City of Sherwood Oregon

Home of the Tualatin River National Wildlife Refuge

ORDINANCE 2016-014

AMENDING CHAPTER 7 OF VOLUME II OF THE SHERWOOD COMPREHENSIVE PLAN AND ADOPTING THE SHERWOOD SANITARY SEWER MASTER PLAN

WHEREAS, the City of Sherwood Sanitary Sewer Master Plan is a long range planning document intended to be updated as conditions within the City change; and

WHEREAS, the existing Sherwood Sanitary Sewer Master Plan was accepted by Resolution 2007-071, on August 7, 2007; and

WHEREAS, at the time of acceptance of the Sherwood Sanitary Sewer Master Plan the associated information in Chapter 7 of Volume II of the Sherwood Comprehensive Plan was not updated: and

WHEREAS, the City has determined that amendments to the Comprehensive Plan and Sanitary Sewer Master Plan are necessary and must be coordinated; and

WHEREAS, the City contracted with Murray Smith and Associated (MSA) to update the Sanitary Sewer Master Plan; and

WHEREAS, in the course of updating the Sanitary Sewer Master Plan, the City has identified the need to update Chapter 7 of Volume II of the Sherwood Comprehensive Plan as it relates to sanitary sewer; and

WHEREAS, after a public open house and recommendations from the Sherwood Planning Commission, staff has proceeded with public noticing and preparing an amendment to: 1) update certain portions of Chapter 7 of Volume II of the Comprehensive Plan as they relate to the Sanitary Sewer Master Plan, so that the information is current; 2) identify the Sanitary Sewer Master Plan as an appendix to the Comprehensive Plan; and 3) adopt the Sanitary Sewer Master Plan; and

WHEREAS, the proposed amendments were reviewed for compliance and consistency with the Comprehensive Plan, as well as regional and state regulations, and found to be fully compliant; and

WHEREAS, the proposed amendments were subject to full and proper public noticing requirements, review, and a public hearing held before the Planning Commission on September 13, 2016 and September 27, 2016; and

WHEREAS, the Planning Commission voted to forward a recommendation of approval to the City Council for the proposed Sanitary Sewer Master Plan and related amendments to Chapter 7 of Volume II of the Comprehensive Plan; and

WHEREAS, the City Council held a public hearing on October 4, 2016 and determined that the proposed amendments to the Comprehensive Plan are consistent with local, regional and state standards; and

WHEREAS, the City Council determined that the Sanitary Sewer Master Plan addressed existing conditions and identified capital improvements and associated project costs needed to meet the future needs for the Sanitary Sewer System over the planning horizon.

NOW, THEREFORE, THE CITY OF SHERWOOD ORDAINS AS FOLLOWS:

Section 1. – Findings: After full and due consideration of the proposed amendments to Chapter 7 of Volume II of the Comprehensive Plan, the updates to the Sanitary Sewer Master Plan, the Planning Commission recommendations, the record of findings which is included as Attachment 1 to the staff report, and evidence presented at the City Council public hearing, the City Council adopts the findings of fact contained in the Planning Commission recommendation, finding that the Sanitary Sewer Master Plan and Comprehensive Plan shall be amended as documented in Attachments 1 and 2.

Section 2. – Approval The proposed amendments for the Sanitary Sewer Master Plan and Comprehensive Plan (PA 16-07) identified in Attachments 1 and 2 are hereby APPROVED.

Section 3. – Planning Department Authorization. The Planning Department is hereby directed to take such action as may be necessary to document this amendment, including notice of adoption to DLCD.

Section 4. – Effective Date. This Ordinance shall become effective 30 days after its enactment by the City Council and approval by the Mayor.

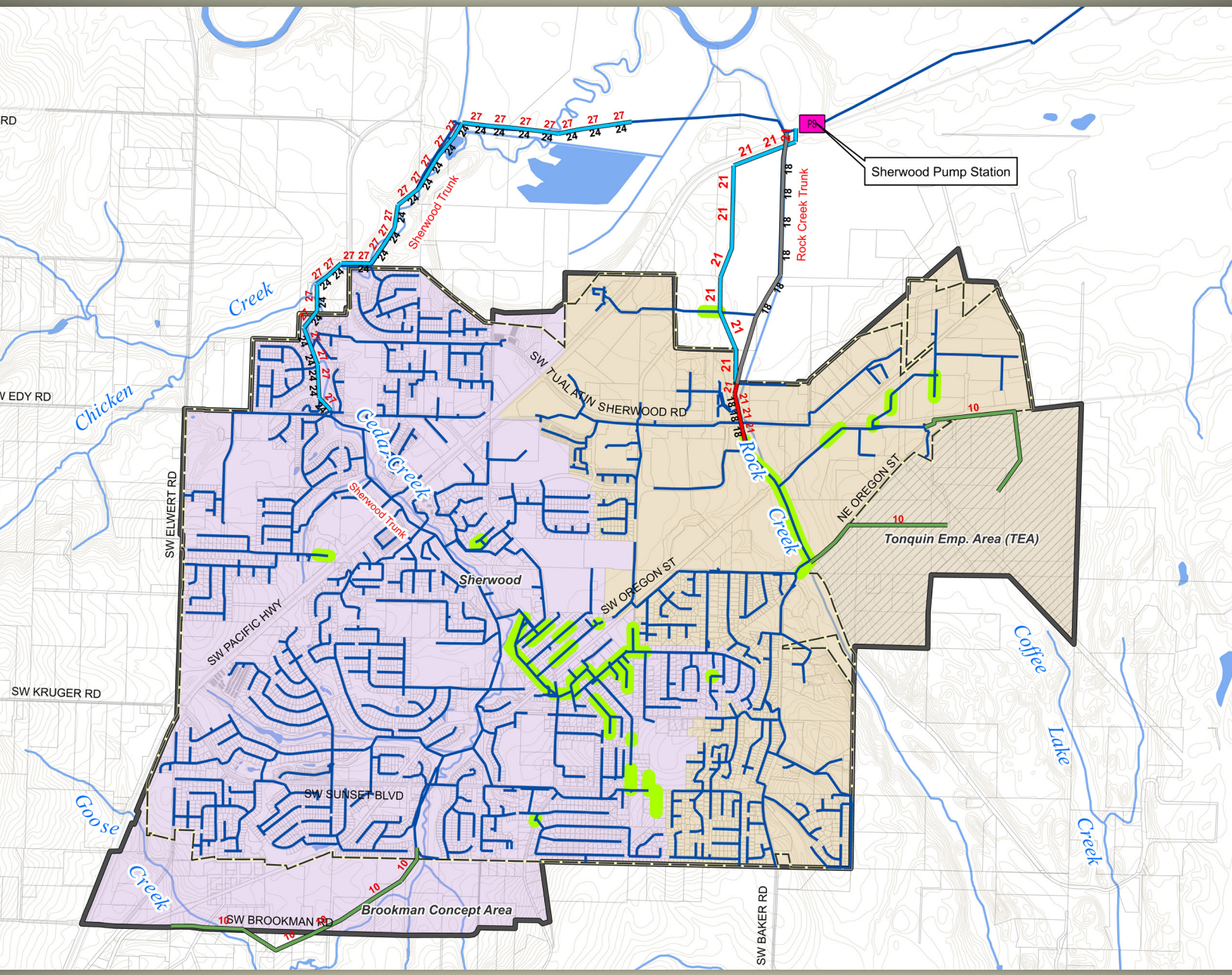
Duly passed by the City Council this 18th day of October, 2016.

Krisanna Clark, Mayor — Date 10/18/16

Attest:

Sylvia Murphy, MMC, City Recorder

	AYE	NAY
Brouse	✓	
Robinson	✓	
Kuiper	✓	
King	✓	
Henderson	✓	
Harris	✓	
Clark	✓	



CITY OF SHERWOOD

SANITARY SEWER MASTER PLAN

SEPTEMBER 2016

City of Sherwood Oregon

ATTACHMENT 2

SANITARY SEWER SYSTEM

MASTER PLAN

FOR

CITY OF SHERWOOD, OREGON

SEPTEMBER 2016

Prepared by:

MURRAY, SMITH & ASSOCIATES, INC.
Engineers/Planners
121 SW Salmon, Suite 900
Portland, Oregon 97204

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EXECUTIVE SUMMARY

INTRODUCTION

The purpose of this Sanitary Sewer Master Plan (SSMP) is to update the City of Sherwood's (City) previous SSMP created in June 2007. The primary goals of this SSMP include: (1) present criteria required for evaluating the system; (2) identify current and future system deficiencies and describe recommended improvements to correct them; and (3) provide planning-level cost information for general budgeting and the development of a prioritized Capital Improvement Program (CIP).

STUDY AREA

The study area for this SSMP is illustrated in Figure ES-1 and includes the current Urban Growth Boundary (UGB) including the Tonquin Employment Area (TEA), and the Brookman Concept Area. The study considers potential impacts to the sanitary system from growth within the existing UGB.

The City shares wastewater management responsibilities with Clean Water Services (CWS) through a "Large City" Intergovernmental Agreement (IGA). The IGA stipulates that the City is responsible for maintenance of the gravity sanitary sewer piping up to 24-inch diameter within the study area, while CWS is responsible for maintenance of sanitary sewer piping of 24-inch diameter or larger, wastewater treatment, and operation of the public sewage pump station that serves the City and surrounding areas. The City is located in the southwest corner of the Durham Basin and is served by the Durham Advanced Wastewater Treatment Facility (AWWTF).

SANITARY SEWER SYSTEM AND SEWER BASINS

The sanitary sewer system is divided into two primary basins, Cedar Creek and Rock Creek, covering approximately 3,390 acres within the study area. These basins are shown in Figure ES-1

The Cedar Creek Basin is the City's largest collection basin, bound to the north, west and south by the current City limits. The Brookman Concept Area will extend the basin boundary south. The basin extends to the east to approximately the center of the City. Residentially zoned areas comprise the major wastewater contributions on the north and south sections of the basin, with commercial areas at its center contributing non-residential wastewater. The basin encompasses 2,080 potential acres of tributary area within the UGB including 1,054 acres of existing developed and sewered area. Major infrastructure within the Cedar Creek Basin includes the 24-inch Sherwood Trunk sewer with a capacity of approximately 5.9 million gallons per day (mgd).

The Rock Creek Basin is bound to the north, east and south by the current City limits and UGB. The Tonquin Employment Area will expand the basin boundary to the east. The basin is bound to the west by the Cedar Creek Basin. Residentially zoned areas in the southern half of the basin generate the major wastewater contributions from the basin. Industrial

customers are more prevalent in the northern half of the basin. The basin encompasses 1,310 potential acres of tributary area in the UGB including 455 acres of existing developed and sewered area. Major infrastructure within the Rock Creek Basin includes the 18-inch Rock Creek Trunk sewer with a capacity of approximately 3.2 mgd.

Both basins flow to the Sherwood Pump Station. The pump stations force main discharges to the Upper Tualatin Interceptor which ultimately flows to the Durham AWWTF. The pump station, force main, and Upper Tualatin Interceptor are all operated and maintained by CWS.

The overall sanitary sewer system is in good condition. Many of the pipes were constructed after 1990 and remain in good repair. Critical deficiencies occur in locations where the piping may be older or connections exist to the storm drain system such as in the Old Town area. Critical operations and maintenance issues occur where newer pipes were sized to accommodate future growth and as a result do not achieve the minimum scouring velocity. Prior to build-out of the service area, these pipelines will require routine flushing and maintenance to prevent solids deposition.

POPULATION AND FLOW PROJECTIONS

The SSMP documents existing wastewater flows and future flow projections based on designated land use. All currently "vacant" parcels within the UGB were assumed to be sewered (i.e., developed) under future build-out conditions. Future residential growth and associated wastewater loading was projected with historical (18,194 population in 2010) and projected populations (19,342 population in 2035 and 23,400 population at build-out), which were a function of Metro land use data and population projections (*Certified Population Estimates*, Portland State University, www.pdx.edu/prc/population-reports-estimates; *Regional Forecast Distribution Methodology & Assumptions, Population and Employment, 2010-40 TAZ Forecast Distribution "Gamma Scenario,"* METRO, 2012*)*. Build-out estimates include the Brookman Concept Area and TEA. The capacity of the sanitary sewer system was evaluated using an estimate of the system wastewater flow projected for both existing and future conditions.

The peak sanitary sewer flow is a combination of dry weather flow (DWF), groundwater infiltration (GWI), and wet weather flow (WWF). DWF is the assumed wastewater base flow contributed by residents and businesses, and varies throughout the day in response to personal habits and business operations. GWI is water that enters the collection system through defective pipes, pipe joints, and manhole walls. GWI varies with groundwater depth and is generally seasonal in nature. WWF, also known as rainfall-derived infiltration and inflow (RDII), is stormwater inflow entering the collection system either during or immediately following a precipitation event. This water enters the system through leaky manhole covers, defective underground pipes, and illegal direct connections, such as roof drains, yard and area drains, and storm drains. Figure ES-2 illustrates how these flow components are combined to estimate the peak wastewater flow for all areas in the collection system.

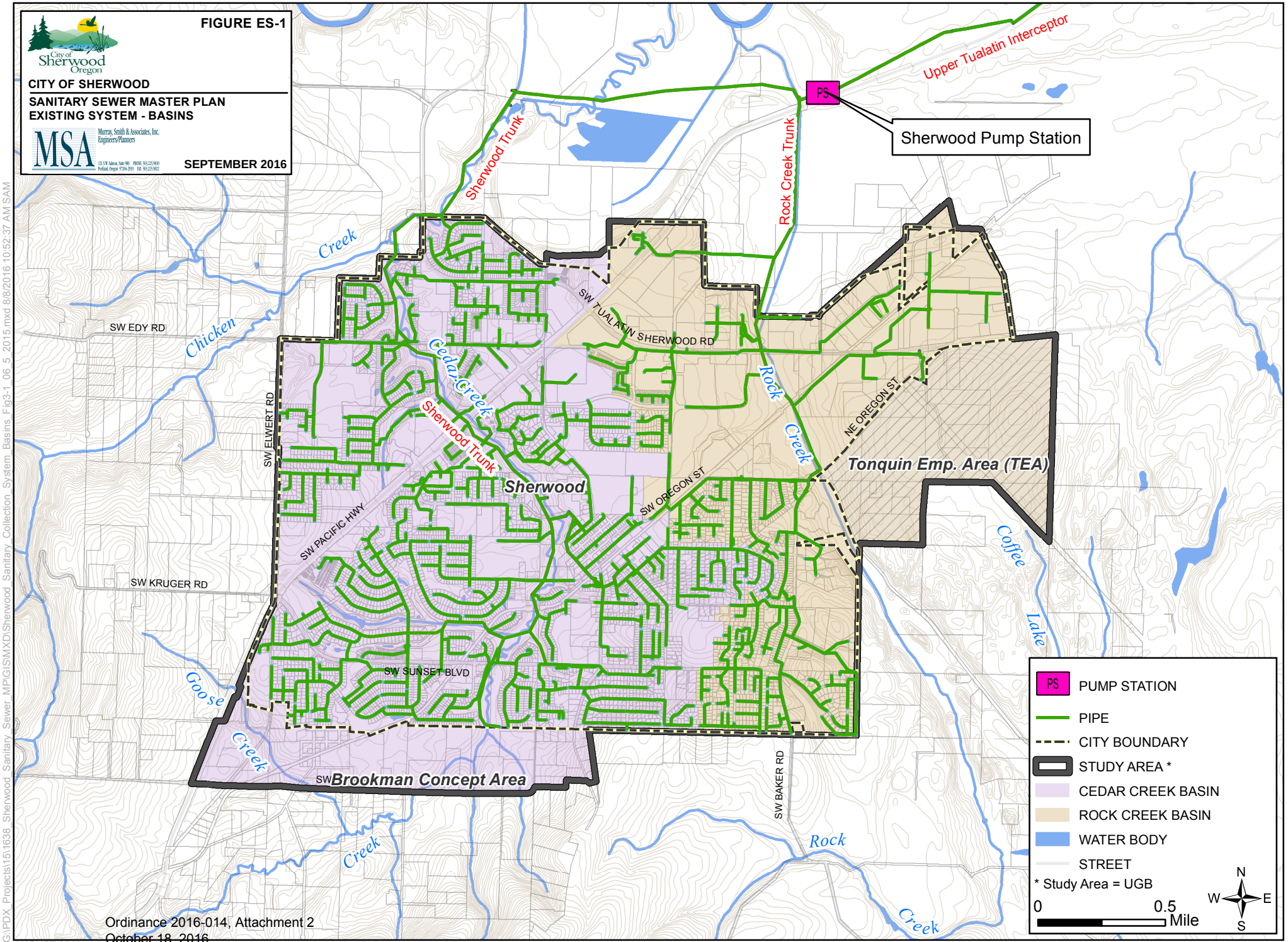


FIGURE ES-1
City of Sherwood Oregon
CITY OF SHERWOOD
SANITARY SEWER MASTER PLAN
EXISTING SYSTEM - BASINS
MSA Murray, Smith & Associates, Inc. Engineers/Planners
SEPTEMBER 2016
Upper Tualatin Interceptor
PS
Sherwood Pump Station
Sherwood Trunk
Rock Creek Trunk
Chicken Creek
SW EDY RD
SW TUALATIN SHERWOOD RD
Cedar Creek
Sherwood Trunk
Rock Creek
NE OREGON ST
SW ELWERT RD
Sherwood
Tonquin Emp. Area (TEA)
SW PACIFIC HWY
SW OREGON ST
Coffee Lake
SW KRUGER RD
SW SUNSET BLVD
Goose Creek
SW Brookman Concept Area
SW BAKER RD
Rock Creek
PS PUMP STATION
PIPE
CITY BOUNDARY
STUDY AREA *
CEDAR CREEK BASIN
ROCK CREEK BASIN
WATER BODY
STREET
* Study Area = UGB
0 0.5 Mile
N W E S
G:\PDX_Projects\151638_Sherwood_Sanitary_Sewer_MP\GIS\MXD\Sherwood_Sanitary_Collection_System_Basins_Fig3-1_06_5_2015.mxd 8/8/2016 10:52:37 AM SAM
AUGUST 2016

Existing system flows were developed from existing winter-time water consumption and flow monitoring data. Existing DWF was estimated from average dry flow conditions between January and March 2013, when flow monitoring data was available. Existing WWF estimation relied on localized flow monitoring data to extract peak RDII rates and unit hydrographs from local storm events to extrapolate the 5-year design storm.

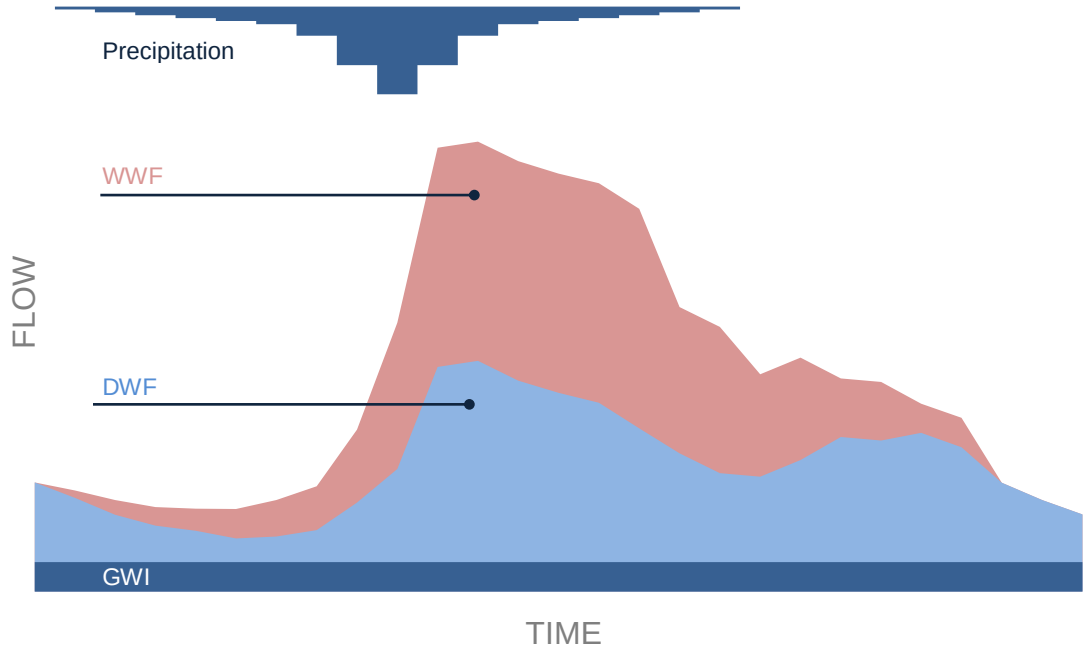
Future flow projections were based on unit flow factors derived from water consumption data and Metro land use data applied at the parcel level to all vacant lands. Future WWF projections utilized the existing extrapolated RDII peak rates for the 5-year design storm for future parcels. A summary of existing and build-out flows is presented in Table ES-1.

Table ES-1 | Peak Dry and Wet Weather Flow Summary by Basin[1]

Basin	Existing Average DWF (gpm)[2]	Existing Peak DWF (gpm)	Existing Peak DWF+ WWF (gpm)	Build-out Average DWF (gpm)	Build-out Peak DWF (gpm)	Future Peak DWF+ WWF (gpm)
Cedar Creek	592	963	2,489	840	1,669	3,111
Rock Creek	272	407	793	550	763	1,952
Total	**864**	**1,370**	**3,282**	**1,390**	**2,432**	**5,063**

Note 1. WWF assumes 5-year design storm. Note 2. gpm= gallons-per-minute.

Figure ES-2 | Generic Schematic of Sanitary Sewer Flow Components



SYSTEM CAPACITY ANALYSIS

A computer model of the sanitary sewer system was developed to evaluate the capacity of the various system components under peaked wastewater flows. To maximize both the qualitative and quantitative accuracy of the analysis, the model was calibrated for dry and wet weather conditions. The model was used to characterize system sensitivity to peak flows and provide an overall range of capacity-related improvements anticipated to be necessary as the City develops towards build-out.

The system analysis identified components which do not meet minimum criteria, as defined by the City's *Engineering Design and Standard Details Manual (2010),* Clean Water Services (CWS) *Design and Construction Standards (2007), Oregon Department of Environmental Quality Design Guidelines (1994),* and *Recommended Standards for Wastewater Facilities [The Great Lakes-Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers, 2004]*. Design criteria focus on a maximum water depth of 80% during dry weather conditions and minimizing surcharging above the pipe crown during the design storm event. For pump stations, the criteria focus on pumping peak wet weather flows with the largest pump out of service. Maximum velocity and minimum scouring velocity are considered secondary criteria and are indicative of undersized or over-sized piping, respectively.

The calibrated sanitary sewer model was used to identify system hydraulic response to existing and build-out flows during the 5-year design storm. The build-out analysis considered sanitary sewer service within the existing UGB.

Existing System Analysis

Results of the existing system analysis indicate zero significant hydraulic deficiencies. Two sections of the Sherwood Trunk (total length approximately 6,000 feet) of 24-inch diameter piping immediately north of Roy Rogers Rd and north of Edy Rd experience some surcharging during the design storm; however, freeboard exceeds 10 feet through the critical pipe segments.

The Sherwood Pump Station and force main has adequate capacity during the design storm to convey the existing peak flow rate of 4.7 million-gallons-per-day (mgd). The existing firm capacity of the pump station is estimated at 6.6 mgd. The existing 18-inch Sherwood Pump Station force main capacity is estimated at 9.1 mgd.

The Upper Tualatin Interceptor also has adequate capacity for existing peak flow contributions from the City. The limiting segments in the downstream Upper Tualatin Interceptor occur in the 27-inch diameter piping immediately downstream of the Sherwood Pump Station force main. This piping has a limiting capacity similar to the firm capacity of the pump station of 6.6 mgd.

Build-out System Analysis

Results of the build-out system analysis indicate significant deficiencies in both the Sherwood and Rock Creek Trunks. The deficiencies in the Sherwood Trunk are primarily driven by development of the Brookman Concept Area including 3,600 feet of 24-inch diameter piping experiencing freeboard of 3 to 10 feet. The deficiencies in the Rock Creek Trunk are primarily driven by development of the Tonquin Employment Area including 4,800 feet of 18-inch diameter piping experiencing freeboard of 0.5 to 10 feet.

The peak build-out flow rate into the Sherwood Pump Station during the design storm is estimated at 7.3 mgd which is greater than the available 6.6 mgd firm capacity of the pump station. Expansion of the Sherwood Pump Station is required to accommodate build-out growth within the existing UGB. A CWS study from 2009 identified an increase in pump station firm capacity to 7.8 mgd by increasing the pump impellers from 445-millimeters (mm) to 465 mm. The Sherwood force main has adequate capacity to convey UGB build out flow.

The Upper Tualatin Interceptor is deficient at build-out peak flows. The critical segments in the downstream Upper Tualatin Interceptor occur in the 27-inch diameter piping immediately downstream of the Sherwood Pump Station force main. Additional limitations occur where the cities of King City, Tigard, and Tualatin also contribute to the interceptor between 124th Avenue and Jurgens Avenue. CWS performed an evaluation in 2012 with the calibrated Durham Basin model to determine the approximate timing of deficiency in the Upper Tualatin Interceptor. The critical segments were determined to be deficient in the 2025 to 2035 timeframe. CWS is currently performing analysis to consider phasing and priority of gravity improvements to the interceptor.

Improvements identified for the build-out analysis were sized for growth within the existing UGB and are highlighted in Figure ES-3. These improvements include:

- City and CWS upsizing of the Sherwood and Rock Creek Trunk sewers
- Abandoning of the Onion Flats section of the Rock Creek Trunk and new upsized CWS pipeline route to avoid sensitive environmental areas
- Pipeline extensions to serve the Brookman Concept and Tonquin Employment areas

Although deficiencies are identified for the Sherwood Pump Station and Upper Tualatin Interceptor at build-out conditions, specific improvements are in the purview of CWS and have not been specifically sized during this study. Critical pump station and downstream pipe improvements are required to serve City UGB growth and should be carefully coordinated with CWS.

CAPITAL IMPROVEMENT PROGRAM

The capacity and condition improvement analysis were used to develop a 20-year Capital Improvement Program (CIP). Improvements were prioritized into three timeframes, including the short-term (0-5 years), medium-term (6-10 years), and long-term (11-20 years).

All improvements are funded by utility revenues generated from wastewater rates and are allocated through the City's Sewer Operating Fund. Capital improvements for future development (i.e. growth) are funded through Sewer Development Charges (SDCs), as dictated by Oregon Revised Statute 223.297 through 223.314 and allocated by the City's Sewer SDC Fund. The total cost for all City improvements are summarized and presented in Table ES-1 and equate to $11,080,000 over the 20-year planning horizon (in 2015 dollars). These costs exclude improvement projects by CWS. Capital improvements are illustrated in Figure ES-3.

Table ES-2 Capital Improvement Program Summary (Estimated Total Costs)[1,2,3]

Category	Time Frame (Cost)			Total Cost
	0-5 Years	6-10 Years	11-20 Years	
Capacity	$780,000	$4,870,000	$0	$5,650,000
Condition	$1,890,000	$1,980,000	$1,309,000	$5,179,000
Other	$0	$250,000	$0	$250,000
Total	$2,670,000	$7,100,000	$1,309,000	$11,079,000

Table ES-1 summarizes CIP costs by improvement category, with the following notes:

Note 1. Cost estimates represent a Class 5 budget estimate, as established by the *American Association of Cost Engineers*. This preliminary estimate class is used for conceptual screening and assumes project definition maturity level below two percent. The expected accuracy range is -20 to -50 percent on the low end, and +30 to +100 percent on the high end, meaning the actual cost should fall in the range of 20 percent below the estimate to 100 percent above the estimate. The cost estimates are consistent with the definition of OAR 660-011-0005(2) and OAR 660-011-035. They are intended to be used as guidance in establishing funding requirements based on information available at the time of the estimate

Note 2. Cost estimates for all improvements assume unit costs for replacement materials and construction. All cost estimates include markups for construction contingency, owner administrative costs, and contract costs.

Note 3. All improvements are sized for build-out of the upstream service area at a planning level of accuracy based on population, density and land use assumptions described in Section 5 of this document. Improvement sizing is limited to service within the existing Urban Growth Boundary. Prior to implementation, each project should undergo standard engineering design phases to finalize improvement sizing and location.

FIGURE ES-3

City of Sherwood Oregon

CITY OF SHERWOOD

SANITARY SEWER MASTER PLAN
CAPITAL IMPROVEMENT PROGRAM

MSA Murray, Smith & Associates, Inc. Engineers/Planners
121 S.W. Salmon, Suite 400 PHONE 503.225.9010
Portland, Oregon 97204-2939 FAX 503.225.9022

SEPTEMBER 2016

Project ID	Name
CWS-1	Onion Flats
CWS - 2	Sherwood Pump Station
CWS-3	Upper Tualatin Interceptor
CWS-4	Sherwood Interceptor Project 1
CWS-5	Sherwood Trunk Project 1
1	Southern Tonquin Emp Area extension
2	Northern Tonquin Emp Area extension
3	Brookman Extension 1
4	Rock Creek Trunk Improvement 1
8 - 22	Condition Based

Upper Tualatin Interceptor (Improvement by CWS multiple segments)

CWS - 2

CWS - 4

CWS - 1

CWS - 3

Upper Tualatin Interceptor

(Force Main)

PS

Sherwood Pump Station (Improvement by CWS)

Sherwood Trunk

Rock Creek Trunk

Existing Sewer is Abandoned, New Alignment to Avoid Sensitive Ecological Area

Chicken Creek

Cedar Creek

Rock Creek

Coffee Lake Creek

Goose Creek

SW EDY RD

SW ELWERT RD

SW TUALATIN SHERWOOD RD

SW PACIFIC HWY

SW OREGON ST

NE OREGON ST

SW KRUGER RD

SW SUNSET BLVD

SW BROOKMAN RD

SW BAKER RD

SW AVE

Sherwood

Tonquin Emp. Area (TEA)

Brookman Concept Area

PS PUMP STATION
CITY BOUNDARY
STUDY AREA *
WATER BODY
STREET

Improvement
Existing Pipe
New Pipe
Improvement
CWS Project
Condition Project

* Study Area = UGB

N W E S

0 0.5 Mile

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August 2016

SECTION 1 | INTRODUCTION

INTRODUCTION

This Sanitary Sewer Master Plan (SSMP) updates the City of Sherwood's (City's) previous SSMP adopted in July of 2007.

