ORDINANCE NO. 915

AN ORDINANCE UPDATING THE CITY OF SCAPPOOSE STORMWATER MASTER PLAN

THE CITY OF SCAPPOOSE ORDAINS AS FOLLOWS:

Section 1. The City of Scappoose Stormwater Master Plan, dated April 2023, is updated as provided in Exhibit A.

CITY OF SCAPPOOSE, OREGON

Mayor Joseph A. Backus

First Reading: May 1, 2023

Second Reading: May 15, 2023

Attest: ______________________________
City Manager Alexandra Rains, MPA

Stormwater Master Plan

April 2023 // **DRAFT**








DRAFT

Scappoose Stormwater Master Plan

Prepared for

City of Scappoose, Oregon

April 2023

This is a draft and is not intended to be a final representation
of the work done or recommendations made by Brown and Caldwell.
It should not be relied upon; consult the final report.

This page left intentionally blank.

Table of Contents

List of Figures

List of Tables

List of Abbreviations

AACE	Association for the Advancement of Cost Engineering
ac	acre
BC	Brown and Caldwell
BMP	best management practice
CB	catch basin
CCTV	closed-circuit television
CIP	capital improvement project
City	City of Scappoose
CPs	capital projects
CWA	Clean Water Act
DEQ	Oregon Department of Environmental Quality
DMA	Designated Management Agency
DS	downstream
EPA	U.S. Environmental Protection Agency
ft	feet/foot
GIS	geographic information system
GWPD	Groundwater Protectiveness Demonstration
H/H	hydrologic and hydraulic
Highway 30	Oregon Highway 30
in.	inch/inches
LF	linear foot/feet
LID	low impact development
MH(s)	manhole(s)
MS4	municipal separate storm sewer system
NPDES	National Pollutant Discharge Elimination System
NRCS	National Resources Conservation Service
ODOT	Oregon Department of Transportation
PCSWMM	PC-Storm Water Management Model
Plan	Stormwater Master Plan
PWDS	Scappoose Public Works Design Standards (Draft)
ROW	right-of-way
R/R	repair/replacement
SDC	System Development Charge
SDIC	Scappoose Drainage Improvement Company
SMP	Stormwater Master Plan
SOPs	standard operating procedures
SSURGO	Soil Survey Database for Columbia County, Oregon
TM	technical memorandum
TMDL	total maximum daily load
UGB	Urban Growth Boundary
UICs	underground injection control
US	upstream
USCS	Unified Classification System
WPCF	water pollution control facility
WQ	water quality

This page left intentionally blank.

Executive Summary

In 2020, the City of Scappoose (City) initiated development of a Stormwater Master Plan (SMP or Plan) to guide capital project and program needs over the next 20-year planning period. Drivers for this SMP include the outdated nature of Scappoose's previous SMP (dated 1998), the changing regulatory environment, new and redevelopment activities, and observed system deficiencies warranting additional study and proposed solutions.

This 2023 SMP identifies projects and programs to increase system capacity, address infrastructure and maintenance needs, and add water quality treatment.

The SMP development process included:

- Incorporation of project need and system improvements information as identified by City staff.
- Identification and validation of storm drainage problems and flooding areas using hydrologic and hydraulic (H/H) models, which help to assess the frequency and severity of flooding.
- Assessment of stormwater retrofit opportunities for water quality treatment and/or flow control.
- Assessment of where Underground Injection Control (UIC) installations are feasible from a regulatory and operational perspective.
- Identification of programmatic opportunities to address maintenance and water quality at a citywide scale.
- Analysis of current staffing levels and the identification of future staffing needs to meet deferred maintenance and regulatory requirements.
- Development of a comprehensive, prioritized Capital Project (CP) list and associated costs.
- Development of an updated stormwater utility rate structure and system development charge (SDC) to support the ongoing execution of projects and programs in accordance with levels of service (LOS) definitions.

Master Plan Technical Analyses

The following technical analyses were conducted to evaluate stormwater system deficiencies and define project and program needs in support of SMP development.

Project Needs Identification. This effort included distributing surveys and questionnaires to City staff, conducting a Geographic Information System (GIS) data review, and site visits. Information collected helped to create a robust inventory of the stormwater collection system features and problem areas related to capacity, maintenance, condition, and infrastructure needs. Hydraulic modeling needs and extents were defined based on problem areas.

