provisions of the Surface Water Treatment Rule. A system's combined filter effluent turbidity is required to be less than 0.3 NTU in at least 95% of the samples collected with no single result greater than 1 NTU in order to provide the required 2-log inactivation of *Cryptosporidium.*

3.3.6 Long Term 2 Enhanced Surface Water Treatment Rule

The Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR) builds on the provisions of the LT1ESWTR for further protection of public health against risks posed by *Cryptosporidium* and other microbial pathogens. The LT2ESWTR applies to all public water systems that use surface water and GWUDI. The City currently does not use surface water or GWUDI, so the LT2ESWTR rule does not apply. However, the regulations may apply to the City for development of future water sources. The following information is provided for reference.

The goal of the LT2ESWTR is to identify high risk systems and require additional treatment to remove *Cryptosporidium* in those systems. Existing drinking water regulations established in the LT1ESWTR require water systems to provide at least 2-log removal of *Cryptosporidium*. New data on *Cryptosporidium* infectivity, occurrence, and treatment indicate that the current treatment requirements are adequate for the majority of systems. However, there is a subset of systems with higher vulnerability to *Cryptosporidium* where additional treatment is necessary.

All water systems that utilize surface water or GWUDI are required to monitor the source water for *Cryptosporidium*. These water systems will be classified into one of four risk bins based on the results of the source water monitoring. The LT2ESWTR specifies a range of treatment and management strategies, collectively termed the "microbial toolbox," that systems can select from to meet any additional treatment requirements that are required as a result of their bin classification.

3.3.7 Disinfectants and Disinfection Byproducts Rule

Disinfection of drinking water can readily be identified as one of the major public health advances of the 20th century. While disinfectants are effective in controlling many microorganisms, they react with natural organic and inorganic matter in water to form disinfection byproducts (DBPs) which have been shown to be carcinogenic in laboratory animals. While it is important to strengthen protection against microbial contaminants, it is also important to reduce the potential health risks of DBPs.

The Federal Total Trihalomethane Rule was published in the Federal Register in November 1979 and established an MCL for total trihalomethanes (TTHMs) for community water systems serving 10,000 people or more. The Stage 1 Disinfectants and Disinfection Byproducts Rule (Stage 1 DBPR) promulgated in December of 1998 built on the TTHM Rule by lowering the existing MCL and widening the range of affected systems to include all public water systems that add a disinfectant to their drinking water. The rule specifically established:

- Maximum residual disinfectant level goal (MRDLG) for chlorine at 4.0 mg/L
- Maximum residual disinfectant level (MRDL) of 4.0 mg/L for chlorine
- Total trihalomethane MCL of 80 µg/L, regulating the sum of four trihalomethanes
- Haloacetic acid (HAA5) MCL of 40 µg/L, regulating the sum of five haloacetic acids

The rule also established removal limits of total organic carbon (TOC) as a DBP precursor.

The Stage 2 Disinfectants and Disinfection Byproducts Rule (Stage 2 DBPR) was finalized on January 4, 2006 and applies to water systems that use groundwater, GWUDI, and surface water. The rule retains the MCLs for TTHMs and HAA5s established in the Stage 1 DBPR and augments the rule by providing more consistent protection from DBPs across the entire distribution system and by focusing on the reduction of DBP peaks.

The Stage 2 DBPR requires community water systems to conduct initial distribution system evaluations (IDSEs) to identify and select new compliance monitoring sites that more accurately reflect sites representing high TTHM and HAA5 levels. These new 'worst-case' monitoring sites are selected based on the results of the Stage 1 DBPR compliance monitoring. The rule also redefines the method of calculating MCLs. Compliance with each MCL will be based on a locational running annual average (LRAA) instead of the running annual average (RAA) method used under the Stage 1 DBPR.

3.3.7.1 Regulatory Monitoring

Community water systems can fulfill the IDSE requirements by applying for 40/30 Certification, a process whereby a community water system certifies that all individual TTHM and HAA5 monitoring results for compliance with the Stage 1 DBPR are less than or equal to 40 µg/L for TTHM and 30 µg/L for HAA5 during a prescribed 2-year period. In addition the system must not have had any Stage 1 DBPR monitoring violations for TTHM and HAA5 during the same period. At the state's discretion, a system meeting all of the requirements for the 40/30 Stage 2 waiver may still be required to conduct standard monitoring. Systems that qualify for reduced monitoring may remain on reduced monitoring as long as their quarterly LRAAs for TTHMS and HAA5 remain no more than 40 µg/L and 30 µg/L, respectively (for systems with quarterly reduced monitoring) or their TTHM and HAA5 samples are no higher than 60 µg/L and 45µg/L, respectively (for systems with annual or less frequent monitoring).

3.3.7.2 Municipal Compliance

The City currently submits samples for DBP testing from one location. TTHM and HAA5 data reported to OHA for 2004 through August 2021 have all been substantially less than the MCLs. At the present time, the City has been granted the 40/30 Stage 2 waiver and is conducting reduced monitoring. There is no indication that the City will have problems complying with the current MCLs and should continue to qualify for reduced monitoring.

3.3.8 Lead and Copper Rule

Lead or copper in Oregon tap water is primarily due to corrosion of plumbing system components within buildings. Consumers commonly describe the presence of copper as metallic, bitter or rusty. The ability to detect copper in tap water is thought to be controlled by individual sensitivity; however, water chemistry also plays a part since the flavor of copper is more noticeable at lower pH levels.

The control of lead and copper concentrations in drinking water began with the Oregon lead solder ban of 1985, which prohibited the use of lead pipe and set lead content limits for plumbing solder and brass fixtures. In 1991 the EPA promulgated the Lead and Copper Rule (LCR) to further regulate lead and copper concentrations in drinking water. The LCR was uniformly adopted by Oregon on December 7, 1992 and applies to community and non-transient, non-community public water systems. The rule is unique in that compliance is measured by water sampled from the consumer's tap instead of from sampling points at the water treatment plant or within the public distribution system. Failure to meet the regulatory limits requires the water utility to implement a corrosion control treatment process designed to reduce the corrosivity of the water.

3.3.8.1 Regulatory Monitoring

The LCR establishes action levels of 15 µg/L for lead and 1.3 mg/L for copper. It also sets a secondary maximum contaminate level (SMCL) for copper at 1 mg/L. The LCR stipulates that sampling be conducted at "high-risk" homes, further defined as homes constructed prior to 1985 that utilize copper piping and lead-based solder. One-liter samples of standing water (first draw after a minimum 6-hours of non-use) are collected from homes identified in the water system sampling plan. In each round of sampling 90% of the samples must have lead levels less than or equal to the action level. The number of samples is determined by the municipal population and equates to 10 initial samples for the City's system.

Water systems that cannot meet the action levels must install corrosion control treatment, and submit water sampling data to OHA at prescribed frequencies. In the event the lead action level cannot be met with these measures in place a public education program, adjustments to the corrosion control program and follow-up sampling is required.

3.3.8.2 Municipal Compliance

The City has monitored copper levels in the distribution grid since the LCR was adopted. The City's system has consistently remained in compliance and qualifies for the 3-year reduced monitoring schedule. However, the data shows a rising trend of copper levels beginning with a level of 0.96 mg/L in 1993 progressing to 1.27 mg/L in 2020—a value that is rapidly approaching the regulatory LCR action level of 1.30 mg/L. A summary level of 1.30 mg/L was measured between 2011 and 2012.

Improvements to the City's Polk Water Treatment Plant are currently in the process of being designed and implemented to address this issue.

3.3.9 Inorganic Contaminants

The USEPA regulates most chemical contaminants (inorganic and organic contaminants) through the rules known as Phase I, II, IIb, and V. The agency has issued the four rules over a five-year period after gathering, updating, and analyzing information on each contaminant's presence in drinking water supplies and its health effects.

Inorganic contaminants (IOCs) most commonly originate in the source of water supply, but can also enter the water from contact with materials used for pipes, plumbing fixtures and storage tanks. For most IOCs adverse health effects result after long-term (lifetime) exposure to the compounds. Water systems in Oregon rarely violate maximum levels for inorganic contaminants from source waters, but these contaminants are routinely detected in drinking water systems at levels more than one-half the maximum level. The most commonly detected inorganics in Oregon drinking water systems are nitrate, arsenic, nitrite, cadmium, and mercury.

The Oregon Drinking Water Act currently regulates 16 inorganic compounds: Antimony, Arsenic, Asbestos, Barium, Beryllium, Cadmium, Chromium, Cyanide, Fluoride, Mercury, Nickel, Nitrate, Nitrite, Selenium, Sodium and Thallium. Oregon law recognizes the acute health effects of nitrate, particularly for young children, and accordingly requires more stringent testing for nitrate.

3.3.9.1 Regulatory Monitoring

The City has regularly tested for IOCs. The monitoring for IOCs is conventionally required once every three years and annually for nitrate. City has qualified for a 9-year reduced monitoring cycle for IOCs with the exception of nitrate which is required annually.

3.3.9.2 Municipal Compliance

OHA records over the past 19 years indicate that IOCs are predominantly not detected in the City's water system. Three IOCs are regularly detected in the City's system that are typically found in municipal water systems at low concentrations: nitrates, fluoride and sodium. The detected concentrations for nitrate and fluoride are well below the MCLs. The EPA does not set a maximum contaminant level or secondary contaminant level for sodium. The City is in compliance for IOC testing. Based on the City's compliance history, the sampling frequency required by OHA will likely remain once every nine years and there is no reason to suspect future compliance issues.

3.3.10 Organic Contaminants

Current drinking water standards regulate a total of 56 organic contaminants frequently classified into two sub-groups, Volatile Organic Chemicals (VOC's) and Synthetic Organic Chemicals (SOC's). Organic contaminants are man-made chemicals and commonly include industrial and commercial solvents and chemicals as well as herbicides and pesticides used in agriculture and landscaping.

3.3.10.1 Regulatory Monitoring

Public water systems are required to test for each contaminant from each water source during every 3-year compliance period. Public water systems with a population greater than 3,300 must test twice during each three-year compliance period for SOCs. Public water systems using surface water or GWUDI must test for VOC's at the entry point annually. Quarterly follow up testing is required for any contaminants that are detected. The exceptions are dioxin and acrylamide/epichlorohydrin. Only those systems determined by OHA to be at risk of contamination must monitor for dioxin. Sampling may be reduced to a 6-year cycle if the system has a certified Drinking Water Protection Plan. Systems that cannot meet the MCLs must install or modify treatment systems or develop alternate sources.

3.3.10.2 Municipal Compliance

The City currently tests for SOC's and VOC's regularly in compliance with OHA regulations. SOC and VOC data since 1984 was reviewed for this study. During this time all results were either "not detected" or below MCLs except for the groundwater contamination at the South Wellfield with PCE that occurred between 2005 and 2007. This contamination event was well documented and extensively mitigated by the City, OHA, and DEQ. This event is described in further detail in Section 4.3.2.1 that discussed the South Wellfield. Based on the results of SOC and VOC water testing, there is no reason to suspect that the City will have issues with these contaminants in the planning period.

3.3.11 Radiologic Contaminants

The purpose of this rule is to limit exposure to radioactive contaminants in drinking water. Most drinking water sources have very low levels of radioactive contaminants, most of which are naturally occurring as trace elements in rocks and soils. Most radioactive contaminants are at levels that are low enough to not be considered a public health concern. At higher levels, long-term exposure to radionuclides in drinking water may cause cancer. Radon, another decay product of radioactive material, is regulated independently under the Radon Rule later in this chapter.

3.3.11.1 Regulatory Monitoring

Initial testing required by this rule began in 2005 and required all public water systems to test each source quarterly for one year, with test results required for gross alpha, radium-226/228 and uranium. The City is required to test for radiologic contaminants every 9 years at each wellfield.

3.3.11.2 Municipal Compliance

All radiologic test results have shown no detected constituents. Based on this history, there is no reason to suspect that radiologic contaminates will become a problem in the future.

3.3.12 Arsenic Rule

On January 22, 2001 EPA adopted a new standard for arsenic in drinking water at 10 micrograms per liter (µg/L or ppb), replacing the old standard of 50 µg/L. Oregon adopted the rule and the new limit went into effect on October 21, 2004.

Arsenic is a naturally occurring chemical found in the earth's crust, but can be dangerous to humans when released into drinking water supplies as rocks, minerals, and soils erode. Studies have linked long-term exposure to arsenic contamination with cancer and cardiovascular, pulmonary, immunological, neurological, and endocrine effects.

3.3.12.1 Regulatory Monitoring

Systems with surface water sources must sample annually whereas systems with groundwater sources sample every three years. Water systems that exceed the MCL must monitor quarterly and meet the MCL as a running annual average. Public water systems that cannot meet the MCL must either install water treatment systems or develop alternate sources of water.

3.3.12.2 Municipal Compliance

The City has tested for arsenic regularly since 1985. All arsenic test results have been in compliance. Based on this history, there is no reason to suspect that arsenic will become a problem in the future.

3.3.13 Secondary Contaminants

The EPA has established National Secondary Drinking Water Regulations that set non-mandatory secondary maximum contaminant level (SMCL) water quality standards for 15 contaminants. The EPA does not enforce these SMCLs as they are not considered to present a risk to human health at the listed levels. They are established only as guidelines to assist public water systems in managing their drinking water for aesthetic considerations. Table 3-1 lists these contaminants.

Table 3-1| Secondary Maximum Contaminant Levels

Contaminant	Secondary MCL	Noticeable Effects above the Secondary SMCL
Aluminum	0.05 – 2.0 mg/L	Colored water
Chloride	250 mg/L	Salty taste
Color	15 color units	Visible tint
Copper	1.0 mg/L	Metallic taste, blue-green staining
Corrosivity	Non-corrosive	Metallic taste, corroded pipes/fixture staining
Fluoride	2.0 mg/L	Tooth discoloration
Foaming Agents	0.5 mg/L	Frothy, cloudy, bitter taste, odor
Iron	0.3 mg/L	Rusty color; sediment, metallic taste, reddish or orange staining
Manganese	0.05 mg/L	Black to brown color, black staining, bitter metallic taste
Odor	3 TON (1)	Musty, "rotten-egg" or chemical smell
pH	6.5 – 8.5	Low pH: bitter metallic taste, corrosion High pH: slippery feel, soda taste, deposits
Silver	0.1 mg/L	Skin discoloration, graying of the white part of the eye
Sulfate	250 mg/L	Salty taste
Total Dissolved Solids	500 mg/L	Hardness, deposits, colored water, staining, salty taste
Zinc	5 mg/L	Metallic taste

1 Threshold Odor Number

3.3.13.1 Regulatory Monitoring

Secondary maximum contaminant levels are non-mandatory regulations and therefore do not have a monitoring requirement.

3.3.14 Groundwater Rule

On November 8, 2006 the US EPA promulgated the final Ground Water Rule (GWR) to reduce the risk of exposure to fecal contamination that may be present in public water systems that use groundwater sources. The GWR builds upon the Total Coliform Rule (TCR) and addresses bacterial and viral contamination at the source (prior to treatment), as a complimentary approach to the distribution monitoring currently required by the TCR.

The GWR establishes a risk-targeted approach to identify groundwater systems that are susceptible to fecal contamination. Indications of risk may come from total coliform monitoring, hydrogeologic sensitivity analyses, or other system-specific data and information. The GWR specifically targets viral pathogens as a category of fecal contaminants.

The rule applies to all public water systems served by groundwater sources that are not treated to Surface Water Treatment Rule (SWTR) standards.

3.3.14.1 Regulatory Monitoring

For systems that elect to achieve 4-log (99.99%) inactivation of viruses by disinfection for all sources, compliance monitoring is required to ensure the reliability of the treatment process (i.e., compliance monitoring includes continuous monitoring of chlorine residual at the entry point to distribution system). This 4-log virus inactivation disinfection requirement is based on CT values between the water source(s) and the first water user. The concept of "CT" is used to verify the level of treatment or inactivation. CT is achieved by providing enough time for chlorine to inactivate potentially harmful organisms in drinking water before it is consumed. **CT** represents an abbreviation of chlorine **C**oncentration (measured at the first user of the drinking water) multiplied by the contact **T**ime (the water's time of travel between the point of chlorine addition to the first user). The CT required for 4-log inactivation of viruses depends on the water temperature and the free chlorine residual concentration in the water. In general, the colder the water temperature (or the higher the pH), the less effective chlorine inactivation is, and greater the CT values that are required (i.e., longer contact time for a given chlorine concentration).

For systems that do not achieve 4-log (99.99%) inactivation of viruses by disinfection for all sources, the following requirements of the GWR apply:

- Triggered source water monitoring
- Hydrogeologic sensitivity assessments for aquifers
- Assessment monitoring for all sources

The triggered source water monitoring provisions of the GWR are more detailed than any other provision of the final rule and can only be avoided by providing the required 4-log virus inactivation and/or removal prior the first customer.

For a groundwater system without 4-log virus treatment, a single positive routine Total Coliform Rule (TCR) compliance sample will initiate triggered monitoring. A single source water sample must be taken within 24 hours from each groundwater source in production at the time of the positive TCR sample. Testing is performed to detect the presence of *Escherichia coli* (*E.coli*). Systems with an initial positive source water sample must take five more source water samples. The rule anticipates the use of 100-mL samples from wells or springs. The switch from the current requirement of fecal coliform testing after identifying a total coliform sample to *E.coli* testing has been made because *E. coli* is currently understood to be a better indicator of the presence of pathogens.

A hydrogeologic sensitivity assessment (HSA) may be required for all groundwater systems that do not provide 4-log virus inactivation/removal. However, the rule does not require that the HSA provision be used on any system's supply, nor does it specify what approach states should use to identify systems that should be targeted for HSAs. The GWR is not explicit on the consequences of an HSA that finds a source to be sensitive, but draft guidance reads, "*Source water assessment monitoring is recommended as necessary and wells located in sensitive aquifers should be targeted for assessment monitoring using a hydrogeologic sensitivity assessment*".

Assessment monitoring occurs at the state's discretion. The GWR suggests that assessment monitoring should include 12 groundwater source samples that represent each month the system provides groundwater to the public. The consequences of a positive sample from assessment monitoring are not specified in the GWR. There appears to be latitude for the state to determine that any positive sample obtained during assessment monitoring triggers the treatment technique provisions.

Under the existing Total Coliform Rule (TCR) sanitary surveys are to be performed on a 5-year interval. The GWR sanitary survey requirement has been structured to provide more frequent and complete sanitary surveys with more stringent penalties for non-compliance. Surveys are to be performed every 3-years with some discretion granted for water systems that have consistently demonstrated outstanding performance. Failure to correct deficiencies and comply with the required corrective action plan or schedule will result in a treatment technique violation for the water system.

The monitoring requirements for 4-log treatment of viruses in groundwater systems are defined in OAR 333-061-0036 (11). The treatment and disinfection requirements for groundwater are defined in OAR 333-061-0032 (6).

3.3.14.2 Municipal Compliance

As described in greater detail in Chapter 4, the City currently sources its water from groundwater and does not treat the water to SWTR standards. Therefore, the City is subject to the Groundwater Rule. The City utilizes an EPA approved disinfection method to achieve at least 4-log treatment of viruses before the first customer. The City continuously monitors entry-point disinfectant residual (at least one sample per day). Therefore, the City is in compliance with the GWR. Additionally, the City monitors coliform annually at each well.

3.3.15 Filter Backwash Recycling Rule

The Filter Backwash Recycling Rule (FBRR) was published in the Federal Register on April 10, 2000 and was adopted by the State of Oregon in June of 2004. The FBRR complements existing surface water and GWUDI treatment rules by reducing the potential for microbial pathogens, particularly *Cryptosporidium* oocysts, to pass through the filters into the finished water. The FBRR requires all recycled waste streams (e.g., spent filter backwash, thickener supernatant, or liquids from dewatering processes) to be returned to the head of the plant and passed through the entire treatment process, unless properly disposed of otherwise.

3.4 CONSUMER CONFIDENCE REPORT RULE

The EPA published the Consumer Confidence Report Rule in the Federal Register on August 19, 1998. The CCR Rule requires community water systems to provide an annual report to their customers detailing information on water quality delivered by the system and documenting water quality monitoring results.

The report must be distributed by July 1 of each year, must contain an explanation of data collected during or prior to the previous calendar year, and must provide the telephone number of the owner, operator or designee of the community water system as a source of additional information concerning the report. This information is typically sent out with water bills; however, systems must make a good faith effort to reach consumers who do not get water bills (typically renters). Water systems must certify to the OHA that the CCR was sent to customers and that the information it contained was correct and consistent with the compliance monitoring data previously submitted to the OHA. Complete details of the rule requirements can be found in OAR 333-061-0043.

The City provides its users with annual Consumer Confidence Reports.

3.5 CROSS-CONNECTION CONTROL PROGRAM

Plumbing cross-connections, defined as actual or potential connections between a potable and non-potable water supply, constitute a serious health hazard. There are numerous well documented cases where cross-connections have been responsible for the contamination of drinking water and have resulted in poisonings or the spread of disease.

Oregon Administrative Rules 333-061-0070 through 0074 detail the requirements for a cross-connection control program. The City is required to establish a cross-connection ordinance and must submit an annual report to OHA. Systems with more than 300 service connections are required to provide a certified tester.

The City's cross-connection control standards are contained in the City's Municipal Code Chapter 34 Division 4.- Cross Connection Requirements. The City currently employs two certified cross-connection control specialists who are responsible for inspecting new devices and installations, monitoring annual inspections, terminating water service in cases of non-compliance and submitting the annual inspection report to OHA. The City regularly submits the annual cross-connection summary report to OHA.

3.6 SANITARY SURVEY

The OHA conducts a sanitary survey of each public water system on a regular basis. Sanitary surveys are a critical component of the State's drinking water regulatory program. Under Oregon statute, sanitary survey is "*an on-site review of the source, facilities, equipment, operation and maintenance of a water system, including related land uses, for the purpose of evaluating the capability of that water system to produce and distribute safe drinking water*."

The sanitary survey (conducted by OHA or contract County health department staff) results in a report that includes, as a minimum, "*the following components of a water system: source of supply; treatment; distribution system; finished water storage; pumps, pump facilities and controls; monitoring, reporting and data verification; system management and operations; and operator certification compliance*." The sanitary survey report identifies any significant deficiency prescribed in OAR 333-061-0076, or any violation of drinking water regulations, discovered during the on-site visit.

Public water systems must have completed corrective action of any significant deficiencies within 120 days of receiving written notice, or be in compliance with a OHA approved "corrective action plan" within 120 days of receiving written notice of a significant deficiency.

The most recent sanitary survey for Independence was completed October 26, 2017. The survey did not identify any deficiencies. Independence is considered an Outstanding Performer. The City's survey frequency is every 3 years.

3.7 VULNERABILITY ASSESSMENT

The events of Sept. 11, 2001, reinforced the need to enhance the security of the United States. Congress responded by passing the Public Health Security and Bioterrorism Preparedness and Response Act of 2002 (the Bioterrorism Act), which was signed into law June 12, 2002. The Act amends the Safe Drinking Water Act, requires every community water system that serves a population greater than 3,300 persons to have an Emergency Response Plan and conduct a Vulnerability Assessment. These documents must be completed in order to fulfill the requirements of a Safe Drinking Water Revolving Loan Fund Program. The law specifies actions that community water systems and the USEPA must take to improve the security of the nation's drinking water infrastructure.

Complete details of the requirements for Oregon water systems can be found in OAR 333-061-0064.

3.8 FUTURE WATER QUALITY REGULATIONS

The following include both existing regulations which may not apply to the City at present, but which it may become subject to in the future, as well as anticipated future rules that are currently in the regulatory pipeline.

The EPA is required to review existing national primary drinking water regulations every six years in order to identify current health risk assessments, changes in technology, and other factors that provide a health or technological basis to support regulatory revisions to maintain or improve public health protection.

3.8.1 Unregulated Contaminant Monitoring Rule

This is an existing regulation that the City may become subject to in the future, if the population limits in the rule are modified, or if the OHA decides to include the City in this program. The Unregulated Contaminant Monitoring Rule (UCMR) is used to collect data for contaminants suspected to be present in drinking water, but that do not have health-based standards set under the Safe Drinking Water Act. The UCMR is closely coordinated with EPA's Contaminant Candidate List. The EPA uses both of these programs to identify drinking water contaminants that are not currently regulated in order to identify future health risks and problems with drinking water.

To date, the program has been implemented in three stages, UCM Rounds 1 & 2, UCMR1 and UCMR2 on a 5-year cycle. The first stage was managed by the state primacy agencies and consisted of screening and assessment monitoring tests. The UCMR1 promulgated on September 17, 1999 utilized a tiered monitoring approach that required all large public water systems and a nationally representative sample of small public water systems serving less than 10,000 people to monitor for selected sets of contaminants. The UCMR2 promulgated on January 4, 2007, is being managed by the EPA and requires monitoring for a new set of unregulated contaminants. To date, the City has not been required to collect data for the UCMR, but may be required to in the future.

3.8.2 Radon

Monitoring of radon in drinking water is an anticipated new regulation. Radon is a naturally occurring gas formed from the decay of uranium-238. Radon in drinking water can contribute to indoor air radon levels from washing and showering. Inhalation or ingestion of radon can result in lung or stomach cancer. The USEPA has proposed preliminary guidelines for the regulation of radon; however, the final form of the rule has yet to be promulgated.

The City is not required to monitor radon at this time.

3.9 CITY PUBLIC WORKS DESIGN STANDARDS

The City has adopted design standards for water system improvements under City jurisdiction. These Public Works Design Standards (PWDS) provide a uniform set of criteria for use by engineers in the design of public water distribution improvements. The intent of these standards is to provide guidelines for the design of public facilities that will provide an adequate service level for present development as well as for future development. The PWDS cannot provide for all situations. They are intended to assist but not to substitute for competent work by design professionals.

The following are the intentions of the PWDS.

- To be consistent with current City Ordinances
- To provide design guidance criteria to the private sector for the design of public improvements within the City of Independence
- To ensure constructed facilities have sufficient structural strength to withstand all external loads that may be imposed
- To ensure facilities are constructed of materials resistant to both corrosion and erosion with a minimum design life of 75 years
- To ensure facilities are economical & safe to build and maintain
- To ensure facilities meet all design requirements of the OHA

3.10 STANDARDS FOR MUNICIPAL WELLS

Construction standards for wells utilized as municipal water sources are regulated by the OHA rules OAR 333-061-0050 (2) a).

3.10.1 Municipal Wells

Oregon's well construction standards are designed to protect groundwater resources and the public. They help prevent contamination of the well or aquifer by surface and subsurface leakage which may carry harmful chemicals or bacteria, and they help prevent physical injury and waste of water. The following is a summary of some of the design & construction standards for these sources, although this list is not all inclusive.

- *Area of Control*. For wells located within municipalities with community gravity sewer systems, the City must own or control the area within 50 feet of the wellhead. For wells outside of the City, the area of control is based on a 100 foot radius.
- *Flood Protection*. Wells typically are not to be located in flood prone areas, unless the area around the well is mounded and the casing is extended a minimum of 2 feet above the 100-year flood elevation.
- *Well Drilling Standards*. Wells shall be drilled and developed in accordance with OAR 690-200 through 220, which is administered by the OWRD.
- *Water Quality Standards*. Prior to placing the well in service, water must be tested to verify that it conforms with drinking water quality standards.
- *Well Pump, Piping & Well House Standards*. Well & pump standards include seals at the top of the well, a casing vent, provisions for water level measurement, sample tap, flow measurement, concrete slab around the well (except when a pitless adapter is used) with well casing 12-inches minimum above the slab, site graded away from well, well house to be insulated & heated with lights, and constructed to allow pump removal.

3.11 WATER USE REGULATIONS & WATER RIGHTS

The Oregon Water Resources Department (OWRD) regulates the use of both surface and groundwater throughout the state of Oregon. On February 24, 1909, the State of Oregon enacted the Water Rights Act, a comprehensive surface water code. This act made "prior appropriation" the sole method of acquiring water rights in Oregon. The system is basically one of first come, first served. Each water right includes a priority date. Prior appropriation utilizes the priority date of a water right to establish the order in which water rights are satisfied in times of shortage. A senior water right is entitled to full delivery of all water under their right before any junior rights are served. Oregon adopted a parallel groundwater code on August 3, 1955. Together, these codes establish a regulatory scheme under which the OWRD exercises jurisdiction over the right to use the State's waters.

In Oregon, all water is publicly owned. Landowners with water flowing past or under their property do not automatically have the right to divert the water without a permit. Over the years as greater demands are placed on limited water resources, OWRD has been exercising greater control over this water use. Water rights have long been used to control the withdrawal of surface or ground water for municipal or agricultural use. Water rights are issued only for beneficial use, without waste. Each water right includes a designated type of "use" and is limited to that purpose. General categories of beneficial use include, but are not limited to irrigation, municipal, industrial, commercial and domestic. Since 1987, the law has specifically included instream flow protection as a beneficial use. A water right holder is entitled to use as much water as is necessary, up to the maximum amount shown on the water right, to accomplish the stated beneficial use. Water rights issued after the adoption of the 1955 groundwater code are issued in two stages: the issuance of an initial water right *permit*, and upon full development, the issuance of a final water right *certificate*.

The first stage is a water right permit, which serves as the initial authorization for a water user to develop the source and begin making beneficial use of the water. The permit typically describes the source, the source location, the priority date, the amount of water that can be used, and documents any water use conditions. Water right permits were typically issued for a five-year period. If the water use had not been developed to the full intended extent within the five-year period, an extension could be requested. In evaluating extension requests, the OWRD considers whether or not the applicant has shown diligence in the development of the water right. Failure to develop a permitted source during the permit period could subject the permit to cancellation by the State.

Until several years ago, permit extensions were routinely granted by the OWRD, largely because there was little or no opposition to the extension requests. In the early 1990s, however, in the face of new Endangered Species Listings and growing attention by environmental groups, the State Attorney General advised the OWRD that the past practice of routine permit extensions was not legally sufficient. As a result, the OWRD made substantial changes to the permit extension process. The new rules require a more extensive analysis of the level of diligence shown by the permit holder in developing the water right, as well as consideration of other competing needs for the water. The process also includes a careful review of potential impacts on listed species, or flows necessary for Scenic Waterway purposes. If a permit extension is approved, new conditions may be added to address public interest concerns raised during the review process.

In 2005, House Bill 3038 was passed by the Oregon legislature. The Bill gives municipal water developers 20 years to develop their water rights and validates old extensions. Development of the water rights must proceed with a reasonable level of diligence. However, OWRD may order or allow an extension of time to complete construction or to perfect a water right beyond the time specified in the permit under the following conditions.

- If the holder shows good cause and if other governmental requirements relating to the project have significantly delayed completion of construction or perfection of a water right;
- The extension of time is conditioned to provide that the municipality may divert water beyond the maximum rate diverted for beneficial use before the extension only upon approval by OWRD of a water management and conservation plan; and
- For the first extension issued after the effective date of the Bill but prior to November 2, 1998, undeveloped portions of the permit is required to maintain the fish listed as sensitive, threatened or endangered, within the waterway affected by the permit.

The second stage involves the issuance of a water right certificate, issued after the source is fully developed and put to use. At such time a Certificate of Beneficial Use (COBU), prepared and submitted by the permit holder, is filed with OWRD. Approval of this document results in the issuance of a water right certificate. Once issued, the final certificate serves as evidence of a fully vested water right. At this stage the water right is treated as a property right held by the water user. A certificated right remains valid indefinitely unless it is unused for a period of five or more years, in which case the user may forfeit the water right. The forfeiture process is not automatic. Oregon law has historically protected municipal water supplies by preventing forfeiture for non-use.

3.12 WATER MANAGEMENT & CONSERVATION PLAN

In addition to regulating water rights, the OWRD has regulatory authority over Water Management and Conservation Plans (WMCP) for public water systems. A WMCP is a plan developed by a water supplier that describes the water system and its needs, identifies its sources of water, and explains how the water supplier will manage and conserve those supplies to meet present and future needs. The requirement for completing such plans is tied to the revised rules surrounding water right permit extensions as described under OAR 690-315. These rules call for all suppliers serving over 1,000 people to complete a WMCP in association with water permit extensions. OAR 690-086 details the requirements of WMCPs.

A current WMCP for the City of Independence is being produced in conjunction with this Master Plan. Once completed, State statutes require WMCP's be updated at 5-year intervals. To assist the City's planning efforts for this expense, a recurring program is listed in the recommended capital improvement plan.

CHAPTER 4

EXISTING WATER SYSTEM

Chapter Outline

4.1 Overview
4.2 Water System Schematic & Maps
4.3 Water Rights & Sources
4.4 Water Treatment
4.5 Water Storage
4.6 Pump Stations
4.7 Distribution System
4.8 SCADA & Telemetry System
4.9 Existing Water System Funding Mechanisms

EXISTING WATER SYSTEM

CHAPTER 4

4.1 OVERVIEW

The City of Independence owns and operates the public drinking water system that serves the municipal population. The City currently sources water from groundwater wells using several water rights. Water is treated at two separate plants before being stored in reservoirs and pumped to the distribution grid. The City's distribution grid is a single service zone that is pressurized by three booster pump stations. The City's system is classified as a "community" water system and has been assigned Public Water System Identification Number OR41 00399 by OHA and EPA.

This chapter provides an inventory of the existing water system components, including sources of supply, water rights, water treatment, distribution system, storage reservoirs, and instrumentation & controls. The evaluation of these specific systems and the specific recommendations for improvements are contained in subsequent chapters.

4.2 WATER SYSTEM SCHEMATIC & MAPS

A schematic representation of the water systems components and processes is presented in Figure 4-1. The components include sources, wells, raw waterlines, treatment plants, instruments, pump stations, and reservoirs. A map of the major water system components is shown in Figure 4-2. Detailed maps of the City's water system are included in **Appendix A**.

4.3 WATER RIGHTS & SOURCES

The City holds twelve water rights comprised of nine groundwater rights and three surface water rights. The City's groundwater rights authorize the use of water for municipal purposes. The City's surface water rights authorize the use of water for municipal purposes and pond maintenance. The City does not currently use surface water to provide water supply. The City's municipal groundwater rights include two water right certificates, three permits, three groundwater registrations, and one limited license. The water rights authorize use from three well fields.

Two of the City's water rights are not used for potable water supply. One of these rights is for a well that is exclusively used for irrigation of the City's parks. The second is a surface water right to South Fork Ash Creek for recreational use. Table 4-2 summarizes all of the water rights currently held by the City of Independence. Each row in the table describes a water right. The water rights are grouped by source and wellfield.

The City currently sources all of its water from groundwater rights. Groundwater is pumped from two separate wellfields within the City Limits. These are called the Polk Wellfield and the South Wellfield. The City also jointly owns a third wellfield with the City of Monmouth, called the Willamette Wellfield.

Additionally, the City has a finished water intertie with the City of Monmouth. This intertie is primarily intended to serve as a temporary backup source in an emergency situation or to supplement the City's water supply during repairs and maintenance of water facilities. An intergovernmental agreement defines the ownership, components, operation, and maintenance of the intertie facilities. A copy of this agreement is included in **Appendix B**.

Each of the City's water sources is described in the following sections. The sources include the Polk, South and Willamette Wellfields, the Willamette River, the Independence-Monmouth Intertie, and potentially a regional water supply being developed by Polk County. The following sections further discuss water rights, wells, equipment and other aspects specifically related to each source. A summary of the City's existing flow rates from wells is included in Table 4-1.

Table 4-1| Summary of Approximate Well Yield

	Yield (gpm) (1) Low Summer/ Fall	*Yield (gpm) (1)* High Winter/ Spring	*Yield (gpm)* Wellfield Design Pumping Rate *(2)*	Notes
Polk Wellfield				
Polk Well 1	350	350	380	-
Polk Well 2	350	450	320	-
Polk Well 3	450	600	490	-
Polk Well 4	500	600	490	This well is currently being designed and is not connected to the City's water system.
River Drive Well	125	125	-	-
Subtotal	1,775	2,125	1,680	
South Wellfield				
South Well 1	125	150	ND	-
South Well 2	125	150	ND	-
South Well 3	125	150	ND	-
South Well 4	100	125	ND	Emergency source/ inactive status.
South Well 5	100	125	ND	Emergency source/ inactive status.
Subtotal	575	700	ND	
Willamette Wellfield - 50% *(3)*				
Willamette Well 1 – 50%	ND	250	ND	-
Willamette Well 2 – 50%	ND	250	ND	This well is not currently viable due to damage to the casing.
Willamette Well 3 – 50%	ND	90	ND	The water quality from this well is severely impacted by iron and turbidity.
Subtotal	ND	590	ND	
Total - Polk & South Wellfields	**2,350**	**2,825**	-	
Total - All Wellfields	**-**	**3,415**	-	

(1) Approximate yield data based on City records. ND = no data.
(2) Wellfield design pumping rate is for simultaneous pumping of Polk Wells 1-4 for 90 days. Referenced from Pumping Interference Calculations v2, 8/8/19, GSI Water Solutions (**Appendix C**). The River Drive Well was excluded from this study. Design pumping rates have not been fully established for the South Wellfield or Willamette Wellfield.
(3) 50% of well yield is owned by the City. Additional testing is needed to verify sustainable yield of Willamette River Wellfield.

Figure 4-1 | Existing Water System Schematic

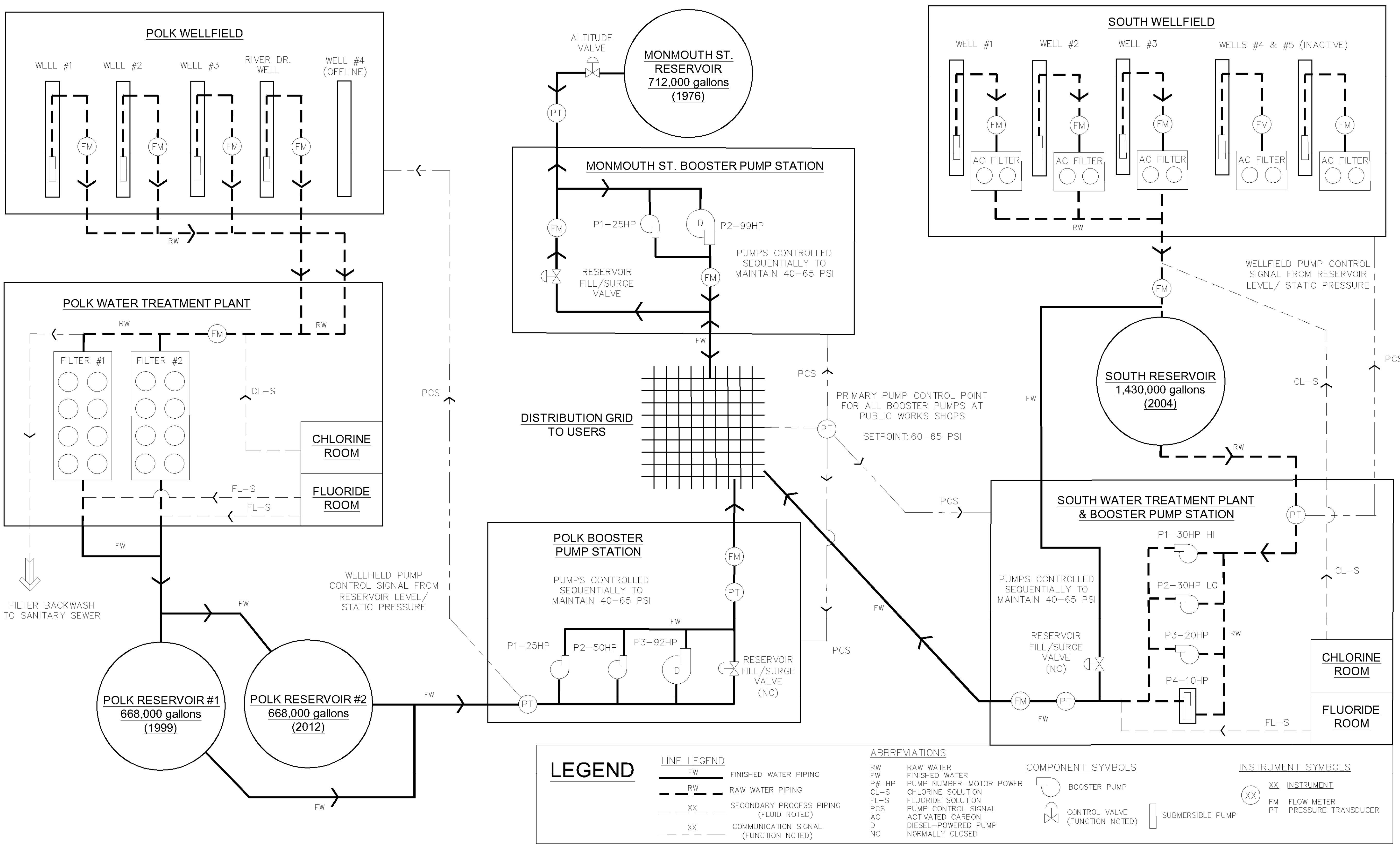


Figure 4-2 | Map of Water System Components

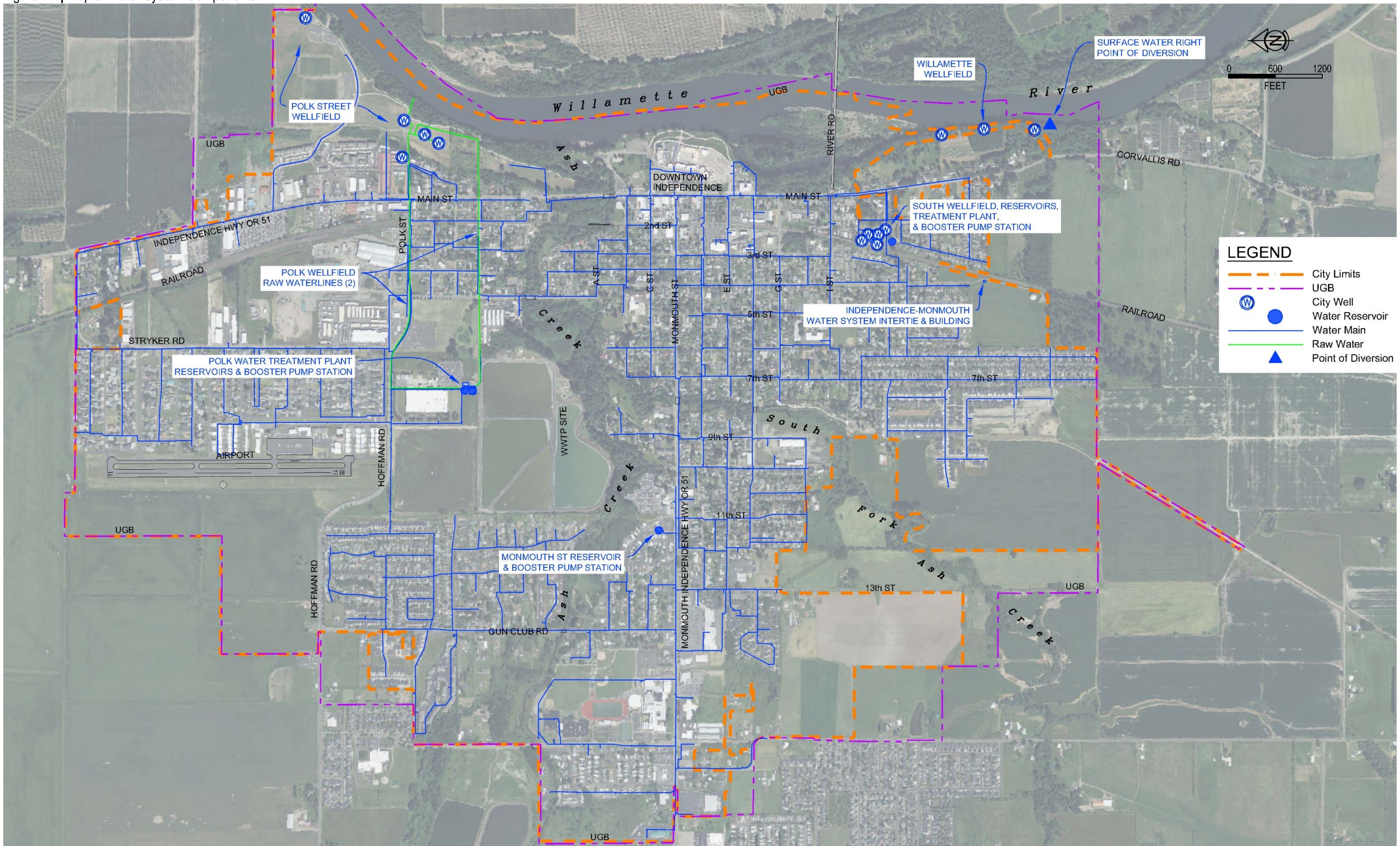


Table 4-2| Water Rights Summary

#	Application / Claim / Limited License	Permit	Certificate	Transfer	Priority Date	Source	Type of Beneficial Use	Authorized Rate (cfs)	Authorized Rate (gpm)	Completion Date	Comments
Groundwater											
1	G-12736	G-12134	--	--	12/19/1991	Polk Well #1	Municipal	2.0 total -1.56 developed* -0.44 undeveloped	897 total -700 developed* -197 undeveloped	10/1/1998	- OWRD is currently processing a permit extension application for this permit. - OWRD is currently processing a permit amendment application for this permit to add Polk Well 3 and 4 as additional sources for this water right. - 0.44 cfs undeveloped and subject to fish persistence conditions when Willamette River does not meet target flows.
2	G-11243	G-10375	~~83231~~ 95501	T-10827	3/8/1984	Polk Wells 1, 2, 3 & River Drive Well	Municipal	0.94*	*422**	N/A	- Permanent water right.
3	G-2469	G-2279	~~31510~~ 95502	T-12261	10/15/1962	Polk Wells 1, 2, 3 & River Drive Well	Municipal	0.56*	*251**	N/A	- Permanent water right.
4	LL-1779	N/A	N/A	N/A	N/A	Polk Wells 3 and 4	Municipal	Well 3 – 1.0 Well 4 – 1.5	Well 3 – 448 Well 4 – 673	N/A	- Temporary water right and temporary authorized rates. - This limited license and its Authorized Rates expire July 15, 2024 or when Polk Wells 3 and 4 are added to Permit G-12134.
							Total for Polk Well Field Permanent & Developed Water Rights*	3.06*	*1,373**	** Permanent and developed water right*	
5	GR-3183	N/A	N/A	T-13060	8/2/1951	South Wells 1, 2, 3, 4 & 5	Municipal	0.557	250	N/A	- None.
6	GR-3184	N/A	N/A	T-13061	9/15/1951	South Wells 1, 2, 3, 4 & 5	Municipal	0.891	400	N/A	- None.
7	GR-3185	N/A	N/A	T-13062	3/25/1953	South Wells 1, 2, 3, 4 & 5	Municipal	0.891	400	N/A	- None.
							Total for South Well Field	2.339	1,050		
8	G-13871	~~G-13015~~ G-17868	--	T-12511 (permit amendment)	11/7/1994	Willamette River Wells 1, 2 & 3	Municipal	1.0 (0.33 from each well)	448	10/1/2020	- The City is filing a permit extension application with OWRD. - Water right transferred from South Wells 4 & 5. - 0.46 cfs developed water right. 0.54 cfs undeveloped. - 0.35 cfs of undeveloped portion is subject to fish persistence conditions when Willamette River does not meet target flows.
9	G-18256	G-17750	--	--	2/4/2016	Park Well	Municipal	0.56	251	4/6/2037	- Water is currently used under the permit to irrigate the sports park.
Surface Water											
1	S-29640	S-23102	~~54268~~	T-12773	12/23/1954	Willamette River (Diversion from POD 2 and Willamette Wells 1, 2 & 3)	Municipal	2.0	898	10/1/2050	- Water right transferred from International Paper Company in 2019.
2	S-86398	S-54331	--	--	8/10/2005	Willamette River	Municipal	4.46	2,001	8/17/2026	- None.
3	S-18304	S-14237	89411	T-7926	7/28/1939	South Fork Ash Creek	Pond maintenance for recreational use	1.0	448	N/A	- The City does not use water under this permit for municipal water supply.

4.3.1 Polk Wellfield

The City's Polk Wellfield is located near the Willamette River in the northeastern part of the City. The locations of the wellfield, waterlines, and individual wells are shown in Figure 4-2. On average, approximately 50 to 70 percent of the water used annually in the City is sourced from the Polk Wellfield. The wellfield is comprised of five wells for municipal water supply. Polk Wells 1,2,3 and the River Drive Well are in use. Polk Well 4 is being developed and will be connected to the existing raw water lines. A sixth well, the Park Well, is only used for irrigation of the parks due to water quality issues. Each well is associated with one or more groundwater water rights as indicated in Table 4-2. A brief history and discussion of each well is included in sections 4.3.1.2 through 4.3.1.6.

Productivity and water levels in the wellfield fluctuate with the seasons, which is typical of wells in the area. The lowest productivity is in the summer months. Table 4-3 summarizes data on the wells and pumps in the wellfield. Table 4-1 lists the approximate yield of each well during the wet and dry seasons. The combined capacity of wells 1,2,3,4 and River Drive ranges from approximately 1,775 to 2,125 gpm. This range exceeds the total authorized rate of diversion for the combined permanent water rights associated with this wellfield (1,373 gpm). Based on hydrogeologic analysis of the wellfield, there is interference that occurs between the existing wells. This means that pumping from one well reduces the capacity of the other wells. For this reason, the location of Polk Well 4 was chosen, in part, to be as far as possible from the other Polk Wells (in order to minimize interference). Any further development of the Polk Wellfield would first have to address the limit to the water rights and second the limitations to the groundwater.

The wellfield produces raw water that is relatively high in dissolved minerals, such as iron and manganese. The wellfield also produces water that is relatively low pH, low alkalinity, and high hardness, which is typical of groundwater in the Willamette Valley. Water quality testing has consistently shown that Polk Well 4 has nitrate levels in excess of the MCL. Water from the well is planned to be blended with the other wells to reduce the concentration of nitrate to below the MCL.

Raw water is conveyed from the wellfield to the Polk Water Treatment Plant via two 8-inch PVC water lines. One waterline runs within Polk Street, which was installed in 1992 when the first 0.75 million-gallon (mg) reservoir was built at the Polk Water Treatment Plant site. The second 8-inch raw waterline is C-900 PVC and was installed along Williams Street in 2016. Approximately 750 feet of 20-inch diameter C-905 PVC connects Wells 1 and 2 to the raw water line on Polk Street. This pipe was originally intended to provide chlorine contact volume for disinfection. The pipe is no longer used for this purpose.

The well pumps are controlled to maintain the water level in the Polk Reservoirs. Radio telemetry is used to send the pump control signal from the water treatment plant site to the wellfield. All of the well pumps are turned on at the same time when the water treatment plant calls for water. Each well has its own flow meter that is read manually on site. The City's SCADA system can display several data points for the wellfield. These include the status of each well pump. The wellfield pumps can be run from the SCADA system, which is accessible remotely.

4.3.1.1 Polk Wellfield Water Rights

Use of groundwater from the five wells in the Polk Wellfield is authorized by Certificates 95501 and 95502, Permit G-12134, and Limited License LL-1779 (a temporary authorization). Combined, the certificates and permit in the Polk Wellfield authorize the use of up to 3.06 cfs (1,373 gpm). An additional 0.44 cfs (197 gpm) will likely be available under most circumstances, but will be subject to development and fish persistence conditions under permit G-12134.

Certificate 95501 authorizes the use of up to 0.94 cfs from Polk Wells 1, 2, and 3, and the River Drive Well. Certificate 95502 authorizes the use of up to 0.56 cfs from the same wells.

Permit G-12134 authorizes the use of up to 2.0 cfs only from Polk Well 1. To date, the City has used a 1.56 cfs portion of the permit and applied for an extension of time until October 1, 2030 to allow sufficient time for development of the remaining 0.44 cfs. As previously mentioned, this 0.44 cfs will be further subject to fish persistence conditions, which could lessen this amount when flow targets are not met in the Willamette River. Following approval of the permit extension the City intends to initiate a permit amendment in order to add Polk Well 3 and Polk Well 4 to the permit. Both the permit extension and permit amendment are anticipated to be approved.

A temporary water right, Limited License LL-1779, authorizes the short-term municipal use of up to 2.5 cfs, which is further limited to 1.0 cfs from Polk Well 3 and 1.5 cfs from the City's new Polk Well 4. The limited license was obtained to temporarily authorize the use of groundwater from Polk Well 3 and the City's Polk Well 4 while the permit extension and subsequent permit amendment application for Permit G-12134 are processed by OWRD. The limited license will expire the earlier of either July 15, 2024 or after the permit amendment is approved.

4.3.1.2 Polk Well 1

Polk Well 1 was originally constructed in 1957 with a 16-inch diameter casing. In 1990, the well was retrofitted with several improvements including a 12-inch casing, a control building and replacement components. The new components included discharge piping, a new submersible pump, power service and controls. Additionally, a chlorination system was installed, which is no longer in use.

Figure 4-3 | Polk Well 1

In 2006, Well 1 was retrofit with a new 25 HP submersible pump, 8-inch discharge piping, flow meter and power service. The discharge piping connects to a 20-inch raw water line near the well. This pipe conveys water from wells 1 and 2 to the 8-inch transmission main along Polk Street. This transmission main discharges to the Polk Water Treatment Plant.

The wellhead and discharge piping are enclosed in a building that houses pump control equipment. Based on as-built survey, the approximate elevation of the wellhead is 163.3 ft (NAVD 1988). The 100-year floodplain elevation at this location is approximately 161.5 ft (FEMA FIRM revised 12/19/06 based on NAVD 1988). Therefore, it is extremely unlikely for flood water to overtop the well and vent. Well construction standards defined by OAR 333-061-0050 require wellheads to be at least 2-feet above the 100-year floodplain elevation The existing wellhead is approximately 3 inches too low to meet this requirement. Specific recommendations are included in Chapter 6.

Control panels and flow meter transmitters for Polk Wells 1 and 2 are mounted on the walls of the building. The site has a perimeter chain link fence. Table 4-3 summarizes data on the well construction and pump.

4.3.1.3 Polk Well 2

Figure 4-4 | Polk Well 2

Polk Well 2 was constructed in 2001 with a 12-inch diameter casing. Electrical equipment for the well is housed in the building at Well 1. The well has an elevated platform to raise components above the floodplain. The platform is constructed of steel tubing, steel angle, and steel grating. The platform bears on the well casing and two concrete footings. On the platform there is an electrical disconnect box for the pump cable and the top of the casing with a well seal. The same platform design is used for Well 3.

The 25 HP submersible pump discharges from the casing using a pitless adapter. At the well there is an insertion flow meter installed in an underground box. The transmitter for this meter is installed in the building at Well 1. There is 8-inch piping between the well and the 20-inch raw water line. The site has a perimeter chain link fence. Table 4-3 summarizes data on the well construction and pump.

Based on as-built survey, the approximate elevation of the wellhead is 163.0 ft (NAVD 1988). The 100-year floodplain elevation at this location is approximately 161.5 ft (FEMA FIRM revised 12/19/06 based on NAVD 1988). Therefore, it is extremely unlikely for flood water to overtop the well and vent. Well construction standards defined by OAR 333-061-0050 require wellheads to be at least 2-feet above the 100-year floodplain elevation. The existing wellhead is approximately 6 inches too low to meet this requirement. Specific recommendations are included in Chapter 6.

4.3.1.4 Polk Well 3

Figure 4-5 | Polk Well 3

Polk Well 3 was constructed in 2006 with a 12-inch diameter casing. In 2006, the pumping equipment and elevated platform were installed. The power service, control panel and flow meter for the well are installed at the River Drive Well location. The 8-inch flow meter was installed in 2017. The well has an elevated platform to raise components above the floodplain. The platform is constructed of steel tubing, steel angle, and steel grating. The platform bears on the well casing and two concrete footings. On the platform there is an electrical disconnect box for the pump cable and the top of the casing with a well seal. The same platform design is used for Well 2.

The 40 HP submersible pump discharges from the casing using a pitless adapter. There is 8-inch piping between the well and the 8-inch raw water line near the River Drive Well location. The site has a perimeter chain link fence. Table 4-3 summarizes data on the well construction and pump.

Based on as-built survey, the approximate elevation of the wellhead is 162.7 ft (NAVD 1988). The 100-year floodplain elevation at this location is approximately 161.5 ft (FEMA FIRM revised 12/19/06 based on NAVD 1988). Therefore, it is extremely unlikely for flood water to overtop the well and vent. Well construction standards defined by OAR 333-061-0050 require wellheads to be at least 2-feet above the 100-year floodplain elevation. The existing wellhead is approximately 10 inches too low to meet this requirement. Specific recommendations are included in Chapter 6.

4.3.1.5 Polk Well 4

Polk Well 4 was constructed in 2019 with a 12-inch diameter casing. It is located north of the other Polk Wells near the boat launch and soccer fields. The well does not have an above-ground structure, equipment, a power service or a raw waterline. The wellhead is sealed. The City is currently in the process of developing the pump station at this well and installing the water line to convey raw water to the existing wellfield's raw water lines. Table 4-3 summarizes data on the well construction. The existing wellhead is below the 100-year floodplain elevation. The casing and wellhead are planned to be raised as a part of the final design of the well.

4.3.1.6 River Drive Well

The River Drive Well was originally constructed in 1999 with a 6-inch diameter casing and altered in 2000 to an 8-inch casing. The well is located at the east end of Polk Street near River Drive, which is above the floodplain. The well has a submersible pump and discharges using a pitless adapter. The well discharges to 6-inch piping before connecting to the 8-inch raw water line to the Polk Water Treatment Plant. The well has a dedicated flow meter. The site has a perimeter chain link fence. Table 4-3 summarizes data on the well construction and pump.

Figure 4-6 | River Drive Well

Table 4-3| Well Summary - Polk Wellfield

	Polk 1	Polk 2	Polk 3	Polk 4	River Drive
Year Drilled	1957 (original) 1990 (rebuilt)	2001	2006	2019	2000
Polk County Well Log #'s – POLK	2945 023	51438	52307	54296	51184
Approximate Wellhead Elevation	163.3'	163.0'	162.7'	(Under design)	±166'
Approximate 100-year Floodplain Elevation	±161.5'	±161.5'	±161.5'	±161.5'	±161.5'
Well Total Depth	52 ft.	57 ft.	52'	63.5'	61'
Intake Depth (bgs)	±51'	±53'	±44'	N/A	±47'
Casing	12" x 0.250" +1.5' to 51' Welded steel	12" x 0.250" +3' to 27' Welded steel	12" x 0.250" +3' to 22' 42' to 52' Welded steel	12" x 0.250" +3' to 63.5' Welded steel	8" x 0.250" +1.5' to 61' Welded steel
Screen Type (S) Screen -Material, Size, Interval, Diameter or (P) Perforated Casing - Size, Interval, Ct.	(P) Torch slots ½" x 9" 22' to 45' 460 ct.	(S) V-slot 304 SST 24' to 27'–10" 150: 27' to 47 – 12"	(S) V-slot 304 SST 100: 22' to 32– 12" 60: 32' to 42'–12"	(S) Wrap rib SST 0.1 screen width 32' to 52'–12"	(P) Torch slots 3/8" x 6" 35' to 50' 120 ct.
Well Pump ▪ Type ▪ Diameter ▪ Motor size ▪ Power ▪ Motor Control	▪ Submersible ▪ 5" ▪ 25 hp ▪ 460 V, 3 φ ▪ FVNR	▪ Submersible ▪ 5" ▪ 25 hp ▪ 460 V, 3 φ ▪ FVNR	▪ Submersible ▪ 6" ▪ 40 hp ▪ 460 V, 3 φ ▪ FVNR	▪ Under design	▪ Submersible ▪ 3" ▪ 7.5 hp ▪ 460 V, 3 φ ▪ FVNR
Design Conditions	350 gpm at 205' TDH	350 gpm at 205' TDH	550 gpm at 203' TDH	-	80 gpm at 200' TDH
Treatment at Well	None	None	None	-	None
Level Monitoring	Manual, monthly	Manual, monthly	Manual, monthly	-	Manual, monthly
Flow Meter Type	Impeller (no telemetry)	Magnetic (no telemetry)	Magnetic (no telemetry)	-	Impeller (no telemetry)
Discharge Rate Control	Manual Throttling Valve	Manual Throttling Valve	Manual Throttling Valve	-	Manual Throttling Valve
Auxiliary Power	None	None	Trailer-mounted 350 kW generator shared with River Drive, 440 g. fuel tank	-	(Same as Polk 3)
Discharge location	Raw waterline to Polk Water Plant	Raw waterline to Polk Water Plant	Raw waterline to Polk Water Plant	-	Raw waterline to Polk Water Plant
Telemetry to Polk WTP	Radio	Radio	Radio	-	Radio

(1) Well pump information listed is based on City records and was not field verified.
(2) Abbreviations: BGS = Below ground surface; SST = Stainless steel; FVNR = Full voltage non-reversing motor starter, ie. across-the-line starter
(3) 100-year floodplain elevation referenced from FEMA FIRM revised 12/19/06, NAVD 1988

4.3.2 South Wellfield

The South Wellfield is the original water source for the City of Independence and was developed in the early 1950's. The site was originally owned by Pacific Power and Light. The wellfield is located along Briar Road and River Oak Road in the southern part of the City. Figure 4-2 shows the location of the wellfield and individual wells. The South Wellfield site additionally has a treatment building with booster pump station and a 1.5-million-gallon reservoir. A perimeter chain link fence surrounds the site.

Figure 4-7 | South Wells 3 and 4

The wellfield is comprised of five wells, numbered 1 through 5. Wells 1, 2, and 3, were replaced in 2006. Two additional wells, 4 and 5, were installed in 1992. Wells 4 and 5 are considered inactive with OHA and are authorized only as emergency sources. Power for the well pumps is routed to the wells from the main treatment plant building. The treatment building houses a generator. According to Public Works, the generator is capable of simultaneously running the wells, treatment systems, and the booster pump station. Each well is associated with all three groundwater rights.

The wellfield's water rights are discussed in the following section. On an annual basis, the City sources between 30 and 50% of its water from the South Wellfield.

Productivity and water levels in the wellfield fluctuate with the seasons, which is typical of wells in the area. The lowest productivity is in the summer months. Table 4-4 summarizes data on the wells and pumps in the wellfield. Table 4-1 lists the approximate production of each well during the wet and dry seasons. The combined capacity of the wells ranges from approximately 575 to 700 gpm. This range is substantially less than the total authorized rate of diversion for the combined water rights associated with this wellfield (1,050 gpm). 700 gpm is considered by Public Works to be the current maximum production rate during the wet season with the existing well configuration. However, since wells 4 & 5 are not in use, it is possible that the maximum production rate of the five wells is less than 700 gpm under a sustained pumping scenario with increased well interference. Public Works operators have observed interference occurring between the wells (where pumping from one well draws down another). For this reason, it is not expected that the wellfield could support additional wells.

Figure 4-8 | South Well 4 Piping & Adsorption Filters

The well pumps are controlled to maintain the water level in the reservoir. All of the well pumps are turned on at the same time when the water treatment plant at this site calls for water. Each well has its own flow meter that is read manually on site. Each well additionally has a sand collection bag. These units are not in use and are deteriorating. The City's SCADA system can display several data points for the wellfield. These include the pump status and total flow rate into the storage reservoir.

Each well has a building that houses discharge piping, valves, a flow meter, and adsorption filters. The five buildings are identical. They are partially insulated, not fully weatherized and are in need of improvements and maintenance. A relatively small power service supplies electricity to all of the buildings' loads. This service has not been adequate in the past to run heaters in all of the buildings. Most of the yard piping at the South Wellfield is relatively old 4 and 6-inch steel piping. The adsorption filters are currently in use as a precaution for removing potential organic contaminants.

4.3.2.1 PCE Contamination, Response and Investigation

Between 2005 and 2007, South Wells 4 and 5 tested positive for tetrachloroethylene (PCE) and exceeded the MCL in some tests. PCE is a volatile organic compound that is a primary contaminant regulated by the EPA in drinking water. In response to the contamination, the City took all five South Wells out of service for approximately one year. At this time, the City also re-drilled wells 1, 2, and 3. The City also placed existing adsorption filters in service with granular activated carbon at all of the wells to ensure PCE does not exceed the MCL. During this time, additional water was sourced from the Polk Wellfield to meet demands. Water quality testing is regularly performed for PCE pre- and post-treatment at the wells. OHA records show that the contaminant has not been detected in the well water since September of 2007.

Between 2014 and 2017, the PCE contamination was the subject of an investigation by the Oregon Department of Environmental Quality (DEQ). The source of the contamination was determined to be located at 155 E Street in Independence, currently known as the RJ Mobility site. The site was formerly operated as a dry-cleaning facility between 1950 and the mid-1980's and is currently operated as a vehicle retrofitting business. The site was determined to be contaminated with products from past dry-cleaning activities. Based on the investigation, in 2017 the DEQ recommended a No Further Action determination and stated, "remedial action to address environmental contamination at RJ Mobility site is completed, and no further action is required." A copy of the DEQ's letter is included in **Appendix D,** which provides more information on the investigation and a map showing the site and the City's wellfields.

4.3.2.2 South Wellfield Water Rights

Three groundwater registrations (GR's) authorize the use of up to 2.339 cfs (1,050 gpm) from the South Wellfield for municipal use. GR-3183 authorizes the use of up to 0.557 cfs (250 gpm) from South Wells 1, 2, 3, 4, and 5. GR-3184 and GR-3185 each authorize the use of up to 0.891 cfs (400 gpm) from the same wells.

4.3.2.3 South Well 1

The South Well 1 was drilled in 2006 in its current location south of the treatment plant building. It has an 8-inch diameter casing. The original well was located inside the building and was formally abandoned.

4.3.2.4 South Well 2

The South Well 2 was drilled in 2006 in its current location between its associated building and the reservoir. It has an 8-inch diameter casing. The original well was located inside the building and was formally abandoned.

4.3.2.5 South Well 3

The South Well 3 was drilled in 2006 in its current location adjacent to its associated building. It has an 8-inch diameter casing. The original well was located inside the building and was formally abandoned.

4.3.2.6 South Wells 4 and 5

The South Wells 4 and 5 were drilled in 1992. Both wells have 8-inch diameter casings that are housed within a building for each well. Per OHA, wells 4 and 5 are currently "inactive" and for emergency use only. However, based on the most recent sanitary survey, the City may propose to use the wells as active sources upon review and approval by OHA.

Table 4-4| Well Summary - South Wellfield

	South Well 1	South Well 2	South Well 3	South Well 4	South Well 5
Year Drilled	2006	2006	2006	1992	1992
Polk County Well Log #'s – POLK	52347	52348	52349	406	420
Approximate Wellhead Elevation	±175'	±175'	±175'	±175'	±175'
Well Total Depth	95 ft.	80 ft.	80 ft.	80 ft.	79 ft.
Intake Depth (bgs)	±80'	±67'	±67'	±70'	±70'
Casing	8" x 0.250" 2' to 95' Welded steel	8" x 0.250" +2' to 80' Welded steel	8" x 0.250" +2' to 80' Welded steel	8" x 0.250" +2' to 80' Welded steel	8" x 0.250" +4.5' to 79' Welded steel
Screen Type (P) Perforated Casing Perforation: width x length Interval Count	(P) Perforator knife 0.375" x 2" 60' to 82' 660 ct.	(P) Perforator knife 0.375" x 2" 50' to 66' 480 ct.	(P) Perforator knife 0.375" x 2" 50' to 66' 480 ct.	(P) Torch/ Perf. knife 5/16" wide x 1-1/4": 55' to 73' 288 ct. 6": 74' to 77' 12 ct.	(P) Perforator knife 3/8"x 1-3/4" 55' to 74' 222 ct.
Well Pump ▪ Type ▪ Diameter ▪ Motor size ▪ Power ▪ Motor Control	 ▪ Submersible ▪ 4" ▪ 10 hp ▪ 460V, 3φ ▪ FVNR	 ▪ Submersible ▪ 4" ▪ 10 hp ▪ 460V, 3φ ▪ FVNR	 ▪ Submersible ▪ 4" ▪ 7.5 hp ▪ 460V, 3φ ▪ FVNR	 ▪ Submersible ▪ 4" ▪ 7.5 hp ▪ 460V, 3φ ▪ FVNR	 ▪ Submersible ▪ 4" ▪ 7.5 hp ▪ 460V, 3φ ▪ FVNR
Design Conditions	200 gpm at 130' TDH	210 gpm at 130' TDH	210 gpm at 130' TDH	175 gpm at 140' TDH	175 gpm at 140' TDH
Treatment at Well	GAC Adsorption Filters	GAC Adsorption Filters	GAC Adsorption Filters	GAC Adsorption Filters	GAC Adsorption Filters
Level Monitoring	Manual, monthly	Manual, monthly	Manual, monthly	Manual, monthly	Manual, monthly
Flow Meter	Yes	Yes	Yes	Yes	Yes
Discharge Rate Control	Manual Throttling Valve	Manual Throttling Valve	Manual Throttling Valve	Manual Throttling Valve	Manual Throttling Valve
Auxiliary Power	200 kW, 3-ph on-site diesel generator min. equipment to run: water treatment plant, booster pump station, and 5 wells, +/- 200 g fuel tank				
Discharge location	Raw waterline to South Reservoir	Raw waterline to South Reservoir	Raw waterline to South Reservoir	Raw waterline to South Reservoir	Raw waterline to South Reservoir
Telemetry to WTP	Hardwired pump control signal	Hardwired pump control signal	Hardwired pump control signal	Hardwired pump control signal	Hardwired pump control signal

Well pump information listed is based on City records and was not field verified. Blanks in table represent unknown information that should be verified by the City.
Abbreviations: GAC: Granular activated carbon; BGS = Below ground surface ; SST = Stainless steel ; FVNR = Full voltage non-reversing motor starter, i.e. across the line starter

4.3.3 Willamette Wellfield

The Cities of Independence and Monmouth jointly own three wells that are along the west bank of the Willamette River. The Cities have an intergovernmental agreement in place that defines the ownership and operation of the facility. A copy of this IGA is included in **Appendix E**. The IGA defines the equal ownership and use of the three wells at the wellfield and further requires each party to be responsible for providing their own water rights to legitimize their share of the well yield.

The wells were drilled in 2007 and 2008 on property that is owned by the City of Independence. The property is a decommissioned railroad grade that was constructed of fill on the bank of the river. Wells 1 and 3 are 80 feet from the river. Well 2 is 25 feet from the river. The wells are accessed from Corvallis Road by Public Works using an easement. The access road runs along the narrow railroad grade between each well. The grade is elevated above the floodplain to the west and the river to the east. The road ends at Well 1 due to a slough that crosses the property. The location of these wells is shown in Figure 4-2.

Each well has an 8-inch casing, a submersible pump, an underground electrical feeder, and pitless adapter. A concrete pad with chain link fence surrounds each well. The wells connect to an 8-inch PVC raw water pipe. This pipe is installed between each well. The pipe is installed across the slough and terminates near the Corvallis Road right-of way. The power service for the wells and electrical equipment are located near this termination point. Electrical equipment is sheltered with a shed that is surrounded by a chain link fence.

The wells are in very close proximity to the Willamette River. Additionally, the wells are relatively shallow and located in an unconfined aquifer. The hydrologic connectivity between the wells and the river was the subject of a study that was completed by a hydrogeologist retained by the City. This study is summarized in a technical memorandum presented in **Appendix F**. Overall, the wells have been determined to be hydrologically linked to the Willamette River. This is advantageous because the wells were able to be authorized as points of appropriation for one of the City's Willamette River surface water rights and one groundwater right (T-12773 and Permit G-17868) . However, this also means that water sourced from the wells is extremely likely to be groundwater under the direct influence of surface water (GWUDI). As discussed in Section 3.3, GWUDI classification requires groundwater to be treated to the same rigorous standards as surface water. The City's water treatment plants are not capable of treating water from this wellfield.

To date, the wellfield has not been used to supply water for Independence. Since construction of the wells in 2007 and 2008, the wells have mostly been idle except for testing and rehabilitation. Well capacity generally degrades over time if the wells are not actively used, due to oxidation, mineralization and activity of bacteria. The current known condition of each well is discussed in the following sections. The wellfield raw waterline has a digital flow meter. The wellfield does not have any telemetry or SCADA capabilities.

4.3.3.1 Willamette Wellfield Water Rights

Permit G-17868 authorizes the use of up to 1.0 cfs (448 gpm) from the City's Willamette River Wells 1, 2, and 3, which is further limited to up to 0.33 cfs from each well.

4.3.3.2 Willamette Well 1

Well 1 is considered to be in usable condition. The reported yield is between 500 and 550 gpm. In September of 2021, the City performed a Rossum sand test. The results showed no sand yield from the well. Additional testing is recommended to verify an adequate sustainable yield rate and specific yield (yield per foot of drawdown).

Figure 4-9 | Willamette Well 1

4.3.3.3 Willamette Well 2

Well 2 is not currently in a usable condition unless repairs are completed. The welded bottom plate of the casing is ruptured and bent up in to the well casing. As a result, a void has formed below the casing. The reported yield is 500 gpm.

A relatively large portion of the river bank adjacent to Well 2 has failed. Continued erosion of the bank along the wells and the raw water line could pose an issue for the wellfield.

Figure 4-10 | Willamette Well 2

4.3.3.4 Willamette Well 3

Well 3 is not in a usable condition due to poor water quality conditions and a relatively low yield of approximately 175 gpm. The well produces relatively high concentrations of iron and turbidity.

Figure 4-11 | Willamette Well 3 & Willamette River

Table 4-5| Well Summary - Willamette Wellfield

	Well 1	Well 2	Well 3
Year Drilled	2007	2008	2008
Polk County Well Log #'s – POLK	52513	52861 DRAFT	52953
Approximate Wellhead Elevation	±168 ft.	±160 ft.	±159 ft.
Well Total Depth	61 ft.	53 ft.	56 ft.
Intake Depth (bgs)	Unknown	Unknown	Unknown
Casing	8" x 0.250" +3' to 61' Welded steel	8" x 0.250" +3.5' to 53' Welded steel	8" x 0.250" +2' to 56' Welded steel
Screen Type (S) Screen Type & Material Slot Size: Interval - Diameter	(S) V-slot 304 SST 100: 41' to 56'–8"	(S) V-slot 304 SST 100: 29' to 45.5'–8"	(S) V-slot 304 SST 100: 31' to 49'–8"
Pump ▪ Type ▪ Motor size ▪ Motor speed ▪ Power ▪ Motor Control	 ▪ Submersible ▪ 20 hp ▪ 3450 rpm ▪ 460V, 3φ ▪ FVNR	 ▪ Submersible ▪ 20 hp ▪ 3450 rpm ▪ 460V, 3φ ▪ FVNR	 ▪ Submersible ▪ 7.5 hp ▪ Unknown ▪ 460V, 3φ ▪ FVNR
Pump Design Conditions	375 gpm at 149 ft TDH	375 gpm at 153 ft TDH	150 gpm at 149 ft TDH
Discharge Rate Control	Gate valve	Gate valve	Gate valve
Auxiliary Power	None		
Discharge location	Raw water line ends at Corvallis Rd. approximately ¼ mile south of Independence Way		
Telemetry	None		

Well pump information listed is based on City records and was not field verified. Blanks in table represent unknown information that should be verified by the City.
Abbreviations: BGS = Below ground surface ; SST = Stainless steel ; FVNR = Full voltage non-reversing motor starter, ie. across-the-line starter

4.3.4 Willamette River Surface Water Rights

The City holds two municipal surface water rights: Transfer T-12773 and Permit S-54331, which authorize the use of up to a total of 6.46 cfs (2,894 gpm). Permit S-54331 authorizes the use of up to 4.46 cfs (2,001 gpm) from the Willamette River, and has an August 10, 2005 priority date.

Transfer T-12773 authorizes the use of up to 2.0 cfs (897 gpm) from the Willamette River for municipal use, and has a priority date of December 23, 1954. The water right originally authorized the use of water for industrial use at International Paper Company (an upstream location). Water is authorized to be diverted under the transfer at the defined point of diversion from the river or from the three Willamette Wellfield wells.

4.3.5 Independence-Monmouth Water System Intertie

The Cities of Independence and Monmouth have a finished water system intertie that is intended to operate as a backup water source for each City during an emergency. An intergovernmental agreement (IGA) defines the ownership, components, operation and maintenance of the facility. A copy of the agreement is included in **Appendix B**. The IGA defines various reasons each party may request to use the intertie, including emergencies, repairs to facilities, contamination, or "any other mutually agreed event". Water delivery is metered using two flow meters, one for each City. The IGA defines that each City is responsible for regulatory compliance of water potability and backflow prevention in their water system. To date, the intertie has not been used to deliver water.

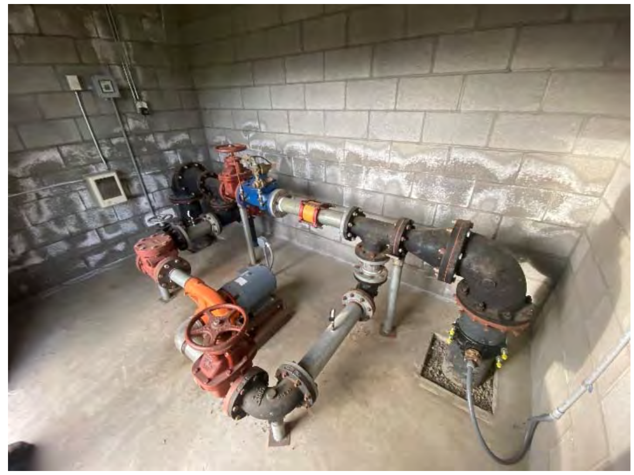


Figure 4-12 | Water System Intertie

The intertie is located at the City of Monmouth's property near the south end of 4th Street in Independence. The interconnection is made in a building that houses valves, a booster pump, and the flow meters, depicted in Figure 4-12. The piping and valves are regularly flushed and exercised. The typical pressure of the Monmouth distribution grid at the intertie is 100 psi. A pressure-reducing valve is used to reduce the pressure of water entering the City's distribution system to 60 psi. The City of Monmouth has a booster pump for transferring water from Independence to their distribution grid. The intertie is not connected to the City's SCADA system.

4.3.6 Polk County Regional Water Supply Plan

Polk County is currently working on a plan to create a new regional water supply for citizens of the county. The County's goal is to improve the reliability and resiliency of water supply in the county. The County holds substantial water rights and is working to utilize them in the near future. The source of the water rights is the Willamette River. The County's goal is to equitably distribute this water to Polk County water providers, such as the City of Independence. As a part of a regional plan, Independence could utilize the water as a backup source or a new primary source.

Several water providers in the county are expecting demand to outgrow their supply capacity in the coming decades. Two primary reasons for developing a regional water supply to meet this deficit are reduced per capita costs, as a result of centralization and economies of scale, and increased resiliency to disasters (such as an earthquake). Some possible drawbacks to a regional water supply system are reduced control of the water system by stakeholders, increased facility complexity, and increased governmental structure complexity. Like all water systems, regulatory compliance and financial aspects would also require evaluation.

The County is in the early stages of planning a regional water supply and is looking for interest from stakeholders. Polk County has identified the largest Cities in the county as high priority stakeholders, including the Cities of Independence, Monmouth and Dallas. According to a recent study for Polk County, these cities represent approximately 70% of the current municipal water demand in the county. The other 30% of the current municipal water demand is from the Cities of Willamina and Falls City, Buell-Red Prairie Water District, Grand Ronde Community Water Association, Luckiamute Domestic Water Cooperative, Perrydale Domestic Water Association, Rickreall Community Water Association, and the Rock Creek Water District. These water providers deliver water to the majority of the County's rural population.

4.4 WATER TREATMENT

4.4.1 Polk Water Treatment Plant

The Polk Water Treatment Plant was originally constructed in 1999 and was significantly expanded in 2017. The treatment plant treats all of the water sourced from the Polk Wellfield. The treatment facilities consist of two separate banks of pressure filters in two separate buildings. These are known as Polk Filter 1 and Polk Filter 2. Polk Filter 2 was added as a part of the 2017 project. The filters remove iron and manganese from raw water using a pyrolusite-based filter media. The treatment plant also provides chlorine gas disinfection and fluoridation prior to storage on site in the Polk Reservoirs. The Polk Pump Station is also located at this site. The site does not have an auxiliary power generator. The treatment plant has a power inlet receptacle and a manual transfer switch for providing auxiliary power to the chlorine feed system.

Figure 4-13 | Polk Water Treatment Plant, Pump Station & Reservoirs

The well pumps at the Polk Wellfield provide the pressure that is necessary to pump through the filters and fill the reservoirs. Raw water is conveyed from the Polk Wellfield to the treatment plant via two 8-inch PVC raw water lines. The combined flow from the wellfield is measured with a flow meter. Chlorine is injected upstream of the filters. Fluoride is injected downstream of each filter with separate feed pumps for each bank of filters. Flow from the two filter banks mixes prior to being conveyed to both reservoirs. A process schematic of the Polk Water Treatment Plant is presented in Figure 4-1. A summary of some of the design characteristics of the treatment plant are listed in Table 4-6.

The City uses a SCADA system to monitor the finished water flow rate at the plant going in to the storage reservoirs. This system can be monitored remotely by Public Works. The treatment plant is automatically controlled by independent control systems associated with each process, further described below. There is no central control panel or PLC for the facility.

Figure 4-14 | Polk Filter Bank 1

Pressure Filter System

The pressure filter system at this facility consists of two separate treatment trains. Each train, or filter bank, is comprised of eight pressure filter units filled with granular media. The filter media is pyrolusite-based which provides iron and manganese removal by oxidation and adsorption. The filter banks are controlled by separate control panels. Each filter unit has control valves that operate the filters in either a forward filtration or a backwashing mode. The valves are hydraulically operated and are controlled using solenoids. The filters typically execute a backwash cycle based on a timer every 24 hours. Secondarily, the control system can initiate a backwash cycle based on a pressure differential.

Figure 4-15 | Polk Filter Bank 2

Media regeneration is achieved by oxidizing the media's surface using chlorine. This maintains the adsorption capacity of the media's manganese dioxide surface.

Each filter bank backwashes one filter vessel at a time while the other seven vessels remain on-line. During backwashing, the pressurized and filtered water discharging from the operating filters is used to backwash the specified filter tank. Backwash rate and volume is metered from each filter bank using a McCrometer propeller meter. These meters are about 8-feet above the floor and require a ladder to read. Backwash water is collected in a tank and then pumped directly to the City's sewage lagoon. The tank has an overflow, which drains to the City's Williams Street Sewer Pump Station.

The individual filter vessels in each filter bank are 48-inches in diameter. According to the specifications for Filter 1 and Filter 2, the media depths are 36-inches and 30-inches, respectively. The filter surface area for the two filter banks is equal, but Filter 1 has approximately 20% more media volume. The plant operates the banks in parallel. Pipe length, diameter and fittings are relatively the same to each filter. Therefore, it is likely that flow is split relatively equally.

Design criteria for Filter 2 indicates a design filter loading rate of 7 gpm per square foot of filter area. The equivalent criteria for Filter 1 was not found in the City's records. Given the similarity in the size and configuration of the filter banks, the loading rate is assumed to be equal for Filter 1. This is likely a conservative estimate given that Filter Bank 1 has 20% more media volume than Filter Bank 2. Based on a total filter area of 200 square feet for the sixteen filter units, the facility has a total estimated capacity of 1,400 gpm. The Polk Wellfield's approximate sustained pumping rate is 1,680 gpm and maximum rate is 2,125 gpm. Based on this analysis, the filters are potentially 18% to 34% undersized. However, a more in-depth analysis is required to determine if the filters are actually deficient for their intended purpose of removing iron and manganese. It's possible that the removal efficiencies are adequate for the City's purposes at the existing loading rates. The current typical backwash volume for the entire facility is 12,000 gallons per day. Further evaluation of the capacity of the water treatment plants is provided in Chapter 7.

Polk Filter Bank 1 was originally installed in 1998 and has continuously been in service for roughly 24 years. The filter media is largely the original media that was installed in 1998. During construction of the second filter bank, the media in Filter 1 was inspected and refilled. In 2010, all of the backwash control valves were replaced. The exterior coating system for the steel piping is peeling in some areas, especially at pipe joints. Some pipe joints are rusting. According to operators, the interior of the units do not show signs of deterioration. The original control system appears to be operating normally and has not historically had issues.

It is recommended that City Operators bi-annually check that the control loop and control valves are working properly for both filter banks.

With regular repair and maintenance, the filters are expected to continue to function for the planning period. Regular maintenance items for the filter banks include verifying control system operation, servicing hydraulic control valves, coating system maintenance, and maintaining media quality and levels.

Disinfection System

Chlorine gas solution is injected at the water treatment plant to provide disinfection and residual disinfection for finished water. Chlorine is injected upstream of the pressure filtration tanks, which functions to disinfect and to regenerate the filter media. Chlorination also provides residual chlorine in the filters to ensure that iron and manganese bacteria, which may be present in the well water, does not grow in the filters. Early chlorination also provides a residual in the reservoir and water distribution system. When operated in the automatic mode, chlorine addition is flow-paced based on the influent flowrate to the treatment plant. Chemical flow-pacing is accomplished using a dedicated controller and gas chlorinator.

Fluoridation System

Sodium fluoride solution is injected downstream of each pressure filter bank with two separate pumps and injection lines. This is to split the flow equally to each finished water line. Operators mix bags of dry sodium fluoride with carrier water in a mixing basin. The carrier water hardness is reduced by a water softener unit upstream of the mixing basin. When operated in the automatic mode, fluoride solution is flow-paced based on the influent flowrate to the treatment plant. Chemical flow-pacing is accomplished using a variable-speed dosing pump with a dedicated controller.

Finished Water Quality

The City's finished water quality from the Polk Water Treatment Plant is generally good and consistently meets water quality treatment standards. As required by the OHA, water from the City's water system is tested periodically for bacteriological contamination, organic and inorganic chemical contaminants, disinfection byproducts, and a variety of radioactive compounds. Based on conversations with City Staff, water in the distribution system has taste and odor issues. Taste and odor issues have not been formally studied. The water quality from the South Wellfield is known to be lower in dissolved minerals than the Polk Wellfield. An evaluation of taste and odor issues is discussed in Chapter 7 - Water Treatment Evaluation.