This SSMP:

- Summarizes basic information describing the wastewater collection system.
- Describes how the system components function.
- Presents technical criteria required for evaluating the system.
- Identifies current system deficiencies and describes recommended improvements to correct them.
- Identifies future system needs to accommodate growth.
- Contains planning-level cost information for general budgeting and a prioritized Capital Improvement Program (CIP).
- Provides a reference document for City leaders, technical staff, consultants, customers and other interested parties about the existing system and future recommended improvements.
- Incorporates community values and priorities through input from a public open house process.
- Facilitates logical planning decisions and utility coordination relative to other City projects and programs.

PURPOSE

This SSMP provides a valuable tool to facilitate timely, orderly and efficient management of the City's wastewater collection system over the next 20 years. This document serves as a "Public Facilities Plan" for wastewater collection systems according to Oregon Administrative Rule (OAR) 660, Division 11. This OAR stipulates that facility plans be developed as support documents for the City's Comprehensive Plan.

How This Plan Should Be Used

This SSMP serves as the guiding document for future collection system improvements, and should:

- Be reviewed annually to prioritize and budget needed improvements.
- Have mapping updated regularly to reflect ongoing development and construction.
- Interpreted as conceptual. The location, size and timing of improvement projects may change as additional site-specific details and potential alternatives are investigated in the preliminary engineering phase of design.
- Be updated and refined as preliminary engineering and final project designs are completed.

SCOPE

Murray, Smith and Associates, Inc. (MSA) was authorized by the City on January 21, 2015 to provide municipal master planning services related to sanitary sewer master planning.

MSA worked closely with the City to develop a Scope of Work that provides the necessary guidance for both current and future sewer management decisions. The Scope of Work includes the following elements:

- Compile and review historic flow monitoring data, pump station data, maintenance reports, condition assessments, maps, record drawings, aerial photography, topography, system base maps, City standards and other information pertaining to the physical sanitary sewer system.
- Review City-furnished information relating to service study area, wastewater drainage basins, and land use.
- Develop criteria for analysis of existing sewer systems and the design of future improvements.
- Document current Federal, State and local rules and regulations that relate to the City's sanitary sewer system. Provide a discussion of future anticipated regulations.
- Develop sewage contributions for each wastewater basin.
- Calibrate sewage contributions based on Clean Water Services flow monitoring data.
- Identify significant Rainfall Derived Inflow and Infiltration (RDII) problems and develop recommended programs and improvements to reduce RDII.
- Conduct a hydraulic analysis of existing sanitary sewer mains.
- Determine existing system deficiencies with respect to ultimate service requirements.
- Determine future collection facilities required to provide service for ultimate build-out within the study area.
- Based on system deficiencies identified, review infrastructure needs and alternatives to meet current and future wastewater flow conditions.
- Develop a CIP which prioritizes short-term and long-term improvements.
- Develop budget-level cost estimates for those projects identified in the CIP.
- Develop a capital improvement map showing both existing and proposed sanitary sewer infrastructure.
- Develop system development charge (SDC) methodology and rate analysis.
- Prepare a SSMP document which describes and illustrates the results of the study.

ORGANIZATION OF THE COLLECTION SYSTEM MASTER PLAN

This master plan report is organized into seven sections, as described in Table 1-1. Detailed technical information and supporting documents are included in the appendices.

Table 1-1 | SSMP Organization

Section Number	Section Title	Description
ES	Executive Summary	Provides a summary of each section of the document and highlights improvement recommendations.
Section 1	Introduction	Explains the purpose and scope of the Sanitary Sewer Master Plan.
Section 2	Study Area Characteristics	Outlines the study area characteristics, including geography, topography, climate, general soil conditions, and land use designations within the City.
Section 3	Existing System Conditions	Presents an overview of the existing system and key facilities, and describes the existing service area and extents of the current Urban Growth Boundary (UGB).
Section 4	Regulations & Policies	Lists applicable policies and guidelines for sanitary sewer systems based on Federal, State, and local governance.
Section 5	Population & Flow Projection	Describes the development of dry weather and wet weather parameters used in determining existing and future design peak flows.
Section 6	System Analysis	Summarizes the methodology and results of the system analysis including alternatives to improve hydraulic and condition-based deficiencies.
Section 7	Capital Improvement Program	Presents a proposed Capital Improvement Program (CIP) consisting of a prioritized list of improvements to be implemented over the study period.
Appendix A	Intergovernmental Agreement (IGA)	Text of City IGA with Clean Water Services
Appendix B	Basis of Opinion of Probable Costs	Presents project unit cost tables for sanitary sewer system assets used to develop estimates for individual projects; provides the cost basis used in the alternatives evaluation of sanitary sewer system improvements in Section 6; and the development of the final CIP budgets associated with the system improvements recommended for adoption by the City in Section 7.
Appendix C	Model Calibration Plots	Dry weather and wet weather calibration plots

SECTION 2 | STUDY AREA CHARACTERISTICS

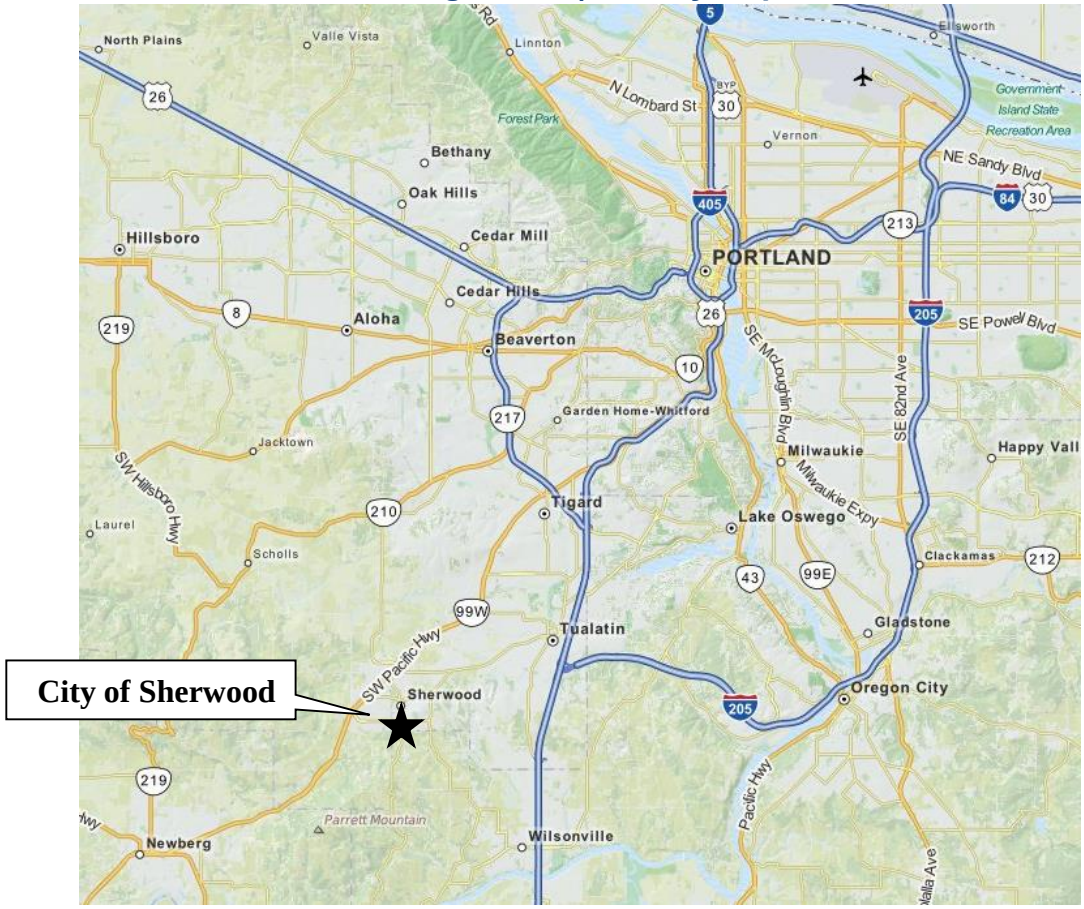
INTRODUCTION

This section of the SSMP outlines the sanitary sewer system study area characteristics including geography, topography, climate, general soil conditions, and land use designations. Land use designations are of particular interest when planning sanitary sewer infrastructure, as the wastewater loading is highly dependent on land use category and density. The City of Sherwood (City) socioeconomic conditions are also documented within this section, including a discussion on the major sources of commerce within the City and the historical population trends over the past three decades.

GEOGRAPHY

The City is located along Highway 99 in Oregon's Tualatin River Valley, within the southeast corner of Washington County (see Figure 2-1). This location places the City on the southwest edge of the Portland metropolitan area, approximately 16 miles from downtown Portland. Neighboring cities are Tualatin to the east, Wilsonville to the southeast, and Tigard to the northeast. Newberg, in Yamhill County, is approximately 9 miles southwest, along Highway 99.

Figure 2-1 | Vicinity Map



Source: Mapquest, www.mapquest.com, 2015.

TOPOGRAPHY

The ground elevations within the City range from approximately 140 feet above mean sea level (MSL) to approximately 420 feet above MSL, with the majority of development occurring between the elevations of 180 to 260 feet above MSL. In general, the elevations are lowest in the northern portions of the City nearing the Tualatin River, and highest in the hilly areas of the southern portions of the City. Elevation change throughout the City is gradual, with typical slopes up to 6 percent. However, some steep slopes, which range up to 25 percent, are located near hills and creek banks.

CLIMATE

The City is in the Marine West Coast Climate Zone. Temperatures are moderate year-round due to a marine influence from the Pacific Ocean that produces generally warm, dry summers and cool, wet winters. Precipitation primarily occurs during the winter months, with the wettest period from October through March. Nearly 41 inches of precipitation occurs annually in the City. July and August are the warmest months, with an average high temperature of 81 degrees Fahrenheit (°F), and December is the coolest month, with an average low temperature of 34 °F. December is also the wettest month, averaging 6.82 inches of precipitation.

STUDY AREA

The study area for this SSMP is illustrated in Figure 2-2 and includes the current city limits, the Tonquin Employment Area (TEA), and the Brookman Concept Area. The study considers potential impacts to the collection system from growth within the existing Urban Growth Boundary (UGB).

The City shares wastewater management responsibilities with Clean Water Services (CWS) through a "Large City" Intergovernmental Agreement (IGA). The IGA stipulates that the City is responsible for maintenance of the gravity sanitary sewer piping up to 24-inch diameter within the study area, while CWS is responsible for maintenance of sanitary sewer piping of 24-inch diameter or larger, wastewater treatment, and operation of the public sewage pump station that serves the City and surrounding areas. The City is located in the southwest corner of the Durham Basin and is served by the Durham Advanced Wastewater Treatment Facility (AWWTF).

LAND USE AND ZONING

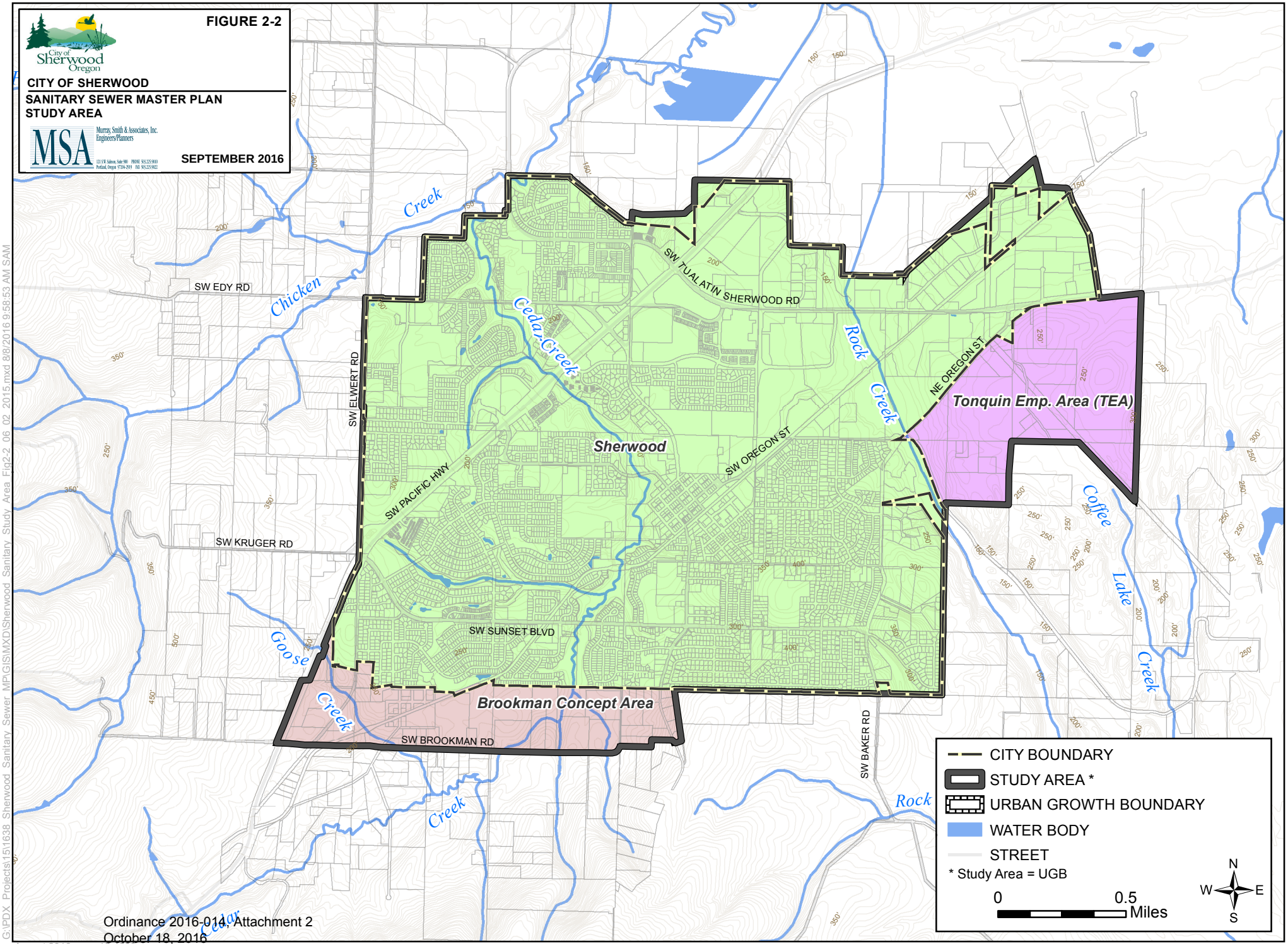
By state law, Metro is responsible for establishing the Portland metropolitan area's UGB, which includes Sherwood. Metro is a regional government serving nearly 1.5 million people in Clackamas, Multnomah and Washington Counties. The agency was formed to administer growth, infrastructure and development policies that cross local jurisdictional boundaries. Land uses and densities inside the UGB are assigned to support urban services such as police and fire protection, roads, schools, and water and wastewater systems. Understanding land use and demographic characteristics within the study area is particularly important in sanitary sewer planning because of the impact they have on wastewater flows.

All parcels within the City were assigned land use designations in accordance with the City's Zoning Map and other relevant land use information supplied by Metro. These designations are generally categorized as commercial, industrial, institutional, residential and "non-developable" land uses. City zoning is shown in Figure 2-3. A summarized inventory of developable and non-developable lands in the study area is shown in Table 2-1. Wastewater flows for the various land use designations are discussed in Section 5.

Table 2-1 | Zoning and Planning Area Summary

Zoning Category	Existing City Limits	Brookman Concept Area	Tonquin Employment Area	Total
Developable Land (gross acres)				
General Commercial (GC)	66	0	0	66
Neighborhood Commercial (NC)	1	0	0	1
Office Commercial (OC)	29	7	0	36
Retail Commercial (RC)	101	0	0	101
Institutional and Public (IP)	169	4	0	173
General Industrial (GI)	230	0	0	230
Light Industrial (LI)	198	30	0	228
Employment Industrial (EI)	0	0	281	281
Very Low Density Residential (VLDR)	96	0	0	96
Low Density Residential (LDR)	590	0	0	590
Medium Density Residential Low (MDRL)	185	139	0	325
Medium Density Residential High (MDRH)	147	7	0	154
High Density Residential (HDR)	135	15	0	150
Subtotal – Developable Land	**1,947**	**202**	**281**	**2,429**
Non-developable Land (gross acres)[1]				
Open Space (OS)	238	0	0	238
Wetland	63	0	4	67
Roadway	485	32	20	537
Floodplain	102	17	1	120
Subtotal - Non-developable Land	**888**	**49**	**25**	**962**
TOTAL - Developable + Non-developable	**2,835**	**251**	**306**	**3,391**
Developable Land - Developed vs. Vacant Summary (gross acres)				
Subtotal – Developed Land	1,508	0	0	1,508
Subtotal - Vacant Land	439	202	281	922

Note 1. Non-developable Land refers to lands in the study area that have a City zoning designation of Open Space (OC), or have been otherwise categorized by Metro RLIS as Wetlands, Roadway, or Floodplain. These additional categories are defined as follows: Wetlands – As identified by Metro RLIS GIS, this includes land in the 1998 National Wetlands Inventory, finished and in-progress local wetland inventories conducted by local jurisdictions, and information/documentation collected during the development of Metro's Title 13 Nature in Neighborhoods Program. Roadway - Land not part of a taxlot, considered to be dedicated to public rights-of-way. These include streets, highways, and railroads. Floodplain - Land in the 100-year floodplain, as delineated by FEMA. Current as of August 2016.



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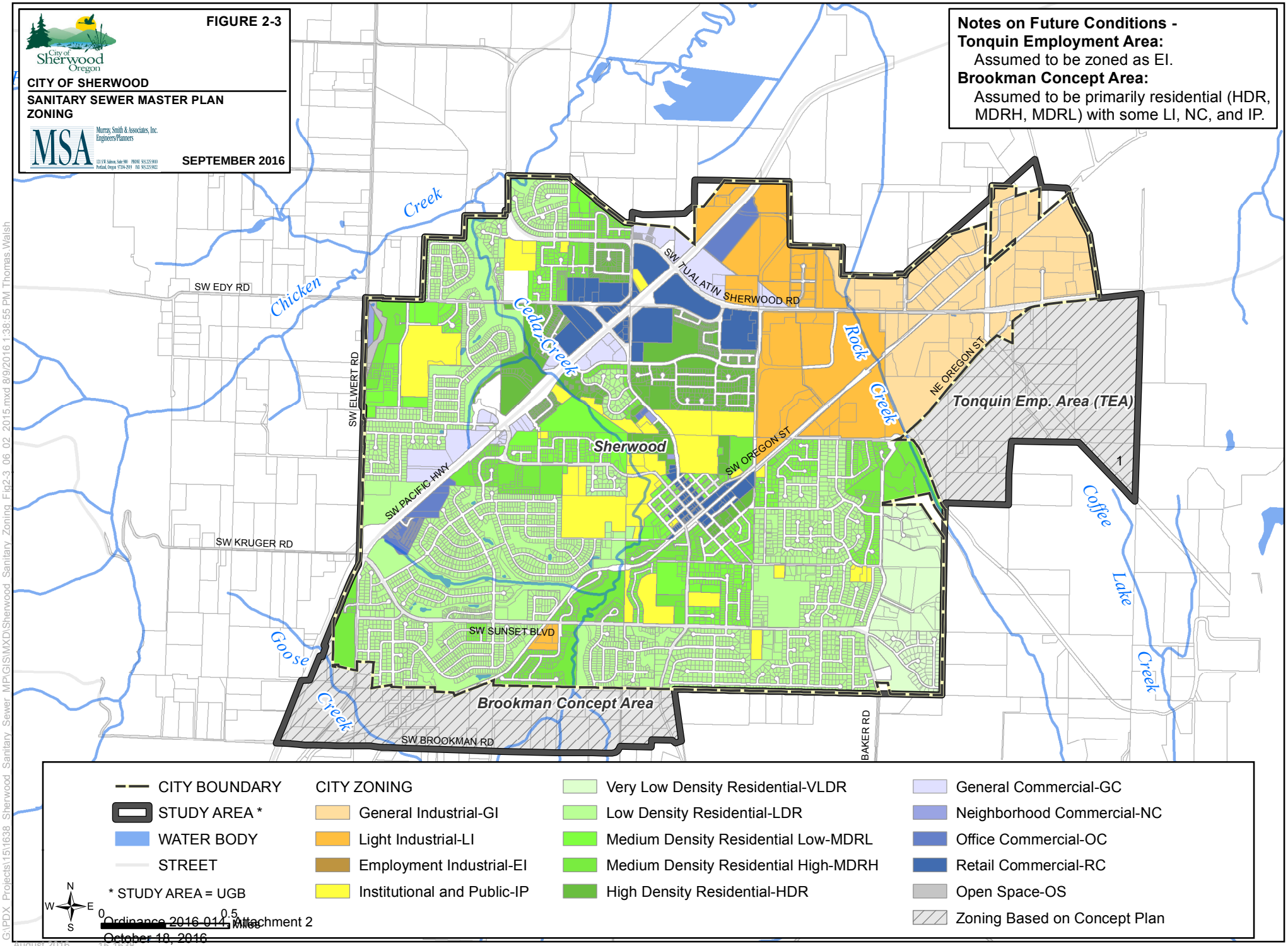

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August 2016 15-1638

FUTURE GROWTH AREAS

The study area includes two future growth areas and in-fill development within the UGB. Concept planning efforts have been completed for the TEA and Brookman Concept Area and reflect future anticipated growth. The concept plan areas are further described below.

Brookman Concept Area

The Brookman Concept Area is a proposed 251-acre residential, commercial, office and light industrial development zoned area within the southern portion of the City's UGB. The planning effort for this area was undertaken by the City in 2009. It is primarily located in unincorporated Washington County, with a minor eastern section located in unincorporated Clackamas County where Brookman Road deviates from an east-west alignment at the county border. The area is bound by Brookman Road and the UBG to the south, the existing City limits to the north, Highway 99 to the west, and the UBG to the east. The timeline for actual development within this planning area is anticipated to begin within the next 5 years, and reach saturation within 20 years.

Tonquin Employment Area (TEA)

The TEA is an Employment Industrial zoned 306-acre area on the eastern portion of the City's UGB. The planning effort for this area was undertaken by the City in 2010. It is fully located in unincorporated Washington County. The area is bound by the UGB to the south, the existing City limits to the north and west, and the UBG to the east along SW 124th Avenue. The timeline for actual development within this planning area is anticipated to begin within the next 5 years, and reach saturation after 20 years.

GEOLOGY, SOILS AND GROUNDWATER

Detailed information on the soils found throughout the study area are summarized in the U.S. Soil Conservation Service's *Soil Survey of Washington County (OR067).* This survey identifies the soil types for construction considerations and potential response to rainfall-derived inflow and infiltration (RDII). In general, the soils within the study area produce a moderate to high rainfall response in terms of stormwater runoff. Conversely, these soils typically infiltrate rainfall at a low to moderate rate.

The Natural Resources Conservation Service (NRCS) indicates locations within the study that contain bedrock at the ground surface. This information is supported by well logs referenced from the Oregon Water Resources Department with mixed results. There are numerous domestic water wells within the study area that report encountering rock within 10 feet of the ground surface.

Surface water hydrology is relatively consistent within the study area, and is influenced by seasonal rainfall. Generally groundwater is well below the surface and does not normally impact construction. However, there are some areas in the City where seasonal groundwater can be very near the surface and may impact construction during the wet weather season.

The Old Town area of central Sherwood is an example where the depth of seasonal groundwater may vary from 2 to 20 feet below the surface, depending on the location. It is recommended that groundwater investigations be undertaken prior to construction in these areas to identify and address groundwater issues. Two perennial streams, Cedar Creek and Rock Creek, flow through the City. Areas along Cedar Creek and Rock Creek are located within the 100-year flood plain boundary, as defined by the Federal Emergency Management Agency (FEMA, 2016).

Several tributaries to these creeks are also within the 100-year flood plain. North of the City limits, much of the Tualatin River National Wildlife Refuge (Refuge) is within the 100-year flood plain. This area typically has saturated soils year round. The existing CWS 24-inch diameter interceptor carrying wastewater from Sherwood passes through this Refuge area.

NATURAL RESOURCE AREAS

Natural resources include air, water, plants, animals and soil. The Tualatin River Valley and its tributary streams provide significant natural resources as documented in the *Comprehensive Plan* (Chapter 5). Historically, the City has managed natural resources through the establishment of "Open Spaces" and by inventories of environmental assets. State and federal requirements have resulted in both independent and cooperative identification and inventory of natural resource areas by multiple federal, state, and local agencies. The U.S. Fish and Wildlife Service established the 3060-acre Tualatin River National Wildlife Refuge roughly located to the north and east of the City. The Refuge was established as an urban refuge providing wetland, riparian, and upland habitats for migratory birds, threatened and endangered species, fish, other resident wildlife, and as a scenic area.

Metro and its member cities also protect other regionally significant natural resources such as the Tonquin Scablands Geologic Area, and other Metro-identified and classified riparian corridors, upland wildlife habitats and aquatic habitats. The majority of these Metro-identified natural resource areas are located alongside or adjacent to creeks, the Refuge, and the Tualatin River. Furthermore, though not formally mapped, CWS *Design and Construction Standards* require a vegetated corridor, or riparian buffer, to be provided and maintained around natural water features upon urban development. The CWS buffer requirement is critical to maintaining and protecting these Metro-identified natural resource areas.

The Metro-identified resources have been recognized in the City's *Comprehensive Plan* (2006) as environmental resources requiring planning and management. The City's *Comprehensive Plan* also identifies a ponderosa pine forest located east of the intersection of Harrison and Middleton streets for preservation. Other City efforts include the acquisition of 300 acres of stream corridor and floodplain for protection from further development. These corridors, in addition to providing protection from flooding, support the functions of the Refuge.

In addition to the statutory recognition of environmentally sensitive areas, grass roots organizations such as the Tualatin Riverkeepers, and Friends of the Tualatin River National

Wildlife Refuge have formed to advocate watershed stewardship in the area. The City also recognizes that it is located in an area with generally good water quality and riparian habitat, and that the urban footprint can have a large impact on the local environment. Consequently, the City has formed partnerships with several of these organizations to provide educational outreach, stream enhancement projects, and assist in efforts to protect and improve the overall health of the nearby natural resources.

Surface Water

The City lies within four major subbasins of the Tualatin River drainage basin, and one major subbasin of the Willamette River. The City's predominant surface water features are Cedar Creek, flowing through the western portion of the City from the south, and Rock Creek flowing through the eastern portion of the City from the south. While the City lies entirely within Washington County, the headwaters of Rock Creek extend into Clackamas County, and those of Cedar Creek extend into Yamhill County.

Chicken Creek is located to the west and northwest of the City. Cedar Creek flows into Chicken Creek at the northwest edge of the City. The Hedges Creek Basin includes the northeast portion of the City along Tualatin-Sherwood Road. The eastern portion of the TEA, which is currently outside the City limits but within the UGB, drains to Coffee Lake Creek. Areas contributing stormwater runoff to Hedges and Coffee Lake creeks encompass roughly 10 percent of the planning area, and are the only portions of the City that do not ultimately drain to the Tualatin River National Wildlife Refuge (Refuge).

Also at the local level, CWS and its member cities provide for water quality management within the Tualatin River Basin. A large scale inventory and environmental study within the urbanized basin, the *Watersheds 2000* program, was conducted in support of cost-effective water quality and environmental management. The *Healthy Streams Plan* (2005) provides general descriptions of watershed areas, and describes the headwaters of Cedar Creek and Chicken Creek as generally undeveloped and in good condition. The plan further identifies that preserving the condition of the headwaters is important to the health of the downstream surface waters and overall watershed, and that development should be managed to protect these upper reaches of the watersheds. Additionally, Chicken, Cedar and Rock Creeks have been identified by the U.S. Environmental Protection Agency (EPA) as providing habitat for anadromous fish that are listed as threatened under the *Federal Endangered Species Act* (ESA).

Floodplain

A floodplain is an area of land adjacent to a river or stream that experiences flooding during periods of high discharge. A floodplain is a natural place for a surface water to dissipate its energy during periods of heavy rainfall. To protect these natural resources from infill, the City and CWS have enacted restrictions on development within the floodplains under their jurisdiction.

The *Flood Insurance Study* (FIS) conducted by the Federal Emergency Management Agency (FEMA) in 1988 indicates that some areas along Chicken, Cedar, and Rock Creeks and their tributaries are at risk of flooding. While the floodplains largely overlap existing wetlands and creek beds, some individual developed lots lie within the floodplain. North of the City limits, much of the Refuge lies within the 100-year floodplain of the Tualatin River that extends south from the river to the City limits.

The City has experienced significant development and growth since the FEMA maps were produced in 1988. Because Washington County as a whole has experienced significant growth since the production of FEMA floodplain maps, CWS has coordinated with FEMA to update the floodplain maps across Washington County, including the City. These updated FEMA floodplain maps were finalized in 2016, with an effective date of November 4, 2016.

HAZARD AREAS

According to the *Washington County Natural Hazards Mitigation Plan* (University of Oregon Community Service Center, 2006), the area surrounding the City is at risk for several types of natural disasters. This plan describes historical impacts, general location, extent, and severity of past natural hazard events, and the probability of future events. Table 2-2 summarizes all the hazards for which the City is at risk, however in terms of the sanitary sewer system, susceptibility to flood is the greatest concern. Official flood hazard maps for the City area and Washington County are published by the Federal Emergency Management Agency (FEMA). Likewise, official earthquake fault lines are documented by the Oregon Department of Geology and Mineral Industries.

The Natural Hazard Risk Assessment probability scores address the likelihood of a future major emergency or disaster within a specific period of time, as follows:

- High = One incident likely within a 10- to 35-year period.
- Moderate = One incident likely within a 35- to 75-year period.
- Low = One incident likely within a 75- to 100-year period.

The vulnerability scores address the percentage of population or region assets likely to be affected by a major emergency or disaster, as follows:

- High = More than 10% affected.
- Moderate = 1%-10% affected.
- Low = Less than 1% affected.