Stormwater Retrofit Analysis A stormwater retrofit analysis was conducted to inform potential locations for water quality improvement and/or detention facilities in the City. Based on the criteria and site characteristics of each location analyzed, two locations were identified with potential to construct a regional facility to meet treatment and flow control requirements. Additional stormwater retrofit elements (use of UICs or green street infrastructure) were also integrated with other project concepts.

UIC Assessment. A UIC feasibility assessment was conducted to inform locations of the city where stormwater UIC installations are feasible from a regulatory and technical (operational) perspective.

The feasibility assessment considered four primary criteria: 1) a minimum vertical separation distance of 5 feet from groundwater; 2) a minimum horizontal separation from water wells; 3) a maximum depth of 20 feet; and 4) a minimum of 5 feet permeable gravel. The assessment was conducted as a desktop GIS analysis and produced a map of feasible areas for UIC installation.

Stormwater System Capacity Evaluation. Stormwater collection system modeling, reflecting City-owned (public) storm pipe, culverts, facilities, and open channel conveyances, was developed for this SMP in targeted areas. H/H modeling was conducted to simulate rainfall and runoff characteristics and to identify capacity limitations under both current and future development conditions.

Maintenance and Staffing Evaluation. Operational activities were assessed to identify staffing levels and constraints. Information on current maintenance activities, regulatory and engineering activities, and compensation rates as provided by the City were incorporated into the staffing analysis.

Project Prioritization. Project needs were prioritized based on various criteria including existing flooding frequency and severity, system condition, recurring maintenance needs, and project concurrence/scheduling. Project scoring and ranking helped establish high, medium, and low priority project needs for use in LOS definitions and stormwater utility rate evaluations.

General Recommendations

Project, program, and policy recommendations in this SMP are proposed to improve and enhance the performance of the storm drainage infrastructure throughout the city, as summarized by the following recommended actions:

- Implement CPs required to address the following objectives: system capacity, system condition, water quality, and infrastructure needs. These CPs are intended to manage frequent system flooding and accommodate potential development and growth.
- Implement stormwater-related programs to address maintenance-related system improvements in an expedited manner.
- Conduct regular stormwater pipe and facility inspections to help evaluate ongoing system condition needs and support asset management principals.
- Procure equipment, install pre-treatment, and add staff necessary to ensure compliance with the City’s WPCF permit.
- Complete ongoing updates to the City’s Public Works Design Standards to ensure the City’s standards address regulatory drivers, support private development activities, and protect stream health (see recommendations outlined in Section 2.8).
- Ensure timely implementation of CPs and programs by establishing updated funding mechanisms and rates in accordance with the City’s stormwater financial evaluation.

Capital Project Summary

A total of 12 CPs, reflecting 17 separately costed (by phase) projects have been developed to address the following objectives:

Increase ***system capacity*** to address existing and potential future deficiencies (i.e., flood control).

Address recurring maintenance needs related to ***infrastructure needs*** (i.e., lack of maintenance access, add infrastructure to address localized drainage issues).

Address ***system condition*** and repair & replacement (R&R) needs.

Incorporate ***water quality*** in accordance with stormwater system improvements.

Table ES-1 summarizes the identified capital projects, costs, and priority. Figure ES-1 shows the location of the proposed CPs by primary objective. Narrative summaries for each CP can be found in Appendix F.

Table ES-1. Capital Project Costs and Priority						
Project Number	Project Name	Primary Objective	Estimated Cost	Project Priority		
				High	Medium	Low
JC-2	High School Way Storm Improvements	Infrastructure Need	$91,000	X		
JC-3, Phase1	E Columbia Storm Improvements – E Columbia Avenue from Miller to outfall	System capacity	$1,793,000	X		
JC-5	6th and Vine UIC Replacement	System condition	$65,000	X		
JW-1, Phase 2	Dutch Canyon System Improvements (culvert)	Infrastructure Need	$105,000	X		
SC-2	JP West Rd Storm Improvements - East	Infrastructure Need	$517,000	X		
SC-3	JP West Rd Storm Improvements - West	Infrastructure Need System capacity	$1,103,000	X		
SC-6	SW 4th St Storm Improvements	System condition	$1,037,000	X		
JC-3, Phase 2	E Columbia Storm Improvements – E Columbia Avenue (Miller and Bird Rd)	System capacity	$2,810,000		X	
JC-3, Phase 3	E Columbia Storm Improvements – E Columbia Avenue (Bird Rd and North Rd)	Infrastructure Need	$1,556,000		X	
JC-4	Sunset Loop Storm Improvements	System capacity	$898,000		X	
SC-4	Keys Rd Storm Improvements	Infrastructure Need System capacity	$657,000		X	
SC-5, Phase 1	EJ Smith Storm Improvements	Infrastructure Need	$1,266,000		X	
JC-1	Elm Street Storm Improvements	System capacity	$2,703,000			X
JC-3, Phase 4	E Columbia Storm Improvements – E Columbia Avenue (North Rd to 4th St)	Infrastructure Need	$479,000			X
JW-1, Phase 1	Dutch Canyon System Improvements (pipe extension)	Infrastructure Need	$1,615,000			X
SC-1	NW 1st St Storm Improvements	System capacity	$1,617,000			X
SC-5, Phase 2	EJ Smith Storm Improvements (regional facility)	Water quality	$2,310,000			X
		TOTAL	$20,622,000	$4,711,000	$6,289,000	$9,622,000