Table 4-6| Polk Water Treatment Plant General Operating & Design Criteria

Process System	Design Criteria
General	
Finished floor elevation	169’
Raw water source	Polk Wellfield: Wells 1,2,3 and River Drive
Finished water discharge location	Outlet of each reservoir
Filter backwash discharge location	2,250-gallon surge tank with pump/gravity overflow to sanitary sewer
Raw Water Conditions	
Influent iron	Unknown
Influent manganese	Unknown
Finished Water Conditions Filter #1	
Effluent iron	Unknown
Effluent manganese	Unknown
Finished Water Conditions Filter #2	
Effluent iron	Unknown
Effluent manganese	Unknown
Raw Water Conveyance Pipe #1	
Installation Year	1998
Pipe Material	PVC (unknown type)
Diameter	8-inch
Approx. Length	4,000 ft.
Estimated Capacity at 5 fps	720 gpm
Raw Water Conveyance Pipe #2	
Installation Year	2017
Pipe Material	PVC IPS Class 160
Diameter	8-inch
Approx. Length	4,200 ft.
Approx. Capacity at 5 fps	720 gpm
Filter Bank 1	
Year Installed	1999
Number of filter vessels	8 total
Filter Unit	
Type	Pyrolusite-media, welded carbon steel tank, epoxy powder-coated
Manufacturer	ATEC Systems
Model	4805-48
Base layer	¾”-0 crushed granite (1998 manufacturer’s spec.)
Filter media	Inversand Greensand pyrolusite filter media and Greensand Plus
Media depth	36”
Unit media volume (ft^3)	37.7
Filter flow type	Down-flow
Control valve type	4-4-3 backwash valve, diaphragm with solenoids
Dimensions	
Sidewall diameter	48 5/8”
Sidewall height	44”
Unit filter area	12.6 sqft
Total bank filter area	100 sqft
Inlet/Outlet Piping	8-inch Sch 40 Steel

Unit Manifold Piping	6-inch Sch 40 Steel
Backwash Piping	4-inch Sch 40 Steel
<u>Filter Design Service Conditions</u>	
Assumed surface loading rate	7 gpm/sqft
Estimated Total Filter 1 capacity	700 gpm
Effluent Iron Objective	50% less than secondary MCL (0.30 mg/L) (1998 manufacturer's spec.)
Effluent Manganese Objective	50% less than secondary MCL (0.05 mg/L) (1998 manufacturer's spec.)
Effluent Turbidity Objective	Less than 1.0 NTU (1998 manufacturer's spec.)
Effluent Water Color Objective	Less than 15 standard color units (1998 manufacturer's spec.)
Particle Size Retention	Greater than or equal to 20 micron (1998 manufacturer's spec.)
Typical operating pressure static/filtering	±10 / 12 psi
Design working pressure	90 psi
Media regeneration system	Chlorine oxidation
<u>Filter Backwash</u>	
Backwash water source	Filtered water from other 7 filters
Backwash flow type	Up-flow
Filter backwash rate	±12 gpm per sqft
Backwash flowrate	±150 gpm per unit
Typical backwash duration	±5 minutes/unit (adjustable)
Typical backwash volume	6,000 gallons (8 units)
Backwash initiation	Timer or pressure differential (8 psi setpoint)
Backwash frequency, typical	1x bank per day, initiated by timer
Filter Bank 2	
Year Installed	2017
Number of filter vessels	8 total
Filter Array Capacity	700 gpm
<u>Filter Unit</u>	
Type	Pyrolusite-media, welded carbon steel tank, skid-mounted, epoxy powder coated interior/exterior
Manufacturer	Everfilt (6 ct. new) & ATEC (2 ct. reused) (see Filter #1 for ATEC unit specifications)
Model	Everfilt SKH48-48-6A
Base layer	½"-3/4" coarse gravel, ¼"-1/2" fine gravel (2017 manufacturer's spec.)
Filter media	Inversand GreenSand Plus pyrolusite filter media (2017 manufacturer's spec.)
Media depth	30" (2017 manufacturer's spec.)
Unit media volume (ft^3)	31.4
Filter flow type	Down-flow
Control valve type	4" multiport backwash valve, diaphragm with solenoids
Dimensions	
Sidewall diameter	48 5/8"
Sidewall height	48"
Unit filter area	12.6 sqft
Total bank filter area	100 sqft
Inlet Piping	10-inch Sch 40 Steel
Outlet Piping	8-inch Sch 40 Steel
Unit Manifold Piping	8-inch Sch 40 Steel
Backwash Piping	4-inch Sch 40 Steel
<u>Filter Design Service Conditions</u>	
Surface loading rate	7 gpm/sqft (2017 manufacturer's spec.)

Effluent Iron Objective	Unknown
Effluent Manganese Objective	Unknown
Effluent Turbidity Objective	Unknown
Effluent Water Color Objective	Unknown
Particle Size Retention	Unknown
Typical operating pressure static/filtering	±10 / 12 psi
Max. operating pressure	100 psi (2017 manufacturer's spec.)
Min. operating pressure	20-30 psi (2017 manufacturer's spec.)
Design Pressure Drop- Clean	3-4 psi (2017 manufacturer's spec.)
Design Pressure Drop- Dirty	7-8 psi (2017 manufacturer's spec.)
Media regeneration system	Chlorine oxidation
Filter Backwash	
Backwash water source	Filtered water from other 7 filters
Backwash flow type	Up-flow
Design filter backwash rate	15 gpm per sqft (2017 manufacturer's spec.)
Design Backwash flowrate	188 gpm per unit (2017 manufacturer's spec.)
Typical backwash duration	4 minutes/unit (adjustable)
Typical backwash volume	6,000 gallons (8 units)
Backwash initiation	Timer or pressure differential (8 psi setpoint)
Backwash frequency, typical	1 per day, initiated by timer
Disinfection System	
System Type	Chlorine gas feed system, vacuum-operated
Make & Model	Wallace & Tiernan, V10k flow-paced
Dosage Concentration	
Dose Rate, initial	0.7 mg/L (pre-filtration)
Reservoir, residual	0.6 mg/L
Free chlorine objective at furthest point in distribution system	0.3 mg/L
Chemical Storage, in-use	2x – 150 lb. cylinders on scales (300 lb.)
Storage, standby	4x – 150 lb. cylinders in rack (600 lb.)
Emergency valve closure	Powell E-pro, automatic
Gas detection	Evoqua gas detector
Tank switchover	Wallace & Tiernan, automatic
Fluoridation System	
System Type	Sodium fluoride saturator with feed pump
Water pre-treatment	Water softener
Injection points	Downstream of each filter bank
Number of Pumps	2, one per filter bank
Dosage Concentration	0.7 mg/L
Storage	50 lb. bags dry, one pallet, ±1,000 lbs
Auxiliary Power	
Generator	Portable, gas-powered generator
Switchgear	Manual transfer switch with generator receptacle

4.4.2 South Water Treatment Plant

The South Water Treatment Plant is part of the City's water supply facility in the southern part of the City. This facility also consists of the South Wellfield, a storage reservoir and booster pump station. The site was historically used only for the wells. In the 1990's, adsorption filters were installed at each well as a precaution for a groundwater contamination event associated with a local lumber mill. In 2004, the storage reservoir and booster pump station were constructed. Chlorination, fluoridation and the carbon filters are the only water treatment processes used at the facility. The treatment plant treats all of the water sourced from the South Wellfield.

Raw water from the wells passes through skid-mounted adsorption filters in each well house and then is conveyed to the reservoir by a common waterline. Chlorine is injected in to the raw water line upstream of the reservoir. The combined flow from the wells is measured with a flow meter. Fluoride is injected downstream of the booster pumps. A process schematic of the South Water Treatment Plant is presented in Figure 4-1. A summary of some of the design characteristics of the treatment plant are listed in Table 4-7.

The City uses a SCADA system to monitor the finished water flow rate at the plant going in to the distribution grid and the discharge pressure. This system can be monitored remotely by Public Works. The treatment plant is automatically controlled by independent control systems associated with each process, further described below. There is no central control panel or PLC for the facility.

Figure 4-16 | South Water Treatment Plant

Adsorption Filters

The South Wellfield has five identical adsorption filter systems, one at each of the five wells. They consist of two skid-mounted welded-steel basins plumbed in parallel with isolation valves. These down-flow pressure filters do not have any cleaning or backwashing operations. The filters were first installed in the 1990's, but were not placed in service until a PCE groundwater contamination event in 2005 (see Section 4.3.2.1 for more information). The carbon media for wells #4 & #5 was replaced in 2016. The filters are used as a precaution for organic contaminants in the wells, such as PCE. The City follows rigorous testing requirements for trace contaminants set by the OHA. Organic contaminants are consistently not detected pre- and post-filtration at the South Wells according to City Staff.

Disinfection System

Chlorine gas solution is injected in to the raw waterline prior to the reservoir inlet. Chlorination provides a free chlorine residual in the reservoir and in the water distribution system. When operated in the automatic mode, chlorine addition is flow-paced based on the influent flow rate to the reservoir. Chemical flow-pacing is accomplished using a dedicated controller and gas-feed rotameter.

Fluoridation System

Sodium fluoride solution is injected downstream of the booster pump station. Operators mix bags of dry sodium fluoride with carrier water in a mixing basin. The carrier water hardness is reduced by a water softener unit upstream of the mixing basin. When operated in the automatic mode, fluoride solution is flow-paced based on the booster pump station discharge rate. Chemical flow-pacing is accomplished using a variable-speed dosing pump with a dedicated controller.

Finished Water Quality

The City's finished water quality from the South Water Treatment Plant is generally good and consistently meets water quality treatment standards. As required by the OHA, water from the City's water system is tested periodically for bacteriological contamination, organic and inorganic chemical contaminants, disinfection byproducts, and a variety of radioactive compounds. Based on conversations with City Staff, water in the distribution system has taste and odor issues. The reasons for these issues is not well understood. The water quality from the South Wellfield is known to be lower in dissolved minerals than the Polk Wellfield. An evaluation of taste & odor issues is discussed in Chapter 7-Water Treatment Evaluation.

Table 4-7| South Water Treatment Plant General Operating & Design Criteria

Process System	**Design Criteria**
General	
Finished floor elevation	170'
Raw water source	South Wellfield: Wells 1,2,3, 4 and 5
Finished water discharge location	Outlet from booster pump station
Raw Water Conditions	
Influent iron	Unknown
Influent manganese	Unknown
Adsorption Filters	
Year Installed	1990's
Number of filter units	10 total (2 units per well)
Filter Unit	
Type	Adsorption, welded carbon steel basin, skid-mounted
Manufacturer	Aqua-scrub (acquired by Evoqua)
Model	PV Series-80-3 (Modern equivalent is Evoqua PV-2000)
Base layer	None
Filter media	Granular activated carbon (GAC) 8x30 mesh
Media depth	60" (modern equivalent spec.)
Unit media volume	68 ft^3 (modern equivalent spec.)
GAC Weight	2,000 lbs (modern equivalent spec.)
Filter flow direction	Down-flow
Flow Rate, Nominal Rating	100 gpm (modern equivalent spec.)
Contact Time at Max. Flow Rate	5 min. (modern equivalent spec.)
Pressure Drop at Max. Flow Rate	2-3 psi (modern equivalent spec. for 8x30 mesh GAC)
Control valve type	None
Dimensions	
Sidewall diameter	48"
Overall height	8-8"
Unit filter area	12.6 sqft
Total filter volume per well	136 ft^3
Filter Design Service Conditions	Unknown
Filter Backwash	None
Disinfection System	
System Type	Chlorine gas feed system, vacuum-operated
Make & Model	Wallace & Tiernan, V10k flow-paced
Dosage Concentration	
Dose Rate, initial	0.7 mg/L
Reservoir, residual	0.6 mg/L

Free chlorine objective at furthest point in distribution system	0.3 mg/L
Storage, in-use	2x – 150 lb. cylinders on scales (300 lb.)
Storage, standby	4x – 150 lb. cylinders in rack (600 lb.)
Emergency valve closure	Powell E-pro, automatic
Gas detection	Evoqua gas detector
Tank switchover	Wallace & Tiernan, automatic
Fluoridation System	
System Type	Sodium fluoride saturator with feed pump
Water pre-treatment	Water softener
Injection points	Downstream of each filter bank
Number of Pumps	2, one per filter bank
Dosage Concentration	0.7 mg/L
Storage	50 lb. bags dry, one pallet, ±1,000 lbs
Auxiliary Power	
Generator	On-site, diesel-powered generator
Switchgear	Automatic transfer switch
Minimum equipment to run	Wells 1-5, Gas feed systems, Pump Station

4.5 WATER STORAGE

All water used in the City of Independence is stored in four ground-level storage tanks. Each reservoir has an associated pump station, which is used to maintain system pressure and to deliver all demands of the distribution system. The City presently has four finished water storage reservoirs in use for a total storage capacity of 3,478,000 gallons. The City also has an elevated water storage tank that is no longer connected to the water system. Table 4-8 provides an inventory of the City's storage reservoirs.

Table 4-8| Reservoir Inventory

Reservoir	*Year Installed*	*Nominal Capacity (g)* (1)	*Nominal Diameter (ft)* (1)	*Nominal Height (ft)* (1)	*Total Storage Depth (ft)* (2)	*Total Storage (g)* (3)	*Approx. Floor Elevation (ft)*	*Approx. Max. Water Surface Elevation (ft)*	*Construction Type*
Polk 1	1999	734,000	61.54	33.01	30.0	668,000	168	198	Glass-fused bolted steel
Polk 2	2012	712,000	61.54	33.01	30.0	668,000	168	198	Glass-fused bolted steel
South	2005	1,488,000	95.11	28.43	26.9	1,430,000	171.5	198	Glass-fused bolted steel
Monmouth Street	1976	750,000	57.0	40.0	37.3	712,000	±171	±208	Welded-steel
					TOTAL	3,478,000			

(1) Reservoir nameplate value
(2) Depth between reservoir floor and fill stop level set point.
(3) Estimated volume based on total storage depth and nominal diameter.

4.5.1 Polk Reservoirs 1 & 2

The Polk Reservoirs are located at the Polk Water Treatment Plant adjacent to the City's wastewater treatment facility. Polk Reservoir 1 is located on the north side of the facility and was constructed in 1999. Polk Reservoir 2 is located south of Polk Reservoir 1 and was constructed in 2012. Both reservoirs are constructed of bolted steel panels with interior and exterior glass-fused coating and a domed aluminum-paneled roof. The total storage volume at the facility is approximately 1.34 million gallons.

Figure 4-17 | Polk Reservoirs 1 & 2

The reservoir levels are managed in tandem and share the same floor and maximum water depth elevations. Water level in the reservoirs is maintained by the operation of the Polk Wellfield pumps. The pumps are turned on/off to maintain the reservoirs in a full state. Water from the reservoirs flows directly to the Polk Pump Station, adjacent to Polk Reservoir 2. The reservoirs may also be filled from the distribution system using a control valve in the booster pump station. The water level in the reservoirs is monitored by the City's SCADA system and operators.

The reservoirs are considered pumped storage, which means a booster pump station is required to convey water at adequate pressure from the reservoirs to the distribution system. The Polk Pump Station draws water directly from the reservoirs.

The reservoirs have access ports located near the base, outside access ladders, roof vents, and hatches. The hatches on all of the reservoirs have alarms. Each reservoir has a mechanical water level indicator. The water level in the reservoirs is measured using a pressure transducer located in the booster pump station.

The City regularly inspects and maintains the reservoirs. The reservoirs are typically inspected by tank divers every 4 years. The reservoirs were last inspected by tank divers in 2017. The inspection report was not available for this study. In 2012, a leak in Reservoir 1 was repaired. This repair involved installing a sealant on the interior of the reservoir around the first row of panels that are embedded in the foundation.

Polk Reservoir 1 was constructed roughly 25 years ago and does not appear to have been designed to withstand seismic forces. Likewise, the City should consider a seismic evaluation and subsequent seismic retrofit. A seismic evaluation will clarify and determine the scope of a retrofit, if necessary.

Polk Reservoir 2 was constructed in 2012. It is unknown whether the reservoir was designed to withstand seismic forces. Similar to Reservoir 1, the City should consider a seismic evaluation and subsequent seismic retrofit. A seismic evaluation will clarify and determine the scope of a retrofit, if necessary. Specific recommendations for the City's reservoirs are described in Chapter 9.

4.5.2 South Reservoir

Figure 4-18 | South Reservoir

The South Reservoir provides approximately 1.43 million gallons of storage for the City's water distribution system. It represents roughly half of the City's water storage. The reservoir is considered pumped storage, which means a booster pump station is required to convey water at adequate pressure from the reservoir to the distribution system. The City's South Pump Station draws water directly from the reservoir. This reservoir primarily serves users in the southern half of the City.

The reservoir was built in 2005. It is located near the intersection of Briar Road and River Oak Road in Independence. It is a bolted steel construction with glass-fused porcelain-enamel coating system. It has a domed, aluminum-paneled, roof. This is the same type of construction as the Polk Reservoirs.

The reservoir has an access port located near the base, outside access ladder, a roof vent, and hatch. The hatch has an alarm. The reservoir has a mechanical water level indicator. The water level in the reservoir is measured using a pressure transducer located in the booster pump station.

Water level in the reservoir is maintained by the operation of the South Wellfield pumps. The pumps are turned on/off to maintain the water level in the reservoir. The reservoir may also be filled from the distribution system using a control valve in the booster pump station. The floor elevation is approximately 171 ft. The maximum water surface elevation is approximately 198 ft. The water level in the reservoir is monitored by the City's SCADA system and operators.

The reservoir undergoes regular inspection repair & maintenance. The reservoir was last inspected by divers in 2017 and is scheduled to be inspected again in late 2022, along with the other reservoirs. The inspection report was not available for this study. A leak at a bolt was detected in the reservoir, which was repaired externally.

The South Reservoir was constructed roughly 20 years ago. It is unknown whether the reservoir was designed to withstand seismic forces. Likewise, the City should consider a seismic evaluation and subsequent seismic retrofit. A seismic evaluation will clarify and determine the scope of the retrofit. Specific recommendations for the City's reservoirs are described in Chapter 9.

4.5.3 Monmouth Street Reservoir

Figure 4-19 | Monmouth Street Reservoir

The Monmouth Street Reservoir provides approximately 712,000 gallons of storage for the City's water distribution system. Like the City's other three reservoirs, the reservoir is considered pumped storage, which means a booster pump station is required to convey water at adequate pressure from the reservoir to the distribution system. The City's Monmouth Street Pump Station draws water directly from the reservoir. The reservoir is located north of Monmouth Street and between 11th and 12th streets.

The reservoir was built in 1976. It is welded steel construction with a flat roof. The internal coating is coal tar. The reservoir has the original lead-based external paint on the walls and roof. No repair or maintenance has been done on the external coating. The external coating has substantially deteriorated. According to operators, the coating is effectively absent from the roof. There are many voids in the exterior coating on the walls where steel is exposed. These areas are 1/2-inch to 6-inches in diameter and are rusting.

The reservoir's piping is the original steel piping that was installed in 1967. According to operators, the piping is severely corroded, like the piping in the adjacent booster pump station. This piping goes underneath the reservoir to fill and drain the structure.

The reservoir has a controlled overflow. The reservoir has an access port located near the base, an outside access ladder, a roof vent, and hatch. The hatch has an intrusion alarm. According to operators, the roof hatch no longer functions properly. The access ladder does not meet current OSHA standards. Additionally, there is no hand rail around the hatch as required by OSHA standards.

The water level in the reservoir is measured using a pressure transducer located in the booster pump station. Pressure in the distribution system is utilized to fill the reservoir. An altitude valve operates automatically to maintain a full water level. This valve closes when the booster pumps are running. The floor elevation is approximately 171 ft. The maximum water surface elevation is approximately 208 ft. The water level in the reservoir is monitored by the City's SCADA system and operators.

The reservoir undergoes regular inspection. The reservoir was last inspected by divers in 2017 and is scheduled to be inspected again in late 2022, along with the other reservoirs. The inspection report was not available for this study.

Based on visual inspection, the reservoir does not appear to be anchored to the concrete foundation. No exterior anchor bolts are present. The reservoir was constructed roughly 60 years ago. It was not designed in accordance with current seismic codes. Specific recommendations for the tank are described in Chapter 9.

4.6 PUMP STATIONS

Three booster pump stations maintain pressure in the City's water distribution system. These are the Polk, South and Monmouth Street Pump Stations. Since all of the City's water storage is at ground level, these pump stations must be able to provide the peak hour flows to the distribution system while maintaining minimum pressure. Additionally, this means that pressure in the distribution system relies on continuous primary or auxiliary power to the pumps. The

South Pump Station is the only station with an auxiliary power generator and automatic transfer switch. However, both the Polk and the Monmouth Street Pump Stations each have a diesel-powered pump, which can be used during a power outage.

Table 4-9 lists the output of each individual pump in this station. The reader should note that the total output of multiple pumps operating together is not the additive output from each individual pump. Total pump station output will increase, but the contributing output of each individual pump will decrease.

All three pump stations are controlled systematically by the City's SCADA system to maintain the pressure in the distribution system. The distribution system pressure is measured using a pressure transducer at the City's Public Works Shops. This sensor provides the pump control signal used to sequentially turn on and off pumps. All of the pump stations have door intrusion alarms. All three pump stations have control valves that automatically open to fill the reservoirs when there is excess pressure in the distribution grid. These valves also act as surge valves.

Figure 4-20 | Polk Pump Station

The SCADA system uses 27 operating levels to vary the use of the pumps and the discharge rate of the pump stations. The SCADA system displays pump status. Each pump station records bi-directional flow from the reservoirs. The SCADA system additionally displays the status of the automatic transfer switch at the South Pump Station.

An inventory of the City's booster pumps is presented in Table 4-9. The City has a combination of pump types, including end-suction centrifugal, vertical turbine, and a submersible. All pumps are controlled with full-voltage non-reversing, "across the line", starters, meaning the pumps operate either at full speed or off. Some pumps are fitted with flow control valves that gradually throttle the flow rate of pumps when they are turned on.

4.6.1 Polk Pump Station

The Polk Pump Station is located adjacent to the Polk Water Treatment Plant and Polk Reservoirs. A concrete masonry unit building houses the pumps, discharge piping, electrical and instrumentation. Fuel for the diesel-powered pump is stored in an above-ground tank outside of the building. Perimeter fencing at this facility and the adjacent wastewater lagoons is not adequate to prevent trespassing. Above-ground tanks are targets for vandalism and theft. Subsequent fuel spills can cause costly environmental cleanups. It is recommended that the perimeter fencing be retrofit to prevent trespassing and vandalism. Additionally, it is uncertain whether this fuel tank was designed to withstand seismic forces. Likewise, the City should consider a seismic evaluation and subsequent seismic retrofit. A seismic evaluation will clarify and determine the scope of the retrofit.

Operators consistently notice an issue with the pump station's operation. During relatively low demand periods in winter, the pump station oscillates between running the 25 and the 50-horsepower pump. The 50-horsepower pump is too powerful for this operating level and frequently cycles on and off. The 25-horsepower pump is not able to meet the demands during these periods. This type of operation puts excess wear and tear on the pump station. Operators have identified this pump as a high priority for upgrading to a variable frequency drive. This would allow the pump to ramp up and down to better meet demands in the distribution system. The City has looked at making this improvement and determined that there is not adequate space in the building for the equipment. The equipment would either have to be installed on the exterior of the building or the building would have to be expanded. Specific recommendations for this pump station are included in Chapter 8.

4.6.2 South Pump Station

Figure 4-21 | South Pump Station

The South Pump Station is located in the same building as the South Water Treatment Plant and at the same location as the South Wellfield and South Reservoir. A concrete masonry unit building houses the pumps, associated piping, electrical, instrumentation, and generator. The pump station was built in 2004.

Public Works has experienced significant problems with the reliability of the power service to this facility. According to the power utility, the area of the grid that delivers power to the facility has a “dirty leg”, meaning that one or more phases of electricity is relatively low quality. A loss in one or more phases can cause permanent damage to pumps. The pump station controls are equipped with a phase-loss relay to protect the pumps. This protection is engaged at the station at least twice per year during low quality power events, which shuts down the pump station. An operator is required to manually reset the pump station control system. Specific recommendations for this pump station are included in Chapter 8.

4.6.3 Monmouth Street Pump Station

Figure 4-22 | Monmouth Street Pump Station

The Monmouth Street Pump Station is located adjacent to the Monmouth Reservoir. A concrete masonry unit building houses one electric pump, one diesel-powered pump, associated piping, reservoir fill control valve, electrical, and instrumentation.

Fuel for the diesel-powered pump is stored in an above-ground tank outside of the building. It is uncertain whether this fuel tank was designed to withstand seismic forces. Likewise, the City should consider a seismic evaluation and subsequent seismic retrofit. A seismic evaluation will clarify and determine the scope of the retrofit.

The piping for this pump station and reservoir is steel pipe. Most of the piping is the original painted steel piping from when the facility was built. The piping has severely corroded in exposed and underground locations. The pipe is approximately 50 years old. Additionally, the piping from the distribution grid to the pump station is asbestos concrete piping that is relatively old and brittle. This AC and steel piping is recommended to be replaced during the planning period.

Table 4-9| Pump Station Inventory

Pump Station	*Pump Number*	*Motor Power (horsepower)*	*Pump Type*	*Power Type*	*Flow Rate (gpm)* (1)	*Total Dynamic Head (ft)* (1)	*Motor Speed Control*
Polk Pump Station	1	25	End-suction centrifugal	Electric	500	150	Constant Speed
	2	50	End-suction centrifugal	Electric	1,100	150	Constant Speed
	3	92	End-suction centrifugal	Diesel	1,500	150	Constant Speed
South Pump Station	1	30 (high flow)	Vertical turbine/ Line-shaft	Electric	750	150	Constant Speed
	2	30 (low flow)	Vertical turbine/ Line-shaft	Electric	500	150	Constant Speed
	3	20	Vertical turbine/ Line-shaft	Electric	350	150	Constant Speed
	4	10	Submersible	Electric	200	150	Constant Speed
Monmouth St. Pump Station	1	25	End-suction centrifugal	Electric	500	150	Constant Speed
	2	99	End-suction centrifugal	Diesel	1,500	150	Constant Speed

1- Pump nominal operating point based on City records and pump curve.

4.7 DISTRIBUTION SYSTEM

The City's distribution system consists of the pipes, fittings, valves, and hydrants that convey finished water from the reservoirs to end users. These components consist of a wide range of sizes, ages, and materials. The City utilizes typical pipe sizes ranging from ¾-inch water services up to 12-inch water mains. Based on City records, there are distribution pipes in use from the 1950's and 1960's. A substantial portion of the pipes were installed in the 1970's. The pipe network consists primarily of asbestos cement (AC) and polyvinyl chloride (PVC) pipe. The system also has some steel, ductile iron (DI) and cast-iron (CI) pipe. For the last several years, the City has standardized around AWWA C-900 PVC water pipe. This subsection presents an inventory and description of the distribution system.

4.7.1 Distribution Pipe Network

The major components of the water distribution network are shown in the water system maps included in **Appendix A**. All public waterlines within the study area are owned by the City, except for some owned by the City of Monmouth. In addition to the City, the Oregon Department of Transportation (ODOT) has jurisdictional oversight for facilities constructed within or along Oregon State Route 51 (Monmouth-Independence Highway and the Independence Highway).

There is a total of approximately 194,200 feet (36.8 miles) of pipe in the City's existing distribution system. As shown in Figure 4-23, the system is roughly half 8-inch diameter pipe and one-third 6-inch diameter pipe. The remainder of the network is comprised of 12-, 10-, 4- and 2-inch pipe.

As shown in Figure 4-23, the existing distribution system is roughly two-thirds PVC and one-quarter asbestos concrete (AC). The remainder is comprised of relatively small quantities of steel, cast-iron (CI), ductile iron (DI), and unknown pipe materials. In the last few decades, the City standardized on C-900 PVC pipe with a minimum diameter of 8-inches for distribution mains. A detailed inventory of pipe sizes and materials is provided in Table 4-10.

Figure 4-23| Length of Distribution Pipe by Diameter and Material

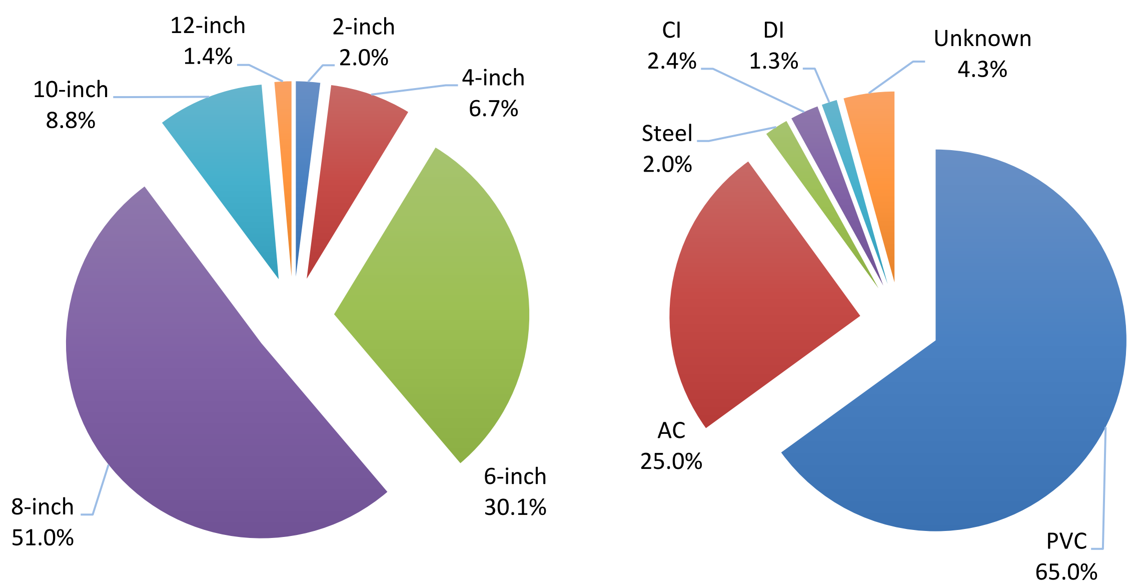


Table 4-10| Distribution System Inventory

DIAMETER [in]	PIPE MATERIAL						TOTAL
	PVC	AC	Unknown	Cast-iron	Steel	Ductile-iron	
2	3,500	-	300	-	-	-	3,800
4	3,900	4,900	300	3,100	2,100	600	14,900
6	35,500	17,700	3,000	1,600	600	-	58,300
8	64,000	25,600	4,800	-	1,200	1,800	97,400
10	17,100	-	-	-	-	-	17,100
12	2,600	-	-	-	-	-	2,600
TOTAL	126,600	48,200	8,400	4,700	3,900	2,400	194,200

The layout of the existing water system appears to be adequate to deliver the required domestic flow rates to the community. Chapter 8 presents a detailed evaluation of the distribution system.

4.7.2 Water Service Levels

Water must be supplied throughout the distribution grid at sufficiently high pressure to meet OHA standards, to prevent contamination and to ensure that appliances operate correctly. Excessive pressures must also be avoided to prevent damage to the distribution system and private plumbing fixtures. A minimum of 20 psi must be maintained at all times in the public distribution system. Common practice is to provide static water pressure in the range of 40 to 90 psi. Static pressure is the water pressure at a given elevation in the distribution system without any water flowing. As elevation changes in the distribution grid, static pressure changes. As elevation in a water distribution system increases, static pressure decreases, and vice versa. Depending upon the range in elevation that must be served by a municipality, a distribution system is separated in to one or more service zones that can deliver the typical static pressure range for all users. Each service zone is typically associated with one or more reservoirs, pump stations, or pressure reducing valves that maintain the pressure range in the service zone.

In the City's case, all three of the booster pump stations maintain pressure in a single service zone that serves the entire distribution system. The City does not have any reservoirs or pressure reducing valves that control the pressure in this zone. The City operates the pump stations to maintain 60 to 65 psi at the Public Works shop buildings near F and Main Streets. The typical static pressure at this location is 60 psi. The elevation at this location is approximately 172 ft. Therefore, the maximum elevation that can be served by the pressure zone with a static pressure of 40 psi is 218 ft. The minimum elevation that can be served by the pressure zone with a static pressure of 90 psi is 103 ft. All locations in the City's UGB are between 218 and 103 feet of elevation. Therefore, a single service zone is capable of serving all current and future users in the UGB. The distribution system currently serves users between an elevation of 160 feet and 185 feet. The lowest elevation users in the distribution system are along Osprey Lane in downtown. The highest elevations in the distribution system are along the far western and south-western edge of the city limits.

The service level is also used to fill the Monmouth Street Reservoir. The maximum water surface elevation of the reservoir is approximately 208 feet. This hydraulic grade is within the service level.

4.7.3 Water Meters

Based on City records, the distribution system has roughly 2,700 customer water meters currently in service. The City has a management system that is used to collect the data via radio and use the data for billing. About 95% of the City's user meters are read remotely from a service truck, (i.e., radio-read). Roughly 5% of the meters are manually read. User meters are typically either ¾-inch or 1-inch. When collecting monthly water usage, operators drive a route through the City. This process typically takes about five man-hours to complete per month for the City. However, wet weather regularly floods the meter boxes and prevents all of the meters from being read remotely. This requires additional labor to manually read roughly 100 meters per month during the wet season.

The City has standardized on Master Meter brand water meters. These water meters consist of a meter body and a register with the radio and battery components. The City regularly replaces meters, but does not currently have a standardized meter replacement program. In 2007, the City started replacing meters with the radio-read models. The meter bodies generally last about 20 years. The meter registers generally last 15 to 20 years before they run out of battery. Within the next five years, the meter bodies are expected to begin being replaced. Between 2019 and 2021, the City replaced all of the meter registers. It is expected that the City will need to replace the meter registers once during the planning period.

Based on discussions with City staff, there is some interest in automating the meter reading process using a radio-based, city-wide network. These types of systems are referred to as Advanced Meter Infrastructure or AMI systems. A radio network is used to read the meters automatically instead of requiring an operator to drive the data collection route. A similar system is used in the City of Monmouth for their water usage and power meter readings. This system could potentially be used by customers to view their water usage patterns. Generally, these systems require a substantial investment to set up due to the amount of radio towers needed to cover an entire town and the additional components needed for the meters. The City's decommissioned water tower might be able to function as a central data collection point for the system. This tower is currently used for telecommunications and antennas.

4.8 SCADA & TELEMETRY SYSTEM

As previously discussed, the City's water system has a central Supervisory Control and Data Acquisition system (SCADA). Operators can monitor and control many aspects of the water system from this system. Specific monitoring and control points for each facility are discussed in greater detail in the previous sections of this chapter. Many of these monitoring points and processes are shown in the water system schematic (Figure 4-1). The SCADA system allows operators to monitor the status of components, such as reservoir levels, pump status, flow rates, and water pressures. The system also allows operators to control certain components, change reservoir level set points, turn pumps on and off and toggle some control valves. The SCADA system automatically controls pumps at each booster pump station to maintain the pressure in the distribution grid. The pump stations and reservoirs communicate with the SCADA system using radio and telephone-based telemetry.

4.9 EXISTING WATER SYSTEM FUNDING MECHANISMS

Funding for the City's existing water system comes from several sources. The primary sources are water user fees and system development charges (SDCs). The City maintains a water system fund for the operations of the City's water department and a water SDC fund. The City does not maintain a dedicated capital reserve fund for capital improvements to the water system. Loans are typically used as the main source for capital improvements to the water system.

4.9.1 Water User Fees

User fees are monthly charges to all residences, businesses, and other users that are connected to the water system. User fees are established by the City Council and are typically the sole source of revenue to finance operation and maintenance. The City's current water user fee schedule is established by Resolution 20-1543. Water user fees include monthly fees for usage, connection fees, and other miscellaneous fees. For most residential and commercial connections (i.e., ¾-inch meters), the City currently charges a base usage fee of $34.79 per month. Users with 1-inch meters are charged a base fee of $73.06 per month. Users with larger meters are charged higher base fees per month. All users regardless of meter size pay an additional fee of $3.33 per 100 cubic feet of water usage per month.

The anticipated revenue from water user fees for the fiscal year 2021/2022 is budgeted to be $2,747,500. Including other various charges and interest earnings, the total water fund revenues for the 2021/2022 fiscal year are budgeted to be $3,025,550. In addition to revenues, the 2021/2022 fiscal year budget also includes a beginning balance of $1,268,310. This is budgeted to be utilized for costs in the fiscal year.

The City's water fund must provide sufficient revenues to properly operate and maintain the water system and provide reserves for normally anticipated replacement of key system components such as meters, pumps, motors, electrical, chemical feed equipment, fire hydrants and distribution piping repairs. Although the City relies exclusively on user fees for operation and maintenance costs, the water fund is typically not adequate to finance major capital improvements without outside funding sources.

4.9.2 System Development Charges

A system development charge (SDC) is a fee collected by the City for each piece of property when it is developed and serviced by the City's roads and utilities. SDC's are used to finance necessary capital improvements and municipal services required by the development. SDC's can be used to recover the capital costs of infrastructure required as a result of the development, but cannot be used to finance either operation and maintenance or replacement costs.

The SDC fee system was most recently adopted by Resolution Number 2004-1132. The City charges different SDC fees based on residential or commercial developments and based on the size of the water meter installed at each development. The current fee structure is listed in Table 4-11. Over the last three fiscal years, the City has collected approximately $130,000 per year in water SDC's.

Table 4-11 | Current Water SDC Fees

Residential	
Single Family Unit	$2,786.00
Multi-family Unit	$2,226.00
Commercial Building	
Meter Size	**SDC Charge**
3/4-inch	$2,226.00
1-inch	$3,961.00
1 ½-inch	$8,906.00
2-inch	$15,833.00
3-inch	$39,667.00
4-inch	$63,501.00

4.9.3 Annual Water System Costs

Annual operations and maintenance costs are recurring costs typically funded through user rates. The City's budget for 2021/2022 fiscal year includes various expenditures as listed below (Table 4-12). The total expenditures (uses) for the fiscal year are budgeted to be approximately $4,293,860.

Table 4-12 | Water Operating Fund Expenditures 2021/22

Item	Budget
Personnel Services	$ 520,000
Materials and Services	$ 406,200
Capital Expense	$ 619,000
Transfers, Debt and Contingency	$ 2,748,660
TOTAL EXPENDITURES (USES)	**$ 4,293,860**

4.9.4 Debt Service

The City currently has two outstanding loans for the water system (Table 4-13). As of May of 2021, the total outstanding principal owed is approximately $1,733,000 and the minimum debt service payments total approximately $185,000 per year.

Table 4-13 | Water Utility Existing Debt

Loan Description	Loan Amount	Term (years)	Payoff Date	Interest Rate	Annual Total Payment	Outstanding Principal (5/2021)
Water Bond 2016A	$1,335,000	20	2036	3.013%	±$91,000	$1,075,000
Water Rights 2019 (Chase Bank)	$800,000	10	2029	2.9%	±$93,307	$657,754

CHAPTER 5

PRESENT AND FUTURE WATER DEMANDS

Chapter Outline

5.1 Introduction
5.2 Terms and Definitions
5.3 Population
5.4 Historical Water Demand
5.5 Projected Water Demand
5.6 Fire Flow

PRESENT AND FUTURE WATER DEMANDS

CHAPTER 5

5.1 INTRODUCTION

A primary measure of the size of a municipal water system is the total amount of water that it delivers to the distribution grid. This capacity is the sum of water required for domestic, commercial, and industrial uses, water that is lost out of the system through leakage, in addition to water required for fire protection.

Future water demands have been prepared based on a number of variables including the following:

- Population projections
- Historical water demand
- Land use zoning within the study area
- Projected fire flows

The demand characteristics developed in this chapter will serve as the basis for evaluating the City's existing water system infrastructure and for sizing supply, treatment, storage, and distribution infrastructure across the planning period.

5.2 TERMS AND DEFINITIONS

5.2.1 System Demand

The following terms are used to describe system demand:

- *Consumption* – Consumptive demand is water delivered to the system's users through service connections. Consumption is generally less than demand. The difference between the two is system loss and unmetered usage. Consumption is measured by the consumer's meter and is accordingly the metered portion of demand.
- *Demand* – The total amount of drinking water entering the transmission/distribution system from water sources and storage facilities to meet various user needs (excludes raw water that has not passed through the water treatment plant). Demand equals consumption plus system loss and is usually measured by master meters.
- *Fire Flow Demand* – Demand required for firefighting purposes. Fire flow demands vary by structure type and use and are proscribed by the City and/or fire code. Fire flow demand is considered to be met if the system can deliver the required flow rate while maintaining a minimum residual pressure in the distribution system of 20 psi.
- *System Loss* – System loss is water that cannot be accounted for. It is the difference between the total demand and the total consumption. System loss is not necessarily the same as leakage. However, the majority of system losses are typically the result of leaks in pipes. Losses can also be attributed to meter error and unmetered uses. Examples of unmetered uses are street flushing, hydrant testing, filter backwashing, and reservoir overflows.

5.2.2 Demand Variations

Water demands in municipal water systems vary widely across time. Seasonal, monthly, daily and hourly demand rates are utilized to evaluate and size various components of the overall water system. For the purposes of this report, the following demand classifications will be used. The definitions are generally listed in order of increasing magnitude.

- *Average Day Demand (ADD)* – The total volume of water that enters the system over a period of one year, divided by 365 days.
- *Maximum Month Demand (MMD)* – The largest total volume of water that enters the system in a one-month period, divided by 30 days.
- *Maximum Day Demand (MDD)* – The largest total volume of water that enters the system in a 24-hour period. MDD is commonly used to size water treatment plants, large diameter transmission mains and factors into the sizing of reservoirs.
- *Peak Hour Demand (PHD)* – The greatest flow occurring in any one-hour period. PHD is used as one criterion for sizing distribution waterlines and factors into the equations used to size pump stations and reservoirs.

5.3 POPULATION

Population projections serve as the basis for future water demand projections. Much of the challenge in projecting water system growth relates to the difficulty in accurately tracking or projecting actual populations.

This section evaluates anticipated growth from a review of several data sources, including historical population data (census information & PSU estimates), County coordinated population projections, and anticipated development.

5.3.1 Historical Municipal Population

Population histories provide a tool for determining the future growth rate of the municipal water system. The population in Independence has steadily increased from 4,475 people in 1990 to 9,828 in 2020. Figure 5-1 shows the population trends in Independence from 1990 to the present.

Table 5-1 | Historical Population

Year	*Population*
1990	4,425
2000	6,035
2010	8,590
2020	9,828

Reference: U.S. Census Bureau; 1990, 2000, 2010, 2020.

5.3.2 Anticipated Future Development & HB 2001

Substantial growth is expected to continue in Independence, especially due to its proximity to the Salem-Keizer metropolitan area. During the planning period, the City anticipates future residential development to continue as both new subdivisions and as infill development (i.e., partitions & redevelopment). A major commercial or industrial development that would dramatically increase the employment opportunities in Independence is not anticipated during the planning period. If a major commercial or industrial development like this occurs, this plan should be updated accordingly.

As discussed in Section 2.4.3, HB 2001 is anticipated to result in increased occupant density in residential neighborhoods. This will result in higher demand on the City's water distribution system than would occur without the legislation. At this time, the State is in the early stages of implementing HB 2001 and it is unclear how the legislation will affect the population within the UGB during the planning period. This document relies on the coordinated population forecasts produced by the Portland State University's Population Forecast Center. The forecasted population is discussed further in the following section. If PSU's forecasts change substantially, this document should be updated accordingly. Additionally, this issue should be reevaluated when this document is periodically updated during the planning period.

5.3.3 Future Population Projections

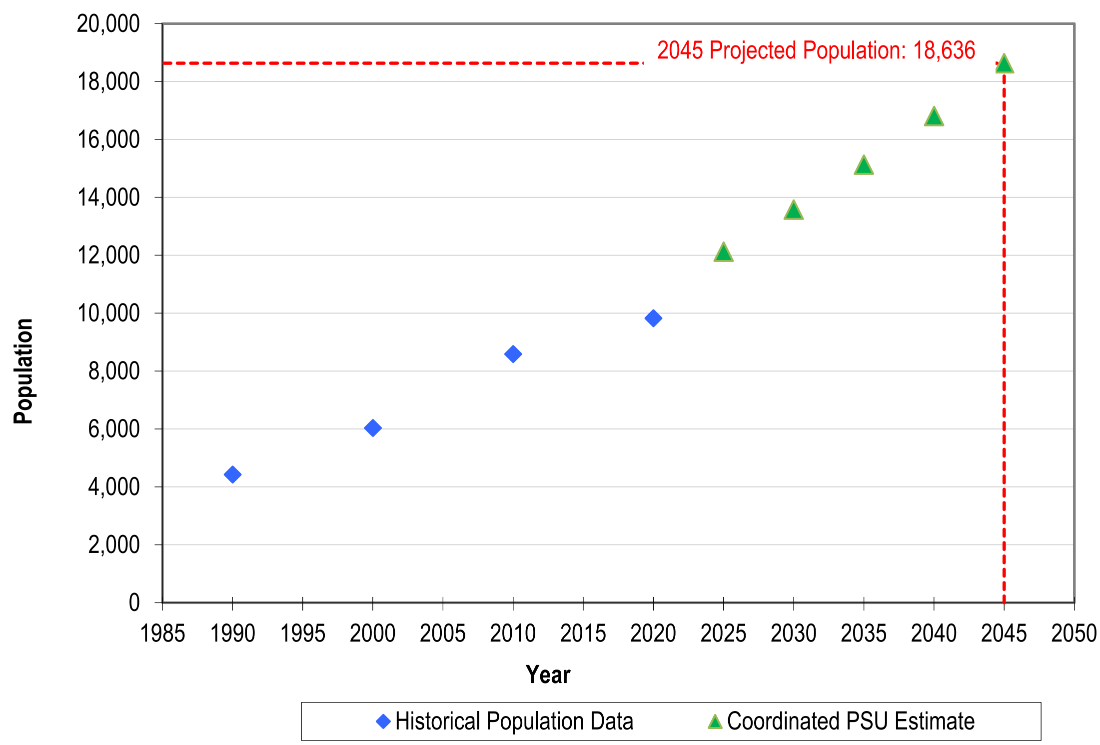
As previously noted, the planning period used in this document is about 20 years, which extends through 2045. In order to be eligible for many public funding sources, population projections (and associated demand projections) must be shown to be compatible with local and statewide planning goals, including adopted statewide and County population allocations (which are used as the 'coordinated number' for evaluating population projections).

In 2021, a population projection for Polk County was prepared by the Portland State University Population Research Center. The County Coordinated population estimates are plotted together with historical population trends in Figure 5-1. Based on the projections the population of Independence is expected to reach 18,636 by 2045. The projected population estimates are listed by year in Table 5-2.

Table 5-2 | Municipal Population Projection

Year	*Population*
2025	12,126
2030	13,578
2035	15,131
2040	16,814
2045	18,636

Figure 5-1 | Population Growth Trend



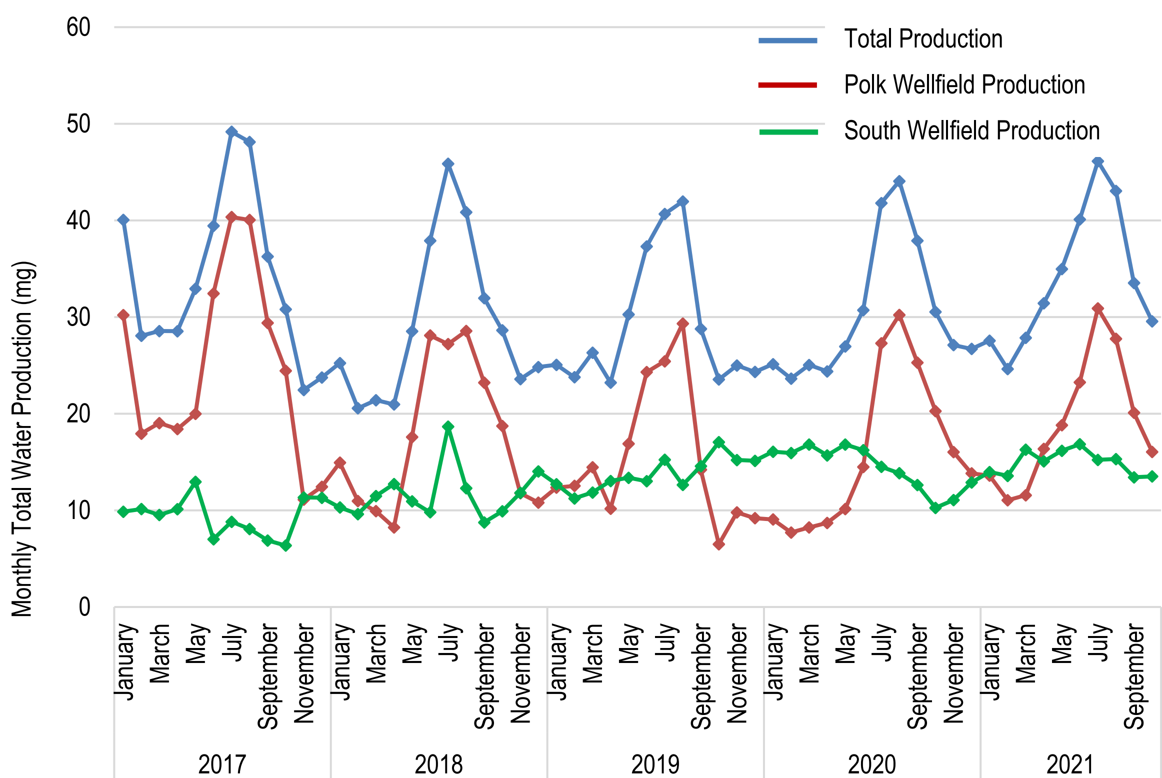
5.4 HISTORICAL WATER DEMAND

Historical records of water demand provided by the City were evaluated to determine usage rates and demand variations. The roughly five-year period from 2017 through October 2021 was used as a basis to establish historical water demands. The information from this section combined with the population data of Section 5.3 forms the basis for estimating future water demands as presented in Section 5.5.

5.4.1 Water Production

The City obtains water from the Polk Wellfield and the South Wellfield. Water produced from each wellfield is measured on a daily basis. Figure 5-2 shows the total water produced on a monthly basis from these sources from 2017 through October of 2021. The figure indicates total water production in blue, Polk Wellfield production in red, and South Wellfield production in green. This figure illustrates the trends and variation in total water production during different periods of the year. As expected, total production increases during the summer to meet increased demand and decreases during the winter months. Peak water production consistently occurs in either July or August in the data set. Base level demand is evident in the data set between October and April. As shown in Figure 5-2, production is generally ramped up from the Polk Wellfield to meet peak seasonal demands. In contrast, the South Wellfield production fluctuates less and is predominantly used to deliver base water demands.

Figure 5-2| Historical Water Production



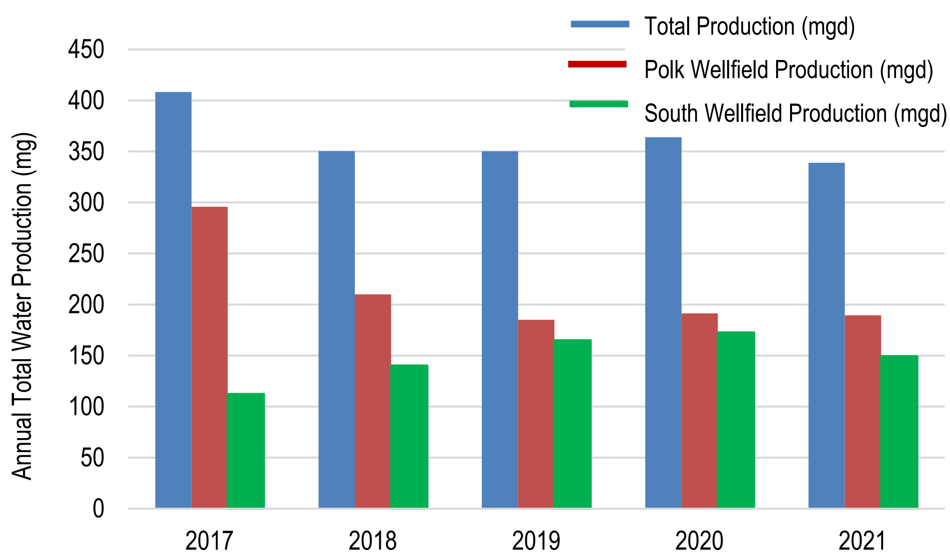
Over the five years of the data set, approximately 50 to 70 percent of the water used annually by the City is sourced from the Polk Wellfield. The amount of finished water produced from each source is listed in Table 5-3. The relative amount of water production from each source is shown graphically in Figure 5-3.

Table 5-3| Summary of Historical Water Production

Year	Total (mg)	Polk Wellfield (mg)	South Wellfield (mg)	Estimated Population[1]
2017	408	296	112	9,448
2018	350	210	140	9,573
2019	350	185	165	9,699
2020	364	191	173	9,828
2021, Jan – Oct	339	189	149	9,961

[1] Population in years other than 2020 was estimated based on an average annual compound growth rate of 1.36% from 2010 to 2020.

Figure 5-3| Historical Water Production by Source



5.4.2 Average Day Demand (ADD)

Water demand is defined as the sum of all water produced and delivered to the City distribution system. It includes water consumed in all use categories and also includes water loss and unaccounted-for water. Water demand varies across seasonal periods, days of the week, and hours of the day. The establishment of an average day demand rate serves as the baseline against which other more intensified demands are measured.

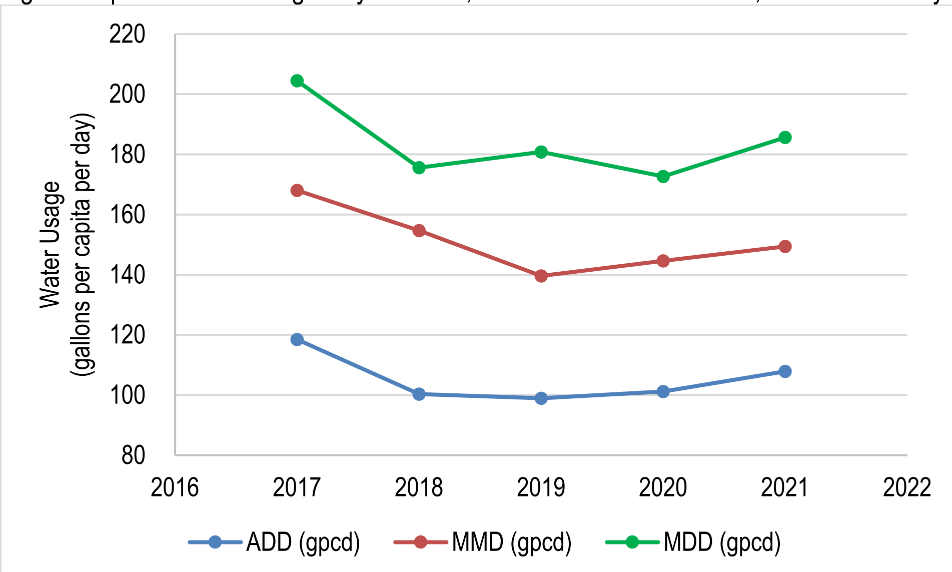
Figure 5-4 below is a graph of the per capita ADD values from 2017 through 2021. An examination of the ADD trend shows that per capita ADD decreased in 2018 and then stayed relatively constant between 2018 and 2021. For the purpose of developing water demand projections into the future, this report uses an ADD of 106 gallons per capita per day (gpcd) for additional users due to population growth. This value is equal to the existing ADD determined from data for 2017 through 2021.

Although the current water use rates in Independence (not counting system leakage) are similar to other comparable municipalities, the City should continue to take a proactive approach to water conservation as a means to preserve this valuable public resource.

5.4.3 Peaking Factors

A graphical representation of the historical ADD, MMD and MDD values normalized against population are depicted in Figure 5-4. These are the average per capita values over the 2017 to 2021 period. These values are used for future projections. Estimated values for the City's population in each year are presented in Table 5-3.

Figure 5-4| Historical Average Day Demand, Maximum Month Demand, & Maximum Day Demand



Variations in water demand are typically expressed as ratios to the average day demand, also known as peaking factors. Peak demands are important planning factors since facilities must be sized for maximum demands, not average demands. Table 5-4 shows the current peaking factors, measured or assumed. A discussion of the basis for each demand category is presented in the following section.

Table 5-4| Summary of Historical & Estimated Water Usage Rates & Peaking Factors

	Average Day Demand, ADD [1]	Maximum Month Demand, MMD [1]	Maximum Day Demand, MDD [1]	Peak Hour Demand, PHD
Average Water Usage (gpcd)	106	152	184	530 [2]
Peaking Factor	N/A	1.43	1.74	5.0 [3]

[1] Historical usage rate and peaking factor are derived from water production records.
[2] Value is estimated based on assumed peaking factor. No data on peak hour demand was available for this study.
[3] Peaking factor is assumed based on typical demand of municipal water systems and engineering literature.

5.4.4 Maximum Month Demand (MMD)

Maximum month demands normalized against population are depicted in Figure 5-4 above. The average MMD from 2017 through 2021 was 152 gpcd. This results in a ADD:MMD peaking factor of 1.43. Maximum month demand is perhaps the most variable of the peaking factors, as the period is long enough to capture the full effect of seasonal weather trends.

5.4.5 Maximum Day Demand (MDD)

MDD values are conventionally utilized to size treatment plant capacity and factor into the sizing of reservoirs. MDD is typically the most critical water demand scenario and is usually the standard by which system adequacy is measured.

The average MDD from 2017 through 2021 was 184 gpcd. This results in a ADD:MDD peaking factor of 1.74. This value is relatively low compared to typical municipal water systems and engineering literature. A typical range for this peaking factor is 2.0 to 3.5. Therefore, an ADD:MDD peaking factor of 2.0 is assumed for this plan. Later sections of this report will apply this peaking factor against population projections to project MDD during the planning period.

5.4.6 Peak Hour Demand (PHD)

Due to the short duration of peak hour demand and the large cost of constructing source and treatment facilities to match this demand, peak hour demand (unlike maximum day demand) is satisfied by drawing down reservoir levels using booster pump stations. The distribution network and pump stations must be capable of supplying peak hour demand with a minimum residual pressure of 20 psi throughout the distribution network.

The City does not currently collect demand data on an hourly basis. Therefore, in order to estimate and project the peak hour demand, a peaking factor is needed. Because of the conservatism typically utilized at the master planning level, an ADD:PHD peaking factor of 5.0 was selected and will be used throughout this report for municipal demands.

5.4.7 Water Loss

Water loss or unaccounted-for water is the difference between the finished water produced and the water sold. It is important to differentiate two categories of water loss: unmetered uses and system leakage.

Unmetered uses are commonly a-typical uses for City water and incomplete or inaccurate metering of consumer demand. The following are typical unmetered uses.

- Hydrant and mainline flushing
- Construction activities
- Unmetered water for operations & maintenance uses
- Unmetered water for firefighting & fire training
- Unauthorized connections
- Reservoir overflows
- Inaccurate water meters and data collection errors
- Street cleaning

System leakage, as the name implies, is water lost due to deteriorating pipe, compromised pipe joints, service connections, valves, etc. With proper record keeping and metering of water, the percentage of unaccounted-for water approaches the net volume lost to actual leakage. Conventionally acceptable rates of water loss range between 10% and 15%, although water loss for many small Oregon municipalities is roughly 20%.

For this report, water production was compared to the amount of water sold and accounted for by the City for fiscal years (FY) 2016/17 through FY 2020/21 (Table 5-5). During this timeframe, the average water loss for the City's system was approximately 21%.

There are several legitimate uses of unaccounted-for water in Independence. Public Works annually flushes fire hydrants and uses distribution system blow-offs. Public Works and the Fire Department perform fire hydrant flow tests. The City has not historically tracked the volumes of water used for this testing or flushing. Considering the amounts of water used for these activities, it is likely that the actual leakage from the distribution system is less than 21%.

Polk County Fire Department 1 utilizes a connection to the City's distribution system for firefighting and training purposes. The meter for this location has not worked for the last several years. The meter at this location was recently replaced, which will improve the City's ability to track this water use.

During 2008 and 2009, the City completed a leak detection survey for the entire distribution system. Several leaks were identified and repaired. It is appropriate at this time for the City to perform an additional system-wide leak detection early in the planning period. Specific recommendations for this are provided in Chapter 8.

OAR 690-086-0150(4)(a) requires municipalities to conduct annual water loss audits. We recommend that the City conduct these water loss audits at least annually. After major water line replacement projects, the City should monitor the decrease in system loss through water loss audits.

Table 5-5| Historical Water Loss

Fiscal Year	*Total Water Production (mg)* [1]	*Retail Sales (mg)*	*Other Metered Uses* [2] *(mg)*	*Water Loss (mg)*	*Water Loss (%)*
2016/17	347.4	267.0	4.4	75.9	22%
2017/18	348.9	275.0	1.9	72.0	21%
2018/19	361.2	274.7	2.3	84.2	23%
2019/20	338.7	263.1	1.9	73.6	22%
2020/21	379.8	310.2	2.8	66.8	18%
			Average Annual	*74.5*	*21%*

[1] Total raw water pumped from the City's wellfields.
[2] "Other" category includes metered backwash volumes at the City's water treatment facilities and metered water use by the City (meters manually read).

5.4.8 Water Users by Category

Water consumption by user category was determined by reviewing available water-billing records for the 2021 calendar year. Residential use is the largest use category and comprises approximately 87% of the consumed water total, increasing slightly in the summer months. Commercial users comprise approximately 10% of the water sold and industrial users comprise approximately 2%. City accounts comprise approximately 2% of the water sold. A summary of the current water user accounts is contained in Table 5-6.

Table 5-6| Water User Summary

User Classification	Number of User Accounts	Percentage of Total User Accounts	Percent Usage Jan-Oct 2021
Residential Single Family	2,440	91.1%	57.3%
Residential Multi-unit	67	2.5%	29.3%
Commercial	135	5.0%	9.6%
Industrial	13	0.5%	1.9%
City	22	0.8%	1.9%
Total	2,677	100.0%	100.0%

1- City billings referenced October 2021

5.5 PROJECTED WATER DEMAND

This section builds on the discussions of population projections in Section 5.3 and the discussion of historical water demand as presented in Section 5.4. The basis for projecting future water demands is based in the establishment of a historical demand baseline along with historical peaking factors. The population projections of Section 5.3 will be combined with historical per capita usage rates and peaking factors established in Section 5.4 to forecast future water demands.

5.5.1 Projected Municipal Water Demand

Projected municipal demands have been based on the following assumptions:

- It is assumed that the ratio of residential to non-residential use (commercial, industrial and public uses) will remain constant. In other words, future commercial and industrial development will growth with population growth.
- It is assumed that the long-term per capita water demands will not exceed the City's historical averages. Since the efficacy of any planned water conservation programs is unknown at this time, the water demand projections of this report exclude conservation. The future success of the City's water conservation policies will serve to further increase the margins of safety used to plan and design the water system infrastructure.
- It is assumed that new commercial and industrial developments will not be large water users; no provision has been made for new industries with heavy water demands such as food processing or beverage production.
- It is assumed that the population projections of Section 5.3 are reasonable estimates of future municipal populations and that the forecasted peaking factors established in Section 5.4 are reasonable estimates of future demand variations.
- It is assumed that future water loss will not exceed the City's historical averages.

5.5.2 Projected Water Demand Summary

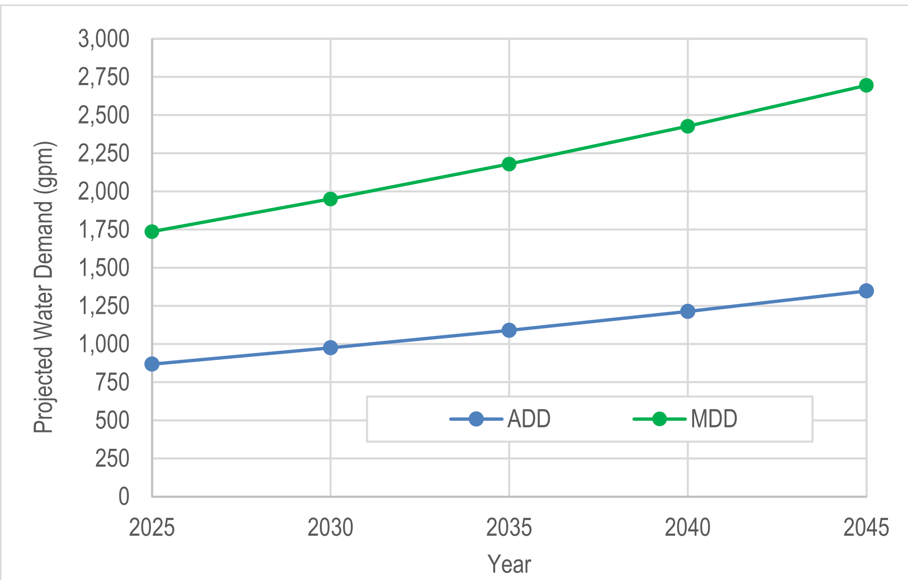
Future water demand in a given planning year for the municipal population is calculated by adding the current demand to the product of the per-capita demand and the projected additional population for the planning year. These results are summarized in Table 5-7 and illustrated in Figure 5-5.

Table 5-7 | Summary of Projected Water Demands

		Average Day Demand, ADD		Maximum Month Demand, MMD		Maximum Day Demand, MDD		Peak Hour Demand, PHD	
Year	Population	(mgd)	(gpm)	(mgd)	(gpm)	(mgd)	(gpm)	(mgd)	(gpm)
2025	12,126	1.25	868	1.79	1,245	2.50	1,737	6.25	4,342
2030	13,578	1.40	975	2.01	1,399	2.81	1,951	7.02	4,877
2035	15,131	1.57	1,090	2.25	1,563	3.14	2,179	7.85	5,448
2040	16,814	1.75	1,214	2.51	1,740	3.50	2,427	8.74	6,068
2045	18,636	1.94	1,348	2.78	1,933	3.88	2,695	9.70	6,738

[1] MMD = ADD x 1.43 peaking factor, MDD = ADD x 2.0 peaking factor, PHD = ADD x 5.0 peaking factor

Figure 5-5| Projected Water Demand



Maximum daily demands have special significance because they can put stress on the water supply capabilities of the system. The water sources should be able to supply the entire maximum day demand in addition to any required fire flows.

5.6 Fire Flow

The water distribution system is a community's primary resource for fighting fires. Storage facilities and fire hydrants must be suitably sized and configured to reliably deliver the required fire flows to all areas within the city limits. The Insurance Services Office (ISO) and Oregon Fire Code (OFC) provide guidelines to determine fire flows for various structures.

The ISO standards require a minimum flow of 1,000 gpm for a 2-hour duration in residential areas and a flow of 3,500 gpm for a 3-hour duration in commercial areas. The OFC recommends fire flows based partially on an evaluation of the construction materials used in a structure, its physical configuration, separation from other structures and occupancy. Based on OFC recommendations, fire flows for large commercial, industrial and multi-family developments may be higher than 3,500 gpm.

The City has adopted a policy of requiring adequate fire flow capacity as a prerequisite for the purposes of planning for future development, and has codified the fire flow requirements in the Public Works Design Standards- Division 5. This information is summarized in Table 5-8. It should be noted that these minimum recommendations do not supersede fire flows required by the Oregon Fire Code or building codes.

Table 5-8| Minimum Fire Flow Requirements

Location	Recommended Fire Flow (gpm)	Duration (hours)	Required Volume (gallons)	Minimum Flow Rate to Replenish Fire Flow Volume in 72-hours (gpm)
Residential R-1	1,000	2	120,000	30
R-2	1,500	2	180,000	50
R-3	2,000	2	240,000	60
Commercial Residential CR	2,500	3	450,000	110
Public (Schools & Institutions)	4,000	4	960,000	230
Commercial/ Industrial - New Facilities	3,250	3	585,000	140
Commercial/ Industrial - Existing Facilities	up to 4,000	4	Up to 960,000	Up to 230

Fire flow values are for planning purposes only and are not site or building specific. These values do not supersede or take the place of Oregon Fire Code (OFC) or building code fire flow requirements. Higher values may be necessary based on OFC, Fire Marshall or ISO requirements. Reductions may be allowed by the Fire Chief for buildings with fire sprinkler systems.

Fire flows in general, are orders of magnitude greater than MDD or PHD flows. In order to limit the size of water mains delivering fire flows to large combustible structures and the overall volume of water required to suppress a fire, some cities have adopted policies stating that all buildings requiring fire flows greater than 2,500 gpm install an automatic sprinkler system.

Lastly, in addition to the required flow rates presented above, OAR 333-061-0025 requires that a minimum pressure of 20 psi must be maintained in the distribution system at all times, inclusive of fire flow events. Chapter 8 of this document presents evaluations of the existing and future capability of the distribution system to deliver the adopted fire flows.

CHAPTER 6

WATER SUPPLY EVALUATION

Chapter Outline

6.1 Evaluation Criteria
6.2 Water Right & Water Source Evaluation
6.3 Water Supply Reliability & Resiliency Evaluation
6.4 Recommended Improvements

WATER SUPPLY EVALUATION

This chapter builds on the inventory of the City's water supply sources and infrastructure as presented in Chapter 4. It discusses the City's water sources, presents the regulatory framework for water rights, and details the water rights secured by the City to-date. It concludes with recommended improvements to strengthen the City's water rights position and to supply forecasted water demands through the planning period. An evaluation of water treatment facilities is included in Chapter 7.

6.1 EVALUATION CRITERIA

Factors used to evaluate the suitability of existing and planned water supplies include reliability, resiliency, and vulnerability. A short explanation of each of these evaluation criteria is presented below. The parameters presented in this section will be utilized in the analysis and recommendations of this chapter.

6.1.1 Water Rights & Water Sources

As previously noted, in Oregon, all water is publicly owned. The Oregon Water Resources Department (OWRD) regulates the use of both surface and groundwater throughout the state. Over the years as greater demands have been placed on limited water resources, OWRD has exercised increasing control over water use. A water right will not guarantee water for the appropriator. Under the prior appropriation doctrine, a water right authorizes diversions of water only to the extent water is available and does not impact a more senior water right. Water rights establish a hierarchy utilized by OWRD to adjudicate water use during shortages. Failure to comply with the requirements and conditions of the City's water rights permits and certificates may result in the restriction or loss of the affected water source. Accordingly, it is paramount that the City secure and maintain suitable water rights to meet long term municipal needs. The recommendations presented in this chapter are based on establishing a strong water rights position for an extended period of time.

6.1.2 Water Supply Reliability & Resiliency

Water supply reliability is the ability of a water system to meet the demands of users during specific operating scenarios. For example, a typical operating scenario for a municipal water source is the production of maximum day demands and fire suppression demands over a specific time period while utilizing grid electricity. Water system resiliency is the ability of a water system to respond to interruptions or failures of components and to resist loss of capacity. Resiliency is often built in to a water supply using redundancy of components, such as multiple sources and auxiliary power systems.

Interruptions to water production can occur due to several reasons, such as a failure of grid power or failure of equipment used to deliver water from the raw water sources to the water treatment plant. Interruptions to water production can also occur due to problems with raw water quality. Contamination of surface water can be caused by commercial or industrial accidents, land management practices, and natural disasters. Changes in water quality can jeopardize water production and, in the absence of suitable water treatment, may require a water treatment plant to be temporarily shut down.

The concept of firm capacity is important for analyzing water supply reliability and resiliency. Firm capacity is a utility's water supply capacity with the largest single source out of service. Firm capacity is relied upon by users during outages or maintenance periods for the largest water source. Outages may last from several days to several weeks. In the event of an extended outage, it is reasonable to assume that a public notification process will be utilized to encourage or require water conservation.

The following three criterion are recommended to ensure a high level of reliability and resiliency for the City's water supply:

1. *Total Capacity: The City's water supply has a total capacity to replenish depleted fire suppression storage within a 72-hour period while concurrently supplying the maximum day demand (MDD).*
2. *Firm Capacity: When the largest single source is out of service, the remaining sources are able to deliver the average day demand (ADD).*
3. *Auxiliary Power: City-owned water sources are able to supply the total capacity criterion while relying exclusively on auxiliary power.*

6.2 WATER RIGHT & WATER SOURCE EVALUATION

The following sections evaluate each of the City's water rights and water sources. These sections assess water right limitations, existing system capacity, potential system capacity, and status of water right development. The City's existing water sources include the Polk Wellfield, the South Wellfield, and the Independence-Monmouth Water System Intertie. The Willamette Wellfield and Willamette River are sources of supply that could be potentially developed by the City. Lastly, the Polk County Regional Water Supply Plan is also briefly discussed. Chapter 4 provides two key tables for reference; Table 4-1 summarizes the approximate yields from each of the wellfields. Table 4-2 details the City's water rights, including the authorized rates of use and limitations of use.

6.2.1 Polk Wellfield

Permanent use of groundwater from the wells in the Polk Wellfield is authorized by Permit G-12134, and Certificates 95501 and 95502.

Permit G-12134 authorizes the use of up to 2.0 cfs from Polk Well 1. The development deadline for this permit was October 1, 1998. The City filed an application for an extension of time, which is currently pending with Oregon Water Resources Department (OWRD). The application indicated that the City had developed a **1.56 cfs** portion of the water right. As part of the permit extension process, it is anticipated that the undeveloped portion of the permit (0.44 cfs) will be conditioned by OWRD to maintain the persistence of listed fish due to the hydraulic connection between the Polk Wellfield and the Willamette River. These fish persistence conditions typically require reduction in use of the undeveloped portion of the permit when identified fish flow targets are not met, which will reduce the reliability of the 0.44 cfs portion of the water right. At this time, OWRD has not defined the fish persistence conditions of the permit, including the portion of the permit subject to the conditions, the target flows for the Willamette River, or the maximum curtailment percent. This study and the Water Management Conservation Plan (WMCP) assume that the same fish persistence conditions defined in the City's permit G-17868 would be applied to permit G-12134 and that all of the 0.44 cfs undeveloped portion is subject to the conditions. In this scenario, a maximum of 20% could be curtailed by the OWRD when fish persistence conditions are not met (**0.35 cfs** authorized for use). This assumption is relatively conservative for the purposes of this study. The actual curtailed amount when fish persistence conditions are not met is expected to be less than 20%. If OWRD defines the fish persistence conditions for permit G-12134 to be substantially different, this plan should be updated accordingly.

Therefore, for planning purposes the reliable rate for permit G-12134 is considered to be the total of **1.56** and **0.35 cfs** (**1.91 cfs**).

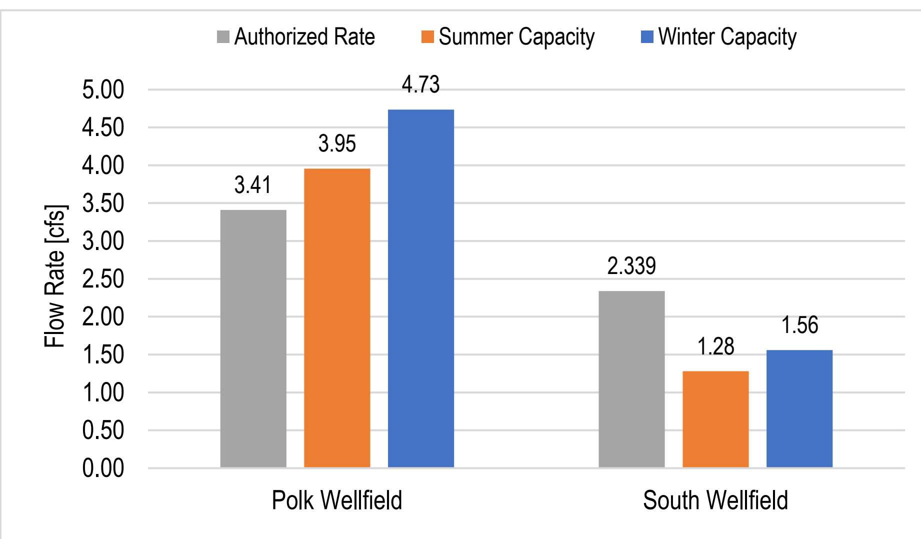
The capacity of Polk Well 1 is much less than the rate authorized by its water right (G-12134). The approximate summer yield of Polk Well 1 is 0.78 cfs, which is 1.13 cfs below the maximum rate authorized by Permit G-12134. In order to maximize Permit G-12134, after the City receives an extension of time for the permit, it is recommended that the City apply for a permit amendment that will request to add Polk Wells 2, 3, 4 and River Drive as authorized points of appropriation. This water rights action is included in recommendations that are described later in this chapter.

Certificates 95501 and 95502 authorize the use of **0.94 cfs** and **0.56 cfs**, respectively. The source wells for these rights (Polk Wells 1, 2, 3 and River Drive Well) have a combined summer capacity of approximately 2.84 cfs (1,275 gpm). The capacities of the wells are sufficient to allow use of these water rights at their maximum authorized rates.

The City's permanent Polk Wellfield water rights do not authorize use of the City's newest well, Polk Well 4, and are currently insufficient to authorize use of the full wellfield capacity. The water rights associated with the Polk Wellfield, identified in bold text above, authorize use of up to **3.41 cfs** (1,530 gpm). The wellfield's summer capacity is 3.95 cfs (1,775 gpm). Therefore, the wellfield is lacking enough water right allocation for 0.54 cfs during the summer. This deficit is shown graphically in Figure 6-1. Specific recommendations to help resolve this issue are described later in this chapter. A short-term solution to this issue is currently in place; limited license (LL-1779) authorizes the temporary use of up to 2.5 cfs from Polk Wells 3 and 4 for municipal use. The limited license allows groundwater use until July 15, 2024 or when a permit amendment adding Polk Wells 3 and 4 to Permit G-12134 is approved. With LL-1779, the City is able to use the full capacity of the Polk Wellfield in the short term. As discussed in Chapter 4, the City is planning to connect Polk Well 4 to the Polk Water Treatment Plant within the next few years. For the purposes of this water supply evaluation, it is assumed that these improvements are complete. If these conditions change, this plan should be updated accordingly.

Appendix C is a study that presents recommended sustained pumping rates for the Polk Wellfield. This study was produced as a part of adding Polk Well 4 to the wellfield. Maximum pumping rates of the wells are limited by well interference, as a result of aquifer properties and well construction. As indicated in the appendix, the maximum pumping rate of the Polk Wellfield is limited by available drawdown and well depth of Polk Well 1 and available drawdown in Polk Well 3. Based on the existing work to date on this subject, it is not likely that the yield of the Polk Wellfield could be significantly increased for meeting the projected demands of the City. This master planning document recommends pursuing other options that are available to the City for increasing water supply capacity that are discussed further in this chapter.

Figure 6-1| Summary of Wellfield Capacity & Authorized Rates



6.2.2 South Wellfield

Three groundwater registrations authorize the use of up to 2.339 cfs (1,050 gpm) from the five wells in the South Wellfield for municipal use. Currently only wells 1, 2, and 3 are regularly used by the City. Wells 4 and 5 are considered backup sources. However, based on the most recent sanitary survey, the City may propose to use the wells as active sources upon approval by OHA. There are no known issues with South Wells 4 & 5 that would prevent the City from utilizing the wells for water supply. For the purposes of this water supply evaluation, it is assumed that these wells are being utilized by the City. If these conditions change, this plan should be updated accordingly. The total capacity of the five wells at the South Wellfield is approximately **1.28 cfs** (575 gpm) during the summer season. A project for placing these wells in service is recommended in this chapter.

The total capacity of the five wells at the South Wellfield is approximately or 1.56 cfs (700 gpm) during the winter, which is 0.779 cfs less than the total permitted rate for the wellfield (2.339 cfs). This deficit is shown graphically in Figure 6-1. As discussed in Chapter 4, the wells have been regularly maintained and are not expected to need rehabilitation. Additionally, the wellfield is known to have noticeable interference between wells, which indicates the wells are not significantly underperforming. Therefore, it is not expected that the South Wellfield could be substantially improved to utilize more of the authorized rate.

In order to utilize more of the South Wellfield's authorized rate, the water rights would have to be sourced from a different wellfield. A potential option is to request approval from OWRD for additional points of appropriation at wells in the same aquifer as the South Wellfield. Based on the existing hydrogeologic studies, the aquifers for the South, Willamette and Polk Wellfields are hydraulically connected. Therefore, the OWRD might allow the City's groundwater rights to be appropriated at any of the three wellfields if other requirements are also met. However, it is not absolute whether this water right action would be approved by the OWRD. This action is not expected to be necessary during the planning period in order for the City to meet projected demands.

It is important to note that the water rights at the South Wellfield are considered groundwater registrations and are not fully certificated water rights. These groundwater registrations will have to be adjudicated by the State of Oregon before the City will receive water right certificates. A groundwater adjudication is an administrative and legal process to identify and quantify groundwater rights that were established before the enactment of Oregon's groundwater statutes in 1955. Groundwater adjudication in Oregon is typically carried out within a given basin. Groundwater adjudication is not currently taking place for water rights in the Willamette Basin and is not anticipated to be an issue within the planning period. However, it is recommended that the City be aware of this issue and modify this plan accordingly if necessary.

6.2.3 Independence-Monmouth Water System Intertie

The water system intertie with the City of Monmouth is an important emergency source for the City's water supply. The intertie delivers finished water from Monmouth's distribution grid and does not require any treatment. A pressure reducing valve reduces the pressure delivered to Independence from 100 psi to 60 psi. The intergovernmental agreement for the intertie defines that the intertie is used for emergencies, such as abnormally high demand or water source failure.

The existing intertie piping that delivers water to Independence is limited in capacity by the pressure reducing valve and 4-inch piping. The capacity of the intertie is unknown, but can be estimated as follows. The flow rate to Independence is controlled passively by the pressure difference between the pressure reducing valve (PRV) and the City's distribution system. If the City's distribution system is at 40 psi at the intertie during an emergency, the pressure differential of 20 psi across this piping would result in roughly 350 gpm being delivered to Independence.

As a note, depending upon existing demands in the system, 40 psi discharge pressure at the intertie may not be sufficient to maintain the minimum pressure of 20 psi at all locations in the distribution system. In this situation, operators may need to adjust the PRV setpoint to increase the discharge pressure of the valve in order to meet minimum distribution system pressure requirements. Increasing the discharge pressure would also increase the flow rate delivered to the City (to an extent).

The existing intertie is in good condition and is not anticipated to need any improvements during the planning period. The use of the intertie for meeting reliability criteria is discussed further in Section 6.3.

6.2.4 Willamette Wellfield

Two water rights currently authorize the appropriation of water from the three Willamette River wells. Permit G-17868 authorizes use of groundwater from the wells up to 1.0 cfs (449 gpm). Transfer T-12773 authorizes use of the wells to divert Willamette River surface water up to 2.0 cfs (898 gpm). The reliability of this water source is affected by both the capacity of the wellfield and water right limitations associated with Permit G-17868.

The Willamette River wellfield has multiple capacity limitations. As previously discussed in Chapter 4, it is expected that water from the wellfield will need to be treated to surface water standards prior to use for municipal purposes. Therefore, a surface water treatment plant would need to be constructed in order for the City to utilize this source. Additionally, the wellfield would require substantial improvements in order to make it a reliable source for the City. Currently, only Willamette Well 1 is in a usable condition. Willamette Well 2 requires repairs before it can be used; and Willamette Well 3 has poor water quality conditions and a relatively low yield. The sustainable yield of the wellfield is not certain at this time. Repairs and further testing would be necessary to be certain of the sustainable yield of all the wells. Additionally, any yield from the wells must be split with the City of Monmouth.

In addition to infrastructure limitations, Permit G-17868 has multiple water right limitations. First, the permit has a development deadline of October 1, 2020. The City filed a permit extension application that requested additional time to fully develop the permit. Second, the City currently has access to only the developed portion of this right (0.46 cfs). 0.54 cfs of the right is undeveloped and not currently available. To use water under the remainder of the permit, the City is requesting access to the 0.54 cfs undeveloped portion of the permit in the Water Management and Conservation Plan being prepared in conjunction with this plan. Finally, when processing a previous permit extension application for Permit G-17868, OWRD determined that a 0.35 cfs portion of the undeveloped portion of the permit would have the “potential for substantial interference” with surface water. Consequently, 0.19 cfs of the permit is undeveloped and not subject to fish persistence conditions. The 0.35 cfs portion of the permit is subject to conditions to maintain the persistence of listed fish in the Willamette River. Under these conditions, the City will need to curtail use under the 0.35 cfs portion of the permit according to the formula provided in the permit condition if identified fish flow targets are not met. The permit condition identifies a maximum of 20% curtailment for the portion of the permit subject to fish persistence conditions. For planning purposes and similar to permit G-12134, this study and the WMCP assume 20% would be curtailed by the OWRD when fish persistence conditions are not met (0.28 cfs authorized for use). This assumption is relatively conservative for the purposes of this study. Therefore, the reliable rate for permit G-17868 is considered to be the total of 0.46, 0.19, and 0.28 cfs (0.93 cfs).

Permit G-17868 is the City’s only groundwater right that is not actively in use. As previously discussed, an option available to the City is to apply for a permit amendment to additionally source Permit G-17868 from other wells in the same aquifer. The Polk Wellfield’s authorized rate currently limits the wellfield’s capacity during the summer (as shown in Figure 6-1). Sourcing this water right from the Polk Wellfield would enable the City to further develop this water right using existing infrastructure and would not require surface water treatment. Based on the existing hydrogeologic studies, the aquifers for the South, Willamette and Polk Wellfields are hydraulically connected. Therefore, the OWRD could possibly authorize the City’s groundwater rights to be appropriated at any of the three wellfields. Utilizing Permit G-17868 at the Polk Wellfield would allow the City to access more of the full capacity of the Polk Wellfield (instead of being limited to the Polk Wellfield's authorized rate). It is recommended that the City request additional points of appropriation for permit G-17868 at the Polk Wellfield in order to access more of the authorized rate. However, it is not absolute whether this water right action would be approved. A project with this recommendation is described later in this chapter.

6.2.5 Willamette River

The City holds two municipal surface water rights that authorize the use of up to 6.46 cfs from the Willamette River (Transfer T-12773 and Permit S-54331). Both water rights have an authorized point of diversion on the Willamette River near Willamette Well 2. Transfer T-12773 authorizes use of up to 2.0 cfs and Permit S-54331 authorizes use of up to 4.46 cfs. The City does not have a river intake on the Willamette River. However, Transfer T-12773 is authorized to be appropriated from the Willamette Wellfield.

The Willamette River has ample water supply to meet the City's need for water use under Transfer T-12773 and Permit S-54331. According to OWRD's Surface Water Availability Reporting Systems for the Willamette River at U.S. Geological Survey (USGS) Gage 14191000 in Salem, water currently is available to meet existing demands year-round. The water availability analyses consider the estimated 80 percent exceedance natural streamflow, and all existing consumptive use and non-consumptive use water rights, including instream water rights, when determining water availability. Since streamflow availability in the Willamette River is expected to be highly reliable in the near-term, both water rights would be expected to provide a secure source of water supply in the near-term. Over the long-term, Transfer T-12773, which has a relatively senior priority date (December 23, 1954), would be expected to be a more secure source of water supply. Permit S-54331, however, has an August 10, 2005 priority date, and is junior in priority relative to most other rights on the Willamette, which could potentially reduce the City's ability to rely on this right at some point in the future.

The future adequacy and reliability of the City's Willamette River municipal water rights will depend on the capacity of a new intake and water treatment plant, and the amount of water in the Willamette River available for the City's use. The ability for the City to access water under Permit S-54331 could be affected by the factors described below.

- The section of the Willamette River adjacent to the City has an unconverted minimum perennial streamflow (MF 183) for 1,300 cfs year-round at USGS Gage 14191000 near Salem for supporting aquatic life. Minimum perennial streamflows are administratively established flow goals that were established in the 1950's and 1960's. The 1987 Instream Water Rights Act requires OWRD to convert the minimum perennial streamflows to instream water rights. If MF 183 is converted to an instream water right, it would receive a priority date of the date it was established (June 22, 1964), which is senior to Permit S-54331. As a result, the City would have reduced access to water under Permit S-54331 when Willamette River streamflow is less than the instream water right.