Table 2-2 | Probability and Vulnerability Assessment – Washington County		
Hazard	**Probability**	**Vulnerability**
Drought	Moderate	Low
Earthquake	Low	High
Extreme Heat	Moderate	Moderate
Fires	Moderate	Moderate
Flood	High	Moderate
Landslides	High	Low
Volcano	Low	High
Wind Storm	Moderate	Low
Winter Storm	High	Moderate

MUNICIPAL WATER SYSTEM

The City operates and maintains a municipal water system that provides potable drinking water to residents within the City limits. The City owns water rights to the Willamette River through their participation in the Willamette River Water Coalition. The municipal water treatment is performed through a partnership with the City of Wilsonville, the source of which is treated surface water withdrawals from the Willamette River to the Willamette River Water Treatment Plant (WRWTP). This state-of-the-art facility produces high-quality finish water which is pumped into transmission mains for distribution throughout the City.

The majority of the City's dry weather wastewater comes from customers' use of the municipal water system. Thus, wastewater flows and municipal water demand follow a similar diurnal cycle throughout the day. The municipal water system experiences a much higher demand in the summer, due to irrigation.

MUNICIPAL STORMWATER SYSTEM

Developed areas within the City are presently served by publicly owned stormwater collection and conveyance facilities, operated through an Intergovernmental Agreement (IGA) between the City and CWS. Under the IGA, the City owns, maintains, and operates the stormwater collection and conveyance system within the City limits. The City maintains the public creeks and open-channels, while CWS is responsible for water quality within the creeks. Additionally, the City maintains and operates local water quality facilities and local water quantity facilities while CWS maintains and operates all regional water quality or quantity facilities both within and outside of the City limits.

All of the stormwater conveyance facilities within the City limits flow by gravity. There are no pumps or pressurized pipes in the system. Many residential properties have direct connections between their roof drains and the public stormwater conveyance system. Many commercial and industrial properties have private stormwater collection and conveyance systems that provide drainage for their facilities including buildings and parking lots. These systems are generally connected directly to the public stormwater conveyance system. There may be limited interconnections between the stormwater and sanitary wastewater systems.

In general, all developments built since 1991 include water quality facilities, and in some cases, water quantity or detention facilities. These stormwater quality and quantity facilities are owned and maintained by the City or by private property owners in commercial and industrial developments. In limited areas, homeowner associations may maintain facilities in residential developments.

SOCIOECONOMIC ENVIRONMENT

Economic Conditions and Trends

The City is located between Oregon's "Wine County" and the Portland metropolitan area. Sherwood's *Economic Development Strategy* (2006) finds that the City of Sherwood is highly suited to support the following industries: small to mid-size light manufacturing; specialty contractors and construction firms; creative services; amusement, recreation, sporting and lodging hospitality; educational facilities; and nursing and health care support services and facilities.

Sherwood's Economic Development Department reports that the City exceeds several economic and educational metrics, as follows:

- Data from 2012 reports show that the City's median household income of $79,209 exceed Oregon's average of $49,850.
- The percentage of the City's (25 and older) population who have a bachelor's degree or higher is 43.4 percent. This surpasses the State of Oregon's average metric of 29.7 percent.

The City's education system is primarily served by the Sherwood School District 88J, which currently serves 5,017 students and 541 staff in 7 schools (www.sherwood.k12.or.us/district/fast-facts). The School District's boundary extends past the study area of this SSMP, serving students in less populated areas between Tualatin and Wilsonville.

Population

Based on data from the U.S. Census, the City's population has seen steady growth over time, with a reported population in 2010 of 18,194. Since the U.S. Census undertakes population surveys only once every decade, the Portland State University (PSU) Population Research Center supplements projected populations annually within Oregon. The certified projected population for the City in 2014 was 18,955. Detailed information related to historical populations and future trends is provided in Section 5, "Population and Flow Projections."

SECTION 3 | EXISTING SYSTEM CONDITION

INTRODUCTION

While the scope of this study is limited to the City of Sherwood (City) sanitary sewer system, this section provides a brief account of the entire existing collection and treatment system structure. The existing collection system includes approximately 70 miles of gravity sewer, more than 1,700 manholes, and one public pump station. Wastewater collects from smaller service pipelines into two larger trunk sewers, the Sherwood Trunk and the Rock Creek Trunk which discharge to the downstream Sherwood Pump Station located on the northern side of Highway 99, approximately 1,000 feet southwest of Kummrow Avenue (see Figure 3-1). Wastewater is conveyed to the Durham Advanced Wastewater Treatment Facility (AWWTF), located along the Tualatin River, via the Sherwood Pump Station and Upper Tualatin Interceptor.

Additionally, this section of the SSMP provides a summary of the infrastructure conditions for gravity pipelines within the City's jurisdiction and provides condition-based improvement and maintenance recommendations for the existing system.

UTILITY MANAGEMENT STRUCTURE

Developed areas within the City are presently served by sewer facilities operated through an Intergovernmental Agreement (IGA) between the City and Clean Water Services (CWS). Under the IGA, the City maintains conveyance facilities smaller than 24-inches in diameter, while CWS maintains the piping 24-inches in diameter and larger, pump stations, and force mains. CWS is also responsible for wastewater treatment. The specifics of the IGA are summarized in Section 4, "Regulations and Policies."

Operating within the Public Works Department, the City's sanitary sewer system provides utility service to approximately 6,000 customers. The Department's Utility Manager, Operations Supervisor, and maintenance staff members are responsible for applicable system operations and maintenance.

WASTEWATER COLLECTION BASINS

The sanitary sewer system is divided into two primary basins, covering approximately 3,390 acres within the study area. These basins are shown in Figure 3-1, summarized in Table 3-1 by land use, and described below. The major infrastructure serving these basins are mentioned in the basin descriptions and described in more detail later in this section.

Cedar Creek Basin

The Cedar Creek Basin is the City's largest collection basin, bound to the north, west and south by the current City limits. The Brookman Concept Area will extend the basin boundary south. The basin extends to the east to approximately the center of the City. Residentially zoned areas comprise the major wastewater contributions on the north and south sections of the basin, with commercial areas at its center contributing non-residential wastewater. The basin encompasses 2,080 potential acres of tributary area within the UGB

including 1,054 acres of existing developed and sewered area. Major infrastructure within the Cedar Creek Basin include the Sherwood Trunk sewer.

Rock Creek Basin

The Rock Creek Basin is bound to the north, east and south by the current City limits and UGB. The Tonquin Employment Area will expand the basin boundary to the east. The basin is bound to the west by the Cedar Creek Basin. Residentially zoned areas in the southern half of the basin generate the major wastewater contributions from the basin. Industrial customers are more prevalent in the northern half of the basin. The basin encompasses 1,310 potential acres of tributary area in the UGB including 455 acres of existing developed and sewered area. Major infrastructure within the Rock Creek Basin include the Rock Creek Trunk sewer.

Table 3-1 | Sanitary Sewer Basin Area Summary

Basin Name	Residential (acres)	Commercial (acres)	Industrial (acres)	Institutional and Public (acres)	Vacant Developable (acres)[1]	Non-developable (acres)[1]	Total Area (acres)
Cedar Creek (Sherwood Trunk)	820	85	2	146	366	662	2,081
Rock Creek (Rock Creek Trunk)	164	50	239	1	556	299	1,310
Totals	985	135	241	147	921	962	3,391

Note 1. Vacant acres refer to zoned developable areas and exclude roadways, wetlands, floodplains, and open space. Non-developable acres include delineated roadways, wetlands, floodplains, and open spaces.

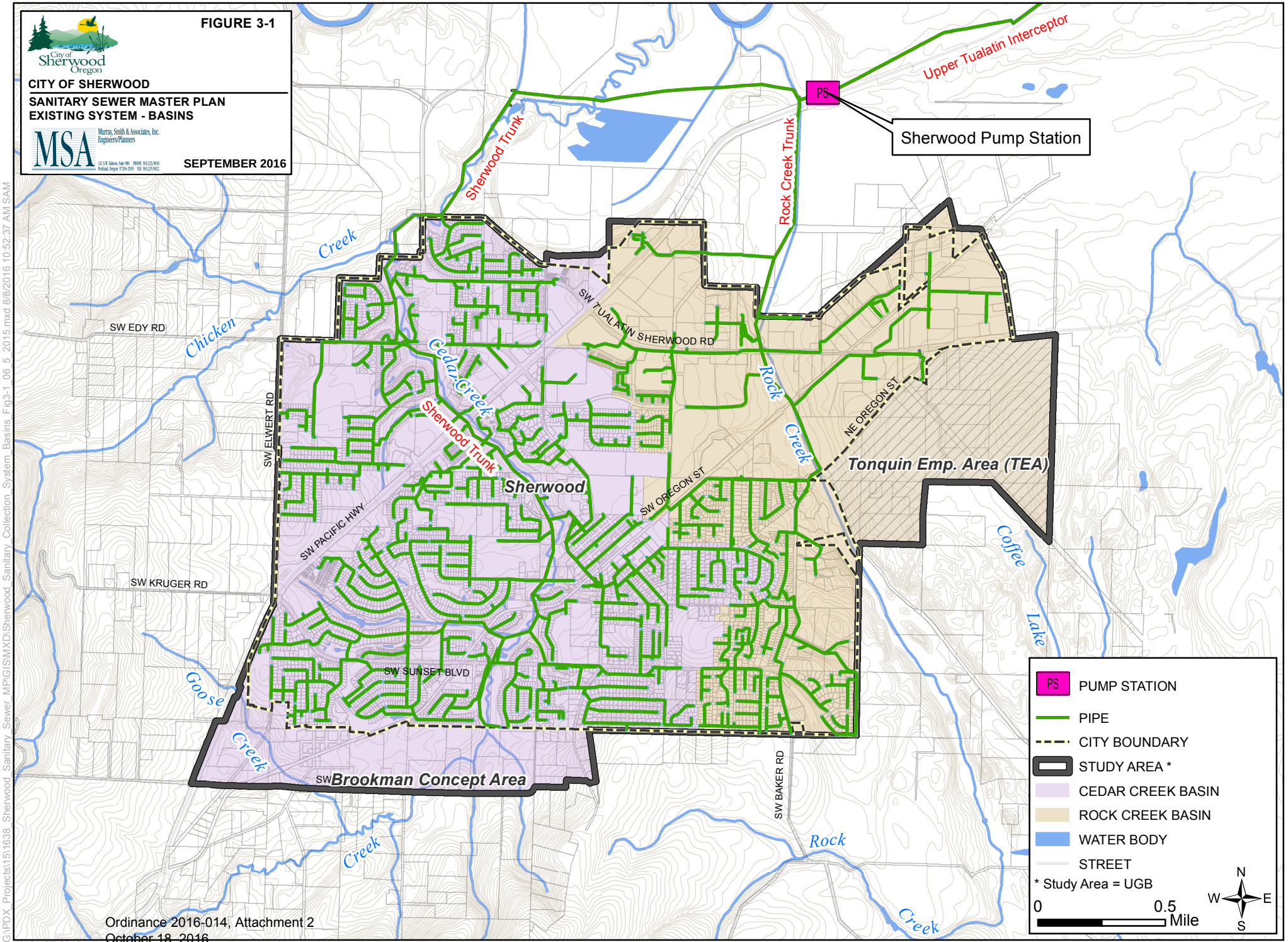
FIGURE 3-1
City of Sherwood Oregon
CITY OF SHERWOOD
SANITARY SEWER MASTER PLAN
EXISTING SYSTEM - BASINS
MSA
Murray, Smith & Associates, Inc.
Engineers/Planners
SEPTEMBER 2016
Upper Tualatin Interceptor
PS
Sherwood Pump Station
Sherwood Trunk
Rock Creek Trunk
Chicken Creek
SW EDY RD
SW TUALATIN SHERWOOD RD
Cedar Creek
Sherwood Trunk
Rock Creek
NE OREGON ST
SW ELWERT RD
Sherwood
Tonquin Emp. Area (TEA)
SW PACIFIC HWY
SW OREGON ST
Coffee Lake
SW KRUGER RD
SW SUNSET BLVD
Goose Creek
SW Brookman Concept Area
SW BAKER RD
Rock Creek
PS PUMP STATION
PIPE
CITY BOUNDARY
STUDY AREA *
CEDAR CREEK BASIN
ROCK CREEK BASIN
WATER BODY
STREET
* Study Area = UGB
0
0.5
Mile
N
W
E
S
G:\PDX_Projects\151638_Sherwood_Sanitary_Sewer_MP\GIS\MXD\Sherwood_Sanitary_Collection_System_Basins_Fig3-1_06_5_2015.mxd 8/8/2016 10:52:37 AM SAM
AUGUST 2016

GRAVITY PIPELINES

The sanitary sewer system is comprised of gravity pipes between 4 and 42 inches in diameter, as illustrated in Figure 3-2. The age of City's wastewater collection system varies, starting with small portions constructed in the 1900's. The majority of the system piping was installed after 1990 when the City began to experience growth. Pipeline materials and age are shown in Figures 3-3 and 3-4.

The smaller system pipelines (8 inches and smaller) convey wastewater to the larger trunk sewers. Table 3-2 summarizes pipeline lengths by diameter and basin as listed in the City's GIS. Tables 3-3 and 3-4 summarize pipeline lengths by material and age. The major trunk sewers are described below.

Sherwood Trunk

The Sherwood Trunk is defined as the trunk pipeline that originates at Sunset Boulevard, then travels north through the Cedar Creek Basin and extends to the Sherwood Pump Station. The 24-inch diameter trunk pipeline is constructed of reinforced concrete pipe and has a capacity flowing full of approximately 5.9 million gallons per day (mgd). The facility is operated and maintained by CWS.

Rock Creek Trunk

The Rock Creek Trunk is defined as the trunk pipeline that begins at Oregon Street and proceeds northerly along Rock Creek, intersecting the Sherwood Trunk just upstream of the Sherwood Pump Station. The Rock Creek Trunk conveys wastewater from the Rock Creek Basin. The 18-inch diameter trunk is constructed of concrete pipe and has a capacity flowing full of approximately 3.2 mgd. The City of Sherwood is responsible for maintaining the segment located within the City limits, and the outlying facilities are operated and maintained by CWS.

Upper Tualatin Interceptor

The Upper Tualatin Interceptor delivers the City's sewage to the Durham AWWTF directly from the Sherwood Pump Station. It is owned, maintained and operated by CWS. The interceptor is approximately 15,700 feet in length and varies from 18 to 42 inches in diameter. The interceptor also collects and delivers wastewater from King City, Tualatin, and Tigard to the Durham AWWTF. An analysis of this interceptor is outside the scope of this study.

Table 3-2 | Gravity Pipe Diameter					
Diameter (inches)	Length by Basin (feet)				Total Length (feet)
	Cedar Creek Basin (includes Sherwood Trunk)	Rock Creek Basin (includes Rock Creek Trunk)	Upper Tualatin Interceptor	Sherwood Force Main	
6	8,271	2,862	0	0	11,133
8	202,478	82,977	0	0	285,455
10	3,556	2,634	0	0	6,190
12	5,442	3,469	279	0	9,189
15	6,591	3,528	0	0	10,119
16	218	0	0	0	218
18	3,259	6,708	312	2,812	13,090
20	546	40	0	0	585
21	160	0	74	0	234
24	17,458	0	295	0	17,753
27	0	0	4,614	0	4,614
36	0	0	3,318	0	3,318
42	0	0	6,465	0	6,465
66	0	0	297	0	297
Feet	**247,978**	**102,217**	**15,653**	**2,812**	**368,659**
Miles	**47**	**19**	**3**	**0.5**	**70**

Table 3-3 | Gravity Pipe Summarized by Material					
Material	Length by Basin (feet)				Total Length (feet)
	Cedar Creek Basin (includes Sherwood Trunk)	Rock Creek (includes Rock Creek Trunk)	Upper Tualatin Interceptor	Sherwood PS Force Main	
PVC	175,905	66,203	48	0	242,156
DIP	2,321	342	0	2,812	5,475
FRP	0	0	5	0	5
C-900	6,084	4,464	0	0	10,548
RCP	16,981	1,953	2,547	0	21,481
CP	37,200	26,085	74	0	63,360
CLAY	2,577	0	0	0	2,577
HDPE	1,349	1,820	0	0	3,169
CSP	5,172	0	12,044	0	17,216
Unspecified	389	1,348	935	0	2,672
Total	**247,978**	**102,217**	**15,653**	**2,812**	**368,659**
Miles	**47**	**19**	**3**	**1**	**70**

Table 3-4 | Gravity Pipe Summarized by Age					
Installation Date	Length by Basin (feet)				Total Length (feet)
	Cedar Creek Basin (includes Sherwood Trunk)	Rock Creek (includes Rock Creek Trunk)	Upper Tualatin Interceptor	Sherwood PS Force Main	
1960-1969	5,968	0	0	0	5,968
1970-1979	19,784	3,171	246	0	23,202
1980-1989	7,485	13,452	74	0	21,011
1990-1999	109,681	43,827	0	0	153,509
2000-2009	49,097	17,066	0	0	66,163
2010-2016	1,677	125	0	0	1,802
Unspecified	54,286	24,575	15,332	2,811	97,006
Total	**247,978**	**102,217**	**15,653**	**2,812**	**368,659**
Miles	**47**	**19**	**3**	**0.5**	**70**

FIGURE 3-2

City of Sherwood Oregon

CITY OF SHERWOOD

COLLECTION SYSTEM MASTER PLAN
EXISTING SYSTEM - PIPE DIAMETER

MSA Murray, Smith & Associates, Inc. Engineers/Planners
121 S.W. Salmon, Suite 900 PHONE 503.225.9010
Portland, Oregon 97204-2919 FAX 503.225.9022

SEPTEMBER 2016

3 Barrel Siphon, 12", 20", 20"

Durham AWWTF

Upper Tualatin Interceptor

Sherwood Pump Station

Sherwood Trunk

Rock Creek Trunk

Cedar Creek Sherwood Trunk

Brookman Concept Area

Sherwood

Tonquin Emp. Area (TEA)

Tualatin River

Chicken Creek

Cedar Creek

Rock Creek

Coffee Lake Creek

Goose Creek

Rock Creek

Nyberg Creek

Saum Creek

SW ELSNER RD

SW TUALATIN RD

SW LEBEAU RD

SW EDY RD

SW ELWERT RD

SW PACIFIC HWY

SW KRUGER RD

SW SUNSET BLVD

SW BROOKMAN RD

SW BAKER RD

NE OREGON ST

SW AVERY ST

SW BOONES FERRY RD

SW DAY RD

PIPE DIAMETER

- <= 8- inch
- 10 to 12-inch
- 15 to 18-inch
- 20 to 24-inch
- 27 to 36-inch
- 42-inch
- 66-inch
- PS PUMP STATION
- ADDITIONAL PIPES
- CITY BOUNDARY
- STUDY AREA
- WATER BODY
- STREET

* Study Area = UGB

0 0.5 Mile

N W E S

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FIGURE 3-3

CITY OF SHERWOOD

COLLECTION SYSTEM MASTER PLAN
EXISTING SYSTEM - PIPE MATERIAL

Murray, Smith & Associates, Inc.
Engineers/Planners
121 S.W. Salmon, Suite 900 PHONE 503.225.9010
Portland, Oregon 97204-2919 FAX 503.225.9022

SEPTEMBER 2016

Tualatin River
Upper Tualatin Interceptor
(Force Main)
PS
Sherwood Pump Station
Durham AWWTF
Sherwood Trunk
Rock Creek Trunk
Sherwood
Tonquin Emp. Area (TEA)
Brookman Concept Area
Cedar Creek
Rock Creek
Coffee Lake Creek
Chicken Creek
Goose Creek
SW LEBEAU RD
SW EDY RD
SW ELWERT RD
SW PACIFIC HWY
SW KRUGER RD
SW SUNSET BLVD
SW BROOKMAN RD
SW BAKER RD
SW OREGON ST
NE OREGON ST
SW TUALATIN RD
SW AVERY ST
SW BOONES FERRY RD
I5 FWY

PS PUMP STATION
CITY BOUNDARY
STUDY AREA

BASIN
CEDAR CREEK BASIN
ROCK CREEK BASIN
WATER BODY
STREET

* Study Area = UGB

0 0.5 Mile

N W E S

PIPE MATERIAL
Unspecified
Chlorinated Polyvinyl Chloride (CPVC)
Clay
Concrete Pipe (CP)
Corrugated Steel Pipe (CSP)
Ductile Iron Pipe (DIP)
Fiberglass Reinforced Plastic (FRP)
High-density Polyethylene (HDPE)
Polyvinyl Chloride (PVC)
Reinforced Concrete Pipe (RCP)

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August 2016

FIGURE 3-4

CITY OF SHERWOOD

COLLECTION SYSTEM MASTER PLAN
EXISTING SYSTEM - PIPE AGE

Murray, Smith & Associates, Inc.
Engineers/Planners
121 S.W. Salmon, Suite 900 PHONE 503.225.9010
Portland, Oregon 97204-2919 FAX 503.225.9022

SEPTEMBER 2016

Tualatin River
West Fork Chicken Creek
Sherwood Trunk
Upper Tualatin Interceptor
PS
Sherwood Pump Station
Durham AWWTF
Fanno
SW TUALATIN RD
SW LEBEAU RD
SW EDY RD
SW ELWERT RD
SW TUALATIN SHERWOOD RD
SW AVERY ST
SW BOONES FERRY RD
Cedar Creek
Rock Creek Trunk
Rock Creek
NE OREGON ST
Tonquin Emp. Area (TEA)
Sherwood
SW OREGON ST
SW PACIFIC HWY
SW KRUGER RD
SW SUNSET BLVD
Brookman Concept Area
SW BROOKMAN RD
SW CHAPMAN RD
SW BAKER RD
Goose Creek
Coffee Lake Creek
Rock Creek
Cedar Creek
I5 FWY

PS PUMP STATION
CITY BOUNDARY
STUDY AREA
STREET
WATER BODY
CEDAR CREEK BASIN
ROCK CREEK BASIN
* Study Area = UGB

PIPE CONSTRUCTION YEAR
1970 - 1979
1980 - 1989
1990 - 1999
2000 - 2010
2010 - present
No Age Information

0 0.5 Miles

N W E S

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PUMP STATION AND FORCE MAIN

The Sherwood Pump Station is located at 19035 SW Pacific Highway (State Highway 99W) approximately 1/4 mile northeast of the City of Sherwood. As described previously, wastewater from the City is conveyed to this pump station through the Sherwood and the Rock Creek Trunks. The pump station conveys wastewater downstream to the Upper Tualatin Interceptor. Operation and maintenance of the Sherwood Pump Station is under the purview of CWS.

The pump station was initially constructed in the late 1970's as part of the Upper Tualatin Sanitary Sewer Interceptor Project. Steady population growth in the City has prompted two noteworthy modifications to the pump station over time. The first modification was an emergency upgrade undertaken in 2001 and was needed to replace the existing 25-year old sewage pumps when repair parts were no longer available. New pumps were installed within the general confines of the existing pump station, and modifications were made to the system piping to allow for temporary station bypass. The firm capacity of the station was increased 60% to 70%, allowing it to operate for almost another decade.

The second modification involved a two-phased plan to meet near- and long-term capacity requirements. The first phase, constructed in 2010, featured installation of new submersible pumps and increased the capacity of the station to 6.6 million gallons per day (mgd). Detailed information regarding the pump and force main components installed during this phase are provided in Table 3-5 below.

Table 3-5 | Sherwood Pump Station and Force Main Characteristics

Pump Station Information	
Type	Duplex wetwell - drywell
Pump Type	Vertically mounted dry-pit submersible pumps
Design Capacity (per pump)	6.6 mgd @ 103 ft TDH (445 mm impeller)
Pump Manufacturer & Model	Flygt NT3306.745
Pump Impeller Size	445 mm (Initial installation)
Estimated Wet Well Volume	Total volume (box and chambers) - 151,500 gallons Total effective volume available for storage - 66,000 gallons
Standby Power Type	350 kw permanent diesel powered generator w/ automatic transfer switch
Force Main Information	
Type and Length	2,800 feet of 18 inch diameter Ductile Iron
Profile	Continuously ascending
Discharge Location	Manhole # 11665, in SW Pacific Drive, IE=176.25ft MSL into 27" diameter gravity trunk line to Durham AWWTF

WASTEWATER TREATMENT FACILITY

The Durham AWWTF discharges treated effluent from the cities of Beaverton, Tigard, Sherwood and Tualatin, the communities of Durham and King City, and portions of

Multnomah and Clackamas counties, into the Tualatin River. The plant was first built in 1976 and has experienced two phased updates in the 1990s to accommodate an expanding regional population and improve treatment efficiencies. A third update completed in 2002 incorporated expanded treatment capacity with odor control and the ability to handle peak wastewater flows during exceptionally wet weather.

GRAVITY SYSTEM CONDITION

The sanitary sewer system condition assessment is based on previous master planning, input from City staff, and TV inspection of portions of the system which document defects utilizing the National Association of Sewer Service Companies (NASSCO) ratings. The NASSCO rating system is described below.

NASSCO Ratings-

- Structural and Operations & Maintenance (O&M) scores are calculated for each pipe segment based on the number and severity of defects. The system expresses a weighted score for each pipe segment based on the individual defects within a given pipe.

$$NASSCO\ Rating\ for\ Pipe\ X = \frac{\sum_{Defect\ 1}^{Defect\ n}(Defect\ 1 * Defect\ 1\ Score\ ) \ldots (Defect\ n * Defect\ n\ Score)}{Total\ Number\ of\ Defects\ in\ Pipe\ Segment}$$

- Defect grades range from 1 to 6, with 6 being the most severe. This range is used for both structural and O&M defects. The severity of defects is documented during TV inspection of pipelines.

- Structural defects include cracks, fractures, holes, deformations, collapses, joint and surface defects and failure of linings or previous repairs. In the City system documented structural defects range from grade 1 to 4 and include pipe defects (bulges), surface spalling, joint offsets, longitudinal and circumferential cracks and joint separation.

- Documented O&M defects in the City system range from grade 1-5 and include gushing and running infiltration, protruding objects, root intrusion, and deposits including grease, sand and gravel.

Figure 3-5 documents system condition projects that have been identified and includes NASCCO ratings where they are available. The ratings have been grouped into the following categories:

- Rating 1 – 2: Lowest priority
- Rating 3 – 4: Moderate priority
- Rating 5 – 6: Highest priority

Figure 3-5 also documents the location of known condition issues provided by City staff. Table 3-6 summarizes condition based projects by pipe length and diameter.

The overall sanitary sewer system is in good condition. Many of the pipes were constructed after 1990 and remain in good repair. As documented in Section 5, "Population and Flow Projections," the peak rainfall derived infiltration and inflow (RDII) rates are between 1,300 and 2,600 gallons-per-acre-per-day (gpad) which fall between 50% to 104% of the CWS standard RDII rate for new construction of 2,500 gpad. Critical deficiencies occur in locations where the piping may be older or connections exist to the storm drain system such as in the Old Town area. Critical O&M issues occur where newer pipes were sized to accommodate future growth and as a result do not achieve the minimum scouring velocity of 2 feet per second (fps) during dry weather flow conditions. Prior to build-out of the service area, these pipelines will require routine flushing and maintenance to prevent solids deposition.

Pipeline Improvement Techniques

The following discussion summarizes common pipeline improvement techniques that may be applied to the City's condition-based improvements.

Chemical Grouting - Chemical grouting is commonly used to seal leaking joints in structurally sound pipe and manholes. The equipment consists of a sealing packer and television camera pulled inside the sewer pipe with cables and winches. Because the sealing is done inside the pipe, excavation is not required unless unique problems develop.

The chemical grouts typically used are acrylamide, acrylate, or urethane gel. The chemicals necessary to form the gels are usually mixed in two separate tanks and pumped through separate hoses to the joint to be sealed. One tank is used to mix and dispense the grouting chemical and the other tank is used to mix and dispense a catalyst. The catalyst initiates a chemical reaction when mixed with the chemical grout. The materials are injected simultaneously into a leaking joint, a gel is formed and the leak is stopped. Urethane gel differs from acrylamide and acrylate gels in that water is the catalyst for the urethane gel material.

Chemical grouting does not improve the structural strength of the pipeline. This rehabilitation technology should not be used on pipes that are broken or deteriorated. If the ground water table drops below the level of the pipe, the chemical grout may become dehydrated and its useful life shortened. When used appropriately, rehabilitation by chemical grouting has a useful life of 10 to 15 years.

The costs for chemical grouting vary depending upon the number of grouting locations and the quality of sealant used. The chemical grouting process generally includes pipelines cleaning, television inspection, testing all joints, sealing deficient joints, and sealing leaking manholes where needed. The television inspection will occasionally locate a section of pipe not repairable by chemical grouting. A point excavation is required to repair such a leak.

Grouting must be repeated approximately every 10 years to control the quantity of RDII in the system because of the limited life of chemical grout. For portions of the system

conducive to chemical grouting, one application performed initially and at the end of 10 years should effectively seal the pipeline during the planning period.

Conventional Pipe Replacement - Pipeline replacement by conventional, open-cut excavation and backfill is normally done when the existing pipeline is deteriorated so badly that other methods of rehabilitation are not feasible. Replacement provides the opportunity to correct misalignments, increase the hydraulic capacity of the line by increasing the pipe diameter, repair service connections, and eliminate sags or stormwater entry points. Replacing pipelines can also remove any "incidental" RDII (i.e., minor leaks that would not be cost-effective to remove). A rehabilitation alternative that is similar to complete pipe replacement is point repairs or spot repairs, which involve excavation, backfill, and pipe replacement for selected areas.

The advantage of pipe replacement is that service life with modern materials and methods is generally greater than 50 years. The cost of replacement is generally high. The replacement has associated inconveniences, and restoration requirements that may be costly in developed areas.

Pipe Bursting - Pipe bursting consists of expanding and breaking in-ground pipe and towing in segments of new polyethylene (PE) or polyvinyl chloride (PVC) pipe. For the pipe cracking operation, a modified soil displacement hammer is pulled through a pipe run via an above-ground winching system. Cutting blades of different size are fixed on the hammer to break the existing pipe. An expander fitted on the rear of the hammer enlarges the original bore so that pipe of equal or larger diameter can be pulled behind the pipe cracking process. The new pipe is fitted into the trailing end of the hammer unit. As the hammer advances through the old main, it cracks the pipe and the fragments are displaced laterally. Simultaneously, the new liner/pipe is then towed in. If a liner is required, the new conduit pipe is then towed in after the entire length of old main has been cracked and lined.