Programmatic Summary

In addition to the identified CPs, the following stormwater program needs were identified to address regulatory drivers and support proactive system maintenance:

Expanded Facility Maintenance Program (P-1). Addresses operational (staffing needs) to conduct stormwater system maintenance activities at frequencies required to meet regulatory obligations.

Closed-circuit television (CCTV) Inspection Program (P-2). Allocates funds to conduct CCTV inspection of stormwater collection pipe, to inform the City's asset management program.

Repair and Replacement (R/R) Program (P-3). Allocates funds to proactively repair and replace stormwater collection pipe as it nears the end of its useful life.

Asset Management Program Maintenance (P-4). Allocates funds to conduct survey of stormwater infrastructure and integrate stormwater assets into the City's GIS system and associated asset management program.

UIC Pretreatment/ Retrofit Program (P-5). Allocates funds to incorporate pretreatment and associated conveyance infrastructure upstream of the 49 public UICs in the City currently lacking the required pretreatment. This work plan and schedule is required in accordance with the City's WPCF permit requirements.

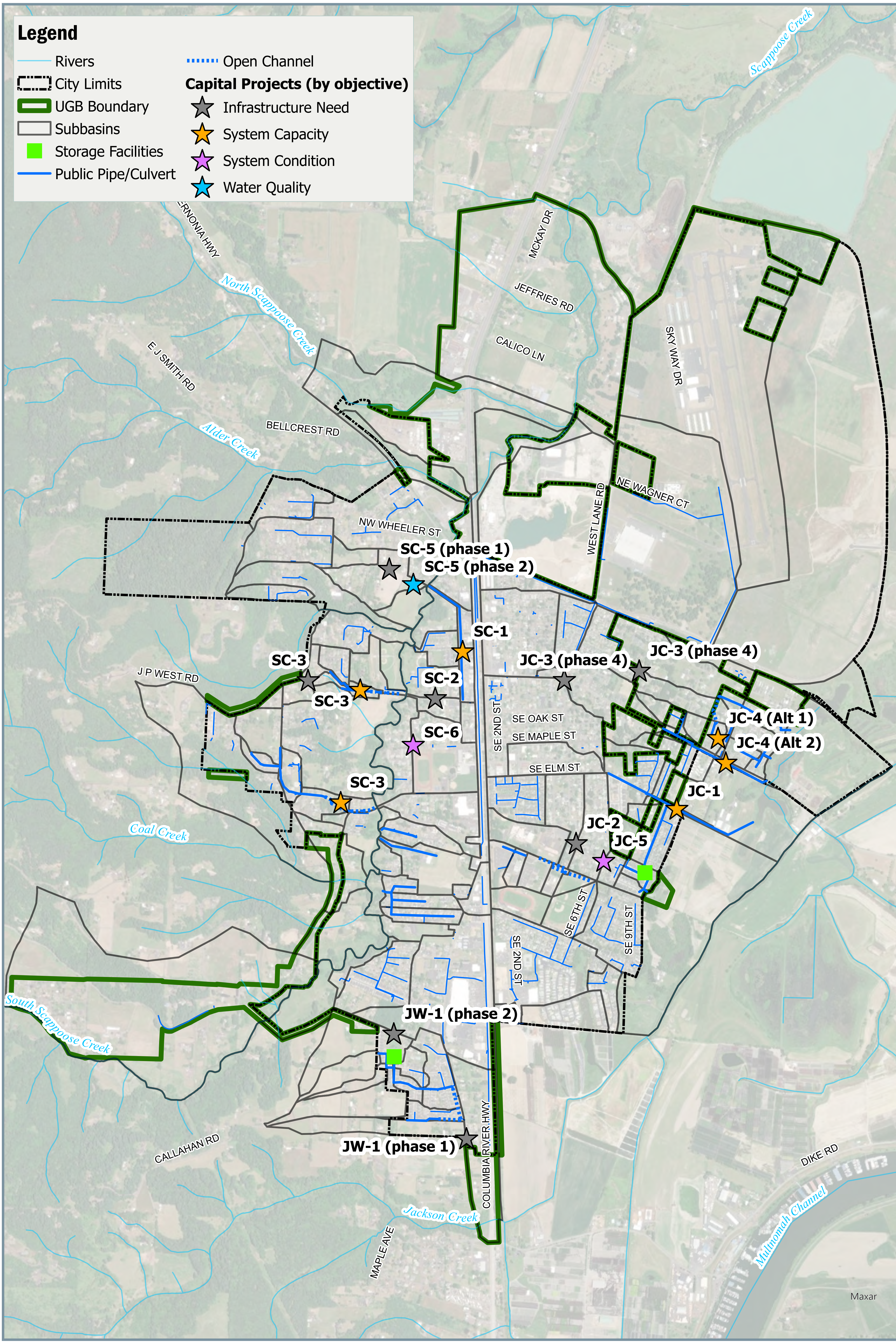
Minor Drainage Improvement Program (P-6). Establishes an annual funding mechanism to address minor drainage improvements that are not anticipated to require extensive engineering services.