- In addition, the Willamette Basin Program (Oregon Water Resources Commission's administrative rules specific to the Willamette Basin) also includes unconverted minimum perennial streamflows for water stored in the U.S. Army Corps of Engineers (USACE) reservoirs upstream from the City. The minimum perennial streamflow for stored water in this reach of the Willamette River would protect up to 4,700 cfs of released stored water at USGS Gage 14191000 near Salem. Significant uncertainty is associated with the ultimate "conversion" of the stored water component of the minimum perennial streamflows to instream water rights.

- Currently, most of the water released from the USACE storage reservoirs is considered natural flow (i.e., unallocated streamflow available to water right holders). Consequently, the City can appropriate this water under its Willamette River municipal water rights. If the stored water component of the minimum perennial streamflow (4,700 cfs) is converted to an instream water right, the City (and other natural streamflow water right holders) could not appropriate the released stored water, regardless of priority date. OWRD would consider the stored water released to meet the instream water right to be a different water source than that identified on the City's water rights (natural flow rather than stored water).

- If unconverted minimum perennial streamflows for natural flow (1,300 cfs) and for stored water (4,700 cfs) are both converted to an instream water right, then a total streamflow of 6,000 cfs would need to be met before the City could have full access to water under Permit S-54331. Historically, there have been times when there is less than 6,000 cfs at USGS Gage 14191000 near Salem; in 2021 the flow was less than 6,000 cfs for most of July and August.

In summary, both of the City's Willamette River water rights are expected to provide a reliable water supply in the near-term. However, there are a number of complex activities under consideration on the Willamette River and the outcome of those activities is difficult to predict. Some of these activities could result in future constraints on the City's use of Permit S-54331 in the long-term and should be monitored closely by the City. At this time, the City should be able to consider the 2.0 cfs of rights authorized under Transfer T-12773 as a reliable, long-term, source option. But, the long-term reliability of the 4.46 cfs authorized under Permit S-54331 is less certain. For this reason, this plan recommends that the City pay attention for possible opportunities to purchase additional senior water rights. If an opportunity becomes available, the City should work with a water right consultant to determine if it is necessary to secure additional water rights.

6.2.6 Polk County Regional Water Supply Plan

As previously discussed in Section 4.3.6, Polk County is working to develop a regional water supply using Polk County's water rights to the Willamette River. This project is early in the planning and design stages. Based on the available information about the plan, it is uncertain whether it will result in a viable water source for the City during the planning period. Therefore, this study does not further evaluate the project as a source for the City. However, it is recommended that the City stay informed about the plan. The project would likely need a surface water intake on the Willamette River in Polk County. A logical location for this facility may be near Independence. If the City develops a surface water intake during the planning period, then there may be an opportunity to reduce capital cost by developing the facility with Polk County in accordance with an intergovernmental agreement.

6.3 WATER SUPPLY RELIABILITY & RESILIENCY EVALUATION

Three criteria for evaluating water supply reliability and resiliency were introduced in Section 6.1.2 and are evaluated in this section.

6.3.1 Total Capacity

- *The City's water supply has a total capacity to replenish depleted fire suppression storage within a 72-hour period while concurrently supplying the maximum day demand (MDD).*

The City's current sources are the Polk Wellfield, the South Wellfield and the water system intertie. As previously discussed, the City's water supply capacity is affected seasonally by well yield. The wellfields are typically 15-20% less productive in the summer months. A conservative approach is taken in this study by evaluating water supply capacity during the summer months. Further recommendations in this study are also based upon securing water supply capacity during the summer months, which is also typically when demand is the highest. As shown in Figure 6-1, the capacity of the Polk Wellfield is limited to 3.41 cfs (1,530 gpm) by the total authorized rate. The South

Wellfield is limited to 1.28 cfs (575 gpm) by the capacity of the wells in the summer. Therefore, the total existing capacity of the City's two water sources during summer conditions is approximately 2,105 gpm.

The flow rate required to replenish fire suppression storage over a 72-hour period for a relatively large fire flow event is approximately 230 gpm (Table 5-8). The maximum day demand in 2025 is estimated to be approximately 1,740 gpm (Table 5-7). Therefore, the total water supply required at the beginning of the planning period is estimated to be 1,970 gpm. The maximum day demand in 2045 is estimated to be approximately 2,700 gpm. Therefore, the total water supply required at the end of the planning period is estimated to be 2,930 gpm. This analysis is summarized in Table 6-1 and shown graphically in Figure 6-2.

Table 6-1| Total Capacity Evaluation

Planning Year	Existing Summer Water Supply Capacity (gpm)	MDD (gpm)	Fire Flow Replenish Rate (gpm)	MDD + Fire Flow Replenish Rate (gpm)	Total Capacity Excess (gpm)	Percent Excess
2025	2,105	1,740	230	1,970	135	+ 7%
2030	2,105	1,951	230	2,181	- 76	- 4%
2035	2,105	2,180	230	2,410	- 305	- 13%
2040	2,105	2,430	230	2,660	- 555	- 21%
2045	2,105	2,700	230	2,930	- 825	- 28%

- Maximum day demand (MDD) values are shown in Table 5-7.
- Existing summer water supply capacity does not include capacity of the intertie.
- Fire flow replenish rate is shown in Table 5-8.

Figure 6-2| Projected Total Water Supply Capacity

Based on this evaluation, the City's existing water supply will be 4% deficient for meeting the total capacity criterion of 2,181 gpm by 2030, as shown in the above figure. By the end of the planning period, the City's existing water supply will be deficient by 825 gpm (28%), based on this evaluation criterion. This analysis assumes that the intertie with the City of Monmouth is not being utilized. It is not recommended that the City rely on the intertie for this type of event, since it is intended to be used for emergencies only.

Based on the total capacity evaluation in Table 6-1, this plan recommends that the City start developing additional water supply at the beginning of the planning period. The total dry-season capacity of the supply should be no less than 825 gpm. Once this is completed, the City will be capable of producing a minimum of 2,930 gpm during the summer months, which will allow the City to meet the total capacity criterion through the end of the planning period. A strategy for developing the necessary capacity is discussed in Section 6.4.1.

6.3.2 Firm Capacity

- *When the largest single source is out of service, the remaining sources are able to deliver the average day demand (ADD).*

The City's largest single source is the Polk Wellfield. The City's other source is the South Wellfield, which has a capacity of 575 gpm during the summer months. A scenario where the Polk Wellfield was entirely offline would be an emergency. For this reason, it is assumed that the City would utilize the intertie with the City of Monmouth in this situation. The estimated capacity of the intertie is 350 gpm (Section 6.2.3). Therefore, the firm capacity of the City's sources in an emergency situation is estimated to be 925 gpm.

The average day demand is estimated to be approximately 870 gpm in 2025 and 1,350 gpm in 2045 (Table 5-7). The City's firm capacity is adequate for meeting the average day demand in 2025, assuming that there are no interruptions to Monmouth's water supply at the intertie. Between 2025 and 2030, the City's average day demand is projected to exceed 925 gpm (as shown in Table 5-7). As previously discussed, this plan recommends that the City start developing additional water supply with a total capacity no less than 825 gpm. Once this is completed, the Polk Wellfield will still be the City's largest source. The City's other sources at this time will be a new source, the South Wellfield, and the intertie. Construction of the new source will enable the City to meet this criteria through the end of the planning period without relying on the intertie. In this scenario, the total firm capacity would be at least 1,400 gpm.

6.3.3 Auxiliary Power

- *City-owned water sources are able to supply the total capacity criterion while relying exclusively on auxiliary power.*

Several types of emergencies can disrupt grid power in Western Oregon for prolonged periods of time, including extreme weather events, wildfires, and earthquakes. Auxiliary power is necessary for maintaining the operability of the City's water supply, storage, treatment and distribution systems during these types of emergencies. In February 2021, a severe ice storm hit the Salem metropolitan area that disrupted the power grid for over a week in Independence. During the event, City Public Works determined that more auxiliary power generators were needed to maintain water and sewer service. Also, adequate fuel supply for facilities and vehicles was an issue. Fuel storage is an extremely important aspect of an auxiliary power strategy for public works and for City operations. Adequate ability to transport stored fuel is also an essential aspect of maintaining auxiliary power. This is a city-wide problem that is recommended to be addressed. The needs of wastewater facilities and local emergency personnel (police & fire) should also be assessed. It is possible that the Polk County Fire Department and the City of Monmouth may be interested in partnering on facilities needed to store and transport fuel. The scope of the evaluation is more in-depth than this study can provide, but it is recommended that the City pursue a study of this issue in order to develop a strategy. The auxiliary power criterion in this study focuses solely on whether the City's water sources have auxiliary power systems in place to run the electrical loads.

In addition to extreme weather events, a major earthquake is anticipated to occur in the next several decades in the Pacific Northwest (the Cascadia Subduction Zone Earthquake). It is possible that this event will disrupt grid power and cause fires. Chapter 10 of this study specifically addresses seismic aspects of the City's water system.

As previously discussed in Section 6.3.1, all of the City's existing and future owned water sources will be needed in order to supply the total capacity criterion. These sources are the Polk Wellfield, the South Wellfield and the future new water source. Therefore, each of these sources need auxiliary power systems.

The Polk Wellfield has a dedicated 350 kW generator set that can provide auxiliary power to Polk Well 3 and the River Drive Well. This generator is large enough to additionally run the other wells at this location (Polk Wells 1 and 2), but this is not currently possible using the existing electrical switchgear. The Polk Well 4 is planned to have a portable generator and manual transfer switch. A project is recommended in this chapter to address auxiliary power systems at the Polk Wellfield.

The South Wellfield, Water Treatment Plant and Booster Pump Station have a standby 200 kW generator. According to Public Works, this generator is configured to simultaneously provide power to the five wells, the four booster pumps and the water treatment plant loads. The total power of the well and booster pumps is 133 horsepower (approximately 98 kW). The auxiliary power systems at the South Wellfield are anticipated to be adequate to meet the demands of the facility. As previously discussed, the facility has issues with the quality of the line power. Improvements are recommended to address this issue in Chapter 8- Distribution System Evaluation.

As previously discussed, the City should plan to develop an additional water source during the planning period. The recommended improvements for this water source include provisions for auxiliary power to satisfy this criterion.

6.3.4 Potential Future Water Sources

As previously discussed, the capacity of the Polk and South Wellfields cannot be increased to a level that would balance the City's deficit in water supply through the end of the planning period. This deficit is discussed in Section 6.3.1. The City will need to develop an additional water source during the planning period. Development of a new municipal water source is a substantial undertaking, which requires use of water rights, access to a source, and significant improvements to infrastructure. In general, new reliable water rights are not available and are becoming increasingly scarce. The development of new water sources typically requires significant investments for new conveyance and treatment facilities. As such, a period longer than 20 years should be considered when making planning decisions for new water sources.

The City has historically sourced all municipal water from groundwater wells; and existing treatment facilities are setup for groundwater. Developing a new groundwater source for the City is possible and would likely be less costly than developing a surface water source, however, there are other challenges that make the pursuit of additional groundwater sources problematic. This would require developing a new wellfield that does not interfere with the existing wells. It is expected this wellfield would need to be roughly within three miles of the City. Water rights for this wellfield could possibly come from three sources: (1) existing South Wellfield excess groundwater registrations, (2) existing water rights purchased near the City, or (3) new groundwater rights near the City. The existing excess amount of groundwater registrations is approximately 0.78 cfs (350 gpm), which is not adequate on its own. Therefore, this approach would require the City additionally to either purchase existing water rights, and(or) apply for new groundwater rights. Based on experiences of municipalities in the Willamette Valley, securing existing groundwater rights is difficult and often requires purchasing an associated agricultural or industrial property.

In order to balance the projected deficit in supply with new groundwater rights, the City would have to apply for new water rights that are at least 475 gpm (a deficit of 825 gpm less 350 gpm from existing groundwater registrations). Based on currently available information, it is uncertain whether the OWRD would permit new municipal groundwater rights in the vicinity of the City. It is possible that groundwater in this area is already over-allocated. This approach may also have a limited ability to provide for growth in future planning periods.

Overall, a water supply strategy based on developing groundwater may not be successful during the planning period and is not recommended as the primary water supply strategy. However, it is recommended that the City investigate potential opportunities in the vicinity of the City to obtain additional groundwater rights. This study recommends the City perform a groundwater availability study to assess the existing opportunities within the vicinity of the City as a secondary water supply strategy. If this approach is successful, it would be less costly than the alternatives associated with surface water sources. This plan includes a recommended project for this groundwater study.

A final consideration is that the City has already invested a significant amount of money in purchasing surface water rights. Based on the available information, developing a surface water source is a more certain and reliable water supply strategy for the City than developing an additional wellfield. Although, this approach is substantially more costly. A surface water source would also enable the City to plan for growth over multiple planning periods. For the reasons previously described, this plan recommends that the City pursue use of their surface water rights during the planning period and always be on the lookout for additional groundwater sources.

The City's available surface water sources are the Willamette Wellfield and the Willamette River. Both the wellfield and the river are sources for the City's surface water rights. These water rights total 6.46 cfs (2,900 gpm) and are not currently in use. As such, these water rights can provide for the City's growth for multiple planning periods. From a water treatment point of view, both the Willamette Wellfield and the Willamette River are effectively surface water sources that would require the construction of a surface water treatment plant during the current planning period. The two main differences between the alternatives are the infrastructure required to make the sources viable and the ability of the sources to provide for the City's growth over multiple planning periods, (i.e., the total potential capacity).

The Willamette Wellfield is partially developed. The City would need to make several improvements in order to make the wellfield a functioning water source. At minimum, these improvements include repairing or replacing Wells 2 and 3, mitigating streambank erosion, constructing civil site & access road improvements, installing flow meters at each well, installing auxiliary power, and making electrical & control improvements. Improvements may also be needed to extend the wellheads above the 100-year flood elevation and to install well service platforms. If a total of three wells can be placed in service in the current planning period that are similar to the existing Well 1, the total capacity can be estimated as approximately 750 gpm for Independence (three 500 gpm wells shared equally by the two Cities). This amount could be used to meet the City's total capacity criterion in the current planning period if supplemented by water right actions that increase the authorized rate of the Polk Wellfield (discussed further in Section 6.3.1). However, based on the available studies and past history, it is possible that existing and new conventional wells at the wellfield will not be able to provide for future demands of both cities. If this is the case, the City would then need to develop a second additional source, such as the Willamette River.

An alternative to further pursuing the Willamette Wellfield is to develop the Willamette River with an intake during the planning period. Planning, designing, and building a municipal river intake is a complicated and relatively costly project. The scope of the improvements and the total capacity of the facility can be sized to meet short-term or very long-term needs. River intakes are often owned by multiple entities, so that a larger facility can be built with a longer design life. The structure in the river must be located such that it functions with the lowest and highest water levels and is not subject to streambed erosion or deposition of sediment. The structure in the river must be designed to withstand maximum flood-stage currents and impacts from debris, to clear screen blockage, and to protect fish. There are different types of screened river intakes, such as intake towers and submerged screens. Intake towers are tall and large concrete structures in the river, which are accessed from the bank by a bridge. An intake tower can be sized to supply any future demand, but also is the most capital-intensive solution and requires extensive permitting. Submerged screens are installed on the riverbed and gravity-feed to a wetwell pump station on the river bank. Intakes utilizing submerged screens are also relatively expensive. In general, screened intakes also have significant problems due to harsh river conditions and clogging. This solution should be considered a last resort.

A less-costly alternative to a screened river intake is a collector well. A collector well is a structure that is generally installed adjacent to a river and collects water from multiple horizontal wells. These wells are installed radially from a central caisson that extends above ground. Water is pumped vertically from the caisson. The caisson is typically built in the floodplain of the river and is set-back from the channel and bank. A collector well has the added benefit of providing river bank filtration, in contrast to a screened intake. This can substantially reduce the amount of turbidity that must be removed by the treatment plant equipment. Similar to screened intakes, a collector well must have the ability to clean the well screens as they become fouled and typically require screen maintenance. Feasibility studies for collector wells were performed for the City in 1972 by Ranney Method Western Corporation and in 2006 by GSI Water Solutions. Both of the studies suggest that a collector well is a potentially feasible solution near the Willamette Wellfield. The 2006 study is included in **Appendix H**. Similar to screened intakes, collector wells can be sized to supply any future demand of the City using a single structure. Unlike screened intakes, collector wells are not subject to the immense physical stresses from river currents and debris and are simpler to permit, since they are not built within the river.

Based on the previous discussion, this plan recommends that the City forgo developing the Willamette Wellfield and plan to source water from the Willamette River using a collector well. This approach will ultimately provide the City with a long-term strategy for water supply. This additionally will avoid the City needing to potentially invest in and maintain both the Willamette Wellfield and the river as sources. Additional engineering work is recommended to be performed during the planning period to validate a collector well as a viable solution for the City. A recommended project is included for the preliminary engineering of the collector well. As a secondary strategy, the City should assess the availability of additional groundwater rights with a formal study and always pay attention for potential opportunities to secure additional groundwater sources. Section 6.4.3 provides more detailed explanation for these recommendations.

6.4 RECOMMENDED IMPROVEMENTS

6.4.1 Recommended 20-Year Water Supply Strategy

The City's existing water sources are generally adequate to provide for the majority of the City's water supply during the planning period. These sources will require some improvements to water rights and infrastructure. Table 6-1 and Figure 6-2 present the projected deficit in capacity based on the total capacity criterion. Based on this evaluation, this plan recommends that the City plan to develop the Willamette River water supply with a total capacity no less than 825 gpm by 2028. It is expected to require multiple years to complete the planning, design and construction of the project. These activities should start as soon as feasible. Once the Willamette River is developed as a source, the City will be able to meet the total and firm capacity criteria through the end of the planning period without using the intertie. Depending upon the scale of the facility, the City may only need minor improvements for water supply in the following planning period.

As shown in Figure 6-1, up to an estimated 0.54 cfs (240 gpm) of additional dry-season capacity could be developed from the Polk Wellfield if the authorized rate was increased. Section 6.2.4 discusses a water right action for permit G-17868 that may be permissible by OWRD to allow this rate to be increased. If this water right action is successful, then the City will be able to delay sourcing water from the Willamette River from roughly the year 2028 to 2033. This water right action should be prioritized in the first year of the planning period in order to determine if development of the new water source can be prolonged.

The following sections describe the recommended improvements to facilitate this water supply strategy.

6.4.2 Recommended Water Right Actions

Recommended actions to strengthen the City's water right position are described in the following paragraphs. These recommendations are general goals and the City will need to work carefully with a water rights consultant to fine tune these recommendations.

- **Project S-1 - Groundwater Right Development, Permit G-12134**

Permit G-12134 has not been certificated and the development deadline expired. An extension of time is pending approval by the OWRD. The water right authorizes use of this water only from Polk Well 1. After the City receives an extension of time for the permit, it is recommended that the City apply for a permit amendment that will request to add Polk Wells 2, 3, 4 and River Drive as authorized points of appropriation. Once the extension and amendment are approved, the City should begin the process of certificating the water right. The City will need to work with a qualified consultant to prepare and submit the applications. The total recommended budget for this project is $10,000.

- **Project S-2 - Groundwater Right Development, Permit G-17868**

Permit G-17868 has not been certificated and the development deadline expired. A permit extension application is pending with OWRD that will request additional time to fully develop the permit. This water right is only authorized to be sourced from the Willamette Wellfield. After the City receives an extension of time for the permit, it is recommended that the City apply for a permit amendment that will request to add the Polk Wells as additional authorized points of appropriation. Once the extension and amendment are approved, the City should begin the process of certificating the water right. An additional 0.93 cfs is estimated to be reliably sourced using this water right (Section 6.2.4). This action would authorize the Polk Wellfield to produce approximately 4.34 cfs, an excess of the wellfield's summer capacity. The City will need to work with a qualified consultant to prepare and submit the applications. The total recommended budget for this project is $10,000.

- **Project S-3 - Groundwater Right Development, Permit G-17750**

Permit G-17750 has not been certificated. The development deadline is in 2037. This water right is used for irrigation of the City's sports fields. It is recommended that the City perform the necessary work by the deadline to get the water right certificated during the planning period. The City will need to work with a qualified consultant to prepare and submit the application. The total recommended budget for this project is $10,000.

- **Project S-4 - Surface Water Right Development, Permit S-54331**

Permit S-54331 has not been certificated. The development deadline is in 2026. According to the permit requirements and based on past experience with the OWRD, the City must commence construction activities towards using the permit by the development deadline and prior to requesting a deadline extension from OWRD for this permit. It is recommended that the City begin activities as soon as feasible prior to the planning period to develop this water right permit. This water right is authorized to be sourced from a surface water point of diversion (POD) adjacent to the Willamette Wellfield. A permit amendment will be required to divert this water from another location or from a collector well. The permit will have to be amended to allow surface water to groundwater transfer for the collector well, which may require a study performed by a Registered Geologist. The City will need to work with a qualified consultant to prepare and submit the applications for the amendment prior to construction and the permit extension. The total authorized rate is 4.46 cfs (2,000 gpm). The total recommended budget for this project is $20,000.

6.4.3 Recommended Water Supply Improvements

Recommended projects to improve the City's water supply infrastructure are described in the following paragraphs.

- **Project S-5 – Polk Wellfield Electrical Improvements**

This project includes auxiliary power and instrumentation upgrades for Polk Wells 1, 2, 3 and the River Drive Well. Polk Wells 1 and 2 are not connected to the existing generator at this site. All of these wells require improvements for instrumentation and SCADA.

City operators are able to power Polk Well 3 and the River Drive Well using a 350-kW portable generator. This generator is typically parked at the River Drive Well, which is above the floodplain. This generator is used by Public Works for other purposes, such as powering sewer pump stations.

This project's improvements will enable Wells 1 and 2 to be powered from the River Drive Well site using the existing generator. The two power services and meters for Polk Wells 1, 2, 3 and the River Drive Well are located at the site. Control panels for Wells 1 and 2 are located in the Well 1 building, approximately 500 feet from the River Drive Well. Control panels for Well 3 and the River Drive Well are located at the River Drive Well. This project will upgrade the existing auxiliary power panel, including manual transfer switch and generator inlet receptacle, in order to simultaneously serve all of the wells with the generator. In this configuration, an operator must connect and start the generator to power the wells. This configuration would allow the generator to be transported to other facilities if necessary. An alternative to this approach is to permanently install the generator on a concrete slab and automatically engage the generator upon an outage using an automatic transfer switch (ATS). This approach is not considered to be necessary, is more costly, and prevents the generator from being used at other facilities.

Changes will also need to be made to the above and below-ground wiring near the site to route power to Wells 1 & 2 through the new auxiliary power panel. The pump control panels are not anticipated to need improvements during the planning period, other than routine repairs and maintenance.

Polk Well 4 is planned to have a water level transducer for monitoring the static level in the well and a magnetic flow meter. The City's SCADA system will be able to monitor and record readings from these instruments. This project will standardize this configuration across the other Polk Wells. Existing propeller flow meters at Polk Well 1 and the River Drive Well will be replaced with magnetic flow meters. Level transducers to monitor static water level will be installed at each of the wells. Each of these instruments and flow meters will be connected to the City's SCADA system with one or more telemetry panels. It may be least costly to aggregate instrument signals at one location with underground conduit, rather than installing and integrating a telemetry panel at each well.

Wellhead Improvements - As discussed in Section 4.3.1, Polk Wells 1, 2 and 3 do not meet OAR well construction standards for wellhead elevation and are vulnerable to contamination from the 100-year flood event. This vulnerability can be resolved by ensuring that all mechanical piping penetrations and seals at the top of the well casing are watertight to prevent flood water leaking into, and flowing down into the well casing. In addition, the air vent line for each well should be extended and tight-piped to a location that places the breather end of the vent well above the 100-year flood elevation. The goal is to completely seal each wellhead from flood water. Additionally, an electrician should evaluate the electrical connections to be sure they are watertight. The vents on the City's wellheads are mated with threaded nipples. Installing longer nipples, roughly 18 inches long, and reconnecting the vents would resolve the issues with the vents. The vent line extension should be secured to a part of the well structure that affords a reasonable level of support and protection. These relatively minor fixes are recommended to be completed as a part of this project.

The total recommended budget for this project is $459,000. The detailed estimate of this budget is included in **Appendix G**.

- **Project S-6 – South Wellfield Improvements**

Several miscellaneous improvements are recommended to be made to the South Wellfield to address aging or deficient components. These include improvements to yard piping, well building equipment, well buildings, and the power service to the buildings.

Yard piping between the wells and the reservoir is relatively old 4 and 6-inch steel piping. According to City staff, this piping is severely corroded and in need of replacement. There is an estimated 1,000 feet of steel piping at the site. The project would replace this piping with restrained-joint ductile iron piping, since this piping is considered to be critical infrastructure during a seismic event. The new piping is expected to be installed adjacent to the existing piping while the wells remain in service. Existing steel piping would be abandoned in place.

Miscellaneous improvements are recommended at each of the five well houses. The existing sand strainers are leaking and, according to City staff, are no longer needed. It is recommended that these strainers be removed. The buildings are partially insulated, not weatherized and do not have a heat source. Improving these conditions would help prolong the life of the piping & equipment and reduce the risk of freeze damage. This project includes building improvements for weatherization, insulation, enclosing the walls & ceiling with plywood, and heaters.

Each well has propeller flow meters in the mechanical building that are read manually. This project includes similar improvements to SCADA and instrumentation that were recommended for the Polk Wellfield. This includes the installation of level transducers in the wells and magnetic flow meters installed in the buildings at the five South Wells and connection of these instruments to the City's SCADA system. The SCADA system will be able to monitor and record readings from the instruments. Signals from the instruments would be aggregated at the water treatment plant facility from each well with underground conduit. The existing telemetry equipment would be upgraded as a part of the project to connect the new instruments to the City's SCADA system.

As discussed in Chapter 4, the five well buildings share a power service that is inadequate for running building loads. This power service is separate from the power service that runs the well pumps, treatment facility, and booster pump station. This project includes a new and larger power service to replace the well building power service. This will allow the buildings to run adequate lighting and heat.

The total recommended budget for this project is $857,000. The detailed estimate of this budget is included in **Appendix G**.

- **Project S-7 – Recommission South Wells 4 & 5**

South Wells 4 and 5 have not been in regular service for roughly 15 years. Their status with OHA is inactive and for emergency use only. The wells are in usable condition and do not require improvements. OHA provided the City with the following guidance on the requirements to place them in service. These requirements should be confirmed with OHA when the City is preparing to place them in service. Prior to placing the wells in service, OHA must review water quality testing results from each well for coliform bacteria, sampled at the wellhead, and for nitrate & PCE, sampled at the entry point. The City sampled nitrate from these wells in 2018, which indicated results of 2 to 2.5 mg/L, which is far below the MCL of 10 mg/L. Additionally, nitrate levels are consistently below the MCL for the other wells in the wellfield. Therefore, nitrate is not anticipated to be an issue for placing the wells in service. PCE has consistently not been detected in the wells.

Upon OHA's review and approval of these results, the City is permitted to supply water from the wells to the distribution system. Once in service, the City will need to submit results for nitrate and PCE at the distribution system entry point when both wells are in use in order to assess water quality being served. The City will also need to submit water quality results for inorganic chemicals, nitrite, arsenic, volatile organic compounds, synthetic organic compounds, and radiological compounds sampled from the entry point within the last three years. The City will also need to notify OHA once the wells are placed back in to service and begin routine water quality reporting.

In addition to completing these requirements, this project includes performance testing and evaluation to determine the total sustainable yield of the wellfield and to assess well interference. This involves monitoring static water levels and flow rates from the wells before and after Wells 4 and 5 are placed in service. It is recommended that the City work with a hydrogeologist to complete this evaluation and to provide recommended pumping rates for each well.

The total recommended budget for this project is $15,000.

- **Project S-8 – New Water System Intertie**

The City's Public Works has recommended installing an additional intertie with the City of Monmouth in the event of an emergency. This is prudent given the size of the City and the projected growth during the planning period. The existing water system intertie is estimated to have a peak capacity of roughly 350 gpm and is located in the southeastern portion of the City. A new intertie is recommended to be installed during the planning period. It is anticipated that this facility would be shared equally by both Cities and governed by a similar agreement to the one in place for the existing intertie.

There are a few locations in the City's distribution system where the water systems of the two cities could readily be connected. Two possible locations are at 16th Street & Marigold Drive and 17th Street & Monmouth Street. Both locations would require acquisition of right-of-way to build the facility. The area near Marigold Drive is much less developed and is not an ODOT right-of-way. This location is expected to be less costly for the project. The City's water main along Marigold Drive is 8-inch C-900 PVC. This water main is connected to two of the City's primary distribution mains along Gun Club Road and Monmouth Street. For these reasons, the new intertie is recommended to be located at 16th Street & Marigold Drive. It may be possible to obtain right-of-way at this location adjacent to the Legacy Oaks Apartments.

This project will include a facility identical to the existing intertie with the addition of a pump to deliver water from Monmouth to Independence. This facility would consist of site improvements, a mechanical building, yard & building piping, two pumps, instruments, power equipment, and control panels. The project also includes costs for easement acquisition.

The total recommended budget for this project is $668,000. It is expected that this cost would be shared equally with the City of Monmouth. The detailed estimate of this budget is included in **Appendix G**.

- **Project S-9 – Collector Well Preliminary Engineering**

As discussed in Section 6.3.4, design of a new water source depends upon the planning horizon, budget, and aspects specific to the source and construction site. The scale and design of a collector well would also be affected by the number of entities it serves. Preliminary engineering for the collector well is necessary for establishing the design criteria and estimating cost. The preliminary design should identify any fatal flaws of a collector well. If any exist, then a screened river intake should be pursued. This project should also prepare a conceptual design for a screened river intake of equal cost. The capacity, operating & maintenance costs, advantages, and disadvantages of the two alternatives should be analyzed to support decision-making. Once an alternative is selected, the project can proceed to the final design of the facility and the conveyance improvements. A separate project is recommended for the final design and construction. This preliminary engineering project is recommended to take place relatively early in the planning period to provide enough time for planning, design and construction prior to the projected water supply deficit.

During preliminary design, various sites for the collector well along the Willamette River should be evaluated. Ideally the well will be located close to the water treatment plant. As discussed in Section 7.2.3, this plan recommends treating the water at a new facility in the southern part of town. Based on available information, this plan assumes that the collector well will be located south of the River Road Bridge. This is where land along the river is relatively undeveloped and is sufficiently far upstream of the City's treated wastewater effluent outfall.

Water right approvals are also needed in order to confirm the location of the collector well. The well will need to be approved as a point of appropriation for the City's surface water rights. A similar approval was granted to appropriate the City's surface water right (T-12551) from the Willamette Wellfield. The collector well will be close to the wells and will draw water in the same vicinity as the wells. As such, it is expected that the water right permitting is feasible.

This project will include a planning effort with the City to determine the budget, desired service life, and build-out capacity for the facility. The project should include studies for topographic survey, bathymetric survey, geotechnical investigation, water right requirements, and permitting requirements. Several engineering disciplines will be needed to prepare a preliminary design, including geotechnical, hydrogeologic, civil, structural, mechanical, and electrical. The caisson is recommended to be located away from the river bank on the City's property near the Willamette Wellfield. The project will need to determine the space and right-of-way requirements for the lateral wells. These typically extend below the river channel. It's possible that additional right-of-way will need to be acquired for the caisson and laterals.

The total recommended budget for this project is $100,000.

- **Project S-10 – Collector Well & Conveyance Improvements**

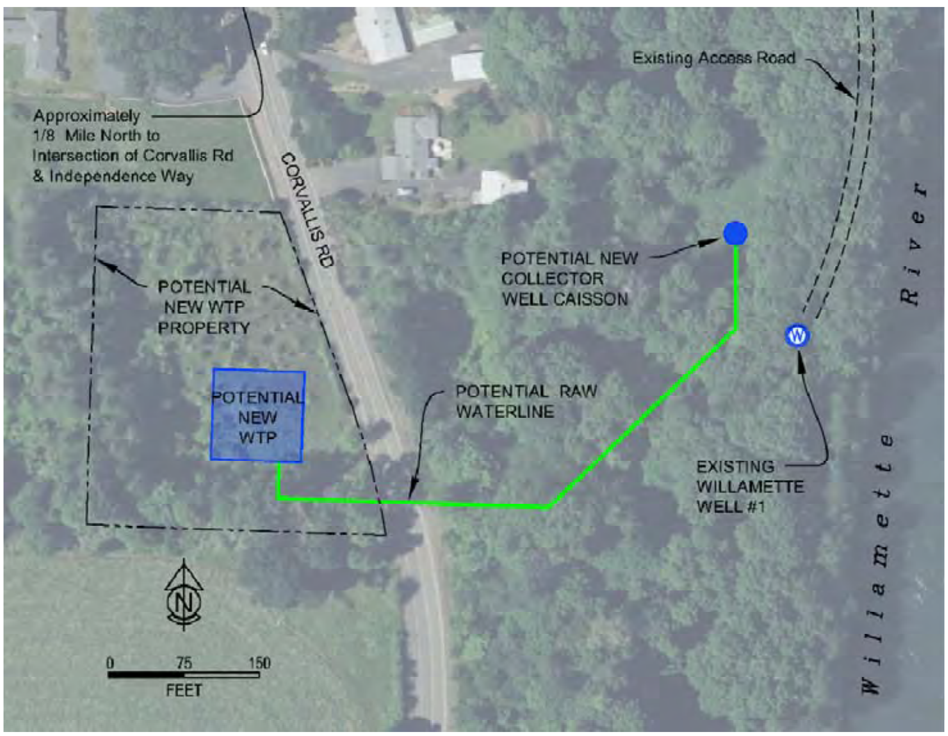
This project includes the final design and construction of the collector well structure, raw water pump station, and pipeline to convey water from the river to the surface water treatment plant. The proposed surface water treatment plant is discussed further in Section 7.3.2. As previously explained, it is uncertain what scale of collector well will be chosen by the City or if other entities will need to be served. For estimating cost, this plan assumes that a structure is built that will be able to serve the needs of the City for multiple planning periods. For planning purposes, it is further assumed that the structure will be located near the southern end of the City's Willamette Wellfield property. The City's property widens at this location and additional property around the site will need to be purchased. This site will be accessed from the north along the City's Willamette Wellfield property using the existing easement from Corvallis Road near River Oak Road (in the same manner as the site is currently accessed for the wells). It is not expected to be feasible to construct a relatively short access road on the City's property between the site and Corvallis Road due to the existing slough. Figure 6-3 is a conceptual site plan that depicts the recommended collector well and conveyance improvements.

The collector well is expected to consist of a 15-foot diameter pre-cast concrete caisson approximately 60-feet deep with 12-inch-thick walls. Well laterals will extend radially from the bottom of the caisson. The structure will be designed to take advantage of water filtration provided by alluvial sediments. The raw water pump station will be built on top of the caisson at an elevation above the 100-year flood level. The pump station is expected to be sized to meet the needs of the City for 20 years. Provisions should be made in the design for adding pump capacity and for additional laterals to provide for growth. The improvements will include yard piping and a flow meter vault. A dedicated power service will be installed that will accommodate the addition of larger pumps at the facility. An auxiliary power system is recommended to be installed on the pump station platform. The pump station additionally should have hoists for pump removal. It is recommended that the caisson and pump station platform be accessible by personnel using a motor boat during flood events.

The project should include a new waterline from the pump station to the new treatment plant. This pipe is estimated to be 12-inch diameter and approximately 600 feet long. The waterline will have to be installed across the existing slough. As described further in Chapter 7, the new treatment facility is recommended to be located near the collector well.

The total recommended budget for this project is $5,590,000. The detailed estimate of this budget is included in **Appendix G**.

Figure 6-3| Conceptual Site Plan for Water Supply Improvements



- **Project S-11 – Groundwater Availability Study**

This project is an assessment of groundwater availability within the vicinity of the City. The purpose of this study is to investigate the potential for an additional groundwater well or wellfield, as discussed in Section 6.3.4. This study should assess both existing water rights and potential for new water right permits. This plan recommends that the groundwater study consider an area roughly within three miles of the City's water treatment plants as a starting point. The total recommended budget for this project is $25,000.

6.4.4 Summary of Recommended Projects

The following table is a summary of the various water supply improvement recommendations developed in this chapter. For more details on particular projects, the reader is directed to the previous discussions. These projects are prioritized in Chapter 12.

Table 6-2| Recommended Water Supply Improvements

Project Code	Project	Recommended Budget
S-1	Groundwater Right Development, Permit G-12134	$ 10,000
S-2	Groundwater Right Development, Permit G-17868	$ 10,000
S-3	Groundwater Right Development, Permit G-17750	$ 10,000
S-4	Surface Water Right Development, Permit S-54331	$ 20,000
S-5	Polk Wellfield Electrical Improvements	$ 459,000
S-6	South Wellfield Improvements	$ 857,000
S-7	Recommission South Wells 4 & 5	$ 15,000
S-8	New Water System Intertie	$ 668,000
S-9	Collector Well Preliminary Engineering	$ 100,000
S-10	Collector Well & Conveyance Improvements	$ 5,590,000
S-11	Groundwater Availability Study	$ 25,000

CHAPTER 7

WATER TREATMENT EVALUATION

Chapter Outline

7.1 Introduction
7.2 Evaluation
7.2.1 Polk Water Treatment Plant
7.2.2 South Water Treatment Plant
7.2.3 Surface Water Treatment
7.3 Water Treatment Improvement Alternatives
7.3.1 Treatment Location Alternatives
7.3.2 Treatment Technology Alternatives
7.4 Recommended Treatment System Improvements

WATER TREATMENT EVALUATION

7.1 INTRODUCTION

This chapter develops and evaluates improvements to adequately meet the City's water treatment needs through the planning period. The improvements discussed in the following sections were developed by considering the projected population and drinking water demands, the condition and performance of the existing facilities, regulatory requirements, and the City's objectives.

7.2 EVALUATION

7.2.1 Polk Water Treatment Plant

The Polk Water Treatment Plant was originally constructed in 1999 and was significantly expanded in 2017. The main treatment components of the facility are two pressure filter banks for removal of iron and manganese, a chlorination system, and a fluoridation system. The facility consistently produces finished water that meets OHA standards. As previously discussed, the City is currently designing and implementing a corrosion control treatment process at the Polk Water Treatment Plant to address rising copper levels in the distribution system. Therefore, this plan does not identify a capital improvement project for corrosion control and assumes this issue is addressed by the existing project.

Overall, evaluation of the existing facility identified two issues with the combined Polk Water Treatment, Storage, and Distribution Facility. The facility only has partial auxiliary power and does not have secure fencing. Recommendations for these issues are provided in Section 8.4.1 as a part of the distribution system improvements.

The existing treatment processes are evaluated in the following paragraphs. In 2017, the iron and manganese filtration systems at the Polk Water Treatment Plant were roughly doubled in size with the addition of Filter Bank 2. Design criteria for the facility were not available for this study. As described further in Section 4.4.1, the total estimated capacity of the filtration system is 1,400 gpm, based on a filter loading rate of 7 gpm per square foot. The Polk Wellfield's approximate sustained pumping rate is 1,680 gpm and maximum rate is 2,125 gpm. Based on this analysis, the filters are potentially 18% to 34% undersized. However, based on operational history, the City has not had issues with iron and manganese removal from the Polk Wellfield. It is possible that the existing removal efficiencies are adequate for the City's purposes (since the City is removing these constituents by choice, not to meet OHA standards). Additionally, Filter Bank 2 was constructed relatively recently. Therefore, this study assumes that the filtration system was designed properly and sized for build-out of the wellfield (including operation of Polk Well #4). If the City has concerns about the filtration capacity, pre-and post-filtration water quality can be monitored. If issues start to arise with iron and manganese in the finished water, then the City should consider an in-depth study on the performance of the filters.

Filter Bank 1 was originally installed in 1999 and utilizes the original plant control panel and solenoid valves. These components operate the hydraulic control valves and backwash process. These components are expected to need replacement during the planning period. The control panel is relatively simple and inexpensive and could be replaced in its entirety or on an individual component basis as needed. Individual solenoid valves for this application are roughly $400 and a wholesale replacement of the control panel is likely to cost on the order of $8,000. It is recommended that the costs for replacing these components be fulfilled out of the City's operations and maintenance budget on an as-needed basis and that a capital project need-not be identified.

Since Filter Bank 1 was placed in service, the original control valves have been replaced and the filter media was refilled. The filter media should be inspected and refilled during the planning period.

Filter Bank 2 and the associated electrical system are relatively new and in good condition. They are expected to continue to meet the City's needs through the end of the planning period with regular maintenance. Filter Bank 2 is not expected to need any capital improvements during the planning period. The filter media should be inspected and refilled during the planning period.

An important maintenance task for both filter banks is routine service of the hydraulic control valves. Each filter bank has eight valves that control the backwashing operation (16 total). It is recommended that the City perform routine maintenance on each valve according to the manufacturer's recommendations. This typically includes flushing and lubricating the valve's internal parts while the valve remains installed. To service the valves, a filter bank will need to be isolated and depressurized. Since the filters treat secondary contaminants, the treatment process can be temporarily taken out of service without causing a regulatory issue, as long as it is disinfected prior to placing it back in service. Flow can be temporarily routed through a single filter bank. During the planning period, the valves for Filter Bank 1 will be between 15 to 35 years old. During maintenance, each valve should be evaluated for replacement.

The existing propeller flow meters for the two filter backwash lines may eventually need to be replaced during the planning period. If this is the case, these should be replaced with magnetic flow meters with digital read-outs that are mounted at eye-level. The read-outs are currently 8-feet above the floor, which causes issues for operators.

In 2017, new chlorination and fluoridation systems were installed at the Polk Water Treatment Plant. In 2022, the City improved the fluoridation system by adding a second pump and dosing line. Both the chlorination and fluoridation systems are in good condition and are expected to serve the City's needs for the planning period with regular maintenance.

7.2.2 South Water Treatment Plant

The City's South Water Treatment Plant was constructed in 2004. The main treatment components of the facility are adsorption filters, a chlorination system, and a fluoridation system. The facility consistently produces finished water that meets OHA standards.

The activated carbon adsorption filters were placed in service in 2005 during the groundwater contamination event (described in Section 4.3.2.1). These filters are still in service as a precaution for removing organic compounds. Based on conversations with City staff, organic compounds are consistently not detected in the raw groundwater. Based on regulatory monitoring data, organic compounds are consistently not detected in finished water from the facility. These filters are relatively inexpensive to maintain and do not have mechanically-wearing parts. As a precaution, it is recommended that the City keep these filters in service and perform regular repairs and maintenance, such as replacing the activated carbon filter media.

In 2017, new chlorination and fluoridation systems were installed at the South Water Treatment Plant. Both the chlorination and fluoridation systems are in good condition and are expected to serve the City's needs for the planning period with regular maintenance.

As previously discussed, the City is implementing a corrosion control process at the Polk Water Treatment Plant. The efficacy of this process will be evaluated as a part of the project. Upon completion of the project, it is recommended that the City consider the need for a corrosion control process at the South Water Treatment Plant. At this time, there is not enough information available to determine if a separate corrosion control process will be needed at this location.

7.2.3 Surface Water Treatment

As discussed in the water supply evaluation in Chapter 6, this plan recommends that the City develop the Willamette River as a new water source to meet projected water demands in the planning period. The City's two water treatment plants are equipped for treating groundwater and, as such, are not capable of treating water to the more stringent surface water requirements. A new water treatment facility will be needed during the planning period in order to provide this level of treatment. An alternative analysis is provided in the following sections to describe the various components of the facility.

7.3 WATER TREATMENT IMPROVEMENT ALTERNATIVES

The City has historically benefitted from the availability of high-quality source water—specifically groundwater that requires very little treatment. This resource is nearing its limit as demands for drinking water increase and new groundwater sources become increasingly difficult to acquire. The City is currently approaching the maximum capacity of its available groundwater sources. As noted in Chapter 6, the City is encouraged to seek out additional high quality groundwater sources to service future demand.

In the absence of new groundwater sources, the City is faced with a rather stark reality; either begin a program of City-wide water curtailment to restrict and limit water use to the capacity of existing water sources, or begin a process to evaluate and utilize the water rights the City currently holds on the Willamette River. The water rights held on the Willamette River satisfy the quantity needs for the City's projected growth, but this source carries a significantly higher cost due to the associated treatment of that water.

Another challenge the City faces is the potential re-classification of some of its existing groundwater sources as groundwater under the influence of surface water (GWUDI). The OHA defines GWUDI as "any water beneath the surface of the ground with significant occurrences of insects or other macro-organisms, algae or other large-diameter pathogens such as *Giardia lamblia* or *Cryptosporidium*, or significant and relatively rapid shifts in water characteristics such as turbidity, temperature, conductivity or pH which closely correlate to climatological or surface water conditions". The geology of the Polk Wellfield aquifer and the proximity of the wells to the Willamette River classifies this groundwater resource as sensitive to influences from the surface water in the Willamette River. This is an evolving issue and the OHA is currently reviewing water quality data from this wellfield to make a determination. If the aquifer and/or particular wells are determined to be GWUDI, the City will be required to either take those wells offline, or provide additional treatment.

The salient point from the above discussion is that the era of "easy water" is coming to a close for the City. As Chapter 6 points out, the City has adequate water resources to satisfy its water quantity needs, however the utilization of these un-tapped water resources requires a robust level of water treatment.

7.3.1 Treatment Location Alternatives

The location of a new surface water treatment plant is closely related to the physical siting of the collector well facility discussed in Chapter 6. The physical distance from the proposed collector well to the existing water storage and treatment facilities at the South Wellfield and at the Polk Treatment Plant prevents these sites from providing any development value to the new water treatment facility. It is recommended that the City site the new treatment plant in areas closer to the collector well where adequate land is available.

It is estimated that a surface water treatment plant will require approximately 4 acres of property to develop the full facility with a reasonable allowance for future expansion. A property of this size would also permit the City to construct a future water storage reservoir at the site. The City has tentatively identified a site west of Corvallis Road directly opposite the City's wellfield parcel located on the east side of the road. This location is favorable as the property is outside the 100-year flood plain and offers good connectivity to the south end of town and the proposed collector well site. The property also includes approximately 0.7 acres of land already owned by the City. This site is shown on Figures 6-3 and 7-2. A new property of sufficient size could have the added benefit of providing for the growth of Public Works over time.

7.3.2 Treatment Technology Alternatives

The development and selection of a water treatment technology must begin with a clear understanding of treatment objectives. The Willamette River is a surface water source and as such it differs significantly from the City's existing groundwater sources. Seasonal rainfall creates wide variations in sediment load and turbidity. Temperature fluctuations in the river can create conditions for algal blooms that can significantly disrupt a treatment facility, or shift the aesthetic value of treated water. Other potential concerns include the water quality impacts from wildfires, landslides, agricultural runoff, and other external contamination sources. All of these variables play a critical role in the type of treatment equipment selected for this plant.

The Willamette River has been a reliable water resource for a number of Oregon cities. The City of Corvallis has utilized the Willamette as a primary source of drinking water since 1949. In 2002 the City of Wilsonville began using the Willamette as the source for their drinking water needs. Other municipalities including Tualatin, Hillsboro, and Newberg are in the process of developing new treatment plants and securing water rights on the Willamette River in order to supplement their existing water sources. What is evident from each of these experiences is that the general public plays a significant partnering role in the development of treatment objectives. The process of public engagement is a lengthy and important process and when conducted properly it will build consensus and demonstrate that the Willamette River can be developed as a source for reliable and high-quality drinking water.

The regulatory requirements established by the OHA and EPA form the basis for the treatment processes and methods proposed in this section. A strict adherence to this set of design standards ensures that the treatment facility will be capable of producing drinking water in full compliance with the current State and Federal drinking water standards. Consideration has also been given to emerging water treatment regulations since it would be remiss to simply design a plant to the current standard. When completed, the water treatment plant will be a significant investment and the treatment recommendations will naturally include technologies that are forward looking to ensure treatment compliance as regulations evolve. Ultimately the final selection and formulation of the treatment process will be a combination of the design elements required by regulatory agencies and other aesthetic and predictive valuations selected by the City and community stakeholders. The evaluation provided in this chapter is a first step.

Treatment Objectives and Recommended Treatment Processes

<u>Inactivation/Removal of Microbial Contaminants</u> The removal and/or inactivation of harmful microbial contaminants forms the most basic structure of every surface water treatment process. This treatment objective is typically achieved utilizing a set of five basic treatment stages consisting of:

> **Coagulation**: Coagulation is a chemical and physical treatment process used to remove solids from water, by manipulating electrostatic charges of particles suspended in water. This process introduces small, highly charged molecules into the water to destabilize the charges on particles, or colloids in suspension. Strong mechanical mixing of the coagulant with the water ensures proper blending and an efficient reaction.
>
> **Flocculation**: Flocculation immediately follows coagulation and consists of a gentle mechanical mixing of the coagulated water column to facilitate bonding between particles. This process creates larger, loosely bound particles which, because of their physical properties, settle faster and become easier to remove.

Sedimentation: Sedimentation follows the flocculation stage and consists of a relatively quiescent chamber of water where the flocculated particles are allowed to settle out primarily using gravitational forces. This settling process can be accelerated with the use of lamella—large, closely separated sheets of plastic or metal, installed in a closely packed parallel array at a 60-degree angle inclined from vertical and submerged within a slowly rising water column of flocculated water. The close distance between each inclined plate shortens the distance a particle needs to fall. As the flocculated particles settle onto the surface of the nearest plate they slide down the face of each plate and accumulate in the base of the sedimentation chamber where they can be pumped out for disposal. Settled water typically leaves the top of the sedimentation chamber and is permitted to flow downward through the filter in the next stage of the treatment process.

Filtration: Filtration typically utilizes a stratified set of sand and gravel layers to mechanically strain and remove surviving particulates and smaller coagulated formations in the water following the sedimentation stage. There are a wide variety of filtration technologies and media types available. The decision to utilize a particular filter type and media is heavily dependent on a number of parameters and seasonal fluctuations in the surface water source. The filtration technologies evaluated for this plant were mixed-media filters (utilizing a combination of anthracite and sand media), granular activated carbon (GAC) filters, which utilize a porous carbon filter media, and micro-filtration membrane treatment modules. Membrane filtration is a physical process where the water is forced through synthetic hollow fibers with very small pore sizes. GAC filters have been selected for this plant as they not only provide excellent mechanical filtration of particulate matter, but have the added ability to adsorb organic compounds which can cause taste and odor problems.

Disinfection: Disinfection is the fifth and final stage of a conventional treatment process whereby pathogenic microbes, protozoa, and viruses are destroyed or inactivated at the cellular level. Disinfection is most commonly accomplished using chlorine, ozone, chloramines, or chlorine dioxide. The use of chlorine is by far the most common method. High-intensity ultraviolet light can also serve as an effective disinfectant and specialized reactors are available for this specific purpose. We propose to utilize a combination of ozone, UV, and chlorine in that order to accomplish specific functions within sequential stages of the treatment process. The use of chlorine at the final stage of the treatment process imparts a residual level of disinfectant to the water that provides a protective benefit as the treated water travels through the municipal distribution grid. Neither ozone, or UV, has the ability to provide this residual benefit.

Inactivation of Difficult Microbials Cryptosporidium parvum is a parasitic protozoa that is resistant to chlorine. The removal of this pathogen is typically accomplished in the first four stages of conventional treatment as described above. OHA requires a 99% reduction (2-log removal) of this pathogen for surface waters that have had a historically low detection of the pathogen in the source water. The segment of the Willamette River at Independence has historically been classified as source with relatively low levels of cryptosporidium and it is anticipated that a conventional filtration sequence will provide the required removal levels for this pathogen. Cryptosporidium is also readily destroyed with high intensity ultraviolet (UV) light. Our recommendation is that the treatment plant be provided with UV reactors after the filtration stage. The provision of UV disinfection is seen as a prudent investment that provides immediate benefits as well as a strong longer-range margin for treating cryptosporidium and other pathogens should the quality of the source water quality change.

Reduction of Disinfection By-Products Natural organic compounds generally occur in higher levels in surface water than groundwater. These compounds reduce the quality of water with regard to color and odor and often impart an undesirable taste to water. Dissolved organic compounds react with chlorine to form a wide range of new chemical, organic and inorganic substances that are commonly referred to as disinfection byproducts (DBPs). DBPs are harmful to human health and are regulated by the EPA. The most common groups of DBPs are trihalomethanes and haloacetic acids. An important treatment objective is to utilize ozone early in the treatment process, after sedimentation, to decompose organic compounds so they can be removed in an adsorptive process by the GAC filters. The combination of ozone oxidation followed by GAC filtration is a proven method for removing DBP precursors and avoiding high levels of DBPs that would otherwise be generated on contact with chlorine later in the plant.

Destruction of Algal Toxins Blue-green algae, more correctly known as cyanobacteria, are frequently found in freshwater systems. Cyanobacteria are often confused with green algae, because both can produce dense mats that can interfere with activities like swimming and fishing, and may cause odor problems and oxygen depletion in waterways. Some forms of freshwater cyanobacteria are able to produce highly potent toxins known as cyanotoxins. Cyanotoxins are produced and contained within the cyanobacterial cells. The release of these toxins into the surrounding water commonly occurs during cell death and the subsequent rupture (lysis) of the cell wall. Lysis can also be induced from mechanical shearing or chemical weakening of the cell wall as the water is pumped and handled in various water treatment stages. In the summer of 2018, the City of Salem struggled with this problem as a cyanotoxin bloom originating in Detroit reservoir passed through the City's treatment process. Algal blooms are occurring with increasing frequency; and warm weather conditions that foster algal blooms are coincident with periods of high water demand. The disruption of a treatment process can occur just when you need water the most.

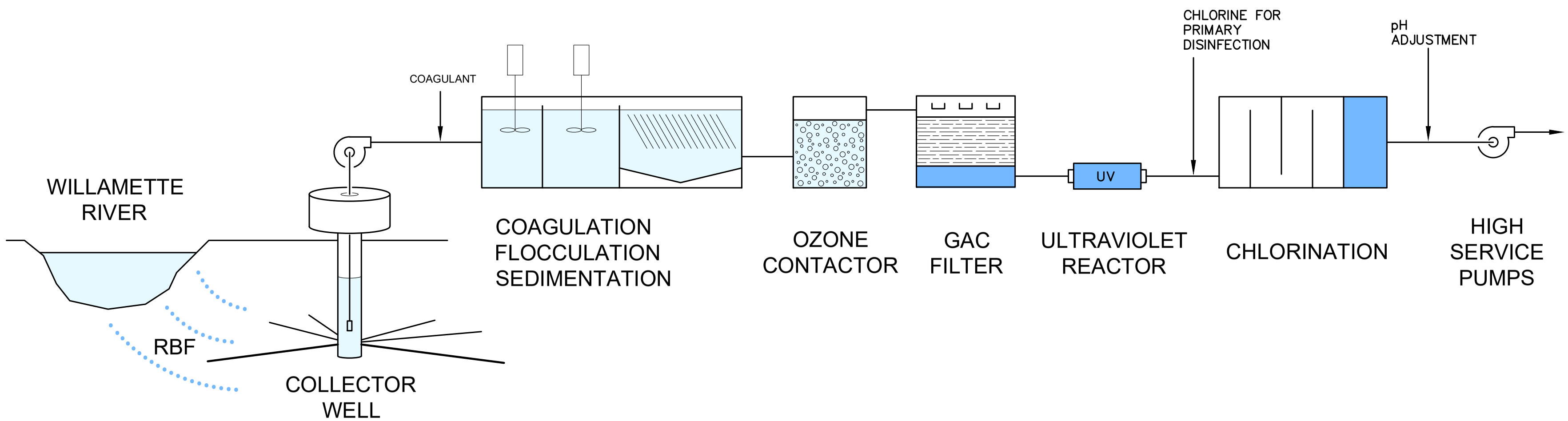
The use of ozone is one of the more common and effective means of inactivating cyanotoxins. This process can rapidly achieve nearly complete destruction of three out of the four most prevalent types of cyanotoxins. This is accomplished at low doses and contact times provided that ozone is applied at levels exceeding the ozone demand. Ozone cleaves these cyanotoxin types at a key chemical structure and thereby inactivates them as a human toxin. The remaining type of cyanotoxin that is not inactivated by ozone (the saxitoxin class) can be readily removed by adsorption to GAC filter media. This is another example of the importance of pairing ozonation with GAC filtration.

Removal of Trace Organics There are a number of synthetic organic compounds that can occur in surface water. These are man-made compounds and can be generated from agricultural uses of herbicides, insecticides, pesticides, fungicides, organochlorinated compounds, and other compounds. Current drinking water regulations require regular testing to detect these compounds in source waters. The removal of such compounds from a source water is most readily achieved by an adsorptive process with the use of GAC filter media.

Seasonal Taste and Odor Control There are a number of compounds in surface water in addition to the previously mentioned compounds that that can impart undesirable tastes and odors. Geosmin and Methyl-Isoborneol (MIB) are two such compounds. The human olfactory system is highly sensitive to both of these compounds and although neither present any health problems they can degrade the aesthetic value of water. Geosmin and MIB both create a musty or earth taste and odor and are some of the most difficult compounds to remove from drinking water. Ozone can partially reduce the compounds but a complete removal of the compounds typically requires the modification of a conventional GAC filter to function as a biologically active GAC filter. This particular formulation of the GAC filtration process is not being considered for the initial treatment plant configuration, but could be developed at a later operational stage should the need arise.

Riverbank Filtration The extraction of water from a surface water source almost always requires some form of mechanical screening to prevent large debris from entering the intake chamber and damaging or fouling mechanical equipment. This is typically accomplished by the use of a mechanical screen that permit the passage of water while preventing sticks, leaves, fish and other items in the river from entering the plant. The use of a collector well in-lieu of a screened river intake has several advantages. Water is collected through a series of horizontal collection laterals that are installed in a radial array from the central caisson into the alluvial gravel and sand layers within the river bank. The porous sand and gravel formations provide a filtering function that benefits the treatment process.

Figure 7-1 | Recommended Surface Water Treatment Process



TREATMENT FUNCTIONS	Riverbank Filtration	Flocculation & Sedimentation	Ozonation	GAC Filtration	UV Reactor	Chlorination	pH Adjustment
	Screening of heavy river debris Partial mitigation of algal toxins Partial reduction of taste and odor (T&O) compounds such as Geosmin & MIB	Flash mixing to blend coagulant Floc formation creates a mass of settleable solids Sedimentation basin removes settleable solids to improve downstream treatment functions Initial reduction DBP precursors	Organic chemical oxidation Algal toxin destruction Oxidation of T&O compounds Reduction of microbials	Organic chemical removal DBP precursor reduction Removal of T&O compounds such as Geosmin and MIB	Inactivation of difficult microbials such as cryptosporidium Inactivation of Giardia Does not affect the taste of water	Completion of Giardia inactivation Completion of virus inactivation Establishes a stabilizing chlorine residual for the distribution system	Corrosion control Taste & Odor (T&O) mitigation

Figure 7-1 has been prepared to graphically present each element of the proposed treatment process. The figure also includes a bulleted summary of the treatment functions provided by each element.

7.4 RECOMMENDED TREATMENT SYSTEM IMPROVEMENTS

- **Surface Water Treatment Facility (Project T-1)**

Based on the capacity limitations of existing groundwater sources and recent emerging concerns over the re-classification of select City wells from groundwater to GWUDI, our recommendation is for the City to proceed with the planning and development of a new surface water treatment plant using the Willamette River as a source. Based on the municipal water demand projection and supply evaluations presented in this study, the recommended phase 1 capacity of the plant is 1.5 mgd (approximately 1,040 gpm). This capacity will enable the City to provide maximum day demands through the end of the planning period and have some margin to provide for growth in the following planning period. As described under Project S-4, the City needs to make construction progress on developing Permit S-54331 by August 2026. This means that work will need to begin on design very early in or prior to the planning period.

Major supporting elements for the water treatment plant facility are described in the following paragraphs. The total recommended budget for Project T-1 is $19,000,000. It should be noted that a portion of this cost is the result of water quality expectations expressed by the public consumer base that other Oregon municipalities have encountered when utilizing the Willamette River as a source for drinking water. There are a number of other treatment options and variations that could be considered should the City desire to marginally reduce the cost of this facility.

The new treatment plant facility and site should be planned for expansion over multiple phases and to ultimately treat & distribute at least 4.2 mgd (6.46 cfs, the total rate of the City's two surface water rights). The full capacity of these water rights is anticipated to be needed by the City to provide for demands in future planning periods. Overall a facility of this scale at build-out is expected to cost between $50-60 million dollars.

<u>Land Acquisition</u> - Acquiring an adequate amount of land is important for the new facility and also to provision for future growth of the City. It is reasonable to assume that this facility and the collector well will be providing for the City's growth in water demands for the foreseeable future. Therefore, it is critical that the facility and site be designed for expansion. This includes the water treatment plant building, future water storage reservoir and finished water pump station. A conceptual site plan for the facility is shown in Figure 7-2. This preliminary layout includes space for a treatment plant building, a storage reservoir, backwash ponds, civil site improvements and space for an additional support building. It is estimated that a surface water treatment plant and the associated structures will require 4 acres with a reasonable allowance for future expansion. The City may elect to acquire more area if the site is to be used for supplemental purposes. As shown in the figure, the City owns a strip of land on the west side of Corvallis Road that is approximately 50-feet wide along the southern edge of the proposed property comprising an 0.7 acre area. Ideally the City will acquire land contiguous with this area. Based on the conceptual site plan, this will require a purchase of at least an additional 3.3 acres of land.

<u>Civil Site Improvements</u> - The land that is proposed to be acquired is undeveloped. It will require clearing, grading and drainage work. Improvements will include a driveway entrance, drive aisles around the site, and a paved yard with parking. The site will need to accommodate large delivery trucks. Utilities will be needed, including storm sewer and sanitary sewer. The facility will also require services for phone, internet, and potentially natural gas. The site will need a perimeter security fence and gate.

Water Treatment Equipment and Building Improvements - The water treatment building will house the treatment plant as discussed in this chapter. An essential assumption of this layout is that the treatment equipment utilized for the coagulation, flocculation and sedimentation stage of the treatment plant will utilize a ballasted flocculation system to keep the footprint of this equipment to a minimum. The intent is to also install a single treatment train instead of two. This is a deviation from a more conventional design approach which utilizes two separate trains to deliver the full treatment capacity of the plant. The latter convention permits the removal of one treatment train from service during maintenance periods. The decision to use a larger capacity single train is a forward looking trade-off that allows for the future second train to be installed adjacent to the first within the footprint of a smaller building. This is a configuration detail that can be further evaluated during the pre-design stage for the facility. It is envisioned that the building for the main treatment plant as well as any auxiliary buildings will be pre-engineered metal buildings with a wainscot wall comprised of CMU block.

Disinfection System - The recommended disinfection system includes a combination of ultraviolet radiation (UV) and chlorination. Chlorine will be utilized to provide the mandatory 0.5-log inactivation of Giardia after filtration and the 2-log inactivation of viruses following the conventional treatment process. The clearwell will be a baffled concrete structure below the treatment plant floor.

Finished Water Storage - The recommended finished water storage reservoir is discussed in Section 9.5 and will be based on the reservoir storage analysis presented in that section. It is recommended that the reservoir be constructed at the same time as the treatment plant. Finished water will be utilized to backwash the filters and will be sourced from this reservoir. The backwash usage will be metered.

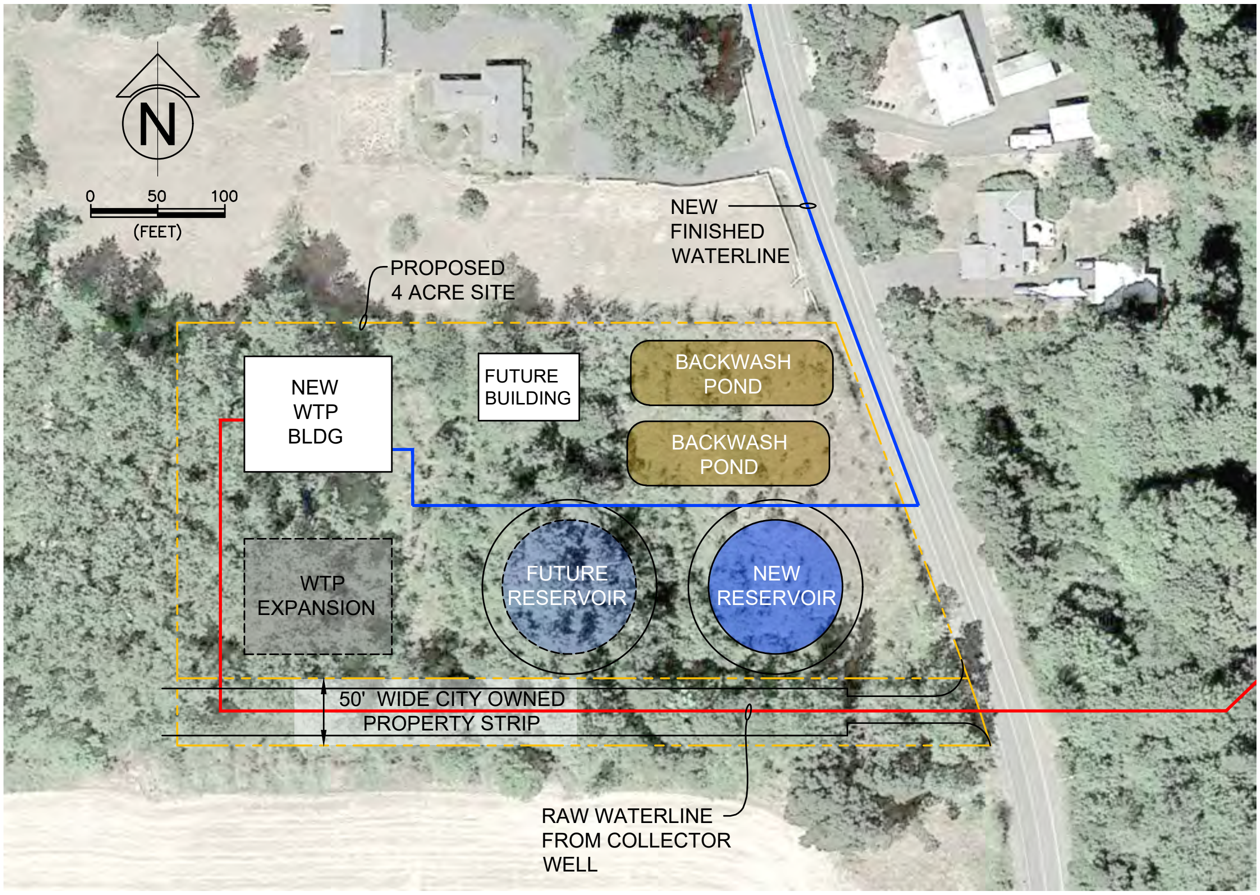
Finished Water Pump Station - A new finished water pump station is required to pump treated water from the proposed storage reservoir to the distribution system. It is currently envisioned that the main treatment plant building will house the pumps for this function as well as any transfer pumps to deliver water from the clearwell into the storage reservoir. The finished water pump station will utilize multiple pumps to provide 100% redundancy with the largest pumping unit out of service. Variable frequency drives will be utilized to optimize performance and to maintain a constant pressure in the distribution system.

Backwash Settling Ponds - Two ponds are to store and settle residuals from the various treatment plant processes. The ponds will be constructed using concrete-lined dikes. Two ponds will be needed to allow one to be emptied of residuals while the other remains in service.

Electrical Power - The site will need a new electrical power service. This service should be sized to accommodate expansion and should be large enough to provide for all of the potential uses of the site. The recommended improvements include an auxiliary-power generator with an automatic transfer switch to provide a backup power source. The generator should be sized to power at least the treatment plant and the finished water pump station. Depending upon other uses of the site, the City may want to increase the generator’s capacity beyond the full operation of the plant.

SCADA Integration - The new water treatment plant and finish water pump station will be integrated into the City’s existing SCADA system. The system will be able to track several regulatory monitoring points, such as flow rates, total volumes, chlorination, and turbidity.

Figure 7-2 | Conceptual Site Plan for the Recommended Surface Water Treatment Facility



CHAPTER 8

DISTRIBUTION SYSTEM EVALUATION

Chapter Outline

8.1 Introduction
8.2 Sizing and Capacity
8.3 Hydraulic Model Development
8.4 Distribution System Analysis
8.5 Summary of Recommended Distribution Improvements

DISTRIBUTION SYSTEM EVALUATION

8.1 INTRODUCTION

The combination of piping, storage, pump stations, and supporting infrastructure is conventionally defined as a water distribution system. For the purposes of this chapter, the discussion of water storage is excluded. Evaluations and recommended improvements to the City's water storage facilities are presented in Chapter 9.

The evaluations of this chapter were derived from the production and study of a computer-based hydraulic model designed to simulate the City's distribution network. This model was used to simulate various operational scenarios, fire flow events, and failure states in order to verify improvement recommendations. These recommendations are presented at the end of this chapter. Prioritized ranking of the recommendations appears in Chapter 12.

8.2 SIZING AND CAPACITY

The primary purpose of a water distribution system is to deliver the full range of consumer demands and fire flows at pressures suited for the particular use. To accomplish this, the distribution system utilizes a combination of various sized distribution mains.

Distribution mains must satisfy both normal consumer domestic demands and fire flows, and thus experience a wide range of operating velocities. Distribution mains were evaluated for their ability to provide fire flow during maximum day demand periods. Most Cities now require new waterlines to be a minimum of 8-inches diameter for single-family residential areas, and 10-inches or larger for industrial, commercial, and multi-family areas with fire flows above 1,500 gpm.

The American Water Works Association (AWWA) recommends piping velocities below 10 feet per second for distribution mains. Maximum friction loss recommendations for distribution mains should also be less than 10 feet of pressure head per 1,000 feet of pipe length. Exceeding this headloss criteria may result in loss of hydraulic conductivity and excessive energy costs.

The following standards are recommended to determine water distribution system adequacy.

- Peak hour demands for the entire system must be met with system pressures remaining above 20 psi.
- The system must be capable of delivering the required fire flows to all portions of the distribution system (in combination with the maximum day demand) while maintaining a minimum residual pressure of 20 psi at all service connections.

8.2.1 System Pressure

Pressure is the primary metric for evaluating the ability of a distribution system to deliver water. There are several concepts relating to water system pressure that must be defined for purposes of this discussion.

Pressure and Head. Water pressure (sometimes called head pressure) is directly related to the height to which water will rise in a vertical and open pipe at that location (a standpipe). Each psi of water pressure equates to 2.31 feet of water column height in a standpipe. Under conditions of no flow through the pipelines, the water level elevation in a standpipe will be the same at all points in a pressurized distribution system (to visualize this concept, imagine a lake, where under no-flow conditions the water level elevation is the same at all points). As the elevation of the ground surface changes, the height of water column above that same point will change proportionately, and the pressure will change (conceptually, as the lake bottom elevation goes up or down, the water depth (and water pressure on the bottom) at that point also changes).

- *Pressure Change with Elevation*. Based on the pressure/head concept noted above, water pressure (i.e., head pressure) will increase with decreasing ground elevation, and will decrease as the ground elevation increases.
- *Static Pressure*. As noted above, pressure in a pipeline is constant at all points in that pipeline ONLY when there is no flow through the pipeline, AND when the elevation remains the same at all points. As noted above, in a real distribution system, the static pressure increases or decreases with changing ground elevation.
- *Head Loss.* As water flows through a pipe, pressure decreases along the length of the pipe due to friction loss between the water and the pipe walls. Similar to dry friction, water friction and turbulence along pipeline walls results in energy loss from the moving object (i.e., flowing water), with the energy loss being manifested as reduced pressure. When the flow stops, the friction loss also stops, and so the system returns to static pressure levels.
- *Dynamic Pressure*. The dynamic pressure (sometimes called residual pressure) is the pressure measured at a point in the distribution system under some defined flow condition. While the *static* pressure in the distribution system remains relatively constant at a given point, the *dynamic* pressure (i.e., the actual observed pressure) can change dramatically. Therefore, pressure at any given point in the distribution system generally decreases as demand for water (and flow velocity) increases.

Periods of heavy fire flow demand depress system pressures significantly. OHA standards (OAR 333-061-0025) stipulates that water suppliers must maintain a minimum pressure of 20 psi to all service connections at all times, including times of peak fire flow demand. Fire flows are typically modeled concurrent with the maximum day demand.

8.2.2 Fire Protection

Table 5-8 in Section 5.6 details the fire flow requirements used for this master plan. These standards will be utilized in the fire flow evaluations of this chapter to ensure that the distribution system is suitably sized and configured to reliably deliver the required fire flows.

8.2.3 Deficiency Categories

In general, distribution system deficiencies fall into several general categories. Many elements of the water system may be experiencing more than one of these problems at the same time. These categories will be used to identify the deficiencies associated with particular elements of the system in the discussions of this chapter.

- *Lack of Capacity*. Undersized pipes cannot deliver peak water demands or fire flows. Although the water system may have capacity to deliver domestic flows, it is often unable to convey larger flows that may be required in an emergency. Pipes in this category have excessive headloss and create flow restrictions. This problem should be addressed either by increasing the size of the existing waterline or constructing new waterlines.
- *Lack of Facility*. Problems in this category are caused by the absence of a waterline, valve or hydrant, or inadequate looping to provide redundancy or reliability. In such cases new components should be constructed in order to increase system reliability or to simplify system operations.
- *End of Useful Life*. This category of problems is the result of old, damaged, or degraded pipes. The most common examples of these problems are leaky pipes and broken valves or hydrants. Corrective measures require the replacement or reconstruction of the failing component(s).

8.3 HYDRAULIC MODEL DEVELOPMENT

8.3.1 Model Methodology

A computer-based numerical model was utilized for this master plan. Modeling of water distribution systems is a proven and effective method for simulating and analyzing the performance of a distribution system under a wide range of operational and hydraulic conditions. A properly constructed and calibrated model permits a robust evaluation of the distribution system and often allows the designer to replicate and evaluate hydraulic scenarios that are too difficult or costly to perform in the real world. Such scenarios are useful to determine the overall performance of a distribution system and to identify weaknesses that require improvements. The evaluation of future pipeline sizes and routing can also be economically performed to ensure that the expansion of the distribution system occurs in an optimized fashion.

The modeling software used for this project was WaterCAD, a commercial modeling software package developed by Bentley Systems Incorporated. This software was utilized to calculate the flow throughout the distribution network and to quantify flow rates, pressures, velocities, headlosses, and pump operating points under various demand and fire flow scenarios.

The general methodology used in the modeling process was to examine the existing distribution grid during various demand and fire flow scenarios. Pressure, flow, or connectivity deficiencies were used to formulate improvement scenarios to remedy the problem. These scenarios were then evaluated to determine their efficacy.

8.3.2 Model Development

At the most basic level the hydraulic model consists of nodes and links. Nodes represent the various elements of the system including water sources, pumps, storage tanks and pipe intersections. Links predominantly represent pipes and define the relationship between each node. The creation of the model utilized information from a variety of sources. The City's existing distribution system maps were used as a base in the early building stage and this information was supplemented with information from record drawings, previous engineering studies, field reconnaissance, and discussions with City staff.

Model pipe elements were constructed based on the diameter, length and material type of each pipe. Hazen-Williams roughness factors were assigned to the pipes based on typical values for pipe materials. Model nodes were placed at pipeline intersections, near fire hydrant locations, and in various locations to simulate clustered water service connections. The model nodes were populated with Oregon State LiDAR elevation data to ensure that elevation differences across the planning area were properly accounted for.

Existing pump stations were simulated based on existing pump model data, elevations, and pump curves.

Due to the size of the City's water system the model was not "skeletonized." Skeletonization is a process which simplifies the system by eliminating or combining short pipe segments, consolidating pipe junctions and eliminating small diameter pipes with insignificant connectivity. This process was not used as the systems simplicity allowed for all pipes to be modeled without the model becoming cumbersome and overly specific.

Once the distribution network was created, the water demands established in Chapter 5 were allocated to specific nodes across the system. Existing distribution networks were modeled with projected demands at the beginning of the planning period. Existing and theoretical future distribution networks were modeled with projected demands in 2045, at the end of the planning period.

8.3.3 Model Scenarios

The model was used to investigate a number of hydraulic scenarios in the distribution system. These scenarios were evaluated using a combination of simulations. The simulations produced a snap-shot of hydraulic conditions at a fixed period in time. The distribution system was evaluated at the beginning and end of the planning period (years 2025 and 2045).

The City has two relatively-large distribution system booster pumps, one at the Monmouth Street Pump Station and one at the Polk Pump Station. These pumps operate to provide fire flows for the distribution system. The firm capacity of the distribution system is typically associated with the largest single pump out of service. This approach is used to ensure system redundancy. Normally, the City would have two large pumps that provide the majority of the fire suppression flow for the system. However, if one of these pumps were out of service, the fire flow for the system must be met with the remaining pump. For this reason, the fire suppression capacity of the distribution system is defined as the flow available with one large pump running at the Monmouth Street Pump Station and the large pump at the Polk Street Pump Station off. The system was also modelled with the large pump at the Monmouth Street Pump Station off and the large pump at the Polk Street Pump Station on. Both of the sub-scenarios are considered to be reasonable estimates of the firm capacity of the system with respect to fire suppression flows. For both sub-scenarios, all of the smaller pumps at both stations were considered to be available. The available fire flow for these two sub-scenarios were modelled along with maximum day demands at 2025 and 2045.

In particular, the hydraulic scenarios investigated include the following under existing conditions at the beginning of the planning period.

- Existing distribution pipe network
- Existing maximum day demands
- Available fire flow rate to each model node in addition to the existing maximum day demand.

The model was also used to simulate various improvements to the distribution system to identify the most cost-effective solutions to address the system deficiencies. Simulations with several combinations of the proposed improvements were analyzed. Recommended improvements at the beginning of the planning period were developed based on modeled available fire flows in 2025.

The results from the computer simulations were used to develop a list of near-term and long-term improvements required to address system deficiencies and to serve the City through the planning period. Since pipelines are not well suited for incremental expansion, it is most cost effective to size the pipes for fully built-out conditions. Steady state simulations of the future system at buildout were performed to determine the required pipe sizes. The following simulations were performed.

- Maximum day demands at build-out.
- Fire flows to each model node in combination with the maximum day demand at build-out.

8.4 DISTRIBUTION SYSTEM ANALYSIS

The evaluation of the existing distribution system was performed to identify system deficiencies and possible remedies for the existing distribution grid, as well as improvements to serve future growth-related needs. This section presents improvements for the distribution system broken into several separate projects comprised of distribution and fire flow improvements.

This section evaluates the adequacy of the distribution system to deliver domestic water to all service areas, as well as an evaluation of the adequacy of system looping. Looped distribution systems are desirable when combined with sufficient valves, as it allows flows to be routed around the failure of any single distribution pipe. This provides service redundancy and facilitates repair work while keeping outage areas as small as possible. A looped configuration also provides multiple water paths to any specific point in the system, which reduces velocities along any given flow path and increases the system's ability to provide high volume fire flows (assuming the looped lines are adequately sized). Also covered in this section is an evaluation of end of useful life. As existing pipes and valves near the end of their useful life, they should be replaced before failure occurs. For this study it was assumed that new waterlines (PVC or ductile iron) will have a 75-year service life.

Independence's distribution system was found to provide a sufficient level of service for domestic flows. There are, however, a number of pipelines that should be upsized to accommodate fire flow requirements (Table 5-8). As noted above, OHA rules require public water suppliers maintain a minimum pressure of 20 psi at all service connections at all times, including during fire flow events. The current distribution system is incapable of providing designed fire flows while maintaining 20 psi at all service connections. The City's distribution grid in general provides an adequate level of redundancy with looping.

A noticeable issue with the City's distribution system is a lack of large-diameter arteries, also known as backbones, that transmit relatively large flows east-west and north-south across the City. The City has some 12-inch and 10-inch lines that serve this purpose, but they are not interconnected. A goal of the recommended projects is to gradually construct backbones of at least 12-inches in diameter around the City. These waterlines are envisioned to be built along Gun Club Road, Hoffman Road, Polk Street, Main Street, Corvallis Road, and Mt. Fir Road. Several of the existing waterlines in these locations also are expected to need replacement due to reaching end of service life during the planning period.

8.4.1 Recommended Distribution System Improvements

The recommended distribution system improvements are described in this section. Maps graphically showing these improvements are included at the end of this chapter (Figure 8-1 through Figure 8-3). The reader is encouraged to review these figures along with the following descriptions to aid in the understanding of the recommendations. The improvements described below are generally recommended for one of five reasons, as categorized below:

1. Increase fire flows (Project Code A)
2. Replace facilities that are expected to reach the end of their service life during the planning period (Project Code B)
3. Comply with the City's design standards (Project Code C)
4. Serve new site developments (Project Code D)
5. Add or upgrade booster pump stations (Project Code P)

Detailed estimates of budget for these projects are included in **Appendix G**. A ranked prioritization of these projects into a comprehensive implementation plan is presented in Chapter 12.

A. FIRE FLOW IMPROVEMENT PROJECTS

The following section describes improvement projects that are recommended to increase fire flows in the City's distribution system. These include waterline replacement projects listed in Table 8-1 and identified graphically in Figure 8-1 through Figure 8-3. It should be noted that most of these projects are replacements for 6-inch-diameter waterlines in low-density residential areas that terminate at fire hydrant and are not looped. Based on the model analyses, these waterlines have existing fire flow capacity that is substantial. These waterlines are identified for replacement to ensure these waterlines can meet the City's design standards for fire flow capacity. For this reason, most of these waterlines are not given high priority. An exception is **Project A-7**, which increases fire flow available to the Independence Elementary School. This project is given high priority in this document.

Table 8-1| Summary of Fire Flow Improvement Projects

Project Code	Description	Diameter Replaced	Material Replaced	Diameter (in)	Length (feet)	Recommended Budget
A-1	Wild Rose Ct Waterline Replacement	6	PVC	8	275	$181,000
A-2	12th Street & Dawn Ct Waterline Replacement	6	PVC	8	900	$430,000
A-3	B Street & Rhoda Ln Waterline Replacement	4 & 6	AC & Steel	8	1,600	$636,000
A-4	17th Street Waterline Replacement	6	PVC	8	1,600	$442,000
A-5	16th Street & Talmadge Road Waterline Replacement	6	AC & PVC	8	1,325	$535,000
A-6	9th Street Waterline Replacement	6	AC	8	750	$333,000
A-7	B & 4th Street Waterline Replacement	4	PVC	8	350	$154,000
A-8	Maple Ct Waterline Replacement	6	AC	8	675	$284,000
A-9	Pine Ct Waterline Replacement	6	AC	8	475	$206,000
A-10	Evergreen Dr Waterline Replacement	6	AC	8	625	$273,000

B. END OF SERVICE LIFE REPLACEMENT PROJECTS

Under typical conditions, municipal waterline materials, such as PVC, Ductile-iron and AC, have a service life of at least 75 years. Several of the City's waterlines will be 75 or more years old by the end of the planning period. These waterlines were installed in 1970 or earlier. Based on available information, some of these waterlines were installed as early as the 1950's. Additionally, waterlines that are cast-iron or steel are less resistant to corrosion and generally have a shorter service life. Projects to replace relatively old pipes made of asbestos concrete are also identified under this category of projects. Asbestos concrete pipe is more brittle that other pipe materials and often has a shorter service life. Table 8-2 identifies waterlines in the City's distribution system that should be considered for replacement during the planning period due to reaching the end of their typical service life.

It should be noted that while these projects are primarily intended for replacing aging infrastructure, they also serve to increase fire flows and to establish "backbone" or "arterial" waterlines that transmit water city-wide. Examples of these projects include **Projects B-1, B-5, B-6, B-9, B-12, and B-15,** which upgrade existing waterlines to 12-inch diameter. The reader is referred to Figure 8-1 through Figure 8-3 for a map of these projects. It should also be noted that some of these projects are recommended to be completed prior to decommissioning the Monmouth Street Pump Station (discussed further in under **Project P-5**); these projects include waterline **Projects B-5, B-6, B-9, and B-12.**

Table 8-2| Summary of End of Service Life Replacement Projects

Project Code	Description	Diameter Replaced	Material Replaced	Diameter (in)	Length (feet)	Recommended Budget
B-1	Gun Club Road Waterline Replacement	6 & 8	AC	12	2,900	$1,353,000
B-2	D Street at 12th St. Waterline Replacement	4	AC	8	550	$253,000
B-3	7th, D & 9th Streets Waterline Replacement	6 & 8	AC, Steel & Cast-iron	8	1,750	$694,000
B-4	D Street at 2nd St. Waterline Replacement	8	Steel	8	425	$189,000
B-5	E Street from 9th to 13th Waterline Replacement	6	AC	12	2,000	$1,010,000
B-6	F Street from 9th to 3rd Waterline Replacement	6	Cast-iron	12	2,000	$931,000
B-7	5th St from E to F Streets Waterline Replacement	6	AC	8	325	$160,000
B-8	3rd St from F to I Streets Waterline Replacement	8	AC	8	1,000	$410,000
B-9	3rd Street & E Street Waterline Replacement	6 & 8	AC	12	1,075	$479,000
B-10	I & H Streets Waterline Replacement	4 & 8	AC & Steel	8	1,550	$680,000
B-11	River Oak Rd Waterline Replacement	6 & 8	AC	8	1,000	$501,000
B-12	Corvallis Road Waterline Replacement	4	Steel	12	1,100	$428,000
B-13	Polk & Walnut Streets Waterline Replacement	6	AC & Steel	8	2,375	$890,000
B-14	Log Cabin Waterline Replacement	4 & 6	AC, PVC & Cast-iron	8	1,300	$664,000
B-15	Main Street Waterline Replacement	4	DI & Cast-iron	12	2,000	$1,050,000
B-16	River Drive Waterline Replacement #1	4	AC	8	1,125	$405,000
B-17	Walnut, Ash & Log Cabin Streets Waterline Replacement	4, 6 & 8	CI, Steel & AC	8	3,950	$1,407,000
B-18	Monmouth St Waterline Replacement	4	Cast-iron	8	1,525	$808,000
B-19	Copper Water Service Replacements		(Not all columns used)			$6,000,000
B-20	Water Meter Replacements		(Not all columns used)			$2,160,000

- **River Oak Road Waterline Replacement (B-11)**

This project includes work needed to utilize an existing 10-inch C-900 PVC waterline along River Oak Road. The existing water services along the 6-inch AC line will be reconnected to the 10-inch line. The existing 6-inch AC line will be disconnected and abandoned.

- **Corvallis Road Waterline Replacement and Water Treatment Plant Transmission Main (B-12 & D-6)**

A new 12-inch waterline is recommended to be constructed to connect the new water treatment plant to the City's distribution grid. This project is an opportunity to replace the existing 4-inch steel waterline along Corvallis Road. Existing water services supplied by the 4-inch waterline that are south of River Oak Road are recommended to be reconnected to the 12-inch waterline. Water services north of River Oak Road that are served by the 4-inch waterline are recommended to be reconnected to the existing 10-inch waterline along Corvallis Road as a part of this project. The existing 4" waterline will be disconnected and abandoned.