Pipe bursting is most often used under highways, railroads, and other structures where excavation is not possible or cost-effective. The service life is virtually identical to a new sewer pipe (50 years), since new pipe is actually being installed. Spot excavations are required to connect service laterals.

Sliplining - Sliplining involves inserting a slightly smaller new flexible pipeline, usually polyethylene, into the existing sewer pipe. This method is typically used where the existing sewer lines are extensively cracked such as in areas with unstable soil conditions, where the lines are badly deteriorating, or in lines with relatively flat grades. Sliplining will reduce the inside diameter of sewer pipe and reduce its flow capacity. Sliplining is generally used on mainlines larger than 8 inches in diameter.

Slip lining involves minimum excavation and accompanying dewatering work. Excavations are required only at insertion pits and for service lateral re-connections. For this reason, sliplining is advantageous in inaccessible or difficult areas, or under landscaping or structures. Sliplining can be installed in existing pipelines having moderate horizontal or vertical deflections. Wastewater flow may be allowed to continue while sliplining operations occur.

The liner pipe is commonly pulled through the existing pipe with a winch assembly placed at a manhole and the liner pipe fed into the existing pipe through an insertion pit. The pipe is pulled by steel cable with the cable attached to a pulling head at the pipe end. The polyethylene pipe will stretch during pulling (one foot per 100 feet is common) and a relax procedure is required after pulling and before connection at manholes. Increased temperatures will also tend to stretch the pipe.

The service life of a sliplined sewer is similar to a new sewer replaced by conventional trench excavation and backfill, which is about 50 years. The new liner pipe is a pressure-capable pipe itself. A disadvantage of sliplining is that excavations are required at service laterals. This is often times consuming, labor intensive, and correspondingly expensive.

Inversion Lining - Inversion lining installs a flexible lining material against the existing sewer pipe that is thermally hardened and requires access to the sewer pipe at a manhole. The liner is fed through the manhole and into the sewer pipe by filling the pipe and manhole with water. As water is pumped into the manhole, the flexible fabric is pushed through the pipe and inverted into place. The water is heated to cure and harden the thermo-setting resins.

Inversion lining is appropriate for pipelines requiring minor structural repair or with misalignments and for correcting corrosion problems. Because this method of rehabilitation does not require excavations, it may be used under highways and buildings. A television inspection of the existing sewer typically precedes the inversion lining work. Video inspection during a period of high groundwater table should be performed following lining to make sure laterals are not leaking or other small holes were not introduced into the side of the liner during lateral cutting. The life of an inversion lined pipe has been claimed by the lining manufacturers to be 50 years. Installations with almost 30 years of service are known to exist.

The inversion lining will reduce the inside diameter of an 8-inch pipe by up to ¾-inch depending on the service requirements. Flow capacity of the pipe may be reduced by the reduced pipe cross-sectional area, or increased by smoothing the flow channel.

FIGURE 3-5

City of Sherwood Oregon

CITY OF SHERWOOD

SANITARY SEWER MASTER PLAN
EXISTING SYSTEM - CONDITION

MSA Murray, Smith & Associates, Inc. Engineers/Planners
123 S.W. Salmon, Suite 900 PHONE 503.225.9010
Portland, Oregon 97204-2919 FAX 503.225.9022

SEPTEMBER 2016

Upper Tualatin Interceptor

PS

Sherwood Trunk

Rock Creek Trunk

Rock Creek

Chicken Creek

SW EDY RD

SW ELWERT RD

SW TUALATIN SHERWOOD RD

NE OREGON ST

Tonquin Emp. Area (TEA)

Sherwood

SW OREGON ST

SW PACIFIC HWY

SW KRUGER RD

SW SUNSET BLVD

Goose Creek

Brookman Concept Area

SW BROOKMAN RD

SW BAKER RD

Coffee Lake Creek

OM Condition
- Lowest priority
- Moderate priority
- Highest priority

STR Condition
- Lowest priority
- Moderate priority
- Highest priority
- PS PUMP STATION
- PIPE
- OTHER CONDITION
- CITY BOUNDARY
- STUDY AREA
- CEDAR CREEK BASIN
- ROCK CREEK BASIN
- WATER BODY
- STREET

Note:
-"OM" refers to operational and maintenance issues
-"STR" refers to structural defects
-"OTHER CONDITION" projects have been identified by City staff

N W E S

0 0.25 0.5 Mile

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August 2016

Table 3-6 I City of Sherwood, Oregon – Condition Improvements						
Project Type	Project ID	Project Description	Basin	Driver	Improvement Length (feet)	Improvement Diameter (inch)
Condition	8	Old Town Mains	Cedar Creek	Pipe and Manhole Condition	900	8
	9	SW Washington, SW Schamburg	Cedar Creek	Pipe and Manhole Condition	1,100	6 - 8
	10	Rock Creek Trunk between SW Tualatin Sherwood Rd and SW Oregon St	Rock Creek	Pipe and Manhole Condition	2,600	15
	11	SW Park St, SW Park Row, SW Columbia, SW Willamette, SW Foundry	Cedar Creek	Pipe and Manhole Condition	4,400	6 - 12
	12	Upstream end of Onion Flats to SW Langer Farms Pkwy	Rock Creek	Pipe and Manhole Condition	300	8
	13	U-haul/McKillian Industrial area, between Wildrose Pl and SW Galbreth	Rock Creek	Pipe and Manhole Condition	800	8 - 10
	14	SW Ladd Hill Rd	Cedar Creek	Pipe and Manhole Condition	100	8
	15	Burried manhole, SW Forest Ave	Rock Creek	Manhole Condition	N/A	N/A
	16	SW Handley St	Cedar Creek	Manhole Condition	N/A	N/A
	17	Along railroad tracks between SW Tualatin Sherwood Rd and Rock Creek Trunk	Rock Creek	Pipe and Manhole Condition	400	10
	18	SW Willamette at Orcutt Place	Cedar Creek	Pipe and Manhole Condition	400	6
	19	SW Willamette at Highland Drive	Cedar Creek	Pipe and Manhole Condition	600	8
	20	SW Gleneagle Drive	Cedar Creek	Pipe and Manhole Condition	100	8
	21	SW Sunset Blvd	Rock Creek	Pipe and Manhole Extension/Condition	800	8
	22	Old Town Laterals	Cedar Creek	Pipe and Manhole Condition	TBD	varies

CAPACITY, MANAGEMENT, OPERATION, AND MAINTENANCE GUIDELINES

The City has a tremendous investment in the infrastructure and equipment which comprise the sanitary sewer collection system. To protect this investment and obtain full useful life of these facilities, a program for operation, maintenance and rehabilitation of the system is necessary. A sanitary sewage collection system functions to transport wastewater from the points of their origin to a treatment facility. To ensure the public safety, it is critical that no release of wastewater from the sanitary sewer system be allowed to occur.

A sanitary sewer overflow (SSO) is an unintentional discharge of raw sewage from a municipal sanitary sewer. A SSO can spill raw sewage into basements or out of manholes and onto city streets, playgrounds and into streams. The untreated sewage from these overflows contaminates our waters, causing serious health and water quality problems.

Requirements for SSOs are established in Oregon Administrative rules. Sanitary sewer overflows are prohibited and if a SSO does occur it must be reported to the Oregon Department of Environmental Quality (DEQ).

SSOs have a variety of causes, including but not limited to inadequate capacity, blocked, broken or cracked pipes, severe weather, power failure or vandalism.

With the goal of reducing or eliminating the incidence of SSOs, the U.S. Environmental Protection Agency (EPA) has developed a guidance document intended to clarify the requirements of the National Pollutant Discharge Elimination System (NPDES) permit language in regard to operation and maintenance of sanitary sewer systems. These guidelines extend to any municipality contributing to the treatment and/or conveyance system of a permit holder. EPA's Guide for Evaluating Capacity, Management, Operation and Maintenance (CMOM) Programs at Sanitary Sewer Collection Systems, January 2005, provides specific suggestions in terms of CMOM programs.

CMOM builds on the standard operation and maintenance activities routinely implemented by the operator with additional information management requirements.

Collection System Management

Efficient operation and effective maintenance efforts are a result of adequate collection system management. A formal CMOM program would include a collection system management plan created to establish procedures for achieving department goals. Some of the goals of the management plan include:

- protection of public health and prevention of unnecessary property damage,
- minimization of infiltration, inflow and exfiltration, and maximum conveyance of wastewater to the treatment plant,
- provision of prompt response to service interruptions,
- efficient use of allocated funds,

- identification of and remedy solutions to design, construction, and operational deficiencies, and
- performance of all activities in a safe manner to avoid injuries.

Collection System Operations and Maintenance

Collection systems have little of what is traditionally referred to as "operability" as compared to a wastewater treatment plant. Efficient operation of the collection system would include knowing what comprises the system (inventory and physical attributes), knowing where the system is (maps and location), knowing the condition of the system (assessment), planning and scheduling work based on condition and performance, performing maintenance based on condition and performance of the system, and training personnel to do the work safely and efficiently. Additionally, the method of operation of each system component or program must be clearly communicated to the operator.

Maintenance Practices

The following sections describe equipment, personnel, procedures and programs currently in place within the Sanitary and Storm Sewer Section of the Public Works Department at the City of Sherwood.

Division of Responsibilities

CWS holds the NPDES permit allowing discharge of treated wastewater to the Tualatin River. CWS owns and operates several waste treatment facilities in the region. The City of Sherwood does not own or maintain treatment facilities but has an IGA to send untreated waste to CWS's Durham Advanced Wastewater Treatment Plant. The Agreement, a copy of which is included in *Appendix A* clarifies the individual responsibilities of the City and the District. In general, the City owns and maintains all components of the collection system smaller than 24-inch in diameter. The District operates and maintains wastewater treatment facilities, the surface water collection system, sanitary sewer trunks 24-inch diameter and larger.

Equipment

The City owns and operates several large pieces of equipment. The "System Truck" is a combination vacuum and jet rodder known as the "jetter". Using the system truck, both functions including power washing and vacuuming can be accomplished. The jetter holds 1000 gallons of water or a nearby fire hydrant can be accessed.

An attachment for the system truck uses the high pressure water to operate a circular saw which cuts roots as it travels along the line. A second attachment is used to cut protruding service taps.

The City also owns and operates a television inspection truck. The camera sits on a transporter which rides on tracks. The speed and direction is controlled from the van. The

operator monitors a video display of the camera travel which is also recorded onto the hard drive. There is a footage counter which records the distance the camera has traveled.

The City does not currently own or have plans to acquire lining or pressure grouting equipment. In the event these activities are required, the City would likely contract with Clean Water Services or hire a private contractor using normal city procurement practices.

Recommended Maintenance Activities

Maintenance operations can be divided into routine, preventative, and emergency response activities.

- Routine - CWS requires the City to clean and inspect a portion of the collection system piping every year.
- Preventative – The City is aware of certain "problem areas". Work is performed in these areas on a regular basis to prevent blockages. Preventative maintenance also includes periodic servicing of mechanical and electrical equipment.
- Emergency – the staff responds to breakages and backups as they occur.

The operation's supervisor has plans to implement an aggressive Infiltration and Inflow (I&I) rehabilitation program. The City has a current program for regular inspection of restaurant grease traps (FOG).

Sewer System Inspection

Sewer inspection is an important component of any maintenance program. Visual inspections provide valuable information regarding the accuracy of system mapping, the presence of infiltration and inflow and the physical condition of the system. Visual inspection should take place on an ongoing basis. Visual inspection allows the operator to determine the structural condition of the system, the presence of grease, roots, or debris and condition of structures including joints. Careful record keeping is the key to prevention of future emergencies. Information to be recorded following an inspection includes:

- Location and identification of line being inspected;
- Pipe size and type;
- Name of personnel performing inspection;
- Distance inspected;
- Cleanliness of the line;
- Structural condition of manholes or pipe, offsets or misalignments;
- Accumulations of grease, debris or grit;
- Presence of corrosion;
- Evidence of surcharge and presence of I&I.

There are sections of CWS's large collection main, located within the refuge area and along Rock Creek, which are below water most of the year. Manholes in this area have been sealed

to prevent infiltration of water into the system. Therefore, inspection at these locations is difficult.

Sewer Cleaning

The purpose of sewer cleaning is to remove accumulated material from the sewer. Cleaning helps to prevent blockages and is also used to prepare the sewer for inspection. Stoppages in gravity sewers are usually caused by a structural defect, poor design, poor construction, an accumulation of material in the pipe, or root intrusion.

There are essentially three methods of sewer cleaning. These include hydraulic, mechanical, and chemical cleaning. The Water Environment Federation's (WEF) Manual of Practice (MOP) No. 7 Wastewater Collection System Management, 6th Edition, offers additional information on sewer cleaning methods.

The City owns a system truck as previously discussed. The system truck is used to jet clean the sewer line with high-pressure water. The debris is then vacuumed from the manhole with the high-powered vacuum hose.

Fats, oils and grease (FOG) in the system can cause an increase in maintenance costs and backups in the system. FOG typically comes from food or petroleum products. Often restaurants, hotels and some industries dispose of significant amounts of FOG into the system. As the wastewater cools, the grease coagulates and is deposited on the pipe walls and can build up in sewer lines. Properly designed and maintained grease traps can effectively trap grease. The City has implemented a program of monitoring and inspecting area grease traps.

The FOG program also includes a grease control ordinance, grease trap and interceptor design standards, permitting and inspecting commercial grease traps and interceptors, a credible enforcement component, a public education component for residential sources, performance measures, and a mechanism for including program information into the IMS.

Accurate record keeping regarding areas of the collection system susceptible to stoppages is essential to an effective sewer cleaning program. Cleaning of gravity sewer mains is typically performed quarterly to remove grease and sediment in the sewer mains.

Root Intrusion

Roots of trees enter sewers typically in older parts of town where the trees are more mature and their root system is more established. When pipes lie outside of the paved street or close to the curb, roots have an opportunity to enter. Roots typically enter the pipe at joints or cracks in the pipe. As the root grows, the crack enlarges impacting the structural integrity of the pipe. Additionally, the enlarged cracks allow more wet weather flow to infiltrate.

As mentioned, the City has an adaptor on the service truck used to cut the roots at the inside edge of the pipe. Typically a chemical treatment is applied that kills the root for several feet back from the pipe.

Vandalism

Sometimes a blockage is created when something is thrown into a manhole. If blockages or overflows become a problem due to vandalism access to manholes can be prevented by installing bolt-down or lockable manhole covers.

Emergency Preparedness and Response

The City should have a plan in place for dealing with routine and catastrophic emergencies. Routine emergencies include overflowing manholes, line breaks, or localized electrical failure. Catastrophic emergencies include floods, tornadoes, earthquakes, serious chemical spills or widespread electrical failure. The plan should be in writing and available to all staff. The plan must clearly identify the steps to be taken in the event of an emergency or a sewer system overflow. The plan should include an overflow response plan detailing response procedures, equipment, and methods of public and regulatory notification.

SECTION 4 | REGULATIONS AND POLICIES

INTRODUCTION

This sanitary sewer master plan (SSMP) has been created in compliance with following Federal, State, and local requirements.

FEDERAL STATUES, REGULATIONS AND PERMITS

Clean Water Act & NPDES Permit

The Clean Water Act (CWA) is the principal federal law in the United States governing water pollution and provides the basis for the U.S. Environmental Protection Agency's National Pollutant Discharge Elimination System (NPDES) permit program. This program regulates pollutants discharged from point sources into waters of the United States through water quality based effluent limits. Other regulations related to the mission of the NPDES program include the Safe Drinking Water Act, Endangered Species Act, National Environmental Policy Act, National Historic Preservation Act, Coastal Zone Management Act, Wild and Scenic Rivers Act, Fish and Wildlife Coordination Act, and Essential Fish Habitat Provisions.

The Clean Water Act Section 404 Permit requires studies into wetland delineation, impact assessment, and mitigation plans for projects including filling or dredging existing wetlands. Through Section 404, the U.S. Army Corps of Engineers (USACE) also has jurisdiction over the construction of utility crossings such as sewers and force mains through navigable waters and wetlands. Final construction of projects within the City through wetlands and waterways will need to be coordinated with the USACE.

The Oregon Department of Environmental Quality (DEQ) administers the state's NPDES permit program on behalf of the federal government. This permit establishes maximum pollutant concentrations and loads allowed in the effluent discharge stream. Clean Water Services (CWS) is the treatment provider for the City, and is authorized by NPDES Permit Application No. 927631 (EPA No. OR0028118) to discharge the City's treated wastewater processed at the Durham Treatment Plant into the Tualatin River.

National Pretreatment Program

The National Pretreatment Program is charged with controlling toxic, conventional, and non-conventional pollutants from non-domestic sources that discharge into wastewater systems, as described in CWA Section 307(a). This program requires all large, publically owned treatment works (POTW) that have a designed treatment capacity of more than five (5) mgd to establish local pretreatment programs.

Local programs must enforce all national pretreatment standards and requirements, in addition to any more stringent local requirements necessary to protect site-specific conditions at the POTW. Because POTWs are generally not designed to treat most toxic or non-conventional pollutants present in industrial waste, the National Pretreatment Program protects the POTW and the environment from adverse impacts that may occur when

hazardous or toxic wastes are discharged into a sanitary wastewater system. This is achieved mainly by regulating nondomestic (industrial) users of POTWs that discharge toxic wastes or unusually strong conventional wastes.

Clean Water Services (CWS) is required under the CWA to conduct an industrial pretreatment program. The primary objective of the program is to prevent harmful discharges into the wastewater collection system that could degrade the quality of municipal digested biosolids, negatively affect the wastewater system, or pass through the treatment process into the Tualatin River. The program also strives to improve opportunities to reclaim wastewater and biosolids.

Endangered Species Act

Endangered and threatened species can be found in this study area. These include:

- Bald eagle, *Haliaeetus leucocephalus* (threatened; proposed delisted)
- Chinook salmon, *Oncorhynchus tshawytscha* (threatened; Upper Willamette River Evolutionary Significant Unit)
- Steelhead, *Oncorhynchus mykiss* (threatened; Upper Willamette River Evolutionary Significant Unit)

Construction in listed species habitat may require a Biological Assessment, and appropriate construction windows will need to be determined to minimize potential impacts to salmon spawning and to eagle nesting periods. The primary consideration for construction around Chicken Creek, Cedar Creek, Rock Creek and the Tualatin River will be allowing adequate lead time to coordinate with regulatory agencies and establish appropriate construction periods.

National Flood Insurance Act

The Federal Emergency Management Agency (FEMA) regulates floodplain protection in part through the National Flood Insurance Act. FEMA's Region X, located in Bothell, Washington, has regulatory oversight over the City. The agency facilitates the National Flood Insurance Program (NFIP), which provides federally subsidized insurance to properties within flood hazard areas.

In response to a lawsuit filed against FEMA in 2009, the National Marine Fisheries Service (NMFS) performed a Biological Opinion (BiOp) regarding impacts the NFIP was having on ESA-listed species. The BiOp was provided by NMFS in April 2016, and documented in a letter to the City of Sherwood, dated June 13, 2016. The letter states that NMFS concluded that implementation of the NFIP in Oregon jeopardizes the continued existence of 18 ESA-listed species and adversely modifies their critical habitat. NMFS considers the issuance of floodplain development permits that do not avoid or compensate for detrimental impacts to ESA-listed species or their critical habitat as noncompliant with the ESA. As a result of the BiOp, FEMA is implementing significant revisions to the NFIP to ensure compliance with ESA. It is anticipated that the City of Sherwood will be implementing those changes into the

City's development code so as to retain full compliance with the FEMA NFIP and maintain the community's eligibility in the program.

With specific regards to sanitary sewer regulations, NFIP will include provisions for minimizing impacts to the floodplain from sanitary sewer infrastructure. The City is recommended to work closely with CWS in development and refinement of sanitary sewer facilities design to ensure compliance with NPDES as well as NFIP requirements.

OREGON STATUTES, REGULATIONS AND PERMITS

Oregon Administrative Rule, Division 660

Oregon requires its cities and counties to adopt pubic facility plans for any urban growth boundary (UGB) areas with a population greater than 2,500. A public facility plan (PFP) helps assure that development within the UGB is guided and supported by the types and levels of urban facilities and services appropriate for the needs and requirements of the areas to be served, and that those facilities and services are provided in a timely, orderly and efficient arrangement, as required by Goal 11 and its implementing administrative rule at Oregon Administrative Rule (OAR) 660-011. This SSMP has been developed in conformance with this rule and will act as a supporting document for the City's Comprehensive Plan.

Oregon Administrative Rule, Division 340

This rule authorizes the actions of the Oregon DEQ. Total Maximum Daily Loads (TMDLs) are established for the local rivers and streams under this rule, which in turn prohibits such activities as discharging waste from industrial and commercial activities without a permit. Pollutant monitoring and testing in Oregon is done by the Department of Environmental Quality (DEQ), which has listed several surface waters within the City's urban growth boundary (UGB) as quality impaired. These impaired streams and their pollutants are summarized in Table 4-1. The pollutants within these streams originate from sources such as animal wastes, chemical fertilizers, pesticides, and urban development.

Table 4-1 | 303(d) Water-Quality Impaired Surface Waters					
Pollutant/Source	Cedar Creek	Chicken Creek	Hedges Creek	Rock Creek	Tualatin River
Arsenic				●	
Ammonia		●		●	●
Aquatic weeds/algae					●
Biological Criteria	●		●	●	●
Chlorophyll-a	●			●	●
Copper					●
Dissolved Oxygen	●	●	●	●	●
Fecal coliform or E. Coli	●	●	●	●	●
Iron		●		●	●
Lead		●		●	●
Mercury					●
Phosphorus	●	●	●	●	●
Temperature	●		●	●	●
Zinc					●

Oregon Revised Statute, Division 224

This statute governs the City's wastewater system management. The operational aspects of the system are defined herein, including the authority of the City to charge for provision or service and obtain debt obligations for construction of wastewater systems.

Oregon Revised Statute, Division 223

This statute allows the City to recover the costs of a new development's share of the system capacity by collecting system development charges (SDCs). Under this statute, new developments must pay a proportional share of expenses to meet the increased demands that they place on the system. SDC fees can be imposed to offset the expense of any system accommodations made necessary by the new development.

LOCAL WASTEWATER ORDINANCES, AGREEMENTS AND RELATED PLANNING POLICIES

Metro 2040 Regional Framework Plan

The City's planning programs are required to support Metro's (formerly Metropolitan Service District) 2040 Regional Framework Plan, a document intended to direct and control the region's urban growth and development. This plan was adopted by Metro council in 1995. This SSMP aids the City in meeting Metro's requirements for infrastructure planning, necessary before an area can be added to the official UGB.

Washington County

Washington County lacks a specific regulation or rule that would apply towards the wastewater collection system within the City.

City of Sherwood, Comprehensive Plan

The Sherwood Comprehensive Plan is an official statement of the goals, policies, implementation measures and physical plans for the City's development. A partial plan revision was adopted by City Council Ordinance 2009-009 to include a number of amending ordinances, as summarized below.

City of Sherwood, Sanitary System Master Plan (July 2007)

This document, prepared by Murray, Smith & Associates, Inc., (MSA) serves as an important starting point for development of this new SSMP, as it summarizes all of the previous wastewater planning efforts to date. The report contains the current Capital Improvement Program (CIP) for the sanitary sewer system and details the analysis used in developing recommended improvements. This plan has served as a primary support document for CWS to renew its NPDES permit from Oregon DEQ.

City of Sherwood, Brookman Addition Concept Plan

The Brookman Addition Concept Plan is a guide to the creation of a new 250-acre community in Sherwood. The central theme of the plan is to create a livable community that is an extension of existing Sherwood. To realize this vision, the document outlines the general location and intensity of future land uses to include residential, mixed use commercial, employment, parks and open space. Basic infrastructure systems to support these land uses are integrated into the planning effort for transportation, trails, utilities and stormwater management.

The concept plan indicates that a local network of sanitary sewers will be needed to completely serve the Brookman Addition. A primary trunk sewer extension of the existing 15-inch diameter sewer stubbed at the southern City limits is necessary to extend through and outside the current UGB along Cedar Creek.

City of Sherwood, Tonquin Employment Area Preferred Concept Plan

The Tonquin Employment Area (TEA) Preferred Concept Plan is intended to guide future employment needs within the concept plan area and within Sherwood. The Preferred Concept Plan identifies the anticipated employment types this area will best accommodate, the associated number of jobs, and the key infrastructure needs that will support this future employment population.

Utility planning for the TEA includes generation of preliminary wastewater flowrates and sizing of sanitary sewer piping. The area is anticipated to generate over 1.6 million gallons of wastewater per day. These flows will be served by piping that connects to the existing 15-inch diameter pipe north of the intersection of SW Oregon Street and SW Tonquin Road and

to an existing 12-inch sewer south of SW Tualatin-Sherwood Road and west of SW Oregon Street.

City of Sherwood, Water System Master Plan Update

The Water System Master Plan (WSMP) was updated in 2015. This document identifies water demands and system capital improvement projects for the 20-year planning horizon. Since the water system provides the primary source of wastewater during dry weather conditions, the WSMP study area and demands were coordinated with loading and planning assumptions for this SSMP.

City of Sherwood, Municipal Code

Titles 13, 15 and 16 of the Municipal Code form the basis of wastewater policy within the City. These sections adopt Clean Water Services standards and allow the City to collect fees from residents for wastewater collection infrastructure. These fees are referred to as System Development Charges (SDC's).

Title 16 of the City's Municipal Code is typically referred to as the "Zoning and Community Development Code," but is also known as the Development Code or Zoning Code. It is enacted to promote the general public welfare by ensuring procedural due process in the administration and enforcement of the City's Comprehensive Plan, zoning, design review, land division, and development standards.

City of Sherwood, Development Standards

Wastewater standards have been adopted by the City to set forth uniform material and workmanship criteria applicable to infrastructure under the City's jurisdiction. Implementing standards streamlines the administration and construction of wastewater facilities and also minimizes maintenance by unifying the materials and equipment used for repairs. These standards are documented in the City's *Engineering Design and Standard Details Manual (2010).*

Chapter VII of this manual pertains specifically to the sanitary sewer system design and construction standards applicable within the City, which have been adopted from CWS *Design and Construction Standards*. These standards outline the City's requirements for: engineering; design; reporting; material, technical and construction specifications; and testing procedures for wastewater collection systems.

Chapter 9 – "Wastewater Pump Stations and Force Mains," and Chapter 10 – "Septic Tank Effluent Pump Stystems (STEP) Design" of the CWS Standards have been dedicated towards wastewater pump station, force main and septic tank effluent pump system design. These pump station and STEP standards are applicable to construction, installation, or modification of any public wastewater pumping facility requiring a City of Sherwood Public Works Permit. The City typically reviews all collection system related documentation for their system, however technical reviews for pump stations and STEP systems are delegated to CWS.

INTERGOVERNMENTAL AGREEMENTS

The City has an intergovernmental agreement (IGA) with CWS for the operation of sanitary sewer and surface water facilities. This IGA summarizes responsibilities for maintenance, capital improvement funding and revenue collection. Specific noteworthy elements of the City-CWS IGA with respect to the wastewater collection system and capital improvements are highlighted below. *Appendix A* contains the full text of the IGA.

- CWS is the NPDES permit holder for the wastewater collection system, and ultimately responsible for its operational conformance with all laws and regulations. Compliance with all CWS orders, standards, specifications, work programs, reporting requirements and performance criteria (CWS Standards) shall be absolute defense to any wastewater regulatory related claim made against the City, provided these CWS Standards are enforced. Inadequate funding shall not constitute a justification for the City's failure to comply with the CWS Standards.
- Both CWS and the City may set rates and charges to finance their respective District Wide and Local programs. Each shall establish separate accounts for stormwater and wastewater programs for the purposes of accounting.
- The City is responsible for maintenance of all wastewater collection system piping less than 24-inches in diameter within its assigned service area.
- The City is responsible for all Local Program capital improvements for piping 12-inches in diameter and smaller. CWS is responsible for piping larger than 12-inches, however the City may be required to provide funding for a Local share of these improvements based on the capacity of a 12-inch pipe.
- The City shall evenly split cost (50/50) for conveyance system repairs and rehabilitation to abate rainfall derived inflow and infiltration (RDII) with CWS.

SECTION 5 | POPULATION & FLOW PROJECTIONS

INTRODUCTION

This section of the Sanitary Sewer Master Plan (SSMP) documents existing wastewater flows and future flow projections based on designated land uses. The flow projections consider existing and future customers within the project study area and highlight potential growth expected within the Urban Growth boundary (UGB). All currently unsewered parcels were assumed to be sewered for build-out conditions. To develop anticipated wastewater flows, the following information was reviewed:

- Population projections
- Current and future service area boundaries
- Delineation of the major sewer basins
- City Comprehensive Plan for location based zoning
- Metro land use data
- Water production records
- Sewer flow monitoring data
- Flow projections from the 2009 Sherwood Pump Station Expansion project
- Sherwood Housing Needs Analysis 2015 to 2035 (March 2015)

This section of the SSMP focuses on definitions, flow characterization, per capita wastewater usage, unit flow factor development, and flow projection summaries. A hydraulic and hydrologic model was developed to generate existing and future flows and evaluate system capacity. Specific discussion of model development, calibration based on flow monitoring data, and application of the flow methodology to evaluate the capacity of the collection system are provided in Section 6 "System Analysis."

HISTORIC AND FUTURE POPULATION DATA

In projecting future growth and associated wastewater loading, the SSMP relies upon several sources of historical and projected population data, such as the United States (U.S.) Census Bureau data, Portland State University (PSU) certified population estimates, and Metro population projections.