Green Street Pilot Program (P-7). Establishes an annual funding mechanism to integrate low impact development (LID) or green infrastructure in conjunction with street improvement and other utility projects.

Implementation

Capital project and program cost information developed as part of this SMP were used to conduct a financial evaluation, develop LOS definitions, and prepare a financial plan including stormwater utility rate structures and an SDC. The financial plan reflects stormwater utility rate increases necessary to implement the City's Capital Improvement Program while meeting other financial obligations. Capital project costs, program costs, and associated staffing needs were collectively used to develop the financial plan.

Implementing capital projects and programs associated with a 20-year planning period, as outlined in this SMP, will require a stormwater utility rate increase and adjustment to the stormwater SDC. Three LOS definitions are presented that reflect a range of project and program implementation. Depending on the selected LOS, an annual stormwater utility rate increase, beginning July 1, 2023, is proposed. Adjustments to the SDC calculation methodology results in a proposed stormwater SDC rate of $654 per equivalent residential unit. The financial plan is subject to a separate City Council approval.



Accessed By: TSUESSER at 04/07/2023 12:43

Path: O:\PW_Exports\155252 - Scappoose_Stormwater_Master_Plan\07_GIS_Internal_BC\Pro Maps\SMP Document\ES-1_Exec_Summary.aprx

City of Scappoose

Stormwater Master Plan

April 2023
Project: 155252

Notes:
1. NAD 1983 HARN StatePlane Oregon North FIPS 3601 International Feet
2. See Table 6-1 of SMP for detailed capital project information by number.

0 1,500 3,000 Feet

N

Figure ES-1: Capital Projects Overview

This page left intentionally blank.

Section 1
Introduction

The City of Scappoose (City) developed this Stormwater Master Plan (SMP or Plan) to guide stormwater and drainage-related capital project, program, and policy decisions over a 20-year planning period.

The City's overall storm drainage system includes segmented piped and open channel (e.g., ditch) conveyances, in addition to collection, treatment, and detention facilities for stormwater management. Drainage from approximately 30 percent of the City infiltrates discharge to Underground Injection Controls (UICs), which collect and infiltrate stormwater runoff to the subsurface. Thus, this SMP collectively considers both piped and open channel conveyances, as well as UIC functionality, as part of the overall storm drainage system.

New regulatory drivers, including the City's 2020 Water Pollution Control Facility (WPCF) permit for the operation of public UICs and the Oregon Department of Environmental Quality's (DEQ's) 2021 finalization of the 2019 Revised Willamette Basin total maximum daily load (TMDL) for mercury warranted consideration of water quality objectives as part of the capital project and program development effort. This SMP addresses water quantity and quality for constructed drainage systems under the City's management.

The City manages approximately 21.9 miles of piped and open channel storm drainage infrastructure. New and re-development activities are rapidly occurring within the current urban growth boundary (UGB) and as such, the City needs a proactive plan to address existing capacity deficiencies and failing infrastructure, while considering land use patterns and development trends.

This Plan documents the processes and methods used to evaluate the City's storm drainage infrastructure. Results of the evaluation provide the City with projects, programs, and policies for implementation over the next 20 years.