- **Copper Water Service Replacements (B-19)**

The City has been working to reduce copper concentrations and pipe corrosion in the distribution system. Replacing water services that utilize copper pipe is one strategy being employed. The City has standardized on HDPE for new service lines. It is recommended that the City replace all of the remaining copper water services with HDPE during the planning period. This project is given a high priority in this document. This project includes replacing an estimated 2,000 remaining copper water services during the first ten years of the planning period. The City has typically been replacing the service saddle, corp. stop, and copper service line to the meter. The City works with a contractor to horizontally drill and install the service lines. Typically, the services are replaced intermittently as time allows and are installed in pairs. The estimated cost to replace each service is roughly $2,500. The total recommended budget for this project is $6,000,000 including soft costs for contingency and administration.

- **Water Meter Replacements (B-20)**

The City has been aggressively maintaining water meters by replacing meter bodies and registers. As discussed in Section 4.7.3, the City replaced all of the meter registers between 2019 and 2021. Based on the typical service life of 15 to 20 years, it is expected that the City will need to replace all of the meter registers once during the planning period. The City has consistently been replacing the meter bodies with radio-read meters since 2007. Meter bodies typically last 20 years. Therefore, the City should continue the existing practice of replacing meter bodies. This project includes replacing an estimated 3,000 meters during the planning period. The estimated cost to replace each meter is roughly $600. The total recommended budget for this project is $2,160,000 including soft costs for contingency and administration.

C. DESIGN STANDARDS IMPROVEMENT PROJECTS

The City's Public Works Design Standards require a minimum of 8-inch diameter C-900 PVC pipe to be installed in the distribution system. The following list identifies waterlines that are 4- and 6-inch diameter that deliver water to or between fire hydrants. The primary reason for this category of project is that these existing waterlines are undersized by the City's current standards. The recommended waterline projects that fall into this category are listed in Table 8-3. These projects are not considered absolutely necessary to provide fire flows. Some of these waterlines are relatively new and are high-quality materials. For example, some of these pipeline segments are AWWA C-900 PVC installed in the 1990's and early 2000's and are relatively new and in good condition Therefore, this list of waterline replacements can be considered to be low priority projects when compared to the other waterline projects identified in this document. Given the relatively large number of identified waterlines, it is not expected that these will all be replaced during the planning period. It may be most cost-effective to replace these waterlines, or portions thereof, in conjunction with other utility projects. The reader is referred to Figure 8-1 through Figure 8-3 for a map of these projects.

Table 8-3| Summary of Design Standards Improvement Projects

Project Code	Description	Diameter Replaced	Material Replaced	Diameter (in)	Length (feet)	Recommended Budget
C-1	Hyacinth St. Waterline Replacement	6	PVC	8	625	$326,000
C-2	Williams St. Waterline Replacement	6	AC	8	1,375	$560,000
C-3	13th St. Waterline Replacement	6	PVC	8	950	$420,000
C-4	11th & 12th St. Waterline Replacements	6	PVC	8	1,325	$556,000
C-5	Randall Way Waterline Replacements	6	AC & PVC	8	1,400	$563,000
C-6	6th & 7th St. Waterline Replacements	6	PVC	8	1,475	$654,000
C-7	Freedom Estates Subdivision Waterline Replacements	6	PVC	8	4,100	$1,635,000
C-8	I St Waterline Replacement	6	AC	8	775	$281,000
C-9	5th & 6th St. Waterline Replacements	6	PVC	8	1,475	$549,000

Table 8-3| Summary of Design Standards Improvement Projects

Project Code	Description	Diameter Replaced	Material Replaced	Diameter (in)	Length (feet)	Recommended Budget
C-10	6th & 7th St. Waterline Replacements	6	PVC	8	1,875	$746,000
C-11	A & B St. Waterline Replacements	6	PVC	8	2,225	$867,000
C-12	2nd & B St. Waterline Replacements	6	PVC	8	1,025	$402,000
C-13	River Drive Waterline Replacement #2	6	PVC	8	600	$242,000
C-14	Independence Airpark Waterline Replacements	6	AC & PVC	8	14,300	$5,170,000

D. UNDEVELOPED AREA DISTRIBUTION SYSTEM PROJECTS

Several waterlines are needed to deliver adequate water service to new developments. The following list identifies these waterlines. These projects would likely be constructed by developers. Not all of the waterlines necessary to serve these undeveloped areas are shown. Only the major supply lines, connections and loops are identified. The reader is referred to Figure 8-1 through Figure 8-3 for a map of these projects.

Table 8-4| Summary of Undeveloped Area Distribution System Projects

Project Code	Description	Diameter (in)	Length (feet)	Recommended Budget
D-1	Airport Residential & Industrial Zone Waterlines	8 & 12	11,900	$4,588,000
D-2	Southwest Area Residential Waterlines - North	8 & 12	11,300	$8,976,000
D-3	Southwest Area Residential Waterlines - South	8 & 12	10,600	$8,112,000
D-4	Mt. Fir Rd Waterline Replacement from Washington to 6th St	12	750	$362,000
D-5	Mt. Fir Rd Waterline	12	2,550	$747,000
D-6	Corvallis Road Waterline	12	1,075	$354,000
D-7	Mt. Fir & Corvallis Road Residential Waterlines	8	3,700	$2,423,000

BOOSTER PUMP STATION PROJECTS

Various improvements for the City's existing and future booster pump stations are described below. These projects address issues identified in Section 4.6 and to supply water from the new recommended water treatment plant.

- **Polk Booster Pump Station Electrical Improvements (P-1)**

Improvements to the Polk Booster Pump Station are recommended to address some electrical issues. These improvements will address aging and inadequate control systems and auxiliary power needs.

The existing pumps have issues operating during relatively low and high-demand periods. The power distribution and pump controls at this station will be 33 years old at the beginning of the planning period. This equipment will likely reach the end of its typical service life and will need to be replaced during the planning period. This is an opportunity also to upgrade the equipment to resolve pump control issues at the station. The pump station's two electric pumps lack variable frequency drives (VFDs) and only run at full speed. This and the existing pump issues result in excess wear and tear on the pumps as they frequently cycle on and off. Public Works has identified this as a high priority issue with the station. Public Works has considered resolving the issue by adjusting the control system settings.

However, there does not appear to be setpoints in the pump control logic that will resolve the issue. Installation of variable frequency drives (VFDs) for these pumps would address this issue by allowing the pump speed to be adjusted to meet demands. Most modern pump stations are now installed with VFD's. Based on the electrical code, there is not adequate space to meet panel clearance requirements if VFD's are installed inside the building. Therefore, this equipment must be installed in a building addition or on an exterior wall in weatherproof enclosures. It is recommended that VFD's be installed for the 25 and 50-horsepower pumps at the station. Operators have expressed interest in eventually upgrading the diesel-powered pump to an electric-powered pump when the existing pump reaches the end of its service life. It is recommended that a VFD be installed when this pump is replaced. The proposed improvements should, therefore, include provisions for the future addition of an electric pump with VFD. Replacing the diesel-powered pump with an electric pump will require the power service to be upgraded. Therefore, this project also includes a new power service that should be sized for build-out of the station. The existing flow meter in the station is a propeller-driven unit that is relatively old. This instrument is recommended to be upgraded with a magnetic flow meter as a part of the project.

Another issue with the booster pump station and water treatment facility is the lack of an auxiliary power source. It is recommended that a generator and automatic transfer switch be installed to supply power to the entire treatment, storage and pump station facility. The utility power service to the combined facility is located at the booster pump station. Therefore, the logical place for the generator equipment is adjacent to the booster pump station in a weather-rated enclosure.

Due to the amount of electrical equipment that is recommended to be added as a part of this project, a building addition is needed to protect the equipment. The addition would be a dedicated electrical room on the south side of the building. The pump station would need to remain in service while the improvements are being constructed.

This project is given high priority due to the installation of a generator. The total recommended budget for this project is $852,000. The detailed estimate of this budget is included in **Appendix G**.

- **Polk Water & Wastewater Facility Fencing Improvements (P-2)**

The City's Polk Booster Pump Station, Water Treatment Plant and the wastewater treatment plant are secured with the same fencing and gate. A large portion of the north side of these facilities is fenced with 5-foot-high barbed-wire field fence that is dilapidated in some areas. This fence is not adequate for preventing intrusion and vandalism to the facilities. The length of fence that is needed is roughly 1,900 feet and comprised of two sections. One section extends from the northwest corner of the lagoons to the booster pump station. The second section extends from the Polk Water Treatment Plant to the Williams Street Pump Station. The City is currently planning to install fencing on the entire west side of the lagoons. **Project P-2** would continue this new fence and complete it all the way to the main access gate at the Williams Street Pump Station. A chain-link fence 6-feet high with barbed wire top is recommended. The project should also include demolition of the existing fence and any necessary clearing and grading.

The total recommended budget for this project is $367,000. The detailed estimate of this budget is included in **Appendix G**.

- **South Booster Pump Station Electrical Improvements (P-3)**

Improvements to the South Booster Pump Station are recommended to address electrical and instrumentation upgrades relatively early in the planning period. Three to four times per year, poor utility power quality causes the station to be shut down and it must be manually operated. The first recommendation is to work with the power utility to determine if the quality of the line power can be improved. Based on available information, it is not certain if this is a possible solution. If this cannot resolve the issue, then it is recommended to utilize the existing generator during poor quality power events. It is expected that this will require replacing the existing automatic transfer switch with one that is able to monitor the quality of the power being delivered to the facility. This will allow the facility to switch power sources until adequate power is restored.

The existing master flow meter in the station is a propeller-driven unit that is relatively old. This should be upgraded with a magnetic flow meter as a part of the project.

The total recommended budget for this project is $84,000. The detailed estimate of this budget is included in **Appendix G**.

- **Willamette Water Treatment Plant Booster Pump Station (P-4)**

The recommended surface water treatment plant described under **Project T-1** includes a booster pump station to convey finished water from the storage reservoir to the distribution grid. As discussed under the description for **Project P-5**, this pump station is partially intended to allow for the Monmouth Street Pump Station to be decommissioned. Therefore, this pump station is recommended to have a redundant fire pump. It is expected that this pump station will initially be constructed with three pumps: one jockey pump for average demands and two relatively large fire pumps. All of the pumps should be run with VFDs, which will allow them to supply varying demands. This pump station will be connected to the City's SCADA system and integrated with the operation of the other booster pump stations. Two 12-inch diameter "backbone" waterlines are recommended to connect this pump station to the distribution grid. These are identified and shown graphically in Figure 8-3 as **Projects B-12, D-5 and D-6**. The budget for this project is included in the estimate for the surface water treatment plant, **Project T-1**.

- **Decommission Monmouth Street Pump Station & Reservoir (P-5)**

The Monmouth Street Pump Station and Reservoir are the City's oldest water system facilities. As previously discussed, these facilities have several issues. The existing issues with the reservoir are discussed in greater detail in Section 9.4.4. The reader is referred to this section for more information on retrofits that would be needed to keep the reservoir in service. The existing pump station is also relatively old and would need upgrades during the planning period. For example, all of the underground piping between the pump station, reservoir and distribution system is steel and has corrosion issues. All of this has been identified by Public Works as high priority for replacement. Additionally, the pump station's control systems are expected to need replacement during the planning period. The new surface water treatment plant will have a booster pump station. The distribution system was evaluated under scenarios where the Monmouth Pump Station was decommissioned with the new booster pump station in operation. Based on the results from the hydraulic model, the Monmouth Street Pump Station serves primarily to deliver fire flows to the western and central parts of the City. The model was used to determine what projects would be necessary to decommission the pump station. Both the new water treatment plant pump station **Project P-5** and waterline **Projects B-5, B-6, B-9 and B-12** are recommended to be completed prior to decommissioning the Monmouth Street Pump Station. These projects are expected to allow the Polk, South, and Willamette Pump Stations to maintain and potentially even increase fire flows that are currently provided using the Monmouth Street Pump Station (during firm capacity scenarios). Based on this analysis, it is recommended that this pump station and reservoir be decommissioned once the new water treatment plant is online and the replacement waterlines are complete. Aspects of this project related to storage are discussed in Section 9.5.

Decommissioning the pump station and reservoir will require removal of equipment, demolition and removal of the building, reservoir and foundation. The reservoir is coated with lead-based paint. A contractor will need to be hired that is licensed to perform removal and containment of lead-based paint. The total recommended budget for this project is $200,000. Demolition of the facility is given relatively low priority compared to other recommendations in this plan.

Table 8-5| Summary of Booster Pump Station Projects

Project Code	Description	Recommended Budget
P-1	Polk Booster Pump Station Electrical Improvements	$852,000
P-2	Polk Water & Wastewater Facility Fencing Improvements	$367,000
P-3	South Booster Pump Station Electrical Improvements	$84,000
P-4	Willamette Water Treatment Plant Booster Pump Station	(See Project T-1)
P-5	Decommission Monmouth Street Pump Station & Reservoir	$200,000

8.4.2 Recommended Miscellaneous Projects

This plan recommends miscellaneous projects that are considered to be necessary for the capital improvement plan. These projects are not limited to the distribution system.

- **Taste & Odor Study (M-1)**

Taste and odor (T&O) of finished water is known to be an issue in the City. Public Works regularly receives complaints from users of T&O issues. T&O issues in public drinking water systems can be relatively difficult problems to pinpoint, because of their highly subjective nature, the sensitivity of users, and variety of possible factors. T&O issues can develop from any part of the water system, including water sources, treatment processes, reservoirs, and distribution pipes.

This plan recommends a T&O study be performed to assess the problem in the City, evaluate causes, and develop alternatives for addressing the issue. Corrosion control improvements are in progress for the Polk Water Treatment Plant and we anticipate this to be a mitigating factor for T&O since pipe corrosion is sometimes a factor in T&O issues. This plan recommends that the corrosion control improvements be functioning for at least one year prior to conducting a T&O study. Taste and odor issues are sometimes caused by water constituents in excess of the EPA's secondary maximum contaminant levels (Table 3-1). This study would monitor these constituents in the distribution system in order to characterize the issues. Additionally, it is recommended that the City conduct a survey of users to collect observations. This survey can be used to diagnose the issues people are experiencing. The overall budget for these activities is $50,000.

- **Water Master Plan Update (M-2)**

The planning assumptions used as the basis for this study are subject to change over the years. As such, the City should update this document at approximately 10-year intervals. To facilitate this, a project is included in the recommended capital improvement plan. The budget for this work is $300,000.

8.4.3 Water Loss Reduction Recurring Programs

Although a water loss ratio of zero is desirable in theory, it is probably not feasible given the complexity and practical realities associated with municipal distribution systems. A typical and reasonable water loss goal for small municipalities is a loss rate of 10% to 15%.

A detailed evaluation of distribution system water losses is contained in Section 5.4.7. The data shows that approximately between 18% and 23% of the water produced is currently unaccounted for. The average water loss experienced by the City's distribution system is 21% (74.5 million gallons per year). Some of this water is being lost through leakage in the distribution system and some of the loss is likely attributed to authorized uses that are not being properly measured. The City should consider the reduction of unaccounted-for water as a major priority, as it will result in significant benefits to all four areas of the water system (i.e., supply, treatment, distribution and storage). The following recurring programs and budgets are recommended to address water loss. Over the years, the City may need to increase or may be able to decrease the recommended funding amounts for these programs depending on performance.

This plan recommends two strategies to reduce the amount of unaccounted-for water. The first is to continue the existing program to measure and record non-metered water uses. These uses include fire flow testing, fire department training, fire truck filling, filter backwash, construction water, street cleaning and mainline flushing. The second recommendation is an aggressive leakage testing and repair program. Specific recommendations are discussed in the following paragraphs.

- **Non-metered Water Use Tracking System (Program-1)**

As described in Section 5.4.7, the City is already diligently tracking non-metered water uses. This program is identified to recommend a recurring budget for this work and to highlight its importance. The City regularly tracks water uses for construction, street sweeping, filter backwashing, hydrant flushing, and fire department training. Public Works is not aware of other uses that could be tracked either manually or using flow meters. The City recently installed an 8-inch magnetic meter for tracking fire hydrant uses by the fire department for training. During the planning period, it is recommended that the filter backwash flow meters at the Polk Water Treatment Plant be upgraded with magnetic meters. An annual budget of $2,000 is recommended for this program. To some extent, this value is a “placeholder” since this work is already incorporated in the normal day to day operations of the Public Works Department.

- **Leak Detection Study & Repair Program (Program-2)**

The City has not had a formal leak detection performed since 2008. It is recommended that the City inspect the entire distribution system for leaks at least every 5 years. Most relatively small cities retain an outside vendor to provide a leak detection survey. Several companies offer these services in Oregon. In most cases, they are able to pinpoint the location of a leak relatively accurately. Leak detection of the entire system is estimated to be performed at a rate of 20,000 feet per day at a cost of $2,500 per day. It would require approximately 10 days to complete the entire distribution system for a total estimated cost of $25,000. We recommend that the City establish a goal for an annual budgetary line item of $5,000 to perform leakage testing of the entire system once every five years.

The costs for repairs are difficult to estimate in a planning document, but a reasonable amount to initially start with would be about $50,000 per year. Therefore, the total recommended annual budget for this program is $55,000. Leak detection and repair should be considered a normal part of water system operation and maintenance. As the distribution system continues to age, new leaks will likely develop, so, this program should be continued indefinitely.

- **Water Management & Conservation Plan Update (Program-3)**

Section 3.12 discusses the OWRD’s requirement for the City to maintain an updated Water Management & Conservation Plan. A current WMCP for the City of Independence is being produced in conjunction with this Master Plan. Once completed, State statutes require WMCP’s be updated at 5-year intervals. To assist the City’s planning efforts for this expense, a recurring program is listed in the recommended capital improvement plan. The recommended annual budget for this program is $6,000 per year. It is envisioned that the City will save these funds on an annual basis (similar to a reserve) in order to prepare the required WMCP updates at 5-year intervals.

Table 8-6| Summary of Miscellaneous Projects & Recurring Programs

Miscellaneous Projects		
M-1	Taste & Odor Study	$50,000
M-2	Water Master Plan Update	$300,000
Recurring Annual Programs		
Program-1	Non-metered Water Use Tracking System	$2,000 / year
Program-2	Leak Detection and Repair Program	$55,000 / year
Program-3	Water Management & Conservation Plan Update	$6,000/ year

8.5 SUMMARY OF RECOMMENDED DISTRIBUTION IMPROVEMENTS

Several improvement projects have been identified based on the distribution system analyses presented in this chapter. Distribution projects have been recommended to improve a combination of fire flow, service life, design standards, and development status. The recommended improvements are summarized in Table 8-1 through Table 8-6 and graphically depicted in Figure 8-1 through Figure 8-3. Additional information supporting these recommendations is included in the City's water utility maps, included in **Appendix A**.

Figure 8-1| Map of Recommended Distribution System Improvements - North

Figure 8-2| Map of Recommended Distribution System Improvements - Central

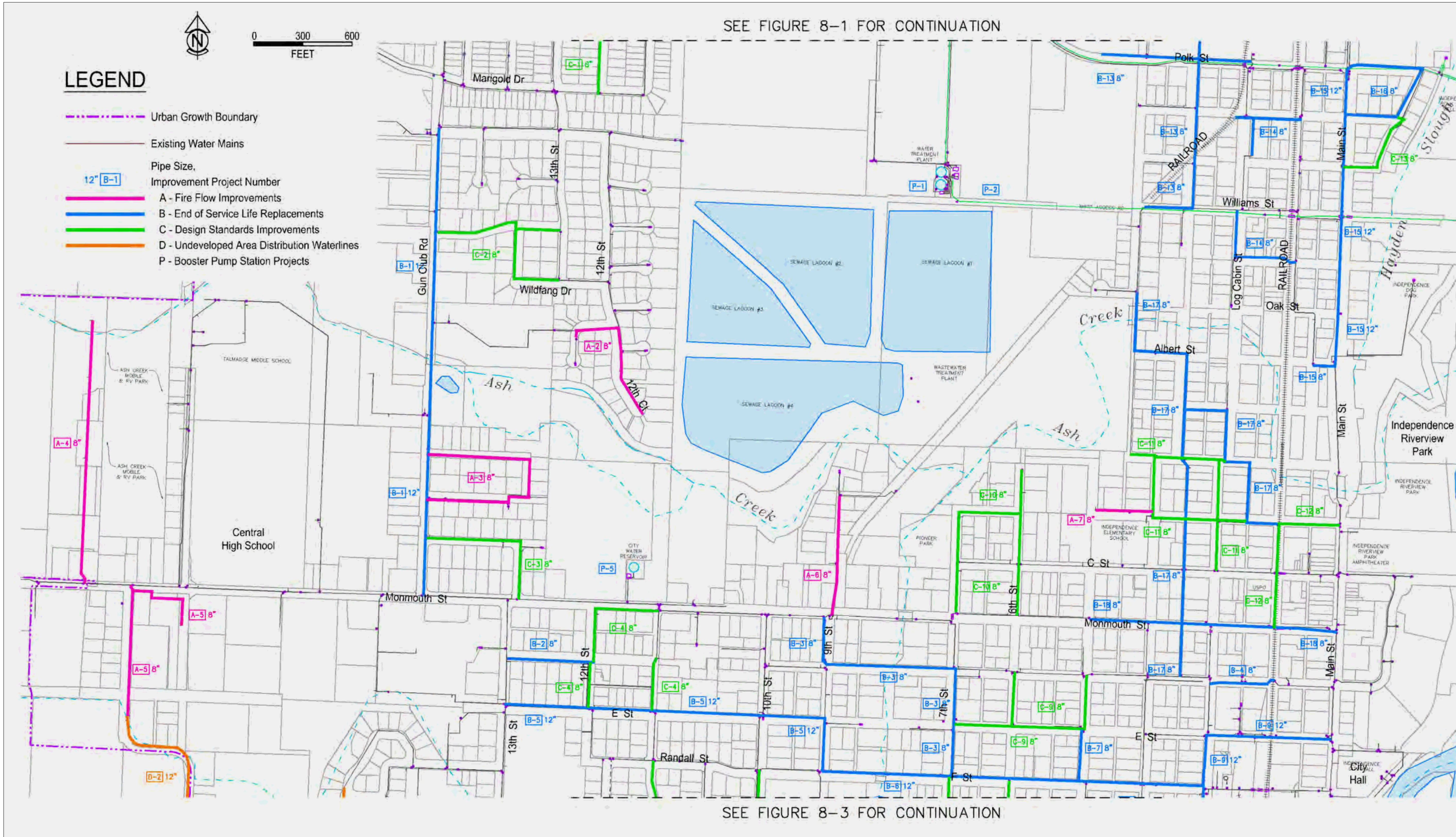
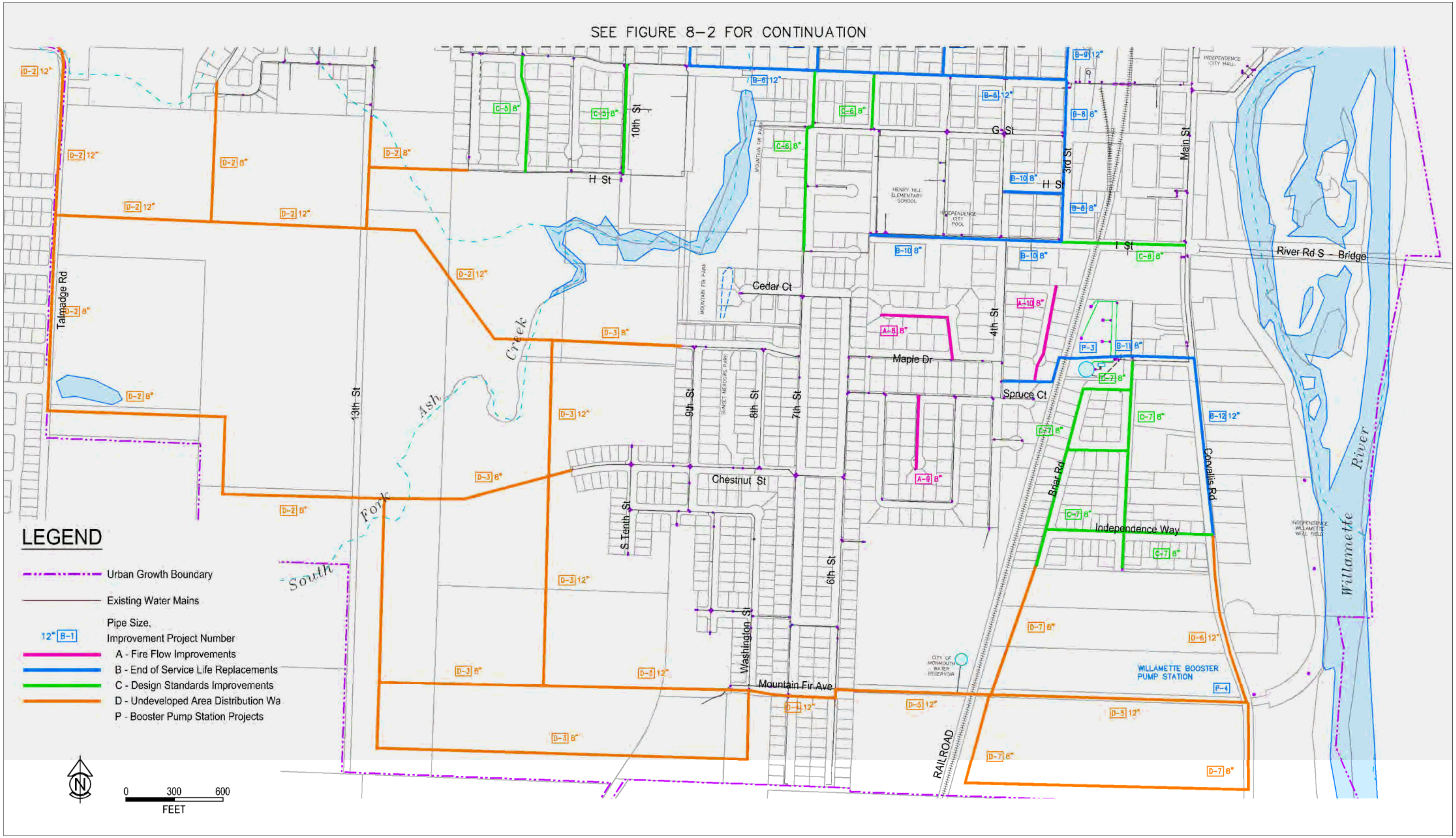


Figure 8-3| Map of Recommended Distribution System Improvements - South



CHAPTER 9

WATER STORAGE EVALUATION

Chapter Outline

9.1 Introduction
9.2 Reservoir Evaluation & Design Criteria
9.3 Water Storage Analysis
9.4 Evaluation of Existing Storage Tanks
9.5 Recommended Improvements
9.6 Summary of Recommended Storage Tank Improvements

9.1 INTRODUCTION

This chapter presents an analysis and recommendations for the City's water storage facilities. Although closely integrated with the overall water distribution system as discussed in Chapter 8, this report presents water storage as a separate discussion to focus on several key issues unique to this subset of the distribution system.

The City's existing storage reservoirs are described in greater detail in Chapter 4. The City has four water storage reservoirs. Throughout this chapter, the terms "reservoir" and "tank" are used interchangeably.

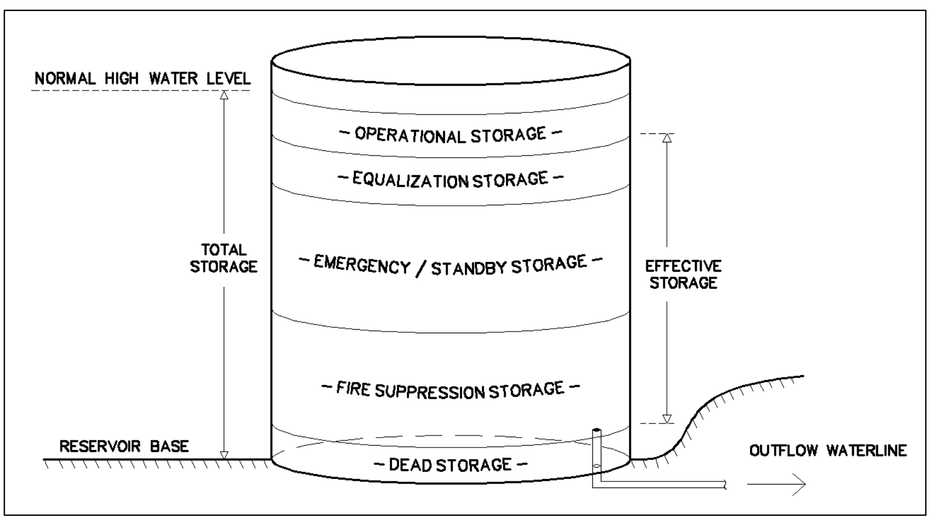
9.2 RESERVOIR EVALUATION & DESIGN CRITERIA

Per OHA rules, engineers are responsible for planning and designing stable and durable reservoirs that meet demands and protect the quality of stored water. Some of the evaluation criteria utilized in the analysis and recommendations of this chapter are discussed below.

9.2.1 Storage Volume Categories

The primary function of water storage is to provide a reserve of water to equalize daily variations between supply and consumer demand, to serve fire-fighting needs, and to meet system demands during an emergency interruption of supply. The overall storage within a system can be divided into several categories as depicted in Figure 9-1. The following sub-sections define these storage allocation categories. An evaluation of how these categories apply to the City's water system is discussed in Section 9.3.

Figure 9-1| Reservoir Storage Volume Categories



Operational Storage

Storage volume within the upper elevation of a storage tank is used by the system operators to control the start and stop of the pumps or sources which fill the reservoir. The operational storage volume is not counted as part of the "effective storage" volume (discussed below), since emergency conditions are as likely to begin when the water level is at the bottom of the operational storage range as when it is at the top of the range. The overall elevation difference (storage volume) required by the pump control system is determined by the type of instrumentation, the number of pumps or sources that fill the reservoir, and operator preferences.

Equalization Storage

Equalization storage is storage that is utilized to meet short term consumer demands that exceed the production capacity of the supply sources. As previously discussed, water demands vary throughout the day based on the water use patterns of the community in addition to variations in use for multiday durations. Demand fluctuations are influenced by the relative mix of residential, commercial and industrial use, as well as by the weather. Commercial and light industrial use tend to be relatively constant through the normal daytime hours (with light to no use at night), while residential use fluctuates between relatively high flows in the morning, low flows during the day, higher flows in the evening, and minimal flows at night. The equalization storage volume required is typically determined as either a percentage of the maximum day demand (MDD), generally 20 to 40%, or by determining the deficit between the peak hour demand (PHD) and the available supply for a determined duration—generally 2 to 4 hours.

Standby Storage (Emergency Storage)

Standby storage is storage required to meet demand during emergency situations such as power outages, supply pipeline failures or natural disasters (often termed as emergency storage). The amount of emergency storage provided can be highly variable depending upon *reliability and diversity of supply sources, an assessment of risk, and the desired degree of system reliability.*

Sources that are "continuously available to the system" means sources that comply with <u>all</u> of the following.

(1) Source is <u>either</u> gravity feed to the storage reservoir, <u>or</u> is equipped with adequate and functional pumping equipment, and the source is provided with adequate and functional treatment equipment (if required).

(2) The pumping and/or treatment equipment is regularly used (or is exercised regularly to ensure its integrity, if not regularly used).

(3) Water is available from the source year-round. The capacity of the source is limited to the flow during the lowest flow period (dry-season limited).

(4) The source activates automatically based on pre-set parameters (i.e., reservoir level, water system pressure, or other conditions).

(5) Pumped source provided with on-site auxiliary backup power equipment (with an automatic transfer switch), or there is a separate dedicated mobile generator for each source which is equipped with a manual transfer switch.

Sources which do not comply with these requirements cannot be reasonably considered to be available during a major emergency, including a system wide power outage, particularly if sources are located in rural areas where restoration of power may take some time.

Fire Suppression Storage

Fire suppression storage is storage required to satisfy the largest design fire flow demand in the system. Fire storage volume is calculated by multiplying the design fire flow rate by its required duration. For this planning effort the design fire flow volumes are identified in Section 5.6. As described in that section, the largest fire flow requirement in Independence is for schools, institutions, and existing commercial or industrial facilities, which is 960,000 gallons.

Dead Storage

Dead storage is the volume of unusable water stored in a reservoir that either cannot be withdrawn or that lies below the minimum recommended operating level for a reservoir. Water that cannot be withdrawn from a reservoir is typically at a level that is below the outlet pipe. For example, in Independence, 6-inches of water in the bottom of Polk Reservoir 1 and the South Reservoir is below the outlet, which is intended for trapping sediment.

The minimum recommended operating level in a reservoir is determined based on maintaining adequate suction pressure to distribution and fire pumps while they are running. Running pumps with less than adequate suction pressure causes excessive wear due to cavitation and shortens the service life of pumps. The minimum suction pressure is called the net positive suction head required (NPSHr), which is defined by the manufacturer of each pump. The NPSHr must be less than or equal to the net positive suction head available (NPSHa). NPSHa is determined based the hydraulic and atmospheric conditions between the reservoir's water level and a pump's inlet.

For the purposes of this study, the minimum recommended water level in each reservoir is the minimum level that results in the NPSHa being greater than or equal to the NPSHr. Storage below the minimum water level for a given booster pump station is considered to be dead storage. Dead storage resulting from NPSHr exists in the City's Polk and Monmouth Reservoirs (estimated in Table 9-1).

Pumped Storage

Pumped storage is stored water that lies below the normal hydraulic head level of the distribution system (i.e., in ground storage tanks). This is water that must be pumped into the distribution system or into an elevated tank before it is available in the distribution system. If the pumps that move this stored water into the distribution system are not available during an emergency, the pumped storage water is also unavailable. All of the water storage in Independence's system is pumped storage.

Effective Storage

As noted above, the total volume in a reservoir often does not equal the effective volume available to the water system. The effective storage volume is defined as the reservoir volume below the bottom of the operational storage level, minus any dead storage. Effective storage is shown graphically in Figure 9-1 and estimated in Table 9-2.

9.2.2 System Pressure

In most municipal distribution systems, the service pressure is determined by the elevation of the free water surface in the storage reservoirs serving the system. This is not the case for the City's distribution system. Service pressure in Independence is maintained by pumps which discharge in to the distribution system (discussed further in Section 4.6). Static service pressures in Independence typically range from 50 to 65 psi. This plan recommends maintaining the existing operating pressure range in the City.

9.2.3 Water Quality

There are no specific regulatory requirements for water turnover rates in storage facilities, but industry sources suggest a complete water turnover be accomplished every 3 to 5 days. Experiences with reservoirs with cement-based internal surfaces suggest a slightly higher turnover rate of 5-7 days.

Historically water storage facilities are operated at near full levels to maintain system pressure and maximize storage volumes for emergencies; however, in times of non-emergency the large storage volumes reserved for firefighting can create water quality problems. Degraded water quality in storage facilities is frequently the result of under-utilization and poor mixing during filling cycles. As water ages, there is also a greater potential for disinfection by-product (DBP) formation.

Excessive water age can result in a diverse set of problems ranging from the loss of residual disinfectant, problems with bacterial proliferation or regrowth, increased formation of DBPs, taste and odor issues, as well as temperature and pH instabilities.

The City currently has approximately 3.48 million gallons of total storage. The average day demand is approximately 1.25 mgd at the beginning of the planning period. Therefore, the theoretical turnover rate is about once every 2.8 days, which is within the acceptable range.

9.2.4 Reliability of Pumped Sources & Pumped Storage

The City's water system relies on water being pumped from the wells and then additionally being pumping from the storage tanks to the distribution system. The City also can source finished water from the intertie. As discussed in Section 4.3.5, the intertie is intended for emergencies only. As such, the analysis below is based on the assumption that the intertie is not being utilized.

Clearly, the provision of emergency backup power and redundant pumping is critical for systems that rely heavily on pumped sources and pumped storage. The recommended improvements in this plan include the installation of auxiliary power systems to operate the wells, water treatment plants, and the booster pump stations. Therefore, the analysis presented below is based on the assumption that these facilities will be able to provide continuously available water by about 2030.

9.2.5 Redundancy

A lack of redundancy with regard to storage facilities is most frequently encountered when a reservoir must be taken off-line for cleaning, inspection or maintenance. While some of these procedures can be accomplished with a facility on-line, others (such as internal recoating) cannot. It is therefore recommended that the planning and construction of reservoir improvements provide the City operators with the flexibility to continue operation of storage facilities where feasible. This is typically accomplished with redundant storage. Storage redundancy is also critical in the wake of natural disasters. As discussed in previous chapters, seismic events present the largest natural disaster threat to these structures.

Redundant storage is expected to be a problem in Independence due to the lack of excess effective storage that would be needed to take a reservoir offline. Redundant storage is also potentially a problem specifically for the Monmouth Street Reservoir and for the South Reservoir, due to pumped storage limitations. The pump stations associated with these reservoirs require the reservoirs to be in service. In order to complete certain types of improvements for these reservoirs, redundant storage would be needed for the City to maintain adequate fire flows during construction. Therefore, taking the Monmouth Street or South Reservoir out of service without making any other improvements would increase the fire risk to the community. The recommended improvements address this problem. The Polk Booster Pump Station can draw water from either of the two Polk Reservoirs. This allows the Polk Pump Station to remain in service while improvements are made to an individual reservoir. Therefore, the two Polk Reservoirs offer good redundancy for the Polk Water Facility.

9.3 WATER STORAGE ANALYSIS

The total recommended storage volume in the system is the sum of the operational, equalization, emergency and fire suppression storage. Any storage tanks built during the planning period are assumed to be designed with zero dead storage. The discussion below summarizes the assumptions under each of the methods used to establish the total recommended storage volume.

9.3.1 Storage Volume Assumptions & Estimates

- Dead Storage Estimate

As previously discussed, there are two types of dead storage in the City's reservoirs. 6 inches of dead storage is known to exist at the bottom of Polk Reservoir 1 and the South Reservoir to trap sediment. Polk Reservoirs 1 and 2, as well as the Monmouth Street Reservoir, have dead storage resulting from net positive suction head required. Dead storage is estimated in Table 9-1. Based on this analysis, the minimum recommended water level for these reservoirs is 5 feet. Dead storage totals approximately 344,000 gallons.

Table 9-1| Reservoir Dead Storage Estimate

Reservoir	*Total Storage (g)*	*Total Storage Depth (ft)*	*Total Storage (gallons per ft)*	*NPSHr (ft)* (1)	*NPSHa (ft)* (2)	*Min. Recommended Water Level (g)* (3)	*Dead Storage (g)*
Polk 1	668,000	30.0	22,267	35	30	5.0	111,000
Polk 2	668,000	30.0	22,267	35	30	5.0	111,000
South	1,430,000	26.9	53,160	16	36	0.5	27,000
Monmouth Street	712,000	37.3	19,088	35	30	5.0	95,000
						TOTAL	344,000

(1) Net positive suction head required is the maximum NPSHr value for booster pumps sourcing water from the reservoir.
(2) Net positive suction head available is estimated based on standard atmospheric pressure and approximate pump inlet head conditions.
(3) Minimum recommended water level is a minimum of 0.5 ft for the reservoir silt stop or the deficit between NPSHa and NPSHr, whichever is greater.

- Operational Storage Estimate

For the purposes of this report, the operational storage was estimated as shown in Table 9-2. Operational storage is estimated based on the pump control setpoints defined in the City's SCADA system. This equates to approximately 697,000 gallons.

- Effective Storage Estimate

Effective storage is estimated as the total storage less the operational and dead storage. Effective storage equates to approximately 2,437,000 gallons as shown in Table 9-2.

Table 9-2| Reservoir Effective Storage Estimate

Reservoir	*Total Storage (g)*	*Total Storage (gallons per ft)*	*Operational Drawdown (ft)* (1)	*Operational Storage (g)*	*Dead Storage (g)*	*Effective Storage (g)*
Polk 1	668,000	22,267	10.0	222,667	111,000	334,000
Polk 2	668,000	22,267	10.0	222,667	111,000	334,000
South	1,430,000	53,160	3.9	207,323	27,000	1,196,000
Monmouth Street	712,000	19,088	2.3	43,903	95,000	573,000
TOTAL	3,478,000			696,560	344,000	2,437,000

- Equalization Storage Assumption

The equalization storage volume required is typically determined as either a percentage of the maximum day demand (typically 20 to 40%) for one day, or by determining the deficit between the peak hour demand and the available supply over a given time period. Hourly flow data is not available for the City. Therefore, it is difficult to determine the deficit between peak hour demands and supply. As such, the former method will be used to estimate the required equalization storage. A mid-range value for equalization storage in the amount of 30% of the maximum day demand for one day is assumed for this study.

- Standby Storage Assumptions

A common approach for determining the amount of standby storage required is to provide twice the average daily demand minus the production rate from sources that are considered to be "continuously available to the system." In an effort to be conservative during an emergency scenario, such as an earthquake, this study further assumes that 50% of both the Polk Wellfield and the new source are either offline or undeveloped. This approach will be used for the storage analysis presented below.

The South Wellfield meets all of the requirements for continuous availability at the beginning of the planning period. The production rate considered to be continuously available from the South Wellfield during the dry season is 0.83 mgd starting in 2025, which includes South Wells #1-5 (see Table 4-1).

As discussed in the previous chapters of this plan, the recommended improvements include upgrades to existing facilities, including wellfields, water treatment plants, and booster pump stations. These improvements include backup power generators as well as other electrical and mechanical improvements. These improvements will allow the facilities to continue to produce and to pump their nominal capacities even during power outages. This storage analysis is based on the assumption that these improvements will be completed by 2030 and that these upgraded facilities will meet all of the previously-identified criteria to be classified as "continuously available to the system."

Based on these assumptions, the production rate considered to be continuously available from the Polk Wellfield is 1.1 mgd starting in 2030 (50% of the existing dry-season capacity).

A new water supply and treatment plant are recommended to be built during the planning period. This storage analysis is based on the assumption that these improvements will be completed by 2030 and that these upgraded facilities will meet all of the previously-identified criteria to be classified as "continuously available to the system." The production rate considered to be continuously available from the new source is 0.59 mgd starting in 2030 (50% of 825 gpm).

- Fire Suppression Storage Assumption

As discussed in Chapter 5, this report utilizes the design fire flows established by the City's Public Works Design Standards. The controlling design fire flow condition is a 4,000-gpm event with a duration of 4 hours, which equates to a total fire suppression volume of 960,000 gallons.

9.3.2 Storage Volume Evaluation

The total recommended storage in the system is the sum of operational, equalization, fire, and standby storage (while discounting any dead storage). Based upon the criteria discussed above, the storage requirements were evaluated to determine the required storage volumes through the end of the planning period. Table 9-3 describes the required water storage that will be necessary for the City during the planning period in response to the increased demand associated with the anticipated population growth.

Table 9-3 shows a deficit of approximately 1 million gallons at the beginning of the planning period. By 2030, a substantial amount of additional water production is anticipated to meet the criteria of "continuously available", which will result in an excess storage of approximately 0.35 million gallons. As growth proceeds in the City, excess storage will decrease and become a storage deficit by 2035. By the end of the planning period, it is estimated that there will be a deficit of approximately 1 million gallons due to population growth. Additional storage will be needed during the planning period. Based on this evaluation, this plan recommends that the City construct an additional reservoir by 2035. This reservoir should have an effective storage capacity of at least 1 million gallons. It is important to note that the storage requirements shown in Table 9-3 are based on the assumption that additional water production becomes continuously available to the system by the year 2030. For this assumption to be valid, improvements to the wellfields, water treatment plants, and booster pump stations must be completed prior to 2030 that have been identified in previous chapters.

Table 9-3| Water Storage Evaluation

Year	2025	2030	2035	2040	2045
Total Service Population	12,126	13,578	15,131	16,814	18,636
ADD (mgd)	1.25	1.40	1.57	1.75	1.94
MDD (mgd)	2.50	2.81	3.14	3.50	3.88
Continuously Available Daily Water Production (mg)	0.83	2.52	2.52	2.52	2.52
Equalization Storage (mg)	0.75	0.84	0.94	1.05	1.16
Fire Suppression Storage (mg)	0.96	0.96	0.96	0.96	0.96
Emergency Storage (mg)	1.67	0.28	0.62	0.98	1.36
Effective Storage Required (mg)	3.38	2.08	2.52	2.99	3.48
Existing Effective Storage (mg)	2.44	2.44	2.44	2.44	2.44
Effective Storage Excess (mg)	-0.94	0.35	-0.09	-0.55	-1.05

9.4 EVALUATION OF EXISTING STORAGE TANKS

This section builds on the information presented in Chapter 4 and presents an overview of the existing issues with the City's storage tanks.

9.4.1 Polk Reservoir 1

Seismic Evaluation- Polk Reservoir 1 was constructed in 1999. Based on the available information, it is likely that the reservoir meets or exceeds current seismic structural code and likely will not need seismic retrofits. However, detailed records of the seismic design of the reservoir were not available for this study. Therefore, this plan recommends that the City have a seismic structural evaluation performed to verify if any retrofits are necessary. The goal of the seismic evaluation should be to determine the scope and costs of any required structural improvements to bring the tank structure into compliance with current building codes. This may require draining the reservoir for a few days in order to determine the critical structural elements of the tank, including things like thickness of the tank panels, roof support structure, etc. Polk Reservoir 2 provides redundancy for pumping from the Polk Reservoirs while Polk 1 is drained. Therefore, the City can maintain operation of the Polk Booster Pump Station while drawing water from Polk Reservoir 2. It is further recommended that any reservoirs be drained during the winter months during lowest demands.

If seismic retrofits are required for the tank, the reservoir will likely need to be drained for a prolonged period of time, which will cause a deficit in total effective storage. This would increase the fire risk to the community. To address this issue, it is recommended that any seismic retrofits be completed after construction of the proposed new reservoir and Willamette Water Treatment Plant (see Projects R-4 in Chapter 9 and T-1 in Chapter 7).

Aluminum-paneled Roof- The roof of this reservoir is constructed of aluminum panels. In some cases, the seals between the panels have deteriorated over time and can fail, which can allow contaminated water to drip in to the reservoir. OHA has had documented cases where municipal finished water quality was compromised by such leaks. It is recommended that the gaskets in the aluminum roof be regularly inspected and cleaned of debris accumulation. It may be possible for the City to include this inspection work in the regular tank inspections performed by a contractor. Any issues with the roof seals are expected to be addressed as repairs and maintenance using the budget for operations.

9.4.2 Polk Reservoir 2

Seismic Evaluation- Polk Reservoir 2 was constructed in 2012. Based on the available information, it is very likely that the reservoir meets or exceeds current seismic structural code and likely will not need seismic retrofits. However, detailed records of the seismic design of the reservoir were not available for this study. Therefore, this plan recommends that the City have a seismic structural evaluation performed to verify if any retrofits are necessary. The goal of the seismic evaluation should be to determine the scope and costs of any required structural improvements to bring the tank structure into compliance with current building codes. This may require draining the reservoir for a few days in order to determine the critical structural elements of the tank, including things like thickness of the tank panels, roof support structure, etc. Polk Reservoir 1 provides redundancy for pumping from the Polk Reservoirs while Polk 2 is drained. Therefore, the City can maintain operation of the Polk Booster Pump Station while drawing water from Polk Reservoir 1. It is further recommended that any reservoirs be drained during the winter months during lowest demands.

If seismic retrofits are required for the tank, the reservoir will likely need to be drained for a prolonged period of time, which will cause a deficit in total effective storage. This would increase the fire risk to the community. To address this issue, it is recommended that any seismic retrofits be completed after construction of the proposed new reservoir and Willamette Water Treatment Plant.

Aluminum-paneled Roof- The roof of this reservoir is constructed of aluminum panels. In some cases, the seals between the panels have deteriorated over time and can fail, which can allow contaminated water to drip in to the reservoir. OHA has had documented cases where municipal finished water quality was compromised by such leaks. It is recommended that the gaskets in the aluminum roof be regularly inspected and cleaned of debris accumulation. It may be possible for the City to include this inspection work in the regular tank inspections performed by a contractor. Any issues with the roof seals are expected to be addressed as repairs and maintenance using the budget for operations.

9.4.3 South Reservoir

Seismic Evaluation- The South Reservoir was constructed in 2005. Based on the available information, it is likely that the reservoir meets or exceeds current seismic structural code and likely will not need seismic retrofits. However, detailed records of the seismic design of the reservoir were not available for this study. Therefore, this plan recommends that the City have a seismic structural evaluation performed to verify if any retrofits are necessary. The goal of the seismic evaluation should be to determine the scope and costs of any required structural improvements to bring the tank structure into compliance with current building codes. This may require draining the reservoir for a few days in order to determine the critical structural elements of the tank, including things like thickness of the tank panels, roof support structure, etc. There is no redundant reservoir for pumping from the South Reservoir. A second issue is the deficit in total effective storage that will occur while this reservoir is drained to undergo seismic retrofits (if necessary). To address these two issues, it is recommended that this reservoir be evaluated or retrofit after construction of the proposed new reservoir and Willamette Water Treatment Plant. It is further recommended that any reservoirs be drained during the winter months during lowest demands.

Aluminum-paneled Roof- The roof of this reservoir is constructed of aluminum panels. In some cases, the seals between the panels have deteriorated over time and can fail, which can allow contaminated water to drip in to the reservoir. OHA has had documented cases where municipal finished water quality was compromised by such leaks. It is recommended that the gaskets in the aluminum roof be regularly inspected and cleaned of debris accumulation.

It may be possible for the City to include this inspection work in the regular tank inspections performed by a contractor. Any issues with the roof seals are expected to be addressed as repairs and maintenance using the budget for operations.

9.4.4 Monmouth Street Reservoir

Seismic Evaluation- The Monmouth Street Reservoir will be roughly 50 years old at the beginning of the planning period. There are no records of the tank's design or construction. The walls, roof, and floor are constructed of welded-steel panels. The reservoir is not anchored to the concrete foundation. It is uncertain whether the foundation is reinforced. It is likely that the concrete foundation is a ring supporting the walls with a base of sand supporting the floor. The reservoir was certainly not constructed to meet current seismic standards. The tank will require seismic retrofits in order to maintain use of the tank through the planning period. Additionally, depending upon the existing steel wall thicknesses, the water level may need to be lowered. Lowering the water level could greatly reduce the storage capacity of the facility.

A seismic evaluation would be required in order to determine the scope and costs of the structural improvements and water level reduction that would be required to bring the structure in to compliance. A seismic evaluation of the tank will require information on several aspects of the tank's structural components. Measurements will be needed of the different steel thicknesses in each area of the tank. Information will be needed on the type and thickness of the concrete foundation, which will require digging a pit to inspect under the reservoir. Additionally, a geotechnical investigation of the site will be needed. The tank will need to be drained and taken out of service for a few days to perform the detailed structural inspection.

Coatings- The tank is coated on the exterior walls with the original lead-based paint. There is substantial pitting in the paint where rust is exposed. There is none of the original paint remaining on the steel roof, which is exposed to the elements. The interior coating is coal tar. If the tank is to be retrofit during the planning period, the coating on the roof and walls will need to be removed and replaced. A contractor will need to be hired that is licensed to perform the required procedures for removal and containment of lead-based paint. The interior coal-tar coating is also expected to need to be removed and replaced.

Operation- Based on discussions with City staff, there are some issues with how the existing reservoir operates as a result of it being filled by the grid in its current configuration. During the winter months, the Polk and South Pump Stations maintain high enough distribution pressure that the Monmouth Street Pump Station does not need to run. Subsequently, the reservoir water does not turnover, which presents the risk of deteriorating water quality. To resolve this issue, operators manually run the pumps every three days. During the summer months, water is being pumped consistently from the reservoir and City staff have difficulty keeping the reservoir full. The reservoir has a common fill and drain line. As a result, there is not enough inflow time available to fill the reservoir. This issue could be resolved by reconfiguring the yard piping to have separate inflow and outflow water lines.

Yard Piping & Valves- The piping between the reservoir and the pump station is the original steel pipe installed in 1976. According to operators, this piping has corrosion issues. Therefore, this piping will likely need to be replaced during the planning period. An altitude valve controls the filling of the reservoir and prevents it from overflowing. Based on discussions with City staff, this valve has reached the end of its useful life and will need to be replaced during the planning period.

Miscellaneous- According to operators, the roof hatch no longer functions properly. The access ladder does not meet current OSHA standards. Additionally, there is no hand rail around the hatch as required by OSHA standards.

Summary- Overall, there are some substantial issues with the Monmouth Street Reservoir that will need to be addressed during the planning period. At approximately 50 years old, the structure will likely reach the end of its useful life during the planning period. Therefore, upgrades to the existing tank are needed if it is to remain in service. These upgrades would include a seismic evaluation, seismic retrofit (and potential capacity reduction), new coatings, new piping, a new altitude valve, and miscellaneous improvements. This would be a substantial capital investment. It is recommended that the City instead use these funds for building a new reservoir that would serve the needs of the City for several decades and meet current seismic codes. This reservoir could either be a replacement at the same location or at a different location, such as the Willamette Water Treatment Plant.

Replacing the reservoir at the Monmouth Street location would require first removing the existing reservoir, since there is not adequate space at the site to build a redundant reservoir. This approach would not allow the existing tank and pump station to stay in service to meet fire flow demands, which would create problems with respect to fire suppression. An alternative is to design the new water treatment plant facility, reservoir and distribution grid so that the Monmouth Street Reservoir and Pump Station could be decommissioned. This would reduce the number of separate water facilities operated by the City and avoid retrofitting the Monmouth Street Pump Station.

Overall, the recommended storage system improvements for all of the City's reservoirs are described in greater detail in the following section based on these evaluations.

9.5 RECOMMENDED IMPROVEMENTS

The analysis presented in this chapter and in Chapter 4 shows the need for reservoir and storage improvement projects during the planning period. Project codes for these are abbreviated with "R". Three of the projects are seismic evaluations of existing reservoirs, which will be used to determine the scope and cost estimates for seismic retrofit projects, if necessary. Based on the available information, seismic retrofit projects are not expected to be needed for Polk Reservoirs 1 & 2 and the South Reservoir. Therefore, this plan does not include projects for these in the capital improvement plan. However, this plan should be modified accordingly if the seismic evaluations determine retrofits to be necessary.

One project is a new reservoir that will address additional demands for storage as a result of growth. This new reservoir is also proposed to be used as a part of the recommended surface water treatment plant. This new reservoir also allows the Monmouth Street Reservoir to be decommissioned. This eliminates the need to expend capital improvement funds on the Monmouth Street Reservoir and Pump Station.

The specific storage-related improvement projects are described in the following paragraphs. The recommended project budgets include construction costs as well as soft costs such as permitting, engineering, legal, and administrative costs. Chapter 12 provides a prioritization of these projects.

- **Polk Reservoir 1 Seismic Evaluation - Project R-1**

A seismic evaluation is recommended to be completed for Polk Reservoir 1 to verify if the existing structure meets current building codes. Additionally, this evaluation should include the existing buildings and equipment at the water treatment plant and booster pump station. The goal of the analysis should be to identify the scope and cost of any needed structural improvements. To perform the seismic evaluation, the City will need to retain the services of a qualified structural engineer. The engineer will need to review the plans and may need to take samples of the concrete. It may also be necessary to drain the tank for a short period (i.e., 1-3 days) of time in order to inspect the interior components. A geotechnical site evaluation may be needed for the evaluation. The recommended budget for this project is $50,000.

- **Polk Reservoir 2 Seismic Evaluation - Project R-2**

A seismic evaluation is recommended to be completed for Polk Reservoir 2 to verify if the existing structure meets current building codes. The goal of the analysis should be to identify the scope and cost of any needed structural improvements. To perform the seismic evaluation, the City will need to retain the services of a qualified structural engineer. The engineer will need to review the plans and may need to take samples of the concrete. It may also be necessary to drain the tank for a short period (i.e., 1-3 days) of time in order to inspect the interior components. A geotechnical site evaluation may also be needed. The recommended budget for this project is $40,000.

- **South Reservoir Seismic Evaluation - Project R-3**

A seismic evaluation is recommended to be completed for the South Reservoir to verify if the existing structure meets current building codes. Additionally, this evaluation should include the existing buildings and equipment at the water treatment plant, wellfield and booster pump station. The goal of the analysis should be to identify the scope and cost of any needed structural improvements. To perform the seismic evaluation, the City will need to retain the services of a qualified structural engineer. The engineer will need to review the plans and may need to take samples of the concrete. It may also be necessary to drain the tank for a short period (i.e., 1-3 days) of time in order to inspect the interior components. A geotechnical site evaluation may also be needed. The recommended budget for this project is $50,000.

- **New 2.0-million-gallon Reservoir – Project R-4**

As discussed in Section 9.3.2 and shown in Table 9-3, there is a projected total deficit in storage of approximately 1.0 million gallons at the end of the planning period. This storage deficit is anticipated to start in 2035. The evaluation of the Monmouth Street Reservoir in Section 9.4.4 includes a recommendation to either replace the existing reservoir or to offset the need for this storage volume by constructing a separate, new, facility. The latter option is recommended in this plan. The proposed improvements include the construction of a new 2.0-million-gallon reservoir to balance the projected storage deficit, replace the Monmouth Street Reservoir and to provide some additional storage for the following planning period. This reservoir is recommended to be constructed in conjunction with the proposed Willamette Water Treatment Plant. As discussed in Section 6.4.1, this plan recommends completing the new water treatment plant by 2028. As discussed in Section 8.4.1, this plan recommends decommissioning the Monmouth Street Pump Station and Reservoir. Consolidating storage capacity at the new treatment plant will allow the City to simplify the water distribution system and avoid upgrading the Monmouth Street facility. This alternative is expected to be less costly than installing both a new 1.25-million-gallon tank and a 750,000-gallon tank to replace the Monmouth Street Reservoir.

For the purposes of estimating cost, this plan assumes a glass-fused bolted-teel tank will be constructed in the same style as the City's other reservoirs. The project includes the reservoir structure, foundation, miscellaneous reservoir components, such as ladders and hatches. The project also includes yard piping to and from the treatment plant, a valve vault, and electrical components. The recommended budget is based upon the project being constructed in conjunction with the treatment plant.

The total recommended budget for this project is $4,039,000. The detailed estimate of this budget is included in **Appendix G**.

9.6 SUMMARY OF RECOMMENDED STORAGE IMPROVEMENTS

Several water storage improvement projects have been identified above. These projects are summarized in the following table. These projects are assigned a priority ranking in Chapter 12.

Table 9-4| Recommended Treatment System Improvements

Project Code	Description	Recommended Budget
R-1	Polk Reservoir 1 & WTP Facility Seismic Evaluation	$50,000
R-2	Polk Reservoir 2 Seismic Evaluation	$40,000
R-3	South Reservoir & WTP Facility Seismic Evaluation	$50,000
R-4	New 2.0-million-gallon Reservoir	$4,039,000

CITY OF INDEPENDENCE
Water System Master Plan
Independence, Oregon

CHAPTER 10

SEISMIC RISK ASSESSMENT & MITIGATION PLAN

Chapter Outline

10.1 Introduction
10.2 Regulatory Requirements
10.3 Critical Facilities
10.4 Likelihood and Consequences of Failure
10.5 Mitigation Plan

SEISMIC RISK ASSESSMENT & MITIGATION PLAN

10.1 INTRODUCTION

OAR 333-061-0060(5)(J) requires every community water system with more than 300 connections to conduct a seismic risk assessment and mitigation plan as part of a water master planning effort. This requirement only applies to communities located within hazard levels VI through X shown in Figure 10-1. The City is located within this hazard level. Therefore, a seismic risk assessment and mitigation plan was conducted as part of this master planning effort. The results of this analysis are presented in this chapter.

10.2 REGULATORY REQUIREMENTS

The requirements for the seismic risk assessment and mitigation plan are stipulated in OAR 333-061-0060(5)(J) and include the following.

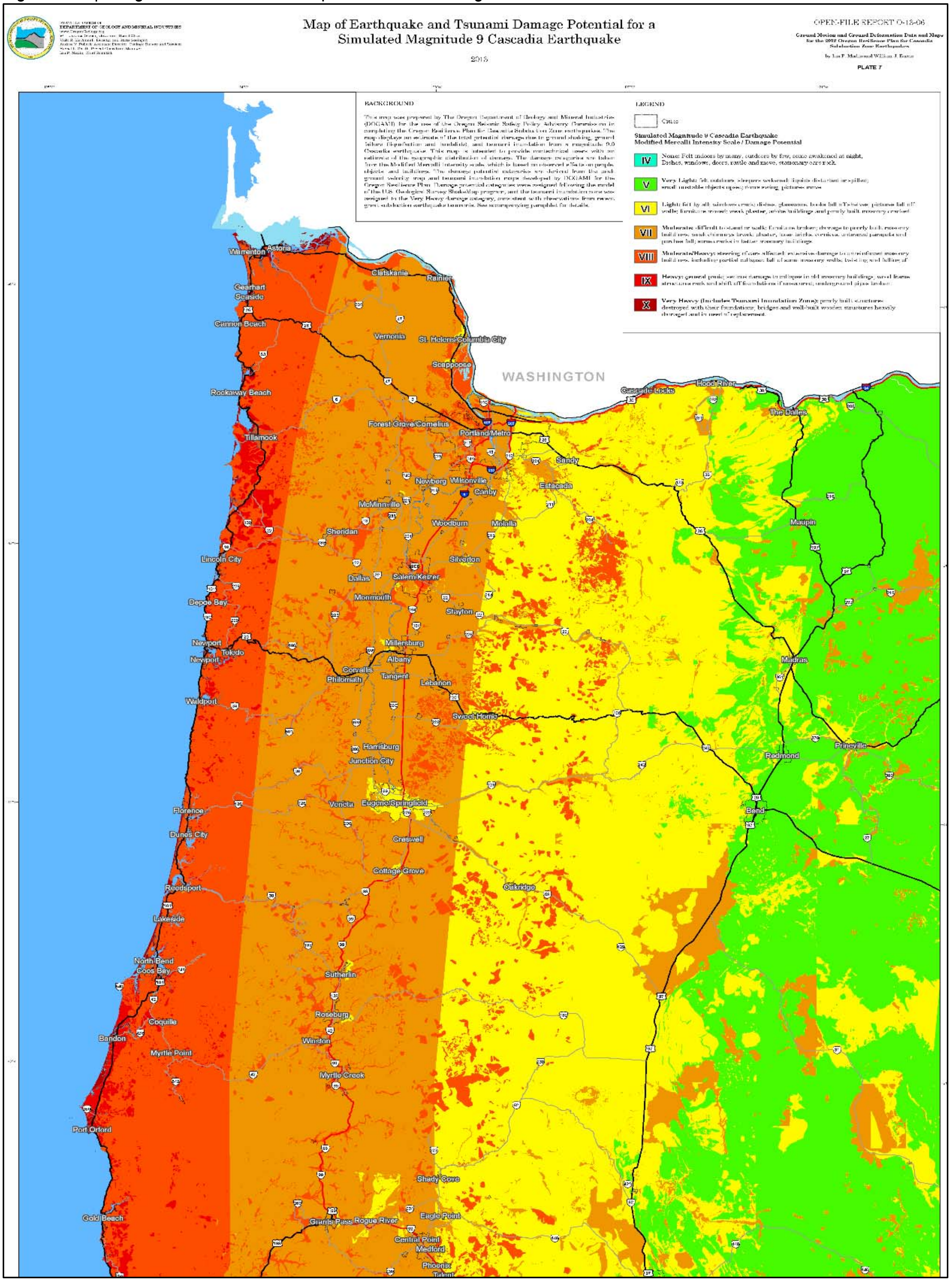
"(J) A seismic risk assessment and mitigation plan for water systems fully or partially located in areas identified as VII to X, inclusive, for moderate to very heavy damage potential using the Map of Earthquake and Tsunami Damage Potential for a Simulated Magnitude 9 Cascadia Earthquake, Open File Report 0-13-06, Plate 7 published by the State of Oregon, Department of Geology and Mineral Industries.

(i) The seismic risk assessment must identify critical facilities capable of supplying key community needs, including fire suppression, health and emergency response and community drinking water supply points.

(ii) The seismic risk assessment must identify and evaluate the likelihood and consequences of seismic failures for each critical facility.

(iii) The mitigation plan may encompass a 50-year planning horizon and include recommendations to minimize water loss from each critical facility, capital improvements or recommendations for further study or analysis."

Figure 10-1| Oregon State DOGAMI Map of Seismic Damage Potential



10.3 CRITICAL FACILITIES

The critical facilities needed to supply water to the community include the wellfields, raw water lines, treatment plants, storage reservoirs, booster pump stations, intertie, and primary water distribution mains. As depicted in Figure 10-2, the critical distribution water mains are along Main Street, Independence Highway, Polk Street, Williams Street, Airport Road, Hoffmann Road, Marigold Dr, Morning Glory Dr, Gun Club Road, Talmadge Road, and Monmouth Street. As shown in the figure, other waterlines are recommended to become critical infrastructure in the future. Together these facilities form the backbone of Independence's water system.

10.4 LIKELIHOOD AND CONSEQUENCES OF FAILURE

This subsection includes an analysis of the likelihood and consequences of failure for each of the critical facilities identified in the previous section. A catastrophic failure of any of these facilities will severely impact the City's ability to produce and deliver drinking water to the system.

Polk Wellfield & South Wellfield

The City's wellfields consist of ten wells constructed between 1990 and 2019. The structural seismic resiliency of the wells and raw water pump stations is unknown. Wells are not typically constructed to meet seismic structural code. It is expected that the City's wells were not designed or constructed to meet specific seismic requirements. The wells primarily consist of ¼-inch-thick welded steel tubing, screens, and various rock & concrete backfill materials. The pump stations typically consist of a pump, piping, controls and an above-ground structure. The submersible pumps are between 8- and 50-horsepower and are approximately 70-feet underground. The pumps are suspended in the well from the discharge piping. The piping is between 3- and 6-inches in diameter. It is likely that the wells are susceptible to damage in the event of a major seismic event. If some or all of the wells are damaged to the point of failure, then the City's ability to obtain raw water will be compromised. The recommended improvements in this plan include developing a new water source from the Willamette River. This water source and treatment system are recommended to be constructed to meet seismic standards. Once completed, the Willamette River water source will provide the City with a redundant source that is independent of the existing wells. This will help minimize the risk to the water system as a result of potential wellfield failures.

Raw Water Mainlines

The City's water system has three main raw water pipes: two for the Polk Wellfield and one for the South Wellfield. The Polk Raw Waterlines must transmit water a relatively long distance from the wells to the treatment plant, approximately 4,200 feet. These pipes are relatively new and consist of unrestrained push-on PVC joints. As such, these pipes are susceptible to being pulled apart if subject to extreme ground motions. Therefore, some pipe failures in the Polk raw water system are possible during a large earthquake event. Since these pipes are relatively new and are adequately sized, this plan does not recommend improvements specifically for seismic risk mitigation. These pipes are one of the most significant vulnerabilities to the City's water system during an earthquake due to their material and importance to the Polk Water System; failure of both would render the system inoperable.

The raw water pipes at the South Wellfield are recommended to be replaced in the planning period due to age and deterioration (see **Project S-6**). It is recommended that these pipes be replaced with earthquake resistant piping systems. This will greatly reduce the likelihood of failure due to a seismic event.

The recommended improvements for the Willamette Water Treatment Plant include a new raw water collector well, pump station and conveyance pipe. The City should construct these to withstand a major earthquake. Constructing these facilities in this manner would improve redundancy of the raw water system and greatly reduce the likelihood of failure.

Finished Water Distribution Mainlines

The finished water distribution network consists of individual pipeline segments that are typically joined by unrestrained push-on joints. As such, the pipe joints are susceptible to being pulled apart if subject extreme ground motions. Many of these pipes are relatively old and deteriorated. Therefore, pipe failures in the distribution system are likely to occur during a large earthquake event. The distribution grid includes a network of pipes that provide multiple flow paths through the City. Therefore, even if a main pipeline artery is ruptured, there is a good chance that the segment can be isolated and bypassed for repair while still maintaining water flow to the majority of the City. The recommended improvements described in this plan include numerous recommended waterlines to replace relatively old pipes. This plan also recommends several “backbone” waterlines that are especially critical to transmit water across the City. It is recommended that the City consider installing the most critical waterlines using earthquake resistant piping systems. This will help mitigate the likelihood of failures in the distribution mains.

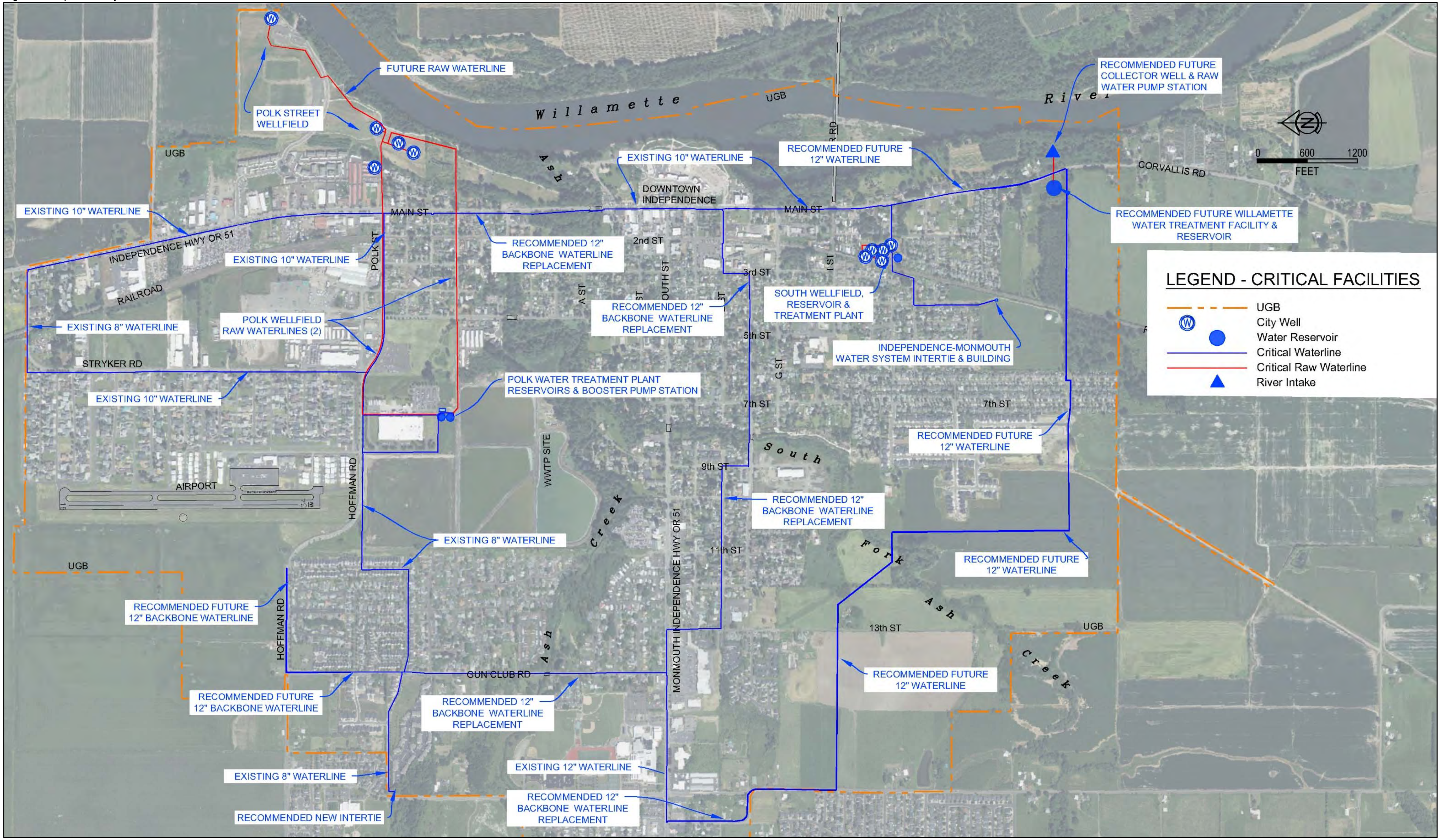
Polk and South Water Treatment Plants, Reservoirs & Booster Pump Stations

The Polk and South Water Treatment Plant, Reservoirs, and Pump Stations were constructed within the last 30 years. It is possible that these facilities meet current seismic design codes. However, the data is not readily available to make this determination. Therefore, seismic evaluations are recommended for the reservoirs, buildings, equipment and other critical elements of these facilities (**Projects R-1 and R-3**). It is recommended that the treatment and booster pump station facilities be evaluated for seismic resiliency in conjunction with the reservoir evaluations. If these facilities were to fail, the City would not be able to treat and pressurize finished water. The recommended improvements in this plan include a new water treatment plant, reservoir, and booster pump station. These facilities are recommended to be constructed to meet seismic standards. Once this system is constructed, the City will have additional redundancy for treatment, storage and booster pump stations. This will help mitigate the risk of failures.

Monmouth Street Reservoir & Booster Pump Station

The Monmouth Street Reservoir and Pump Station are expected to be vulnerable to a major earthquake. These facilities are recommended to be decommissioned during the planning period. Therefore, seismic risk due to failure is not expected to be an issue for these facilities over the 50-year seismic risk mitigation planning horizon.

Figure 10-2| Water System Critical Facilities



10.5 MITIGATION PLAN

The recommended mitigation plan over the next 50 years consists of various capital improvements and recommended changes to some of the City's design & construction standards. Each element of the plan is discussed in this section.

- Willamette River Water Supply Improvements **(Projects S-10, T-1, P-4, R-4, and B-12)**

The capital improvement plan recommended in this document lists several projects that are needed to bring the Willamette River into use. This includes new facilities for raw water intake & conveyance, treatment, storage, a distribution pump station and mainline arteries. This set of projects is an opportunity to build redundancy and seismic resiliency for all elements of the water system. It is recommended that these facilities be designed to withstand a major seismic event. These projects are a major component of the seismic mitigation plan. All of these projects are assigned the highest priority ranking (priority 1) in the capital improvement plan. Once these facilities are complete, the City will greatly minimize the risk of water system failure due to a seismic event. The only aspect of the water system that this facility does not address is city-wide transmission of finished water. This is recommended to be addressed by several waterline projects discussed below.

- Main Water Distribution Arteries (**Projects B-1, B-5, B-6, B-9, B-12, and B-15**)

The main water distribution pipelines that supply water to the City primarily consists of AC and PVC pipe with push-on joints. So, the risk of failures within the distribution grid after a large earthquake is relatively high. The recommended capital improvement plan described in Chapter 12, includes replacing sections of the main distribution backbones. These segments should be installed using earthquake resistant piping systems.

- Polk Booster Pump Station Improvements (**Project P-1**)

The Polk Booster Pump Station Improvements project includes the installation of an auxiliary power generator to power the pump station and the treatment plant. This is important, because it is likely that a major earthquake would disrupt grid power to the City. Completion of this project will greatly reduce the risk of power interruption during a seismic event.

- Polk Wellfield Electrical Improvements (**Project S-5**)

The Polk Wellfield Improvements project is primarily intended to improve the auxiliary power systems at the wellfield. This project will ensure that the City can power all of these wells using an existing generator. This is important, because it is likely that a major earthquake would disrupt grid power to the water system.

- South Wellfield Improvements (**Project S-6**)

Project S-6 will substantially upgrade the existing underground piping systems at the South Wellfield. It is recommended that the piping be replaced with earthquake resistant piping systems.

- New Water System Intertie (**Project S-8**)

The recommended new water system intertie increases redundancy by adding a finished water source to the water system. This facility acts as a backup in case the City's existing sources are offline. The City already has an intertie on the opposite side of the City. Two interties in different locations further improves the City's ability to deliver water to the City.

- Reservoir Seismic Evaluations (**Projects R-1, R-2, and R-3**)

Seismic structural evaluations are recommended in this plan to verify if retrofits are needed during the planning period for specific reservoirs. These are important to ensure that the existing reservoirs can resist catastrophic failure and to plan for necessary improvements. Once any necessary improvements are completed, the risk due to failure of the reservoirs should be minimized.

- Emergency Fuel Storage Cache

After a large earthquake, the line-power needed to operate the City's water system may not be available for several days or longer. The commercial fuel supply is also likely to be interrupted. The City has mitigated this risk by making an agreement with a local fuel supplier and by installing equipment at a local gas station for running a generator. The critical components of the City's water system will eventually be equipped with backup power generators. However, the onsite fuel storage capacity of these generators will be somewhat limited. The City may want to consider working with other emergency services agencies in the area to establish a fuel storage cache that can be used for prolonged emergency situations. This is discussed further in Section 6.3.3.

- Earthquake Resistant Piping

The previous discussions include references to earthquake resistant piping systems. This paragraph includes a brief introduction to this topic. Most traditional pipe materials used for buried water distribution systems were not designed to resist extreme ground motions. Most pipelines are constructed of individual pipeline segments that are jointed using bell and spigot joints that are not restrained. Therefore, they can be pulled apart if subjected to extreme ground motions. The concept of earthquake resistant piping is relatively new. Several Japanese companies have developed earthquake resistant ductile iron pipe with flexible joints that are restrained and allow the pipe joints to move in response to ground motions without pulling apart. This pipe is commonly used in Japan and manufactured by several Japanese companies. Earthquake resistant ductile iron pipe is not commonly used in the United States. Some large western cities (e.g., Los Angeles, San Francisco, Portland, Seattle) have begun importing and installing earthquake resistant ductile iron pipe. Therefore, it may become more common in the US in the future. If so, this pipe may eventually be a reasonable option for the City for future pipeline improvement projects. In the meantime, HPDE pipe is also a good option. HDPE pipe is flexible and the individual pipe segments are joined by heat fusing. With heat-fused joints, an entire HDPE pipeline acts a single pipe without joints. Therefore, HDPE pipe is able to respond to ground motion with a low risk of failure. HDPE pipe does present installation challenges in roadways subject to vehicular traffic and is not typically used in areas where water service taps are common. As various improvements to the City's distribution system are made in the coming years, the City should consider the use of earthquake resistant piping materials. Over time, as the City is able to replace existing piping with earthquake resistant piping, the overall resiliency of the distribution grid will be improved.

CHAPTER 11

OPERATION & MAINTENANCE

Chapter Outline

11.1 Introduction
11.2 Water System Record Keeping
11.3 Water Use Audit
11.4 Leak Detection
11.5 Distribution System Flushing Program
11.6 Valve Exercising
11.7 Cross-Connection Control Program
11.8 Master Meter Maintenance
11.9 Customer Water Meter Maintenance
11.10 Hydrant Maintenance and Replacement
11.11 Reservoir Inspection and Maintenance Program

11.1 INTRODUCTION

The maintenance of water systems is necessary to ensure the proper operation of the facilities and to obtain the full useful life of those facilities. Water systems represent a significant investment of public capital. If a water system is allowed to fall into disrepair because of the lack of maintenance, it will not operate efficiently or as designed. Health problems and property damage may result from leaking mains or services, mainline breaks, inoperable valves or fire hydrants. The repair of failed portions of a public water system is costly, quite often equaling or exceeding the original cost of construction. Because of this it is imperative that municipalities consistently provide adequate maintenance funding and staffing to protect their investment.

System maintenance is frequently classified as preventative or corrective. Preventative maintenance involves routinely scheduled inspections of the system and the collection of data to identify problem areas. The proper documentation and analysis of collected data should be performed so that scheduled maintenance can be allocated to specific problems. As a general rule, as preventative maintenance increases, the amount of corrective maintenance required decreases.

Corrective maintenance, often referred to as emergency maintenance, is typically performed when the water system fails, such as leaking mainlines, inoperable pumps, control systems or fire hydrants. Corrective maintenance requires immediate action and the City will typically pay a premium for the completion of this work.

Therefore, it is important to emphasize that preventative maintenance, documentation, and program evaluation ultimately result in a lower cost to the consumer by extending the life of the treatment, distribution or storage system components and reduce costs associated with unscheduled or emergency repairs.

11.2 WATER SYSTEM RECORD KEEPING

Record keeping is an important part of a successful operation and maintenance program. Unfortunately, record keeping is often neglected because of time and staffing limitations, and the often immediate needs of other maintenance programs. The following categories of record keeping are viewed as central to improving the long term efficiency of the operation and maintenance program.

11.2.1 Water Production

The planning elements of water system expansion and water conservation are strongly rooted in the evaluation of water system demands. The recording of daily water production and billing records provide a basis for projecting future system needs and measuring the efficacy of conservation efforts. The City should continue its good practice of diligently recording water use.

Water use data collection should include:

- Daily water production from all sources and treatment facilities
- Monthly amounts of water used for filter backwash
- Historical water use. Track average day, maximum day and monthly total demands.

- Unaccounted-for-water, recorded on a monthly and annual basis to include a breakdown of non-revenue water. The City should track any use of water that is not recorded by a water meter. This includes water for hydrant testing, line flushing, and any other unmetered water sources. The City should estimate quantities of water used and keep a log to document the use of unaccounted for water.
- Daily amounts of waste streams from source and treatment facilities (i.e., filter backwash).

11.2.2 Regulatory Record Keeping

It is the responsibility of the water system operations staff to develop and maintain records relating to the quality of the water produced as well as the condition of the physical components of the system. These requirements are detailed in OAR 333-061-0040. Regulatory records should be maintained at a convenient location within or near the area served by the water system. Table 11-1 provides an overview of record keeping requirements. Operators are encouraged to review the statute for the most current compliance requirements as other rule-specific requirements may apply.

Table 11-1| General Regulatory Record Keeping Requirements

Specific Record or Report	Record Retention
Residual disinfectant measurements	2 years
Copies of public notices issued pursuant to OAR 333-061-0042 and certifications made to the OHA	3 years
Actions taken to correct violations of primary drinking water regulations	3 years [1]
Bacteriological analysis	5 years
Monitoring plans for disinfection byproducts	5 years
Consumer Confidence Reports	5 years
Records concerning variances or permits	5 years [2]
Chemical analysis, secondary contaminants, turbidity and radioactive substances results	10 years
Reports, summaries or communications on sanitary surveys	10 years
Lead and Copper Rule data	12 years

1 Retention period begins after the last action taken with respect to the particular violation
2 Retention period begins after the expiration of the variance or permit

The City is also encouraged to retain organized records of all correspondence with regulators, operator certificates, and the results of any comprehensive performance evaluations.

11.2.3 Operations and Maintenance Records

There are commercially available asset management software programs that allow cities to develop a comprehensive maintenance system to manage operational efforts for the water and wastewater systems (such as those developed by the Hansen Software Corporation or Beehive Industries). This computer software tracks and schedules work orders, labor expenditures, regularly scheduled maintenance activities, inspection reports, and repairs.

The City is currently implementing Beehive public asset management software. Information from this system will be helpful to establish the need for additional staff, equipment, training or other resources that may be required to accomplish operations and maintenance programs.

11.2.4 Water System Mapping & System Inventory

The City coordinates through the City Engineer to use AutoCAD to inventory and map their installed infrastructure. A complete inventory of the water system will greatly improve operational efficiency and will enhance future planning efforts.

As is often the case with municipal systems this size, the City relies on the memory and experience of staff members to provide a full account of many system details. As the City continues to grow, it becomes increasingly important that this wealth of information is transferred and organized into a formalized record keeping system.

11.3 WATER USE AUDIT

The definition of unaccounted-for-water is defined as water which is lost through leaks, evaporation, or use that is not recorded and/or accounted-for. Unaccounted-for-water includes distribution pipe leakage, unmetered water use such as fire fighting, hydrant flushing, overflows, street cleaning, and WTP backwash water or instrumentation error.

The City tracks typical "unaccounted-for-water" uses on a monthly basis, such as filter plant backwash, construction water, reservoir overflows, and water used for street cleaning. The City recently replaced the meter used to track water consumed for fire-fighting training by the local fire department. It is recommended that these water use tracking practices continue. Requirements for annual water audits are set forth in OAR 690-086-150(4a). If the City is looking to expand this program, the City should begin with an inventory of all unmetered uses and install metering devices at these locations to the greatest extent possible. In the event metering is not feasible, estimates should be made to record the unmetered use.

New water meters may need to be installed to properly track waste sources, such as backwash at the treatment plant. The installation of these meters will allow the City to establish a monthly audit of its raw and treated water systems.

An annual water audit should utilize the sum of all metered sales from each customer class and production records and should be performed in a systematic and well-documented manner to accurately quantify all authorized unmetered and unauthorized uses. A formalized program for non-metered water use tracking is identified in Section 8.4.3.

11.4 LEAK DETECTION

Municipal leak detection includes hiring a leak detection firm to inspect the entire distribution system. The City most recently performed a complete leak detection survey around 2008. It is recommended that the City inspect the entire distribution system for leaks at least every 5 years. Therefore, this plan recommends establishing a recurring leak detection program with an annual budget and schedule. Specific recommendations are included in Section 8.4.3.

11.5 DISTRIBUTION SYSTEM FLUSHING PROGRAM

Maintaining water quality and preserving the hydraulic capacity of a water distribution system is a key concern for water utilities. Mineral precipitation, microbiological activity, and corrosion can all form deposits on the pipe walls and contribute to a reduction in flow and water quality.

Flushing the distribution water mains is an effective way to maintain water quality and system capacity.

A properly conducted flushing program can improve water quality by restoring the disinfectant residual, reducing bacterial regrowth, dislodging biofilms, removing sediments and deposits, controlling corrosion, restoring flows and pressures, eliminating taste and odor problems, and reducing disinfectant demand throughout the system. These benefits prolong the life expectancy of the distribution system and reduce the potential for waterborne disease outbreaks.

11.6 VALVE EXERCISING

Many components of the water system require periodic maintenance to remain functional. Valves and hydrants, in particular, must be exercised on a regular basis to ensure that they remain in operational condition. It is commonly recommended that all valves be exercised annually; however, this is often times not practical due to staffing limitations. When flushing waterlines, Public Works typically uses different hydrants each year. This helps to exercise all of the hydrants over time.

A complete valve exercising program should include the following elements:

- Systematically locating and accessing all distribution system valves. Often valves boxes have been paved over or are partially buried and are difficult to locate. Valve boxes should be cleaned out to fully expose the valve nut, adjusted and realigned as necessary to allow unobstructed access to the valve. Structurally damaged valve boxes should be replaced.
- Each valve should be operated a minimum of two full cycles and an additional cycle if the torque on the valve is high.
- Replacement of the gland packing. In many cases minor leaks in the packing will stop once the gland packing is wetted and is exercised; however, the valve should be repaired if the packing is damaged and the leak does not stop.
- All data collected from the event (valve location, size, initial open/closed status, number of turns, torque (if measured), and any other anomalies should be entered into the City's maintenance database.
- Perform minor street repairs around the valve box as required.

Valve exercising should be coordinated with flushing operations to ensure that any debris in the distribution system dislodged by the valve exercising is flushed from the system.

In cases where staffing levels do not permit the execution of a full exercising program staff should focus on operating each valve greater than 12-inches on an annual basis and other system valves on a 4 year cycle.

11.7 CROSS-CONNECTION CONTROL PROGRAM

Oregon Administrative Rules 333-061-0070 through 0074 detail the requirements for a cross-connection control program. The City is required to establish a cross-connection ordinance and must submit an annual report to OHA. Systems with more than 300 service connections are required to provide a certified tester.

The City currently has a cross-connection control program. The City currently employs two certified cross connection control specialists. These people are responsible for inspecting new devices and installations, monitoring annual inspections, terminating water service in cases of non-compliance, and compiling and submitting the annual inspection report to OHA.

The City should continue funding this program and work to integrate the location of all backflow devices into the water system mapping. The identification and monitoring of high risk installations is also recommended. In some cases, high hazard assemblies are tested every six months.