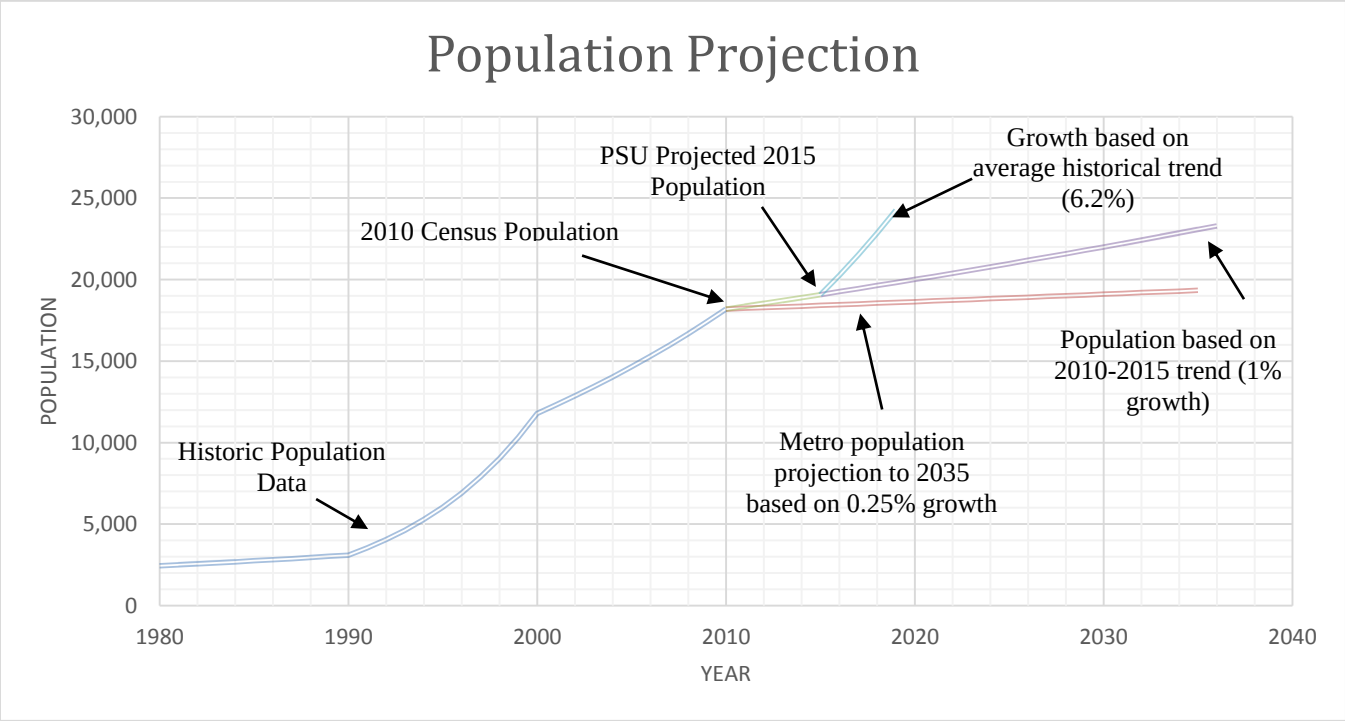
Historic data and the U.S. Census demonstrate that the City's population has experienced steady growth over time, with a reported population of 18,194 for the 2010 census. The growth rates vary by decade with 2.4% growth in the 1980's, 14.3% growth in the 1990's, and 4.4% growth in the 2000's.

Metro's projected annual populations for Oregon cities is applied to growth estimates through 2035 as shown in Figure 5-1. The growth rate between 2010 and 2035 based on the Metro 2035 population projection of 19,342 is approximately 0.25% and significantly lower than the 6.2% average historical rate of growth for the City (*Certified Population Estimates*,

Portland State University, www.pdx.edu/prc/population-reports-estimates; *Regional Forecast Distribution Methodology & Assumptions, Population and Employment, 2010-40 TAZ Forecast Distribution "Gamma Scenario,"* METRO, 2012*)*.

The population at build-out of the UGB is estimated at 23,390. This projection is based on in-fill of all residential tax lots assuming average housing densities by zoning classification and the Metro projected number of 2.66 people per household. Portland State University (PSU) Population Research Center's certified population estimates for 2015 indicate a growth rate of approximately 1% between 2010 and 2015 with a 2015 population estimate of 19,080. Extrapolating growth to build-out at the 1% growth rate results in build-out occurring around 2036. Extrapolating growth to build-out at the average historic rate of 6.2% results in build-out occurring around 2019. The *Sherwood Housing Needs Analysis, 2015 to 2035* (Draft March 2015), concludes that growth projections require development of the Brookman Concept Area and potential UGB expansion. The Brookman Concept Area is included in the SSMP population projections. UGB expansion is not considered in the SSMP.

Figure 5-1 | Population Projections for the City



Sources: *Certified Population Estimates*, Portland State University, www.pdx.edu/prc/population-reports-estimates; *Regional Forecast Distribution Methodology & Assumptions, Population and Employment, 2010-40 TAZ Forecast Distribution "Gamma Scenario,"* METRO, 2012.

WASTEWATER FLOW CHARACTERIZATION

Flow Components

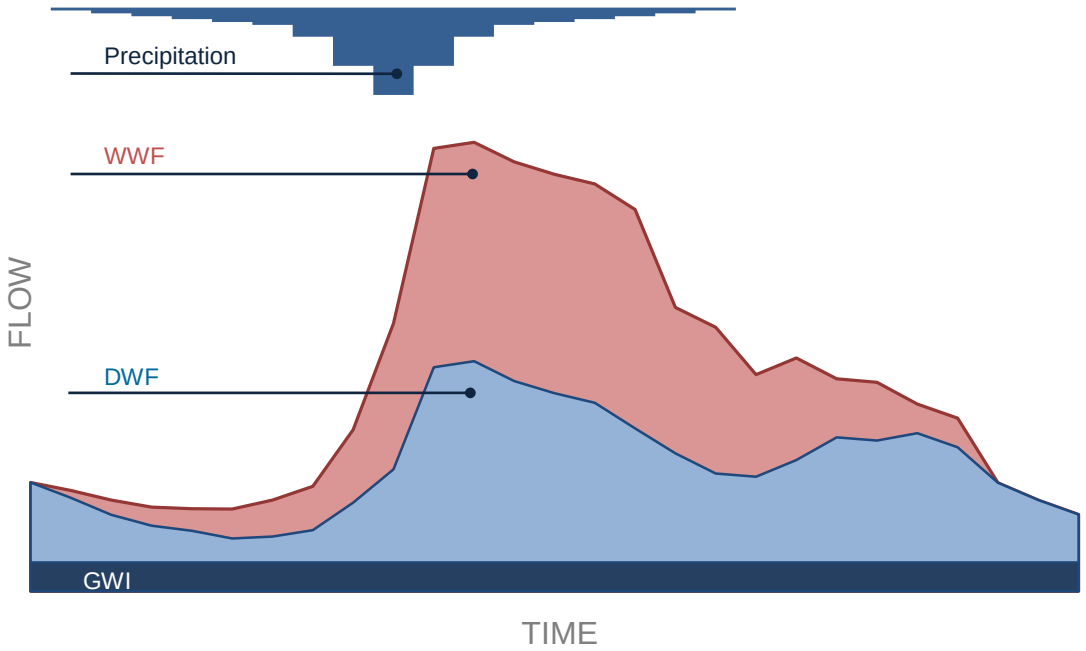
The major components of the wastewater flow are defined below. Figure 5-2 provides a generic schematic of the wastewater flow components.

1. ***Dry Weather Flow (DWF)*** is wastewater from residential, commercial, institutional (e.g., schools, churches, hospitals) and industrial sources. The dry weather wastewater flow is a function of the population and land use, and varies throughout the day in response to personal habits and business operations.

2. ***Groundwater Infiltration (GWI)*** is defined as groundwater entering the sanitary sewer system unrelated to a specific rain event. GWI occurs when groundwater is at or above the sewer pipe invert, and infiltrates through defective pipes, pipe joints and manhole walls. This component of the dry weather flow is typically seasonal.

3. ***Wet Weather Flow (WWF)***, also known as *rainfall derived infiltration and inflow* (RDII), is precipitation that enters the sanitary sewer system either during or immediately following a rain event. Stormwater inflow reaches the sanitary sewer system by direct connections such as roof downspouts connected to sewer piping, yard and area drains, holes in manhole covers, or cross-connections with storm drains or catch basins. Rainfall-dependent infiltration includes flow that enters defective pipes, pipe joints and manhole walls after percolating through the soil during and immediately following a rain event.

Figure 5-2 | Generic Schematic of Wastewater Flow Components



Flow Methodology

Existing system flows were developed from flow monitoring data at two locations. Future flow projections were based on unit flow factors derived from flow monitoring data and zoning at the tax lot or parcel level. A general discussion of the flow methodology is provided below.

1. ***Existing DWF –*** The existing average DWF, often referred to as dry weather loading, was generated from localized flow monitoring data and distributed to the sanitary sewer system at the parcel level based on metered winter-time water consumption. The flow monitoring data and water consumption were used to develop per capita wastewater factors and per acre unit flow factors by zoning classification. Diurnal patterns were developed at each flow meter location to describe flow variability throughout the day at hourly increments. GWI was included in the existing DWF based on the time of year considered for the dry weather period. The hourly and peak DWF are estimated by applying the diurnal pattern to the average dry weather flow.

2. ***Future DWF*** – The unit flow factors established from the flow monitoring data were applied to net developable acres of vacant parcels to forecast future average DWF. Future GWI was assumed to be included in the DWF component of the flow. The peak DWF was estimated by applying the existing DWF diurnal pattern to the average DWF projection.

3. ***Existing WWF –*** The existing WWF relied on localized flow monitoring data and precipitation data to extract unit hydrograph parameters during larger storm events. The WWF area of impact (sewershed) for application of the precipitation and development of the unit hydrographs was assumed to be a 50-foot buffer around all existing pipelines. The sewershed area multiplied by the precipitation depth generates the total stormwater volume, and the unit hydrograph defines the percentage of volume entering the system over time. The WWF response was extrapolated to the Clean Water Services (CWS) Durham Basin 5-year design storm by applying the design storm precipitation to the existing sewershed areas and routing the stormwater to the sanitary sewer system using the basin specific unit hydrographs.

4. ***Future WWF*** – The future WWF projections utilized representative existing peak unit hydrograph parameters. These parameters were extrapolated to the 5-year design storm event and applied to future sewersheds. Future sewersheds were assumed at 58% of the total future net developable acreage based on correlation with existing developed net acreage to sewershed area.

Existing Dry Weather Flow Loading

The City's sanitary sewer system conveys wastewater of both "domestic" and "industrial" dischargers. Domestic wastewater includes residences, retail, commercial enterprises, and institutional facilities (e.g., schools). Industrial dischargers typically include larger and more significant flows generated by manufacturing, non-retail commercial facilities, and other

large facilities. Sanitary flows generated in the City can generally be characterized as residential.

CWS operates two flow meters, located on the Sherwood Trunk. These meters are located at manhole 11659 (upstream of the confluence of the Sherwood and Rock Creek Trunks) and manhole 800892 (immediately upstream of the Sherwood Pump Station). The meters allow for flow analysis of each of the major trunk sewers and basins. Existing DWF was summarized by extracting the average and diurnal flow occurring under dry conditions between January and March 2013 at the two meter locations as summarized in Table 5-1.

Table 5-1 | Existing Dry Weather Flow Summary by Basin

Basin	Average DWF (gpm)[1]	Peak DWF (gpm)
Cedar Creek	592	963
Rock Creek	272	407
Total	**864**	**1,370**

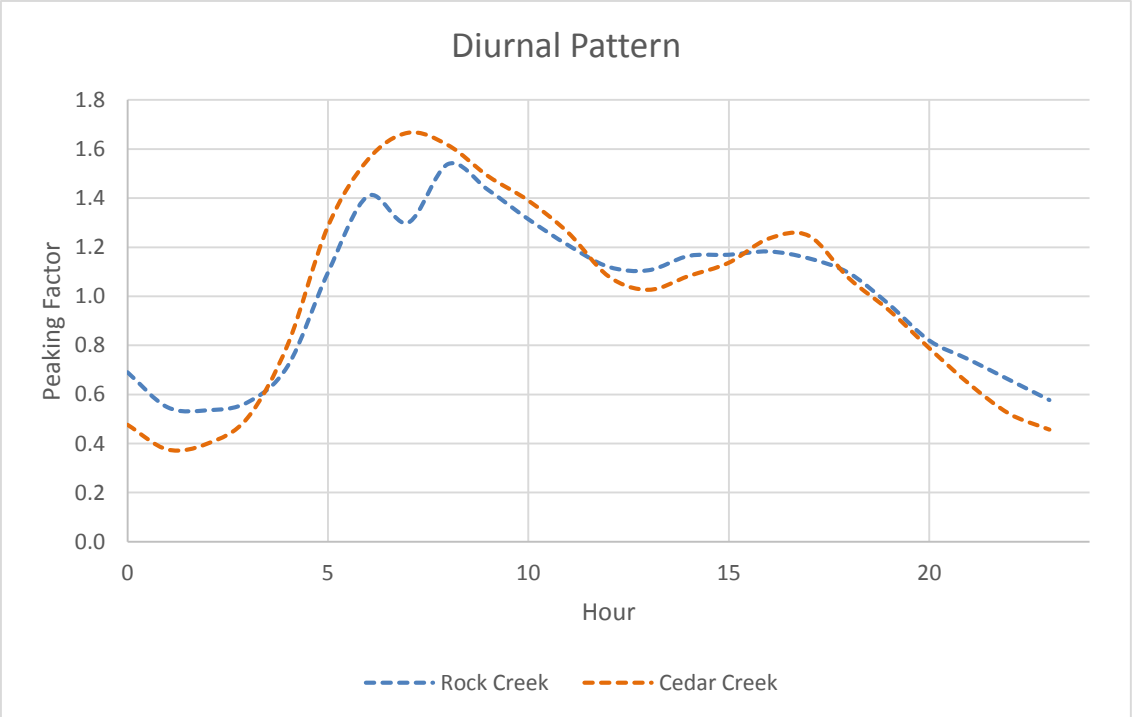
Note 1. gpm = gallons-per-minute

A per capita residential wastewater flow of 50 gallons-per-capita-per-day (gpcpd) was calculated based on a population of 19,050 (as of 2013-2014) and the metered average DWF summary. The per capita flow value falls at the low end of the typical range for other communities with primarily residential services. The average DWF was distributed to sewered parcels using winter-time water consumption. The parcel level data, per capita wastewater usage, and applicable residential densities were then used to establish unit loading factors for residential zoning classifications. Unit flow factors for non-residential zoning classifications were assumed to be 1,000 gallons-per-acre-per-day (gpad) based on net acreage and adjusted to match the flow monitoring data in each basin. The residential and non-residential unit flow factors are summarized in Table 5-2. Diurnal patterns are presented in Figure 5-3.

Table 5-2 | Unit Loading Factors by Zoning Classification			
Zoning Classification	**Description**	**Density (units/acre)**	**Unit Loading Factor (gpad)[1]**
Commercial/Industrial			
GC	General Commercial	--	1,000
NC	Neighborhood Commercial	--	1,000
OC	Office Commercial	--	1,000
RC	Retail Commercial	--	1,000
GI	General Industrial	--	1,000
LI	Light Industrial	--	400
EI	Employment Industrial	--	850
Public			
IP	Institutional and Public	--	1,000
OS	Open Space	--	0
Residential[2]			
VLDR	Very Low Density Residential	1-2	135-270
LDR	Low Density Residential	5	670
MDRL	Medium Density Residential-Low	8	1,100
MDRH	Medium Density Residential-High	11	1,500
HDR	High Density Residential	16-24	2,150-3,250

Note 1. Unit loading factors scaled to flow monitoring data. Unit loading factors are applied to gross acreage x 0.85 net acreage factor.
Note 2. Residential unit loading factors based on 50 gpcd residential wastewater usage.

Figure 5-3 | Dry Weather Flow Diurnal Patterns



Future Dry Weather Flow Loading

Future DWF loading was developed for build-out conditions of the UGB at the parcel level. Dry weather loading for future parcels assumed an 85% net acreage factor applied to each unsewered parcel and the zoning specific unit flow factors presented in Table 5-3. The diurnal pattern previously described in Figure 5-3 with a maximum hour peaking factor of 1.72 or 1.54 (basin specific) was applied to average DWF to establish peak DWF. The existing and future total DWF loading is summarized by zoning classification in Table 5-3.

Table 5-3 | Existing and Future Dry Weather Loading by Basin Zoning Classification

Basin	Existing DWF (gpm)	Build-out DWF (gpm)
General Commercial-GC	22	38
Neighborhood Commercial-NC	1	1
Office Commercial-OC	8	21
Retail Commercial-RC	49	59
Institutional and Public-IP	87	102
Open Space-OS	0	0
General Industrial-GI	103	134
Light Industrial-LI	29	93
Employment Industrial-EI	0	164
Very Low Density Residential-VLDR	4	8
Low Density Residential-LDR	219	235
Medium Density Residential High-MDRH	63	111
Medium Density Residential High-MDRL	134	235
High Density Residential-HDR	146	190
Total	865	1,391

Existing Wet Weather Flow Loading

The WWF component of the wastewater flow is generated by developing unit hydrographs for each sewer basin from the flow monitor data and applying precipitation to the sewershed buffer area around existing pipelines. The WWF is then summarized on a per acre basis as a peak RDII rate for the entire meter basin. Flow monitoring data were examined during large storm events between 2011 and 2015. The largest events occurred January 16, 2012 and November 17, 2012 with cumulative rainfall at the CWS Lower Tualatin rain gage estimated at 3.8 and 4.2 inches for the maximum 72 hour storms respectively. The wet weather response was then extrapolated to CWS Durham Basin 5-year design storm (also 72 hours) using the basin specific unit hydrographs. The observed and extrapolated precipitation and peak RDII rates are summarized in Table 5-4.

Table 5-4 | Observed and Extrapolated Storm Event Summary			
Event Date	Event Precipitation Depth (in, 72-hour)	Peak RDII Rate (gpad)	
		Rock Creek Basin	Cedar Creek Basin
1/16/2012	3.8	1,410	3,711
11/17/2012	4.27	1,070	3,755
5-year Design Storm	3.6	1,300	2,600

The extrapolated peak RDII rates for the 5-year design storm indicate that the sanitary sewer system is in good condition and experiences limited impacts from rainfall and wet weather conditions. The peak RDII rate of 1,300 gpad for the Rock Creek Basin is approximately 50% lower than the standard RDII rate that CWS assumes for new construction of 2,500 gpad. The peak RDII rate of 2,600 gpad for the Cedar Creek Basin is approximately 5% greater than the standard RDII rate.

Future Wet Weather Flow Loading

Future WWF loading for build-out conditions also assumed full development of the UGB. Based on the existing system RDII analysis and the extrapolation of the 5-year design storm, the unit hydrographs and peak RDII rates presented in Table 5-4 were applied to unsewered and vacant parcels to generate future WWF. The minimum peak RDII rate was consist

The total peak flow estimates are summarized in Table 5-5 including DWF and WWF contributions from existing services and future development within the UGB.

Table 5-5 | Peak Dry and Wet Weather Flow Summary by Basin[1]						
Basin	Existing Average DWF (gpm)	Existing Peak DWF (gpm)	Existing Peak DWF+ WWF (gpm)	Build-out Average DWF (gpm)	Build-out Peak DWF (gpm)	Future Peak DWF+ WWF (gpm)
Cedar Creek	592	963	2,489	840	1,669	3,111
Rock Creek	272	407	793	550	763	1,952
Total	**864**	**1,370**	**3,282**	**1,390**	**2,432**	**5,063**

Note 1. WWF assumes 5-year design storm.

SECTION 6 | SYSTEM ANALYSIS

INTRODUCTION

This section of the Sanitary Sewer Master Plan (SSMP) outlines the City of Sherwood (City) sanitary sewer capacity analysis and hydraulic model assumptions. To evaluate system capacity, design criteria were established for maximum allowable flow depth during dry and wet weather conditions, maximum velocity, and pump station capacity. A hydraulic model was developed and calibrated to evaluate the response of the system against the design criteria under both existing and build-out flow scenarios. The hydraulic model was applied as a tool to evaluate and recommend system improvements. This section documents the model development, design criteria assumptions, existing and future system capacity analyses, and capital improvement analysis.

All improvements are evaluated at the master planning level of accuracy which allows for determination of budget level cost estimates for the purpose of determining system development charges (SDCs) and rates (user fees) to support the Capital Improvement Program (CIP), as presented in Section 7, "Capital Improvement Program." Prior to implementation, each improvement project will require standard design phases to identify construction details and refine infrastructure sizing.

MODEL DEVELOPMENT

To evaluate the existing and future capacity of the system, a collection system hydraulic model was developed in INFOSWMM™ (Innovyze) which utilizes the industry-standard SWMM 5 hydraulic engine developed by the Environmental Protection Agency (EPA). The Clean Water Services (CWS) Durham Basin model from 2012 was used as the starting point for the model development. All pipelines 8-inches and larger were incorporated into the model network from the City Geographical Information System (GIS). Information required to perform the hydraulic calculations in a network model include pipeline diameter, pipeline length, pipeline slope (based on pipeline inverts), manhole invert elevations, and manhole rim elevations. The model includes the Sherwood and Rock Creek Trunk sewers, but was truncated immediately upstream of the Sherwood Pump Station wet well.

Model Calibration

Model calibration generally consists of adjusting initial model parameters such that model and field data match within a reasonable tolerance. At the conclusion of each calibration iteration, field data are compared with the modeled data to determine the model's level of accuracy. Once the desired level of accuracy has been achieved, the calibration is complete.

In collection system modeling, the level of accuracy is both qualitative and quantitative. Flow rates measured at each flow monitoring site are visually compared to model flow rates for an extended period of time. A dry weather period including both weekdays and weekend days and a wet weather period are selected for model calibration. The dry weather flows are calibrated first with adjustments to the model loading and diurnal patterns until field and model flows match. The wet weather flows are calibrated second with adjustments to unit hydrographs and sewershed areas (wet weather impact areas) until field and model flows

match during a significant rain event. Actual precipitation gage data is used in the model during the wet weather calibration. "Good," "moderate," and "poor" calibration result categories occur when field and model peak flows match within 10-percent, 20-percent, and greater than 20-percent respectively.

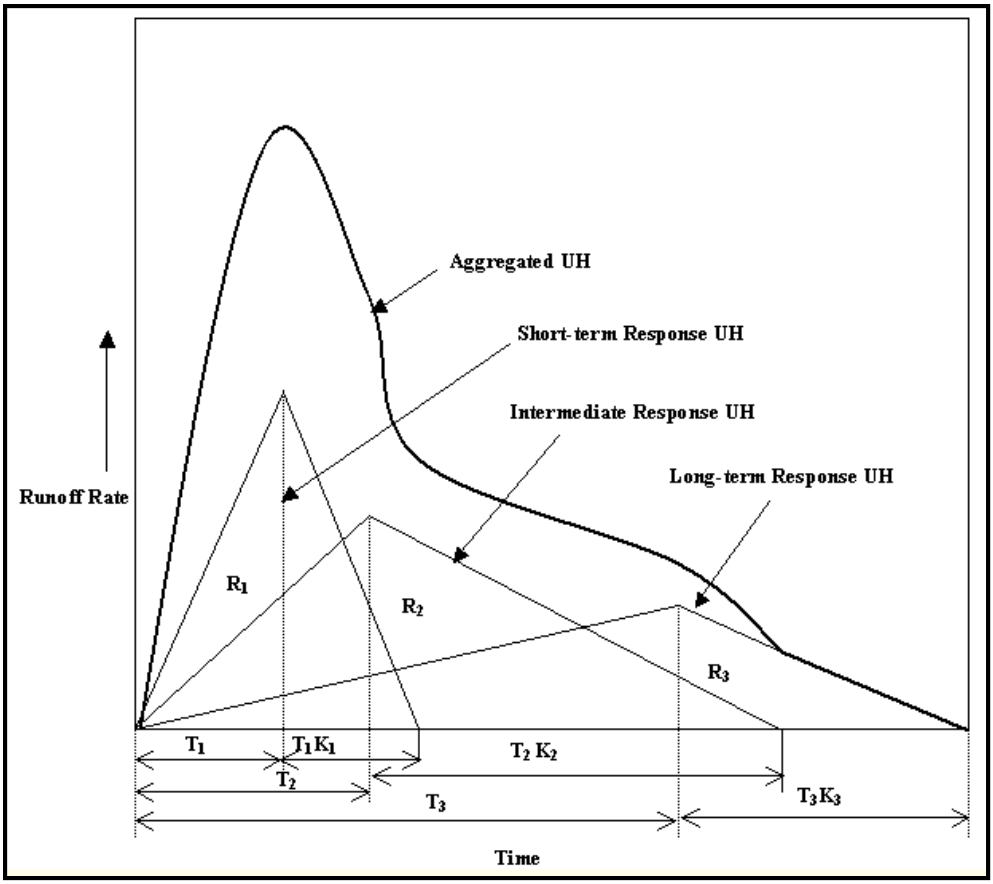
For the wet weather portion of the model, rainfall derived infiltration and inflow (RDII) unit hydrographs define the amount of runoff (percentage of the volume created from the sewershed and rain depth) which enters the system and the travel time. The unit hydrograph is a composite of three component hydrographs representing initial, intermediate, and long-term system response. Each of the three hydrographs is defined by three parameters which are adjusted during model calibration until field and model flows match within the desired level of accuracy. The unit hydrograph parameters are described below and shown in Figure 6-1.

Unit Hydrograph Parameter 1 - R1, **R2**, **R3 -** Response ratios for the short-term, intermediate-term, and long-term UH responses, respectively.

Unit Hydrograph Parameter 2 - T1, **T2**, **T3** - Time to peak for the short-term, intermediate-term, and long-term UH responses, respectively.

Unit Hydrograph Parameter 3 - K1, **K2**, **K3 -** Recession limb ratios for short-term, intermediate-term, and long-term UH responses, respectively.

Figure 6-1 | SWMM Unit Hydrograph



Available flow meter data was used for the model calibration at manhole 11659 (upstream of the confluence of the Sherwood and Rock Creek Trunks) and manhole 800892 (immediately upstream of the Sherwood Pump Station). The dry weather calibration was performed for dry periods between January and March 2013 because of the accuracy of available flow meter data during this period. The wet weather calibration was performed for two larger storm events occurring on January 17-21, 2012 and November 17 -20 2012. The model results compared to the flow monitoring data for the dry and wet weather calibration are presented in *Appendix C*. The dry and wet weather calibrations are within a 10-20% level of accuracy which represents a good to moderate level of calibration. The goal of the calibration was to first match peak flow rates and second to match wastewater volume. Both the dry and wet weather calibrations are conservative which provides a safety factor for the deficiencies and improvements analysis.

DESIGN CRITERIA

The City criteria for defining sanitary sewer system deficiencies and planning improvements are shown in Tables 6-1 and 6-2. These standards are consistent with the City's *Engineering Design and Standard Details Manual (2010),* Clean Water Services (CWS) *Design and Construction Standards (2007), Oregon Department of Environmental Quality Design Guidelines (1994),* and *Recommended Standards for Wastewater Facilities [The Great Lakes-Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers, 2004]*.

For sanitary sewer pipelines, the criteria focus on a maximum water depth of 80% during dry weather conditions and minimizing surcharging above the pipe crown during the design storm event. For pump stations, the criteria focus on pumping peak wet weather flows with the largest pump out of service. Maximum velocity and minimum scouring velocity are considered secondary criteria and are indicative of undersized or over-sized piping, respectively. In the case of the minimum scouring velocity violations, the pipelines are flagged for additional maintenance and flushing to prevent deposition of solids. Solids deposition can be an issue when pipelines are constructed at less than minimum design slopes or prior to build-out of the upstream service area.

In general, the standard practice for this plan is to assume there exists a high risk to property and health when the surcharged hydraulic grade line (HGL) is within 3 feet of the ground surface and a moderate to low risk when the surcharged HGL is within 10 feet of the ground surface. The specific risk criteria are summarized in Table 6-2 based on allowable freeboard during the design storm event and CWS HGL status codes.

Table 6-1 | Sanitary Sewer Design Criteria			
Standard	**Category**	**Criteria**	**Explanation**
Primary	Maximum water depth to diameter ratio during dry weather conditions	0.8	When the depth to diameter ratio exceeds 0.9, the pipe begins to lose gravity capacity due to greater frictional loss
	Minimum freeboard during 5-year design storm, (clearance from water surface to manhole rim)	3 feet minimum, hydraulic gradeline categories determine risk (Table 6-2)	The City standard considers level of risk when prioritizing improvements.
	Pump Station firm capacity	Pump stations have capacity to pump at flows greater than or equal to peak hour flows with largest pump out of service	The firm capacity criteria protects against loss of service during equipment failure and allows for pump cycling for longer equipment life
	Maximum force main velocity	8.0 feet per second (fps)	The velocity criteria protects against excessive head loss and allows pumps to operate efficiently
Secondary	Maximum gravity pipeline velocity	< 15.0 fps or anchored appropriately for extreme slopes	The maximum velocity criteria protects pipelines from turbulent flow conditions and excessive air entrainment
	Minimum cleansing/scouring velocity, gravity pipeline	2.0 fps	Pipe diameters and minimum slopes should be selected to prevent solids deposition
	Minimum cleansing/scouring velocity of force mains	3.5 fps	Pipe diameters should be selected to prevent solids deposition, with a minimum pipe diameter of 4 inches

Table 6-2 | Freeboard Criteria and Hydraulic Gradeline (HGL) Status for Wet Weather Deficiencies				
HGL Status	**Description[1]**	**Risk Level**	**Action**	**Map Legend Color**
LS	Overflow or pressure with significant HGL increase	High	Improve	Red
LH	Overflow or pressure	High	Improve	Yellow
HS	Less than 3 feet freeboard with significant HGL increase	High	Improve	Orange
HH	Less than 3 feet freeboard	High	Improve	Brown
IS	3 to 10 feet freeboard with significant HGL increase	Low	Improve	Purple
IH	3 to 10 feet freeboard	Low	None	Pink
DS	Greater than 10 feet freeboard with significant HGL increase	Negligible	None	Light Blue
DH	Greater than 10 feet freeboard	Negligible	None	Dark Green
OK	HGL below pipe crown	Negligible	None	Light Green

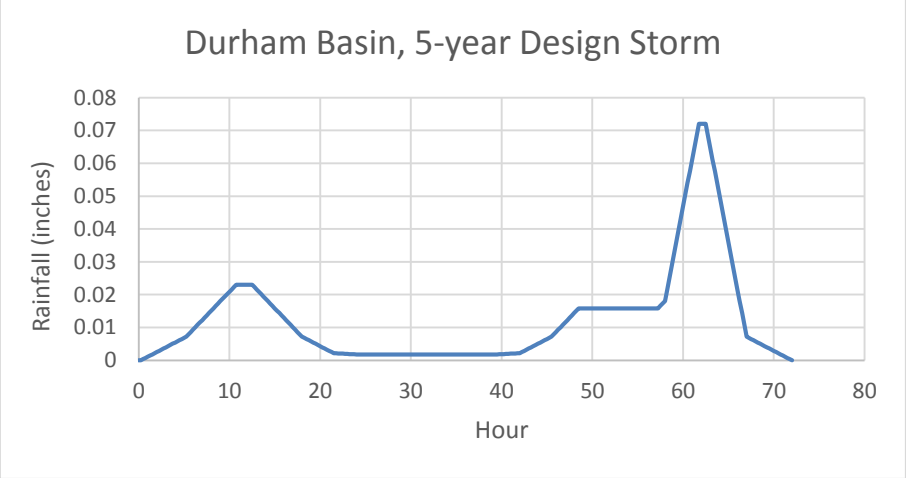
Source: Clean Water Services Sanitary Sewer Master Plan Update, Appendix M (2009). Note 1: A significant increase in HGL indicates that the peak flow rate exceeds the full flow capacity of the pipeline. This designation is given to pipelines where the HGL slope exceeds the pipeline slope by greater than 5% causing a backwater impact in the upstream system. Color codes consistent with CWS master plan mapping.