1.1 Stormwater Master Plan Objectives

The City's overarching goal for this SMP is to guide storm drainage infrastructure improvements over a 20-year implementation period. Improvements must address maintenance/system condition issues, capacity issues, and water quality needs into the future. Specific objectives of the City's SMP include the following:

- Establish a process for evaluating and prioritizing stormwater needs in Scappoose.
- Solicit information from staff to inform the identification of project needs and improvements.
- Identify known areas of flooding and other storm drainage problems, and provide project solutions related to collection, conveyance, and treatment.
  - Develop targeted hydrologic and hydraulic (H/H) models to evaluate system capacity based on current system information as obtained from the City's GIS and survey data.
  - Assess the frequency of nuisance flooding based on developed H/H models.
- Identify programmatic and planning opportunities to address areas of frequent maintenance needs, system condition deficiencies, and water quality concerns on a City-wide scale.

- Support current, pending, and future regulatory requirements and drivers through policy and code recommendations.

This Plan is intended to support regulatory directives under the City's total maximum daily load (TMDL) obligations and Water Pollution Control Facility (WPCF) permit for UICs.

1.2 Background and Related Studies

The City's last stormwater master plan was completed in 1998 (1998 Plan). Since 1998, capital projects identified through the planning process have not been consistently implemented. The City has also experienced significant population growth. With the advancement of evaluation methods and tools, previously identified project needs will be confirmed and reevaluated. Previously identified project needs include the installation of stormwater drainage systems along JP West Road, along 5th, 6th, and 7th Street west of Oregon Highway 30, as well as conveyance improvements to West Lane, Columbia Avenue, Elm, Vine and Sawyer Streets.

In addition to the 1998 Plan, BC obtained copies of various development-specific drainage reports and studies prepared between 1999 and 2018 to help inform areas of observed stormwater problems and potential stormwater project needs. A summary of the reports and studies reviewed and considered for this SMP are listed in Table 1-1.

Table 1-1. Existing Stormwater Planning Documentation and Reports

Report	Date	Summary and application to the SMP
Surface Water Management Plan	1998	Provides background information and historic basis for the need to update the SMP.
Scappoose Drainage Improvement Company (SDIC) Interior Drainage Study	2017	Documents the 100-year flood plain for area protected from the Columbia River by the SDIC-operated levee. Provides background information related to the capacity of the SDIC drainage system, which received a portion of stormwater runoff from the City.
Miscellaneous drainage reports	Varies	Private development drainage reports summarizing drainage patterns and drainage infrastructure.
Scappoose Industrial Subdivision Project Phases 1 and 2	2018	Drainage report for a large commercial/industrial development for the northeast corner of the city, east of the airport.
Spring Lake Development, Master Storm Drainage Plan	1999	Offers historical context to drainage patterns in the area to better understand existing patterns.
Design Manual for Dutch Canyon Estates	2007	Provides background on drainage patterns and the infiltration facility providing stormwater control for the three phases of the Dutch Canyon developments.
Storm Drainage Report, Dutch Canyon II	2014	
Storm Drainage Report for Dutch Canyon Estates III	2016	

1.3 SMP Development Process

The City developed this SMP using an initial, collaborative planning approach with Engineering and Public Works staff to assess known storm drainage problem areas and identify areas where infrastructure addition, replacement, or retrofit are needed to address an issue. Assessment efforts to evaluate capacity limitations, size new infrastructure, investigate water quality opportunities, and develop project concepts were conducted following this initial planning process. Capital project opportunity areas were prioritized to inform modeling needs prior to development of project and program costs. This overall process allowed the City to focus resources and develop information for areas and projects most likely to be prioritized in a capital improvement program.

Figure 1-1 outlines the approach used to develop this Plan. Details related to specific assessment efforts can be found in the following technical memorandums:

- Technical Memorandum #1 (TM1)- Stormwater Basis of Planning, not included directly in this SMP document, but much of the content and figures have been integrated into this SMP document.
- Technical Memorandum #2 (TM2)–Hydrology and Hydraulic Modeling Methods and Results, included in this SMP as Appendix C.

Sections 3, 4, and 5 of this SMP provide additional detail related to the compilation and evaluation of data to inform project and program development efforts.