11.8 MASTER METER MAINTENANCE

Master meters are installed at the wells, water treatment plants, and booster pump stations. These meters record the total water pumped to different parts of the water system. Data from the booster pump station meters is utilized in conjunction with consumed water from metered connections to establish benchmarks for water loss.

Discussions with staff indicate that many of these meters have not been calibrated for some time and that there is no program designated to accomplish this. It is recommended that these meters be calibrated on an annual basis to ensure that water loss and other operational decisions are being made on a sound basis.

11.9 CUSTOMER WATER METER MAINTENANCE

The accuracy and performance of water meters is vital to utilities whose billable revenues are derived directly from the collected readings. Loss of revenue from inaccurate or broken meters can be significant and may warrant a meter testing schedule. Meters tend to under-register over time because of wear and deposits and since almost all meters lose accuracy with age, any utility can sooner or later find economic justification for meter maintenance.

11.9.1 Large & Mid-size Meters

An important part of a water utility's operations should be a systematic testing and maintenance program for its larger meters. Large meter installations typically represent a significant portion of a utility's revenue and the cost of a program that focuses on proper installation, maintenance and calibration of these larger meters is often small compared to the potential gain in revenue. Large meters are typically defined as those that are 2-inches or larger.

It is recommended that meters 2-inches and larger be calibrated annually. Large meter installations should be inspected to confirm whether strainers, isolation valves and test ports are present. The length of exposed straight pipe in the meter set should be observed for conformance to the manufacturer's recommendation. Flow-demand recording devices can be utilized to confirm that larger meters are appropriately typed and not oversized for the service they see since significantly oversized meters can result in lost revenue because of inaccurate registration during periods of low flow. Using the correct size and type of meter for each application, combined with routine calibrations, will ensure that customers are charged equitably for water use.

11.9.2 Conventional Meters

The City has been relatively proactive about maintaining and replacing the common customer meters. All user meters are radio-read meters. Regular replacements of meters should continue indefinitely. Customer meters need to be replaced at approximately 20-year intervals. The City's current practice of replacing a portion of the meters every year or every few years is a good approach to maintaining accurate customer meters. Based on discussions with City staff, the existing meter replacement practices are considered to be adequate and no changes are recommended in this plan.

11.10 HYDRANT MAINTENANCE AND REPLACEMENT

Hydrants are maintained and replaced on an as-needed basis as they are damaged, or as problems are identified in the flushing and hydrant testing programs. Due to budgetary constraints, there is currently no formal hydrant infill program in the City other than the policy of replacing or augmenting hydrants as waterlines are constructed and/or replaced.

Ultimately it is the community, through its economic decisions with respect to taxation and user fees, that determines the standard of fire protection and coverage. To the degree that funding is available, the City is encouraged to develop an inventory of existing hydrant coverage and to integrate this in the maintenance program so that future infill efforts can proceed in a logical fashion.

11.11 Reservoir Inspection & Maintenance Program

Reservoirs should be inspected and potentially cleaned at least every 5 years. This process typically requires the use of divers. Historically the City has hired divers to clean and inspect all of the City's reservoirs every 4 years. In an effort to formalize this maintenance activity, a recurring program for annual reservoir maintenance is recommended. The proposed annual inspection budget is $1,500 per year. It is envisioned that the City would save this amount each year for four years to stay on the same inspection schedule. The City typically hires a contractor to perform the inspection work. A line item for this recurring program is included in the recommended capital improvement plan presented in Chapter 12 under **Program-4**.

11.12 Staffing Levels

As of May 2022, Public Works has 9 employees. The City dedicates 1-1/2 full-time employees to the operation and maintenance of the water system, with additional employee time allocated as needed. Discussions with Public Works staff indicate that more utility workers are needed in order to perform all of the necessary operation and maintenance activities. Public Works is actively hiring more utility operators to address this need. If the City continues to hire more utility workers as planned, it is not expected that an additional crew member will be needed to address the recommended changes identified in this chapter. The City should ensure that new staff have the required certifications for all aspects of the water system operations, monitoring & maintenance.

CHAPTER 12

CAPITAL IMPROVEMENT PLAN

Chapter Outline

12.1 Introduction
12.2 Prioritized Improvements
12.3 Basis of Cost Estimates
12.4 Construction Cost Estimates
12.5 Funding Sources
12.6 Recommended Implementation Plan

12.1 INTRODUCTION

As documented in the previous sections, there is a need for water system improvements within the study area to correct existing and projected deficiencies. Some of these deficiencies are more critical than others. While some deficiencies prevent the City from currently providing the desired level of service, other deficiencies will manifest as the City expands and as the existing systems continue to age.

Recommended improvements for specific components of the City's water system have been described in previous chapters. This chapter builds on that work by assigning a priority and providing background information on the costs of the improvement recommendations. The cost estimates have been developed to a conceptual level, for planning and budgeting purposes (see Section 12.3); more detailed cost estimates will be necessary as the projects are implemented.

12.2 PRIORITIZED IMPROVEMENTS

Since the scope of the proposed improvements is quite large, a prioritizing process is required. Projects that resolve immediate deficiencies or public health concerns should naturally have a higher priority than long-term growth-related improvements. The following approach is designed to provide a basis for evaluating and ranking the improvement projects.

12.2.1 Prioritization Criteria

The assignment of a particular project or capital improvement project to a priority level was made after an evaluation using the following criteria:

- *Public Health Concerns*. Projects targeted to resolve existing or near-term regulatory compliance issues were assigned the highest priority.
- *Consumed Infrastructure (end of useful life)*. Projects to replace damaged or deteriorated infrastructure (particularly those facilities that have reached the end of their useful life and no longer function as designed) were assigned a higher priority.
- *Capacity or Size Deficiencies*. The severity of the deficiency was considered and compared with the service improvements provided by the replacement components. The projected benefit (versus cost) of a project was used to assign a priority.
- *City Priority*. Projects identified by City operations and maintenance personnel to be high priority due to operational or maintenance problems.
- *Demand Development*. The anticipated timeframe for the development of land within the service area of proposed improvements was considered. Projects to serve approved or near-term developments should be given higher priority than improvements targeted to long-term future developments.

12.2.2 Prioritization Levels

In order to assist the City with their planning, scheduling and construction efforts each improvement project was assigned to one of four priority levels. The priority levels are:

Priority 1- Near-Term Improvements

These projects are targeted problem areas needing immediate attention. They are projects necessary to resolve existing or near-term system deficiencies, resolve regulatory compliance issues or to serve known near-term demand increases. It is recommended that Priority 1 improvements are undertaken as soon as practical (as quickly as financing can feasibly be arranged and construction/permitting/land or easement acquisition considerations can be addressed).

Priority 2- Intermediate Improvements

These are projects that will be needed to maintain adequate water service based on the condition of aging infrastructure, seismic risk mitigation, and to improve redundancy. Although not critical at this time, they should be considered as improvement projects that will be upgraded to Priority 1 prior to the end of the planning period.

Priority 3- Long-Term Improvements/Possible Future Need

These projects are projects to improve system reliability and operability, but are not necessary during the planning period. While important, they are not considered to be critical at the present time and can be delayed to the next planning period. Should conditions in the City change, it is always the City's choice to increase the priority ranking of these projects and construct them sooner rather than later.

Priority 4-Design Standards Improvements

Priority 4 projects are intended to bring existing waterlines in to compliance with the City's design standards for minimum waterline size standards. These projects are not considered absolutely necessary during the planning period. These waterlines may be most cost-effective to build in conjunction with other utility or street improvement projects.

12.2.3 Prioritized Capital Improvement Projects & Estimated Project Costs

To aid in the development of a water system capital improvement program (CIP), each improvement project was examined and assigned to one of the priority classes described above. Table 12-1 below summarizes the total cost of the capital improvement plan presented in Table 12-2.

Table 12-1| Summary of CIP Estimated Costs

Priority Level	Total Estimated Cost
Priority 1	$44,588,000
Priority 2	$11,630,000
Priority 3	$26,086,000
Priority 4	$12,971,000
Total	$95,275,000

Table 12-2 is a comprehensive listing of the recommended water system improvement projects. The cost estimates are rounded to the nearest $1,000 increment. Maps showing the locations of the prioritized improvements are included in Figure 12-1 through Figure 12-4. The reader is referred to previous chapters of this report for more detailed descriptions of the individual projects.

At a minimum, it is recommended that all of the Priority 1 and Priority 2 improvements be included in the City's Capital Improvement Plan (CIP) for the 20-year planning period ending in 2045. Priority 3 and 4 improvements are considered to be optional.

The recurring annual programs, listed in Table 12-2, should be incorporated into the City's operation and maintenance budgets for the water utility. It is envisioned that the City's budget will be increased by these amounts upon the adoption of this plan. A description of the project codes is provided at the end of Table 12-2.

Table 12-2| Recommended Capital Improvement Projects by Priority

Project Code (1)	Project Description	Chapter	Priority	Total Estimated Project Cost (2)
S-1	Groundwater Right Development, Permit G-12134	6	1	$10,000
S-2	Groundwater Right Development, Permit G-17868	6	1	$10,000
S-4	Surface Water Right Development, Permit S-54331	6	1	$20,000
S-5	Polk Wellfield Electrical Improvements	6	1	$459,000
S-6	South Wellfield Improvements	6	1	$857,000
S-7	Recommission South Wells 4 & 5	6	1	$15,000
S-9	Collector Well Preliminary Engineering	6	1	$100,000
S-10	Collector Well & Conveyance Improvements	6	1	$5,590,000
S-11	Groundwater Availability Study	6	1	$25,000
T-1	Surface Water Treatment Facility	7	1	$19,000,000
A-7	B & 4th Street Waterline Replacement	8	1	$154,000
B-2	D Street at 12th St Waterline Replacement	8	1	$253,000
B-3	7th, D & 9th Streets Waterline Replacement	8	1	$694,000
B-4	D Street at 2nd St Steel Waterline Replacement	8	1	$189,000
B-5	E Street from 9th to 13th Waterline Replacement	8	1	$1,010,000
B-6	F Street from 9th to 3rd St Waterline Replacement	8	1	$931,000
B-9	3rd Street & E Street Waterline Replacement	8	1	$479,000
B-10	I & H Streets Waterline Replacement	8	1	$680,000
B-12	Corvallis Road Steel Waterline Replacement	8	1	$428,000
B-17	Walnut, Ash & Log Cabin Streets Waterline Replacement	8	1	$1,407,000
B-18	Monmouth St Waterline Replacement	8	1	$808,000
B-19	Copper Water Service Replacements	8	1	$6,000,000

Table 12-2| Recommended Capital Improvement Projects by Priority

Project Code (1)	Project Description	Chapter	Priority	Total Estimated Project Cost (2)
D-6	Corvallis Road Waterline	8	1	$354,000
P-1	Polk Booster Pump Station Electrical Improvements	8	1	$852,000
P-3	South Booster Pump Station Electrical Improvements	8	1	$84,000
P-4	Willamette Water Treatment Plant Booster Pump Station	8	1	(See Project T-1)
R-1	Polk Reservoir 1 & WTP Facility Seismic Evaluation	9	1	$50,000
R-2	Polk Reservoir 2 Seismic Evaluation	9	1	$40,000
R-3	South Reservoir& WTP Facility Seismic Evaluation	9	1	$50,000
R-4	New 2.0-million-gallon Reservoir	9	1	$4,039,000
	Subtotal Priority 1			**$44,588,000**
A-1	Wild Rose Ct Waterline Replacement	8	2	$181,000
A-2	12th Street & Dawn Ct Waterline Replacement	8	2	$430,000
A-3	B Street & Rhoda Ln Waterline Replacement	8	2	$636,000
A-4	17th Street Waterline Replacement	8	2	$442,000
A-5	16th Street & Talmadge Road Waterline Replacement	8	2	$535,000
A-6	9th Street Waterline Replacement	8	2	$333,000
A-8	Maple Ct Waterline Replacement	8	2	$284,000
A-9	Pine Ct Waterline Replacement	8	2	$206,000
A-10	Evergreen Dr Waterline Replacement	8	2	$273,000
B-1	Gun Club Road Waterline Replacement	8	2	$1,353,000
B-7	5th St from E to F Streets Waterline Replacement	8	2	$160,000
B-8	3rd St from F to I Streets Waterline Replacement	8	2	$410,000
B-11	River Oak Rd Waterline Replacement	8	2	$501,000
B-13	Polk & Walnut Streets Waterline Replacement	8	2	$890,000
B-14	Log Cabin Waterline Replacement	8	2	$664,000
B-15	Main Street Waterline Replacement	8	2	$1,050,000
B-16	River Drive Waterline Replacement #1	8	2	$405,000
B-20	Water Meter Replacements	8	2	$2,160,000
P-2	Polk Water & Wastewater Facility Fencing Improvements	8	2	$367,000
M-1	Taste & Odor Study	8	2	$50,000
M-2	Water Master Plan Update	8	2	$300,000
	Subtotal Priority 2			**$11,630,000**
D-1	Airport Residential & Industrial Zone Waterlines	8	3	$4,588,000
D-2	Southwest Area Residential Waterlines - North	8	3	$8,976,000

Table 12-2| Recommended Capital Improvement Projects by Priority

Project Code [1]	Project Description	Chapter	Priority	Total Estimated Project Cost [2]
D-3	Southwest Area Residential Waterlines - South	8	3	$8,112,000
D-4	Mt. Fir Rd Waterline Replacement from Washington to 6th St	8	3	$362,000
D-5	Mt. Fir Rd Waterline	8	3	$747,000
D-7	Mt. Fir & Corvallis Road Residential Waterlines	8	3	$2,423,000
P-5	Decommission Monmouth Street Pump Station & Reservoir	8	3	$200,000
S-3	Groundwater Right Development, Permit G-17750	6	3	$10,000
S-8	New Water System Intertie	6	3	$668,000
	Subtotal Priority 3			**$26,086,000**
C-1	Hyacinth St Waterline Replacement	8	4	$326,000
C-2	Williams St Waterline Replacement	8	4	$560,000
C-3	13th St Waterline Replacement	8	4	$420,000
C-4	11th & 12th St Waterline Replacements	8	4	$556,000
C-5	Randall Way Waterline Replacements	8	4	$563,000
C-6	6th & 7th St Waterline Replacements	8	4	$654,000
C-7	Freedom Estates Subdivision Waterline Replacements	8	4	$1,635,000
C-8	I St Waterline Replacement	8	4	$281,000
C-9	5th & 6th St Waterline Replacements	8	4	$549,000
C-10	6th & 7th St Waterline Replacements	8	4	$746,000
C-11	A & B St Waterline Replacements	8	4	$867,000
C-12	2nd & B St Waterline Replacements	8	4	$402,000
C-13	River Drive Waterline Replacement #2	8	4	$242,000
C-14	Independence Airpark Waterline Replacements	8	4	$5,170,000
	Subtotal Priority 4			**$12,971,000**
Recurring Annual Programs (see section 8.4.3)				
Program-1	Non-metered Water Use Tracking System	8	1	$2,000 / year
Program-2	Leak Detection and Repair Program	8	1	$55,000 / year
Program-3	Water Management & Conservation Plan Update	8	1	$6,000/ year
	Subtotal Recurring Annual Programs			**$63,000 per year**

[1] Project Code Legend:
A : Distribution- Fire Flow B: Distribution- End of Service Life C: Distribution- Design Standard Improvement
D : Distribution- Undeveloped Areas
S : Water Source/Supply T : Treatment R : Reservoir/ Storage
M : Miscellaneous Program : Recurring Annual Program

[2] See Section 12.3.2 for basis of project cost estimates, August 2022 ENR 20 City Construction Cost Index of 13171

[3] See Appendix G for detailed project cost estimates.

Figure 12-1 | Water System Capital Improvement Priorities - North

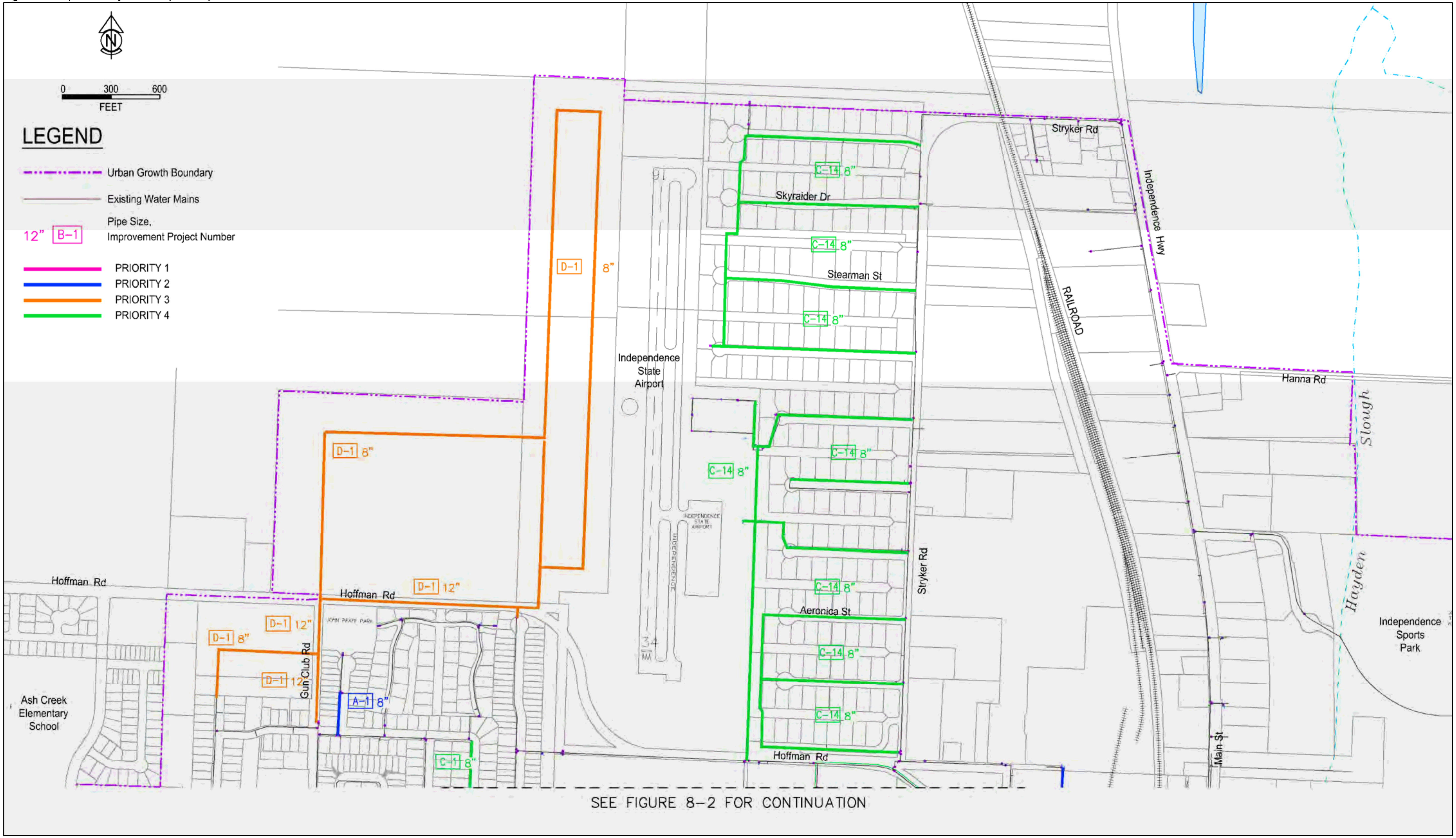


Figure 12-2 | Water System Capital Improvement Priorities - Central

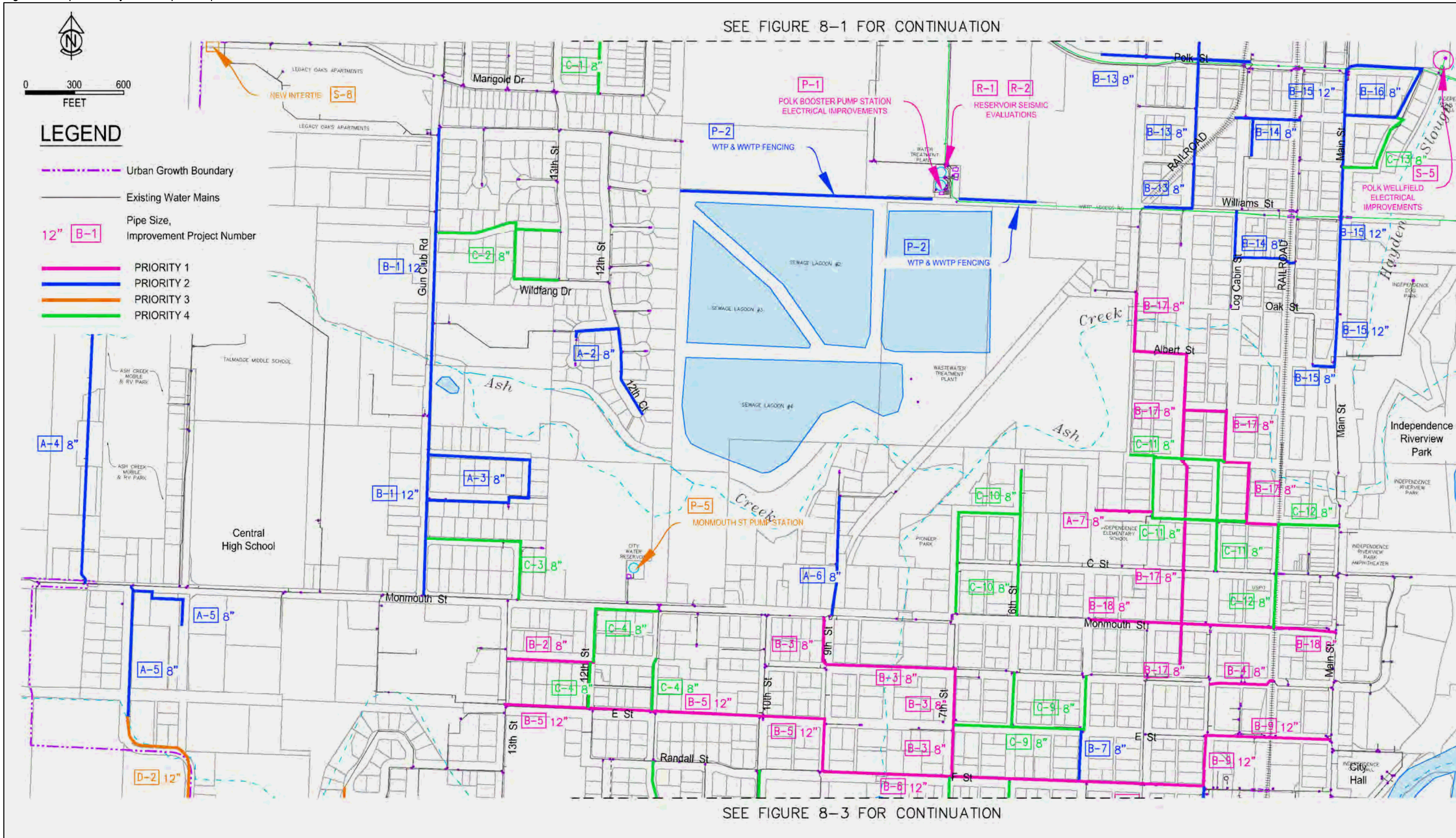


Figure 12-3 | Water System Capital Improvement Priorities - South

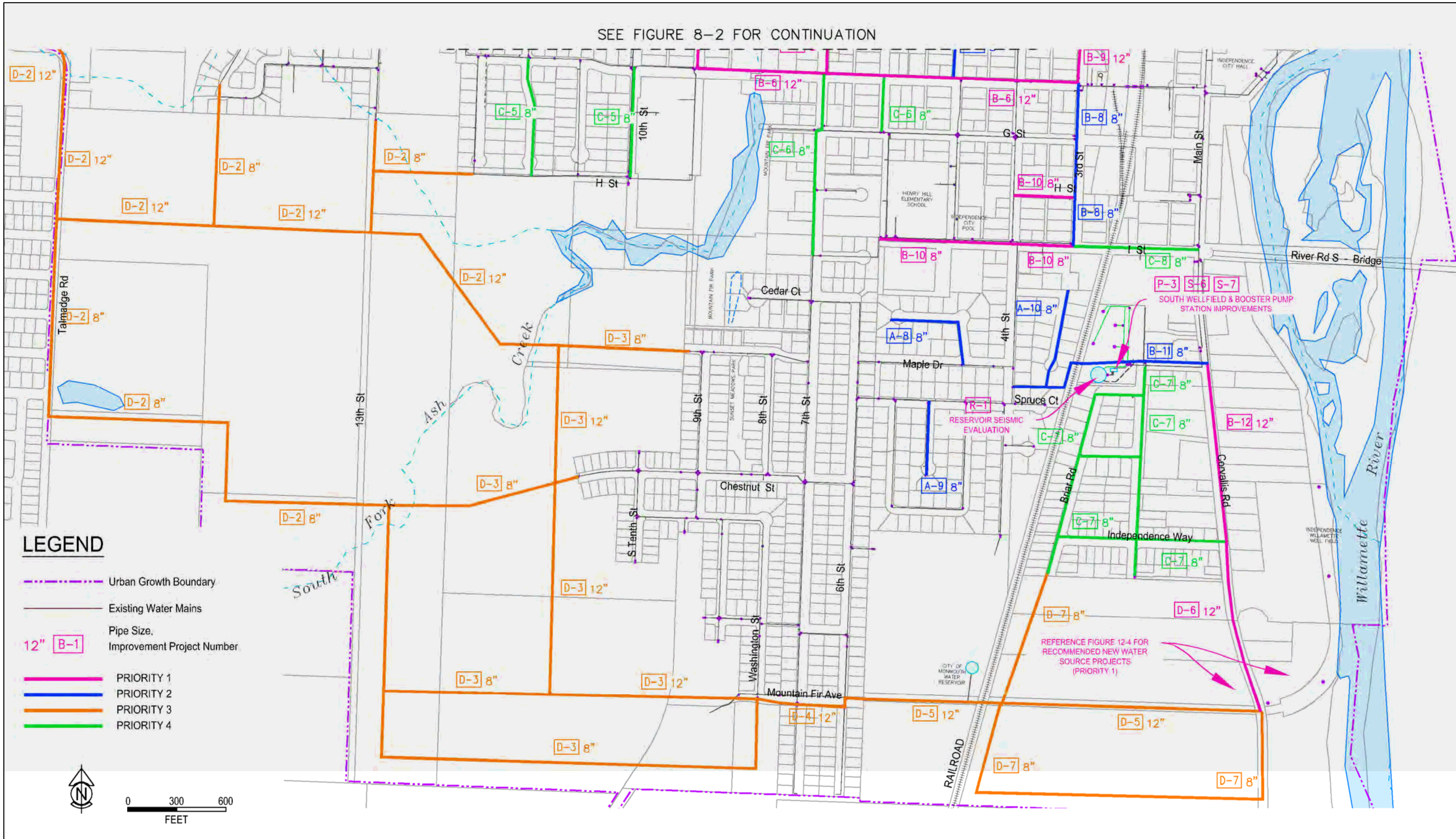
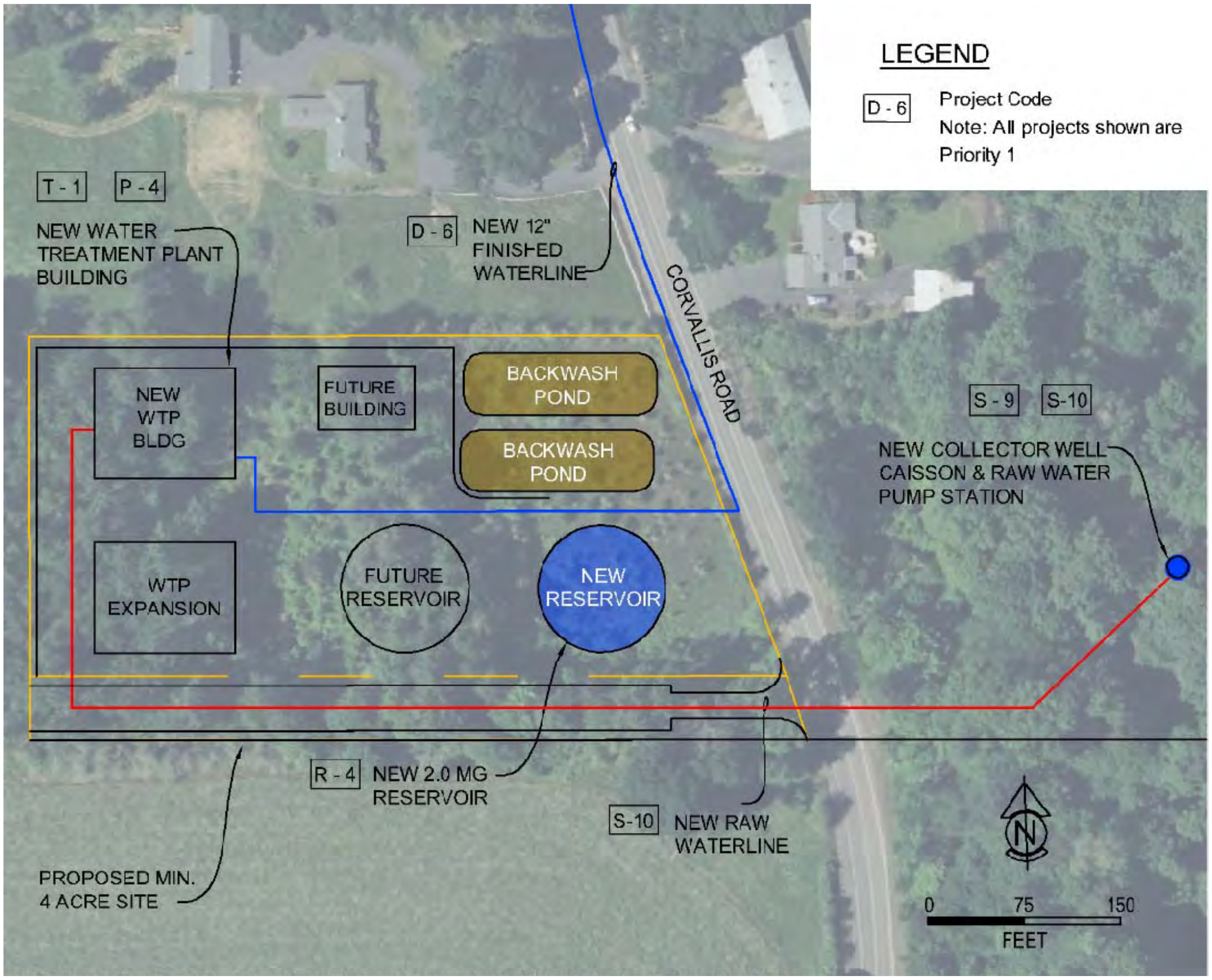


Figure 12-4| Water System Capital Improvement Priorities - New Water Source



12.2.4 Environmental Impacts

It should be noted that while the improvements recommended in this report are not anticipated to have significant adverse impacts on the environment, each CIP project may need to undergo project-specific environmental review as part of the preliminary and final design process.

12.3 Basis of Cost Estimates

In order to forecast municipal capital expenditures, cost estimates have been prepared for each of the improvements. The preparation methodology and intended use of these cost estimates is summarized below. The cost estimates are based on numerous assumptions necessary due to the relative lack of detail available at the master planning stage.

12.3.1 Accuracy of Cost Estimates

The accuracy and precision of cost estimates is a function of the level to which improvement alternatives are developed (i.e., detail and design) and the techniques used in preparing the actual estimate. Estimates are typically divided into three basic categories as follows:

- *Planning Level Estimate*. These are order-of-magnitude estimates made without detailed engineering design data. They are often performed at the zero to 2 percent stage of project completion and typically range from 35 percent over to 25 percent below the final project cost. A relatively large contingency is typically included to reduce the risk of under-estimating. This is particularly important since many times the project financing must be secured before the detailed design can proceed.
- *Budgetary Estimates*. This level of estimate is prepared during the preliminary design phase using process flow sheets, preliminary layouts and equipment details. This type of estimate is typically accurate to (+)30 and (-)15 percent of the final project cost.
- *Engineer's Estimate*. This estimate is prepared on the basis of well-defined engineering data, typically when the construction plans and specifications are completed. The estimating process at this level relies on piping and instrument diagrams, electrical diagrams, equipment data sheets, structural drawings, geotechnical data and a complete set of specifications. This estimate is sometimes called a definite estimate. The engineer's estimate is expected to be accurate within (+)15 to (-)5 percent of the pricing secured during the bidding process.

The project costs prepared as part of this study are planning level estimates. Actual project costs will depend on the final project scope, labor and material costs, market conditions, construction schedule, and other variables at the time the project is built. These variables are typically uncertain at the time planning level estimates are performed.

12.3.2 Adjustment of Cost Estimates Over Time

A commonly used indicator to evaluate the change of construction costs over time is the Engineering News-Record (ENR) construction cost index. The index is computed from the prices for structural steel, Portland cement, lumber, and common labor, and is based on a value of 100 in the year 1913. The construction costs developed in this analysis are based on the August 2022 ENR 20 City Construction Cost Index of 13,171. As the planning period elapses, the costs presented in this study can be updated to the present by applying the ratio of the current cost index to the index used during the preparation of the estimate.

12.3.3 Engineering and Administrative Costs, Contingencies

The cost of engineering services for major projects typically covers special investigations, pre-design reports, topographic surveying, geotechnical investigations, contract drawings and specifications, construction administration, inspection, project start-up, the preparation of O&M manual narratives, and performance certifications. Depending on the size and type of the project, engineering costs may range from 16 to 25 percent of the contract cost when all of the above services are provided. The lower percentage applies to large projects without complex mechanical systems. The higher percentage applies to smaller, more complex projects that require the integration of a complex design into an existing facility and where full time inspection is required by the funding agencies or desired by the Owner.

The City will have administrative costs associated with any construction project. These include internal planning and budgeting costs, administration of engineering and construction contracts, legal services, and coordination with regulatory and funding agencies. The specific values used for engineering, administrative, and construction costs for each type of improvement project are described in the following sections.

Since the funding sources for the completion of the recommended improvements have not yet been confirmed, the cost estimates outlined below are based on the assumption that each of the projects will be designed and constructed separately with local funds.

12.4 CONSTRUCTION COST ESTIMATES

The planning level estimates for the water system improvements recommended in this study are based on a number of assumptions as follows. The cost estimates reflect projects bid in late winter or early spring for summer construction. The estimates are based on construction costs of similar historical projects and on current estimates solicited from material and equipment vendors. The estimates are expected to have accuracies of +35 percent and –25 percent of the actual project cost. The following sections describe the cost estimating process for the various categories of projects.

12.4.1 Pipeline Improvement Costs

The proposed pipeline improvement projects range in size from 8-inches to 12-inches in diameter. These costs were developed using the following assumptions:

- Pipe material for buried pipelines is PVC AWWA C900
- Installation of valves and hydrants are included and shall be installed per City standards
- Standard soil cover is 3 feet and trenching costs exclude rock excavation and trench dewatering
- Reconnection of all services are included for waterline replacement projects
- Asphalt trench repair for the full length of the project for the trench width only
- Railway and highway bores must be added to the unit costs at $900 per linear foot
- Construction contingencies for unforeseen costs are 10% of estimated construction cost
- Engineering is 20% of estimated construction cost
- Legal, permits and administrative costs are 10% of estimated construction cost

Total project costs per foot of installed pipe appear in Table 12-3, along with the percentages listed above for engineering design and administrative costs. Detailed cost estimates for the distribution system improvements are include in **Appendix G**.

Table 12-3| Estimated Pipeline Improvement Costs

Size & Location	Total Cost per Foot
8-inch Pipe in City Right-of-Way	$160
12-inch Pipe in City Right-of-Way	$185
8-inch Pipe in ODOT Right of Way	$210
12-inch Pipe in ODOT Right of Way	$235
Mainline Connections	$15,000 each
Auger Bore Pipe Installation	$900/ ft
Water Services	$4,000 each
New Fire Hydrants Including Lateral Piping	$8,000 each

12.4.2 Source Improvement Costs

Construction costs for the new collector well structure includes site preparation, structures, buildings, pumps, mechanical piping, electrical and instrumentation. Project costs have been based on historical construction cost information for similarly sized projects.

A construction contingency of 10% was assumed for the source improvements. Engineering costs of 20% as well as legal, administration, and permitting costs of 10% were also assumed for these projects.

12.4.3 Water Treatment Improvement Costs

Construction costs for water treatment plant improvements include mobilization, buildings, associated mechanical piping and pumping, as well as electrical and instrumentation modifications.

A construction contingency of 10% was assumed for the water treatment improvements. Engineering costs of 20% as well as legal, administration, and permitting costs of 10% were also assumed for these projects.

12.4.4 Storage Tank Improvement Costs

Construction costs for storage tank improvements include mobilization, erosion control, excavation & earthwork, associated mechanical piping, electrical and instrumentation, as well as civil site improvements.

A construction contingency of 10% was assumed for the storage tank improvements. Engineering costs of 20% as well as legal, administration, and permitting costs of 10% were also assumed for these projects.

12.5 FUNDING SOURCES

It is anticipated that the funding for the recommended capital improvement plan outlined in this report will be secured from multiple sources, including system development charges (SDCs), monthly user fees, as well as state and federal grant and loan programs. The following section outlines the major local and State/Federal funding programs that may be available for these projects.

12.5.1 Local Funding Sources

To a large degree, the type and amount of local funding used for the water system improvements will depend on the amount of grant funding obtained and the requirements of any loan funding. Local revenue sources for capital improvements include ad valorem taxes (property taxes), various types of bonds, water user fees, connection fees and SDCs. Local revenue sources for operating costs are generally limited to water user fees. The following sections discuss local funding sources and financing mechanisms that are most commonly used for the type of capital improvements presented in this study.

12.5.1.1 Existing Debt Service

The City currently has two outstanding loans for the water system (Table 12-4). As of May of 2021, the total outstanding principal owed is approximately $1,733,000 and the minimum debt service payments total approximately $185,000 per year.

Table 12-4 | Water Utility Existing Debt

Loan Description	Loan Amount	Term (years)	Payoff Date	Interest Rate	Annual Total Payment	Outstanding Principal (5/2021)
Water Bond 2016A	$1,335,000	20	2036	3.013%	±$91,000	$1,075,000
Water Rights 2019 (Chase Bank)	$800,000	10	2029	2.9%	±$93,307	$657,754

12.5.1.2 Water User Fees

User fees are monthly charges to all residences, businesses, and other users that are connected to the water system. User fees are established by the City Council and are typically the sole source of revenue to finance operation and maintenance. The City's current water user fee schedule is established by Resolution 20-1543. Water user fees include monthly fees for usage, connection fees, and other miscellaneous fees. For most residential and commercial connections (i.e., ¾-inch meters), the City currently charges a base usage fee of $34.79 per month. Users with 1-inch meters are charged a base fee of $73.06 per month. Users with larger meters are charged higher base fees per month. All users regardless of meter size pay an additional fee of $3.33 per 100 cubic feet of water usage per month.

The anticipated revenue from water user fees for the fiscal year 2021/2022 is budgeted to be $2,747,500. Including other various charges and interest earnings, the total water fund revenues for the 2021/2022 fiscal year are budgeted to be $3,025,550. In addition to revenues, the 2021/2022 fiscal year budget also includes a beginning balance of $1,268,310. This is budgeted to be utilized for costs in the fiscal year.

The City's water fund must provide sufficient revenues to properly operate and maintain the water system and provide reserves for normally anticipated replacement of key system components such as meters, pumps, motors, electrical, chemical feed equipment, fire hydrants and distribution piping repairs. Although the City relies exclusively on user fees for operation and maintenance costs, the water fund is typically not adequate to finance major capital improvements without outside funding sources.

12.5.1.3 System Development Charges

A system development charge (SDC) is a fee collected by the City for each piece of property when it is developed and serviced by the City's roads and utilities. SDC's are used to finance necessary capital improvements and municipal services required by the development. SDC's can be used to recover the capital costs of infrastructure required as a result of the development, but cannot be used to finance either operation and maintenance or replacement costs.

The SDC fee system was most recently adopted by Resolution Number 20-1543. The City charges different SDC fees based on residential or commercial developments and based on the size of the water meter installed at each development. The current fee structure is listed in Table 4-11.

Table 12-5 | Current Water SDC Fees

Residential	
Single Family Unit	$3,089.00
Multi-family Unit	$2,468.00
Commercial Building	
Meter Size	**SDC Charge**
3/4-inch	$2,468.00
1-inch	$4,391.00
1 ½-inch	$9,874.00
2-inch	$17,552.00
3-inch	$43,973.00
4-inch	$70,395.00

As established in ORS 223, an SDC can have two principal elements, the reimbursement fee and the improvement fee. The reimbursement fee portion of the SDC is the fee for buying into either existing capital facilities or those that are under construction (i.e., it represents a charge for utilizing excess capacity in an existing facility that was paid for by the City or previous developers). The revenue from this fee is typically used to repay existing improvement loans.

The improvement fee portion of the SDC is the fee designed to cover the costs of capital improvements that must be constructed to provide an increase in capacity to support the development.

Over the last three fiscal years, the City has collected approximately $130,000 per year in water SDC's.

Based on the infrastructure improvements and cost projections presented in this master plan, the existing SDC fee structure is insufficient to meet the planning period goals. This plan accordingly recommends that the City complete a full review of its SDC rate structure and update these fees accordingly.

12.5.1.4 Connection Fees

Many cities charge connection fees to cover the cost of connecting a new development to the municipal water system. There are two types of connection fees. The first is for newly constructed connections and is designed to cover the cost of City inspections at the time of connection to the distribution system. The second type of fee is designed to defray the City's administrative cost of setting up a new account and is charged against newly constructed connections as well as transfers of an existing service to a new owner.

12.5.1.5 Capital Construction Fund

Capital construction funds or sinking funds are often established as a budget line item to set aside money for a particular construction purpose. A set amount from each annual budget is deposited in a sinking fund until sufficient reserves are available to complete the project. Such funds can also be developed from user fee revenues or from SDCs.

12.5.1.6 General Obligation Bonds

The sale of municipal general obligation bonds is a traditional method of funding municipal water improvement projects. General obligation bonds utilize the City's basic taxing authority and are retired with property taxes based on an equitable distribution of the bonded obligation across the City's assessed valuation. General obligation bonds are normally associated with the financing of facilities that benefit an entire community and must be approved by a majority vote of the City's voters.

General obligation bonds are backed by the City's full faith and credit, as the City must pledge to assess property taxes sufficient to pay the annual debt service. This portion of the property tax is outside the State constitutional limits that restrict property taxes to a fixed percentage of the assessed value. The City may use other sources of revenue, including water user fee revenues, to repay the bonds. If it uses other funding sources to repay the bonds, the amount collected as taxes is reduced commensurately.

The general procedure followed when financing water system improvements with general obligation bonds is typically as follows:

- Determination of the capital costs required for the improvement
- An election by the voters to authorize the sale of bonds
- The bonds are offered for sale
- The revenue from the bond sale is used to pay the capital cost of the project(s)

General obligation bonds can be "revenue supported", wherein a portion of the user fee is pledged toward repayment of the bond debt. The advantage of this method is that the need to collect additional property taxes to retire the bonds is reduced or eliminated. Such revenue supported general obligation bonds have most of the advantages of revenue bonds in addition to a lower interest rate and ready marketability.

The primary disadvantage of general obligation debt is that it is often added to the debt ratios of the City, thereby restricting the flexibility of the municipality to issue debt for other purposes.

12.5.1.7 Revenue Bonds

Revenue bonds are similar to general obligation bonds, except they rely on revenue from the sales of the utility (i.e., user fees) to retire the bonded indebtedness. The primary security for the bonds is the City's pledge to charge user fees sufficient to pay all operating costs and debt service. Because the reliability of the source of revenue is relatively more speculative than for general obligation bonds, revenue bonds typically have slightly higher interest rates.

The general shift away from ad valorem property taxes makes revenue bonds a frequently used option for payment of long term debt. Many communities prefer revenue bonding, because it ensures that no additional taxes are levied. In addition, repayment of the debt obligation is limited to system users since repayment is based on user fees.

One advantage with revenue bonds is that they do not count against a City's direct debt. This feature can be a crucial advantage for a municipality near its debt limit. Rating agencies closely evaluate the amount of direct debt when assigning credit ratings. There are normally no legal limitations on the amount of revenue bonds that can be issued; however, excessive issue amounts are generally unattractive to bond buyers because they represent high investment risks.

Under ORS 288.805-288.945, cities may elect to issue revenue bonds for revenue producing facilities without a vote of the electorate. Certain notice and posting requirements must be met and a sixty (60) day waiting period is mandatory.

The bond lender typically requires the City to provide two additional securities for revenue bonds that are not required for general obligation bonds. First, the City must set user fees such that the net projected cash flow from user fees plus interest will be at least 125% of the annual debt service (a 1.25 debt coverage ratio). Secondly, the City must establish a bond reserve fund equal to maximum annual debt service or 10% of the bond amount, whichever is less.

12.5.1.8 Improvement Bonds

Improvement (Bancroft) bonds are an intermediate form of financing that are less than full-fledged general obligation or revenue bonds. This form of bonding is typically used for Local Improvement Districts.

Improvement bonds are payable from the proceeds of special benefit assessments, not from general tax revenues or user fees. Such bonds are issued only where certain properties are recipients of water system improvements. For a specific improvement, all property within the designated improvement district is assessed on the same basis, regardless of whether the property is developed or undeveloped. The assessment is designed to divide the cost of the improvements among the benefited property owners. The manner in which it is divided is in proportion to the direct or indirect benefits to each property. The assessment becomes a direct lien against the property, and owners have the option of either paying the assessment in cash, or applying for improvement bonds. If the improvement bond option is taken, the City sells Bancroft Improvement Bonds to finance the construction, and the assessment is paid in accordance with a payment schedule.

The assessments against the properties are usually not levied until the actual cost of the project is determined. Since actual costs cannot normally be determined until the project is completed, funds are not available from assessments for the purpose of paying costs at the time of construction. Therefore, some method of interim financing must be arranged.

The primary disadvantage to this source of revenue is that the development of an assessment district is very cumbersome and expensive when facilities for an entire City are contemplated. Therefore, this method of financing should only be considered for discrete improvements to the system where the benefits are localized and easily quantified.

12.5.1.9 Certificates of Participation

Certificates of Participation are a form of bond financing that is distinct from revenue bonds. While it is more complex, and typically has a higher interest rate than revenue bonds, it is a process controlled by the City Council, and it does not have to be referred to the voters. This can result in significant time savings.

12.5.1.10 Ad Valorem Taxes

Ad valorem property taxes were often used in the past as a revenue source for public utility improvements. These taxes were the traditional means of obtaining revenue to support all local governmental functions. Ad valorem taxation is a financing method that applies to all property owners that benefit, or could potentially benefit from a water system improvement, whether the property is developed or not. The construction costs for the improvement project are shared proportionally among all property owners based on the assessed value of each property. Ad valorem taxation, however, is less likely to result in individual users paying their proportionate share of the costs as compared to their benefits.

12.5.2 State and Federal Grant and Loan Programs

Several state and federal grant and loan programs are available to provide financial assistance for municipal water system improvements. The primary sources of funding available for water system financing are Rural Utilities Service (RUS), Special Public Works Fund (SPWF), the Water/Wastewater (W/W) Financing Program, the Community Development Block Grant (CDBG) program, and the Safe Drinking Water Revolving Loan Fund (SDWRLF).

12.5.2.1 Rural Utility Services

Rural Utility Service (RUS) provides federal loans and grants to rural municipalities, counties, special districts, Indian tribes, and not-for-profit organizations to construct, enlarge, or modify water treatment and distribution systems and wastewater collection and treatment systems. Preference is given to projects in low-income communities with populations below 10,000.

Borrowers of RUS loans must be able to demonstrate the following:

- Monthly user rates must be at or above the state-wide average.
- They have the legal authority to borrow and repay loans, to pledge security for loans, and to operate and maintain the facilities and services.
- They are financially sound and able to manage the facility effectively.
- They have a financially sound facility based on taxes, assessments, revenues, fees, or other satisfactory sources of income to pay for all facility costs including O&M and to retire indebtedness and maintain a reserve.

The maximum RUS loan term is 40 years, but the finance term may not exceed statutory limitations on the agency borrowing the money or the expected useful life of the improvements. The reserve can typically be funded at 10 percent per year over a ten-year period. Interest rates for RUS loans vary based on median household income, but tend to be lower than those obtained in the open market.

12.5.2.2 Infrastructure Finance Authority

The Oregon Infrastructure Finance Authority (IFA) manages a number of grant and low interest loan programs as describe in the following sections.

- *Special Public Works Fund*

The IFA administers the Special Public Works Fund (SPWF) program. The SPWF is a lottery-funded loan and grant program that provides funding to municipalities, counties, special districts, and public ports for infrastructure improvements to support industrial/manufacturing and eligible commercial economic development. Eligible commercial economic development is defined as commercial activity that is marketed nationally, or internationally, and attracts business from outside Oregon. Funded projects are usually linked to a specific private sector development and the resulting direct job creation (i.e., firm business commitment), of which 30% of the created jobs must be "family wage" jobs. The program also funds projects that build infrastructure capacity to support industrial/manufacturing development where recent interest by eligible business(s) can be documented.

The SPWF is primarily a loan program, although grant funds are available based on economic need of the community. Although the maximum loan term is 25 years, loans are generally made for 20-year terms. The maximum loan amount for projects funded with direct SPWF money is $1 million, while the maximum for projects financed with bond funds is $10 million.

- *Bond Bank Program*

The Bond Bank program, administered by IFA, attempts to lower the cost of issuing debt by pooling small revenue bond issues from many communities into one large revenue bond issue. It uses lottery proceeds to write down financing costs, and to improve the debt/equity ratio on projects. The interest rate for repayment of funds is typically around 6 percent, with up to a 25 year term.

- *Water/Wastewater Financing Program*

IFA also administers the W/W Financing Program, which gives priority to projects that provide system-wide benefits and helps communities meet the Clean Water Act or the Safe Drinking Water Act standards. It is intended to assist local governments that have been hard hit with state and federal mandates for public drinking water systems and wastewater systems. In order to be eligible for this program, the system must be out of compliance with federal or state rules, regulations or permits, as evidenced by issuance of a Notice of Non-Compliance by the appropriate regulatory agency. The funded project must be needed to meet state or federal regulations. Priority is given to communities under economic distress.

Similar to the SPWF, the W/W Financing Program is primarily a loan program, although grant funds are available in certain cases, based on economic need of the community. Although the maximum loan term is 25 years, loans are generally made for 20-year terms. The maximum loan amount for projects funded with direct W/W money is $500,000, while the maximum for projects financed with bond funds is $10 million.

- *Economic and Community Development Block Grant*

The IFA administers the CDBG, but the funds are from the U.S. Department of Housing and Urban Development (HUD), so all federal grant management rules apply to the program. The federal eligibility standards are strict. There are two subcategories of Public Works projects eligible for funding, "Public Water and Wastewater," and "Public Works for New Housing." Only the former is considered in this discussion.

Grants are available for critically needed construction, improvement, or expansion of publicly owned water and wastewater systems for the benefit of current residents. Generally, projects must be necessary to resolve regulatory compliance problems identified by state and/or federal agencies and the project must serve a community that is comprised of more than 51% of low and moderate income persons.

The program separates projects into three parts. Grants are available for:

- *Preliminary Engineering and Planning Projects*. Generally, these grants fund preparation or update of Water System Master Plans and Wastewater Facility Plans, as required by the Oregon Department of Environmental Quality or Oregon Health Division. In addition, funds for grant administration and preparation of a final design funding application can be included in the project budget. All plans produced with grant funds must be approved by the appropriate regulatory agency. Grants of up to $10,000 can also be made for problem identification studies to delineate problems and corrective measures, as required by a regulatory agency.
- *Final Design and Engineering Projects*. Final design and engineering, bid specifications, environmental review, financial feasibility, rate analysis, grant administration, and preparing a construction funding application are all eligible project activities. The final design, plans and specifications must be approved by the appropriate regulatory agency before a grant will be awarded.
- *Construction Projects*. These grants fund construction and related activities, grant administration, and land/permanent easement acquisition. IFA has established an evaluation system that gives priority to projects that provide system-wide benefits. The overall maximum grant amount per water or wastewater project is $2,500,000 (including all planning, final engineering, and construction). The project cannot be divided locally into phases with the expectation of receiving more than one $2,500,000 grant. In order to qualify for grant funding under this program, the water user rates must be at or above statewide averages.

12.5.2.3 Safe Drinking Water Loan Fund & Drinking Water Protection Loan Fund

The Safe Drinking Water Loan Fund is administered by IFA with assistance from OHA and provides loans to cities, counties, special districts, and Indian tribes to construct, expand, or rehabilitate water treatment, distribution, and storage facilities in order to comply with the federal Safe Drinking Water Act. Interest rates on loans are about 80% of the general obligation bond rate; however, there are additional financing costs and annual service fees that increase the effective rate. The maximum loan amount per project is $6,000,000. The maximum loan term is 20 years except for disadvantaged communities that may qualify for loan terms up to 30 years provided the loan term does not exceed the useful life of the facility being constructed.

12.5.2.4 Water Development Loan Fund

The Water Development Loan Fund is administered by the Oregon Water Resources Department. This program provides loans to municipal water suppliers with a population under 30,000. These loans are available with up to 30-year terms.

12.5.3 Funding Recommendations

As available grant funding on public works projects has decreased in the last several years, it will be incumbent upon the City to aggressively pursue funding to finance the cost of the recommended improvements. Based on the infrastructure improvements and cost projections presented in this master plan, the existing user rates and SDC fee structure is insufficient to fund all the Priority 1 and Priority 2 projects. This plan accordingly recommends that the City complete a full review of its SDC and user fee structure and update these fees accordingly.

12.6 RECOMMENDED IMPLEMENTATION PLAN

It is recommended that the City plan to construct all Priority 1 and Priority 2 projects during the planning period. It is envisioned that the Priority 3 improvements will be constructed by the City after the current planning period (i.e., after 2045). It is recommended to begin design work on the highest priority projects as soon as possible after final approval of the Master Plan.

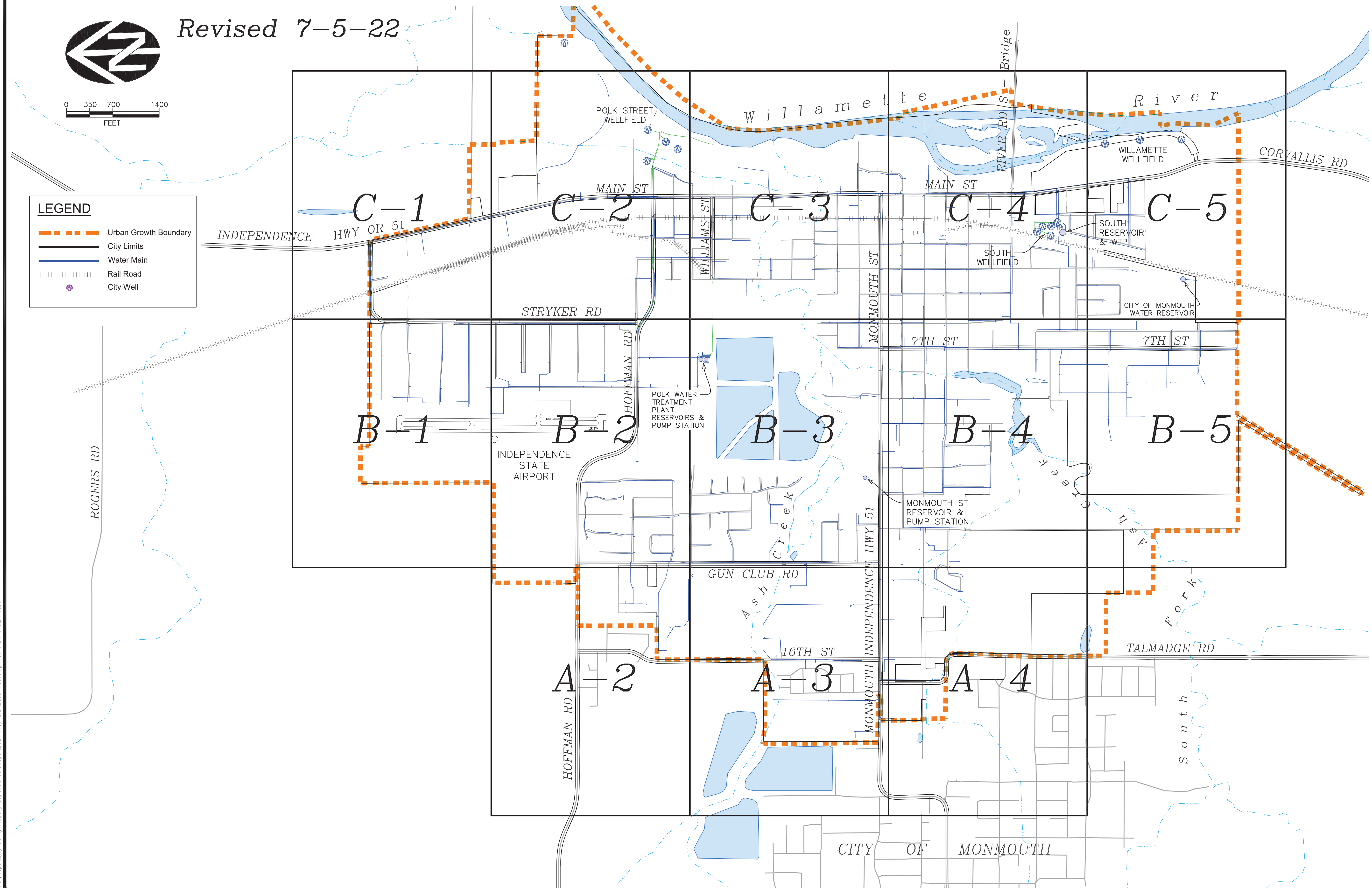
APPENDICES

APPENDIX A

City of Independence Water System Utility Maps

WATER SYSTEM MAP INDEX – CITY OF INDEPENDENCE

Revised 7–5–22



VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING

0 1"

IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

DSN.	PS
DRN.	TMT
CKD.	PS
DATE:	SEPT 2021

NO.	DATE	DESCRIPTION	BY
1			

REVISIONS

REVIEW

WESTECH ENGINEERING, INC.
CONSULTING ENGINEERS AND PLANNERS
3841 Fairview Industrial Dr. S.E., Suite 100, Salem, OR 97302
Phone: (503) 585–2474 Fax: (503) 585–3986
E-mail: westech@westech-eng.com

CITY OF INDEPENDENCE, OREGON

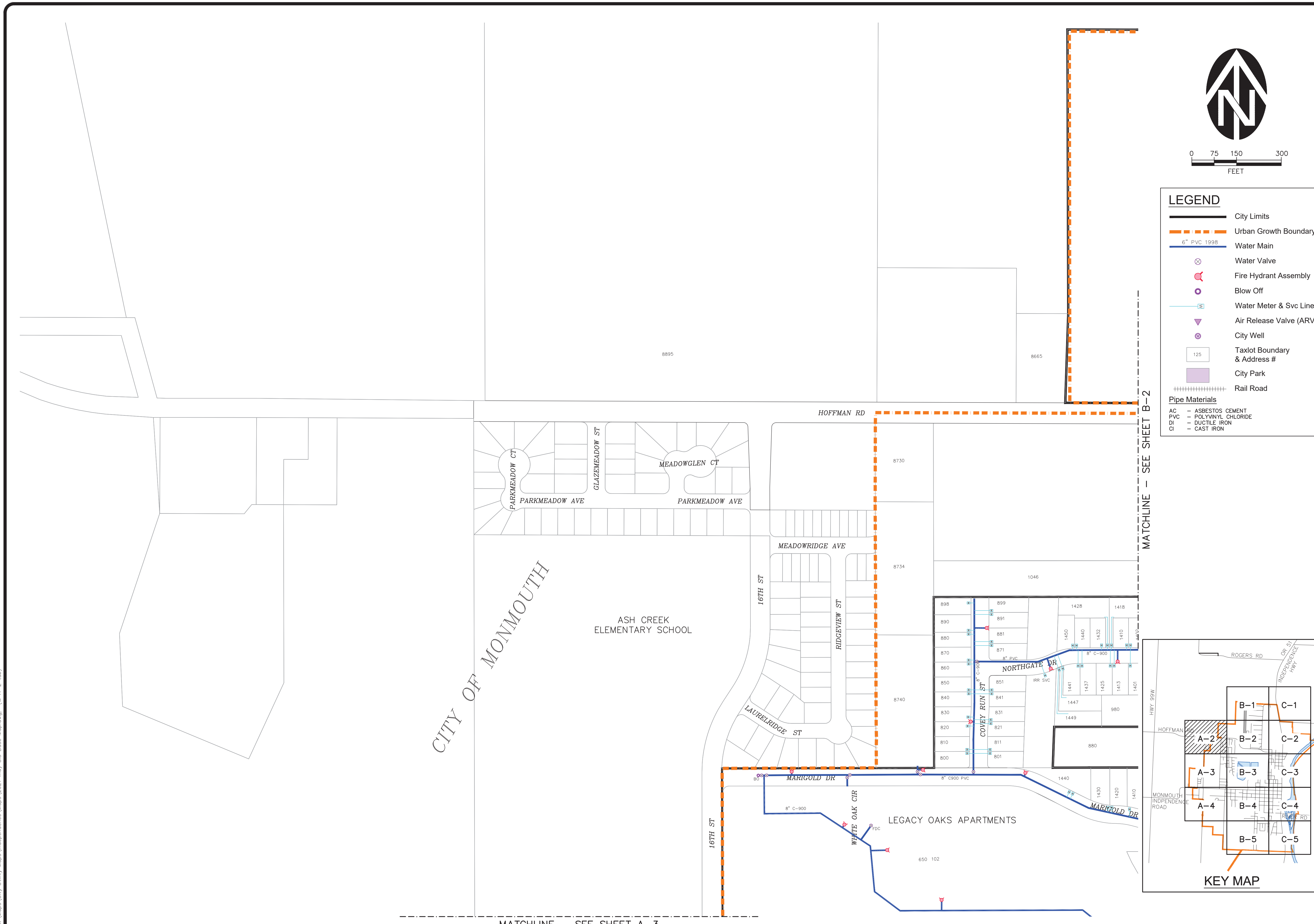
UTILITY MAP

WATER SYSTEM MAP INDEX

SHEET INDEX 1 OF 14

JOB NUMBER 2814.4020.0

7/5/2022 2:35:22 PM R:\Maps\City Utility Maps\Independence\Maps\2021 Indy GIS Base Map.dwg, (WATER-INDEX tab)



REVISIONS

NO.	DATE	DESCRIPTION	BY
1			

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

DSN. PS
DRN. TMT
CKD. PS
DATE: SEPT 2021

REVIEW

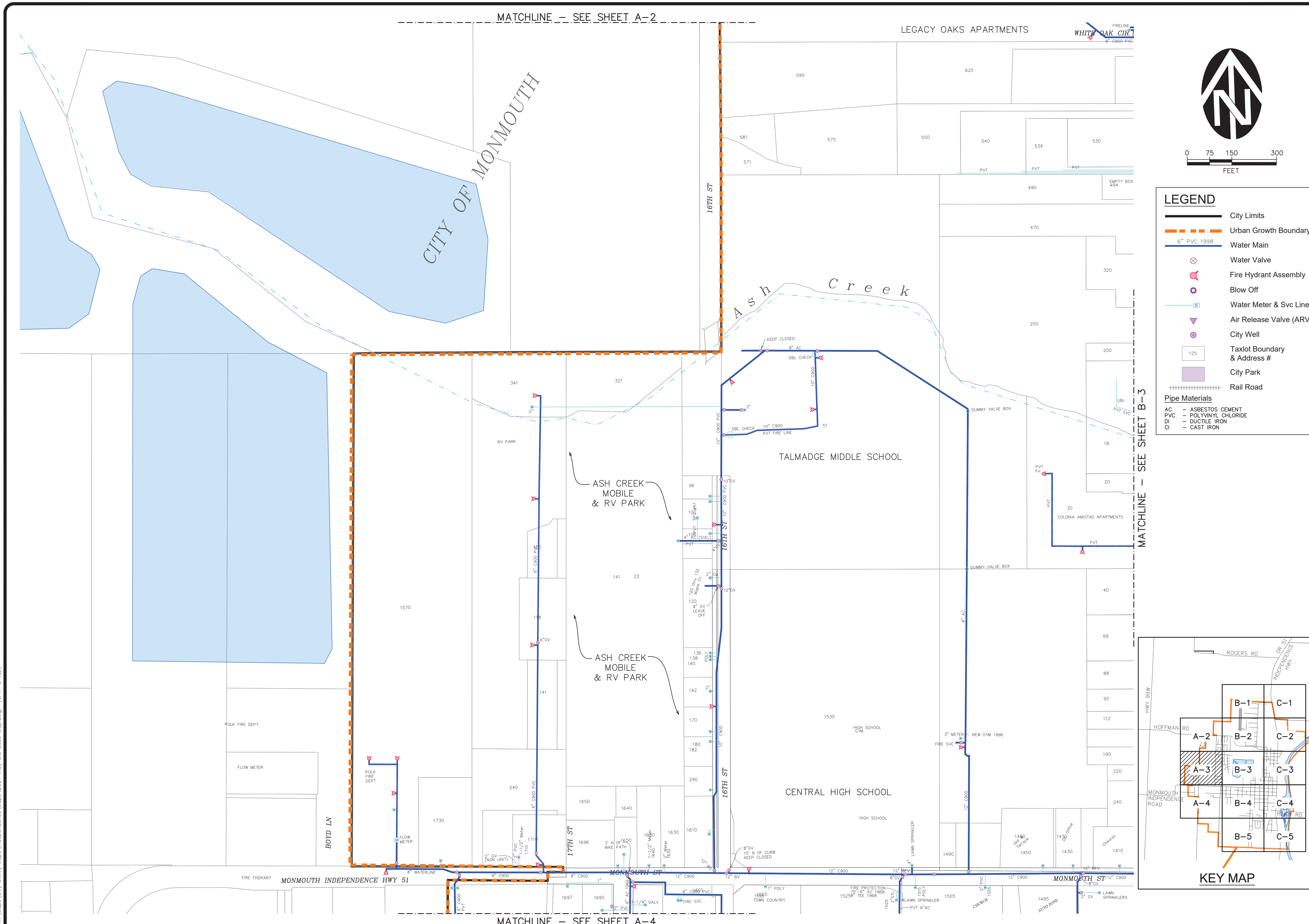
WESTECH ENGINEERING, INC.
CONSULTING ENGINEERS AND PLANNERS
3841 Fairview Industrial Dr. S.E., Suite 100, Salem, OR 97302
Phone: (503) 585-2474 Fax: (503) 585-3986
E-mail: westech@westech-eng.com

CITY OF INDEPENDENCE, OREGON
UTILITY MAP

WATER SYSTEM MAP A–2

SHEET A–2
2 OF 14

JOB NUMBER
2814.4020.0



7/5/2022 2:10:41 PM
R:\Maps\City Utility Maps\Independence\Maps\2021 Indy GIS Base Map.dwg, (W A-3 tab)

NO.	DATE	DESCRIPTION	BY
1			

REVISIONS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

DSN. PS
DRN. TMT
CKD. PS
DATE: SEPT 2021

REVIEW

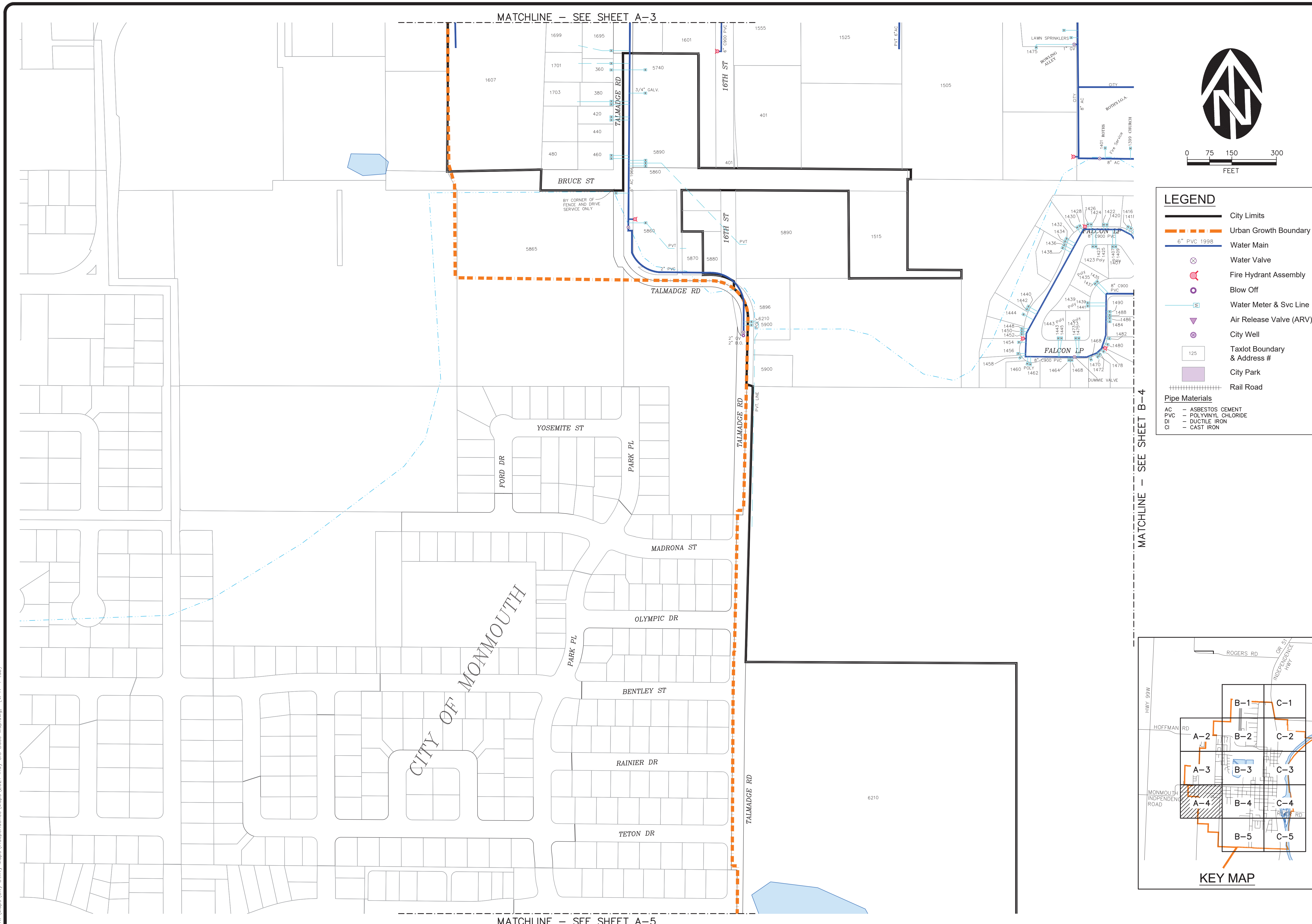
WESTECH ENGINEERING, INC.
CONSULTING ENGINEERS AND PLANNERS
3841 Fairview Industrial Dr. S.E., Suite 100, Salem, OR 97302
Phone: (503) 585-2474 Fax: (503) 585-3986
E-mail: westech@westech-eng.com

CITY OF INDEPENDENCE, OREGON
UTILITY MAP

WATER SYSTEM MAP A–3

SHEET
A–3
3 OF 14

JOB NUMBER
2814.4020.0



VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

NO.	DATE	DESCRIPTION	BY
1			

REVISIONS

DSN. PS
DRN. TMT
CKD. PS
DATE: SEPT 2021

REVIEW

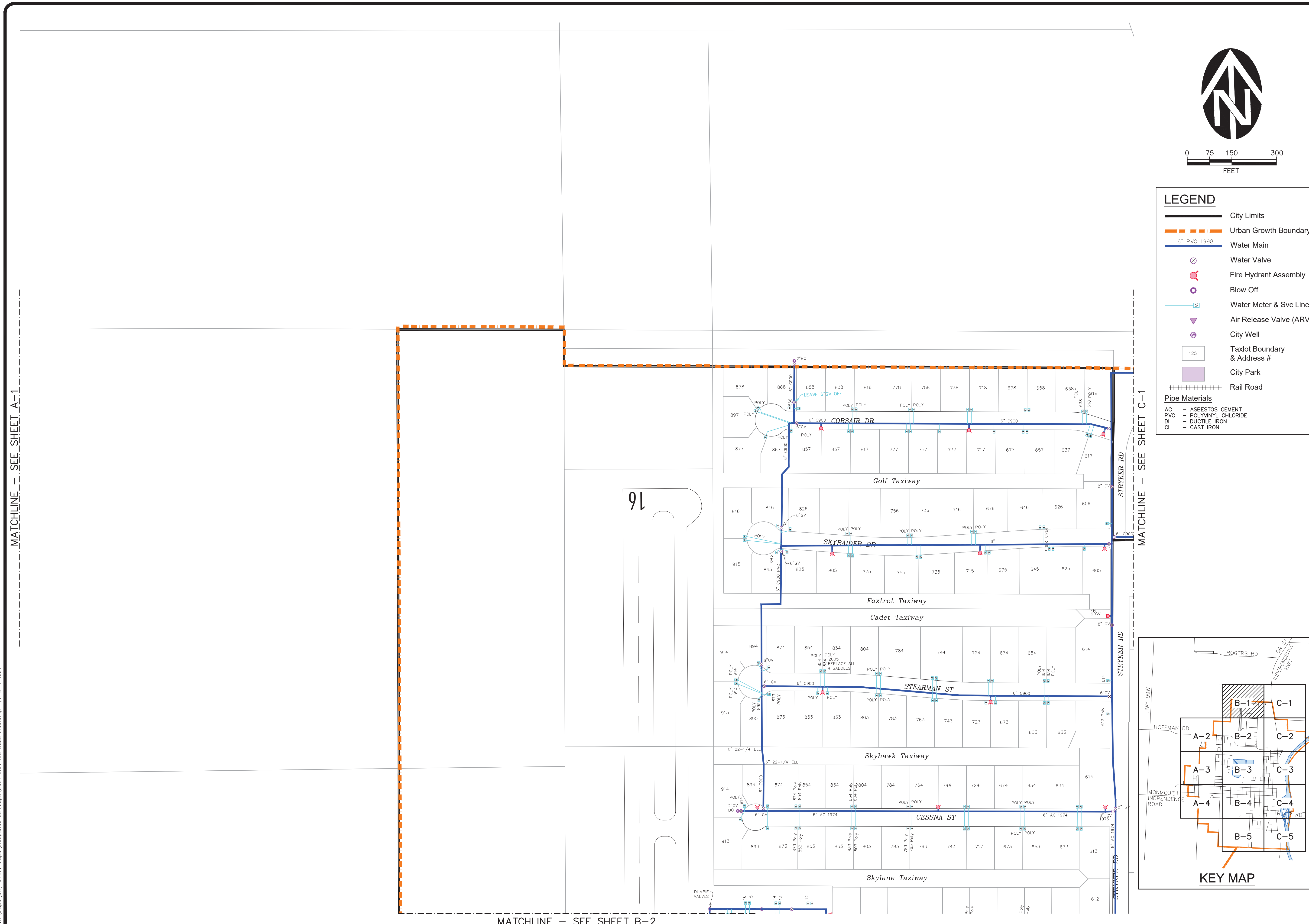
WESTECH ENGINEERING, INC.
CONSULTING ENGINEERS AND PLANNERS
3841 Fairview Industrial Dr. S.E., Suite 100, Salem, OR 97302
Phone: (503) 585-2474 Fax: (503) 585-3986
E-mail: westech@westech-eng.com

CITY OF INDEPENDENCE, OREGON
UTILITY MAP

WATER SYSTEM MAP A-4

SHEET A-4
4 OF 14

JOB NUMBER
2814.4020.0



7/5/2022 2:10:45 PM
R:\Maps\City Utility Maps\Independence\Maps\2021 Indy GIS Base Map.dwg, (W B-1 tab)

NO.	DATE	DESCRIPTION	BY
1			

REVISIONS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.
0 1"

DSN. PS
DRN. TMT
CKD. PS
DATE: SEPT 2021

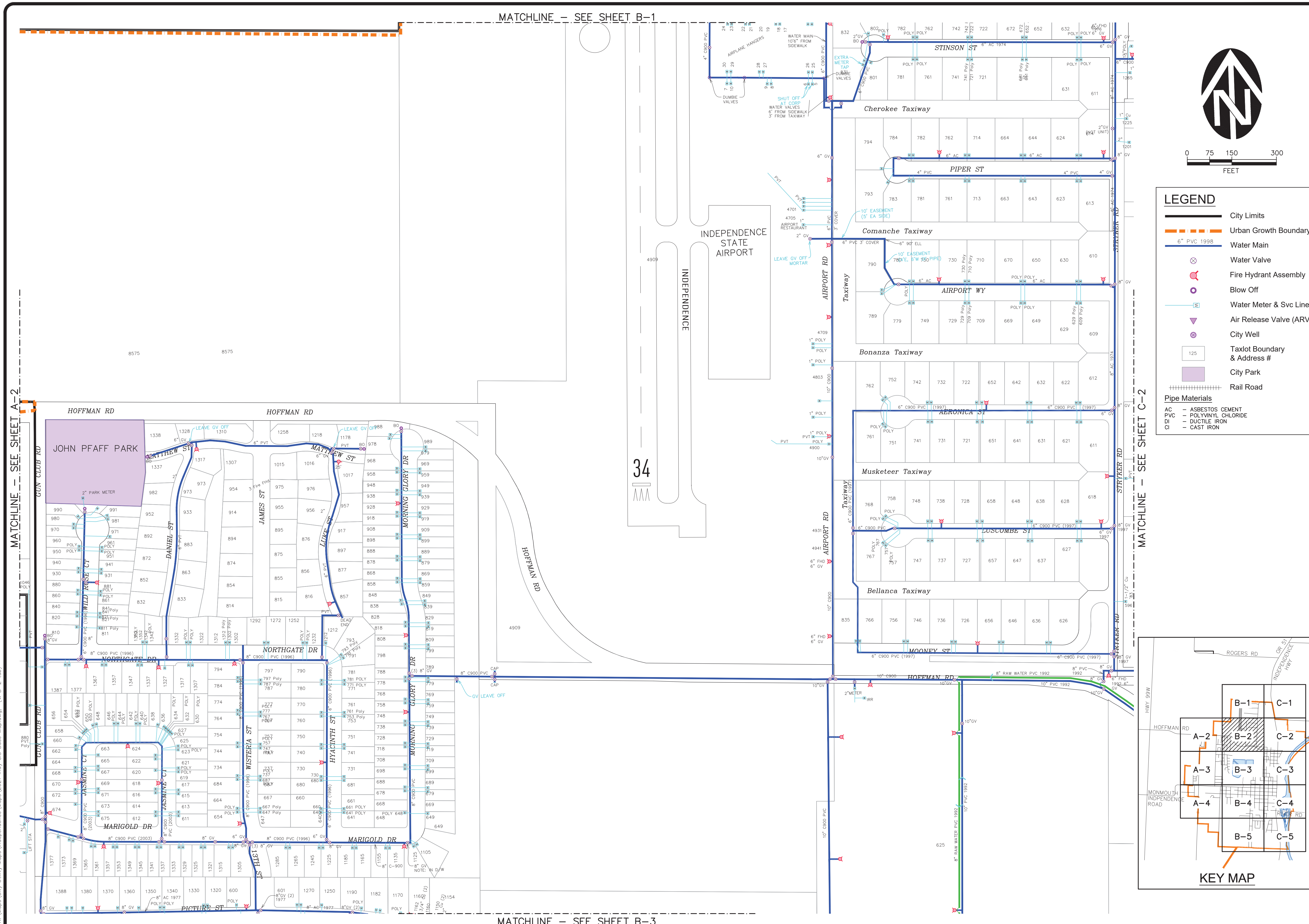
REVIEW

WESTECH ENGINEERING, INC.
CONSULTING ENGINEERS AND PLANNERS
3841 Fairview Industrial Dr. S.E., Suite 100, Salem, OR 97302
Phone: (503) 585-2474 Fax: (503) 585-3986
E-mail: westech@westech-eng.com

CITY OF INDEPENDENCE, OREGON
UTILITY MAP
WATER SYSTEM MAP B-1

SHEET
B-1
5 OF 14

JOB NUMBER
2814.4020.0



7/5/2022 2:10:47 PM
R:\Maps\City Utility Maps\Independence\Maps\2021 Indy GIS Base Map.dwg, (W B-2 tab)

NO.	DATE	DESCRIPTION	BY
1			

REVISIONS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

DSN. PS
DRN. TMT
CKD. PS
DATE: SEPT 2021

REVIEW

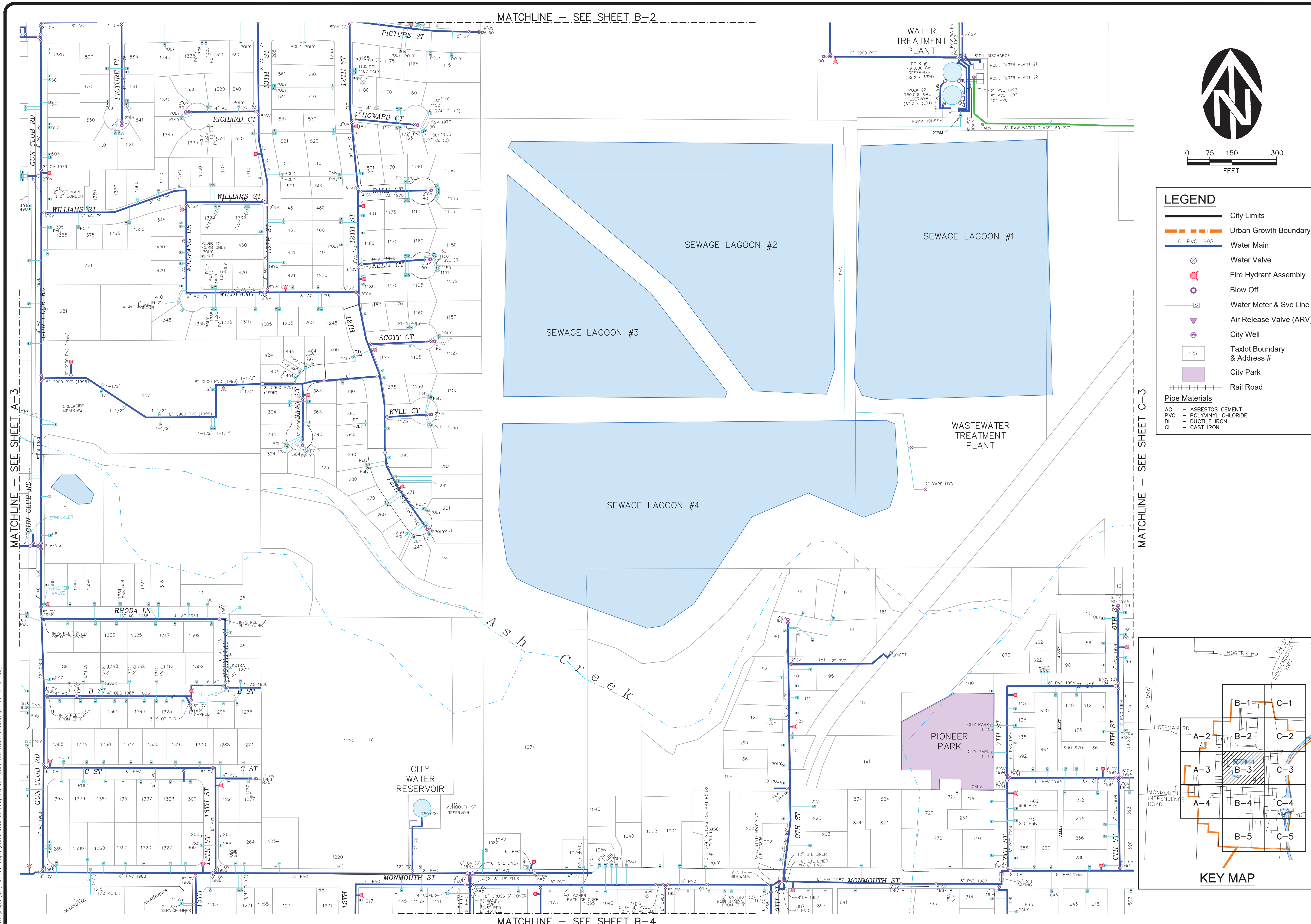
WESTECH ENGINEERING, INC.
CONSULTING ENGINEERS AND PLANNERS
3841 Fairview Industrial Dr. S.E., Suite 100, Salem, OR 97302
Phone: (503) 585-2474 Fax: (503) 585-3986
E-mail: westech@westech-eng.com

CITY OF INDEPENDENCE, OREGON
UTILITY MAP

WATER SYSTEM
MAP B–2

SHEET
B–2
6 OF 14

JOB NUMBER
2814.4020.0



REVIEW

CITY OF INDEPENDENCE, OREGON
UTILITY MAP
SANITARY SEWER SYSTEM
MAP B-3

WESTECH ENGINEERING, INC.
CONSULTING ENGINEERS AND PLANNERS
3841 Fairview Industrial Dr. S.E., Suite 100, Salem, OR 97302
Phone: (503) 585-2474 Fax: (503) 585-3986
E-mail: westech@westech-eng.com