Design Storm

Sanitary sewer system deficiencies are typically the result of RDII associated with large storm events. Based on the November 2010, *Internal Management Directive Sanitary Sewer Overflows (SSOs)* document from the Oregon Department of Environmental Quality (DEQ) and *Oregon Administrative Rules Chapter 340-Division 041(OAR 340-041-0009),* all SSOs are prohibited. However, DEQ may withhold enforcement action for those SSOs that occur from larger storm events; e.g. a winter storm that corresponds to a 1 in 5-year frequency and a summer storm that corresponds to a 1 in 10-year frequency. CWS and the City have elected to apply the 1 in 5-year frequency storm event to determine system deficiencies and improvements.

In 2012, CWS developed a Durham Basin specific 5-year design storm. The analysis considered large storm events over a 50-year period and evaluated the frequency of overflow within the system caused by each storm event. The final design storm was a composite of historical events that generated the 1 in 5-year frequency of system overflows. The CWS Durham Basin 5-year design storm is a 3.6-inch, 72-hour event as shown in Figure 6-2.

Figure 6-2 | Clean Water Services Durham Basin, 5-year Design Storm



EXISTING SYSTEM EVALUATION

The calibrated sanitary sewer model was used to identify system hydraulic response to existing dry and wet weather flows upstream of the Sherwood Pump Station. The system response was documented for the design criteria presented in Tables 6-1 and 6-2 and the 5-year design storm. Results of the existing system analysis are presented in Figure 6-3 and indicate zero significant hydraulic deficiencies. Two sections of the Sherwood Trunk (total length approximately 6,000 feet) of 18 to 24-inch diameter piping immediately north of Roy Rogers Rd and north of Edy Rd experience some surcharging during the design storm; however, freeboard exceeds 10 feet through the critical pipe segments.

The City's system has been sized to accommodate future growth and as a result many pipeline segments do not achieve the minimum scouring velocity of 2 feet per second (fps) during dry weather flow conditions. These segments are primarily located where piping was designed for ultimate flows and service areas have not fully built out. Prior to build-out of the service area, these pipelines will require routine flushing and maintenance to prevent solids deposition.

The Sherwood Pump Station and force main has adequate capacity during the design storm to convey the existing peak flow rate of 4.7 million-gallons-per-day (mgd). The existing firm capacity of the pump station is estimated at 6.6 mgd. The existing 18-inch Sherwood Pump Station force main capacity is estimated at 9.1 mgd.

The Upper Tualatin Interceptor also has adequate capacity for existing peak flow contributions from the City. The limiting segments in the downstream Upper Tualatin Interceptor occur in the 27-inch diameter piping immediately downstream of the Sherwood Pump Station force main. This piping has a limiting capacity similar to the firm capacity of the pump station of 6.6 mgd.

FIGURE 6-3

CITY OF SHERWOOD

SANITARY SEWER MASTER PLAN SYSTEM ANALYSIS - EXISTING SYSTEM DEFICIENCIES

Murray, Smith & Associates, Inc. Engineers/Planners

121 S.W. Salmon, Suite 900 PHONE 503.225.9010
Portland, Oregon 97204-2919 FAX 503.225.9022

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HGL Status			
HGL Status	Description[1]	Risk Level/Action	Legend Color
LS	Overflow or pressure with significant HGL increase	High/Improve	Red
LH	Overflow or pressure	High/Improve	Yellow
HS	Less than 3 feet freeboard with significant HGL increase	High/Improve	Orange
HH	Less than 3 feet freeboard	High/Improve	Brown
IS	3 to 10 feet freeboard with significant HGL increase	Low/Improve	Purple
IH	3 to 10 feet freeboard	Low/None	Pink
DS	Greater than 10 feet freeboard with significant HGL increase	Negligible/None	Light Blue
DH	Greater than 10 feet freeboard	Negligible/None	Dark Green
OK	HGL below pipe crown	Negligible/None	Light Green

Sherwood Pump Station
(4.7 mgd peak < 6.6 mgd firm cap)

- CITY BOUNDARY
- STUDY AREA
- CEDAR CREEK BASIN
- ROCK CREEK BASIN
- WATER BODY
- STREET
- Manhole
- Backwater

HGL STATUS
- OK
- DH
- DS
- IH
- IS
- HS
- HH
- LH
- LS
- Force Main Max Velocity < 10 ft/sec
- Force Main Max Velocity >=10 ft/sec

Note 1: Clean Water Services Sanitary Sewer Master Plan Update, Appendix M (2009). A significant increase in HGL indicates that the peak flow rate exceeds the full flow capacity of the pipeline. This designation is given to pipelines where the HGL slope exceeds the pipeline slope by greater than 5% causing a backwater impact in the upstream system. Color codes consistent with CWS master plan mapping.

0 0.5 Miles

N W E S

Sherwood

Brookman Concept Area

Tonquin Emp. Area (TEA)

SW EDY RD
SW ELWERT RD
SW PACIFIC HWY
SW KRUGER RD
SW SUNSET BLVD
SW BROOKMAN RD
SW TUALATIN SHERWOOD RD
SW OREGON ST
NE OREGON ST
SW BAKER RD

Chicken Creek
Cedar Creek
Rock Creek
Goose Creek
Coffee Lake Creek

BUILD-OUT SYSTEM EVALUATION

The calibrated sanitary sewer model was used to identify system hydraulic response to build-out dry and wet weather flows for growth within the Urban Growth Boundary (UGB). The system response was documented for the design criteria presented in Tables 6-1 and 6-2 and the 5-year design storm. Results of the build-out system analysis are presented in Figure 6-4 and indicate significant deficiencies in both the Sherwood and Rock Creek Trunks. The deficiencies in the Sherwood Trunk are primarily driven by development of the Brookman Concept Area including 3,600 feet of 24-inch diameter piping experiencing freeboard of 3 to 10 feet. The deficiencies in the Rock Creek Trunk are primarily driven by development of the Tonquin Employment Area including 4,800 feet of 18-inch diameter piping experiencing freeboard of 0.5 to 10 feet.

The peak build-out flow rate into the Sherwood Pump Station during the design storm is estimated at 7.3 million-gallons-per-day (mgd) which is greater than the available 6.6 mgd firm capacity of the pump station. Expansion of the Sherwood Pump Station is required to accommodate build out growth within the existing UGB. A CWS study from 2009 identified an increase in pump station firm capacity to 7.8 mgd by increasing the pump impellers from 445-millimeters (mm) to 465 mm. The Sherwood force main has adequate capacity to convey UGB build out flow. The pump station has capacity for approximately 60% of the future growth within the UGB which includes in-fill, Brookman Concept Area, and Tonquin Employment Area growth. Alternately, the pump station has capacity for 100% in-fill growth and 35% of Brookman Concept and Tonquin Employment growth.

The Upper Tualatin Interceptor is deficient at build-out peak flows. The critical segments in the downstream Upper Tualatin Interceptor occur in the 27-inch diameter piping immediately downstream of the Sherwood Pump Station force main. Additional limitations occur where the cities of King City, Tigard, and Tualatin also contribute to the interceptor between 124th Avenue and Jurgens Avenue. CWS performed an evaluation in 2012 with the calibrated Durham Basin model to determine the approximate timing of deficiency in the Upper Tualatin Interceptor. The critical segments were determined to be deficient in the 2025 to 2035 timeframe. CWS is currently performing analysis to consider phasing and priority of gravity improvements to the interceptor.

Improvements identified for the build-out analysis were sized for growth within the existing UGB and are highlighted in Table 6-3 and Figure 6-5. Once improvements are complete the HGL status criteria was identified as “OK” (below pipe crown) or “DH/DS” (greater than 10 feet of freeboard for all system pipelines. These improvements include:

- City and CWS upsizing of the Sherwood and Rock Creek Trunk sewers
- Abandoning of the Onion Flats section of the Rock Creek Trunk and new upsized CWS pipeline route to avoid sensitive environmental areas
- Pipeline extensions to serve the Brookman Concept and Tonquin Employment areas

Although deficiencies are identified for the Sherwood Pump Station and Upper Tualatin Interceptor at build out conditions, specific improvements are in the purview of CWS and have not been specifically sized during this study. Critical pump station and downstream pipe improvements are required to serve City UGB growth and should be carefully coordinated with CWS.

Table 6-3 I City of Sherwood, Capacity Improvements						
Project Type	**Project ID**	**Project Description**	**Basin**	**Driver**	**Improvement Length (feet)**	**Improvement Diameter (inch)[1]**
Clean Water Services – Upsize Pipe and Pump Station	CWS-1	Rock Creek Trunk - Onion Flats Section	Rock Creek	UGB In-fill, Tonquin Employment Area	5,400	21
	CWS-2	Sherwood Pump Station	Cedar Creek & Rock Creek	UGB In-fll, Tonquin Employment Area and Brookman Concept Area	N/A	N/A
	CWS-3	Upper Tualatin Interceptor	Cedar Creek & Rock Creek	UGB In-fll, Tonquin Employment Area and Brookman Concept Area	TBD by CWS	TBD by CWS
	CWS-4	Sherwood Trunk - SW Edy Rd to Sherwood Pump Station	Cedar Creek	UGB In-fill, Brookman Concept Area	9,800	27
City - New Pipe	1	South Tonquin Employment Area pipeline extension to SW Tonquin Rd	Rock Creek	Tonquin Employment Area	2,700	10
	2	North Tonquin Employment Area pipeline extension to SW Oregon St	Rock Creek	Tonquin Employment Area	4,100	10
	3	Brookman pipeline extension - SW Brookman Rd to SW Cobble Ct	Cedar Creek	Brookman Concept Area	5,500	10
City – Upsize Pipe	4	Rock Creek Trunk between SW Tualatin Sherwood Rd and Rock Creek Railroad Trestle	Rock Creek	UGB In-fill, Tonquin Employment Area	1,300	21

Note 1. Improvements sized for build-out of the existing Urban Growth Boundary.

FIGURE 6-4

CITY OF SHERWOOD

SANITARY SEWER MASTER PLAN
SYSTEM ANALYSIS -
UGB BUILD OUT SYSTEM DEFICIENCIES

Murray, Smith & Associates, Inc.
Engineers/Planners
121 S.W. Salmon, Suite 900 PHONE 503.225.9010
Portland, Oregon 97204-2919 FAX 503.225.9022

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Limited Capacity in Sherwood Trunk (multiple segments)

Limited Capacity in Upper Tualatin Interceptor (multiple segments)

Limited Capacity in Rock Creek Trunk (Causes Backwater)

Sherwood Pump Station Deficient (7.3 mgd peak > 6.6 mgd firm cap)

HGL Status			
HGL Status	Description[1]	Risk Level/Action	Legend Color
LS	Overflow or pressure with significant HGL increase	High/Improve	Red
LH	Overflow or pressure	High/Improve	Yellow
HS	Less than 3 feet freeboard with significant HGL increase	High/Improve	Orange
HH	Less than 3 feet freeboard	High/Improve	Brown
IS	3 to 10 feet freeboard with significant HGL increase	Low/Improve	Purple
IH	3 to 10 feet freeboard	Low/None	Pink
DS	Greater than 10 feet freeboard with significant HGL increase	Negligible/None	Light Blue
DH	Greater than 10 feet freeboard	Negligible/None	Dark Green
OK	HGL below pipe crown	Negligible/None	Light Green

CITY BOUNDARY
STUDY AREA
CEDAR CREEK BASIN
ROCK CREEK BASIN
WATER BODY
STREET
Manhole
Backwater

HGL STATUS
OK
DH
DS
IH
IS
HS
HH
LH
LS
Force Main Max Velocity < 10 ft/sec
Force Main Max Velocity >=10 ft/sec

0 0.5 Miles

Note 1: Clean Water Services Sanitary Sewer Master Plan Update, Appendix M (2009). A significant increase in HGL indicates that the peak flow rate exceeds the full flow capacity of the pipeline. This designation is given to pipelines where the HGL slope exceeds the pipeline slope by greater than 5% causing a backwater impact in the upstream system. Color codes consistent with CWS master plan mapping.

Sherwood
Brookman Concept Area
Tonquin Emp. Area (TEA)
SW EDY RD
SW ELWERT RD
SW PACIFIC HWY
SW TUALATIN SHERWOOD RD
SW OREGON ST
NE OREGON ST
SW KRUGER RD
SW SUNSET BLVD
SW BROOKMAN RD
SW BAKER RD
Chicken Creek
Cedar Creek
Rock Creek
Goose Creek
Coffee Lake Creek

FIGURE 6-5

City of Sherwood Oregon

CITY OF SHERWOOD

SANITARY SEWER MASTER PLAN
SYSTEM IMPROVEMENTS
UGB BUILD OUT

MSA Murray, Smith & Associates, Inc. Engineers/Planners
123 S.W. Salmon, Suite 900 PHONE 503.225.9010
Portland, Oregon 97204-2989 FAX 503.225.9022

SEPTEMBER 2016

Upper Tualatin Interceptor (Improvement by CWS multiple segments)

Upper Tualatin Interceptor (Force Main)

PS

Sherwood Pump Station (Improvement by CWS)

Existing Sewer is Abandoned, New Alignment to Avoid Sensitive Ecological Area

Sherwood Trunk

Rock Creek Trunk

Chicken Creek

Rock Creek

SW TUALATIN SHERWOOD RD

SW AVERY ST

NE OREGON ST

Tonquin Emp. Area (TEA)

SW ELWERT RD

SW PACIFIC HWY

SW OREGON ST

Sherwood

SW SUNSET BLVD

Brookman Concept Area

SW BROOKMAN RD

Goose Creek

SW BAKER RD

Coffee Lake Creek

Coffee Lake

SW KRUGER RD

SW ROY ROGERS RD

PS PUMP STATION
CITY BOUNDARY
STUDY AREA
WATER BODY
STREET

Improvement
Existing Pipe
New Pipe
Improvement
CWS Project

0 0.25 Mile

N W E S

G:\PDX_Projects\1511638_Sherwood_Sanitary_Sewer_MP\GIS\MXD\Sherwood_Sanitary_Collection_System_Capacity_Imp_05_23_2016.mxd 8/9/2016 9:50:07 AM SAM

May 2016

SECTION 7 | CAPITAL IMPROVEMENT PROGRAM

INTRODUCTION

This section summarizes the City of Sherwood (City) Capital Improvement Program (CIP) which consists of a list of prioritized sanitary sewer system projects and estimated costs in 2015 dollars. The CIP is a blueprint for forecasting capital expenditures, and is one of the most important means of meeting the City's obligation towards community development and financial planning. All improvements have been sized for service within the existing Urban Growth Boundary (UGB).

The CIP is a direct result of the condition analysis described in Section 3, "Existing System Description" and the capacity analysis described in Section 6, "System Analysis." All projects are analyzed at a planning level of accuracy based on population and land use assumptions described in Section 5, "Population and Flow Projections." Prior to implementation, each project should undergo standard engineering design phases to finalize improvement sizing and location.

SANITARY SEWER CAPITAL IMPROVEMENT PROGRAM

The City's CIP is organized into categories based on project type and prioritized based on system age and risk of design criteria violation. Project descriptions and cost estimates are provided in Table 7-1 and presented in Figure 7-1. The major categories are described below with reference to projects to be constructed by Clean Water Services (CWS) and projects to be constructed by the City.

Project Type

Capacity Upgrades - These improvements include existing trunk line upgrades and extensions to increase capacity for future development within the Urban Growth Boundary (UGB).

- CWS Upsize – Pipeline and pump station improvements within CWS jurisdiction including the Rock and Sherwood Trunks, Upper Tualatin Interceptor, and Sherwood Pump Station

- CWS New – New pipeline infrastructure within CWS jurisdiction including a new alignment of the Onion Flats segment of the Rock Creek Trunk

- City Upsize – Pipeline improvements within the City's jurisdiction including the Rock Creek Trunk

- City New – New pipeline infrastructure within the City's jurisdiction including extensions of the Sherwood Trunk to serve the Brookman Concept area and piping to serve the Tonquin Employment area

Condition Based Improvements – These improvements include replacement and repair of existing manholes or pipelines to address aging or poorly constructed infrastructure.

- Old Town condition improvements and extensions
- Rock Creek trunk condition improvements
- NW Rock Creek basin condition improvements
- Manhole improvements

Project Prioritization

Improvements are prioritized into three timeframes: short-term (0-5 years), medium-term (6-10 years), and long-term (11-20 years). Condition-based improvement prioritization is based on the following guideline:

- Improvements to repair and replace pipelines and manholes are assumed to occur at a similar rate of investment for each 5-10 year period.

- Improvements are prioritized based on rating severity and staff condition reports.

For development driven improvements, projects are prioritized based on risk of design criteria violation at existing and build-out conditions.

- Improvements identified in the City's current CIP for the next five years are identified in the 0-5 year timeframe.

- Existing system capacity violations are identified in the 0-5 year timeframe.

- Build-out system capacity violations resulting in dry weather criteria violations are identified in the 6-10 year timeframe.

- Build-out system capacity violations resulting in wet weather overflows are identified in the 6-10 year timeframe.

- Build-out system capacity violations resulting in wet weather freeboard violations, but not overflowing are identified in the 11-20 year timeframe.

Project Driver

In addition to the prioritization categories and timeframe, information is provided in the CIP table identifying the project catalyst or driver. Common drivers include:

- UGB Infill and Development
- Tonquin Employment Area Development
- Brookman Concept Area Development
- Infrastructure age and condition

If the driver does not materialize, a project's timeframe can be postponed without impacting the performance of the collection system. At times, phased development may be allowed without full implementation of a project. Likewise, if the project driver occurs sooner than the assumed timeframe, some improvements projects may require acceleration.

Cost Estimation

Costs presented in the CIP tables are estimated using an approach outlined in the *Basis of Opinion of Probable Cost* contained in Appendix B. This document contains the assumptions used in developing project costs, addressing such items as unit costs for materials, labor and construction, contingency factors, and the City's administrative costs.

All project descriptions and cost estimates in this document represent a Class 5 budget estimate in 2015 dollars, as established by the *American Association of Cost Engineers*. This preliminary estimate class is used for conceptual screening and assumes project definition maturity level below two percent. The expected accuracy range is -20 to -50 percent on the low end, and +30 to +100 percent on the high end, meaning the actual cost should fall in the range of 20 percent below the estimate to 100 percent above the estimate.

The cost estimates are consistent with the definition of OAR 660-011-0005(2) and OAR 660-011-035 which define "rough cost estimates" for facility plans as "approximate costs expressed in current-year dollars." These estimates are intended to "provide an estimate of the fiscal requirements to support the land use designation" and "for use by the facility provider in reviewing the provider's existing funding mechanisms." They are intended to be used as guidance in establishing funding requirements based on information available at the time of the estimate. The CIP cost estimates should be reevaluated periodically to account for changes in inflation. It is important to note that the CIP omits costs for routine maintenance.

CAPITAL IMPROVEMENT PROGRAM FUNDING

Capital improvements within the City are primarily funded through the following mechanisms:

- The City funds capital improvements impacting existing customers through utility revenues generated from sanitary sewer rates. These costs are allocated to the City's Sewer Operating Fund.

- Capital improvements for future development, or growth are funded through System Development Charges (SDCs) as allowed under Oregon Revised Statute 223.297 through 223.314. These costs are allocated to the City's Sewer SDC Fund.

The City may also seek funding and financing of specific projects through these additional internal and external sources:

- Business Oregon, including Community Development Block Grants, the Water/Wastewater program, and the Special Public Works Funds

- Developer dedications

- Oregon DEQ Clean Water State Revolving Fund
- Oregon Immediate Opportunity Program
- Oregon Industrial Development Revenue Bonds
- Oregon Infrastructure Bank
- City General Obligation Bonds
- City Local Improvement Districts
- City Sewer Revenue Bonds
- City Urban Renewal Program

SDCs and Percent Related to Growth

For each improvement project, a growth percentage is provided in the CIP table to aid the City in establishing SDCs for the sanitary sewer system. For improvements that benefit both current and new customers, the growth percentage can be applied to the project cost to allocate funding requirements through collection of SDCs.

The method used to calculate growth percentage for a proposed pipe project employs a formula (shown below) based on the ratio of existing and future flows.

Percent Related to Growth = 1 – (Peak Existing Flow / Peak Build-out Flow)

The growth percentage relates directly to SDC percentage. The percentage not related to growth is funded through sanitary sewer rates (e.g. Sewer Operating Fund).

Table 7-1 I City of Sherwood, Oregon - Capital Improvement Program									
Project Type	**Project ID**	**Project Description**	**Basin**	**Time Frame**	**Driver**	**Improvement Length (feet)**	**Improvement Diameter (inch)[3]**	**Growth Ratio[4]**	**Estimated Cost[1,2]**
Clean Water Services – Upsize Pipe and Pump Station	CWS-1	Rock Creek Trunk - Onion Flats Section	Rock Creek	5-year	UGB In-fill, Tonquin Employment Area	5,400	21	0.60	$2,430,000
	CWS-2	Sherwood Pump Station	Cedar Creek & Rock Creek	10-year	UGB In-fill, Tonquin Employment Area and Brookman Concept Area	N/A	N/A	0.60	TBD by CWS
	CWS-3	Upper Tualatin Interceptor	Cedar Creek & Rock Creek	10-year	UGB In-fill, Tonquin Employment Area and Brookman Concept Area	TBD	TBD	TBD	TBD by CWS
	CWS-4	Sherwood Trunk - SW Edy Rd to Sherwood Pump Station	Cedar Creek	10-year	UGB In-fill, Brookman Concept Area	9,800	27	0.21	$7,130,000
City - New Pipe	1	South Tonquin Employment Area pipeline extension to SW Tonquin Rd	Rock Creek	10-year	Tonquin Employment Area	2,700	10	1.0	$630,000
	2	North Tonquin Employment Area pipeline extension to SW Oregon St	Rock Creek	10-year	Tonquin Employment Area	4,100	10	1.0	$2,370,000
	3	Brookman pipeline extension - SW Brookman Rd to SW Cobble Ct	Cedar Creek	10-year	Brookman Concept Area	5,500	10	1.0	$1,870,000
City – Upsize Pipe	4	Rock Creek Trunk between SW Tualatin Sherwood Rd and Rock Creek Railroad Trestle	Rock Creek	5-year	UGB In-fill, Tonquin Employment Area	1,300	21	0.62	$780,000
Condition	8	Old Town Mains	Cedar Creek	5-year	Pipe and Manhole Condition	900	8	N/A	$240,000
	9	SW Washington, SW Schamburg	Cedar Creek	5-year	Pipe and Manhole Condition	1,100	6 - 8	N/A	$250,000
	10	Rock Creek Trunk between SW Tualatin Sherwood Rd and SW Oregon St	Rock Creek	5-year	Pipe and Manhole Condition	2,600	15	N/A	$1,400,000
	11	SW Park St, SW Park Row, SW Columbia, SW Willamette, SW Foundry	Cedar Creek	10-year	Pipe and Manhole Condition	4,400	6 - 12	N/A	$1,980,000
	12	Upstream end of Onion Flats to SW Langer Farms Pkwy	Rock Creek	20-year	Pipe and Manhole Condition	300	8	N/A	$90,000
	13	U-haul/McKillian Industrial area, between Wildrose Pl and SW Galbreth	Rock Creek	20-year	Pipe and Manhole Condition	800	8 - 10	N/A	$380,000
	14	SW Ladd Hill Rd	Cedar Creek	20-year	Pipe and Manhole Condition	100	8	N/A	$20,000
	15	Burried manhole, SW Forest Ave	Rock Creek	20-year	Manhole Condition	N/A	N/A	N/A	$3,000
	16	SW Handley St	Cedar Creek	20-year	Manhole Condition	N/A	N/A	N/A	$4,000
	17	Along railroad tracks between SW Tualatin Sherwood Rd and Rock Creek Trunk	Rock Creek	20-year	Pipe and Manhole Condition	400	10	N/A	$340,000
	18	SW Willamette at Orcutt Place	Cedar Creek	20-year	Pipe and Manhole Condition	400	6	N/A	$80,000
	19	SW Willamette at Highland Drive	Cedar Creek	20-year	Pipe and Manhole Condition	600	8	N/A	$140,000
	20	SW Gleneagle Drive	Cedar Creek	20-year	Pipe and Manhole Condition	100	8	N/A	$31,000
	21	SW Sunset Blvd	Rock Creek	20-year	Pipe and Manhole Extension/Condition	800	8	N/A	$169,000
	22	Old Town Laterals	Cedar Creek	20-year	Pipe and Manhole Condition	TBD	varies	N/A	$52,000
Master Plan	25	Master Plan Update	Cedar Creek & Rock Creek	10-year	UGB Growth and Expansion	N/A	N/A	N/A	$250,000
								Subtotal CWS (Rock Creek and Sherwood Trunks Only)	$9,560,000
								Subtotal City	$11,079,000
								Total	$20,639,000

SUMMARY

This section presents a proposed City CIP for the 20-year period between 2015 and 2035, as shown in Table 7-1 and Figure 7-1. Improvements are defined to address condition issues within the existing system and future growth within the City's UGB. The total estimated project costs for the City are summarized in Table 7-2.

Table 7-2 Capital Improvement Program Summary (Estimated Total Costs)[1,2,3]

Category	Time Frame (Cost)			Total Cost
	0-5 Years	6-10 Years	11-20 Years	
Capacity	$780,000	$4,870,000	$0	$5,650,000
Condition	$1,890,000	$1,980,000	$1,309,000	$5,179,000
Other	$0	$250,000	$0	$250,000
Total	$2,670,000	$7,100,000	$1,309,000	$11,079,000

Notes for Tables 7-1 and 7-2

Note 1. Cost estimates represent a Class 5 budget estimate, as established by the *American Association of Cost Engineers*. This preliminary estimate class is used for conceptual screening and assumes project definition maturity level below two percent. The expected accuracy range is -20 to -50 percent on the low end, and +30 to +100 percent on the high end, meaning the actual cost should fall in the range of 20 percent below the estimate to 100 percent above the estimate. The cost estimates are consistent with the definition of OAR 660-011-0005(2) and OAR 660-011-035. They are intended to be used as guidance in establishing funding requirements based on information available at the time of the estimate

Note 2. Cost estimates for all improvements assume unit costs for replacement materials and construction. All cost estimates include markups for construction contingency, owner administrative costs, and contract costs.

Note 3. All improvements are sized for build-out of the upstream service area at a planning level of accuracy based on population, density and land use assumptions described in Section 5 of this document. Improvement sizing is limited to service within the existing Urban Growth Boundary. Prior to implementation, each project should undergo standard engineering design phases to finalize improvement sizing and location.

Note 4. The growth percentage is an estimate of the percentage of the build-out flow associated with future development within the existing Urban Growth Boundary. *Percent related to growth = 1 – (Peak Existing Flow / Peak Build-out Flow).*

FIGURE 7-1

City of Sherwood Oregon

CITY OF SHERWOOD

SANITARY SEWER MASTER PLAN
CAPITAL IMPROVEMENT PROGRAM

MSA Murray, Smith & Associates, Inc. Engineers/Planners
121 S.W. Salmon, Suite 900 PHONE 503.225.9010
Portland, Oregon 97204-2910 FAX 503.225.9022

SEPTEMBER 2016

Project ID	Name
CWS-1	Onion Flats
CWS - 2	Sherwood Pump Station
CWS-3	Upper Tualatin Interceptor
CWS-4	Sherwood Interceptor Project 1
CWS-5	Sherwood Trunk Project 1
1	Southern Tonquin Emp Area extension
2	Northern Tonquin Emp Area extension
3	Brookman Extension 1
4	Rock Creek Trunk Improvement 1
8 - 22	Condition Based

Upper Tualatin Interceptor (Improvement by CWS multiple segments)

CWS - 2

CWS - 4

CWS - 1

CWS - 3

Upper Tualatin Interceptor

(Force Main)

PS

Sherwood Pump Station (Improvement by CWS)

Sherwood Trunk

Rock Creek Trunk

Existing Sewer is Abandoned, New Alignment to Avoid Sensitive Ecological Area

SW TUALATIN SHERWOOD RD

SW EDY RD

SW ELWERT RD

SW PACIFIC HWY

SW KRUGER RD

SW SUNSET BLVD

SW OREGON ST

NE OREGON ST

SW BAKER RD

SW BROOKMAN RD

SW AVE

Chicken Creek

Cedar Creek

Rock Creek

Goose Creek

Coffee Lake Creek

Sherwood

Tonquin Emp. Area (TEA)

Brookman Concept Area

PS PUMP STATION
CITY BOUNDARY
STUDY AREA *
WATER BODY
STREET

Improvement
Existing Pipe
New Pipe
Improvement
CWS Project
Condition Project

* Study Area = UGB

N W E S

0 0.5 Mile

G:\PDX_Projects\15\1638_Sherwood_Sanitary_Sewer_MP\GIS\MXD\Sherwood_Sanitary_Collection_System_Improvements_11x17_05_12_2015.mxd 8/9/2016 5:27:53 PM SAM

August 2016

APPENDIX A | INTERGOVERNMENTAL AGREEMENT

Clean Water Services
Our commitment is clear.