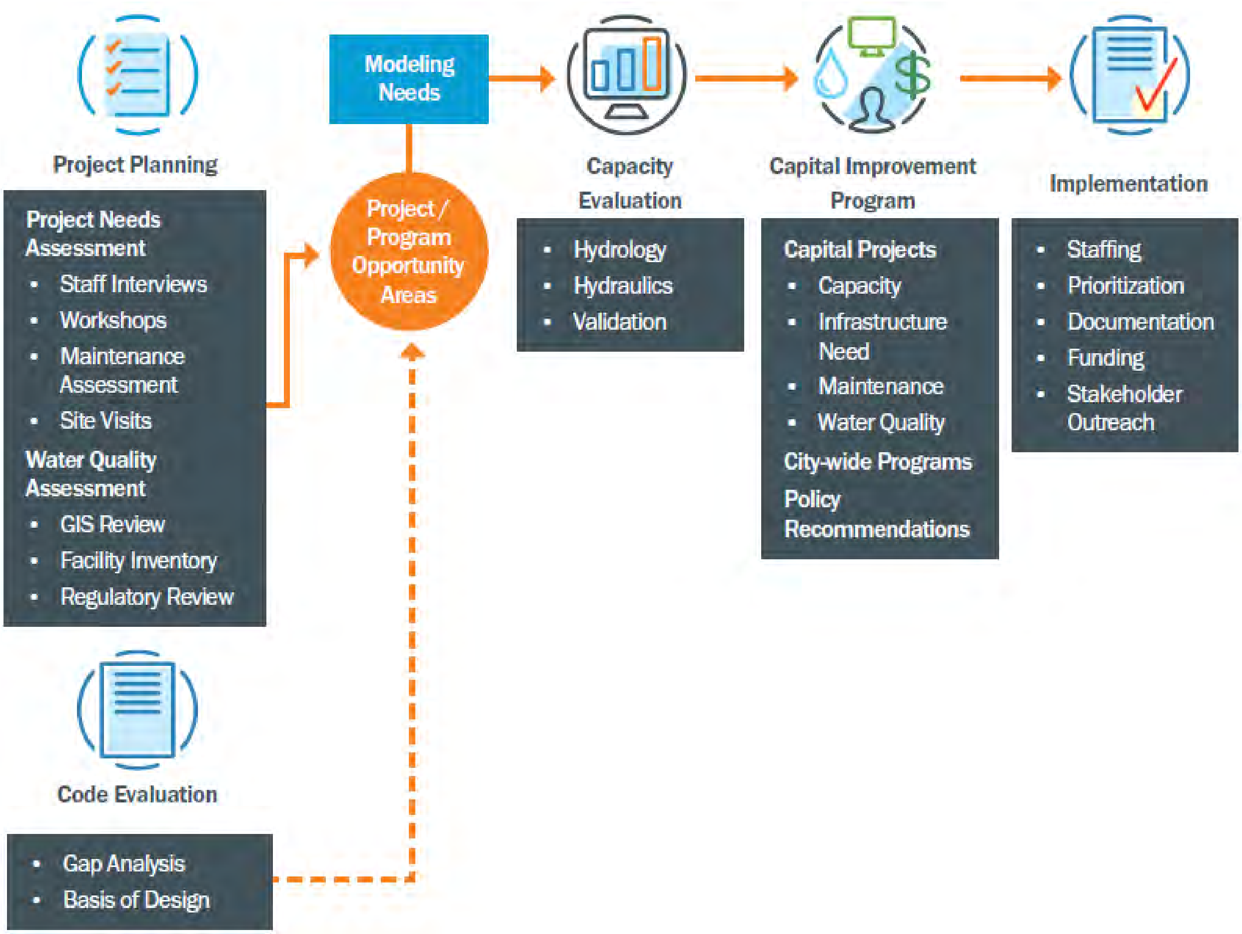


Figure 1-1. Stormwater Master Plan approach

1.4 Document Organization

Following this introductory Section 1, this SMP is organized as follows:

- Section 2 includes a description of the study area characteristics.
- Section 3 outlines the basis of planning, including the project needs assessment (identification of stormwater problem areas and modeling needs). Project Opportunity Locations stemming from the planning process are identified.
- Section 4 describes H/H modeling methods and results of the stormwater drainage system capacity evaluation, including qualification of capacity-related capital project needs.
- Section 5 describes City-initiated maintenance activities and programmatic project development.
- Section 6 summarizes the overall stormwater capital improvement program, including the final capital projects, city-wide programs, policies, and respective cost estimates.
- Section 7 provides an overview of the implementation elements of the capital improvement program, including a summary of staffing needs to support proposed projects and programs, the project prioritization process, and financial evaluation results.

Section 2

Study Area Characteristics

This section provides an overview of study area characteristics, including location, topography, soils, land use, drainage system configuration, and regulatory objectives.

Referenced figures depicting study area characteristics are located at the end of this section.