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

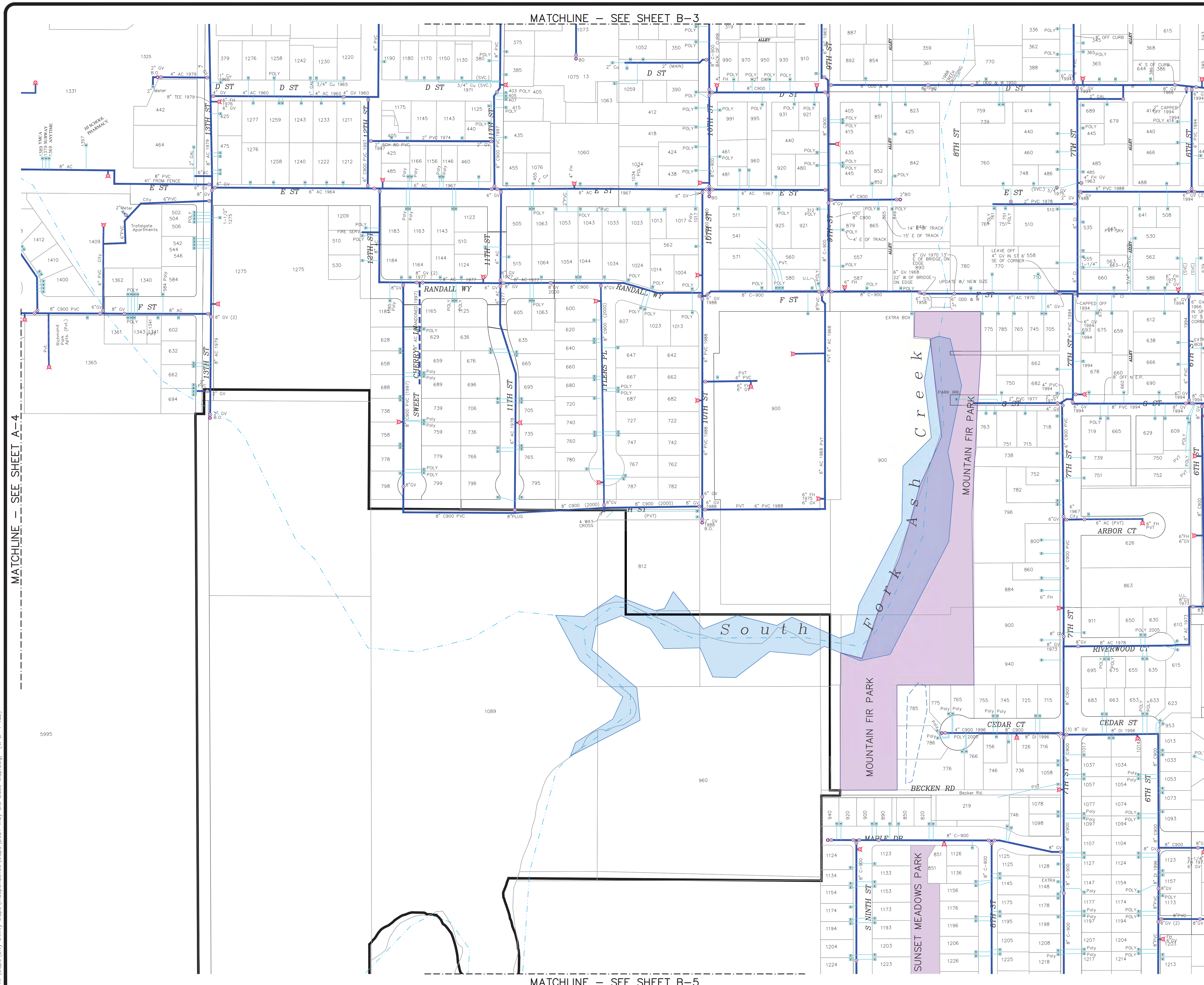
DSN.	PS
DRN.	TMT
CKD.	PS
DATE:	SEPT 2021

NO.	DATE	DESCRIPTION	BY
		REVISIONS	

SHEET
B-3
7 OF 14

JOB NUMBER
2814.4020.0

7/5/2022 2:10:51 PM
R:\Maps\City Utility Maps\Independence\Maps\2021 Indy GIS Base Map.dwg, (W B-3 tab)



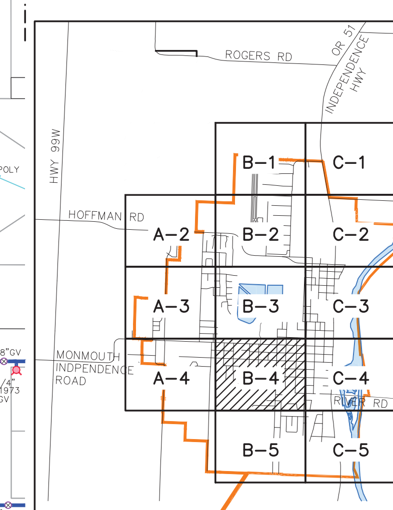
0 75 150 300
FEET

LEGEND

- City Limits
- Urban Growth Boundary
- Water Main (6" PVC 1998)
- Water Valve
- Fire Hydrant Assembly
- Blow Off
- Water Meter & Svc Line
- Air Release Valve (ARV)
- City Well
- Taxlot Boundary & Address # (125)
- City Park
- Rail Road

Pipe Materials

- AC – ASBESTOS CEMENT
- PVC – POLYVINYL CHLORIDE
- DI – DUCTILE IRON
- CI – CAST IRON



KEY MAP

NO.	DATE	DESCRIPTION	BY
1			

REVISIONS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

DSN. PS
DRN. TMT
CKD. PS
DATE: SEPT 2021

REVIEW

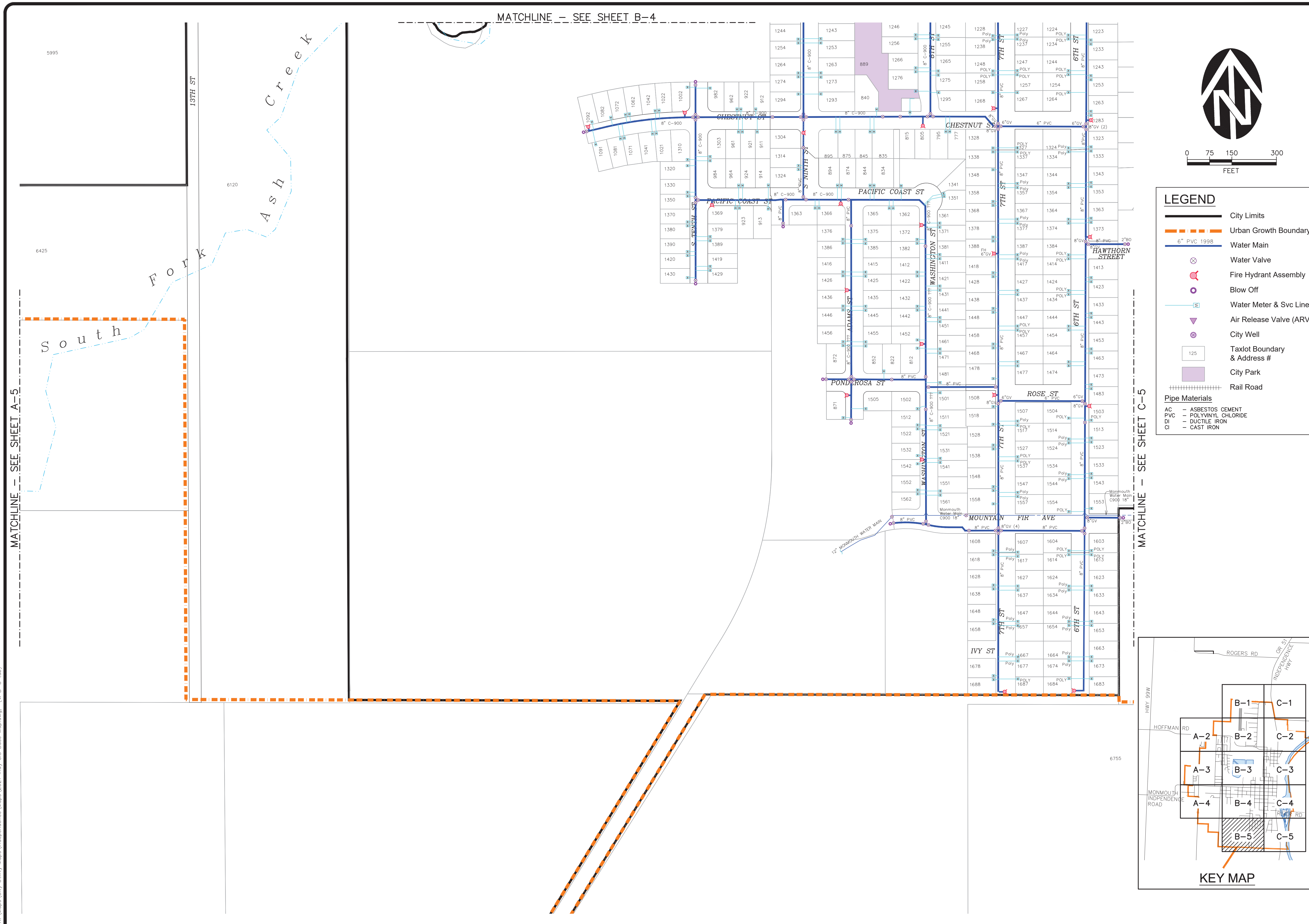
WESTECH ENGINEERING, INC.
CONSULTING ENGINEERS AND PLANNERS
3841 Fairview Industrial Dr. S.E., Suite 100, Salem, OR 97302
Phone: (503) 585-2474 Fax: (503) 585-3986
E-mail: westech@westech-eng.com

CITY OF INDEPENDENCE, OREGON
UTILITY MAP
WATER SYSTEM MAP B-4

SHEET B-4
8 OF 14

JOB NUMBER 2814.4020.0

7/5/2022 2:10:54 PM
R:\Maps\City Utility Maps\Independence\Maps\2021 Indy GIS Base Map.dwg, (W B-4 tab)



VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

DSN. PS
DRN. TMT
CKD. PS
DATE: SEPT 2021

NO.	DATE	DESCRIPTION	BY
1			

REVISIONS

REVIEW

WESTECH ENGINEERING, INC.
CONSULTING ENGINEERS AND PLANNERS
3841 Fairview Industrial Dr. S.E., Suite 100, Salem, OR 97302
Phone: (503) 585-2474 Fax: (503) 585-3986
E-mail: westech@westech-eng.com

CITY OF INDEPENDENCE, OREGON

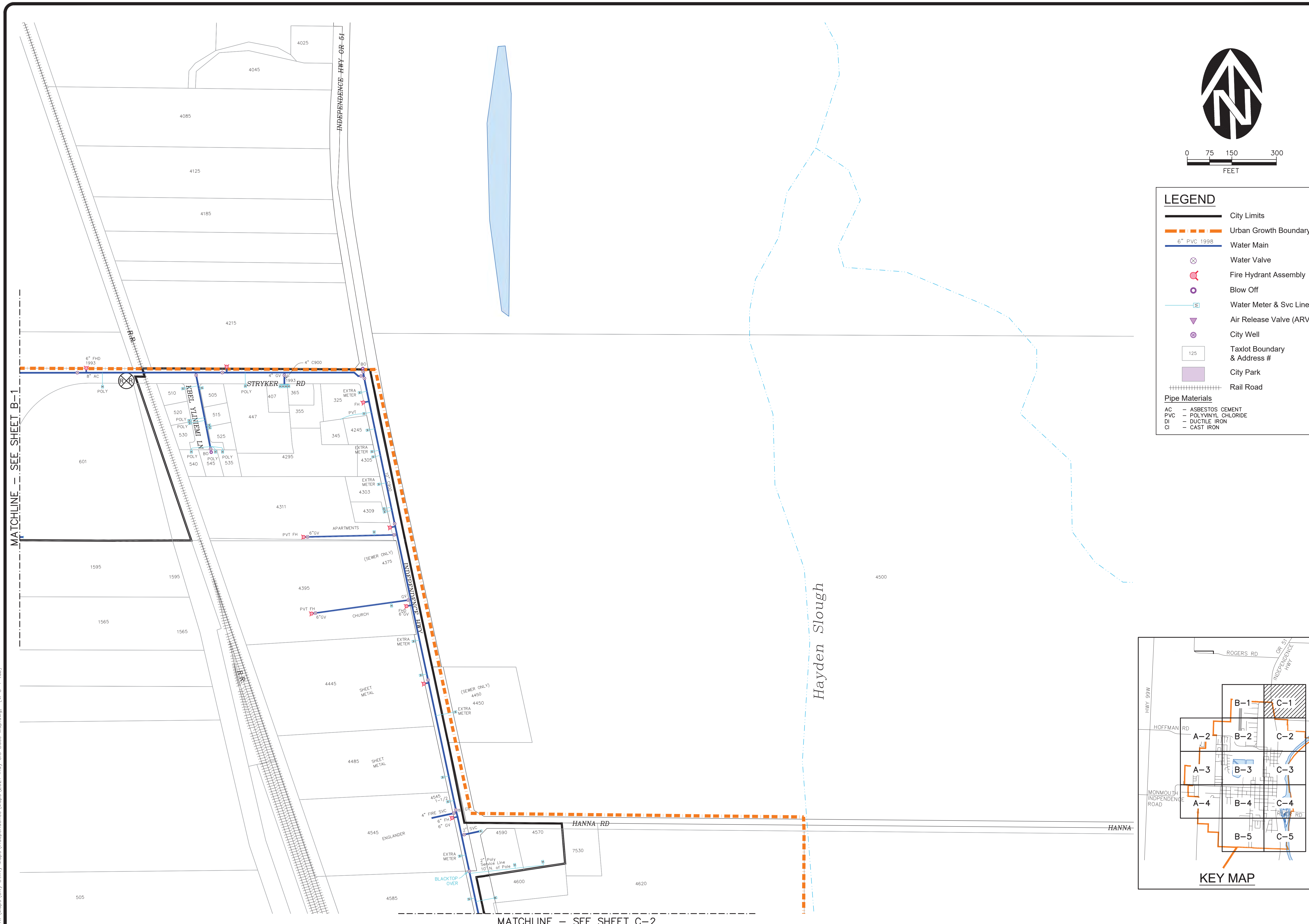
UTILITY MAP

WATER SYSTEM MAP B-5

SHEET B-5
9 OF 14

JOB NUMBER
2814.4020.0

7/5/2022 2:10:57 PM
R:\Maps\City Utility Maps\Independence\Maps\2021 Indy GIS Base Map.dwg, (W B-5 tab)



7/5/2022 2:10:59 PM
R:\Maps\City Utility Maps\Independence\Maps\2021 Indy GIS Base Map.dwg, (W C–1 tab)

NO.	DATE	DESCRIPTION	BY
1		REVISIONS	

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

DSN. PS
DRN. TMT
CKD. PS
DATE: SEPT 2021

REVIEW

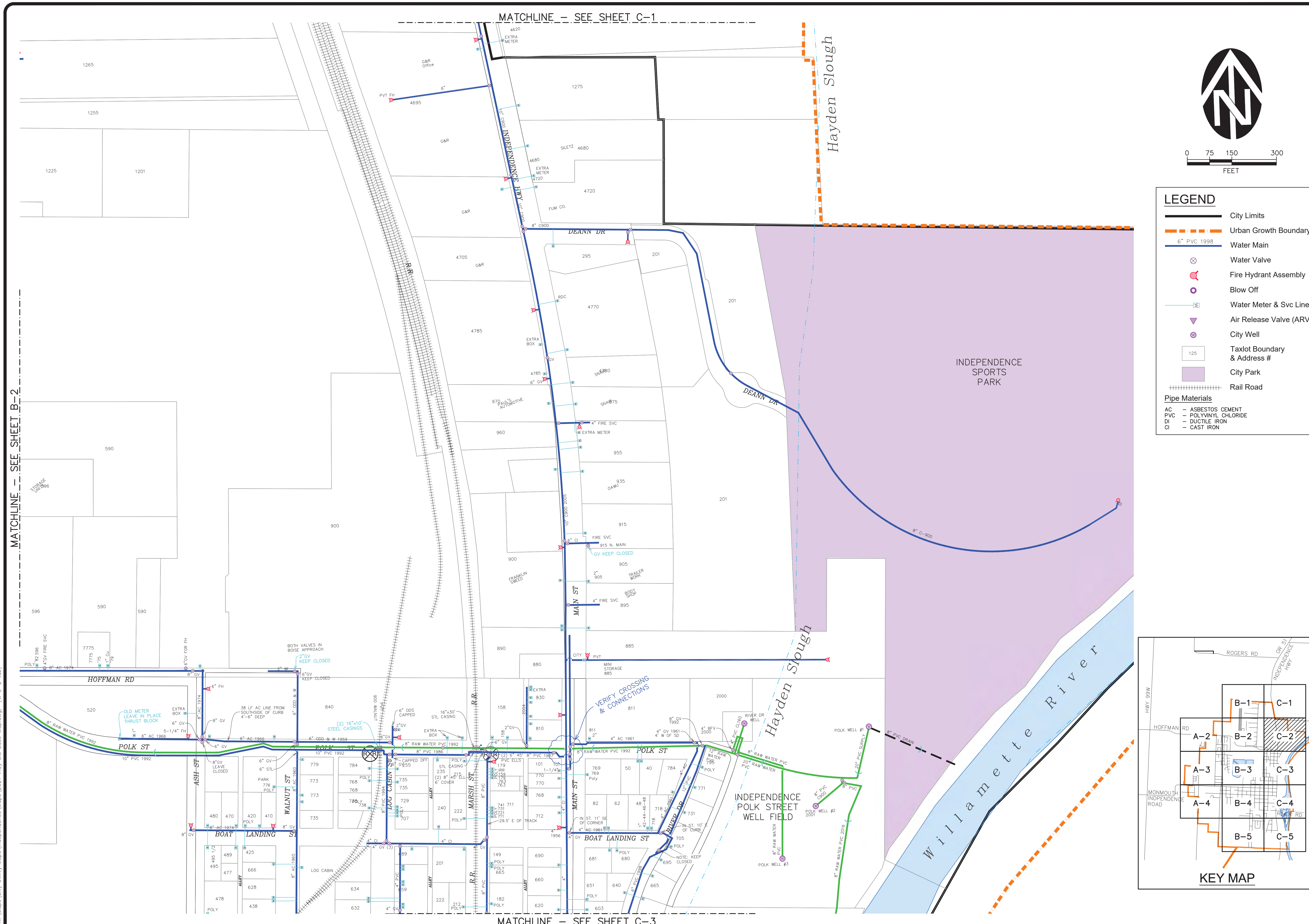
WESTECH ENGINEERING, INC.
CONSULTING ENGINEERS AND PLANNERS
3841 Fairview Industrial Dr. S.E., Suite 100, Salem, OR 97302
Phone: (503) 585–2474 Fax: (503) 585–3986
E–mail: westech@westech–eng.com

CITY OF INDEPENDENCE, OREGON
UTILITY MAP

WATER SYSTEM MAP C–1

SHEET
C–1
10 OF 14

JOB NUMBER
2814.4020.0



NO.	DATE	DESCRIPTION	BY
1			

REVISIONS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

DSN. PS
DRN. TMT
CKD. PS
DATE: SEPT 2021

REVIEW

WESTECH ENGINEERING, INC.
CONSULTING ENGINEERS AND PLANNERS
3841 Fairview Industrial Dr. S.E., Suite 100, Salem, OR 97302
Phone: (503) 585-2474 Fax: (503) 585-3986
E-mail: westech@westech-eng.com

CITY OF INDEPENDENCE, OREGON

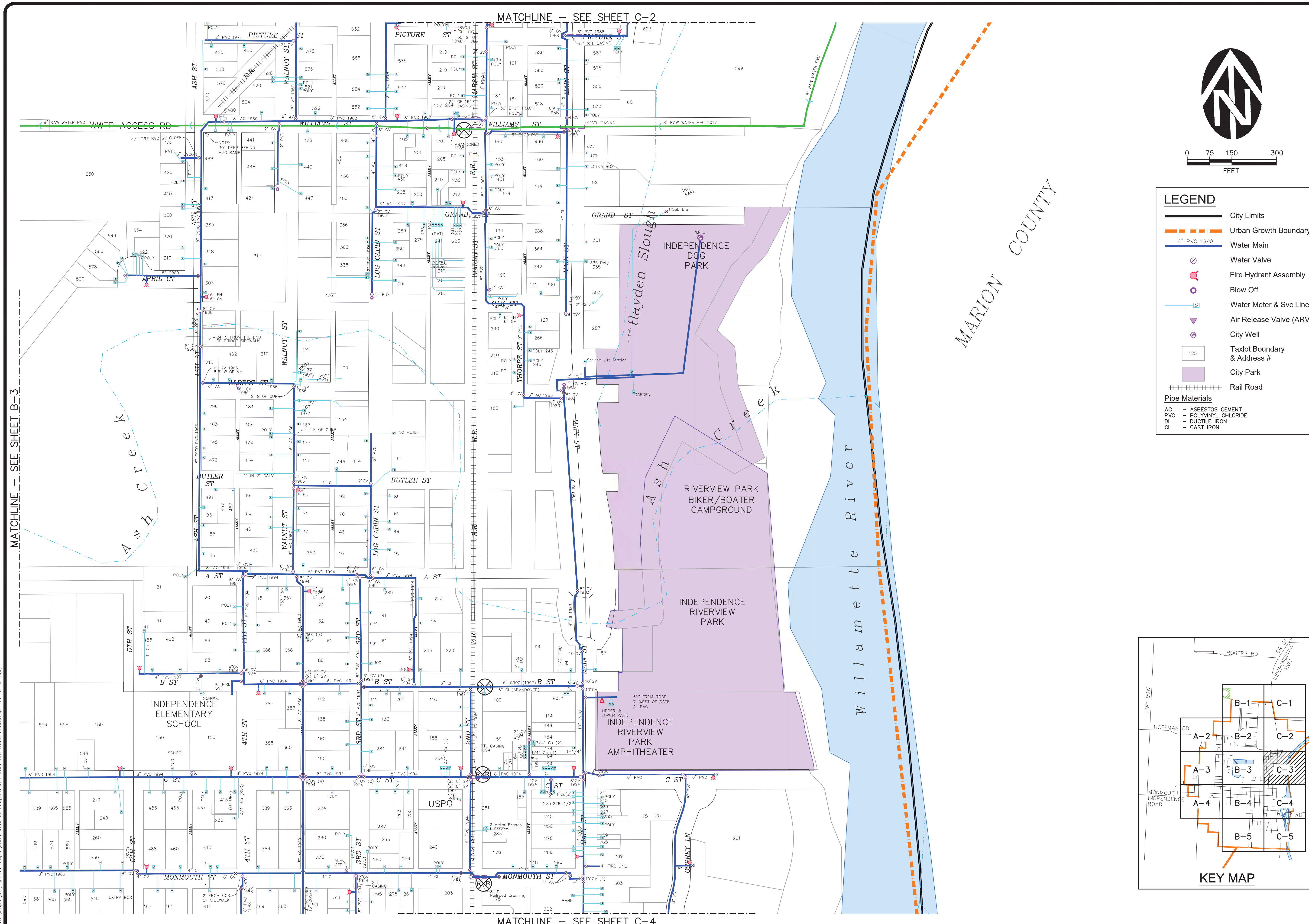
UTILITY MAP

WATER SYSTEM MAP C-2

SHEET C-2
11 OF 14

JOB NUMBER
2814.4020.0

7/5/2022 2:11:02 PM
R:\Maps\City Utility Maps\Independence\Maps\2021 Indy GIS Base Map.dwg, (W C-2 tab)



7/5/2022 2:11:05 PM
R:\Maps\City Utility Maps\Independence\Maps\2021 Indy GIS Base Map.dwg, (W C-3 tab)

NO.	DATE	DESCRIPTION	BY
1		REVISIONS	

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

DSN. PS
DRN. TMT
CKD. PS
DATE: SEPT 2021

REVIEW

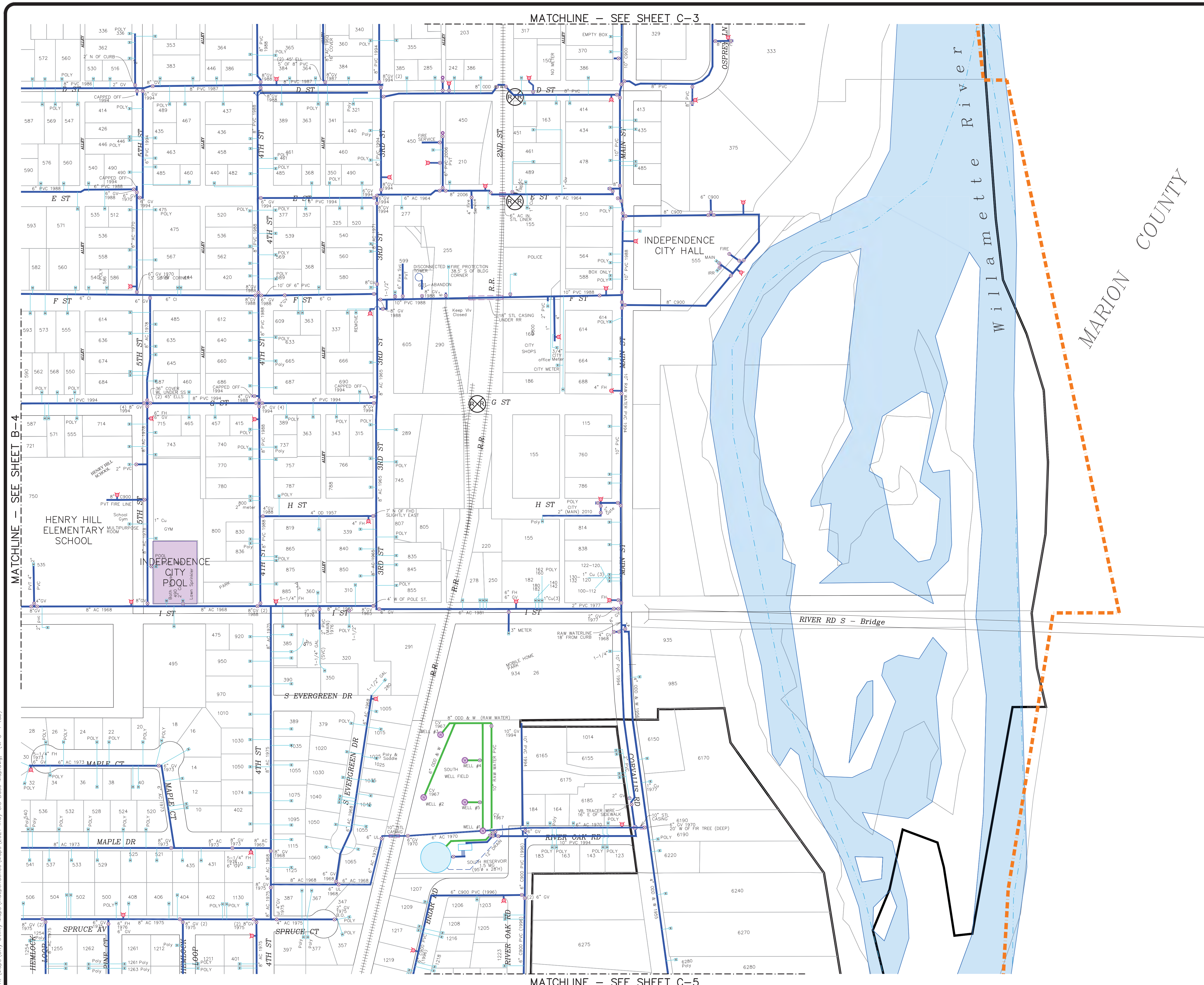
WESTECH ENGINEERING, INC.
CONSULTING ENGINEERS AND PLANNERS
3841 Fairview Industrial Dr. S.E., Suite 100, Salem, OR 97302
Phone: (503) 585–2474 Fax: (503) 585–3986
E–mail: westech@westech–eng.com

CITY OF INDEPENDENCE, OREGON
UTILITY MAP

WATER SYSTEM MAP C–3

SHEET
C–3
12 OF 14

JOB NUMBER
2814.4020.0

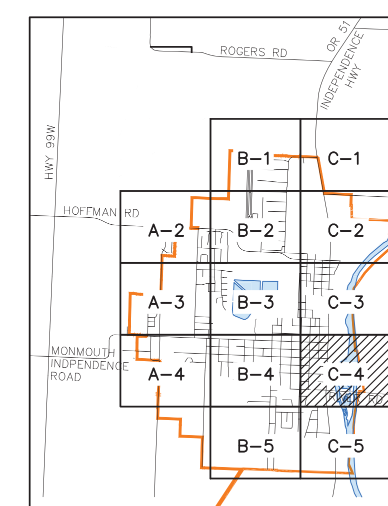


LEGEND

	City Limits
	Urban Growth Boundary
6" PVC 1998	Water Main
	Water Valve
	Fire Hydrant Assembly
	Blow Off
	Water Meter & Svc Line
	Air Release Valve (ARV)
	City Well
125	Taxlot Boundary & Address #
	City Park
	Rail Road

Pipe Materials

AC – ASBESTOS CEMENT
PVC – POLYVINYL CHLORIDE
DI – DUCTILE IRON
CI – CAST IRON



KEY MAP

NO.	DATE	DESCRIPTION REVISIONS	BY
1			

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

DSN. PS
DRN. TMT
CKD. PS
DATE: SEPT 2021

REVIEW

WESTECH ENGINEERING, INC.
CONSULTING ENGINEERS AND PLANNERS
3841 Fairview Industrial Dr. S.E., Suite 100, Salem, OR 97302
Phone: (503) 585-2474 Fax: (503) 585-3986
E-mail: westech@westech-eng.com

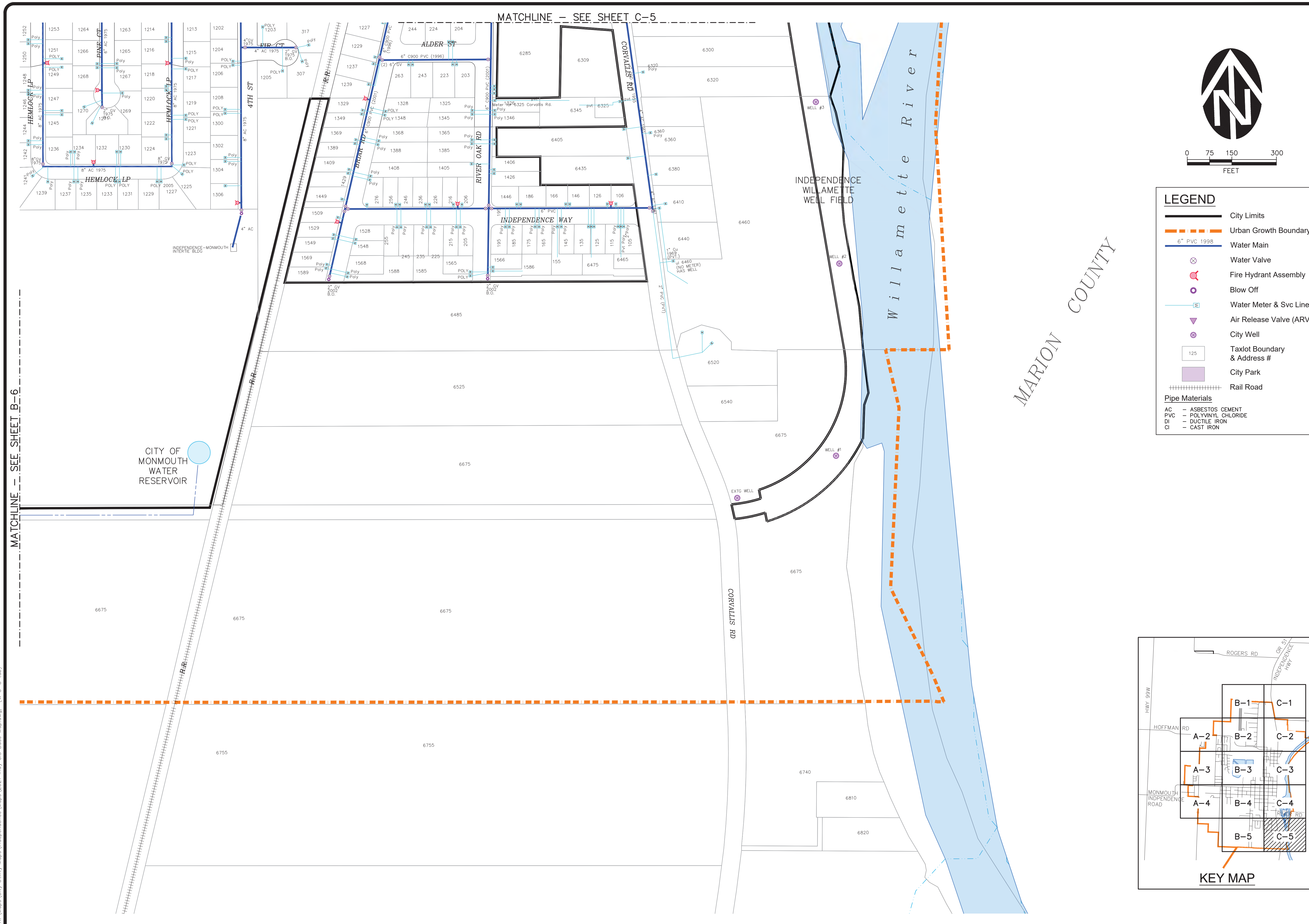
CITY OF INDEPENDENCE, OREGON
UTILITY MAP

WATER SYSTEM MAP C-4

SHEET C-4
13 OF 14

JOB NUMBER
2814.4020.0

7/5/2022 2:11:09 PM
R:\Maps\City Utility Maps\Independence\Maps\2021 Indy GIS Base Map.dwg, (W C-4 tab)



REVIEW

NO.	DATE	DESCRIPTION	BY
1		REVISIONS	

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

DSN. PS
DRN. TMT
CKD. PS
DATE: SEPT 2021

WESTECH ENGINEERING, INC.
CONSULTING ENGINEERS AND PLANNERS
3841 Fairview Industrial Dr. S.E., Suite 100, Salem, OR 97302
Phone: (503) 585-2474 Fax: (503) 585-3986
E-mail: westech@westech-eng.com

CITY OF INDEPENDENCE, OREGON
UTILITY MAP
WATER SYSTEM MAP C–5

SHEET C–5
14 OF 14
JOB NUMBER 2814.4020.0

APPENDIX B

Independence-Monmouth Intertie Intergovernmental Agreement

Emergency Water Agreement

Craig

This Intergovernmental Agreement, made and entered into pursuant to ORS Chapter 190 on this 19th day of January, 2010, is by and between the City of Independence, Oregon, an Oregon municipal corporation, hereafter referred to as Independence, and the City of Monmouth, Oregon, an Oregon municipal corporation, hereafter referred to as Monmouth.

WITNESSED:

Whereas Independence's water supply system consists of the exclusive use of groundwater sources, delivered directly from potable water wells and through a single pressurized distribution system;

Whereas Monmouth's water supply system consists of the exclusive use of groundwater sources, delivered directly from potable water wells and through a single pressurized distribution system;

Whereas both Cities have ample water supply to serve their respective communities under normal conditions and during most emergency situations;

Whereas both Cities have a desire to further develop their backup and emergency water supply capability in order to handle any severe, unexpected, and/or dire emergency situations;

Now, therefore, it is hereby mutually understood and agreed that each City will supply to the other, upon proper request, surplus water during emergency situations. The entire water sale agreement between the City of Independence and the City of Monmouth is contained within the following sections:

SECTION I

Each City will provide to the other surplus water, only during periods of a legitimate emergency, including a valid emergency or unusual system repairs, extremely high and/or unusual periods of water usage, temporary loss of water supply due to a local, regional, or widespread loss of electrical power, water source or water system contamination, or any other mutually agreed event. Water sold to either City will be invoiced at the average (i.e., the arithmetic mean) of the currently existing commodity rate of both entities, i.e. if either City needs to purchase water, the unit rate charged by the other City will be based on the average of the sum of the combined Monmouth and Independence commodity rates in effect at the time of the transaction (water purchase).

SECTION II

An active and state compliant backflow program shall be maintained in each water system and shall be continued throughout the life of this Agreement in accordance with Oregon Statutes.

SECTION III

An operable and accurate water measuring device shall be installed and maintained to measure the instantaneous and totalized rate of flow of water in either direction. This device shall either be a single device capable of two-way measurement of flow or two separate flow measuring devices. An electrically driven booster pump, capable of elevating water pressure from the Independence water system to the Monmouth water system and an inline pressure reducing valve, capable of automatically reducing the water pressure from the Monmouth water system to the Independence water system shall be installed and maintained. All of this equipment shall be installed and maintained in a weather-proofed, lockable, and insulated permanent structure on property owned by the City of Monmouth, located at the southern end of Fourth Street in Independence. The cost of installation, normal maintenance, electrical power consumption, and yearly testing of all equipment shall be equally shared by both Cities.

SECTION IV

When water is required on an emergency basis by either City, the impacted City needing water will first notify the other City to insure that surplus water is available. The Director of Public Works, Community Development Director, and/or Public Works Supervisor of each City is individually authorized to make these determinations and/or authorize the sale or purchase of surplus water for their respective City. Once each City is satisfied as to the need and water system conditions, initial water meter readings for both Cities shall be observed and recorded, the relevant intertie valves shall be opened and the appropriate equipment, i.e. the booster pump or pressure reducing valve, shall be manually activated and continually supervised and attended to enable the transfer of water between Cities. Shall any condition arise at any time during the transfer of surplus water which could possibly compromise or interrupt providing an adequate water supply or pressure to its normal customer base, the City supplying water shall have the option of immediately discontinuing the supply of surplus water until the said condition has been satisfied. Upon transfer deactivation, the final water meter readings shall be observed and recorded, which shall thereafter provide the basis for billing. The City supplying the water shall assume the responsibility for collecting the appropriate data, processing, and distributing the billings to the City buying the water. All charges billed under this agreement shall be due and payable within thirty (30) days following receipt of the invoice(s).

SECTION V

Each City shall be solely responsible for maintaining the individual potability and chemical quality of their finished water supply, in accordance with the applicable rules and regulations of the EPA and Drinking Water Section of the Oregon Health Division. The most recent results of the chemical analyses and total coliform bacteria counts shall be supplied by the City selling water to the City purchasing the surplus water supply before beginning the transfer of water.

SECTION VI

This Agreement shall commence on the date indicated above and shall continue in force until terminated. This Agreement can be terminated without cause by either City, solely by providing thirty (30) days of written notice of such termination from one City to the other City.

SECTION VII

To the extent it lawfully may, under the constitution and laws of the State of Oregon, each City agrees to indemnify, defend, and save harmless the other from any actions arising from their acts, and/or errors of the City, its officers, agents, or employees.

This Agreement is hereby executed by the following authorized individuals:

City of Independence, Oregon	City of Monmouth, Oregon
By: [signature]	By: [signature]
City Manager	City Manager
Attest: [signature]	Attest: [signature]
City Recorder	City Recorder
Approved As to Form:	Approved As to Form:
________________	[signature]
City Attorney	City Attorney

APPENDIX C

Pumping Interference Calculations v2 (Polk Wellfield), GSI Water Solutions, 8/8/19

Operational Scenarios Summary

Scenario	Well ID	Pumping Rate (gpm)	Pumping Duration (days)	Minimum Static Water Level (feet bgs)	Drawdown from Pumping at Well (feet)	Interference From Polk Wells 1-3 (feet)	New Interference from Polk Well 4 (feet)	Pump Intake Setting (feet bgs)	Pump Submergence Requirement (feet)	Initial Available Drawdown: Polk Wells 1-3 Running (feet)	Remaining Available Drawdown: Polk Wells 1-4 Running (feet)
Existing Operations	Polk Well 1	390	90	32.4	6.63	4.91	1.81	51.00	5	2.06	0.2
	Polk Well 2	290	90	23.8	5.17	6.32	1.67	52.72	5	12.43	10.8
	Polk Well 3	490	90	24	7.93	4.55	1.58	43.88	5	2.40	0.8
	Polk Well 4	490	90	24	12.05	3.98	-	58	5	25.02	13.0
	TOTALS	**1,660**	**(Baseline)**								
Polk Wellfield New Design Pumping Rates	Polk Well 1	380	90	32.4	6.49	5.11	1.81	51.00	5	2.00	0.2
	Polk Well 2	320	90	23.8	5.62	6.25	1.67	52.72	5	12.04	10.4
	Polk Well 3	490	90	24	7.93	4.71	1.58	43.88	5	2.24	0.7
	Polk Well 4	490	90	24	12.05	4.10	-	58	5	24.90	12.8
	TOTALS	**1,680**	**(+20 GPM)**								
Polk Well 4 Maximum Pumping Rate (Short Term Emergencies)	Polk Well 1	380	90	32.4	6.49	5.11	1.82	51.00	5	2.00	0.2
	Polk Well 2	320	90	23.8	5.62	6.25	1.64	52.72	5	12.04	10.4
	Polk Well 3	490	90	24	7.93	4.71	1.53	43.88	5	2.24	0.7
	Polk Well 4	600	45	24	12.48	4.10	-	58	5	24.90	12.4
	TOTALS	**1,790**	**(+130 GPM)**								
Polk Well 4 Minimum Pumping Rate* (Prevent Screen Dewatering)	Polk Well 1	380	90	32.4	6.49	5.11	0.38	51.00	5	2.00	1.6
	Polk Well 2	320	90	23.8	5.62	6.25	0.35	52.72	5	12.04	11.7
	Polk Well 3	490	90	24	7.93	4.71	0.33	43.88	5	2.24	1.9
	Polk Well 4	100	90	24	3.80	4.10	-	58	5	24.90	21.1
	TOTALS	**1,290**	**(-370 GPM)**								

Notes:

* The initial/remaining available drawdown presented for Polk Well 4 under the 'Minimum Pumping Rate' scenario does not account for the top of the well screen at 32 feet below ground surface. While there is 17 feet of "remaining available drawdown", the pumping water level is at the top of the well screen.

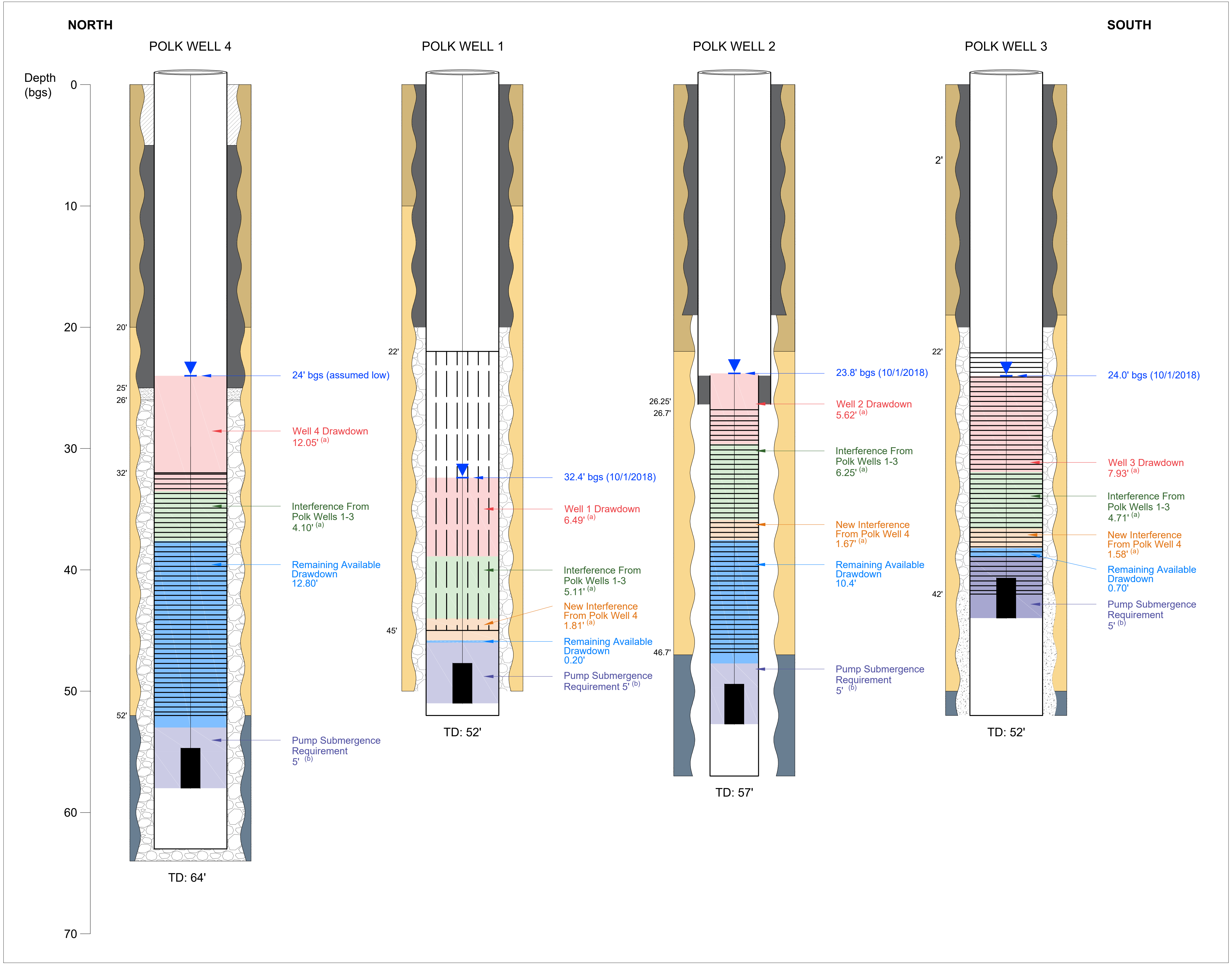


FIGURE 7

Polk Wellfield
Design Pumping Rates and Available Drawdown

Independence, OR

Available Drawdown Legend

- Minimum Recorded Static Water Level
- Drawdown from Pumping At Well
- Interference from Polk Wells 1-3
- New Interference from Polk Well 4
- Pump Submergence Requirement
- Remaining Available Drawdown

Geology Legend

- Willamette Silt Unit (Younger Alluvium)
- Willamette Aquifer (Younger Alluvium)
- Willamette Confining Unit

Notes

(a) Drawdown at individual wells and interference from existing Polk Wells calculated using the Cooper-Jacob equation, assuming:
- 90 day pumping duration
- T =115,000 gpd/ft
- S = 0.02
- Q = 380 gpm, Well 1
  320 gpm, Well 2
  490 gpm, Well 3
  490 gpm, Well 4

(b) Pump submergence requirement of 5 feet conservatively assumed

GSI Water Solutions, Inc.

APPENDIX D

Oregon DEQ No Further Action Determination RJ Mobility Site, 12/18/2017

Oregon
Kate Brown, Governor

Department of Environmental Quality
Western Region
4026 Fairview Industrial Dr.
Salem, OR 97302
(503) 378-8240
FAX (503) 373-7944
TTY 711

December 18, 2017

Attn: Kevin Rowland
Rowland and Company LLC
P O BOX 128
Independence, OR 97351

RE: No Further Action Determination
for RJ Mobility, Independence
ECSI #4569

Dear Mr. Rowland:

The Oregon Department of Environmental Quality (DEQ) has completed its contamination investigation of the RJ Mobility site located at 155 E Street in Independence, Oregon, Polk County Map and Tax Lot 8428BD 4200. Investigation work on this site has been completed under DEQ's Orphan Program.

DEQ has determined that remedial action to address environmental contamination at RJ Mobility site is complete, and no further action is required. This determination is based on the DEQ regulations and the facts as we now understand them including, but not limited to the following:

- The site operated as a dry cleaning and laundry business between 1950 and the mid-1980's and as RJ Mobility since 1986. RJ Mobility is a vehicle retrofitting business for people with physical disabilities.
- Petroleum and chlorinated solvent contamination found in the soil, soil gas and groundwater beneath the site resulted from past dry cleaner operations which used Stoddard solvent and perchloroethylene in the cleaning process.
- The site and surrounding area are zoned Mixed Use Pedestrian Friendly Commercial. The site is occupied by a commercial business and is expected to remain commercial for the foreseeable future.
- The area is serviced by municipal water from the City of Independence. The City's South Wellfield is located approximately 1600 feet south of the site.
- Contamination remaining in the soil and soil gas is below DEQ's acceptable risk levels for the site and surrounding properties.
- Remaining groundwater contamination appears to be stable or decreasing with time. Groundwater contamination above DEQ's residential tapwater risk level extends approximately 120 feet offsite to the south and 180 feet offsite to the east. There are no private or municipal wells located within the area of contamination.
- Groundwater contamination above the residential tapwater level does not appear to reach the City of Independence South Wellfield located 1600 feet to the south. The City has also equipped its wellfield wells with carbon filtration to remove potential contaminants prior to distribution.
- The Willamette River is approximately 600 feet east of the site. Groundwater contamination from the site above ecological risk screening levels is not expected to reach the river.

- No comments or objections to the site closure were received during a 30-day public comment period conducted in July 2017.

Based on the available information, RJ Mobility is currently protective of public health and the environment. The site requires no further action under the Oregon Environmental Cleanup Law, ORS 465.200 et seq. unless new or previously undisclosed information becomes available, or there are changes in site development or land and water uses, or more contamination is discovered. DEQ has updated the Environmental Cleanup Site Information System (ECSI) database to reflect this decision.

This letter only applies to the release discussed above. If any contaminated soil or groundwater is encountered in the future, it must be handled and disposed of in accordance with local, state and federal regulations.

A copy of the staff memo supporting this No Further Action decision can be viewed at http://www.deq.state.or.us/lq/ECSI/ecsiquery.asp (enter site ID 4569). DEQ recommends keeping a copy of all of the documentation associated with this remedial action with the permanent facility records. If you have any questions, please contact Nancy Sawka at 503-378-5075 or via email at sawka.nancy@deq.state.or.us.

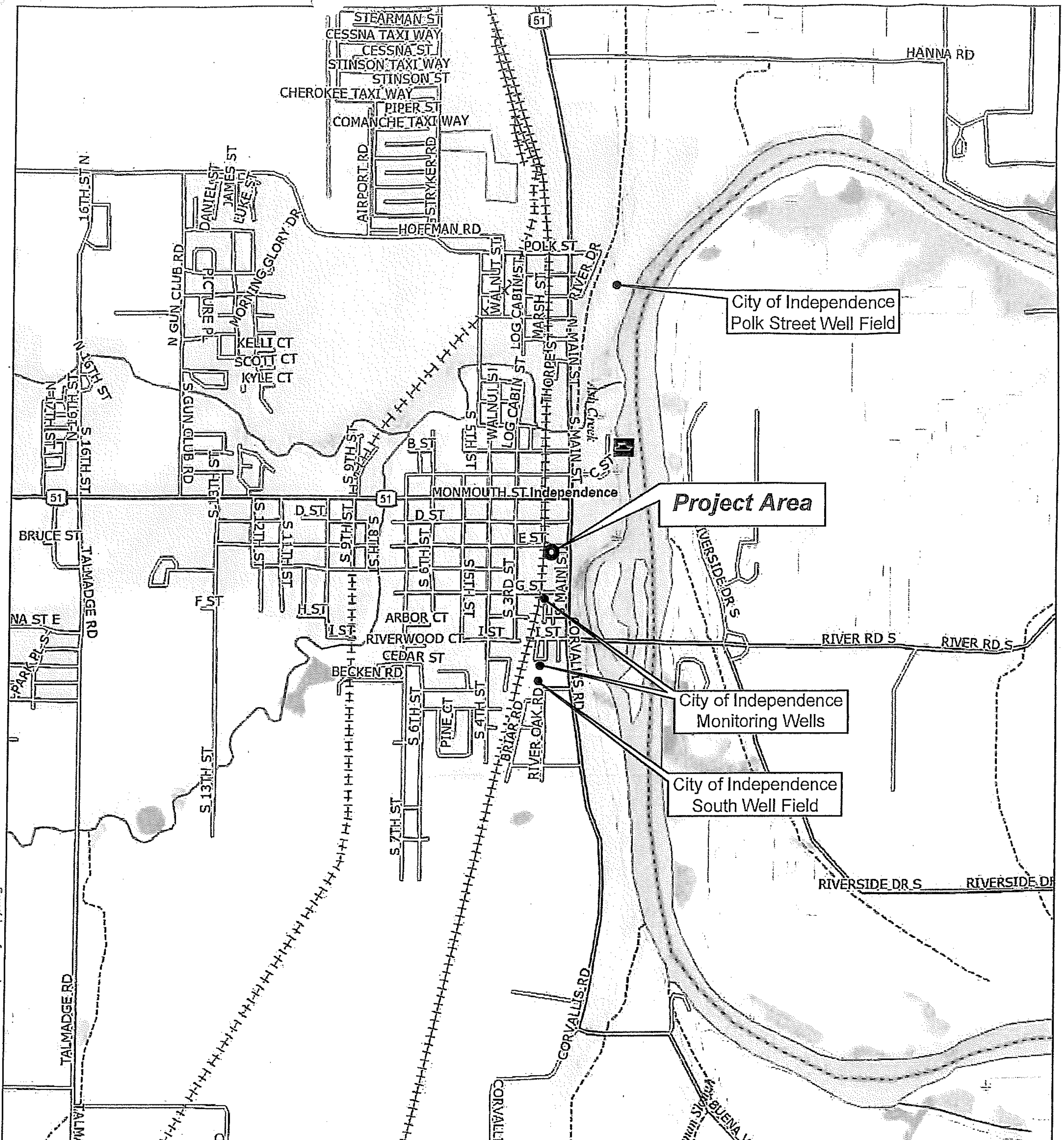
Sincerely,

Donald E. Hanson, RG
Acting Manager
Western Region Environmental Cleanup and
Emergency Response Program

Attachments: Site Map
Staff Report

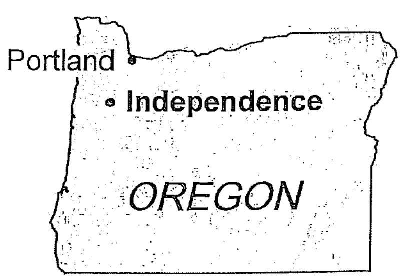
cc: ECSI #4569 File
Ken Perkins, City Shops, City of Independence, 160 F St, Independence, OR 97351
Bart Bretherton, Oregon Department of Transportation, 455 Airport Rd SE, Bldg A, Salem, OR 97301

ec: Bruce Scherzinger (w/o attachments)



0 2,000 4,000

Scale in Feet



N

RJ Mobility
155 E Street, Independence, Oregon

Vicinity Map

15800-00 11/15

HARTCROWSER

Figure 1

Source: DeLorme Topo USA®.

MAS 11/6/15 F:\Notebooks\1580000_DEQ RJ Mobility Site Investigation\CAD\1580000-001 (Vicinity Map).dwg

APPENDIX E

Independence-Monmouth Willamette Wellfield Intergovernmental Agreement

WILLAMETTE RIVER WELL FIELD

INTERGOVERNMENTAL AGREEMENT

This agreement is made and entered into pursuant to ORS Chapter 190, by and between the City of Monmouth, Oregon (Monmouth) and the City of Independence, Oregon (Independence).

RECITALS

A. The parties to this agreement are the parties to that certain Memorandum of Understanding dated July 12, 2005 (MOU), a copy of which is attached hereto as Exhibit 1, and by reference incorporated herein.

B. Pursuant to the MOU, the parties have equally and jointly participated in the design, construction and development of three eight-inch diameter water intake wells, with a Year 2011 combined potential capacity of 1200 gallons per minute, and in which the combination of the wells have resulted in a single shallow well field on real property located in and owned by Independence, which well field is known as the Willamette River Well Field (Well Field).

C. A map of the Well Field is attached hereto as Exhibit 2, and by reference incorporated herein. The entire parcel is referred to generally herein as the "Well Field." That improved portion of the Well Field between and including Well No. 1 and Well No. 3, including all pipe, stubs, valves and appurtenances is referred to in this agreement as the "Shared Facilities." The "Shared Facilities" also include the eight-inch discharge pipe, the control panel, electric service and the security fence as shown on Exhibit 2.

D. By this agreement, the parties desire to memorialize their joint commitment to negotiate the full development and operations of the Well Field for the equal and beneficial use by both parties. Each party is responsible to obtain their equal share of water right associated with their respective equal share of water drawn from the fully developed Well Field.

E. By this agreement, the parties will undertake testing of the Shared Facilities' proposed filtration equipment, water quality, and production capacity via a pilot program providing for regulatory review and approval of the proposed filtration equipment.

AGREEMENT

Now, therefore, in consideration of the foregoing and the mutual covenants and obligations set forth herein, it is hereby agreed as follows:

1. Testing Costs. The parties will mutually agree to the pilot testing program's process, timing and scope of work. Each party agrees to pay one-half of the costs incurred while undertaking the pilot test program for the Shared Facilities' proposed filtration equipment, water quality and production testing, including but not limited to all associated permits, licenses, testing, regulatory compliance, and premiums for insurance covering the Well Field and the Shared Facilities during the period of the testing program. Except in the case of an emergency, neither party will undertake or incur any expense associated with the testing of the Shared Facilities without the prior consent of the other party.

2. Payments. Independence will pay each incurred cost or bill as it becomes due, and will invoice Monmouth for its share in accordance with Section 1, above. The invoice will be itemized, and accompanied by copies of invoices, receipts or statements showing actual costs incurred. Monmouth will remit payment of its share of all incurred costs within 30 days of receipt of Independence's invoice.

3. Neither party will commit, permit or suffer any act that causes or threatens any damage to or loss of capacity or contamination of the Well Field or the Shared Facilities or that jeopardizes the Well Field or the Shared Facilities ongoing future use as a Well Field as contemplated in this agreement and the underlying 2005 MOU between the parties.

4. Upon receipt of state approval that the Shared Facilities meet all applicable water quality and production capacity requirements and regulations, the parties will mutually agree to terms governing future usage, expansion, improvement, or development of the Well Field or the Shared Facilities. Unless otherwise agreed to, such usage and costs will be shared equally by the parties. This section shall not apply to the improvement or development of the parties' individual pipes extended to the parties' own water distribution systems, which will be paid for individually by the respective owning party.

5. Upon execution of the terms referenced in paragraph 4 above, Independence will grant Monmouth an easement for access to, over and upon the Well Field, including the Shared Facilities, generally, and for laying, repairing, maintaining, and replacing facilities extending from the Shared Facilities to Monmouth's water distribution system. Monmouth agrees to bear

the cost of any survey required to describe such easement and the cost of preparing and recording such easement.

6. Each party will defend, indemnify and hold the other, its officers, employees and agents, harmless from and against all claims, liabilities, demands, damages or actions, of whatever form or nature, including property damage, bodily injury or death, as well as attorney fees incurred in defense thereof, arising out of or relating in any way to the indemnifying party's (and its employees' and agents') use and occupancy of the Well Field and any breach by the indemnifying party of any of its obligations under the terms of this agreement.

7. Any amendment to this agreement will be effective only if made in writing and signed by both parties.

8. The waiver by either party of a breach in performance of any obligation under this agreement by the other party will not constitute a waiver of any future breach of the same or any other obligation.

Dated November 21, 2016

CITY OF INDEPENDENCE, OREGON	CITY OF MONMOUTH, OREGON
By: [signature]	By: [signature]
Title: City Manager	Title: City Manager

Exhibit 1

MEMORANDUM OF UNDERSTANDING

This Memorandum of Understanding is executed this 12th day of July, 2005, between the City of Independence, hereinafter "**INDEPENDENCE**", and the City of Monmouth, hereinafter "**MONMOUTH**" to memorialize mutually agreed upon actions that will be taken cooperatively regarding both city's Water Utility.

1. It is agreed and understood that:

a. The City of Monmouth desires to update the City of Monmouth Water System Master Plan of February, 2000.

b. The City of Independence desires to update the City of Independence Water System Master Plan of 1997.

c. Both cities have executed two related Intergovernmental Agreements each titled, "Independence - Monmouth Water Systems Emergency Inter-Tie" on November 5, 1986 for the purpose of providing water service, during time of emergency from the City of Independence system to the City of Monmouth or from the City of Monmouth system to the City of Independence.

d. The two cities desire to closely coordinate the updating of their Water System Master Plans to the mutual benefit of each city.

e. The two cities will engage a professional consultant, who shall be the same consultant for both update processes, to produce the updated Water System Master Plans.

f. The two cities will coordinate the scopes of work for the professional consultant such that each update will address any mutual economies of scale or efficiencies of operation that may be beneficial to both cities.

g. The scopes of work for the professional consultant will specifically contain coordinated direction to investigate and advise on the treatment of water and the acquisition of water rights from the Willamette River by each or both city(ies).

h. Each city will apply for Willamette River surface water rights of sufficient quantity to provide for each city's water system needs for the next 75 years without other augmentation from other sources, and will proceed to perfect such water rights.

i. Each city will continue to proactively work for the individual benefit of the water system and cooperatively work for the mutual benefit of both water systems in future design, operation and capital improvement.

j. Either city will provide sufficient (deemed to be six months) notice of a desire to dissolve this Memorandum of Understanding or to modify it.

For the City of Independence

Mayor John McArdle

Attest:

Karin Johnson, CMC, City Recorder

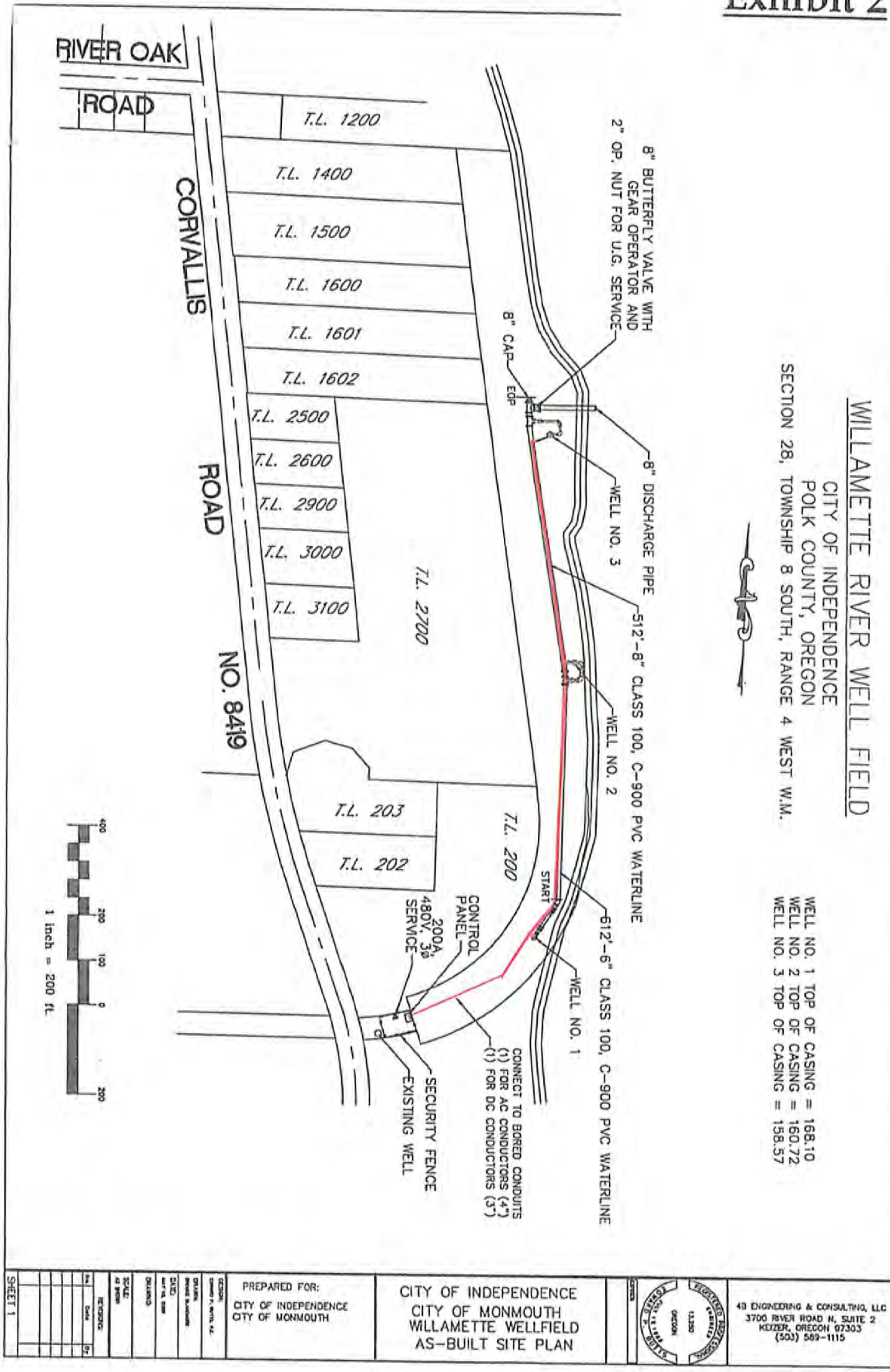
For the City of Monmouth

Mayor Larry Dalton

Attest:

Sarah Salisbury, City Recorder

Exhibit 2



WILLAMETTE RIVER WELL FIELD
CITY OF INDEPENDENCE
POLK COUNTY, OREGON
SECTION 28, TOWNSHIP 8 SOUTH, RANGE 4 WEST W.M.
WELL NO. 1 TOP OF CASING = 168.10
WELL NO. 2 TOP OF CASING = 160.72
WELL NO. 3 TOP OF CASING = 158.57
RIVER OAK ROAD
CORVALLIS ROAD NO. 8419
T.L. 1200
T.L. 1400
T.L. 1500
T.L. 1600
T.L. 1601
T.L. 1602
T.L. 2500
T.L. 2600
T.L. 2900
T.L. 3000
T.L. 3100
T.L. 2700
T.L. 203
T.L. 202
T.L. 200
8" BUTTERFLY VALVE WITH GEAR OPERATOR AND 2" OP. NUT FOR U.G. SERVICE
8" CAP
EOP
8" DISCHARGE PIPE
WELL NO. 3
512'-8" CLASS 100, C-900 PVC WATERLINE
WELL NO. 2
START
612'-6" CLASS 100, C-900 PVC WATERLINE
WELL NO. 1
CONTROL PANEL
200A, 480V, 3Ø SERVICE
CONNECT TO BORED CONDUITS (1) FOR AC CONDUCTORS (4") (1) FOR DC CONDUCTORS (3")
SECURITY FENCE
EXISTING WELL
400
200
100
0
200
1 inch = 200 ft.
PREPARED FOR:
CITY OF INDEPENDENCE
CITY OF MONMOUTH
CITY OF INDEPENDENCE
CITY OF MONMOUTH
WILLAMETTE WELLFIELD
AS-BUILT SITE PLAN
4B ENGINEERING & CONSULTING, LLC
3700 RIVER ROAD N, SUITE 2
KEIZER, OREGON 97303
(503) 589-1115
SHEET 1

APPENDIX F

Technical Memorandum: City of Independence Willamette River Wellfield – Surface Water to Groundwater Transfer, Hydrogeologic Evaluation of Wells' Connection to River, GSI Water Solutions, 11/8/17

GSI
Water Solutions, Inc.

REGISTERED PROFESSIONAL
OREGON
BRUCE A. BRODY-HEINE
No. G1391
GEOLOGIST

Technical Memorandum

To: Kie Cottam, City of Independence

From: Bruce Brody-Heine, RG, GSI Water Solutions, Inc.

Date: **November 8, 2017**
Revised September 13, 2018
(changes highlighted in yellow)

Re: **City of Independence**
Willamette River Wellfield - Surface Water to Groundwater Transfer
Hydrogeologic Evaluation of Wells' Connection to River

I. Introduction

International Paper is, for the benefit of the City of Independence (City), transferring a portion of surface water right Certificate 54268 to the City's three groundwater production wells (Willamette Wells 1, 2 and 3) that are located immediately adjacent to the Willamette River. Oregon Water Resources Department's (OWRD) administrative rules allow for a surface water right to be transferred to a groundwater well under Oregon Administrative Rules (OAR) 690-380-2130. Under these rules (OAR 690-380-2130) a surface water right may be transferred to a groundwater source if:

a) The criteria in OAR 690-380-5000 are met;
b) the new point of diversion (the wells) appropriate ground water from an aquifer that is hydraulically connected to the authorized surface source;
c) The proposed change in point of diversion will affect the surface water source similarly to the authorized point of diversion specified in the water use subject to transfer;
d) The withdrawal of groundwater at the new point of diversion (the wells) is located within 500 feet of the surface water source and is also located within 1,000 feet upstream or downstream of the original point of diversion as specified in the water use subject to transfer; or
e) If the distance requirements are not met, the holder of a water use subject to transfer shall submit to the Department evidence prepared by a licensed geologist that demonstrates that the use of the groundwater at the new point of diversion [new wells] will meet the criterial set forth in OAR 690-380-2130 2 (a), (b) and (c).

The authorized surface water source for Certificate 54268 is the Willamette River. The wells to which a portion of Certificate 54268 will be transferred are within 500 feet of the river. The wells are, however, located more than 1,000 feet from the original point of diversion (near Millersburg). As a result, this report has been prepared to demonstrate that the use of groundwater at the new well locations meet the criteria set forth in OAR 690-380-2130 2(a), (b) and (c).

II. Criteria

OAR 690-380-2130 2(a). The criteria in OAR 690-380-5000 require that the water right to be transferred is subject to transfer and is not cancelled pursuant to ORS 540.610, the proposed transfer would not result in injury, and the proposed transfer would not result in enlargement. Certificate 54368 is a water right subject to transfer and has not been cancelled. The changes proposed in the transfer to the points of diversion/appropriation, place of use, and character of use would not result in injury or enlargement. We understand OWRD will evaluate these criteria as part of the transfer application review process.

OAR 690-380-2130 2 (b) and (c). As described in more detail below, the new points of diversion (the wells) appropriate groundwater from an aquifer that is hydraulically connected to the authorized surface water (the Willamette River). Moreover, use of groundwater from the wells will affect the surface water source similarly to the authorized point of diversion. The term "similarly" is defined in OAR 690-380-2130 11 (b) to mean the use of the groundwater from the new well affects the surface water source specified in water right being transferred and would result in stream depletion of at least 50 percent of the rate of appropriation within 10 days of continuous pumping.

The following is a description of an analysis of the City's water wells and reasons why the proposed use of groundwater from the wells meets the above-described criteria for a surface water to groundwater transfer.

III. Analysis

The City has conducted several evaluations of the hydraulic connection of wells to the Willamette River at the proposed location. These evaluations included a Ranney collector study in 1972, installing a series of test wells and completing an aquifer test in 2006, and an 8-day aquifer test completed in 2008. The City provided GSI with several reports and the following information from the evaluations: 1) the aquifer parameters from the 1972 aquifer test associated with a Ranney Collector study, 2) the results of a 2-hour aquifer test in 2006, and 3) the raw data from the 2008 aquifer test.

Hydraulic Connection to the Willamette River. Based on the information obtained from the previous evaluations described above, the City's three production wells (Willamette Wells 1, 2 and 3) were installed in January 2007, and July and August 2008 along the edge of the Willamette River. The well logs are presented in Attachment A and the approximate locations of City's well are also shown on the Figure in this attachment. All three of the City's wells are located within 500 feet from the river. Willamette Well 1 is located 80 feet from the Willamette River; Willamette Well 2 is 25 feet from the river; and Willamette Well 3 is 80 feet from the river. All three wells develop groundwater from an approximately 20 foot thick gravel unit that is located above a blue clay layer between 50 and 57 feet below ground surface. A cross section showing the geologic formations in relationship to the Willamette River from the 2006 study is provided in Attachment B. This cross section is oriented approximately east west near the location of the current City's Willamette Well 1.

The cross-section shows there is a direct connection between the gravel aquifer and the adjacent Willamette River. The cross-section, in combination with the high transmissivity values calculated for each well (see description below), demonstrates the City's wells are completed in gravel deposit that is hydraulically connected to the Willamette River. Therefore, Willamette Wells 1, 2 and 3 appropriate groundwater from an aquifer that is hydraulically connected to the authorized surface water source (the Willamette River).

Groundwater Use will Affect the Surface Water Source Similarly. GSI reviewed and plotted the 2008 aquifer test data to determine the aquifer parameters (transmissivity and storativity) in the vicinity of the three Willamette River wells (see water level plots in Attachment C). Unfortunately, limited static water level data was available either prior to or after the test and the transducer data recorded only a very small drawdown within the actual pumping wells. This indicates that the aquifer was not under much stress during the test and the wells likely could produce more water than the rates used in the aquifer test. GSI used a combination of the maximum drawdown observed in the transducer data and recorded notes at the base of the Pump Test Data Sheets to calculate a transmissivity (T) value for each well using the Theis equation. The calculated aquifer parameters from the 2008 test (Table 1) were similar to those determined from the previous aquifer test results (300,000 to 550,000 gallons per day per foot).

The 2003 Hunt Model was used to calculate the stream flow depletion created by pumping each of the Willamette River wells (Attachment D). The results of the calculation for each well (Willamette Wells 1, 2, and 3) indicate that the stream depletion created by pumping of the wellfield wells are 87 percent, 82 percent, and 91 percent, respectively, in 10 days of continuous pumping. These percentages significantly exceed the required minimum of 50 percent stream depletion within 10 days. The use of groundwater from each of the 3 wells (Willamette Wells 1, 2 and 3) would, therefore, affect the Willamette River similarly to the authorized point of diversion in Certificate 54268.

IV. Conclusion

The proposed changes to a portion of Certificate 54268 meets the requirements of OAR 690-380-2130. As discussed above, the criteria in OAR 690-380-5000 are met. The Willamette Wells 1, 2 and 3 appropriate water from a gravel unit that is hydraulically connected to the Willamette River. The proposed new wells are all located within 500 feet from the Willamette River. Although the wells are not located within 1000 feet downstream from the original point of diversion in Certificate 54268, the evidence provided in this report and its attachments demonstrates that the use of the groundwater at the new points of diversion would affect the Willamette River similarly to the authorized point of diversion. Accordingly, the proposed change would meet the criteria in OAR 690-380-2130(2).

References

GSI 2006. *Cities of Independence and Monmouth – Collector Well Feasibility Study*. GSI Memorandum. Prepared for Ed Butts, 4B Engineering & Consulting. October 20, 2006.

4B Engineering & Consulting. *Cities of Independence and Monmouth – Willamette Wellfield Preliminary Data*. Report. Prepared Cities of Monmouth and Independence. May 2011.

TABLE 1

2008 7-Day Pumping Test

Aquifer Property Estimate & Stream Depletion

City of Independence

	TRANSMISSIVITY (T)				Stream Depletion
	Transducer Dataset[1]		Summary Statement[2]		
	gpd/ft	ft^2/day	gpd/ft	ft^2/day	% at 10 days
Well 1	3,900,000	520,000	530,000	71,000	87%
Well 2	8,200,000	1,090,000	620,000	83,000	82%
Well 3	1,200,000	160,000	37,000	4,900	91%

Notes:

1 = no static water level data provided for the wells, and transducer data provided required some interpretation

2 = Summary statement found at bottom of manual water level data summary sheet

Storativity value estimated to be 0.10 for all calculations due to proximity to the River

[shaded] = T values used in stream depletion calculations (largest T values showed the smallest depletion)

Attachment A

Well Logs and Location Map

Attachment A

N

0 50 100 150

1 inch = 100 feet

Document Path: Y:\0602_Independence\Source_Figures\001_WR_Due_Diligence\AttachmentA.mxd

POLK 52513

Polk 52513

STATE OF OREGON
WATER SUPPLY WELL REPORT
(as required by ORS 537.765)
Instructions for completing this report are on the last page of this form.

WELL I.D. # L 68856
START CARD # 163044

(1) LAND OWNER Well Number ____
Name CITY OF INDEPENDENCE
Address P.O. Box 7
City INDEPENDENCE State OR. Zip 97351

(2) TYPE OF WORK
☑ New Well ☐ Deepening ☐ Alteration (repair/recondition) ☐ Abandonment

(3) DRILL METHOD:
☐ Rotary Air ☐ Rotary Mud ☑ Cable ☐ Auger
☐ Other ____

(4) PROPOSED USE:
☐ Domestic ☐ Community ☐ Industrial ☐ Irrigation
☐ Thermal ☐ Injection ☐ Livestock ☑ Other Municipal

(5) BORE HOLE CONSTRUCTION:
Special Construction approval ☐ Yes ☑ No Depth of Completed Well 61 ft.
Explosives used ☐ Yes ☑ No Type ____ Amount ____

HOLE Diameter	From	To	SEAL Material	From	To	Sacks or pounds
12"	0'	61'	CEMENT	-1'	35'	35 SACKS
			BENTONITE	0'	-1'	1 SACK

How was seal placed: Method ☐ A ☐ B ☑ C ☐ D ☐ E
☑ Other Dry bentonite poured
Backfill placed from 38 ft. to 35 ft. Material 1/4" crush'd rk.
Gravel placed from 61 ft. to 38 ft. Size of gravel 1/8"x1/4"

(6) CASING/LINER:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:	8"	+3'	41'	.250"	☑	☐	☑	☐
	8"	56'	61'	.250"	☑	☐	☑	☐
Liner:					☐	☐	☐	☐

Drive Shoe used ☐ Inside ☐ Outside ☑ None
Final location of shoe(s) ____

(7) PERFORATIONS/SCREENS:
☐ Perforations Method ____
☑ Screens Type V-SLOT Material 304 S.Steel

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
41'	56'	100		8"	PS	☐	☐

(8) WELL TESTS: Minimum testing time is 1 hour
☑ Pump ☐ Bailer ☐ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
500 GPM	5'-2 1/4"		71 hr.s

Temperature of water 50° Depth Artesian Flow Found ____
Was a water analysis done? ☑ Yes By whom ____
Did any strata contain water not suitable for intended use? ☐ Too little
☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☐ Other ____
Depth of strata: ____

RECEIVED
FEB 21 2007
WATER RESOURCES DEPT
SALEM, OREGON

(9) LOCATION OF WELL by legal description:
County POLK Latitude ____ Longitude ____
Township 8S [redacted] N or S Range 4W E or W. WM.
Section 33 NW 1/4 NE 1/4
Tax Lot 201 Lot ____ Block ____ Subdivision ____
Street Address of Well (or nearest address) S. Corvallis Rd.; Independence, Or.

(10) STATIC WATER LEVEL:
24 ft. below land surface. Date 01-16-07
Artesian pressure ____ lb. per square inch Date ____

(11) WATER BEARING ZONES:
Depth at which water was first found 35'

From	To	Estimated Flow Rate	SWL
41'	56'	500 GPM	24'

(12) WELL LOG:
Ground Elevation ____

Material	From	To	SWL
Gravel, sand, soil Fill	0'	17.5'	
Dry Brown clay	17.5	30'	
Brown clay w/ Gravel, silt	30'	34'	
Gravel, small - large, brown sand W.B.	34'	57'	24'
Blue-gray clay	57'	61'	

RECEIVED
SEP 17 2007
WATER RESOURCES DEPT
SALEM, OREGON

Date started DECEMBER 11, '06 Completed January 20, '07

(unbonded) Water Well Constructor Certification:
I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon water supply well construction standards. Materials used and information reported above are true to the best of my knowledge and belief.
WWC Number ____
Signed ____ Date ____

(bonded) Water Well Constructor Certification:
I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon water supply well construction standards. This report is true to the best of my knowledge and belief.
WWC Number 633
Signed [signature] Date 02-08-07

ORIGINAL – WATER RESOURCES DEPARTMENT FIRST COPY – CONSTRUCTOR SECOND COPY – CUSTOMER

POLK 52861 ~~State~~ DRAFT

L 93614

STATE OF OREGON
WATER WELL REPORT
(as required by ORS 537.765)

(START CARD) # 196825

(1) OWNER: Well Number #2
Name City of Independence
Address P.O. Box 7
City Independence State Or Zip 97351

(2) TYPE OF WORK:
☒ New Well ☐ Deepen ☐ Recondition ☐ Abandon

(3) DRILL METHOD:
☐ Rotary Air ☐ Rotary Mud ☒ Cable
☐ Other

(4) PROPOSED USE:
☐ Domestic ☐ Community ☐ Industrial ☐ Irrigation
☐ Thermal ☐ Injection ☒ Other Municipal

(5) BORE HOLE CONSTRUCTION:
Special Construction approval ☐ Yes ☒ No Depth of Completed Well 53 ft.
Explosives used ☐ Yes ☒ No Type ___ Amount ___

HOLE Diameter	From	To	SEAL Material	From	To	Amount sacks or pounds
12"	0'	53'	Cement	27'	17'	40 sacks
			Bentonite	17'	13'	28 sacks
			Cement	13'	1.5'	15 sacks
			Bentonite	1.5'	0'	3 sacks

How was seal placed: Method ☐ A ☐ B ☒ C ☐ D ☐ E
☒ Other poured - probed
Backfill placed from 27 ft. to 29 ft. Material 1/4" minus
Gravel placed from 29 ft. to 53 ft. Size of gravel 7/8 round

(6) CASING/LINER:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:	8"	+3.5'	29'	.250	☒	☐	☒	☐
					☐	☐	☐	☐
	8"	45.5'	53'		☒	☐	☒	☐
					☐	☐	☐	☐
Liner:					☐	☐	☐	☐
					☐	☐	☐	☐

Final location of shoe(s) none

(7) PERFORATIONS/SCREENS:
☐ Perforations Method
☒ Screens Type V-Slot Material 304SS

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
29'	45.5'	100		8"	P.S.	☐	☐
						☐	☐
						☐	☐
						☐	☐
						☐	☐

(8) WELL TESTS: Minimum testing time is 1 hour
☐ Pump ☒ Bailer ☐ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
45 GPM	0'		1 hr.

Temperature of Water 54° Depth Artesian Flow Found ___
Was a water analysis done? ☐ Yes By whom ___
Did any strata contain water not suitable for intended use? ☐ Too little
☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☐ Other ___
Depth of strata: ___

(9) LOCATION OF WELL by legal description:
County Polk Latitude ___ Longitude ___
Township 8S N or S. Range 4W E or W. WM.
Section 33 NW ¼ NE ¼
Tax Lot 201 Lot ___ Block ___ Subdivision ___
Street Address of Well (or nearest address) S. Corvallis Rd, Independence, Or.

(10) STATIC WATER LEVEL:
23.5 ft. below land surface. Date 07-16-08 ~~06-17-08~~
Artesian pressure ___ lb. per square inch. Date ___

(11) WATER BEARING ZONES:
Depth at which water was first found 19

From	To	Estimated Flow Rate	SWL
23'	46'	45+GPM	23.5

(12) WELL LOG:
Ground elevation ___

Material	From	To	SWL
Fill Gravel - Pit Run	0'	6'	
Clay - Sandy - Brown	6'	15'	
Sand, Silt with Clay & Gravel	15'	17'	
Gravel, small - medium w/ brown sand - loose	17'	46'	23.5'
Gravel, tight w/ sand	46'	52'	23.5'
Clay - Blue	52'	57'	
Back filled w/ 1/4" minus from 57' to 53'			

RECEIVED
SEP 18 2008
WATER RESOURCES DEPT
SALEM, OREGON

Date started 06-09-08 Completed 07-16-08

(unbonded) Water Well Constructor Certification:
I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon well construction standards. Materials used and information reported above are true to my best knowledge and belief.
WWC Number ___
Signed ___ Date ___

(bonded) Water Well Constructor Certification:
I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon well construction standards. This report is true to the best of my knowledge and belief.
WWC Number 633
Signed Michael Waldroop Date 07-27-08

ORIGINAL & FIRST COPY - WATER RESOURCES DEPARTMENT SECOND COPY - CONSTRUCTOR THIRD COPY - CUSTOMER 9809C 10/91

POLK 52953

L93615

STATE OF OREGON
WATER WELL REPORT
(as required by ORS 537.765)

(START CARD) # 196828

(1) OWNER: Well Number #3B
Name CITY OF INDEPENDENCE-MON.
Address P.O. BOX 7
City INDEPENDENCE State OR Zip 97351

(2) TYPE OF WORK:
[X] New Well [ ] Deepen [ ] Recondition [ ] Abandon

(3) DRILL METHOD:
[ ] Rotary Air [ ] Rotary Mud [X] Cable
[ ] Other

(4) PROPOSED USE:
[ ] Domestic [ ] Community [ ] Industrial [ ] Irrigation
[ ] Thermal [ ] Injection [X] Other Municipal

(5) BORE HOLE CONSTRUCTION:
Special Construction approval [ ] Yes [X] No Depth of Completed Well 56 ft.
Explosives used [ ] Yes [X] No Type ___ Amount ___

HOLE Diameter	From	To	SEAL Material	From	To	Amount sacks or pounds
12"	0'	56'	CEMENT	0'	29'	48 SKS

How was seal placed: Method [ ] A [ ] B [X] C [ ] D [ ] E
[ ] Other
Backfill placed from 31 ft. to 29 ft. Material 1/4" MINUS
Gravel placed from 56 ft. to 31 ft. Size of gravel 3/8" ROUND

(6) CASING/LINER:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:	8"	+2'	31'	.250	[X]	[ ]	[X]	[ ]
	8"	49'	56'	.250	[X]	[ ]	[X]	[ ]
Liner:								

Final location of shoe(s) NONE

(7) PERFORATIONS/SCREENS:
[ ] Perforations Method
[X] Screens Type V-SLOT Material 304 SS

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
31'	49'	100		8"	PS	[ ]	[ ]

(8) WELL TESTS: Minimum testing time is 1 hour
[ ] Pump [X] Bailer [ ] Air [ ] Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
45 GPM	0		1 hr.