May 15, 2009

Craig Sheldon
Public Works Director
City of Sherwood
22560 SW Pine Street
Sherwood, OR 97140

Dear Mr. Sheldon:

Jan Kingsfather of our office sent you by email a draft of modified Appendix A, Division of Responsibilities, to the Operating Inter-Governmental Agreement, utilizing Beaverton as an example, on April 29, 2009. Since then, the Service Delivery Study (SDS) project committee has worked on its finalization. So, I would consider the attached document as a final draft of Appendix A. If you have any concerns with any of the functions contained in it, please do not hesitate to contact me to discuss.

Also enclosed is an Amendment to City Agreement, which formally modifies and approves Appendix A. As stated in it, Appendix A may be modified by the parties with the approval of the City Manager. In our SDS committee meetings, however, we discussed the fact that some cities may choose to present it to their City Councils for approval because it represents a tremendous amount of work by the representatives of the seven large Cities and District. We leave it up to each individual city regarding presentation to its Council.

Since Appendix A has an effective date of July 1, 2009, time is of the essence for approving it. I would appreciate receiving a response from you regarding the City's time line for approving it. Thank you in advance for your staff's and your help and cooperation in completing the new and, hopefully, better Appendix A.

Sincerely,

Robert C. Cruz
Deputy General Manager

Enclosure

2550 SW Hillsboro Highway • Hillsboro, Oregon 97123
Phone: (503) 681-3600 • Fax: (503) 681-3603 • www.CleanWaterServices.org

AMENDMENT TO CITY AGREEMENT

The City of Sherwood (City) and Clean Water Services (District) have entered into an Intergovernmental Agreement dated January 4, 2005. Section 3.B. of that agreement allows the parties to modify Appendix A of that Agreement (the Responsibility Matrix) with the approval of the District's General Manager or Designee and the City Manager. The revised Appendix A is attached and will take effect July 1, 2009. Both parties hereby acknowledge amending Appendix A to change the effective date to July 1, 2009.

Approved by both parties on _____, 2009.

CLEAN WATER SERVICES

By _____
General Manager or Designee

CITY OF SHERWOOD, OREGON

By _____
City Manager

Approved as to Form:

_____
District Counsel

_____
City Attorney

APPENDIX A	EFFECTIVE JULY 1, 2009		V3 Revised 6/16/09	
Sherwood				
DIVISION OF RESPONSIBILITIES				
	Inside City, and Inside "Areas of Assigned Service Responsibility"	Outside City, and Inside "Areas of Assigned Service Responsibility"	Inside City, and Outside "Areas of Assigned Service Responsibility"	
I. Sanitary Maintenance				
A. Local Program				
Lines under 24"				
Line Cleaning	City	City	District	
Manhole and lid maintenance and adjustment (excluding sealing)	City	City	District	
Root Cutting and Chemical Control	City	City	District	
Maintenance TV inspection (See Engineering Section for new construction TV)	City	City	District	
Vector Control	City	City	District	
Surface Inspection, marking, self closing lids, of lines in stream corridors	City	City	District	
Easement and Access Road Maintenance	City	City	District	
Siphon maintenance where line leading to siphon is under 24"	City	City	District	
Overflow and Complaint response, investigation, and reporting	City	City	District	
Emergency response	City	City	District	
Utility Locates	City	City	District	
Minor repairs including point repairs and individual laterals	City	City	District	
B. District Wide Program				
Lines 24" and Larger				
All O&M on lines 24" and larger	District	District	District	
Siphon maintenance where line leading to the siphon is 24" and larger	District	District	District	
All Lines and All Areas				
Compilation of TV reports and system-wide evaluation	District	District	District	
Non-structural line sealing (pressure grouting)	District	District	District	
Manhole rehabilitation (sealing)	District	District	District	
Treatment Plant O&M	District	District	District	
Pump Station O&M	District	District	District	

II. Sanitary CIP (Service Charge Rate and SDC Funded) -- See Attachment 1 for detailed responsiblility	Inside City, and Inside "Areas of Assigned Service Responsibility"	Outside City, and Inside "Areas of Assigned Service Responsibility"	Inside City, and Outside "Areas of Assigned Service Responsibility"	
A. Local Program				
Lines 12" and Under				
Repairs, replacements, reconstruction, rehabilitation, CIP construction and improvements (except projects for Conveyance system I&I abatement projects). Project Management to be determined by the City, with the exception of the middle column	City	District	City	
B. District Wide Program				
Lines Larger than 12" and under 24"				
Repairs, replacements, reconstruction, rehabilitation, CIP construction and improvements except projects for Conveyance system I&I abatement projects; Funding responsibility only; Project management to be determined by the City, with the exception of the middle column	District *	District *	District *	
Lines 24" and Larger				
Repairs, replacements, reconstruction, rehabilitation, CIP construction and improvements	District	District	District	
All Other Facilities (Project Management to be determined by District)				
Treatment Plant CIP	District	District	District	
Pump Station CIP	District	District	District	
C. I&I Repairs and Rehabilitaion				
Conveyance system repairs and rehabilitation to abate I&I; Funding responsibility only; Project management to be determined by the City with the exception of the middle column	City and District 50/50 Funding*	District Funding*	City and District 50/50 Funding*	

III. SWM Maintenance	Inside City, and Inside "Areas of Assigned Service Responsibility"	Outside City, and Inside "Areas of Assigned Service Responsibility"	Inside City, and Outside "Areas of Assigned Service Responsibility"
A. Local Program			
Line Cleaning	City	City	District
Manhole maintenance and adjustment	City	City	District
Manhole repair and grouting	City	City	District
Root Cutting	City	City	District
TV inspection (except related to new construction)	City	City	District
Catch Basin cleaning	City	City	District
Water quality manhole cleaning	City	City	District
Local surface retention/detention facility maintenance	City	City	District
Filter vault inspection and maintenance	City	City	District
Complaint response, investigation, and reporting	City	City	District
Storm and emergency response	City	City	District
Roadside ditches and piping system in City Roads	City	None	City
Street Sweeping	City	City	District
Placement of catch basin and other material from storm system structures into drop boxes or other designated locations (excluding leaves)	City	City	District
Maintenance of public streams/creeks/open channels	City	City	District
Proactive leaf management program including leaf collection, hauling, processing and disposal	City	City	District
Hauling, processing and disposal of sweeper material	City	City	District
Hauling, processing and disposal of catch basin and other material from storm system structures	District	District	District
Culvert maintenance under 36" in City Roads	City	City	District
Culvert maintenance 36" and larger and bridge maintenance in City Roads	City	None	City
Culvert maintenance under 36" in County Roads	City	City	District
Culvert maintenance 36" and larger and bridge maintenance in County Roads	County	County	County
Vector Control including mosquito treatment, beaver, nutria, rats and others that impact the storm system	City	City	District
Utility Locates	City	City	District
Repairs, replacements, reconstruction, rehabilitation, CIP construction and improvements. Note: It is anticipated these responsibilities will change to more closely match the CIP shown under Sanitary beginning July 1, 2009	City	District	City
B. District Wide Program			
Regional surface treatment or control facilities where the treatment area is 1 acre or larger	District	District	District
Roadside ditches and piping system maintenance in County Roads	District through County funding	District through County funding	District through County funding
Compilation of TV reports and system-wide evaluation	District	District	District

IV. ENGINEERING, INSPECTION, AND SUPPORT ELEMENTS	Inside City, and Inside "Areas of Assigned Service Responsibility"	Outside City, and Inside "Areas of Assigned Service Responsibility"	Inside City, and Outside "Areas of Assigned Service Responsibility"
A. Local Program			
Maintaining local GIS information	City	District	City
Maintaining local system mapping	City	District	City
Maintaining Engineering records of systems	City	District	City
MMIS	City	City	District
Service Provider Letter Pre-screening	District	District	District
Service Provider Letters Issuance	District	District	District
Development Process (development review, plan review, land use)	City	District	City
Sanitary Sewer connection permit issuance	City	District	City
SWM connection permit issuance	City	District	City
Erosion control permit issuance	City	District	City
1200C Permit	City	District	City
Inspection of developer projects and new construction	City	District	City
Erosion control inspection	City	District	City
Post construction TV	City	District	City
1-year warranty TV	City	District	City
Fat, Oil and Grease Program	City	District	City
Preparing and revising local sanitary sewer masterplans	City	District	City
Preparing and revising local SWM masterplans	City	District	City
Formation and Administration of LID's	City	District	City
Cross connection investigation and response	City	City	District
Inspection of Private Facilities	City	District	City
Fixture Counting	City	District	City
Billing and collection of monthly service charges	City	District	City
Response to customer billing inquiries	City	District	City
B. District Wide Program			
Industrial Waste Program	District	District	District
Maintaining system-wide GIS and mapping	District	District	District
Preparing and maintaining system-wide storm and sanitary masterplans	District	District	District
Public information, newsletters, etc., for SWM and Sanitary programs**	District	District	District
Flow Monitoring	District	District	District
Sanitary sewer connection permit issuance authorization	District	District	District
SWM connection permit issuance authorization	District	District	District
Preparation of five-day letter	District	District	District
Notes			
1. Where "District *" is shown, this does not preclude a City funding a project with its own source of funds and also does not limit the ability for District and City to agree as to who actually performs the work.			
2. ** "Public Information" is the overall ad and public information campaigns (TV, radio, brochures, etc.) and does not include the activities related to local projects and local maintenance which are a part of those activities			

SANITARY CAPITAL IMPROVEMENT PROGRAM FUNDING RESPONSIBILITY

Pipe Size, New	Responsibility	SDC Eligible
12-inch and smaller	Local	Yes, 100%
Larger than 12 inches	District-Wide*	Yes, 100%

Pipe Size, Replacement/Upsize	Responsibility	SDC Eligible
From 12-inch and smaller to 12-inch and smaller	Local	Yes, Proportional to new capacity provided
From 12-inch and smaller to larger than 12-inch	Shared cost based on proportionate capacity*	Yes, Proportional to new capacity provided
From larger than 12-inch to larger than 12-inch	District-Wide	Yes, Proportional to new capacity provided

*Note: A Local share is required based on the capacity of a 12-inch pipe

AMENDMENT TO INTERGOVERNMENTAL AGREEMENT BETWEEN CITY OF SHERWOOD AND CLEAN WATER SERVICES

THIS AMENDMENT is made and entered into as of the 1st day of July, 2008, between the **City of Sherwood,** a municipal corporation of the State of Oregon, hereinafter referred to as "City," and **Clean Water Services**, a municipal corporation and county service district, hereinafter referred to as the "District."

WHEREAS City and District entered into an Intergovernmental agreement (IGA) on January 4, 2005 for the operation of sanitary sewer and surface water facilities; and

WHEREAS Section 7 of that IGA allows the agreement to be amended upon approval of the governing bodies of both parties; and

WHEREAS that IGA is now in need of amendment.

NOW, THEREFORE, it is agreed that the IGA be amended as follows:

1. In the recitals, revise the second "Whereas" statement to read:

   WHEREAS as a county service district organized under ORS 451, the District has the legal authority for the sanitary sewerage and storm water (surface water) management programs within its boundaries consistent with relevant laws, rules and agreements. The District performs watershed, sub-basin and facility planning, develops standards and work programs, is the permit holder, and operates and maintains wastewater treatment facilities, ~~surface water collection system and~~ the public sanitary sewer conveyance systems, and the public surface water collection systems within ~~unincorporated areas and within certain cities within~~ its boundaries~~. The District also performs various ancillary functions throughout the basin and within various cities~~; and

2. In Section 1, Definitions, add the following new definitions, number them alphabetically, and renumber the existing definitions:

   A. Local Program – The elements of the work program that are available for the City to perform.

   B. District Wide Program – The elements of the work program that are performed exclusively by the District in all areas within the District's boundary.

   C. Roadside Facilities include all of the following stormwater facilities within road rights of way:

1. Roadside Ditches and Swales are man-made ditches on one or both sides of roadways, within the road right-of-way and generally intended for the collection and conveyance of storm and surface water runoff from the road.

2. Driveway Culverts are short pipes passing under driveways connecting two sections of roadside ditch.

3. Roadside Ditch Cross Piping is the piping system connecting a roadside ditch or roadside piping system on one side of the road to a roadside ditch or roadside piping system on the other side of the road, and being at the grade of the roadside ditches or piping systems.

4. Roadside Piping Systems are shallow pipes and inlets on one or both sides of a road, which are generally at a similar grade as typical roadside ditches, and generally lack manholes.

3. Revise Section 2 to read:

"Section 2. Determination of Programs, Rules, Policies and Standards

The District is responsible for the management and operation of the public sanitary sewer and storm and public surface water systems within its boundary, and is the designated permittee who shall obtain and enforce timely compliance with relevant Federal and delegated State Clean Water Act permits for treatment plants, collection systems, and stormwater. The District, after considering input from the cities, shall adopt orders, standards, specifications, work programs, reporting requirements, and performance criteria for the proper and effective operation of the sanitary sewer and storm and surface water systems and to comply with State and Federal permits, laws and regulations. In addition, the District, after considering input from the cities, shall have the authority to make changes to its orders, work programs, reporting requirements, and performance Standards. Any such changes to work programs, reporting requirements, and performance standards that the Board determines are necessary to meet or are required by state and/or federal permits or regulations will become effective 90 days from the date of notice to City by District or as mutually agreed to. Any changes to work programs, reporting requirements, and performance standards, not required by state and/or federal permits and regulations, shall be mutually agreed to by the District and City before they become effective. Proposed changes not required by state and/or federal permits and regulations should be communicated between the District and the City in or before December of the year before they are to be implemented to allow District and City to budget appropriately for the following fiscal year.

A. City agrees to follow and enforce the Orders, Standards, specifications, work programs, reporting requirements, and performance criteria promulgated by the District, subject, however, ~~to program funding and~~ to the extent that City may be lawfully authorized to act. The City shall not be responsible for any failure to act or defect in performance caused by ~~lack of adequate program funding,~~ inadequacies in the Work Program and Performance Standards as adopted by the District, or lack of lawful authority to act. ~~Lack of adequate~~

~~funding from the District and~~ Compliance with the Work Program and Performance Standards as adopted by the District shall be absolute defenses to any claim against the City under this Agreement. City further agrees to notify District of apparent violations of the subject Orders, Standards, specifications, work programs, and performance criteria, of which it has knowledge, which may require District legal action or enforcement.

4. Revise Section 3.A.1 to read:

   The purpose of this agreement is to delegate to and contract with the City to perform specific ~~functions~~portions of the Local Program. The responsibilities of the District and City are defined in this Section and Appendix A. Exhibit A is a map showing boundaries of responsibility between the District and City and is hereby made a part of Appendix A and incorporated into this agreement.

5. Revise Section 3.B.2 to read:

   Responsibilities defined in this Section and Appendix A may be modified by the District Board after receiving input from the City and determining the change is necessary to meet or comply with State or Federal permits, laws or regulations. The District Board shall not reduce the total scope of City responsibilities without consent of the City unless there is a change in the program or funding requiring the reduction, or unless the Board determines the City has failed to correct identified instances of nonperformance related to the adopted standards that are necessary to meet or comply with state or federal permits, laws or regulations. The District Board may adopt procedures regarding determination of nonperformance.

6. Revise Section 3.B.3 to read:

   Upon reasonable notice from City to District, District shall assume responsibility for any portion of the Local Program defined in this Section and Appendix A. Reasonable notice shall be at least 6 months, unless agreed to in writing by the District and City. Corresponding adjustments to the revenue allocation shall be made to reflect the change in responsibility upon implementation of such changes. City shall be responsible for correcting or paying to have corrected any deficiencies in the system resulting from non-performance of the programs under its responsibility~~, subject, however, to funding availability~~. For any Local Program activity the City previously elected to be performed by the District, the City may at any time request that activity be transferred back to being a City responsibility by following the procedures in Section 3.B.1 above. The District shall approve the request unless the District determined the City can not provide a reasonably equivalent level of overall efficiency. The date of the transfer of responsibility shall be as mutually agreed to, or in no case longer than one year from the date of the request.

7. Revise Section 3.C.2 to read:

   Require persons who are proposing 'development', as defined in the District's Design and Construction Standards Resolution and Order, to obtain a Service Provider Letter from the District. City shall not issue a stormwater connection permit without verification that the District has issued a Service Provider Letter.

8. Revise Section 3.C.6 to read:

   Inform the District in writing not less than 30 days prior to initiating or entering into any agreement for the financing or incurring of indebtedness relating to the storm and surface water system or the sanitary sewerage system. Revenues ~~allocated by the District to the City~~ defined in Section 4 of this agreement for the performance of functions identified in Appendix A are considered restricted, and may only be used to perform those functions (including reasonable administration) delegated to the City for such things as operation and maintenance of the sanitary or storm and surface water system. City shall not obligate any assets or facilities of the District's sanitary or storm and surface water system for any debt. For purposes of debt funding, the District's asset schedule for storm and surface water and sanitary sewer facilities shall be the basis for determining ownership within City boundaries. In general, sanitary sewer lines 24" and over are the property of the District regardless of location, as are sanitary treatment plants and pump stations, and storm and surface water quality and quantity facilities that are one acre or greater in surface area.

9. Revise Section 4 to read:

   Section 4. Determination of Monthly Service Charge Rates and System Development Charges; ~~and Division of Revenue;~~ Operating Procedures and Rules Relating to Revenue and Reporting

   A. ~~After consultation between City and district staff, the District Board shall determine and certify annually for both the sanitary sewerage system and for the storm and surface water system the monthly service charge and system development charge. The City agrees to impose these charges as a minimum. The City may impose additional charges as allowed in Section 4.E.4.~~

   B. ~~After consultation between City and district staff, the District Board shall determine and certify annually for both the sanitary sewerage system and for the storm and surface water system the portion of the monthly service charge and system development charge to be retained by the City for performance of the functions defined in this Agreement and for the City's share of annual debt service payment. Except as provided in Section 4.D, District shall notify City by the September preceding the start of the next Fiscal Year of any proposed decrease in the monthly service charge and system development charge to be retained by the City and any other proposed changes that could affect the City's 5-Year Sanitary Sewer or Stormwater Financial Forecast Plans.~~

~~C. The District Board shall not implement any significant change in the division of monthly service charge revenue from that shown in the Rates and Charges Resolution and Order No. 01-34 effective Fiscal Year 2001/2002 until July 1, 2004 with the following exceptions:~~

~~1. The Board may make routine principal and interest adjustments for debt service repayment.~~

~~2. The Board may make adjustments in response to significant increases or decreases in program responsibilities~~

A. Setting of Rates and Charges

1. After consultation between City and District staff, the District Board shall determine and certify for the Storm and Sanitary Sewer programs:

   a. District Wide System Development Charges that apply in all areas within the District boundary.
   b. Local System Development Charges that apply to areas outside of the City Limits.
   c. District Wide Monthly Service Charge Rates that apply in all areas within the District boundary.
   d. Monthly Service Charge Rates for the Local Program that apply to the areas outside the City limits.
   e. Funding levels for elements of the Local Program performed by the District within the City's Area of Geographic Responsibility.
   f. Funding levels for elements of the Local Program performed by the District within the City Limits but outside of the City's Area of Geographic Responsibility.
   g. Funding levels for elements of the Local Program performed by the City outside of the City Limits but inside the City's Area of Geographic Responsibility.
   h. Funding levels for elements of the Local Program performed by the District within the City Limits but outside of the City's Area of Geographic Responsibility where the City identifies a higher level of service than in the District's adopted standards.
   i. Elements within items "e" through "h" of this subsection may be expressed in terms of monthly service charge rates or rates per unit of facility.

2. The City shall set for the Storm and Sanitary Sewer programs:
   a. Local System Development Charges that apply to areas inside the City Limits.
   b. Monthly Service Charge Rates for the Local Program that apply to the areas inside the City Limits.

B. Collection of Rates and Charges as set in Section A above
1. The District shall collect for both the Storm and Sanitary Sewer programs:
   ~~a. System Development Charges in areas where the District issues connection~~ permits.

b. Local and District Wide Monthly Service Charges in areas where the District provides the billing function.

2. The City shall collect for both the Storm and Sanitary Sewer programs:
   a. Local and District Wide System Development Charges in areas where the City issues connection permits.
   b. The Monthly Service Charges for the District Wide Rate and the Local Rate in areas where the City provides the billing function.

C. Transfer and Remittance of Funds

1. The District shall transfer to the City the portion of the Storm and Sanitary Sewer revenue from the Local Rate collected for the elements of the Local Program performed by the City in areas that are inside the City's Area of Geographic Responsibility, but where the District does the billing.

2. The City shall transfer to the District for the Storm and Sanitary Sewer Programs:

   a. Revenue from the District Wide System Development Charges collected by the City.
   b. Revenue from the District Wide Monthly Service Charge Rate collected by the City.
   c. The portion of the revenue from fees and the Local Monthly Service Charge rate for the elements of the Local Program performed by the District within the City Limits and within the City's Area of Geographic Responsibility.
   d. The portion of the revenue from fees and the Local Monthly Service Charge rate for the elements of the Local Program performed by the District within the City Limits but outside the City's Area of Geographic Responsibility.
   e. Funds for performance of elements of the work program by the District within the City Limits but outside the City's Area of Geographic Responsibility where the City has identified a higher level of service than in the adopted District standards.

D. ~~Changes in the division of revenue will typically be made as a part of the annual Fiscal Year budget process. However, the division of revenue may be adjusted by the District to recognize changes in responsibilities that occur outside the normal budget cycle after coordination and communication with the Cities. Any such mid-year changes in the division of revenue initiated by the District Board shall only be implemented when the Board determines such a change is necessary to comply with State or Federal permits, laws or regulations. If there is a mid-year change in responsibilities, which the District determines to be significant, the District Board may, upon 60 days notice to City, adjust the division of revenue outside of the annual budget process.~~ Determination by the District of the items in Section 4.A.1 will typically be made as a part of the annual Fiscal Year budget process. However, these rates and funding levels may be adjusted by the District to recognize changes that occur outside the normal budget cycle after coordination and communication with the Cities. Any such mid-year changes initiated by the District Board shall only be implemented when the Board determines such a change is

necessary to comply with State or Federal permits, laws or regulations, or that are due to changes in responsibility.

E. Operating Procedures Relating to Revenue

~~1. City shall remit to the District the portion of sanitary sewer service charges and systems development charges collected, and storm and surface water service charges and systems development charges collected, less the City Portion, as identified in Section 4.B.~~

1. Payments shall be remitted on a monthly basis, with a report on District designated forms.

2. Payments ~~to the District~~ of revenue collected by the billing party shall be due within 20 days following the end of each month, unless the payment has been appealed by the billing party.

3. City may charge and collect a Local Monthly Service Charge or System Development Charge at a higher rate per DUE and ESU than that set by the District when the City determines it is needed for the Local ~~City~~ Program elements performed by the City. ~~system. The City shall retain 100% of these additional revenues collected.~~ Such additional charge shall be consistent with the services provided by City and with applicable federal rules in order to preserve eligibility for grants and other funding programs.

~~4. City may request District to perform permit and inspection services for private development construction of public storm and surface water facilities and sanitary sewer facilities, and for erosion control. City shall remit to the District the fee set forth in District's Rates and Charges to compensate District for its costs for such services performed relative to these fees, as prescribed by District Order or separate agreement with City.~~

4. For Industrial Waste fees, District shall remit to City 5 percent ~~a percentage~~ of system development charges, and 15 percent of the volume, and monthly service charges collected within the City's Area of Responsibility~~equal to the percentages of service charges retained by the City as defined in Section 4.B~~. District shall retain one hundred percent (100%) of the annual Industrial Waste permit fee, and any penalty fees, COD, SS (as those terms are defined in the Rates and Charges) and other fees related to Industrial Waste that may be assessed.

5. City will institute administrative procedures to diligently maintain regular billings and collection of fees, adjust complaints thereto, and pursue delinquency follow-ups and take reasonable steps for collection thereof.

~~6. City and District shall each establish separate accounts for the storm and surface~~ water program and sanitary sewerage program for the purpose of accounting for

service charges and systems development charges collected and received pursuant to this agreement.

7. District or City may at any reasonable time upon reasonable notice inspect and audit the books and records of the other with respect to matters within the purview of this Agreement.

8. City and District shall each prepare and submit to each other a performance report of the storm and surface water functions, and the sanitary sewer functions for which each is responsible. After consultation with the City, District will specify the requirements, frequency, and content of the performance report.

9. The City and District may, each at its own cost, install permanent and temporary volume and quality monitoring stations, and other monitoring equipment, to determine the effectiveness of City and District programs.

10. Interest shall accrue on late monthly payments as specified in Section 4.C~~E.1~~ at a rate of 1.25 times the monthly Local Government Investment Pool (LGIP) earnings rate as posted for the previous month, and will be applied each month to the unpaid balance.

11. The City and District will form a CIP Review Committee along with representatives from other Cities within the District's boundary for the purpose of recommending the prioritization and funding of sanitary sewer and Stormwater collection system projects. Board will adopt the CIP funding and project selection only after holding a public hearing to allow the Cities to provide additional input to the Board.

10. Revise Section 5.G to read:

District and City acknowledge that District may receive notices of violation or fines from state or federal agencies for violations of state or federal rules. As the permittee and the entity that establishes standards and controls payment, District shall be responsible for responding to notices of violations and for payment of all fines. District shall invite the City to participate in any discussions with State and Federal agencies regarding notices of violation involving City actions or responsibility. City will cooperate with District in the investigation and response to any notice of violation involving actions relating to actions or responsibilities of the City. If a fine is imposed, City shall reimburse District to the extent that the fine results from non-performance of adopted programs or non-compliance with District, State, or Federal rules or policies by the City and those acting on behalf of the City. If possible, the City shall reimburse the District prior to the date due for payment of the fine. ~~The City shall not be responsible for reimbursement if the City's non-performance or non-compliance was caused by lack of adequate funding by District.~~ If more than one party is responsible, the City's responsibility for reimbursement payment will be allocated based on the degree of responsibility and degree of fault of the City. Disputes over the amount of reimbursement shall be resolved by the dispute resolution process set out in Section 6 of this Agreement. ~~To the extent that the City is required to perform any work to correct a violation,~~

~~District shall provide adequate funding for the work to be performed, unless the violation was caused by the City's omission or misconduct.~~

11. Revise Section 7 to read:

1. This Agreement shall supersede all prior agreements of similar scope and subject matter, including amendments and the "City Committee Agreement" between the parties with respect to sanitary sewerage and service, storm and surface water management; provided that, except as expressly modified herein, all rights, liabilities, and obligations of such prior agreements shall continue. This agreement shall be effective upon its execution by both parties hereto, and unless terminated earlier, shall end at the end of the day on June 30, 2027 ~~and shall continue in effect for four renewable terms of five years each~~.

2. ~~This Agreement shall be deemed automatically renewed for a single succeeding five year term up to a limit of 25 years, unless either party gives the other written notice not less than one year prior to the nominal expiration of term of its intent not to renew this agreement~~. This agreement may be terminated when either party gives the other written notice per the dates in the table below of its intent not to renew this agreement, and the agreement shall then terminate on June 30 of the following calendar year.

Notice given on or prior to June 30 of	Termination effective at the end of the day on June 30 of
2009	2010
2010	2011
2011	2012
2016	2017
2021	2022

3. The notice of termination may be withdrawn at any time prior to the termination date with written approval of the City's Chief Executive Officer and District General Manager.

4. If District enters into an intergovernmental agreement with any other city in its territory covering the same subject as this Agreement and if any of the provisions of the other agreement differ from this Agreement, the City may elect to replace any provision of this Agreement with the parallel provision from the other agreement, with the exception of Appendix A and Exhibit A. The replacement shall be effective on receipt by District of written notice from the City. This Agreement may not otherwise be modified except by written amendment or as otherwise specified in this Agreement.

IN WITNESS WHEREOF, this instrument has been executed in duplicate by authority of lawful actions by the Council and District's Board of Directors.

CLEAN WATER SERVICES

By _____
FOR General Manager

Approved as to Form:

_____
Attorney for District

CITY OF SHERWOOD, OREGON

By _____
City Manager

Attest: _____
City Recorder

_____
City Attorney

AMENDMENT TO CITY AGREEMENT

The City of Sherwood (City) and Clean Water Services (District) have entered into an Intergovernmental Agreement dated January 4, 2005. Section 3.B of that agreement allows the parties to modify Appendix A of that agreement (the Responsibility Matrix) with the approval of the District's General Manager and the City's Administrator/Mayor. The revised Appendix A is attached and will take effect July 1, 2008. Both parties hereby acknowledge amending Appendix A to change the effective date to July 1, 2008.

Approved by both parties on July 1, 2008.