2.1 Location

The City of Scappoose (City) is located approximately 20 miles northwest of Portland, Oregon in Columbia County. The City is approximately 2.75 square miles in area, surrounded on all sides by Unincorporated Columbia County (Figure 2-1).

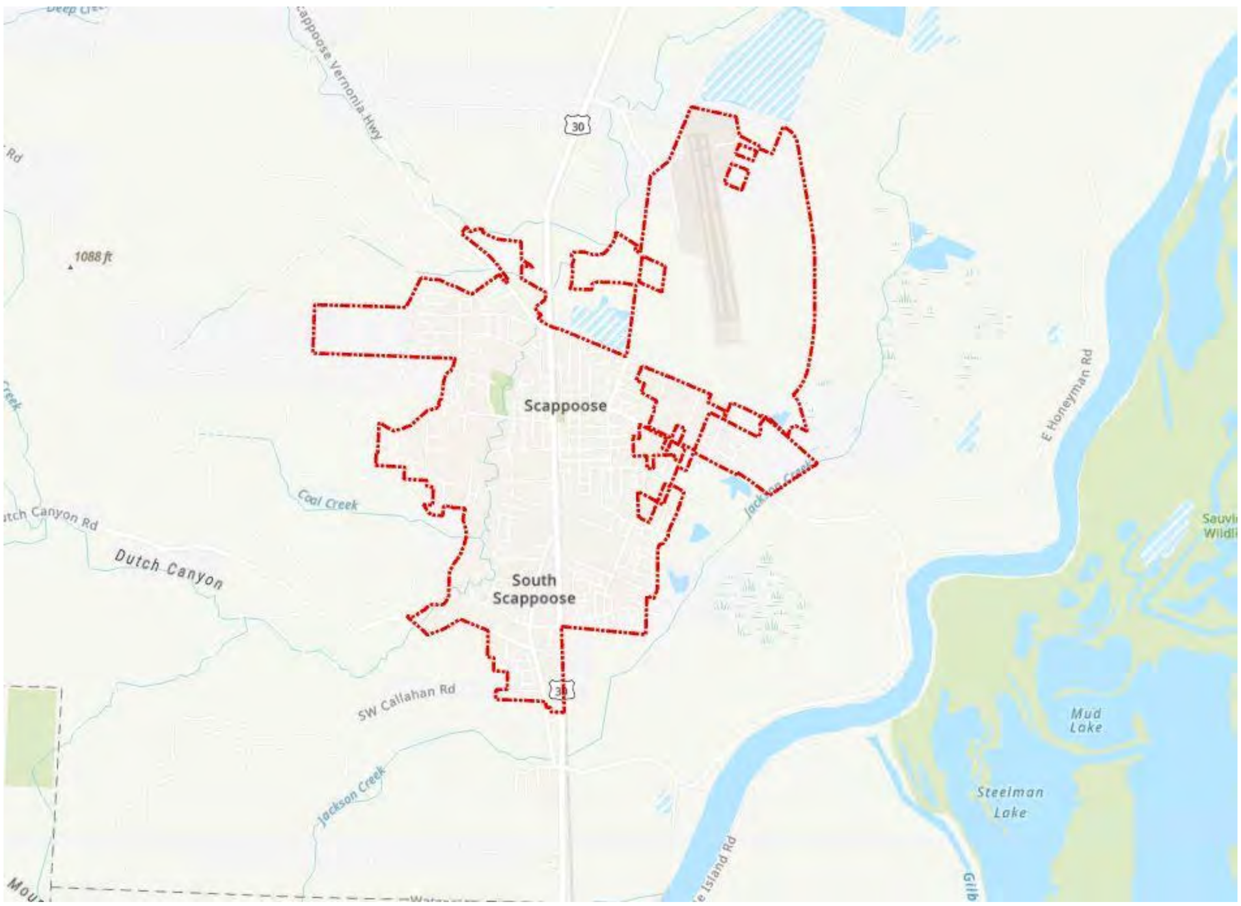


Figure 2-1. Location Overview

The city is located in the Columbia River watershed. Major drainage channels include South Scappoose Creek, a tributary to the Columbia River, and Jackson Creek, a tributary to the Multnomah Channel. South Scappoose Creek runs south to north through the center of the city and combines with North Scappoose Creek before transitioning to Scappoose Creek at the northern city limits. Oregon Highway 30 (Highway 30) runs north-south through the center of the city and parallels South Scappoose Creek.