Temperature of Water 54° Depth Artesian Flow Found
Was a water analysis done? [ ] Yes By whom
Did any strata contain water not suitable for intended use? [ ] Too little
[ ] Salty [ ] Muddy [ ] Odor [ ] Colored [ ] Other
Depth of strata:

(9) LOCATION OF WELL by legal description:
County POLK Latitude ___ Longitude ___
Township 8S N or S. Range 4W E or W. WM.
Section 33 NW ¼ NE ¼
Tax Lot 201 Lot ___ Block ___ Subdivision ___
Street Address of Well (or nearest address) WELL #3B S. Corvallis Rd., IND. OR 97351

(10) STATIC WATER LEVEL:
28 ft. below land surface. Date 08-19-08
Artesian pressure ___ lb. per square inch. Date ___

(11) WATER BEARING ZONES:
Depth at which water was first found 28'

From	To	Estimated Flow Rate	SWL
31'	49'	45+GPM	28'

(12) WELL LOG:
Ground elevation

Material	From	To	SWL
FILL - SAND + GRAVEL	0'	12'	
CLAY - SILTY BROWN	12'	18'	
CLAY - BROWN	18'	25'	
CLAY - GRAVELLY	25'	27'	
GRAVELLY CLAY	27'	31'	
GRAVEL, SMALL - LARGE w/ SOME BROWN SAND	31'	50'	28'
BLUE CLAY	50'	56'	

RECEIVED OVER THE COUNTER

RECEIVED JUN 03 2009 WATER RESOURCES DEPT SALEM, OREGON

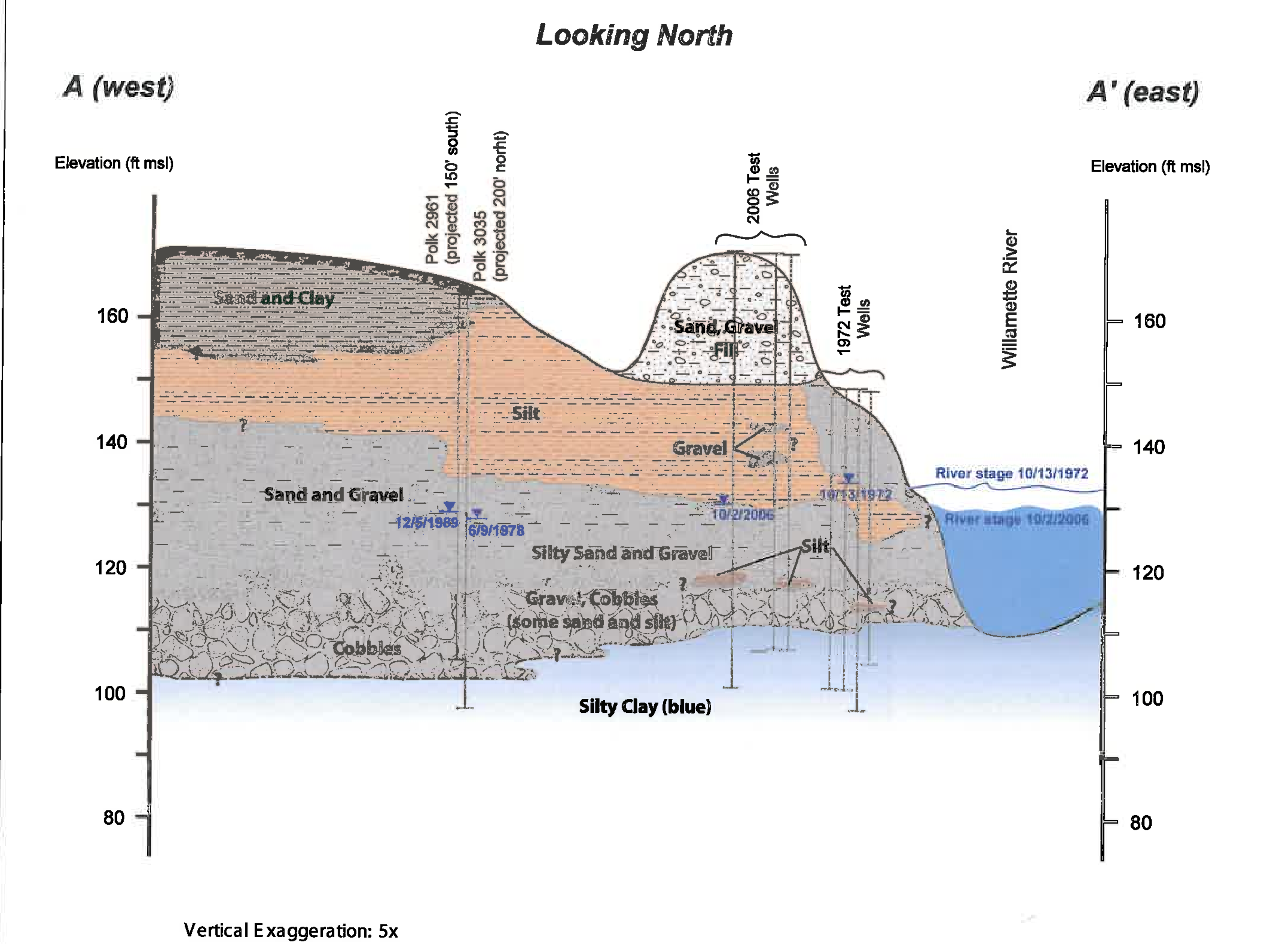
Date started 07-24-08 Completed 08-20-08

(unbonded) Water Well Constructor Certification:
I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon well construction standards. Materials used and information reported above are true to my best knowledge and belief.
WWC Number ___
Signed ___ Date ___

(bonded) Water Well Constructor Certification:
I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon well construction standards. This report is true to the best of my knowledge and belief.
WWC Number 633
Signed Michael Waldorf Date 09-01-08

ATTACHMENT B

2006 Geologic Cross Section - City Well 1 Area



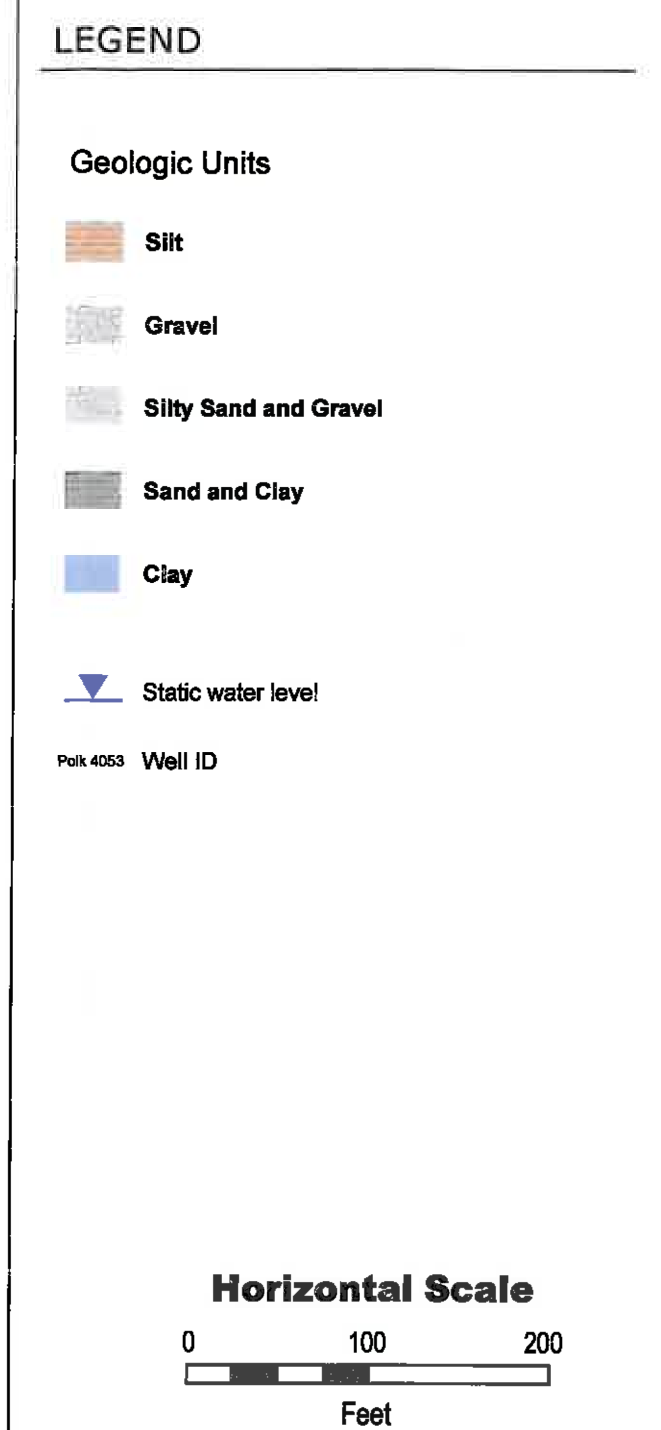


Figure 7

Geologic Cross Section A-A'

Collector Well Feasibility Study
Cities of Independence and Monmouth

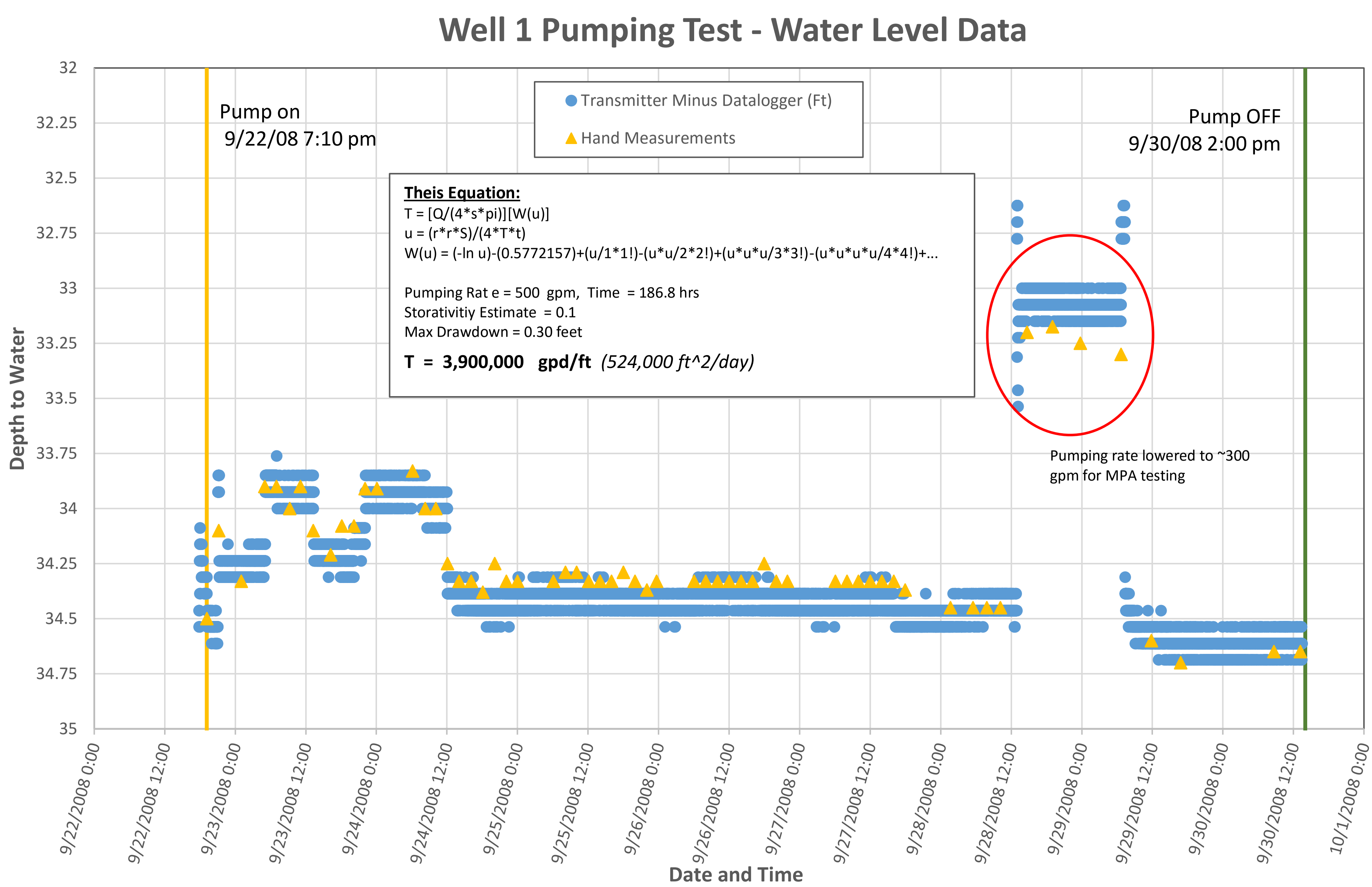
Groundwater Solutions Inc.

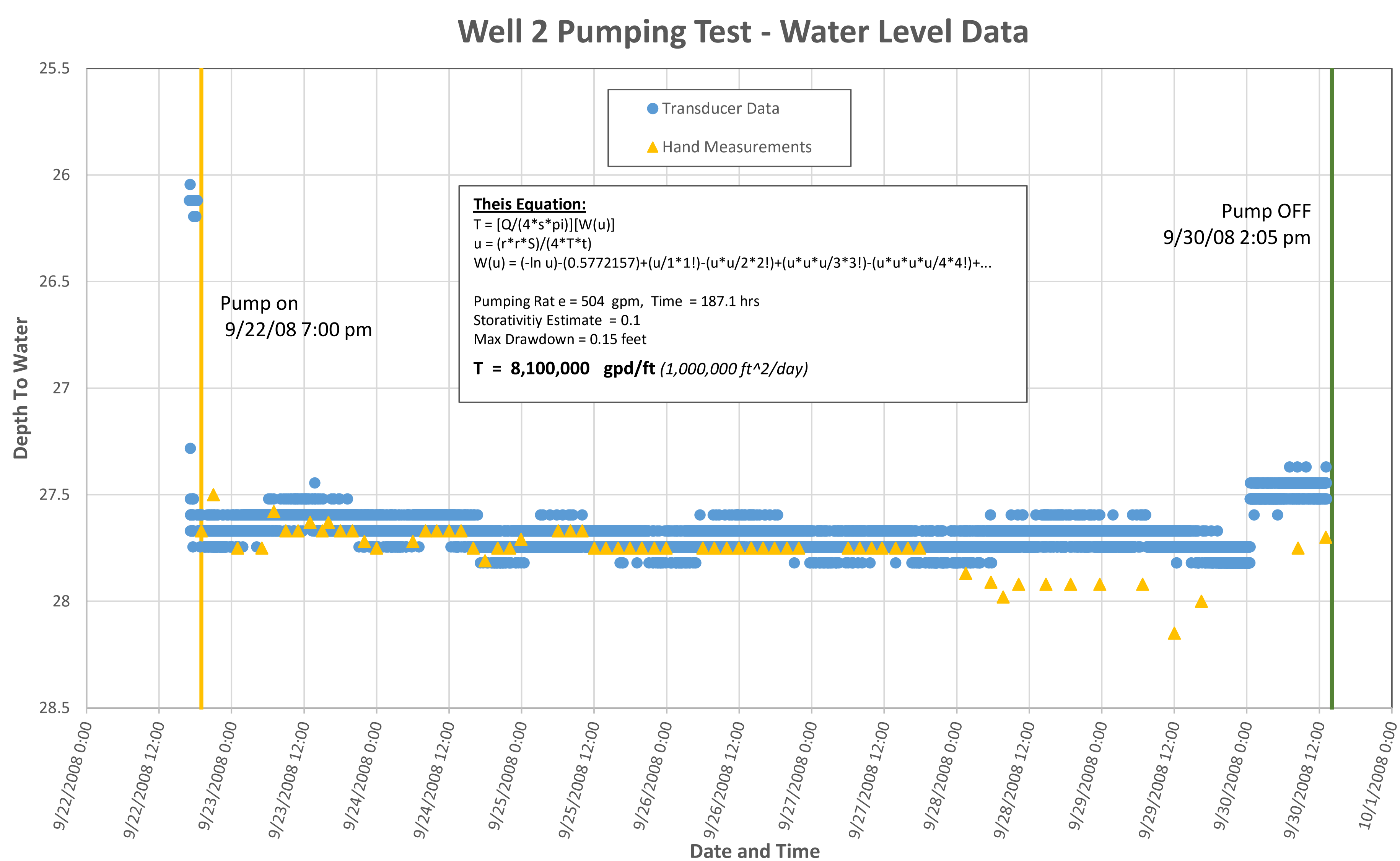
Map Date: October 16, 2006

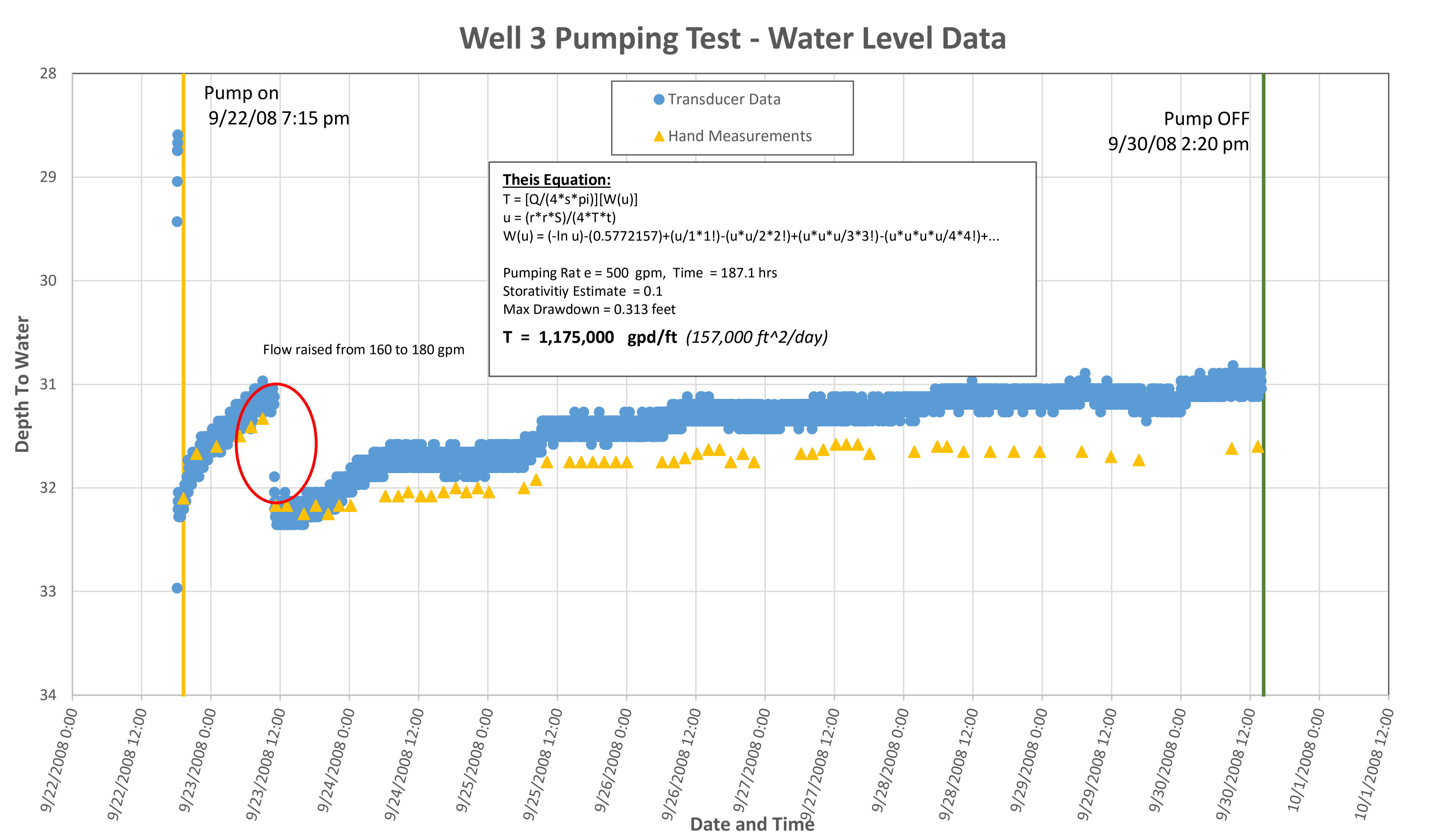
P:\203 - Independence\001 - Collector Well Feasibility\Reports-Memos\figures\w-e_section.pdf

ATTACHMENT C

2008 Pump Test Parameter Evaluation


Well 1 Pumping Test - Water Level Data
Transmitter Minus Datalogger (Ft)
Hand Measurements
Pump on
9/22/08 7:10 pm
Pump OFF
9/30/08 2:00 pm
Theis Equation:
T = [Q/(4*s*pi)][W(u)]
u = (r*r*S)/(4*T*t)
W(u) = (-ln u)-(0.5772157)+(u/1*1!)-(u*u/2*2!)+(u*u*u/3*3!)-(u*u*u*u/4*4!)+...
Pumping Rat e = 500 gpm, Time = 186.8 hrs
Storativitiy Estimate = 0.1
Max Drawdown = 0.30 feet
T = 3,900,000 gpd/ft (524,000 ft^2/day)
Pumping rate lowered to ~300 gpm for MPA testing
Depth to Water
32
32.25
32.5
32.75
33
33.25
33.5
33.75
34
34.25
34.5
34.75
35
9/22/2008 0:00
9/22/2008 12:00
9/23/2008 0:00
9/23/2008 12:00
9/24/2008 0:00
9/24/2008 12:00
9/25/2008 0:00
9/25/2008 12:00
9/26/2008 0:00
9/26/2008 12:00
9/27/2008 0:00
9/27/2008 12:00
9/28/2008 0:00
9/28/2008 12:00
9/29/2008 0:00
9/29/2008 12:00
9/30/2008 0:00
9/30/2008 12:00
10/1/2008 0:00
Date and Time


Well 2 Pumping Test - Water Level Data
Transducer Data
Hand Measurements
Theis Equation:
T = [Q/(4*s*pi)][W(u)]
u = (r*r*S)/(4*T*t)
W(u) = (-ln u)-(0.5772157)+(u/1*1!)-(u*u/2*2!)+(u*u*u/3*3!)-(u*u*u*u/4*4!)+...
Pumping Rat e = 504 gpm, Time = 187.1 hrs
Storativitiy Estimate = 0.1
Max Drawdown = 0.15 feet
T = 8,100,000 gpd/ft (1,000,000 ft^2/day)
Pump on
9/22/08 7:00 pm
Pump OFF
9/30/08 2:05 pm
Depth To Water
25.5
26
26.5
27
27.5
28
28.5
Date and Time
9/22/2008 0:00
9/22/2008 12:00
9/23/2008 0:00
9/23/2008 12:00
9/24/2008 0:00
9/24/2008 12:00
9/25/2008 0:00
9/25/2008 12:00
9/26/2008 0:00
9/26/2008 12:00
9/27/2008 0:00
9/27/2008 12:00
9/28/2008 0:00
9/28/2008 12:00
9/29/2008 0:00
9/29/2008 12:00
9/30/2008 0:00
9/30/2008 12:00
10/1/2008 0:00



Well 3 Pumping Test - Water Level Data
Pump on
9/22/08 7:15 pm
Transducer Data
Hand Measurements
Pump OFF
9/30/08 2:20 pm
Theis Equation:
T = [Q/(4*s*pi)][W(u)]
u = (r*r*S)/(4*T*t)
W(u) = (-ln u)-(0.5772157)+(u/1*1!)-(u*u/2*2!)+(u*u*u/3*3!)-(u*u*u*u/4*4!)+...
Pumping Rat e = 500 gpm, Time = 187.1 hrs
Storativitiy Estimate = 0.1
Max Drawdown = 0.313 feet
T = 1,175,000 gpd/ft (157,000 ft^2/day)
Flow raised from 160 to 180 gpm
Depth To Water
28
29
30
31
32
33
34
9/22/2008 0:00
9/22/2008 12:00
9/23/2008 0:00
9/23/2008 12:00
9/24/2008 0:00
9/24/2008 12:00
9/25/2008 0:00
9/25/2008 12:00
9/26/2008 0:00
9/26/2008 12:00
9/27/2008 0:00
9/27/2008 12:00
9/28/2008 0:00
9/28/2008 12:00
9/29/2008 0:00
9/29/2008 12:00
9/30/2008 0:00
9/30/2008 12:00
10/1/2008 0:00
10/1/2008 12:00
Date and Time

WELL TEST DATA SHEET

4B Engineering & Consulting LLC, 3000 Market St. NE, Suite 527, Salem, OR 97301 Ph: 503-589-1115, Fax: 503-589-1118

Pg.____ of ____

Owner's Name: Cities of Monmouth and Independence		***Well Location: Willamette River Wellfield (South)***	
Well Name/No.: #1 (South Well)		***Date(s) of Test: Sept 22, 2008 to Sept 30, 2008***	
Well Diameter:	Depth:	Static Level:	Screen/Perf at:
Test Pump Setting:	Test Pump Type:	Air Line/Probe/Transmitter	W/L Device Length: 41'
SWL After Test:	Drilled By:	Test Started: 1910 Hrs.	Test Stopped: 1400 Hrs.
Tested By (Firm):	Name:	Max. GPM: 500 @ 34.5' PWL After 188 Hrs.	

GPM	PUMPING LEVEL	TIME OF DAY	CONDITION OF WATER	GPM	PUMPING LEVEL	TIME OF DAY	CONDITION OF WATER
500	**34.5'**	**9/22/08 7:10 pm**		**500**	**34.33'**	**8:01 am**	
500	**34.1'**	**9:10 pm**		**500**	**34.33'**	**10:02 am**	
525	**34.33'**	**9/23/08 1:00 am**		**500**	**34.33'**	**12:01 pm**	
500	**33.9'**	**5:00 am**		**500**	**34.33'**	**2:02 pm**	
490	**33.9'**	**7:00 am**		**500**	**34.33'**	**4:00 pm**	
500	**34'**	**9:15 am**		**500**	**34.25'**	**5:58 pm**	
500	**33.9'**	**11:05 am**		**500**	**34.33'**	**8:01 pm**	
475	**34.1'**	**1:15 pm**		**500**	**34.33'**	**9:56 pm**	
490	**34.21'**	**4:13 pm**		**500**	**34.33'**	**9/27/08 6:06 am**	
500	**34.08'**	**6:07 pm**		**500**	**34.33'**	**8:03 am**	
525	**34.08'**	**8:11 pm**		**500**	**34.33'**	**10:01 am**	
525	**33.91'**	**10:06 pm**		**500**	**34.33'**	**12:02 pm**	
490	**33.91'**	**9/24/08 12:07 am**		**500**	**34.33'**	**1:59 pm**	
490	**33.83'**	**6:09 am**		**500**	**34.33'**	**4:00 pm**	
475	**34.00'**	**8:17 am**		**500**	**34.37'**	**5:58 pm**	
500	**34.00'**	**10:06 am**		**500**	**34.45'**	**9/28/08 1:40 am**	
475	**34.25'**	**12:05 pm**		**500**	**34.45'**	**5:30 am**	
500	**34.33'**	**2:05 pm**		**500**	**34.45'**	**7:50 am**	
500	**34.33'**	**4:08 pm**		**500**	**34.45'**	**10:10 am**	
500	**34.38'**	**6:07 pm**		**300+**	**33.2'**	**2:40 pm**	**MPA started at 1:00 pm**
500	**34.25'**	**8:07 pm**		**300+**	**33.175'**	**7:00 pm**	
500	**34.33'**	**10:06 pm**		**300**	**33.25'**	**11:45 pm**	
500	**34.33'**	**9/25/08 12:01 am**		**300**	**33.3'**	**9/29/08 6:40 am**	
520	**34.33'**	**6:07 am**		**500**	**34.6'**	**11:50 am**	
500	**34.29'**	**8:11 am**		**500**	**34.7'**	**4:50 pm**	
500	**34.29'**	**10:05 am**		**500**	**34.65'**	**9/30/08 8:40 am**	
500	**34.33'**	**12:07 pm**		**500**	**34.65'**	**1:10 pm**	
500	**34.33'**	**2:03 pm**					
500	**34.33'**	**4:00 pm**					
500	**34.29'**	**6:02 pm**					
500	**34.33'**	**8:00 pm**					
500	**34.37'**	**10:01 pm**					
500	**34.33'**	**11:39 pm**					
500	**34.33'**	**9/26/08 6:04 am**					

Comments: Summary Capacity: 500 GPM @ 34.7' PWL (2' drawdown) (≈250 GPM/ft.)

By: ________________ Firm:______________________ Approved:_________________ Firm:_____________________

WELL TEST DATA SHEET

4B Engineering & Consulting LLC, 3000 Market St. NE, Suite 527, Salem, OR 97301 Ph: 503-589-1115, Fax: 503-589-1118

Pg.____ of ____

Owner's Name: Cities of Monmouth and Independence		***Well Location: Willamette River Wellfield (South)***	
Well Name/No.: #2		***Date(s) of Test: Sept 22, 2008 to Sept 30, 2008***	
Well Diameter: 8"	Depth:	Static Level:	Screen/Perf at:
Test Pump Setting:	Test Pump Type:	Air Line/Probe/Transmitter	W/L Device Length: 43.085'
SWL After Test:	Drilled By:	Test Started: 1900 Hrs.	Test Stopped: 1405 Hrs.
Tested By (Firm):	Name:	Max. GPM: @	PWL After Hrs.

GPM	PUMPING LEVEL	TIME OF DAY	CONDITION OF WATER	GPM	PUMPING LEVEL	TIME OF DAY	CONDITION OF WATER
510	**27.67'**	**9/22/08 7:00 pm**		**510**	**27.75'**	**9/26/08 6:00 am**	
500	**27.5'**	**9:00 pm**		**500**	**27.75'**	**7:54 am**	
500	**27.75'**	**9/23/08 1:00 am**		**500**	**27.75'**	**9:57 am**	
500	**27.75'**	**5:00 am**		**500**	**27.75'**	**11:56 am**	
500	**27.58'**	**7:00 am**		**500**	**27.75'**	**1:59 pm**	
510	**27.67'**	**9:00 am**		**510**	**27.75'**	**3:56 pm**	
500	**27.67'**	**11:00 am**		**510**	**27.75'**	**5:51 pm**	
500	**27.63'**	**1:00 pm**		**500**	**27.75'**	**7:55 pm**	
500	**27.67'**	**3:00 pm**		**510**	**27.75'**	**9:51 pm**	
500	**27.63'**	**4:01 pm**		**510**	**27.75'**	**9/27/08 6:01 am**	
510	**27.67'**	**6:01 pm**		**500**	**27.75'**	**7:56 am**	
510	**27.67'**	**8:00 pm**		**500**	**27.75'**	**9:56 am**	
500	**27.72'**	**9:59 pm**		**510**	**27.75'**	**11:38 am**	
510	**27.75'**	**9/24/08 12:01 am**		**510**	**27.75'**	**1:54 pm**	
500	**27.72'**	**6:01 am**		**510**	**27.75'**	**3:56 pm**	
510	**27.67'**	**8:06 am**		**510**	**27.75'**	**5:53 pm**	
510	**27.67'**	**9:59 am**		**500**	**27.87'**	**9/28/08 1:30 am**	
500	**27.67'**	**11:59 am**		**500**	**27.91'**	**5:40 am**	
500	**27.67'**	**1:58 pm**		**500**	**27.98'**	**7:40 am**	
510	**27.75'**	**4:00 pm**		**500**	**27.92'**	**10:15 am**	
510	**27.81'**	**5:57 pm**		**510**	**27.92'**	**2:45 pm**	
500	**27.75'**	**8:03 pm**		**510**	**27.92'**	**6:50 pm**	
510	**27.75'**	**10:01 pm**		**510**	**27.92'**	**11:40 pm**	
500	**27.71'**	**11:55 pm**		**510**	**27.92'**	**9/29/08 6:45 am**	
510	**27.67'**	**9/25/08 6:02 am**		**500**	**28.15'**	**12:00 pm**	
500	**27.67'**	**8:04 am**		**500**	**28.0'**	**4:30 pm**	
510	**27.67'**	**10:01 am**		**480**	**27.75'**	**9/30/08 8:30 am**	
510	**27.75'**	**12:02 pm**		**480**	**27.70'**	**1:05 pm**	
510	**27.75'**	**1:58 pm**					
500	**27.75'**	**3:58 pm**					
500	**27.75'**	**5:56 pm**					
500	**27.75'**	**7:55 pm**					
500	**27.75'**	**9:57 pm**					
510	**27.75'**	**11:55 pm**					

Comments: Summary Capacity: 510 GPM @ 28' PWL (1.75' drawdown) (≈275 GPM/ft.)

By: ________________ Firm:______________________ Approved:_________________ Firm:____________________

WELL TEST DATA SHEET

4B Engineering & Consulting LLC, 3000 Market St. NE, Suite 527, Salem, OR 97301 Ph: 503-589-1115, Fax: 503-589-1118

Owner's Name: Cities of Monmouth and Independence		***Well Location: Willamette River Wellfield (South)***	
Well Name/No.: #3 (North Well)		***Date(s) of Test: Sept 22, 2008 to Sept 30, 2008***	
Well Diameter: 8"	Depth:	Static Level:	Screen/Perf at:
Test Pump Setting:	Test Pump Type:	Air Line/Probe/Transmitter	W/L Device Length: 40.83"
SWL After Test:	Drilled By:	Test Started: 1915 Hrs.	Test Stopped: 1420 Hrs.
Tested By (Firm):	Name:	Max. GPM: @ PWL After Hrs.	

GPM	PUMPING LEVEL	TIME OF DAY	CONDITION OF WATER	GPM	PUMPING LEVEL	TIME OF DAY	CONDITION OF WATER
150	32.1'	9/22/08 7:15 pm		160	31.71'	10:08 am	
150	31.67'	9:30 pm		160	31.67'	12:12 pm	
160	31.6'	9/23/08 1:00 am		160	31.63'	2:12 pm	
160	31.5'	5:00 am		160	31.63'	4:05 pm	
160	31.41'	7:00 am		160	31.75'	6:04 pm	
160	31.33'	9:00 am		160	31.67'	8:10 pm	
180	32.17'	11:15 am	Raise flow	160	31.75'	10:03 pm	
170	32.17'	1:10 pm		160	31.67'	9/27/08 6:13 am	
170	32.25'	4:07 pm		160	31.67'	8:11 am	
170	32.17'	6:12 pm		160	31.63'	10:05 am	
170	32.25'	8:20 pm		160	31.58'	12:15 pm	
170	32.17'	10:15 pm		160	31.58'	2:04 pm	
170	32.17'	9/24/08 12:14 am		160	31.58'	4:04 pm	
170	32.08'	6:15 am		160	31.67'	6:04 pm	
170	32.08'	8:27 am		175	31.65'	9/28/08 1:50 am	
170	32.04'	10:11 am		175	31.6'	5:50 am	
170	32.08'	12:22 pm		175	31.6'	7:30 am	
170	32.08'	2:10 pm		175	31.65'	10:20 am	
170	32.04'	4:18 pm		175	31.65'	3:00 pm	
170	32.00'	6:26 pm		175	31.65'	7:05 pm	
165	32.04'	8:15 pm		175	31.65'	11:35 pm	
170	32.00'	10:14 pm		175	31.65'	9/29/08 6:50 am	
170	32.04'	9/25/08 12:09 am		175	31.7'	11:55 am	
170	32.00'	6:15 am		175	31.73'	4:45 pm	
170	31.92'	8:20 am		175	31.62'	9/30/08 8:50 am	
160	31.75'	10:12 am		175	31.6'	1:20 pm	
160	31.75'	2:09 pm					
160	31.75'	4:08 pm					
160	31.75'	6:08 pm					
160	31.75'	8:07 pm					
170	31.75'	10:09 pm					
160	31.75'	9/26/08 12:05 am					
160	31.75'	6:09 am					
160	31.75'	8:11 am					

Comments: Summary Capacity: 175 GPM @ 31.7' PWL (8.6' drawdown) (≈20 GPM/ft.)

By: __________ Firm: __________ Approved: __________ Firm: __________

Transmissivity from Specific Capacity using the Theis Equation **WELL 1**

Adapted from Vorhis (1979)

Theis Equation: T = [Q/(4*s*pi)][W(u)]
u = (r*r*S)/(4*T*t)
W(u) = (-ln u)-(0.5772157)+(u/1*1!)-(u*u/2*2!)+(u*u*u/3*3!)-(u*u*u*u/4*4!)+...

T = transmissivity (L*L/T)
s = drawdown (L)
S = storage coefficient (dimensionless)
pi = 3.141592654

r = radial distance (L)
t = time (T)
u = dimensionless
W(u) = well function

Note: Transmissivity is derived using an iterative process
The calculations use a known or assumed Storage Coeficient (S) provided by the user
Specific Capacity (Q/s) is used to first approximate the Transmissivity (T) used to calculate u in the first Theis equation iteration
The Transmissivity of the previous iteration is used to calculate u in a given Theis equation iteration
Total Theis Equation iterations = 25 iterations
Can accept answer if difference in calculated Transmissivity for the last 2 iterations is < 0.0001
Can accept answer if u in the last iteration is < 7.1

Note: Well efficiency is not included in the calculations

References:

Theis, C.V. 1935. The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using ground water storage. American Geophysical Union Transactions, 16 annual meeting, vol. 16, pg. 519-524.

Vorhis, R.C. 1979. Transmissivity from pumped well data. Well Log, National Water Well Association newsletter, vol. 10, no. 11, Dec. 1979, pg. 50-52.

Data Entry	Enter Data Below (yellow boxes only)	
Well Log ID or Comment for Records	Average Specific Capacity	
Pumping Rate (gpm) = Q =	500.00	(gpm)
Drawdown (feet) = s =	0.30	(feet)
Time (hours) = t =	186.8000	(hours)
Storage Coefficient = S =	0.100000	(dimensionless)
Well Diameter (inches) = d =	8.0000	(inches)
	Press F9 to Calculate	

Calculated Results	Calculated Results	
Transmissivity (ft2/day) = T =	524,164.64	(ft2/day)
Transmissivity (gpd/ft) = T =	3,921,024.09	(gpd/ft)
Transmissivity Difference = (last 2 iterations)	0.0000E+00 okay to use T if diff < 0.0001	(ft2/day)
u = (last iteration)	6.8087E-10 okay to use T if u <7.1	

Drawdown s (feet)	Storage Coefficient S	Pumping Rate Q (gal/min)	Pumping Rate Q (ft3/sec)	Time t (days)	Distance r = d/2 (feet)	u	W(u)	Transmissivity T (ft2/day)	Transmissivity difference from previous	Comments	Theis Equation Iteration
Note:	yellow grid areas are where values are calculated					Note : W(u) calculation valid when u < 7.1					
						7.0000	1.1545E-04			W(u) calculation test	
0.30	**0.10000**	**500.00**	**1.11**	**7.78**	**0.33**			**320,833.31**		T = Q/s	
0.30	0.10000	500.00	1.11	7.78	0.33	1.1124E-09	20.0396	511,631.83	1.9080E+05	T = Theis Equation	1.00
0.30	0.10000	500.00	1.11	7.78	0.33	6.9755E-10	20.5062	523,546.78	1.1915E+04	T = Theis Equation	2.00
0.30	0.10000	500.00	1.11	7.78	0.33	6.8167E-10	20.5293	524,134.53	5.8775E+02	T = Theis Equation	3.00
0.30	0.10000	500.00	1.11	7.78	0.33	6.8091E-10	20.5304	524,163.18	2.8646E+01	T = Theis Equation	4.00
0.30	0.10000	500.00	1.11	7.78	0.33	6.8087E-10	20.5304	524,164.57	1.3953E+00	T = Theis Equation	5.00
0.30	0.10000	500.00	1.11	7.78	0.33	6.8087E-10	20.5304	524,164.64	6.7965E-02	T = Theis Equation	6.00
0.30	0.10000	500.00	1.11	7.78	0.33	6.8087E-10	20.5304	524,164.64	3.3104E-03	T = Theis Equation	7.00
0.30	0.10000	500.00	1.11	7.78	0.33	6.8087E-10	20.5304	524,164.64	1.6125E-04	T = Theis Equation	8.00
0.30	0.10000	500.00	1.11	7.78	0.33	6.8087E-10	20.5304	524,164.64	7.8541E-06	T = Theis Equation	9.00
0.30	0.10000	500.00	1.11	7.78	0.33	6.8087E-10	20.5304	524,164.64	3.8248E-07	T = Theis Equation	10.00
0.30	0.10000	500.00	1.11	7.78	0.33	6.8087E-10	20.5304	524,164.64	1.8685E-08	T = Theis Equation	11.00
0.30	0.10000	500.00	1.11	7.78	0.33	6.8087E-10	20.5304	524,164.64	8.7311E-10	T = Theis Equation	12.00
0.30	0.10000	500.00	1.11	7.78	0.33	6.8087E-10	20.5304	524,164.64	0.0000E+00	T = Theis Equation	13.00
0.30	0.10000	500.00	1.11	7.78	0.33	6.8087E-10	20.5304	524,164.64	0.0000E+00	T = Theis Equation	14.00
0.30	0.10000	500.00	1.11	7.78	0.33	6.8087E-10	20.5304	524,164.64	0.0000E+00	T = Theis Equation	15.00
0.30	0.10000	500.00	1.11	7.78	0.33	6.8087E-10	20.5304	524,164.64	0.0000E+00	T = Theis Equation	16.00
0.30	0.10000	500.00	1.11	7.78	0.33	6.8087E-10	20.5304	524,164.64	0.0000E+00	T = Theis Equation	17.00
0.30	0.10000	500.00	1.11	7.78	0.33	6.8087E-10	20.5304	524,164.64	0.0000E+00	T = Theis Equation	18.00
0.30	0.10000	500.00	1.11	7.78	0.33	6.8087E-10	20.5304	524,164.64	0.0000E+00	T = Theis Equation	19.00
0.30	0.10000	500.00	1.11	7.78	0.33	6.8087E-10	20.5304	524,164.64	0.0000E+00	T = Theis Equation	20.00
0.30	0.10000	500.00	1.11	7.78	0.33	6.8087E-10	20.5304	524,164.64	0.0000E+00	T = Theis Equation	21.00
0.30	0.10000	500.00	1.11	7.78	0.33	6.8087E-10	20.5304	524,164.64	0.0000E+00	T = Theis Equation	22.00
0.30	0.10000	500.00	1.11	7.78	0.33	6.8087E-10	20.5304	524,164.64	0.0000E+00	T = Theis Equation	23.00
0.30	0.10000	500.00	1.11	7.78	0.33	6.8087E-10	20.5304	524,164.64	0.0000E+00	T = Theis Equation	24.00
0.30	0.10000	500.00	1.11	7.78	0.33	6.8087E-10	20.5304	524,164.64	0.0000E+00	T = Theis Equation	25.00

Transmissivity from Specific Capacity using the Theis Equation **WELL 1**

Adapted from Vorhis (1979)

Theis Equation: T = [Q/(4*s*pi)][W(u)]
u = (r*r*S)/(4*T*t)
W(u) = (-ln u)-(0.5772157)+(u/1*1!)-(u*u/2*2!)+(u*u*u/3*3!)-(u*u*u*u/4*4!)+...

T = transmissivity (L*L/T)
s = drawdown (L) — r = radial distance (L)
S = storage coefficient (dimensionless) — t = time (T)
pi = 3.141592654 — u = dimensionless
W(u) = well function

Note: Transmissivity is derived using an iterative process
The calculations use a known or assumed Storage Coeficient (S) provided by the user
Specific Capacity (Q/s) is used to first approximate the Transmissivity (T) used to calculate u in the first Theis equation iteration
The Transmissivity of the previous iteration is used to calculate u in a given Theis equation iteration
Total Theis Equation iterations = 25 iterations
Can accept answer if difference in calculated Transmissivity for the last 2 iterations is < 0.0001
Can accept answer if u in the last iteration is < 7.1

Note: Well efficiency is not included in the calculations

References:

Theis, C.V. 1935. The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using ground water storage. American Geophysical Union Transactions, 16 annual meeting, vol. 16, pg. 519-524.

Vorhis, R.C. 1979. Transmissivity from pumped well data. Well Log, National Water Well Association newsletter, vol. 10, no. 11, Dec. 1979, pg. 50-52.

Data Entry	**Enter Data Below (yellow boxes only)**	
Well Log ID or Comment for Records	**Average Specific Capacity**	
Pumping Rate (gpm) = Q =	**500.00**	**(gpm)**
Drawdown (feet) = s =	**2.00**	**(feet)**
Time (hours) = t =	**186.8000**	**(hours)**
Storage Coefficient = S =	**0.100000**	**(dimensionless)**
Well Diameter (inches) = d =	**8.0000**	**(inches)**
	Press F9 to Calculate	

Calculated Results	**Calculated Results**	
Transmissivity (ft2/day) = T =	**70,966.93**	**(ft2/day)**
Transmissivity (gpd/ft) = T =	**530,869.53**	**(gpd/ft)**
Transmissivity Difference = (last 2 iterations)	**0.0000E+00 okay to use T if diff < 0.0001**	**(ft2/day)**
u = (last iteration)	**5.0289E-09 okay to use T if u <7.1**	

Drawdown s (feet)	Storage Coefficient S	Pumping Rate Q (gal/min)	Pumping Rate Q (ft3/sec)	Time t (days)	Distance r = d/2 (feet)	u	W(u)	Transmissivity T (ft2/day)	Transmissivity difference from previous	Comments	Theis Equation Iteration
Note:	yellow grid areas are where values are calculated					Note : W(u) calculation valid when u < 7.1					
						7.0000	1.1545E-04			W(u) calculation test	
2.00	0.10000	500.00	1.11	7.78	0.33			48,125.00		T = Q/s	
2.00	0.10000	500.00	1.11	7.78	0.33	7.4159E-09	18.1424	69,479.44	2.1354E+04	T = Theis Equation	1.00
2.00	0.10000	500.00	1.11	7.78	0.33	5.1366E-09	18.5097	70,885.80	1.4064E+03	T = Theis Equation	2.00
2.00	0.10000	500.00	1.11	7.78	0.33	5.0347E-09	18.5297	70,962.55	7.6744E+01	T = Theis Equation	3.00
2.00	0.10000	500.00	1.11	7.78	0.33	5.0292E-09	18.5308	70,966.69	4.1439E+00	T = Theis Equation	4.00
2.00	0.10000	500.00	1.11	7.78	0.33	5.0289E-09	18.5308	70,966.92	2.2363E-01	T = Theis Equation	5.00
2.00	0.10000	500.00	1.11	7.78	0.33	5.0289E-09	18.5308	70,966.93	1.2068E-02	T = Theis Equation	6.00
2.00	0.10000	500.00	1.11	7.78	0.33	5.0289E-09	18.5308	70,966.93	6.5124E-04	T = Theis Equation	7.00
2.00	0.10000	500.00	1.11	7.78	0.33	5.0289E-09	18.5308	70,966.93	3.5143E-05	T = Theis Equation	8.00
2.00	0.10000	500.00	1.11	7.78	0.33	5.0289E-09	18.5308	70,966.93	1.8965E-06	T = Theis Equation	9.00
2.00	0.10000	500.00	1.11	7.78	0.33	5.0289E-09	18.5308	70,966.93	1.0234E-07	T = Theis Equation	10.00
2.00	0.10000	500.00	1.11	7.78	0.33	5.0289E-09	18.5308	70,966.93	5.5152E-09	T = Theis Equation	11.00
2.00	0.10000	500.00	1.11	7.78	0.33	5.0289E-09	18.5308	70,966.93	3.0559E-10	T = Theis Equation	12.00
2.00	0.10000	500.00	1.11	7.78	0.33	5.0289E-09	18.5308	70,966.93	0.0000E+00	T = Theis Equation	13.00
2.00	0.10000	500.00	1.11	7.78	0.33	5.0289E-09	18.5308	70,966.93	0.0000E+00	T = Theis Equation	14.00
2.00	0.10000	500.00	1.11	7.78	0.33	5.0289E-09	18.5308	70,966.93	0.0000E+00	T = Theis Equation	15.00
2.00	0.10000	500.00	1.11	7.78	0.33	5.0289E-09	18.5308	70,966.93	0.0000E+00	T = Theis Equation	16.00
2.00	0.10000	500.00	1.11	7.78	0.33	5.0289E-09	18.5308	70,966.93	0.0000E+00	T = Theis Equation	17.00
2.00	0.10000	500.00	1.11	7.78	0.33	5.0289E-09	18.5308	70,966.93	0.0000E+00	T = Theis Equation	18.00
2.00	0.10000	500.00	1.11	7.78	0.33	5.0289E-09	18.5308	70,966.93	0.0000E+00	T = Theis Equation	19.00
2.00	0.10000	500.00	1.11	7.78	0.33	5.0289E-09	18.5308	70,966.93	0.0000E+00	T = Theis Equation	20.00
2.00	0.10000	500.00	1.11	7.78	0.33	5.0289E-09	18.5308	70,966.93	0.0000E+00	T = Theis Equation	21.00
2.00	0.10000	500.00	1.11	7.78	0.33	5.0289E-09	18.5308	70,966.93	0.0000E+00	T = Theis Equation	22.00
2.00	0.10000	500.00	1.11	7.78	0.33	5.0289E-09	18.5308	70,966.93	0.0000E+00	T = Theis Equation	23.00
2.00	0.10000	500.00	1.11	7.78	0.33	5.0289E-09	18.5308	70,966.93	0.0000E+00	T = Theis Equation	24.00
2.00	0.10000	500.00	1.11	7.78	0.33	5.0289E-09	18.5308	70,966.93	0.0000E+00	T = Theis Equation	25.00

Transmissivity from Specific Capacity using the Theis Equation **WELL 2**

Adapted from Vorhis (1979)

Theis Equation: T = [Q/(4*s*pi)][W(u)]
u = (r*r*S)/(4*T*t)
W(u) = (-ln u)-(0.5772157)+(u/1*1!)-(u*u/2*2!)+(u*u*u/3*3!)-(u*u*u*u/4*4!)+...

T = transmissivity (L*L/T)
s = drawdown (L)
S = storage coefficient (dimensionless)
pi = 3.141592654

r = radial distance (L)
t = time (T)
u = dimensionless
W(u) = well function

Note: Transmissivity is derived using an iterative process
The calculations use a known or assumed Storage Coeficient (S) provided by the user
Specific Capacity (Q/s) is used to first approximate the Transmissivity (T) used to calculate u in the first Theis equation iteration
The Transmissivity of the previous iteration is used to calculate u in a given Theis equation iteration
Total Theis Equation iterations = 25 iterations
Can accept answer if difference in calculated Transmissivity for the last 2 iterations is < 0.0001
Can accept answer if u in the last iteration is < 7.1

Note: Well efficiency is not included in the calculations

References:

Theis, C.V. 1935. The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using ground water storage. American Geophysical Union Transactions, 16 annual meeting, vol. 16, pg. 519-524.

Vorhis, R.C. 1979. Transmissivity from pumped well data. Well Log, National Water Well Association newsletter, vol. 10, no. 11, Dec. 1979, pg. 50-52.

Data Entry	Enter Data Below (yellow boxes only)	
Well Log ID or Comment for Records	Average Specific Capacity	
Pumping Rate (gpm) = Q =	504.00	(gpm)
Drawdown (feet) = s =	0.15	(feet)
Time (hours) = t =	187.1000	(hours)
Storage Coefficient = S =	0.100000	(dimensionless)
Well Diameter (inches) = d =	8.0000	(inches)
	Press F9 to Calculate	

Calculated Results	Calculated Results	
Transmissivity (ft2/day) = T =	1,094,703.23	(ft2/day)
Transmissivity (gpd/ft) = T =	8,188,949.39	(gpd/ft)
Transmissivity Difference = (last 2 iterations)	0.0000E+00 okay to use T if diff < 0.0001	(ft2/day)
u = (last iteration)	3.2549E-10 okay to use T if u <7.1	

Drawdown s (feet)	Storage Coefficient S	Pumping Rate Q (gal/min)	Pumping Rate Q (ft3/sec)	Time t (days)	Distance r = d/2 (feet)	u	W(u)	Transmissivity T (ft2/day)	Transmissivity difference from previous	Comments	Theis Equation Iteration
Note:	yellow grid areas are where values are calculated					Note : W(u) calculation valid when u < 7.1					
						7.0000	1.1545E-04			W(u) calculation test	
0.15	0.10000	504.00	1.12	7.80	0.33			646,799.96		T = Q/s	
0.15	0.10000	504.00	1.12	7.80	0.33	5.5089E-10	20.7423	1,067,619.26	4.2082E+05	T = Theis Equation	1.00
0.15	0.10000	504.00	1.12	7.80	0.33	3.3375E-10	21.2434	1,093,413.78	2.5795E+04	T = Theis Equation	2.00
0.15	0.10000	504.00	1.12	7.80	0.33	3.2587E-10	21.2673	1,094,642.56	1.2288E+03	T = Theis Equation	3.00
0.15	0.10000	504.00	1.12	7.80	0.33	3.2551E-10	21.2684	1,094,700.38	5.7811E+01	T = Theis Equation	4.00
0.15	0.10000	504.00	1.12	7.80	0.33	3.2549E-10	21.2685	1,094,703.09	2.7182E+00	T = Theis Equation	5.00
0.15	0.10000	504.00	1.12	7.80	0.33	3.2549E-10	21.2685	1,094,703.22	1.2781E-01	T = Theis Equation	6.00
0.15	0.10000	504.00	1.12	7.80	0.33	3.2549E-10	21.2685	1,094,703.23	6.0091E-03	T = Theis Equation	7.00
0.15	0.10000	504.00	1.12	7.80	0.33	3.2549E-10	21.2685	1,094,703.23	2.8254E-04	T = Theis Equation	8.00
0.15	0.10000	504.00	1.12	7.80	0.33	3.2549E-10	21.2685	1,094,703.23	1.3284E-05	T = Theis Equation	9.00
0.15	0.10000	504.00	1.12	7.80	0.33	3.2549E-10	21.2685	1,094,703.23	6.2445E-07	T = Theis Equation	10.00
0.15	0.10000	504.00	1.12	7.80	0.33	3.2549E-10	21.2685	1,094,703.23	2.9569E-08	T = Theis Equation	11.00
0.15	0.10000	504.00	1.12	7.80	0.33	3.2549E-10	21.2685	1,094,703.23	0.0000E+00	T = Theis Equation	12.00
0.15	0.10000	504.00	1.12	7.80	0.33	3.2549E-10	21.2685	1,094,703.23	0.0000E+00	T = Theis Equation	13.00
0.15	0.10000	504.00	1.12	7.80	0.33	3.2549E-10	21.2685	1,094,703.23	0.0000E+00	T = Theis Equation	14.00
0.15	0.10000	504.00	1.12	7.80	0.33	3.2549E-10	21.2685	1,094,703.23	0.0000E+00	T = Theis Equation	15.00
0.15	0.10000	504.00	1.12	7.80	0.33	3.2549E-10	21.2685	1,094,703.23	0.0000E+00	T = Theis Equation	16.00
0.15	0.10000	504.00	1.12	7.80	0.33	3.2549E-10	21.2685	1,094,703.23	0.0000E+00	T = Theis Equation	17.00
0.15	0.10000	504.00	1.12	7.80	0.33	3.2549E-10	21.2685	1,094,703.23	0.0000E+00	T = Theis Equation	18.00
0.15	0.10000	504.00	1.12	7.80	0.33	3.2549E-10	21.2685	1,094,703.23	0.0000E+00	T = Theis Equation	19.00
0.15	0.10000	504.00	1.12	7.80	0.33	3.2549E-10	21.2685	1,094,703.23	0.0000E+00	T = Theis Equation	20.00
0.15	0.10000	504.00	1.12	7.80	0.33	3.2549E-10	21.2685	1,094,703.23	0.0000E+00	T = Theis Equation	21.00
0.15	0.10000	504.00	1.12	7.80	0.33	3.2549E-10	21.2685	1,094,703.23	0.0000E+00	T = Theis Equation	22.00
0.15	0.10000	504.00	1.12	7.80	0.33	3.2549E-10	21.2685	1,094,703.23	0.0000E+00	T = Theis Equation	23.00
0.15	0.10000	504.00	1.12	7.80	0.33	3.2549E-10	21.2685	1,094,703.23	0.0000E+00	T = Theis Equation	24.00
0.15	0.10000	504.00	1.12	7.80	0.33	3.2549E-10	21.2685	1,094,703.23	0.0000E+00	T = Theis Equation	25.00

Transmissivity from Specific Capacity using the Theis Equation

WELL 2

Adapted from Vorhis (1979)

Theis Equation: T = [Q/(4*s*pi)][W(u)]
u = (r*r*S)/(4*T*t)
W(u) = (-ln u)-(0.5772157)+(u/1*1!)-(u*u/2*2!)+(u*u*u/3*3!)-(u*u*u*u/4*4!)+...

T = transmissivity (L*L/T)
s = drawdown (L)
S = storage coefficient (dimensionless)
pi = 3.141592654

r = radial distance (L)
t = time (T)
u = dimensionless
W(u) = well function

Note: Transmissivity is derived using an iterative process
The calculations use a known or assumed Storage Coeficient (S) provided by the user
Specific Capacity (Q/s) is used to first approximate the Transmissivity (T) used to calculate u in the first Theis equation iteration
The Transmissivity of the previous iteration is used to calculate u in a given Theis equation iteration
Total Theis Equation iterations = 25 iterations
Can accept answer if difference in calculated Transmissivity for the last 2 iterations is < 0.0001
Can accept answer if u in the last iteration is < 7.1

Note: Well efficiency is not included in the calculations

References:

Theis, C.V. 1935. The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using ground water storage. American Geophysical Union Transactions, 16 annual meeting, vol. 16, pg. 519-524.

Vorhis, R.C. 1979. Transmissivity from pumped well data. Well Log, National Water Well Association newsletter, vol. 10, no. 11, Dec. 1979, pg. 50-52.

Data Entry	Enter Data Below (yellow boxes only)	
Well Log ID or Comment for Records	Average Specific Capacity	
Pumping Rate (gpm) = Q =	510.00	(gpm)
Drawdown (feet) = s =	1.75	(feet)
Time (hours) = t =	187.1000	(hours)
Storage Coefficient = S =	0.100000	(dimensionless)
Well Diameter (inches) = d =	8.0000	(inches)
	Press F9 to Calculate	

Calculated Results	Calculated Results	
Transmissivity (ft2/day) = T =	83,458.13	(ft2/day)
Transmissivity (gpd/ft) = T =	624,310.19	(gpd/ft)
Transmissivity Difference = (last 2 iterations)	0.0000E+00 okay to use T if diff < 0.0001	(ft2/day)
u = (last iteration)	4.2694E-09 okay to use T if u <7.1	

Drawdown s (feet)	Storage Coefficient S	Pumping Rate Q (gal/min)	Pumping Rate Q (ft3/sec)	Time t (days)	Distance r = d/2 (feet)	u	W(u)	Transmissivity T (ft2/day)	Transmissivity difference from previous	Comments	Theis Equation Iteration
Note:	yellow grid areas are where values are calculated					Note : W(u) calculation valid when u < 7.1					
						7.0000	1.1545E-04			W(u) calculation test	
1.75	0.10000	510.00	1.14	7.80	0.33			56,100.00		T = Q/s	
1.75	0.10000	510.00	1.14	7.80	0.33	6.3514E-09	18.2974	81,684.87	2.5585E+04	T = Theis Equation	1.00
1.75	0.10000	510.00	1.14	7.80	0.33	4.3621E-09	18.6731	83,362.25	1.6774E+03	T = Theis Equation	2.00
1.75	0.10000	510.00	1.14	7.80	0.33	4.2743E-09	18.6934	83,453.00	9.0745E+01	T = Theis Equation	3.00
1.75	0.10000	510.00	1.14	7.80	0.33	4.2697E-09	18.6945	83,457.85	4.8570E+00	T = Theis Equation	4.00
1.75	0.10000	510.00	1.14	7.80	0.33	4.2694E-09	18.6946	83,458.11	2.5982E-01	T = Theis Equation	5.00
1.75	0.10000	510.00	1.14	7.80	0.33	4.2694E-09	18.6946	83,458.13	1.3898E-02	T = Theis Equation	6.00
1.75	0.10000	510.00	1.14	7.80	0.33	4.2694E-09	18.6946	83,458.13	7.4343E-04	T = Theis Equation	7.00
1.75	0.10000	510.00	1.14	7.80	0.33	4.2694E-09	18.6946	83,458.13	3.9767E-05	T = Theis Equation	8.00
1.75	0.10000	510.00	1.14	7.80	0.33	4.2694E-09	18.6946	83,458.13	2.1272E-06	T = Theis Equation	9.00
1.75	0.10000	510.00	1.14	7.80	0.33	4.2694E-09	18.6946	83,458.13	1.1381E-07	T = Theis Equation	10.00
1.75	0.10000	510.00	1.14	7.80	0.33	4.2694E-09	18.6946	83,458.13	6.0536E-09	T = Theis Equation	11.00
1.75	0.10000	510.00	1.14	7.80	0.33	4.2694E-09	18.6946	83,458.13	3.4925E-10	T = Theis Equation	12.00
1.75	0.10000	510.00	1.14	7.80	0.33	4.2694E-09	18.6946	83,458.13	0.0000E+00	T = Theis Equation	13.00
1.75	0.10000	510.00	1.14	7.80	0.33	4.2694E-09	18.6946	83,458.13	0.0000E+00	T = Theis Equation	14.00
1.75	0.10000	510.00	1.14	7.80	0.33	4.2694E-09	18.6946	83,458.13	0.0000E+00	T = Theis Equation	15.00
1.75	0.10000	510.00	1.14	7.80	0.33	4.2694E-09	18.6946	83,458.13	0.0000E+00	T = Theis Equation	16.00
1.75	0.10000	510.00	1.14	7.80	0.33	4.2694E-09	18.6946	83,458.13	0.0000E+00	T = Theis Equation	17.00
1.75	0.10000	510.00	1.14	7.80	0.33	4.2694E-09	18.6946	83,458.13	0.0000E+00	T = Theis Equation	18.00
1.75	0.10000	510.00	1.14	7.80	0.33	4.2694E-09	18.6946	83,458.13	0.0000E+00	T = Theis Equation	19.00
1.75	0.10000	510.00	1.14	7.80	0.33	4.2694E-09	18.6946	83,458.13	0.0000E+00	T = Theis Equation	20.00
1.75	0.10000	510.00	1.14	7.80	0.33	4.2694E-09	18.6946	83,458.13	0.0000E+00	T = Theis Equation	21.00
1.75	0.10000	510.00	1.14	7.80	0.33	4.2694E-09	18.6946	83,458.13	0.0000E+00	T = Theis Equation	22.00
1.75	0.10000	510.00	1.14	7.80	0.33	4.2694E-09	18.6946	83,458.13	0.0000E+00	T = Theis Equation	23.00
1.75	0.10000	510.00	1.14	7.80	0.33	4.2694E-09	18.6946	83,458.13	0.0000E+00	T = Theis Equation	24.00
1.75	0.10000	510.00	1.14	7.80	0.33	4.2694E-09	18.6946	83,458.13	0.0000E+00	T = Theis Equation	25.00

Transmissivity from Specific Capacity using the Theis Equation **WELL 3**

Adapted from Vorhis (1979)

Theis Equation: T = [Q/(4*s*pi)][W(u)]
u = (r*r*S)/(4*T*t)
W(u) = (-ln u)-(0.5772157)+(u/1*1!)-(u*u/2*2!)+(u*u*u/3*3!)-(u*u*u*u/4*4!)+...

T = transmissivity (L*L/T)
s = drawdown (L) — r = radial distance (L)
S = storage coefficient (dimensionless) — t = time (T)
pi = 3.141592654 — u = dimensionless
W(u) = well function

Note: Transmissivity is derived using an iterative process
The calculations use a known or assumed Storage Coeficient (S) provided by the user
Specific Capacity (Q/s) is used to first approximate the Transmissivity (T) used to calculate u in the first Theis equation iteration
The Transmissivity of the previous iteration is used to calculate u in a given Theis equation iteration
Total Theis Equation iterations = 25 iterations
Can accept answer if difference in calculated Transmissivity for the last 2 iterations is < 0.0001
Can accept answer if u in the last iteration is < 7.1

Note: Well efficiency is not included in the calculations

References:

Theis, C.V. 1935. The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using ground water storage. American Geophysical Union Transactions, 16 annual meeting, vol. 16, pg. 519-524.

Vorhis, R.C. 1979. Transmissivity from pumped well data. Well Log, National Water Well Association newsletter, vol. 10, no. 11, Dec. 1979, pg. 50-52.

Data Entry — **Enter Data Below (yellow boxes only)**

Well Log ID or Comment for Records	**Average Specific Capacity**	
Pumping Rate (gpm) = Q =	**166.00**	**(gpm)**
Drawdown (feet) = s =	**0.31**	**(feet)**
Time (hours) = t =	**187.1000**	**(hours)**
Storage Coefficient = S =	**0.100000**	**(dimensionless)**
Well Diameter (inches) = d =	**8.0000**	**(inches)**
	Press F9 to Calculate	

Calculated Results	**Calculated Results**	
Transmissivity (ft2/day) = T =	**157,014.36**	**(ft2/day)**
Transmissivity (gpd/ft) = T =	**1,174,549.08**	**(gpd/ft)**
Transmissivity Difference = (last 2 iterations)	**0.0000E+00 okay to use T if diff < 0.0001**	**(ft2/day)**
u = (last iteration)	**2.2693E-09 okay to use T if u <7.1**	

Drawdown s (feet)	Storage Coefficient S	Pumping Rate Q (gal/min)	Pumping Rate Q (ft3/sec)	Time t (days)	Distance r = d/2 (feet)	u	W(u)	Transmissivity T (ft2/day)	Transmissivity difference from previous	Comments	Theis Equation Iteration
Note:	yellow grid areas are where values are calculated					Note : W(u) calculation valid when u < 7.1					
						7.0000	1.1545E-04			W(u) calculation test	
0.31	**0.10000**	**166.00**	**0.37**	**7.80**	**0.33**			**102,092.64**		**T = Q/s**	
0.31	0.10000	166.00	0.37	7.80	0.33	3.4901E-09	18.8961	153,517.22	5.1425E+04	T = Theis Equation	1.00
0.31	0.10000	166.00	0.37	7.80	0.33	2.3210E-09	19.3040	156,831.37	3.3142E+03	T = Theis Equation	2.00
0.31	0.10000	166.00	0.37	7.80	0.33	2.2720E-09	19.3254	157,004.89	1.7352E+02	T = Theis Equation	3.00
0.31	0.10000	166.00	0.37	7.80	0.33	2.2695E-09	19.3265	157,013.87	8.9839E+00	T = Theis Equation	4.00
0.31	0.10000	166.00	0.37	7.80	0.33	2.2693E-09	19.3266	157,014.34	4.6486E-01	T = Theis Equation	5.00
0.31	0.10000	166.00	0.37	7.80	0.33	2.2693E-09	19.3266	157,014.36	2.4053E-02	T = Theis Equation	6.00
0.31	0.10000	166.00	0.37	7.80	0.33	2.2693E-09	19.3266	157,014.36	1.2446E-03	T = Theis Equation	7.00
0.31	0.10000	166.00	0.37	7.80	0.33	2.2693E-09	19.3266	157,014.36	6.4396E-05	T = Theis Equation	8.00
0.31	0.10000	166.00	0.37	7.80	0.33	2.2693E-09	19.3266	157,014.36	3.3320E-06	T = Theis Equation	9.00
0.31	0.10000	166.00	0.37	7.80	0.33	2.2693E-09	19.3266	157,014.36	1.7241E-07	T = Theis Equation	10.00
0.31	0.10000	166.00	0.37	7.80	0.33	2.2693E-09	19.3266	157,014.36	8.9058E-09	T = Theis Equation	11.00
0.31	0.10000	166.00	0.37	7.80	0.33	2.2693E-09	19.3266	157,014.36	4.9477E-10	T = Theis Equation	12.00
0.31	0.10000	166.00	0.37	7.80	0.33	2.2693E-09	19.3266	157,014.36	0.0000E+00	T = Theis Equation	13.00
0.31	0.10000	166.00	0.37	7.80	0.33	2.2693E-09	19.3266	157,014.36	0.0000E+00	T = Theis Equation	14.00
0.31	0.10000	166.00	0.37	7.80	0.33	2.2693E-09	19.3266	157,014.36	0.0000E+00	T = Theis Equation	15.00
0.31	0.10000	166.00	0.37	7.80	0.33	2.2693E-09	19.3266	157,014.36	0.0000E+00	T = Theis Equation	16.00
0.31	0.10000	166.00	0.37	7.80	0.33	2.2693E-09	19.3266	157,014.36	0.0000E+00	T = Theis Equation	17.00
0.31	0.10000	166.00	0.37	7.80	0.33	2.2693E-09	19.3266	157,014.36	0.0000E+00	T = Theis Equation	18.00
0.31	0.10000	166.00	0.37	7.80	0.33	2.2693E-09	19.3266	157,014.36	0.0000E+00	T = Theis Equation	19.00
0.31	0.10000	166.00	0.37	7.80	0.33	2.2693E-09	19.3266	157,014.36	0.0000E+00	T = Theis Equation	20.00
0.31	0.10000	166.00	0.37	7.80	0.33	2.2693E-09	19.3266	157,014.36	0.0000E+00	T = Theis Equation	21.00
0.31	0.10000	166.00	0.37	7.80	0.33	2.2693E-09	19.3266	157,014.36	0.0000E+00	T = Theis Equation	22.00
0.31	0.10000	166.00	0.37	7.80	0.33	2.2693E-09	19.3266	157,014.36	0.0000E+00	T = Theis Equation	23.00
0.31	0.10000	166.00	0.37	7.80	0.33	2.2693E-09	19.3266	157,014.36	0.0000E+00	T = Theis Equation	24.00
0.31	0.10000	166.00	0.37	7.80	0.33	2.2693E-09	19.3266	157,014.36	0.0000E+00	T = Theis Equation	25.00

Transmissivity from Specific Capacity using the Theis Equation **WELL 3**

Adapted from Vorhis (1979)

Theis Equation: T = [Q/(4*s*pi)][W(u)]
u = (r*r*S)/(4*T*t)
W(u) = (-ln u)-(0.5772157)+(u/1*1!)-(u*u/2*2!)+(u*u*u/3*3!)-(u*u*u*u/4*4!)+...

T = transmissivity (L*L/T)
s = drawdown (L) — r = radial distance (L)
S = storage coefficient (dimensionless) — t = time (T)
pi = 3.141592654 — u = dimensionless
W(u) = well function

Note: Transmissivity is derived using an iterative process
The calculations use a known or assumed Storage Coeficient (S) provided by the user
Specific Capacity (Q/s) is used to first approximate the Transmissivity (T) used to calculate u in the first Theis equation iteration
The Transmissivity of the previous iteration is used to calculate u in a given Theis equation iteration
Total Theis Equation iterations = 25 iterations
Can accept answer if difference in calculated Transmissivity for the last 2 iterations is < 0.0001
Can accept answer if u in the last iteration is < 7.1

Note: Well efficiency is not included in the calculations

References:

Theis, C.V. 1935. The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using ground water storage. American Geophysical Union Transactions, 16 annual meeting, vol. 16, pg. 519-524.

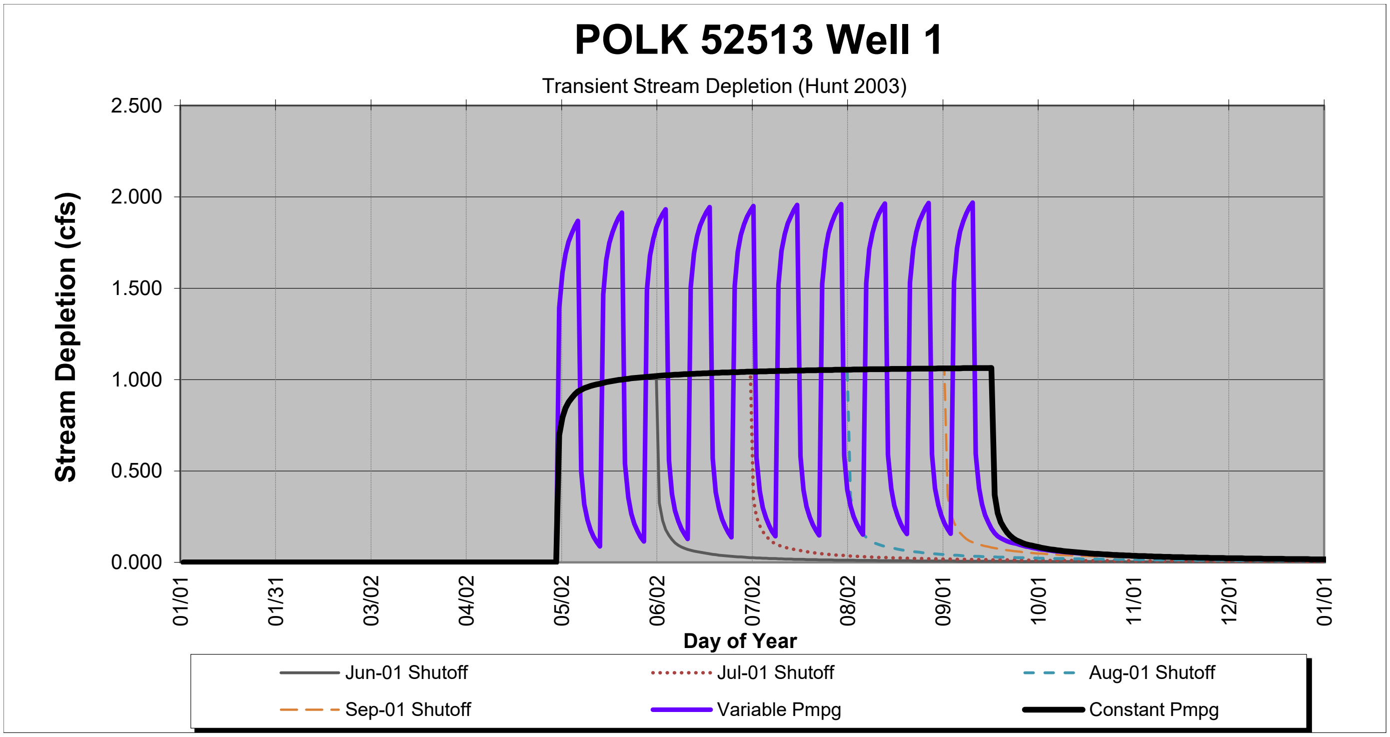
Vorhis, R.C. 1979. Transmissivity from pumped well data. Well Log, National Water Well Association newsletter, vol. 10, no. 11, Dec. 1979, pg. 50-52.

Data Entry	Enter Data Below (yellow boxes only)	
Well Log ID or Comment for Records	Average Specific Capacity	
Pumping Rate (gpm) = Q =	175.00	(gpm)
Drawdown (feet) = s =	8.60	(feet)
Time (hours) = t =	187.1000	(hours)
Storage Coefficient = S =	0.100000	(dimensionless)
Well Diameter (inches) = d =	8.0000	(inches)
	Press F9 to Calculate	
Calculated Results	**Calculated Results**	
Transmissivity (ft2/day) = T =	4,946.62	(ft2/day)
Transmissivity (gpd/ft) = T =	37,003.27	(gpd/ft)
Transmissivity Difference = (last 2 iterations)	0.0000E+00 okay to use T if diff < 0.0001	(ft2/day)
u = (last iteration)	7.2032E-08 okay to use T if u <7.1	

Drawdown s (feet)	Storage Coefficient S	Pumping Rate Q (gal/min)	Pumping Rate Q (ft3/sec)	Time t (days)	Distance r = d/2 (feet)	u	W(u)	Transmissivity T (ft2/day)	Transmissivity difference from previous	Comments	Theis Equation Iteration
Note:	yellow grid areas are where values are calculated					Note : W(u) calculation valid when u < 7.1					
						7.0000	1.1545E-04			W(u) calculation test	
8.60	0.10000	175.00	0.39	7.80	0.33			3,917.15		T = Q/s	
8.60	0.10000	175.00	0.39	7.80	0.33	9.0963E-08	15.6356	4,873.88	9.5673E+02	T = Theis Equation	1.00
8.60	0.10000	175.00	0.39	7.80	0.33	7.3107E-08	15.8541	4,942.00	6.8118E+01	T = Theis Equation	2.00
8.60	0.10000	175.00	0.39	7.80	0.33	7.2100E-08	15.8680	4,946.33	4.3264E+00	T = Theis Equation	3.00
8.60	0.10000	175.00	0.39	7.80	0.33	7.2036E-08	15.8689	4,946.60	2.7277E-01	T = Theis Equation	4.00
8.60	0.10000	175.00	0.39	7.80	0.33	7.2032E-08	15.8689	4,946.62	1.7190E-02	T = Theis Equation	5.00
8.60	0.10000	175.00	0.39	7.80	0.33	7.2032E-08	15.8689	4,946.62	1.0832E-03	T = Theis Equation	6.00
8.60	0.10000	175.00	0.39	7.80	0.33	7.2032E-08	15.8689	4,946.62	6.8261E-05	T = Theis Equation	7.00
8.60	0.10000	175.00	0.39	7.80	0.33	7.2032E-08	15.8689	4,946.62	4.3015E-06	T = Theis Equation	8.00
8.60	0.10000	175.00	0.39	7.80	0.33	7.2032E-08	15.8689	4,946.62	2.7106E-07	T = Theis Equation	9.00
8.60	0.10000	175.00	0.39	7.80	0.33	7.2032E-08	15.8689	4,946.62	1.7083E-08	T = Theis Equation	10.00
8.60	0.10000	175.00	0.39	7.80	0.33	7.2032E-08	15.8689	4,946.62	1.0759E-09	T = Theis Equation	11.00
8.60	0.10000	175.00	0.39	7.80	0.33	7.2032E-08	15.8689	4,946.62	6.8212E-11	T = Theis Equation	12.00
8.60	0.10000	175.00	0.39	7.80	0.33	7.2032E-08	15.8689	4,946.62	0.0000E+00	T = Theis Equation	13.00
8.60	0.10000	175.00	0.39	7.80	0.33	7.2032E-08	15.8689	4,946.62	0.0000E+00	T = Theis Equation	14.00
8.60	0.10000	175.00	0.39	7.80	0.33	7.2032E-08	15.8689	4,946.62	0.0000E+00	T = Theis Equation	15.00
8.60	0.10000	175.00	0.39	7.80	0.33	7.2032E-08	15.8689	4,946.62	0.0000E+00	T = Theis Equation	16.00
8.60	0.10000	175.00	0.39	7.80	0.33	7.2032E-08	15.8689	4,946.62	0.0000E+00	T = Theis Equation	17.00
8.60	0.10000	175.00	0.39	7.80	0.33	7.2032E-08	15.8689	4,946.62	0.0000E+00	T = Theis Equation	18.00
8.60	0.10000	175.00	0.39	7.80	0.33	7.2032E-08	15.8689	4,946.62	0.0000E+00	T = Theis Equation	19.00
8.60	0.10000	175.00	0.39	7.80	0.33	7.2032E-08	15.8689	4,946.62	0.0000E+00	T = Theis Equation	20.00
8.60	0.10000	175.00	0.39	7.80	0.33	7.2032E-08	15.8689	4,946.62	0.0000E+00	T = Theis Equation	21.00
8.60	0.10000	175.00	0.39	7.80	0.33	7.2032E-08	15.8689	4,946.62	0.0000E+00	T = Theis Equation	22.00
8.60	0.10000	175.00	0.39	7.80	0.33	7.2032E-08	15.8689	4,946.62	0.0000E+00	T = Theis Equation	23.00
8.60	0.10000	175.00	0.39	7.80	0.33	7.2032E-08	15.8689	4,946.62	0.0000E+00	T = Theis Equation	24.00
8.60	0.10000	175.00	0.39	7.80	0.33	7.2032E-08	15.8689	4,946.62	0.0000E+00	T = Theis Equation	25.00

ATTACHMENT D

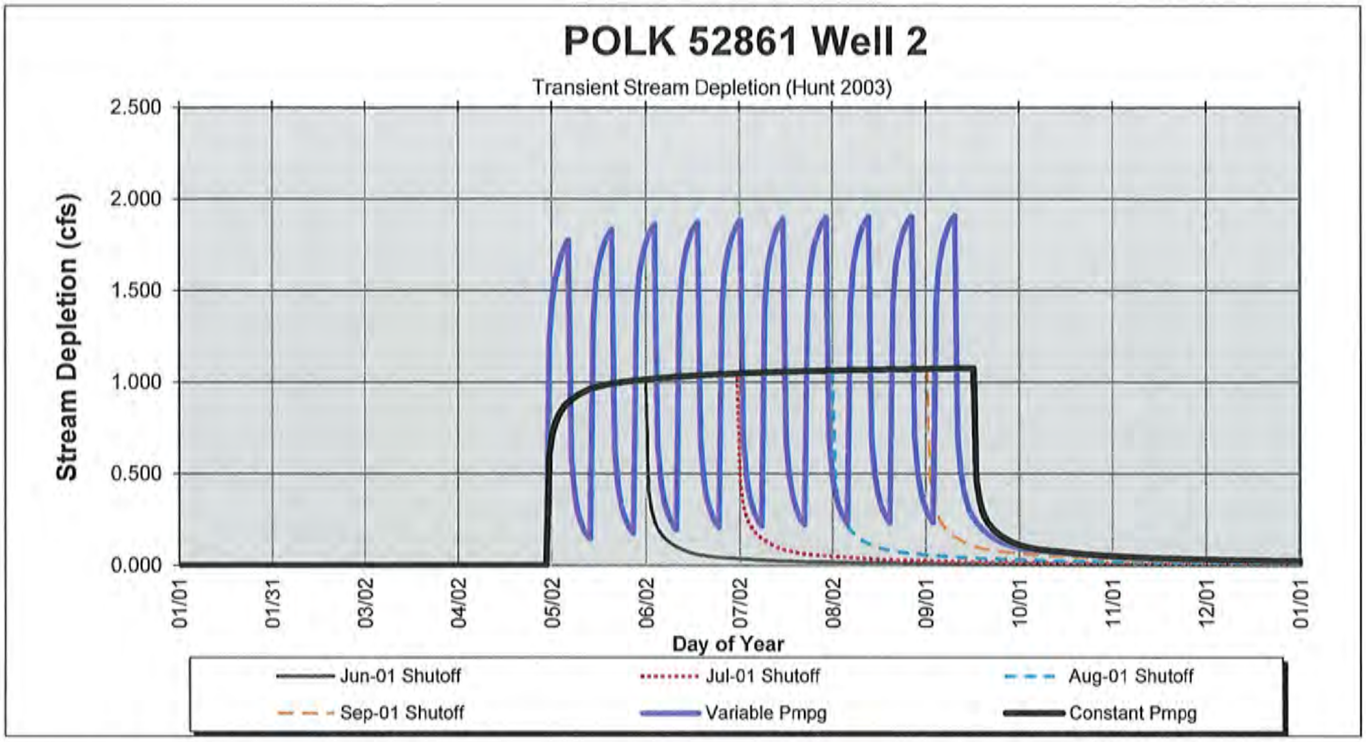
Stream Depletion Evaluation



Parameters:		Values	Units
Perpendicular from well to stream	a	90	ft
Well depth	d	61	ft
Aquifer transmissivity	T_ft	520,000	ft*ft/day
Aquifer storativity or specific yield	S	0.1000	Dimensionless
Stream width	ws	350	ft
Aquitard vertical hydraulic conductivity	Kva	50.0000	ft/day
Aquitard saturated thickness	ba	20	ft
Aquitard thickness below stream	babs	20	ft
Aquitard porosity	n	0.100	Dimensionless
Maximum irrigated acres per well, on all water rights		0.00	acres
Maximum pumping rate on all water rights	Qmwr	3.0000	cfs
Maximum pumping rate per well, all water rights	Qmp	2.2200	cfs
Constant pumping rate for model (Qmp/2)	Qwc	1.1100	cfs
Variable weekly pumping rate for model (Qmp)	Qwv	2.2200	cfs
Pumping days in irrigation season		138	days
Total acre feet pumped at constant pumping rate, Qwc		303.83	acre feet
Model start date		01/01/2014	
Date Pump On		05/01/2014	

Date	01/31	02/28	03/31	04/30	05/31	06/30	07/31	08/31	09/30	10/31	11/30	12/31
Stream Depl, %Q	0.0	0.0	0.0	0.0	91.8	94.0	95.0	95.6	7.9	3.3	2.1	1.5
Strrm Depl, cfs	**0.000**	**0.000**	**0.000**	**0.000**	**1.019**	**1.043**	**1.055**	**1.061**	**0.088**	**0.037**	**0.023**	**0.017**
Strm Depl Jun-01 shutoff, cfs	0.000	0.000	0.000	0.000	1.019	0.027	0.012	0.007	0.005	0.004	0.003	0.002
Strm Depl Jul-01 shutoff, cfs	0.000	0.000	0.000	0.000	1.019	1.043	0.037	0.018	0.012	0.008	0.006	0.005
Strm Depl Aug-01 shutoff, cfs	0.000	0.000	0.000	0.000	1.019	1.043	1.055	0.044	0.023	0.015	0.011	0.009
Strm Depl Sep-01 shutoff, cfs	0.000	0.000	0.000	0.000	1.019	1.043	1.055	1.061	0.050	0.027	0.018	0.014
Relief after Jun-01 shutoff (SD= 1.020, cfs)						**0.993**	**1.008**	**1.013**	**1.015**	**1.016**	**1.017**	**1.018**
Relief after Jul-01 shutoff (SD= 1.044, cfs)							**1.006**	**1.025**	**1.032**	**1.035**	**1.037**	**1.039**
Relief after Aug-01 shutoff (SD= 1.055, cfs)								**1.011**	**1.031**	**1.039**	**1.044**	**1.046**
Relief after Sep-01 shutoff (SD= 1.062, cfs)									**1.011**	**1.035**	**1.043**	**1.048**
Stream depletion at 138 = 1.064 cfs												
Stream depletion at 30 days = 91.6 %												

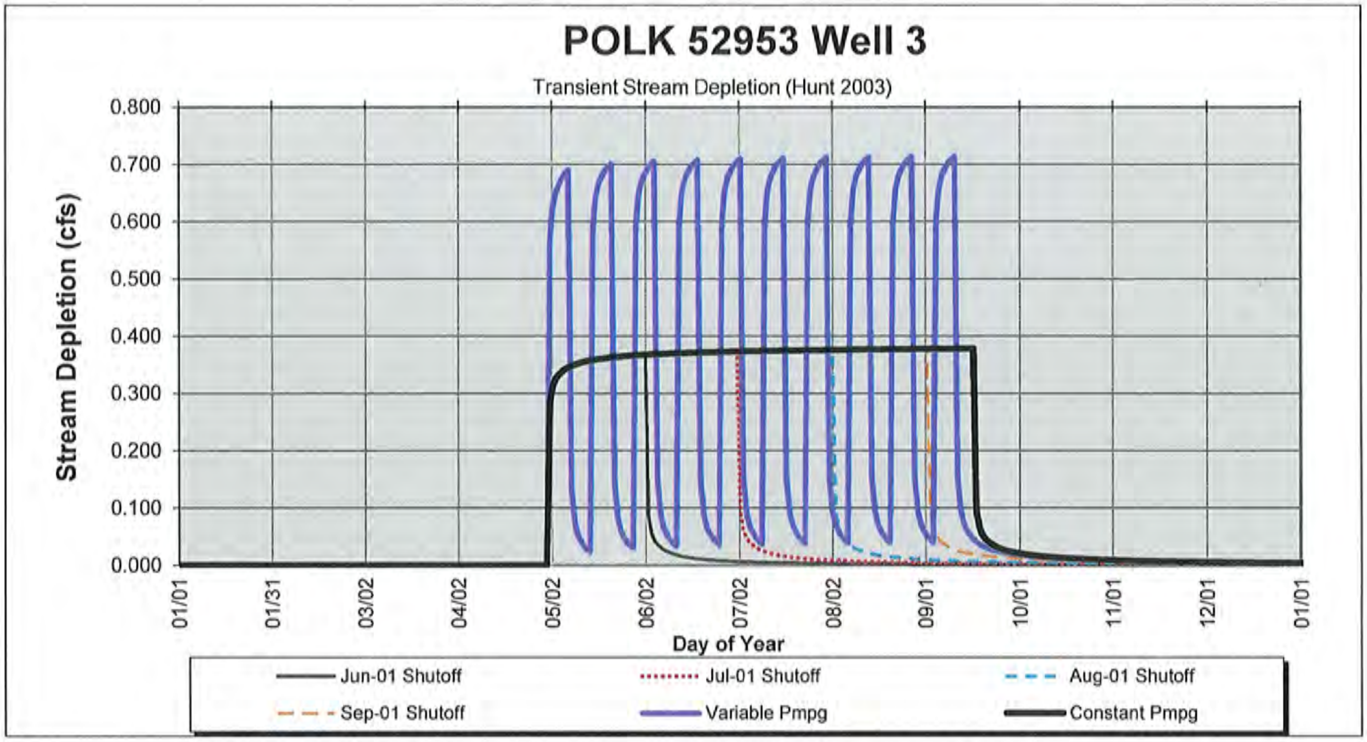
Stream depletion at 10 days = 86.5 %



Parameters:		Values	Units
Perpendicular from well to stream	a	95	ft
Well depth	d	57	ft
Aquifer transmissivity	T_ft	1,090,000	ft*ft/day
Aquifer storativity or specific yield	S	0.1000	Dimensionless
Stream width	ws	350	ft
Aquitard vertical hydraulic conductivity	Kva	50.0000	ft/day
Aquitard saturated thickness	ba	20	ft
Aquitard thickness below stream	babs	20	ft
Aquitard porosity	n	0.100	Dimensionless
Maximum irrigated acres per well, on all water rights		0.00	acres
Maximum pumping rate on all water rights	Qmwr	3.0000	cfs
Maximum pumping rate per well, all water rights	Qmp	2.2800	cfs
Constant pumping rate for model (Qmp/2)	Qwc	1.1400	cfs
Variable weekly pumping rate for model (Qmp)	Qwv	2.2800	cfs
Pumping days in irrigation season		138	days
Total acre feet pumped at constant pumping rate, Qwc		312.04	acre feet
Model start date		01/01/2014	
Date Pump On		05/01/2014	