CLEAN WATER SERVICES

By _____
For General Manager

CITY of Sherwood, OREGON

By _____
City Administrator/Mayor

Approved as to Form:

_____
District Counsel

_____
City Attorney

APPENDIX A				V12b 4/14/08
Sherwood				
DIVISION OF RESPONSIBILITIES	**EFFECTIVE JULY 1, 2008**			
	Inside City, and Inside "Areas of Assigned Service Responsibility"	Outside City, and Inside "Areas of Assigned Service Responsibility"	Inside City, and Outside "Areas of Assigned Service Responsibility"	Effective Dates. Unless shown differently, activities are effective July 1, 2008 and continue through the term of the agreement
I. Sanitary Maintenance				
A. Local Program				
Lines under 24"				
Line Cleaning	City	City	District	
Manhole and lid maintenance and adjustment (excluding sealing)	City	City	District	
Root Cutting and Chemical Control	City	City	District	
Maintenance TV inspection (See Engineering Section for new construction TV)	City	City	District	
Vector Control	City	City	District	
Surface Inspection, marking, self closing lids, of lines in stream corridors	City	City	District	
Easement and Access Road Maintenance	City	City	District	
Siphon maintenance where line leading to siphon is under 24"	City	City	District	
Overflow and Complaint response, investigation, and reporting	City	City	District	
Emergency response	City	City	District	
Utility Locates	City	City	District	
Minor repairs including point repairs and individual laterals	City	City	District	
B. District Wide Program				
Lines 24" and Larger				
All O&M on lines 24" and larger	District	District	District	
Siphon maintenance where line leading to the siphon is 24" and larger	District	District	District	
All Lines and All Areas				
Compilation of TV reports and system-wide evaluation	District	District	District	
Non-structural line sealing (pressure grouting)	District	District	District	
Manhole rehabilitation (sealing)	District	District	District	
Treatment Plant O&M	District	District	District	
Pump Station O&M	District	District	District	

II. CIP (Service Charge Rate and SDC Funded)	Inside City, and Inside "Areas of Assigned Service Responsibility"	Outside City, and Inside "Areas of Assigned Service Responsibility"	Inside City, and Outside "Areas of Assigned Service Responsibility"	
A. Local Program				
Lines Under 24"				
Repairs, replacements, reconstruction, rehabilitation, CIP construction and improvements	City	District	City	This row is effective July 1, 2008 through June 30, 2009***
Repairs and rehabilitation to abate I&I	City	District	City	This row is effective July 1, 2008 through June 30, 2009***
Lines Under 12"				
Repairs, replacements, reconstruction, rehabilitation, CIP construction and improvements (except projects for Collection system I&I abatement projects)	City	District	City	This row is effective beginning July 1, 2009 and continues through the term of the agreement.***
B. District Wide Program				
Lines 24" and Larger				
Repairs, replacements, reconstruction, rehabilitation, CIP construction and improvements	District *	District *	District *	This row is effective July 1, 2008 through June 30, 2009***
Lines 12" and Larger				
Repairs, replacements, reconstruction, rehabilitation, CIP construction and improvements	District *	District *	District *	This row is effective beginning July 1, 2009 and continues through the term of the agreement.***
All Lines and All Areas				
Treatment Plant CIP	District	District	District	
Pump Station CIP	District	District	District	
Collection system repairs and rehabilitation to abate I&I	District *	District *	District *	This row is effective beginning July 1, 2009 and continues through the term of the agreement.***

III. SWM Maintenance	Inside City, and Inside "Areas of Assigned Service Responsibility"	Outside City, and Inside "Areas of Assigned Service Responsibility"	Inside City, and Outside "Areas of Assigned Service Responsibility"	
A. Local Program				
Line Cleaning	City	City	District	
Manhole maintenance and adjustment	City	City	District	
Manhole repair and grouting	City	City	District	
Root Cutting	City	City	District	
TV inspection (except related to new construction)	City	City	District	
Catch Basin cleaning	City	City	District	
Water quality manhole cleaning	City	City	District	
Local surface retention/detention facility maintenance	City	City	District	
Filter vault inspection and maintenance	City	City	District	
Complaint response, investigation, and reporting	City	City	District	
Storm and emergency response	City	City	District	
Roadside ditches and piping system in City Roads	City	None	City	
Street Sweeping	City	City	District	
Placement of sweeper, catch basin and other material from storm system structures into drop boxes or other designated locations (excluding leaves)	City	City	District	
Maintenance of public streams/creeks/open channels	City	City	District	
Proactive leaf management program including leaf collection, hauling, processing and disposal	City	City	District	
Hauling, processing and disposal of sweeper, catch basin and other material from storm system structures	City - Sweeper Material District - All Others	City	City - Sweeper Material District - All Others	
Culvert maintenance under 36" in City Roads	City	City	District	
Culvert maintenance 36" and larger and bridge maintenance in City Roads	City	None	City	
Culvert maintenance under 36" in County Roads	City	City	District	
Culvert maintenance 36" and larger and bridge maintenance in County Roads	County	County	County	
Vector Control including mosquito treatment, beaver, nutria, rats and others that impact the storm system	City	City	District	
Utility Locates	City	City	District	
Repairs, replacements, reconstruction, rehabilitation, CIP construction and improvements	City	District	City	This row is effective July 1, 2008 through June 30, 2009****
B. District Wide Program				
Regional surface treatment or control facilities where the treatment area is 1 acre or larger	District	District	District	
Roadside ditches and piping system maintenance in County Roads	District through County funding	District through County funding	District through County funding	
Compilation of TV reports and system-wide evaluation	District	District	District	

IV. ENGINEERING, INSPECTION, AND SUPPORT ELEMENTS	Inside City, and Inside "Areas of Assigned Service Responsibility"	Outside City, and Inside "Areas of Assigned Service Responsibility"	Inside City, and Outside "Areas of Assigned Service Responsibility"	
A. Local Program				
Maintaining local GIS information	City	District	City	
Maintaining local system mapping	City	District	City	
Maintaining Engineering records of systems	City	District	City	
MMIS	City	City	District	
Service Provider Letter Pre-screening	District	District	District	
Service Provider Letters Issuance	District	District	District	
Development Process (development review, plan review, land use)	City	District	City	
Sanitary Sewer connection permit issuance	City	District	City	
SWM connection permit issuance	City	District	City	
Erosion control permit issuance	City	District	City	
1200C Permit	City	District	City	
Inspection of developer projects and new construction	City	District	City	
Erosion control inspection	City	District	City	
Post construction TV	City	District	City	
1-year warranty TV	City	District	City	
Fat, Oil and Grease Program	City	District	City	
Preparing and revising local sanitary sewer masterplans	City	District	City	
Preparing and revising local SWM masterplans	City	District	City	
Formation and Administration of LID's	City	District	City	
Cross connection investigation and response	City	City	District	
Inspection of Private Facilities	City	District	City	
Fixture Counting	City	District	City	
Billing and collection of monthly service charges	City	District	City	
Response to customer billing inquiries	City	District	City	
B. District Wide Program				
Industrial Waste Program	District	District	District	
Maintaining system-wide GIS and mapping	District	District	District	
Preparing and maintaining system-wide storm and sanitary masterplans	District	District	District	
Public information, newsletters, etc., for SWM and Sanitary programs**	District	District	District	
Flow Monitoring	District	District	District	
Sanitary sewer connection permit issuance authorization	District	District	District	
SWM connection permit issuance authorization	District	District	District	

Notes

1. Where "District *" is shown, this does not preclude a City funding a project with its own source of funds and also does not limit the ability for District and City to agree as to who actually performs the work.
2. ** "Public Information" is the overall ad and public information campaigns (TV, radio, brochures, etc.) and does not include the activities related to local projects and local maintenance which are a part of those activities

***Scheduled to be finalized and adopted by governing bodies by December 31, 2008, to reflect local and District Wide funding.

****Scheduled to be reviewed with changes adopted by governing bodies during fiscal year 2009.

APPENDIX B | BASIS OF OPINION OF PROBABLE COST

INTRODUCTION

This section summarizes the approach used in development of unit costs and project costs used in the Capital Improvement Program (CIP).

All project descriptions and cost estimates in this document represent a Class 5 budget estimate, as established by the American Association of Cost Engineers. This preliminary estimate class is used for conceptual screening and assumes project definition maturity level below two percent. The expected accuracy range is -20 to -50 percent on the low end, and +30 to +100 percent on the high end, meaning the actual cost should fall in the range of 50-percent below the estimate to 100-percent above the estimate.

Cost estimates are intended to be used as guidance in establishing funding requirements based on information available at the time of the estimate. The procedure used to generate cost information presented herein is consistent with the definition of "rough cost estimates" under OAR 660-011-0005(2) and OAR 660-011-035. The final cost of individual projects will depend on actual labor and material costs, site topography, existing utility installations within the limits of work, competitive market conditions, regulatory requirements, project schedule, contractor bidding strategies and other factors. All cost estimates are in 2015 dollars.

Due to the project definition maturity level at this phase in system planning, the following considerations are excluded from the opinion of costs:

- Land or Right-of-Way Acquisition;
- Required improvements or upgrades to the Durham AWWTF to accommodate system expansion;
- Studies, planning or modeling of the Transportation System, Sanitary System, Water System, or Stormwater System;
- Borrowing or finance charges during the planning, design, or construction of assets;
- Improvements to distribution, conveyance, pumping, storage, or treatment facilities in response to changes in regulatory standards or rules;
- Remediation or fines associated with system violations.

PROJECT COST DEVELOPMENT

Project costs were developed through a progression of steps, starting with development of construction costs. Construction costs consist of the sum of materials, labor and equipment of easily identifiable features of a project such as piping, manholes, trench work, and road work. The estimated costs for each improvement are based on averages from the *RS Means Heavy Construction Cost Data* (Reed Construction Data, 2015), supplemented with quotes from local suppliers, City input and construction costs for similar projects near the City of Sherwood. Information from RS Means is derived from a national average of construction

cost indexes from over 700 cities. To correlate these costs to local market conditions, a Portland market location factor was applied to both materials (98.8) and labor (100.4). The historical cost index for the date of publication is 206.7 (January 2015).

Component Unit Costs

The unit costs are applied to improvement pipe lengths for varied depths and assumed manhole spacing at approximately 400 feet. The unit costs account for the materials, labor, and equipment necessary to complete the improvements. Unit costs for wastewater collection system improvements are shown in Tables B-1 through B-6. These costs include considerations for:

- Trench saw cutting, excavation and hauling of waste;
- Importing and placement of pipe zone bedding;
- Trench backfill and compaction of native soils;
- Pipe material and installation labor;
- Trench safety systems (temporary shoring or trench box);
- Testing and video inspection;
- Surface restoration of unpaved streets, or paved local versus arterial roads;
- Dewatering;
- Bypass pumping on pipe replacement projects.
- Subcontractor's markup for profit and overhead

The CIP presents projects defined into three categories; existing system capacity upgrades, condition based improvements, and new infrastructure for future development. The unit costs were applied differently depending on the category of project, as summarized below:

- Cost estimates for projects specifying replacement or upsizing of existing pipes for condition utilize the unit costs tabulated in Tables B-1, B-2, B-3 and B-4.
- Cost estimates for projects specifying new pipe trunk line new infrastructure utilize the unit costs contained within Tables B-1, B-2, B-5 and B-6.

Table B-1 | 2015 Unit Costs for Surface Restoration of Pipelines ($/linear-foot)		
Surface Restoration Cost with Road Category		
Local – 4" Asphalt	Arterial – 6" Asphalt	Unpaved
$51	$65	$4

Table B-2 | 2015 Unit Costs for Force Mains ($/linear-foot)		
Pipe Diameter (inch)	Material	Installation and Equipment Cost with Depth Category
		<10 ft
4	$6	$60
6	$11	$62
8	$15	$65
10	$22	$68
12	$26	$71
16	$54	$75
18	$60	$81
21	$63	$90
24	$86	$100

Table B-3 | 2015 Unit Costs for Condition Based Replacement and Upsizing of Existing Gravity Pipelines ($/linear-foot)					
Pipe Diameter (inch)	Material Cost	Installation and Equipment Cost with Depth Category			
		<10 ft	10-15 ft	15-20 ft	20-25 ft
8	$7	$68	$124	$235	$402
10	$12	$71	$127	$238	$405
12	$13	$73	$129	$240	$407
15	$13	$81	$136	$247	$414
18	$15	$88	$144	$255	$422
21	$21	$95	$151	$262	$429
24	$27	$102	$158	$269	$436
27	$37	$160	$216	$327	$494
30	$50	$172	$227	$338	$505
36	$66	$201	$257	$368	$535
42	$84	$226	$282	$393	$560
48	$102	$252	$307	$419	$585

Table B-4 | 2015 Unit Costs for Condition Based Repair of Existing Manholes ($/each)		
Manhole Diameter (inch)	Corresponding Pipe Size	Installation and Equipment Cost
48	Pipe Ø< 24”	$1,528
60	24” ≤ Pipe Ø < 48”	$1,813
72	Pipe Ø ≥ 48”	$2,181

Table B-5 | 2015 Unit Costs for New Gravity Pipelines ($/linear-foot)					
Pipe Diameter (inch)	Material Cost	Installation and Equipment Cost with Depth Category			
		<10 ft	10-15 ft	15-20 ft	20-25 ft
8	$7	$61	$111	$212	$362
10	$12	$62	$113	$214	$364
12	$13	$64	$115	$215	$365
15	$13	$70	$121	$221	$372
18	$15	$76	$127	$228	$378
21	$21	$82	$132	$233	$383
24	$27	$87	$138	$238	$388
27	$37	$129	$179	$280	$430
30	$50	$136	$187	$288	$438
36	$66	$158	$209	$310	$460
42	$84	$177	$227	$328	$478
48	$102	$195	$246	$346	$497

Table B-6 | 2015 Unit Costs for New Manholes ($/each)									
Manhole Diameter (inch)	Corresponding Pipe Size	Material Cost with Depth Category				Installation and Equipment Cost with Depth Category			
		<10 ft	10 to 15 ft	15 to 20 ft	20 to 25 ft	<10 ft	10 to 15 ft	15 to 20 ft	20 to 25 ft
48	Pipe Ø< 24”	$3,088	$5,002	$5,637	$6,272	$3,062	$5,258	$8,072	$17,867
60	24” ≤ Pipe Ø < 48”	$5,236	$8,180	$9,580	$10,980	$3,539	$8,600	$13,035	$18,517
72	Pipe Ø ≥ 48”	$6,595	$10,230	$12,130	$14,030	$4,669	$10,710	$16,098	$22,731

Unit Cost Notes Applicable to Tables B-1 through B-6:

1. Unit costs exclude lateral tie-ins.
2. Unit costs exclude utility relocation associated with potential conflicts.
3. Road resurfacing assumes:
   a. Local = 4-inch AC + 8-inch base course + 2-inch leveling course
   b. Arterial = 6-inch AC + 10-inch base course + 4-inch leveling course
   c. Unpaved = 4-inch base course.
4. The pipe material for gravity sewer was assumed to be PVC (ASTM D-3034, SDR 35) for 15-inch diameter pipe and smaller, and Class III (ASTM C-76) reinforced concrete for pipe with a diameter greater than 15 inches.
5. The pipe material assumed for new sewer force mains was PVC (AWWA C-900) for 4-inch to 12-inch diameter pipe. Force mains were assumed to be at a minimum cover depth of four feet.
6. Manhole installation assumes that surface restoration effort is covered under the surface restoration cost associated with the pipeline trenching (Table B-1).
7. The bypass pumping for condition based replacement and upsizing of existing gravity lines is for above grade application (no trenchwork) and includes the cost of the piping, installation and removal.

Rock Excavation

Specific geotechnical investigations were not provided during this master planning effort; however the geologic mapping and the Natural Resource Conservation Service (NRCS) Soil Survey were referenced for any obvious conflicts for pipe installation with lithic bedrock. Additionally, well logs were referenced from the Oregon Water Resources Department with mixed results. There are numerous domestic water wells within the study area reporting encountering rock within 10 feet of the ground surface.

Basalt rock near the ground surface appears prevalent in the southeast corner of the City, and there are no projects within the CIP needed within this area. For this reason, unit costs associated with construction of new and upsized pipelines exclude rock excavation. Pipeline replacement costs for condition-based improvements also exclude rock excavation since presumably any rock encountered during installation of the existing pipeline has been removed and replaced with granular backfill.

Trenchless Construction Methods

Where existing pipes are recommended to be replaced with new larger pipes, upsizing within two pipe diameters of the original pipe size is assumed to be a candidate for pipe bursting. In the absence of site specific geotechnical information which would preclude this construction practice, this trenchless approach is typically less expensive than open trench construction. Pipe bursting costs are highly variable and rely upon site specific influences such as soil type, installation depth, length of construction, and ability to excavate departure and receiving pits.

The information presented in Table B-7 is provided for the City's reference in budgeting future pipe replacement projects utilizing the pipe bursting approach. Due to the absence of

geotechnical information for the projects presented in the CIP, these prices have been excluded from use during preparation of project cost estimates.

Table B-7 | 2015 Unit Costs for Replacing Existing Gravity Pipelines Using Pipe Bursting ($/linear-foot)			
	From Existing Pipe Dia. To New Pipe Dia. (Inch)	Material Cost	Installation and Equipment Cost
Increase One Pipe Diameter	8 to 10	$19	$47
	10 to 12	$26	$53
	12 to 15	$41	$61
	15 to 18	$46	$70
	18 to 21	$48	$95
	21 to 24	$66	$107
	24 to 27	$74	$125
	27 to 30	$89	$143
Increase Two Pipe Diameter	8 to 12	$26	$81
	10 to 15	$41	$90
	12 to 18	$46	$102
	15 to 21	$48	$115
	18 to 24	$66	$155
	21 to 27	$74	$172
	24 to 30	$89	$198
	27 to 36	$130	$225

CONSTRUCTION COST ALLOWANCES

Costs for commonly occurring general work elements in wastewater collection projects were factored into the construction costs through the use of assumed allowances. Table B-8 presents a summary of these allowances, and when they are combined with the unit costs and multiplied by the improvement lengths, create an estimated "bid price" for the work. Detailed information justifying the assumed allowance values is provided below.

Table B-8 | Construction Cost Allowances	
Additional Cost Factor	Percent
Traffic Control	3%
Erosion Control	1%
General Contractor's Overhead	10%
General Contractor's Profit	8%
Mobilization	7%
Clearing and Grubbing	2.5%
Removal of Structures and Obstructions	4%

Traffic Control

Traffic control will be required for all projects that occur in roadways. The traffic control mark-up is intended to account for such costs as signage, flagging and temporary barriers, pavement markings, lane delineators and lighting at flagging locations.

Erosion Control

The erosion control mark-up accounts for materials and practices to protect adjacent property, stormwater conveyance systems, and surface water in accordance with regulatory requirements. Obtaining Erosion Control Permit compliance will require construction site runoff control for activities that result in a land disturbance exceeding 500 square feet. More complex projects may require the development of a stormwater pollution prevention plan, 1200-C permit application and reporting, installation of erosion control best management practices (BMPs), and routine maintenance, testing and inspection of all installed BMPs.

General Contractors Overhead

Overhead costs associated with the General Contractor's day-to-day operations such as staff salary, taxes, benefits, insurance, marketing, and proposal preparation are an inherent cost of running their business. Contractors will typically markup their subcontractor's costs as a management expense as a way to keep their business running.

General Contractors Profit

In addition to the overhead costs, contractors will typically markup their subcontractors to realize a profit for their effort. This is one of the most highly variable parts of a budget and depends upon the type of project, its size, the amount of risk involved, how much money the contractor wants to make, the general market conditions, and bidding strategies.

Mobilization

Before construction of a project may begin, setup and preparatory activities are necessary to become ready to perform the work. Mobilization is a general term that used to capture many variables but typically relates to:

- Moving staff, equipment, supplies, and incidentals to the project site
- Establishing site trailers or offices or other facilities necessary for the project
- Incurring costs as necessary before beginning work on the project. This may include expenses associated with acquisition of bonds and insurance.

PROJECT COST ALLOWANCES

The project cost is the sum of construction component unit costs with additional cost allowances for contingency, engineering, permitting, legal and administration fees. Table B-9 below presents the cost allowances for each additional project cost. These project cost

allowances are factored on top of the total construction cost, not the individual unit costs. The engineering costs include design and surveying. Construction administration is the cost associated with managing the construction of the project. The administration and legal costs are those associated with the City providing financial and legal oversight of the contract.

Table B-9 | Project Cost Allowances	
Additional Cost Factor	**Percent**
Engineering, Legal, Permitting and Construction Services	20%
Contingency	30%
City Internal Overhead	12%

Engineering, Legal, Permitting and Construction Services

This category is intended to capture the costs needed for development of all the upfront project related documentation to make a project bid ready. Construction drawings, specifications and permit applications are both time and resource intensive, often requiring months of preparatory work before a project may be bid. Additional services typically provided by the engineering team during construction include site inspections, assisting the contractor in interpretation of the contract documents and preparation of record drawings.

Costs for engineering, legal, permitting and construction services can vary widely based on the unique scope of work for each project. A cost factor approach is an appropriate assumption for most projects of the size and character within the CIP, however the cost factor is not well suited for projects with construction costs below $300,000. For these smaller projects, the engineering, legal, permitting and construction services costs should be evaluated by the City on a case-by-case basis for project budgeting.

Contingency

A contingency was included in each project's cost to account for the uncertainties inherent within the preliminary level of the estimate. Contingency is a term used in estimating that refers to costs that will probably occur based on past experience, but with some uncertainty regarding the amount. This factor was applied to all estimated project costs except for the City Internal Overhead. The contingency is provided to account for factors such as:

- Unanticipated utilities;
- Relocation and connection to existing infrastructure;
- Minor elements of work not addressed in component unit cost development;
- Details of construction;
- Changes in site conditions;
- Variability in construction bid climate.

The contingency excludes:

- Major scope changes such as end product specification, capacities and location of project;
- Extraordinary events such as strikes or natural disasters;
- Management reserves;

- Escalation and currency effects.

City Internal Overhead

The City of Sherwood has an assortment of departments and personnel that are involved in the realization of a construction project. This cost allowance is intended to capture the effort

needed on the part of the City related to project management, plan review, permit processing, code compliance, construction inspections and financial management.

PROJECT COST MULTIPLIER

For simplicity in estimating overall project costs, a multiplier can be applied against the construction costs determined from unit pricing. This multiplier accounts for the allowances for both construction costs and project costs into one easily used factor. An example calculation showing how this multiplier was developed is provided in Table B-10 below.

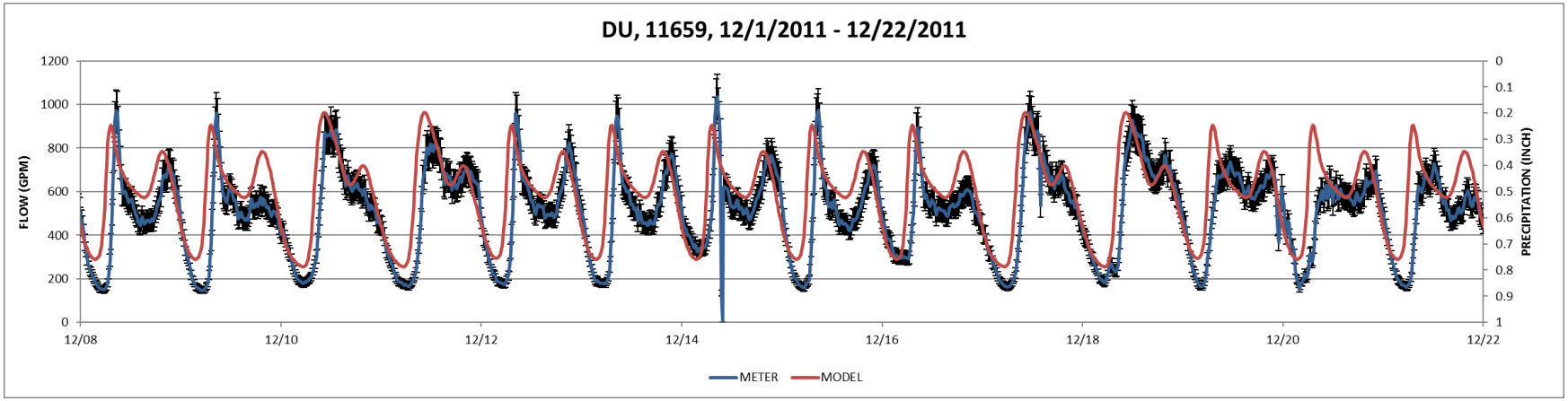
Table B-10 | Project Cost Multiplier

Construction and Project Cost Allowances	Allowance Factor	Cost
Example Construction Cost Total	-	$1,000,000
Mobilization	7%	$70,000
Erosion Control	1%	$10,000
Clearing and Grubbing	2.5%	$25,000
Traffic Control	3%	$30,000
Removal of Structures and Obstructions	4%	$40,000
	MOB Subtotal	*$175,000*
General Contractor's Overhead	10%	$117,000
General Contractor's Profit	8%	$94,000
Engineering, Legal, Permitting and Construction Services	20%	$234,000
	Contractor Cost Subtotal	*$380,000*
	Construction Subtotal	*$1,555,000*
Contingency	30%	$466,500
	Subtotal	*$2,021,500*
City Internal Overhead	12%	$242,580
	Project Cost Subtotal	**$2,264,080**

Project Cost Multiplier	
Total Project Cost divided by	$2,264,080
Unit Construction Costs	$1,000,000
= Project Cost Multiplier *(Rounded)*	**2.26**

APPENDIX C | MODEL CALIBRATION PLOTS

Figure C-1 | Dry Weather Flow Calibration Plots



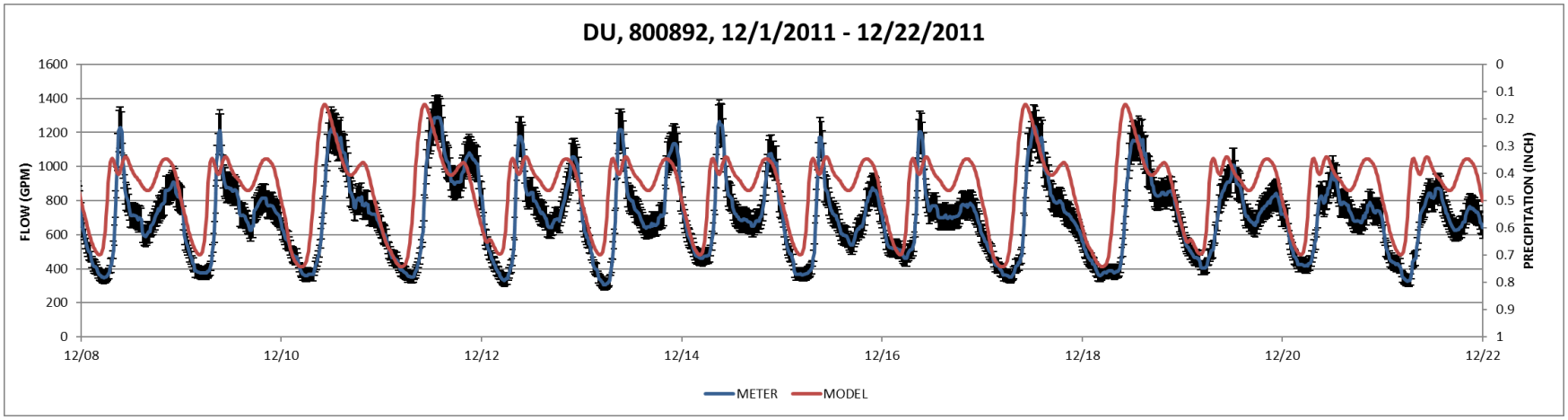
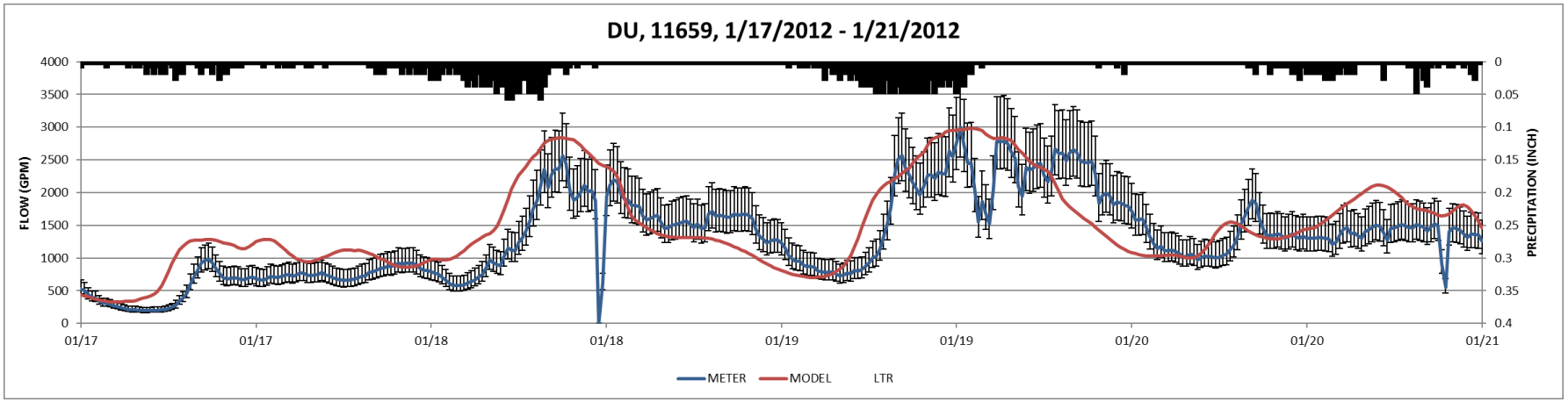
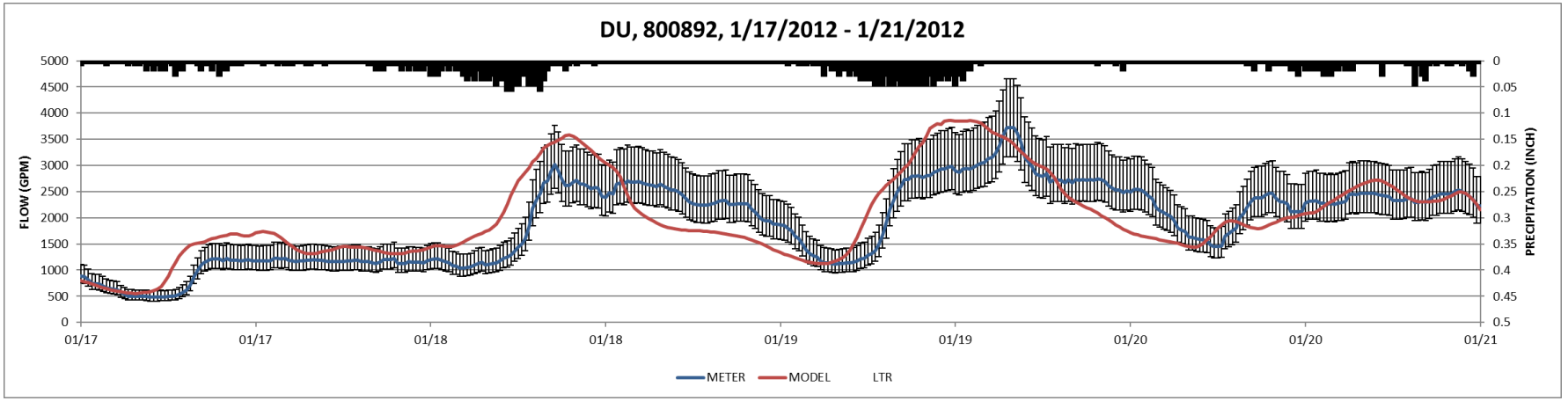


Figure C-2 | Wet Weather Flow Calibration Plots





MSA

MURRAY, SMITH & ASSOCIATES, INC.
ENGINEERS|PLANNERS