Date	01/31	02/28	03/31	04/30	05/31	06/30	07/31	08/31	09/30	10/31	11/30	12/31
Stream Depl, %Q	0.0	0.0	0.0	0.0	88.8	91.8	93.2	94.1	10.2	4.5	2.8	2.0
Strrm Depl, cfs	**0.000**	**0.000**	**0.000**	**0.000**	**1.012**	**1.047**	**1.063**	**1.072**	**0.116**	**0.051**	**0.032**	**0.023**
Strm Depl Jun-01 shutoff, cfs	0.000	0.000	0.000	0.000	1.012	0.038	0.017	0.010	0.007	0.005	0.004	0.003
Strm Depl Jul-01 shutoff, cfs	0.000	0.000	0.000	0.000	1.012	1.047	0.052	0.026	0.016	0.012	0.009	0.007
Strm Depl Aug-01 shutoff, cfs	0.000	0.000	0.000	0.000	1.012	1.047	1.063	0.062	0.033	0.021	0.016	0.012
Strm Depl Sep-01 shutoff, cfs	0.000	0.000	0.000	0.000	1.012	1.047	1.063	1.072	0.070	0.038	0.025	0.019
Relief after Jun-01 shutoff (SD= 1.014, cfs)						**0.976**	**0.998**	**1.004**	**1.007**	**1.009**	**1.010**	**1.011**
Relief after Jul-01 shutoff (SD= 1.047, cfs)							**0.995**	**1.022**	**1.031**	**1.036**	**1.039**	**1.040**
Relief after Aug-01 shutoff (SD= 1.063, cfs)								**1.001**	**1.030**	**1.042**	**1.048**	**1.051**
Relief after Sep-01 shutoff (SD= 1.073, cfs)									**1.002**	**1.035**	**1.047**	**1.054**
Stream depletion at 138 = 1.076 cfs												
Stream depletion at 30 days = 88.6 %												

Stream depletion at 10 days = 81.4 %



Parameters:		Values	Units
Perpendicular from well to stream	a	100	ft
Well depth	d	56	ft
Aquifer transmissivity	T_ft	160,000	ft*ft/day
Aquifer storativity or specific yield	S	0.1000	Dimensionless
Stream width	ws	350	ft
Aquitard vertical hydraulic conductivity	Kva	50.0000	ft/day
Aquitard saturated thickness	ba	20	ft
Aquitard thickness below stream	babs	20	ft
Aquitard porosity	n	0.100	Dimensionless
Maximum irrigated acres per well, on all water rights		0.00	acres
Maximum pumping rate on all water rights	Qmwr	3.0000	cfs
Maximum pumping rate per well, all water rights	Qmp	0.7780	cfs
Constant pumping rate for model (Qmp/2)	Qwc	0.3890	cfs
Variable weekly pumping rate for model (Qmp)	Qwv	0.7780	cfs
Pumping days in irrigation season		138	days
Total acre feet pumped at constant pumping rate, Qwc		106.48	acre feet
Model start date		01/01/2014	
Date Pump On		05/01/2014	

Date	01/31	02/28	03/31	04/30	05/31	06/30	07/31	08/31	09/30	10/31	11/30	12/31
Stream Depl, %Q	0.0	0.0	0.0	0.0	94.4	95.9	96.6	97.0	5.4	2.3	1.4	1.0
Strrm Depl, cfs	**0.000**	**0.000**	**0.000**	**0.000**	**0.367**	**0.373**	**0.376**	**0.378**	**0.021**	**0.009**	**0.006**	**0.004**
Strm Depl Jun-01 shutoff, cfs	0.000	0.000	0.000	0.000	0.367	0.007	0.003	0.002	0.001	0.001	0.001	0.001
Strm Depl Jul-01 shutoff, cfs	0.000	0.000	0.000	0.000	0.367	0.373	0.009	0.004	0.003	0.002	0.002	0.001
Strm Depl Aug-01 shutoff, cfs	0.000	0.000	0.000	0.000	0.367	0.373	0.376	0.011	0.006	0.004	0.003	0.002
Strm Depl Sep-01 shutoff, cfs	0.000	0.000	0.000	0.000	0.367	0.373	0.376	0.378	0.012	0.007	0.004	0.003
Relief after Jun-01 shutoff (SD= 0.367, cfs)						**0.361**	**0.365**	**0.366**	**0.366**	**0.367**	**0.367**	**0.367**
Relief after Jul-01 shutoff (SD= 0.373, cfs)							**0.364**	**0.369**	**0.370**	**0.371**	**0.372**	**0.372**
Relief after Aug-01 shutoff (SD= 0.376, cfs)								**0.365**	**0.370**	**0.372**	**0.373**	**0.374**
Relief after Sep-01 shutoff (SD= 0.378, cfs)									**0.365**	**0.371**	**0.373**	**0.374**
Stream depletion at 138 = 0.378 cfs												
Stream depletion at 30 days = 94.3 %												

Stream depletion at 10 days = 90.5 %

APPENDIX G

Cost Estimates for Recommended Capital Improvement Projects

Summary of Project Cost Estimates

City of Independence - Water System Master Plan — 11/7/2022

Project Code	Priority	Project Description	Total Construction Cost	Soft Costs: Construction Contingency 10%	Soft Costs: Engineering 20%	Soft Costs: Legal, Permits, & Admin. 10%	Total Cost: Estimated Project Cost	Cost by Priority: 1	Cost by Priority: 2	Cost by Priority: 3	Cost by Priority: 4
Distribution System Improvements (Reference Waterline Project Cost Estimates)											
Fire Flow Improvement Projects											
A-1	2	Wild Rose Ct Waterline Replacement	$ 129,000	$ 12,900	$ 25,800	$ 12,900	$ 181,000	$ -	$ 181,000	$ -	$ -
A-2	2	12th Street & Dawn Ct Waterline Replacement	$ 307,000	$ 30,700	$ 61,400	$ 30,700	$ 430,000	$ -	$ 430,000	$ -	$ -
A-3	2	B Street & Rhoda Ln Waterline Replacement	$ 454,000	$ 45,400	$ 90,800	$ 45,400	$ 636,000	$ -	$ 636,000	$ -	$ -
A-4	2	17th Street Waterline Replacement	$ 316,000	$ 31,600	$ 63,200	$ 31,600	$ 442,000	$ -	$ 442,000	$ -	$ -
A-5	2	16th Street & Talmadge Road Waterline Replacement	$ 382,000	$ 38,200	$ 76,400	$ 38,200	$ 535,000	$ -	$ 535,000	$ -	$ -
A-6	2	9th Street Waterline Replacement	$ 238,000	$ 23,800	$ 47,600	$ 23,800	$ 333,000	$ -	$ 333,000	$ -	$ -
A-7	1	B & 4th Street Waterline Replacement	$ 110,000	$ 11,000	$ 22,000	$ 11,000	$ 154,000	$ 154,000	$ -	$ -	$ -
A-8	2	Maple Ct Waterline Replacement	$ 203,000	$ 20,300	$ 40,600	$ 20,300	$ 284,000	$ -	$ 284,000	$ -	$ -
A-9	2	Pine Ct Waterline Replacement	$ 147,000	$ 14,700	$ 29,400	$ 14,700	$ 206,000	$ -	$ 206,000	$ -	$ -
A-10	2	Evergreen Dr Waterline Replacement	$ 195,000	$ 19,500	$ 39,000	$ 19,500	$ 273,000	$ -	$ 273,000	$ -	$ -
End of Service Life Replacement Projects											
B-1	2	Gun Club Road Waterline Replacement	$ 966,500	$ 96,650	$ 193,300	$ 96,650	$ 1,353,000	$ -	$ 1,353,000	$ -	$ -
B-2	1	D Street at 12th St Waterline Replacement	$ 181,000	$ 18,100	$ 36,200	$ 18,100	$ 253,000	$ 253,000	$ -	$ -	$ -
B-3	1	7th, D & 9th Streets Waterline Replacement	$ 496,000	$ 49,600	$ 99,200	$ 49,600	$ 694,000	$ 694,000	$ -	$ -	$ -
B-4	1	D Street at 2nd St Steel Waterline Replacement	$ 135,000	$ 13,500	$ 27,000	$ 13,500	$ 189,000	$ 189,000	$ -	$ -	$ -
B-5	1	E Street from 9th to 13th Waterline Replacement	$ 721,500	$ 72,150	$ 144,300	$ 72,150	$ 1,010,000	$ 1,010,000	$ -	$ -	$ -
B-6	1	F Street from 9th to 3rd Waterline Replacement	$ 665,000	$ 66,500	$ 133,000	$ 66,500	$ 931,000	$ 931,000	$ -	$ -	$ -
B-7	2	5th St from E to F Streets Waterline Replacement	$ 114,000	$ 11,400	$ 22,800	$ 11,400	$ 160,000	$ -	$ 160,000	$ -	$ -
B-8	2	3rd St from F to I Streets Waterline Replacement	$ 293,000	$ 29,300	$ 58,600	$ 29,300	$ 410,000	$ -	$ 410,000	$ -	$ -
B-9	1	3rd Street & E Street Waterline Replacement	$ 341,875	$ 34,188	$ 68,375	$ 34,188	$ 479,000	$ 479,000	$ -	$ -	$ -
B-10	1	I & H Streets Waterline Replacement	$ 486,000	$ 48,600	$ 97,200	$ 48,600	$ 680,000	$ 680,000	$ -	$ -	$ -
B-11	2	River Oak Rd Waterline Replacement	$ 358,000	$ 35,800	$ 71,600	$ 35,800	$ 501,000	$ -	$ 501,000	$ -	$ -
B-12	1	Corvallis Road Steel Waterline Replacement	$ 305,500	$ 30,550	$ 61,100	$ 30,550	$ 428,000	$ 428,000	$ -	$ -	$ -
B-13	2	Polk & Walnut Streets Waterline Replacement	$ 636,000	$ 63,600	$ 127,200	$ 63,600	$ 890,000	$ -	$ 890,000	$ -	$ -
B-14	2	Log Cabin Waterline Replacement	$ 474,000	$ 47,400	$ 94,800	$ 47,400	$ 664,000	$ -	$ 664,000	$ -	$ -
B-15	2	Main Street Waterline Replacement	$ 750,000	$ 75,000	$ 150,000	$ 75,000	$ 1,050,000	$ -	$ 1,050,000	$ -	$ -
B-16	2	River Drive Waterline Replacement #1	$ 289,000	$ 28,900	$ 57,800	$ 28,900	$ 405,000	$ -	$ 405,000	$ -	$ -
B-17	1	Walnut, Ash & Log Cabin Streets Waterline Replacement	$ 1,005,000	$ 100,500	$ 201,000	$ 100,500	$ 1,407,000	$ 1,407,000	$ -	$ -	$ -
B-18	1	Monmouth St Waterline Replacement	$ 577,250	$ 57,725	$ 115,450	$ 57,725	$ 808,000	$ 808,000	$ -	$ -	$ -
B-19	1	Copper Water Service Replacements	$ 5,000,000	$ 500,000	$ -	$ 500,000	$ 6,000,000	$ 6,000,000	$ -	$ -	$ -
B-20	2	Water Meter Replacements	$ 1,800,000	$ 180,000	$ -	$ 180,000	$ 2,160,000	$ -	$ 2,160,000	$ -	$ -

Summary of Project Cost Estimates

City of Independence - Water System Master Plan — 11/7/2022

Project Code	Priority	Project Description	Total Construction Cost	*Soft Costs*			*Total Cost*				
				Construction Contingency 10%	Engineering 20%	Legal, Permits, & Admin. 10%	Estimated Project Cost	Cost by Priority			
								1	2	3	4
Design Standards Improvement Projects											
C-1	4	Hyacinth St Waterline Replacement	$ 233,000	$ 23,300	$ 46,600	$ 23,300	$ 326,000	$ -	$ -	$ -	$ 326,000
C-2	4	Williams St Waterline Replacement	$ 400,000	$ 40,000	$ 80,000	$ 40,000	$ 560,000	$ -	$ -	$ -	$ 560,000
C-3	4	13th St Waterline Replacement	$ 300,000	$ 30,000	$ 60,000	$ 30,000	$ 420,000	$ -	$ -	$ -	$ 420,000
C-4	4	11th & 12th St Waterline Replacements	$ 397,000	$ 39,700	$ 79,400	$ 39,700	$ 556,000	$ -	$ -	$ -	$ 556,000
C-5	4	Randall Way Waterline Replacements	$ 402,000	$ 40,200	$ 80,400	$ 40,200	$ 563,000	$ -	$ -	$ -	$ 563,000
C-6	4	6th & 7th St Waterline Replacements	$ 467,000	$ 46,700	$ 93,400	$ 46,700	$ 654,000	$ -	$ -	$ -	$ 654,000
C-7	4	Freedom Estates Subdivision Waterline Replacements	$ 1,168,000	$ 116,800	$ 233,600	$ 116,800	$ 1,635,000	$ -	$ -	$ -	$ 1,635,000
C-8	4	I St Waterline Replacement	$ 201,000	$ 20,100	$ 40,200	$ 20,100	$ 281,000	$ -	$ -	$ -	$ 281,000
C-9	4	5th & 6th St Waterline Replacements	$ 392,000	$ 39,200	$ 78,400	$ 39,200	$ 549,000	$ -	$ -	$ -	$ 549,000
C-10	4	6th & 7th St Waterline Replacements	$ 533,000	$ 53,300	$ 106,600	$ 53,300	$ 746,000	$ -	$ -	$ -	$ 746,000
C-11	4	A & B St Waterline Replacements	$ 619,000	$ 61,900	$ 123,800	$ 61,900	$ 867,000	$ -	$ -	$ -	$ 867,000
C-12	4	2nd & B St Waterline Replacements	$ 287,000	$ 28,700	$ 57,400	$ 28,700	$ 402,000	$ -	$ -	$ -	$ 402,000
C-13	4	River Drive Waterline Replacement #2	$ 173,000	$ 17,300	$ 34,600	$ 17,300	$ 242,000	$ -	$ -	$ -	$ 242,000
C-14	4	Independence Airpark Waterline Replacements	$ 3,693,000	$ 369,300	$ 738,600	$ 369,300	$ 5,170,000	$ -	$ -	$ -	$ 5,170,000
Undeveloped Area Distribution System Projects				$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
D-1	3	Airport Residential & Industrial Zone Waterlines	$ 3,277,000	$ 327,700	$ 655,400	$ 327,700	$ 4,588,000	$ -	$ -	$ 4,588,000	$ -
D-2	3	Southwest Area Residential Waterlines - North	$ 6,411,389	$ 641,139	$ 1,282,278	$ 641,139	$ 8,976,000	$ -	$ -	$ 8,976,000	$ -
D-3	3	Southwest Area Residential Waterlines - South	$ 5,794,444	$ 579,444	$ 1,158,889	$ 579,444	$ 8,112,000	$ -	$ -	$ 8,112,000	$ -
D-4	3	Mt. Fir Rd Waterline Replacement from Washington to 6th St	$ 258,750	$ 25,875	$ 51,750	$ 25,875	$ 362,000	$ -	$ -	$ 362,000	$ -
D-5	3	Mt. Fir Rd Waterline	$ 533,750	$ 53,375	$ 106,750	$ 53,375	$ 747,000	$ -	$ -	$ 747,000	$ -
D-6	1	Corvallis Road Waterline	$ 252,875	$ 25,288	$ 50,575	$ 25,288	$ 354,000	$ 354,000	$ -	$ -	$ -
D-7	3	Mt. Fir & Corvallis Road Residential Waterlines	$ 1,731,000	$ 173,100	$ 346,200	$ 173,100	$ 2,423,000	$ -	$ -	$ 2,423,000	$ -
Booster Pump Station Projects											
P-1	1	Polk Booster Pump Station Electrical Improvements	$ 608,750	$ 60,875	$ 121,750	$ 60,875	$ 852,000	$ 852,000	$ -	$ -	$ -
P-2	2	Polk Water & Wastewater Facility Fencing Improvements	$ 262,000	$ 26,200	$ 52,400	$ 26,200	$ 367,000	$ -	$ 367,000	$ -	$ -
P-3	1	South Booster Pump Station Electrical Improvements	$ 60,000	$ 6,000	$ 12,000	$ 6,000	$ 84,000	$ 84,000	$ -	$ -	$ -
P-4	1	Willamette Water Treatment Plant Booster Pump Station		(See Surface Water Treatment Plant Project)							
P-5	3	Decommission Monmouth Street Pump Station & Reservoir	$ 200,000	Not Used			$ 200,000	$ -	$ -	$ 200,000	$ -

Summary of Project Cost Estimates

City of Independence - Water System Master Plan 11/7/2022

Project Code	Priority	Project Description	Total Construction Cost	Soft Costs: Construction Contingency 10%	Soft Costs: Engineering 20%	Soft Costs: Legal, Permits, & Admin. 10%	Total Cost: Estimated Project Cost	Cost by Priority: 1	Cost by Priority: 2	Cost by Priority: 3	Cost by Priority: 4
Supply Improvements											$ -
S-1	1	Groundwater Right Development, Permit G-12134	$ 10,000		Not Used		$ 10,000	$ 10,000	$ -	$ -	$ -
S-2	1	Groundwater Right Development, Permit G-17868	$ 10,000		Not Used		$ 10,000	$ 10,000	$ -	$ -	$ -
S-3	3	Groundwater Right Development, Permit G-17750	$ 10,000		Not Used		$ 10,000	$ -	$ -	$ 10,000	$ -
S-4	1	Surface Water Right Development, Permit S-54331	$ 20,000		Not Used		$ 20,000	$ 20,000	$ -	$ -	$ -
S-5	1	Polk Wellfield Electrical Improvements	$ 328,000	$ 32,800	$ 65,600	$ 32,800	$ 459,000	$ 459,000	$ -	$ -	$ -
S-6	1	South Wellfield Improvements	$ 612,000	$ 61,200	$ 122,400	$ 61,200	$ 857,000	$ 857,000	$ -	$ -	$ -
S-7	1	Recommission South Wells 4 & 5	$ 15,000		Not Used		$ 15,000	$ 15,000	$ -	$ -	$ -
S-8	3	New Water System Intertie	$ 477,000	$ 47,700	$ 95,400	$ 47,700	$ 668,000	$ -	$ -	$ 668,000	$ -
S-9	1	Collector Well Preliminary Engineering	$ 100,000		Not Used		$ 100,000	$ 100,000	$ -	$ -	$ -
S-10	1	Collector Well & Conveyance Improvements	$ 3,993,000	$ 399,300	$ 798,600	$ 399,300	$ 5,590,000	$ 5,590,000	$ -	$ -	$ -
S-11	1	Groundwater Availability Study	$ 25,000		Not Used		$ 25,000	$ 25,000	$ -	$ -	$ -
Treatment Improvements											$ -
T-1	1	Surface Water Treatment Facility	$19,000,000		Not Used		$ 19,000,000	$ 19,000,000	$ -	$ -	$ -
Storage Improvements											$ -
R-1	1	Polk Reservoir 1 & WTP Facility Seismic Evaluation	$ 50,000		Not Used		$ 50,000	$ 50,000	$ -	$ -	$ -
R-2	1	Polk Reservoir 2 Seismic Evaluation	$ 40,000		Not Used		$ 40,000	$ 40,000	$ -	$ -	$ -
R-3	1	South Reservoir & WTP Facility Seismic Evaluation	$ 50,000		Not Used		$ 50,000	$ 50,000	$ -	$ -	$ -
R-4	1	New 2.0-million-gallon Reservoir	$ 2,884,700	$ 288,470	$ 576,940	$ 288,470	$ 4,039,000	$ 4,039,000	$ -	$ -	$ -
Miscellaneous Projects											$ -
M-1	2	Taste & Odor Study	$ 50,000		Not Used		$ 50,000	$ -	$ 50,000	$ -	$ -
M-2	2	Water Master Plan Update	$ 300,000		Not Used		$ 300,000	$ -	$ 300,000	$ -	$ -
						TOTALS	**$ 95,275,000**	**$ 44,588,000**	**$ 11,630,000**	**$ 26,086,000**	**$ 12,971,000**

Waterline Project Cost Estimates

City of Independence - Water System Master Plan

11/7/2022

Project Code	Project Description	Diameter Replaced	Material Replaced	Diameter [in]	Length [ft]	Mainline Unit Cost [$ / ft]	Mainline Connections	Mainline Connection Cost	Water Services [qty]	Water Service Cost	Fire Hydrants [qty]	Fire Hydrant Cost	Misc. Costs	Total Construction Cost
FIRE FLOW IMPROVEMENT PROJECTS														
A-1	Wild Rose Ct Waterline Replacement	6	PVC	8	275	$ 160	3	$ 45,000	10	$ 40,000	-	$ -	$ -	$ 129,000
A-2	12th Street & Dawn Ct Waterline Replacement	6	PVC	8	900	$ 160	5	$ 75,000	22	$ 88,000	-	$ -	$ -	$ 307,000
A-3	B Street & Rhoda Ln Waterline Replacement	4 & 6	AC & Steel	8	1,600	$ 160	2	$ 30,000	38	$ 152,000	2	$ 16,000	$ -	$ 454,000
A-4	17th Street Waterline Replacement	6	PVC	8	1,600	$ 160	4	$ 60,000	-	$ -	-	$ -	$ -	$ 316,000
A-5	16th Street & Talmadge Road Waterline Replacement	6	AC & PVC	8	1,325	$ 160	6	$ 90,000	20	$ 80,000	-	$ -	$ -	$ 382,000
A-6	9th Street Waterline Replacement	6	AC	8	750	$ 160	2	$ 30,000	20	$ 80,000	1	$ 8,000	$ -	$ 238,000
A-7	B & 4th Street Waterline Replacement	4	PVC	8	350	$ 160	2	$ 30,000	6	$ 24,000	-	$ -	$ -	$ 110,000
A-8	Maple Ct Waterline Replacement	6	AC	8	675	$ 160	1	$ 15,000	18	$ 72,000	1	$ 8,000	$ -	$ 203,000
A-9	Pine Ct Waterline Replacement	6	AC	8	475	$ 160	1	$ 15,000	12	$ 48,000	1	$ 8,000	$ -	$ 147,000
A-10	Evergreen Dr Waterline Replacement	6	AC	8	625	$ 160	1	$ 15,000	18	$ 72,000	1	$ 8,000	$ -	$ 195,000
END OF SERVICE LIFE REPLACEMENT PROJECTS														$ -
B-1	Gun Club Road Waterline Replacement	6 & 8	AC	12	2,900	$ 185	10	$ 150,000	60	$ 240,000	5	$ 40,000	$ -	$ 966,500
B-2	D Street at 12th St Waterline Replacement	4	AC	8	550	$ 160	3	$ 45,000	12	$ 48,000	-	$ -	$ -	$ 181,000
B-3	7th, D & 9th Streets Waterline Replacement	6 & 8	AC, Steel & CI	8	1,750	$ 160	8	$ 120,000	20	$ 80,000	2	$ 16,000	$ -	$ 496,000
B-4	D Street at 2nd St Steel Waterline Replacement	8	Steel	8	425	$ 160	2	$ 30,000	6	$ 24,000	1	$ 8,000	$ 5,000	$ 135,000
B-5	E Street from 9th to 13th Waterline Replacement	6	AC	12	2,300	$ 185	8	$ 120,000	40	$ 160,000	2	$ 16,000	$ -	$ 721,500
B-6	F Street from 9th to 3rd Waterline Replacement	6	CI	12	2,000	$ 185	9	$ 135,000	36	$ 144,000	2	$ 16,000	$ -	$ 665,000
B-7	5th St from E to F Streets Waterline Replacement	6	AC	8	325	$ 160	2	$ 30,000	6	$ 24,000	1	$ 8,000	$ -	$ 114,000
B-8	3rd St from F to I Streets Waterline Replacement	8	AC	8	1,000	$ 160	3	$ 45,000	20	$ 80,000	1	$ 8,000	$ -	$ 293,000
B-9	3rd Street & E Street Waterline Replacement	6 & 8	AC	12	1,075	$ 185	6	$ 90,000	8	$ 32,000	2	$ 16,000	$ 5,000	$ 341,875
B-10	I & H Streets Waterline Replacement	4 & 8	AC & Steel	8	1,550	$ 160	10	$ 150,000	16	$ 64,000	3	$ 24,000	$ -	$ 486,000
B-11	River Oak Rd Waterline Replacement	6 & 8	AC	8	1,000	$ 185	5	$ 75,000	20	$ 80,000	1	$ 8,000	$ 10,000	$ 358,000
B-12	Corvallis Road Steel Waterline Replacement	4	Steel	12	1,100	$ 185	2	$ 30,000	14	$ 56,000	2	$ 16,000	$ -	$ 305,500
B-13	Polk & Walnut Streets Waterline Replacement	6	AC & Steel	8	2,375	$ 160	8	$ 120,000	28	$ 112,000	3	$ 24,000	$ -	$ 636,000
B-14	Log Cabin Waterline Replacement	4 & 6	AC, PVC & CI	8	1,300	$ 160	6	$ 90,000	40	$ 160,000	2	$ 16,000	$ -	$ 474,000
B-15	Main Street Waterline Replacement	4	DI & CI	12	2,000	$ 235	8	$ 120,000	34	$ 136,000	3	$ 24,000	$ -	$ 750,000
B-16	River Drive Waterline Replacement #1	4	AC	8	1,125	$ 160	3	$ 45,000	14	$ 56,000	1	$ 8,000	$ -	$ 289,000
B-17	Walnut, Ash & Log Cabin Streets Waterline Replacement	4, 6 & 8	CI, Steel & AC	8	3,950	$ 160	11	$ 165,000	44	$ 176,000	4	$ 32,000	$ -	$ 1,005,000
B-18	Monmouth St Waterline Replacement	4	CI	8	1,525	$ 210	7	$ 105,000	32	$ 128,000	3	$ 24,000	$ -	$ 577,250
B-19	Copper Water Service Replacements													$ 5,000,000
B-20	Water Meter Replacements													$ 1,800,000

Waterline Project Cost Estimates

City of Independence - Water System Master Plan

11/7/2022

Project Code	Project Description	Diameter Replaced	Material Replaced	Diameter [in]	Length [ft]	Mainline Unit Cost [$ / ft]	Mainline Connections	Mainline Connection Cost	Water Services [qty]	Water Service Cost	Fire Hydrants [qty]	Fire Hydrant Cost	Misc. Costs	Total Construction Cost
DESIGN STANDARDS IMPROVEMENT PROJECTS														$ -
C-1	Hyacinth St Waterline Replacement	6	PVC	8	625	$ 160	3	$ 45,000	22	$ 88,000	-	$ -	$ -	$ 233,000
C-2	Williams St Waterline Replacement	6	AC	8	1,375	$ 160	4	$ 60,000	30	$ 120,000	-	$ -	$ -	$ 400,000
C-3	13th St Waterline Replacement	6	PVC	8	950	$ 160	4	$ 60,000	22	$ 88,000	-	$ -	$ -	$ 300,000
C-4	11th & 12th St Waterline Replacements	6	PVC	8	1,325	$ 160	7	$ 105,000	20	$ 80,000	-	$ -	$ -	$ 397,000
C-5	Randall Way Waterline Replacements	6	AC & PVC	8	1,400	$ 160	6	$ 90,000	22	$ 88,000	-	$ -	$ -	$ 402,000
C-6	6th & 7th St Waterline Replacements	6	PVC	8	1,475	$ 160	9	$ 135,000	24	$ 96,000	-	$ -	$ -	$ 467,000
C-7	Freedom Estates Subdivision Waterline Replacements	6	PVC	8	4,100	$ 160	8	$ 120,000	98	$ 392,000	-	$ -	$ -	$ 1,168,000
C-8	I St Waterline Replacement	6	AC	8	775	$ 160	3	$ 45,000	8	$ 32,000	-	$ -	$ -	$ 201,000
C-9	5th & 6th St Waterline Replacements	6	PVC	8	1,475	$ 160	4	$ 60,000	24	$ 96,000	-	$ -	$ -	$ 392,000
C-10	6th & 7th St Waterline Replacements	6	PVC	8	1,875	$ 160	7	$ 105,000	32	$ 128,000	-	$ -	$ -	$ 533,000
C-11	A & B St Waterline Replacements	6	PVC	8	2,225	$ 160	9	$ 135,000	32	$ 128,000	-	$ -	$ -	$ 619,000
C-12	2nd & B St Waterline Replacements	6	PVC	8	1,025	$ 160	5	$ 75,000	12	$ 48,000	-	$ -	$ -	$ 287,000
C-13	River Drive Waterline Replacement #2	6	PVC	8	600	$ 160	3	$ 45,000	8	$ 32,000	-	$ -	$ -	$ 173,000
C-14	Independence Airpark Waterline Replacements	6	AC & PVC	8	14,300	$ 160	35	$ 525,000	220	$ 880,000	-	$ -	$ -	$ 3,693,000
UNDEVELOPED AREA DISTRIBUTION SYSTEM PROJECTS														$ -
D-1	Airport Residential & Industrial Zone Waterlines	n/a	n/a	8 & 12	11,900	$ 160	3	$ 45,000	300	$ 1,200,000	16	$ 128,000	$ -	$ 3,277,000
D-2	Southwest Area Residential Waterlines - North	n/a	n/a	8 & 12	11,300	$ 185	8	$ 120,000	1,000	$ 4,000,000	25	$ 200,889	$ -	$ 6,411,389
D-3	Southwest Area Residential Waterlines - South	n/a	n/a	8 & 12	10,600	$ 185	3	$ 45,000	900	$ 3,600,000	24	$ 188,444	$ -	$ 5,794,444
D-4	Mt. Fir Rd Waterline Replacement from Washington to 6th St	n/a	n/a	12	750	$ 185	8	$ 120,000	-	$ -	-	$ -	$ -	$ 258,750
D-5	Mt. Fir Rd Waterline	n/a	n/a	12	2,550	$ 185	2	$ 30,000	-	$ -	4	$ 32,000	$ -	$ 533,750
D-6	Corvallis Road Waterline	n/a	n/a	12	1,075	$ 185	2	$ 30,000	2	$ 8,000	2	$ 16,000	$ -	$ 252,875
D-7	Mt. Fir & Corvallis Road Residential Waterlines	n/a	n/a	8	3,700	$ 160	5	$ 75,000	250	$ 1,000,000	8	$ 64,000	$ -	$ 1,731,000

Notes

(1) Unit construction costs

Mainline Connection	$ 15,000
Water Service	$ 4,000
Fire Hydrant	$ 8,000

(2) Watermain Costs

Diameter	Cost ($/ft) City ROW	Cost ($/ft) ODOT ROW
8-inch	$ 160	$ 210
12-inch	$ 185	$ 235

City of Independence - Water System Master Plan

Polk Booster Pump Station Electrical Improvements — Project P-1

Planning Level Cost Estimate

Item		Qty	Unit	Unit Cost	Total Cost
1	Mobilization, bonds, permits and insurance	10%	%	% of Total	$55,000
2	Surveying	ALL	LS	Lump Sum	$1,000
3	Compaction and materials testing	ALL	LS	Lump Sum	$2,000
4	Erosion control	ALL	LS	Lump Sum	$1,000
5	Demolition	ALL	LS	Lump Sum	$10,000
6	Earthwork, clearing & grading	35	CY	$ 150	$5,250
7	Baserock & gravel surfacing	ALL	LS	Lump Sum	$10,000
8	Building addition, complete	190	SF	$ 350	$66,500
9	Power service, complete	ALL	LS	Lump Sum	$50,000
10	Pump VFD Electrical & Controls (for 2 pumps w/ room for third)	ALL	LS	Lump Sum	$125,000
11	Auxiliary power generator system, entire facility	ALL	LS	Lump Sum	$120,000
12	Miscellaneous underground and site work improvements	ALL	LS	Lump Sum	$20,000
13	Instrumentation improvements	ALL	LS	Lump Sum	$15,000
14	Miscellaneous electrical & controls	ALL	LS	Lump Sum	$50,000
15	SCADA integration, communications/conduit, telemetry equipment & programming	ALL	LS	Lump Sum	$70,000
16	As-built drawings and O&M manuals	ALL	LS	Lump Sum	$8,000
				TOTAL:	**$608,750**

City of Independence - Water System Master Plan

Polk Water & Wastewater Facility Fencing Improvements — Project P-2

Planning Level Cost Estimate

Item		Qty	Unit	Unit Cost	Total Cost
1	Mobilization, bonds, permits and insurance	10%	%	% of Total	$24,000
2	Surveying	ALL	LS	Lump Sum	$2,500
3	Demolition & disposal	ALL	LS	Lump Sum	$5,000
4	Earthwork, clearing & grading	ALL	LS	Lump Sum	$2,500
5	Chain link fencing	1900	LF	$ 120	$228,000
				TOTAL:	**$262,000**

City of Independence - Water System Master Plan

South Booster Pump Station Electrical Improvements — Project P-3

Planning Level Cost Estimate

Item		Qty	Unit	Unit Cost	Total Cost
1	Mobilization, bonds, permits and insurance	10%	%	% of Total	$6,000
2	Automatic transfer switch	ALL	LS	Lump Sum	$20,000
3	Instrumentation improvements	ALL	LS	Lump Sum	$10,000
4	Miscellaneous electrical & controls	ALL	LS	Lump Sum	$15,000
5	SCADA integration & programming	ALL	LS	Lump Sum	$5,000
6	As-built drawings and O&M manuals	ALL	LS	Lump Sum	$4,000
				TOTAL:	**$60,000**

City of Independence - Water System Master Plan

Polk Wellfield Electrical Improvements

Project S-5

Planning Level Cost Estimate

Item		Qty	Unit	Unit Cost	Total Cost
1	Mobilization, bonds, permits and insurance	10%	%	% of Total	$30,000
2	Demolition	ALL	LS	Lump Sum	$5,000
3	Auxiliary power improvements at River Drive Site	ALL	LS	Lump Sum	$75,000
4	Miscellaneous underground and site work improvements	ALL	LS	Lump Sum	$15,000
5	Instrumentation improvements	ALL	LS	Lump Sum	$60,000
6	Miscellaneous electrical & controls	ALL	LS	Lump Sum	$40,000
7	SCADA integration, communications/conduit, telemetry equipment & programming	ALL	LS	Lump Sum	$95,000
8	As-built drawings and O&M manuals	ALL	LS	Lump Sum	$8,000
				TOTAL:	**$328,000**

City of Independence - Water System Master Plan

South Wellfield Improvements — Project S-6

Planning Level Cost Estimate

Item		Qty	Unit	Unit Cost	Total Cost
1	Mobilization, bonds, permits and insurance	10%	%	% of Total	$56,000
2	Surveying, potholing & utiilty locates	ALL	LS	Lump Sum	$5,000
3	Compaction and materials testing	ALL	LS	Lump Sum	$2,000
4	Erosion control	ALL	LS	Lump Sum	$2,000
5	Demolish and abandon existing piping	ALL	LS	Lump Sum	$5,000
6	Yard piping	1000	LF	$ 175	$175,000
7	Connections to existing mainlines	7	Each	$ 2,000	$14,000
8	Miscellaneous civil site work	ALL	LS	Lump Sum	$30,000
9	Mechanical piping improvements in well buildings	5	Each	$ 3,000	$15,000
10	Building improvements, each well	5	Each	$ 12,000	$60,000
11	Upgrade power service for buildings, complete	ALL	LS	Lump Sum	$20,000
12	Instrumentation improvements	ALL	LS	Lump Sum	$100,000
13	Miscellaneous electrical & controls	ALL	LS	Lump Sum	$50,000
14	SCADA integration, communications/conduit, telemetry equipment & programming	ALL	LS	Lump Sum	$70,000
15	As-built drawings and O&M manuals	ALL	LS	Lump Sum	$8,000
				TOTAL:	**$612,000**

City of Independence - Water System Master Plan

New Water System Intertie — Project S-8

Planning Level Cost Estimate

Item		Qty	Unit	Unit Cost	Total Cost
1	Mobilization, bonds, permits and insurance	10%	%	% of Total	$43,000
2	Easement acquisition	ALL	LS	Lump Sum	$30,000
3	Surveying	ALL	LS	Lump Sum	$2,000
4	Compaction and materials testing	ALL	LS	Lump Sum	$2,500
5	Erosion control	ALL	LS	Lump Sum	$2,000
6	Earthwork, clearing & grading	50	CY	$ 120	$6,000
7	Baserock & gravel surfacing	ALL	LS	Lump Sum	$10,000
8	Yard piping	330	LF	$ 150	$49,500
9	Connections to existing mainlines	2	Each	$ 2,000	$4,000
10	Sanitary sewer service (for floor drain)	125	LF	$ 100	$12,500
11	Building structure, complete	300	SF	$ 350	$105,000
12	Chain link fencing	150	LF	$ 150	$22,500
13	Miscellaneous civil site work	ALL	LS	Lump Sum	$20,000
14	Pumps, piping & appurtenances	ALL	LS	Lump Sum	$80,000
15	Power service	ALL	LS	Lump Sum	$20,000
16	Electrical, controls and instrumentation	ALL	LS	Lump Sum	$60,000
17	As-built drawings and O&M manuals	ALL	LS	Lump Sum	$8,000
				TOTAL:	**$477,000**

City of Independence - Water System Master Plan

Collector Well & Conveyance Improvements — Project S-10

Planning Level Cost Estimate

Item		Qty	Unit	Unit Cost	Total Cost
1	Mobilization, bonds, permits and insurance	10%	%	% of Total	$363,000
2	Miscellaneous permitting requirements	ALL	LS	Lump Sum	$75,000
3	Right-of-way acquisition	ALL	LS	Lump Sum	$100,000
4	Collector well caisson and well laterals	ALL	LS	Lump Sum	$2,000,000
5	Raw water pump station	ALL	LS	Lump Sum	$900,000
6	Yard piping and flow meter vault	ALL	LS	Lump Sum	$75,000
7	Civil site, fencing & access road improvements	ALL	LS	Lump Sum	$75,000
8	Power service, complete	ALL	LS	Lump Sum	$100,000
9	Electrical, controls, instrumentation & auxiliary power	ALL	LS	Lump Sum	$175,000
10	12-inch raw waterline	600	LF	$ 200	$120,000
11	As-built drawings and O&M manuals	ALL	LS	Lump Sum	$10,000
				TOTAL:	**$3,993,000**

City of Independence - Water System Master Plan

New 2.0-million-gallon Reservoir — Project R-4

Planning Level Cost Estimate

	Item		Qty	Unit	Unit Cost		Total Cost
Civil	1	Mobilization, bonds, permits and insurance	10%	%	% of Total		$262,000
	2	Civil site improvements	ALL	LS	Lump Sum		$20,000
	3	As-built drawings and O&M manuals	ALL	LS	Lump Sum		$8,000
Reservoir	4	Bolted-steel tank w/ glass-fused coating	2,000,000	G	$	1.10	$2,200,000
	5	Overflow cone assembly	1	EA	$	1,000	$1,000
	6	Silt-stop assembly	2	EA	$	500	$1,000
	7	Reservoir exterior access ladder	1	EA	$	8,500	$8,500
	8	Roof hatches	2	EA	$	8,000	$16,000
	9	Roof vent	1	EA	$	7,000	$7,000
	10	Reservoir interior access ladder	1	EA	$	8,000	$8,000
	11	Safety railing at hatches	64	LF	$	50	$3,200
	12	Valve vault structure	ALL	LS	Lump Sum		$ 30,000
Mechanical	13	Yard piping	ALL	LS	Lump Sum		$ 120,000
	14	Piping and valves	ALL	LS	Lump Sum		$ 50,000
	15	Miscellaneous mechanical	ALL	LS	Lump Sum		$ 30,000
Electrical	16	Electrical and controls	ALL	LS	Lump Sum		$ 100,000
	17	Reservoir sampling cabinet, valves and piping	ALL	LS	Lump Sum		$10,000
	18	Chlorine residual analyzer	1	EA	$	5,000	$10,000
						TOTAL:	**$2,884,700**

APPENDIX H

Collector Well Feasibility Study- Cities of Independence and Monmouth, Oregon; Groundwater Solutions, Inc., 10/20/2006

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

Collector Well Feasibility Study – Cities of Independence and Monmouth, Oregon

To: Ed Butts – 4 B Engineering

From: Jeff Barry, RG, CWRE – GSI
Robyn Cook - GSI

Date: October 20, 2006

REGISTERED PROFESSIONAL OREGON JEFF BARRY 1206 GEOLOGIST
6/30/07

Introduction

This memorandum presents the results of a hydrogeologic study to determine the feasibility of developing a collector well for the Cities of Independence and Monmouth, Oregon. This effort serves as a follow up to a collector well feasibility study completed by Ranney Method Western Corporation (Ranney) in 1972. The Ranney study determined that approximately 10 million gallons a day (MGD) could be produced by a collector well sited on the edge of the Willamette River, approximately ¾ miles upstream of Independence. The purpose of this study is to substantiate the earlier work. To accomplish this, four new test wells were installed near the original study location (Figures 1 and 2), the wells were logged, and a pump test was conducted. Detailed geologic descriptions from the well drilling and results from the pump test are included below.

Location and Hydrogeology

The study area for this work and the location of the 1972 study are shown in Figure 1. The four test wells drilled for this study are located along an old railroad grade, on the western bank of the Willamette River, just south of Independence (Figure 2). Sonic drilling technology performed by Prosonic Corporation was used to obtain representative samples. Three 2-inch diameter monitoring wells and one 6-inch diameter production test well were completed to a total depth of approximately 58 ft below ground surface (bgs) (111 feet above mean sea level (ft msl). In general, the first 15 ft of material below the surface consisted of sand and gravel fill that was used to construct the railroad grade. Below the fill is approximately 20 ft of silt, grading from organic to inorganic, with some sand and gravel lenses. Below the silt is 15 to 20 ft of sandy to silty gravel. The amount of silt and sand, the thicknesses of sandy or silty zones and the size of the gravel and cobbles all varies spatially from well to well. This unit was identified in the Ranney study as the target aquifer for the collector well. Below the gravel unit is a silty blue clay, which was found at an elevation of 111 ft msl. The static water level was measured at an elevation of 132 ft msl. See the attached well log schematics (Figures 3-6) for detailed geologic descriptions of each well, and Figures 7 and 8 for cross sections of the study area. Each of the monitoring wells is screened for 15 ft from the base of the gravel aquifer, and the production well was screened for 10 feet from the base of the aquifer. The production well was developed by pumping water through the screened interval until the water was clear. The first five minutes of development produced very muddy water, but by 10 minutes, the water was clear. The test well was developed for a total of 20 minutes.

Hydrogeologic Units

Figures 7 and 8 present geologic cross sections through the study area. A description of each unit observed in the core samples is presented below. More detailed descriptions of the material are presented in the logs contained in Figures 3 through 6.

Artificial Fill– Sandy gravel. The old railroad grade, which runs along the Willamette River, is a levee constructed of gravel and sand. This fill unit is above the water table, except at extremely high river stages. The top of the levee is at an elevation of 165 ft msl, and the highest river stage on record reached 160 ft msl (Ranney, 1972).

***Silt* (semi-confining unit).** The silt in this unit is dark brown and grades from hard, dense organic silt to less dense inorganic silt. There are occasional sand and gravel layers.

Gravel. The gravel unit thickness ranged between 16 and 20 feet and consists of gravel to cobble size rounded clasts, and varying amounts of sand and/or silt. The percentage of silt present within the space between gravel clasts was up to 50 percent, suggesting that this material has less permeability than gravel that contains predominantly sand. The thickness of the gravel unit was somewhat less and contained more silt in a southerly direction. Two of the four wells had notable silt and/or sand layers within the gravel, suggesting that this unit contains packages of silt and sand. These lenses vary in thickness from 1.5 to 2.5 ft thick, and contain up to 98% silt.

As mentioned previously, this gravel unit was identified in the Ranney study (1972) as the target aquifer for the collector well. Test wells completed for the Ranney study were located slightly upstream and 50 to 75 feet closer to the Willamette River (Figure 2) than the wells completed for this study. Geologic logs from the Ranney test wells indicate the gravel unit is approximately 20 feet thick at that location.

Clay. The contact between the overlying gravel unit and a hard, blue, silty clay unit is quite sharp in two of the wells, while in the other two wells there is a gradational change from gravel to coarse sand and silt to the blue clay. This unit was identified in the 1972 study, and although one well was drilled to 68 ft bgs (97 ft msl) we did not drill through this unit.

Pumping Test Results

Data were collected during a two-hour pumping test, during which the test well (P-1) (see Figure 2) was pumped continuously at an average rate of 104 gallons per minute (gpm) from 2:12 PM to 4:15 PM on October 4, 2006. See Figure 6 for a schematic of the production well. Water levels were monitored at the three observation wells during pumping (B-1, B-2 and B-3) and at two wells (B-2 and B-3) during the recovery period. Discharge rate measurements were collected at the same time intervals as water level measurements. Water level changes were small (on the order of tenths to hundredths of a foot) at the monitoring wells, which is likely due to the transmissive properties of the aquifer, the short duration of the pumping test, and because the pump discharge was relatively low. The data was analyzed using distance drawdown and recovery methods (Figures 9 and 10). Values of transmissivity obtained from these methods range from 305,000 to 528,000 gallons per day per foot (gpd/ft), for the distance drawdown and recovery data, respectively. The estimated average transmissivity for these two methods is 416,500 gpd/ft.

Estimated Collector Well Yield

Based on the pumping test results, and a formula used to estimate collector well yield in the Ranney report, the most conservative estimate for the yield of a collector well at this location would be 9.0 MGD during the summer months, and a low of 5.7 MGD during low river stage periods. This is comparable to Ranney's predictions of 10.0 and 6.3 MGD, respectively.

It should be noted that the pumping test conducted for this study was completed at a significantly lower pumping rate (~100 gpm vs. 500 gpm) and for a significantly shorter time period (2 hours vs. 48 hours). This may result in an overestimation of aquifer parameters that are used to estimate collector well yield; and consequently, the estimate for the collector well yield may be high. Overall, based on the pumping test results and physical observation of the aquifer material, it appears that a collector well in this location will produce water at rates similar to those presented in the Ranney report.

Conclusions and Recommendations

While this study concurs with the yields presented in the earlier study, a few constraints on yield predictions were also identified that have not yet been adequately addressed. The main constraint is that the saturated thickness of the aquifer is fairly low (ranging from 50 ft at extreme flood stage to 19 ft at extreme low stage). River stage controls the elevation of the water table and consequently the saturated thickness (see Figure 7), so when river stage decreases, the water level in the aquifer drops, and the saturated zone is reduced. A cursory examination of river stage (from a station approximately 12.5 miles downstream in Salem) for a period of 60 years suggest that overall river stage is not declining. The low stage reported in the Ranney report is still accurate for the period of record. This means that the saturated thickness of the aquifer does not appear to be decreasing, and the minimum saturated thickness calculated in the Ranney report is likely still representative of low river stage conditions. This condition was not tested in either the earlier Ranney study or this study and so the performance of a collected under low river stage and saturated thickness can only be estimated.

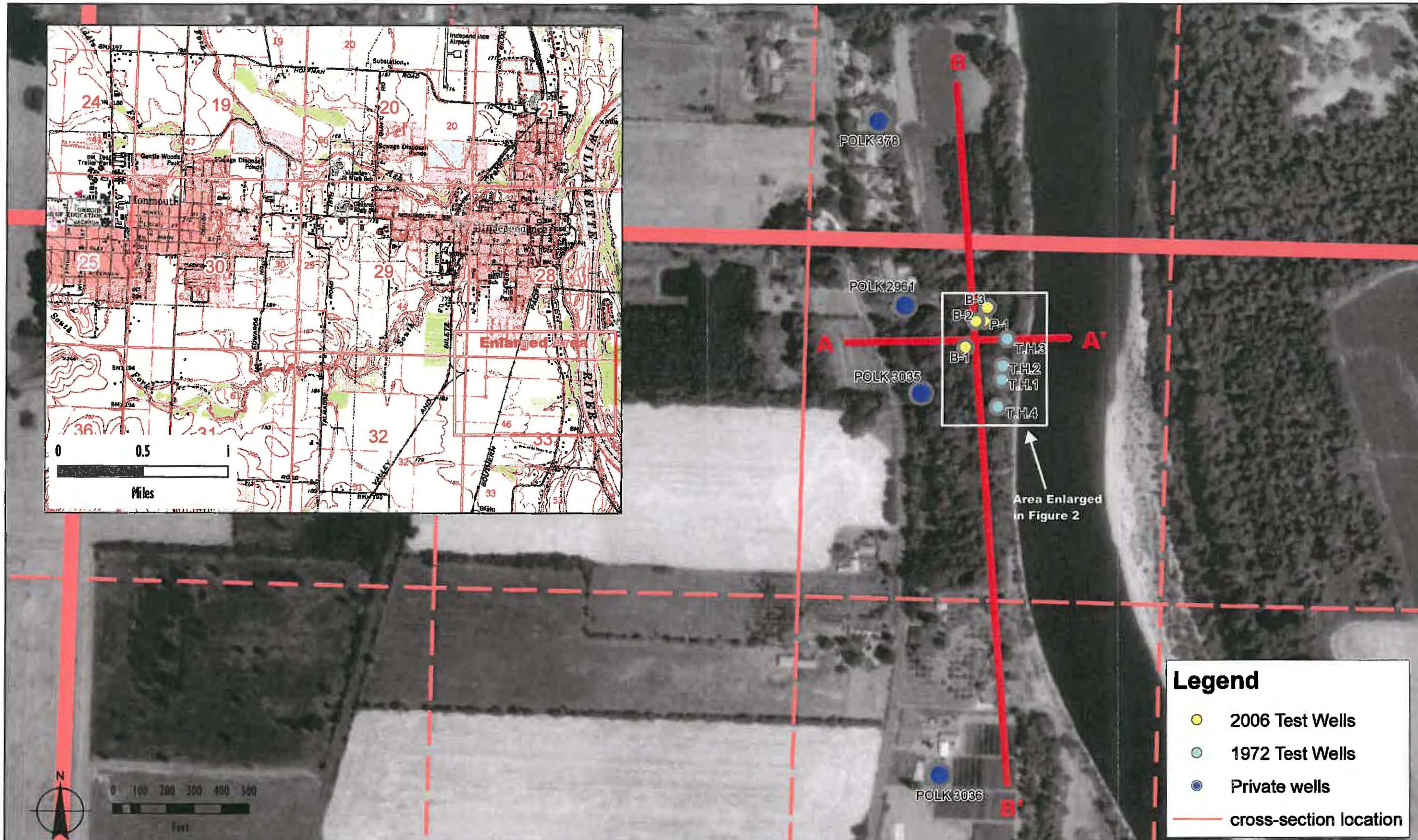
Another control on aquifer thickness is the local geology. Our conceptual model of this area suggests that the thickness of the gravel aquifer appears to thin to the south (see Figures 7 and 8). Because of this observation, we recommend that the collector well be sited on the north end of both testing areas, near P-1 or T.H. 3 (Figure 1), depending on accessibility to the site.

Despite the constraints on the saturated thickness of the aquifer, our short term testing and geologic interpretation of the aquifer material corroborates Ranney's assessment of aquifer properties and estimated collector yield.

References

Ranney Method Western Corporation, 1972. Report on Hydrogeological Survey for City of Monmouth, Oregon.

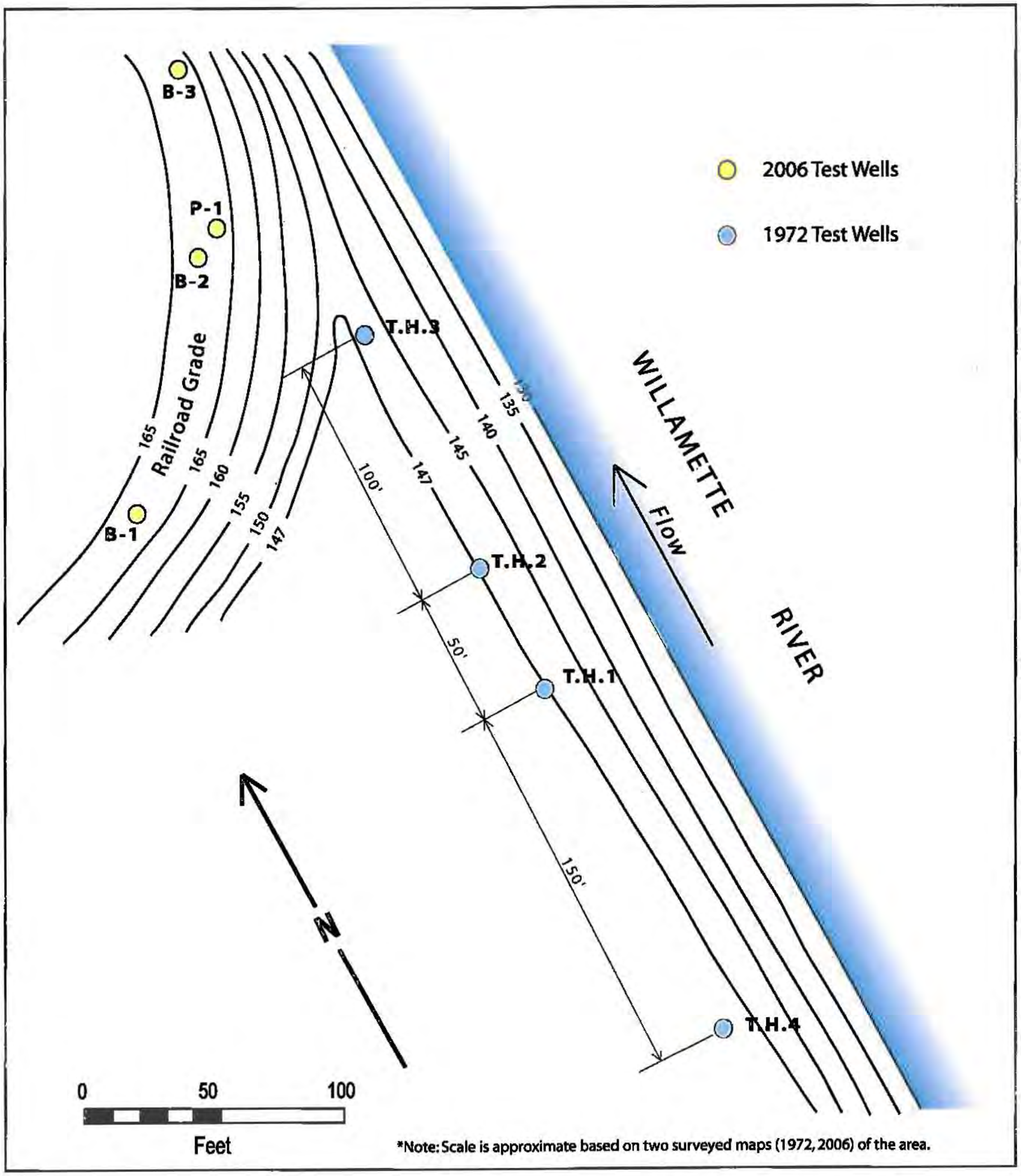
P:\203 - Independence\001 - Collector Well Feasibility\Project_GIS\Project_mxds\Fig1_location.mxd
Last Modified: October 20, 2006 - rc



Groundwater Solutions, Inc.

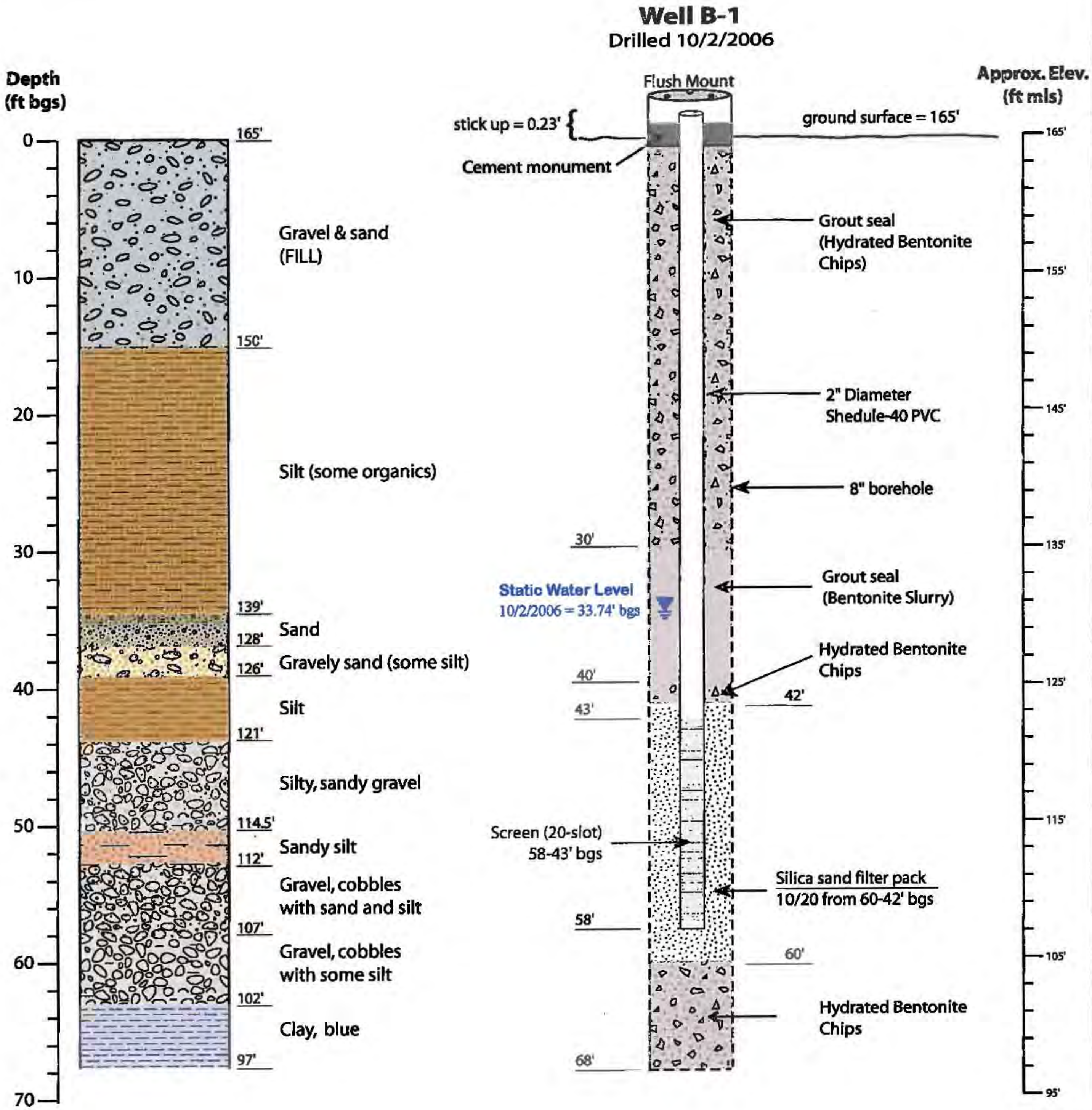
Figure 1
Location Map

Collector Well Feasibility Study
Cities of Independence and Monmouth



Groundwater Solutions Inc.

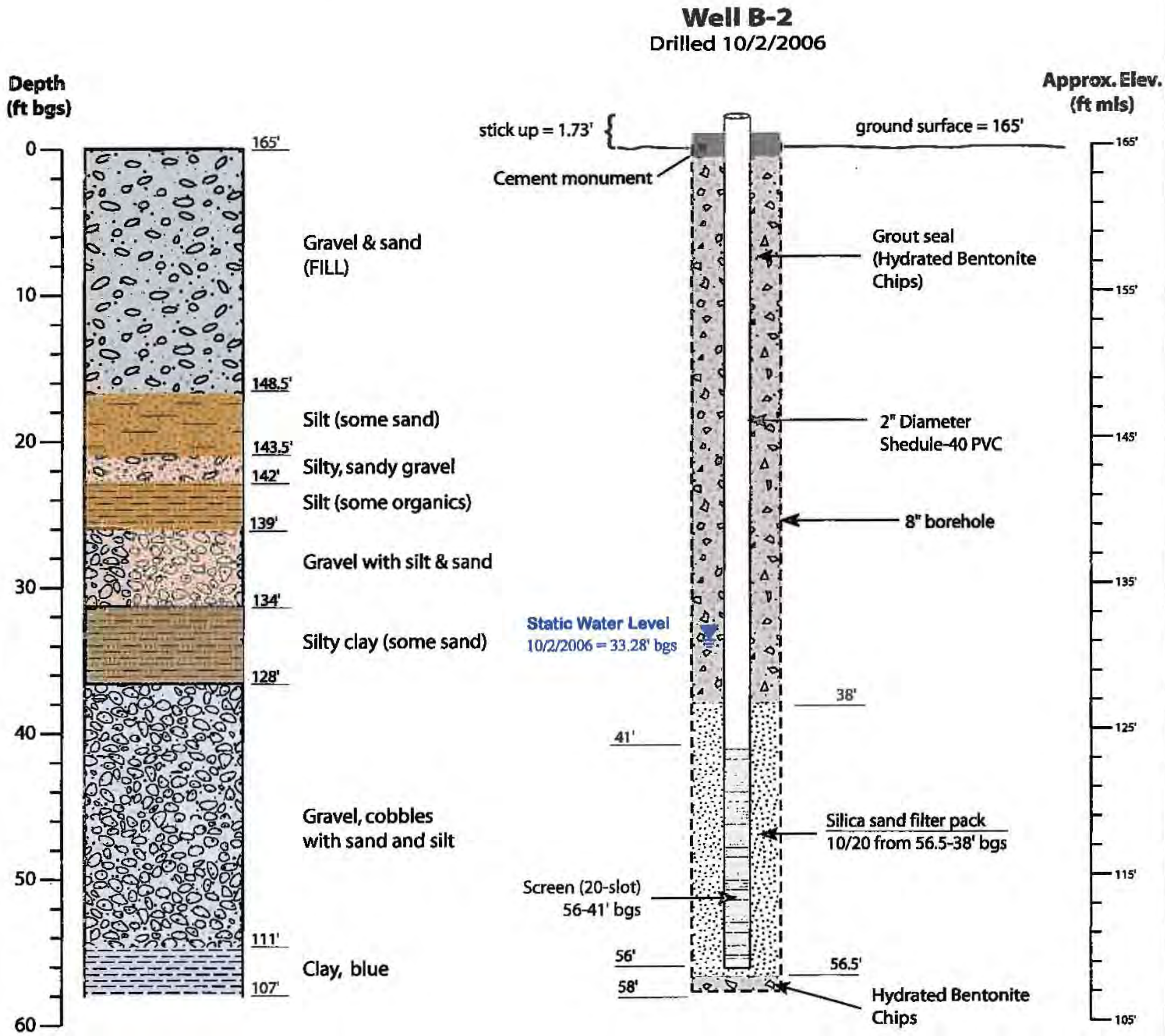
Figure 2
Test Well Locations
Adapted from Clark & Groff Engineers, Inc.
Cities of Independence and Monmouth



WELL LOCATION:
Railroad Grade Adjacent to
Willamette River
South of Independence

Groundwater Solutions Inc.

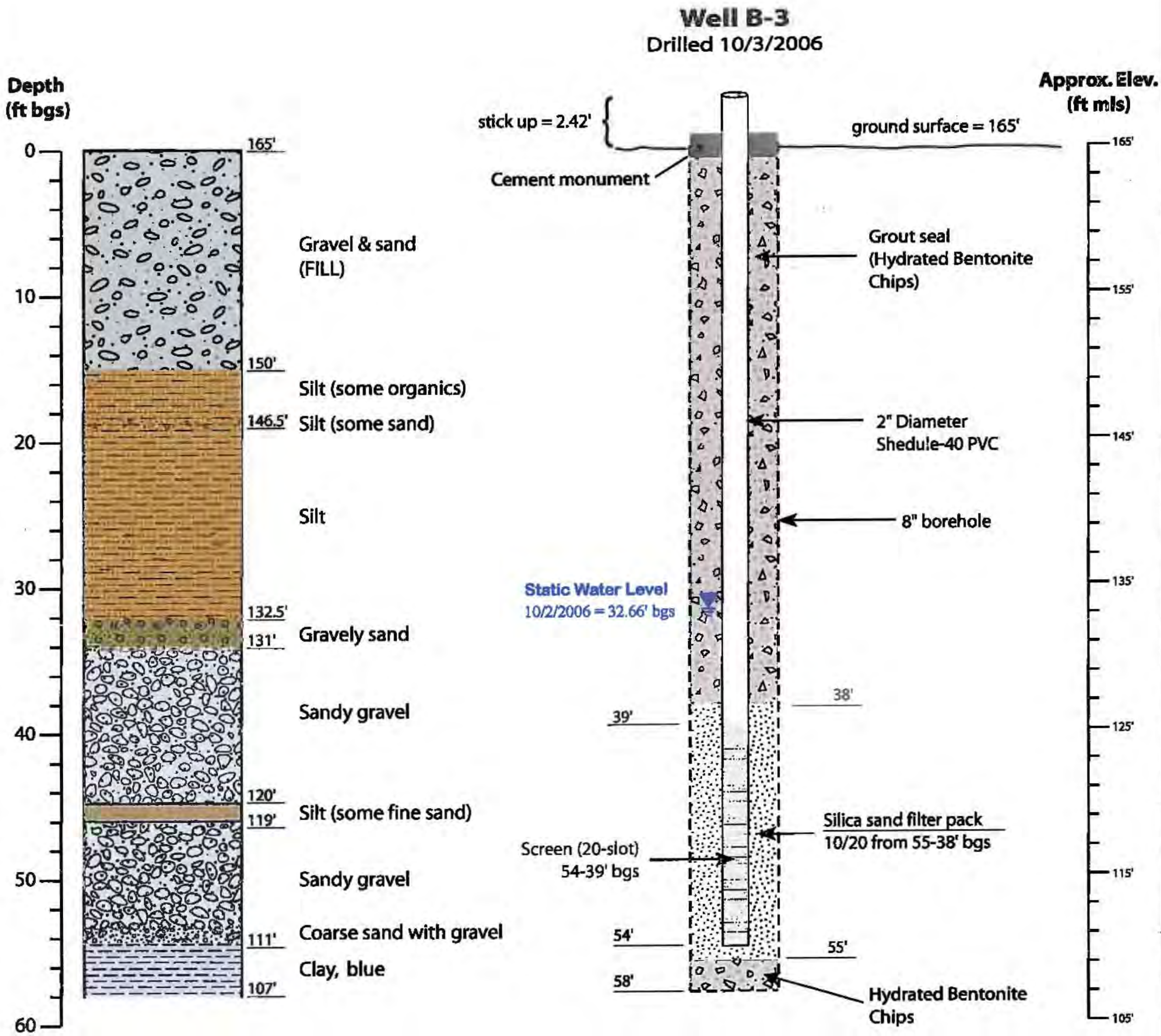
Figure 3
Test Well B-1
Lithology and Construction
Cities of Independence and Monmouth



WELL LOCATION:
Railroad Grade Adjacent to
Willamette River
South of Independence

Groundwater Solutions Inc.

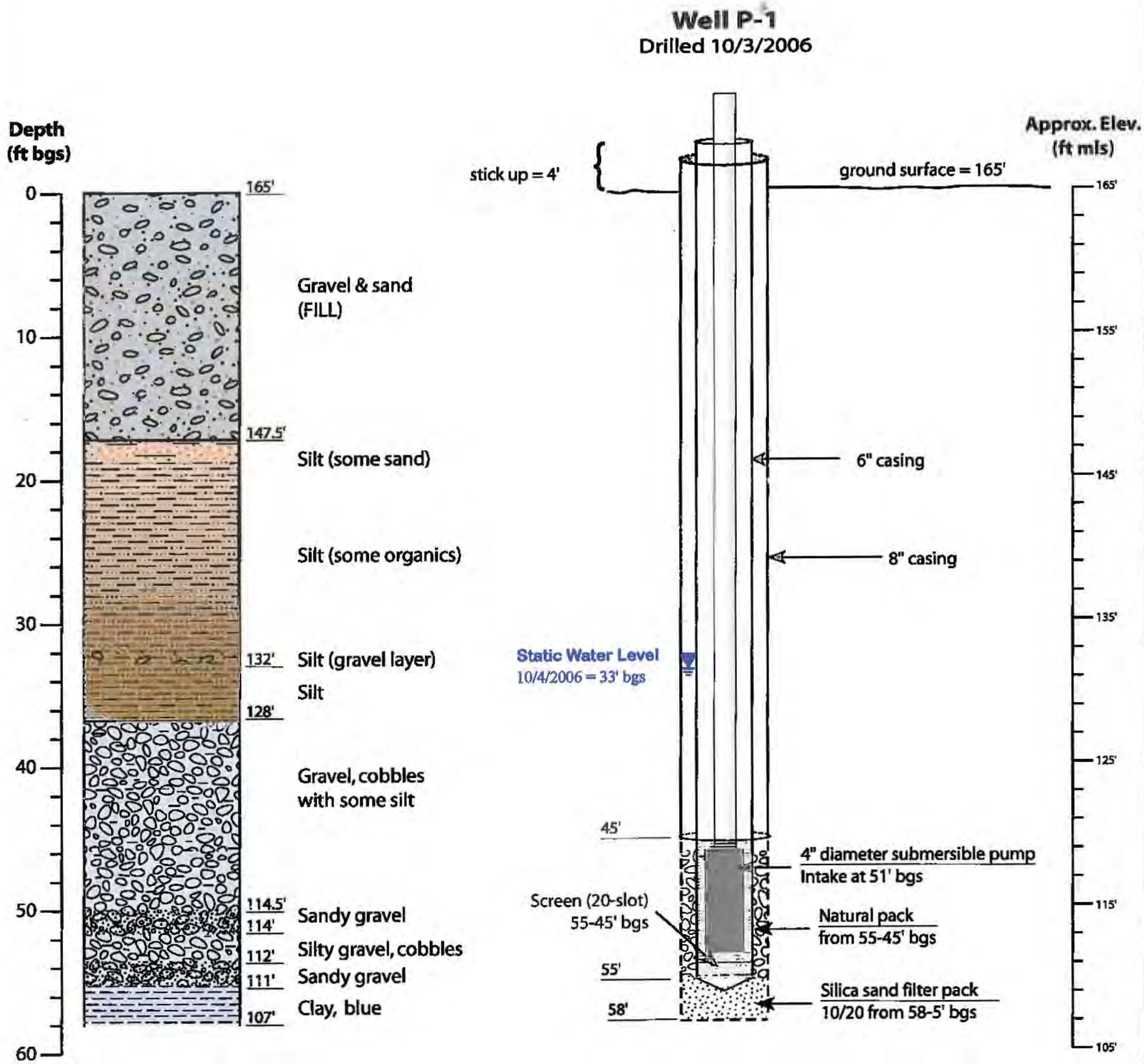
Figure 4
Test Well B-2
Lithology and Construction
Cities of Independence and Monmouth



WELL LOCATION:
Railroad Grade Adjacent to
Willamette River
South of Independence

Groundwater Solutions Inc.

Figure 5
Test Well B-3
Lithology and Construction
Cities of Independence and Monmouth

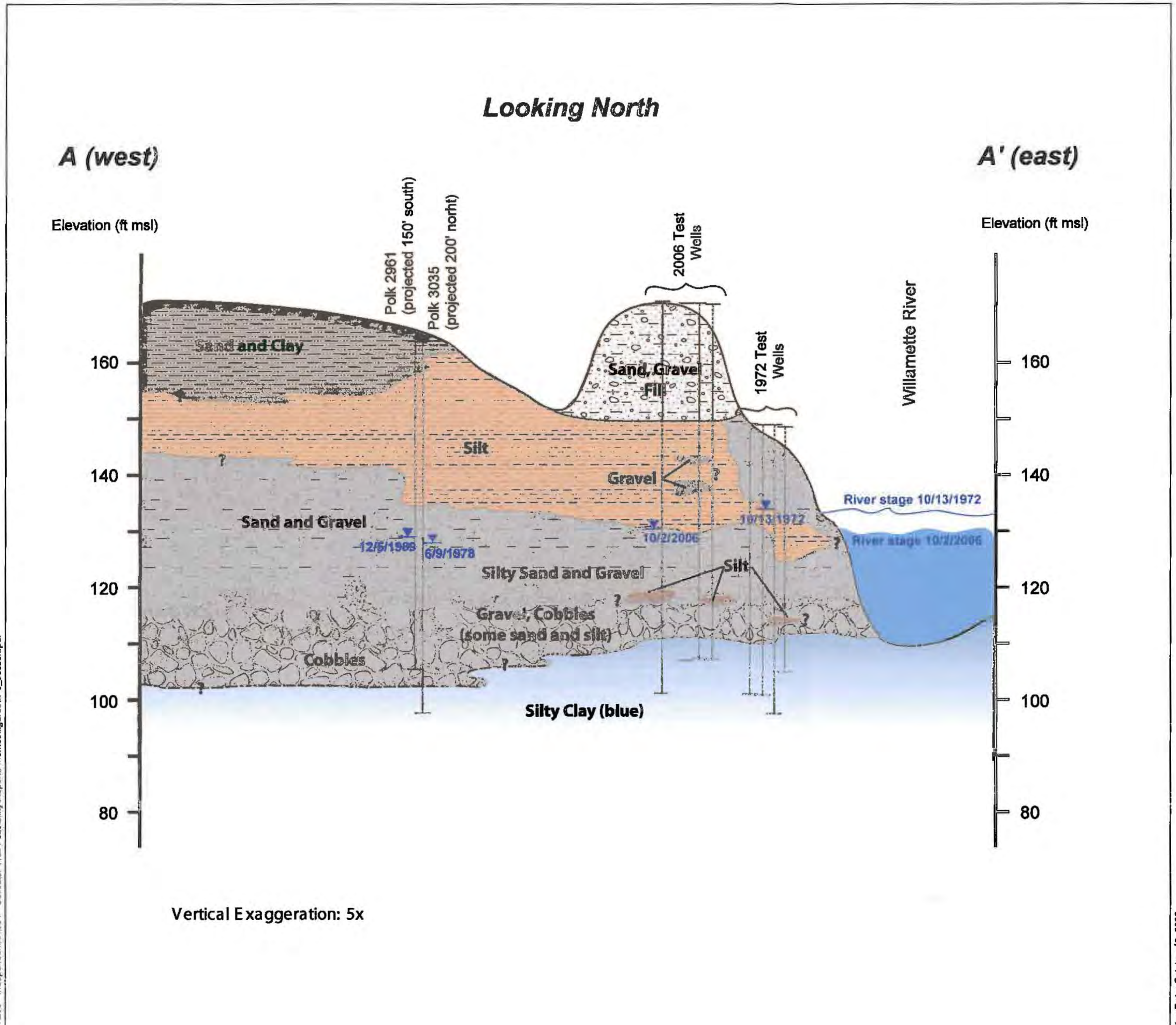


After test, well was abandoned by filling 8" borehole with hydrated bentonite chips

WELL LOCATION:
Railroad Grade Adjacent to Willamette River
South of Independence

Groundwater Solutions Inc.

Figure 6
Test Well P-1
Lithology and Construction for Pump Test
Cities of Independence and Monmouth



LEGEND

Geologic Units

- Silt
- Gravel
- Silty Sand and Gravel
- Sand and Clay
- Clay

Static water level

Polk 4053 Well ID

Horizontal Scale

0 100 200

Feet

Figure 7

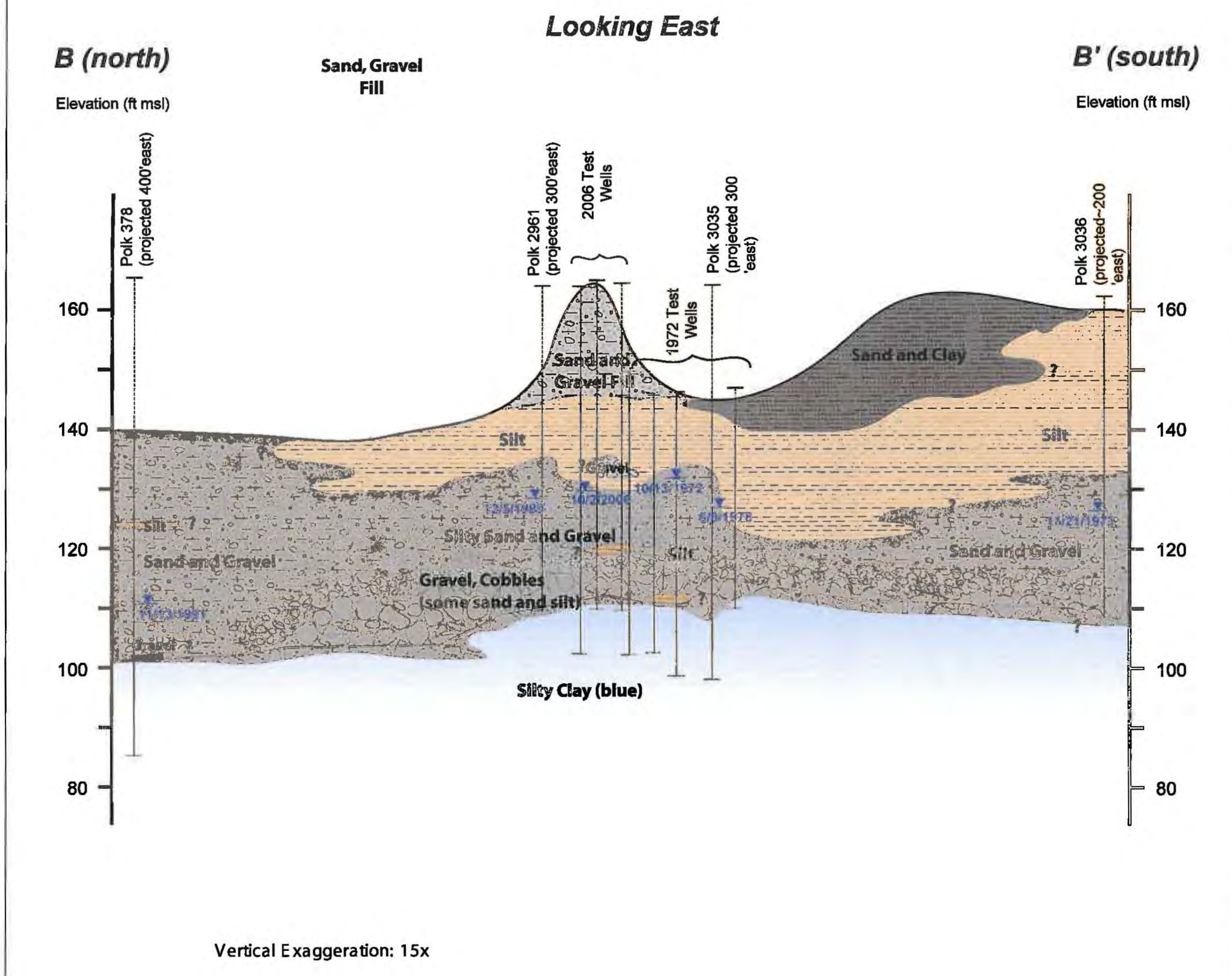
Geologic Cross Section A-A'

Collector Well Feasibility Study
Cities of Independence and Monmouth

Groundwater Solutions Inc.

Map Date: October 16, 2006

P:\203 - Independence\001 - Collector Well Feasibility\Reports-Memos\figures\w-e_section.pdf



Map Date: October 16, 2006

LEGEND

Geologic Units

- Silt
- Gravel
- Silty Sand and Gravel
- Sand and Clay
- Clay

Static water level

Polk 4053 Well ID

Horizontal Scale

0 200 400

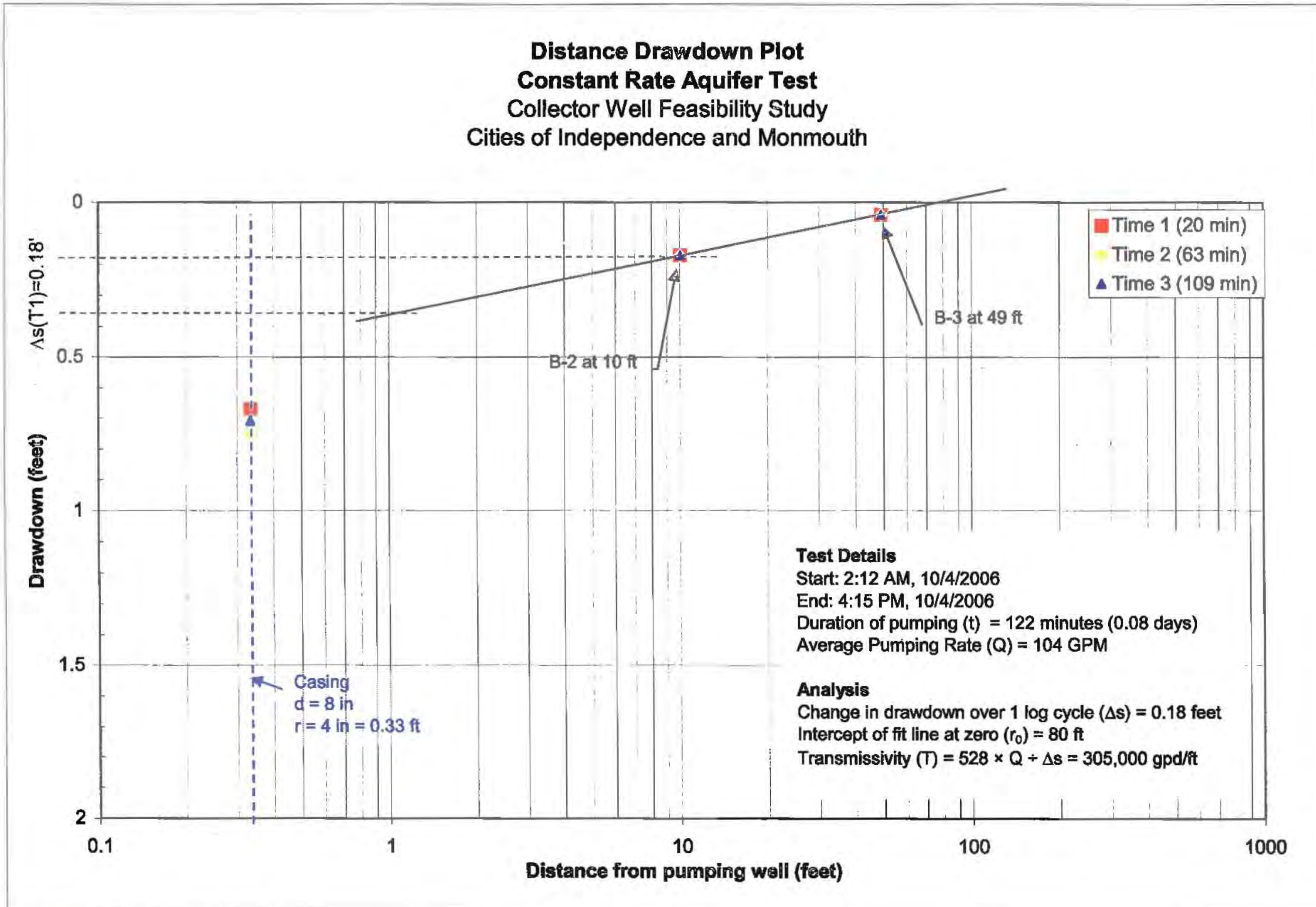
Feet

Figure 8

Geologic Cross Section B-B'

Collector Well Feasibility Study
Cities of Independence and Monmouth

Groundwater Solutions Inc.



Groundwater Solutions, Inc.

Figure 9
Distance Drawdown
Collector Well Feasibility Study
Cities of Independence and Monmouth

P:\203 - City of Independence\001 - Collector Well Feasibility\Data\Hydrogeologic Data\Feasibility Pump Test\P-1 constant rate test.xls

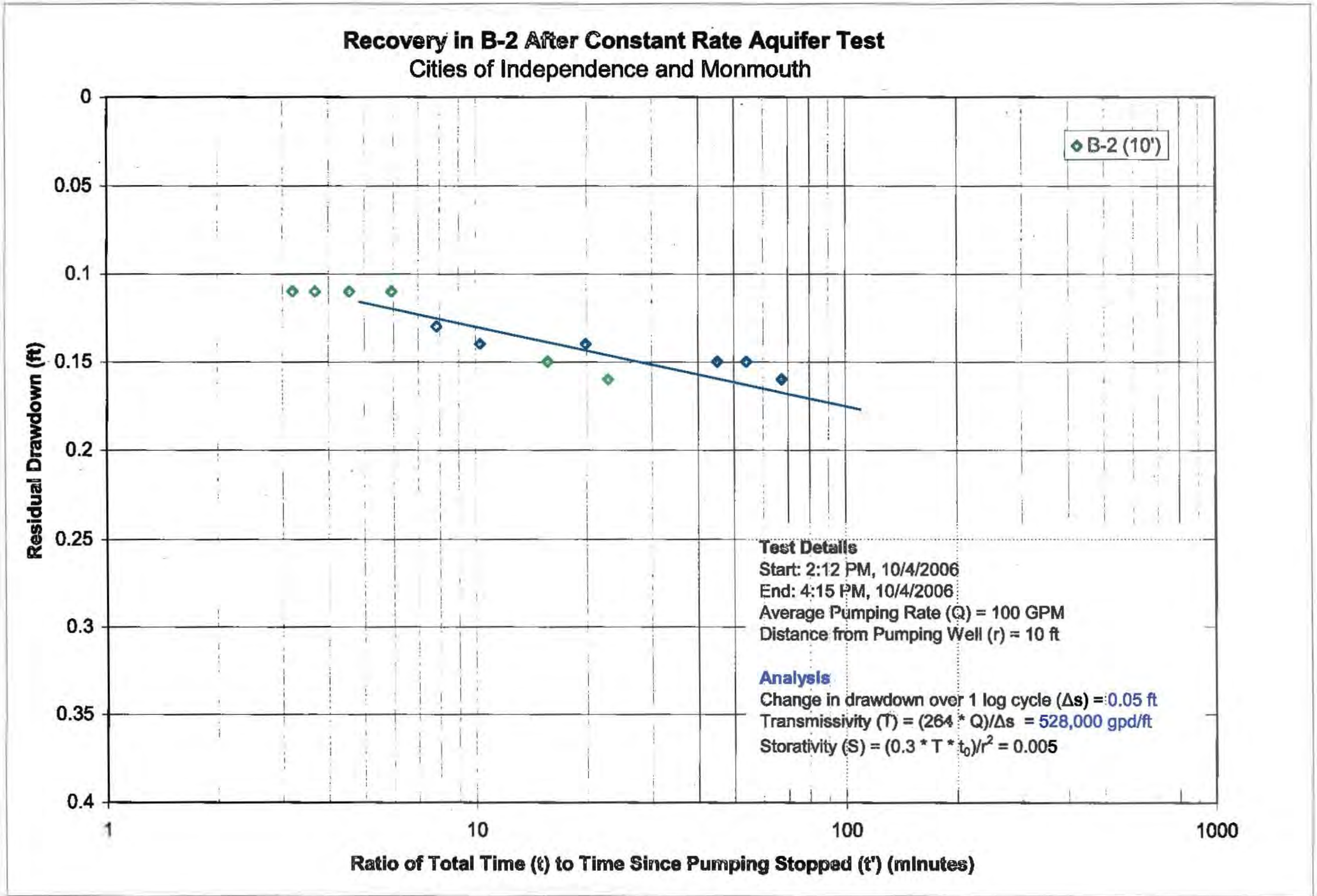


Figure 10
Recovery Data
Collector Well Feasibility Study
Cities of Independence and Monmouth

P-1 constant rate test.xls