Jackson Creek flows from west to east, crossing under Highway 30. At Highway 30, Jackson Creek is typically diverted south to the Multnomah Channel. When not diverted, it continues flowing east into the Santosh Channel, before discharging to the Multnomah Channel northeast of the City. The Multnomah Channel runs just east of the city and is the primary receiving water for city area east of Highway 30. Multnomah Channel is regulated by pump stations and levees separating it from the Columbia River, which are operated by the Scappoose Drainage Improvement Company (SDIC).

The study area for this SMP includes area within the Scappoose city limits and UGB and area outside of the UGB that contributes flow to City infrastructure, and is divided into six major drainage basins (see Figure 2-2): Alder Creek, Coal Creek, Jackson Creek, Jackson Creek West (which includes the area west of Highway 30 that drains to Jackson Creek), North Scappoose Creek, and South Scappoose Creek. For purposes of this report, Jackson Creek and its diverted portion as the Santosh Channel are both referred to as Jackson Creek. Contributing drainage area by basin is listed in summarized in Table 2-1.

Table 2-1. Study Area Overview

Basin	Study Area (ac)			Total Study Area (ac)
	Within City Limits	Outside of City Limits (within the UGB)	Outside UGB	
Alder Creek	26.7	5.2	2.7	33.6
Coal Creek	35.5	9.5	61.0	106.0
Jackson Creek	1288.8	215.8	148.8	1653.4
Jackson Creek West	141.4	20.3	63.1	224.8
N. Scappoose Creek	19.8	259.5	37.9	317.2
S. Scappoose Creek	617.6	130.8	125.0	873.4
Total	**2129.8**	**641.1**	**438.5**	**3209.4**

2.2 Topography and Soils

Scappoose's natural topography is characterized by steep hillsides on the western edge of the city and relatively flat topography and floodplain area around South Scappoose Creek in the center of the city and east of Highway 30. Topography can influence the conveyance capacity of channelized and piped infrastructure as well as rates of stormwater runoff entering downstream collection systems. Drastic slope changes can exacerbate ponding and backwater conditions. Significant grade changes are observed west of South Scappoose Creek.

Soils are an important watershed characteristic for evaluating potential runoff rates and volumes. Soils information for the study area was sourced from the National Resources Conservation Service (NRCS) Soil Survey online tool. Soil information is based upon data obtained from a 2016 publication from the U.S. Department of Agriculture, NRCS titled "Soil Survey (SSURGO) Database for Columbia County, Oregon."

For this SMP, soils are generalized into soil texture classifications for hydrologic modeling purposes. These texture classifications include various parameters that approximate soil runoff and infiltration potential. Generally, soils with sandy or silt textures have higher rates of infiltration and lower runoff potential, whereas soils with clay textures have lower rates of infiltration and high runoff potential.

Most soils within the study area have clay or clay loam soil texture features with more limited infiltration potential. Table 2-2 lists the NRCS Soil Texture Classes by percent coverage within the study area, and Table 2-3 lists the percent coverage by basin. Figure 2-3 shows the soil texture classification throughout the study area.

Table 2-2. Soil Textures within the Study Area

Soil Texture	Acres	Percent of Total Study Area [a]
Clay loam	62	2
Silt loam	1,046	33
Silty clay loam	2,101	65
Total [b]	**3,209**	**100%**

a. *Rounded percentages.*
b. *Total area may be slightly different than project area due to rounding.*

Table 2-3. Soil Textures within the Study Area (by % of basin)

Basin	Clay Loam	Silt Loam	Silty Clay Loam
Alder Creek	3%	3%	0%
Coal Creek	53%	5%	0%
Jackson Creek	0%	24%	67%
Jackson Creek West	1%	7%	7%
N. Scappoose Creek	11%	11%	10%
S. Scappoose Creek	32%	51%	15%
Total	**100%**	**100%**	**100%**

2.3 Land Use and Population

Scappoose has experienced significant population growth over the last 20 years. In 2000, the City's population was 4,976. In 2020, the population was 8,010, reflecting an average annual growth rate of approximately 2.5 percent.

The City is primarily comprised of low-density residential land use, with areas of commercial land use along the Highway 30 corridor. Vacant lands with potential for new or redevelopment are located throughout the City.

BC developed land use coverage in GIS to reflect existing and future development conditions to evaluate stormwater runoff conditions in the City. Land use coverage was based on City-provided GIS of zoning and Comprehensive Plan designations, overlay areas, wetland and floodplain areas, and developable lands. BC created the developable lands layer using mapped vacant lands, potential growth areas as identified in the City's 2018 Sewer Facilities Master plan, and through discussion with City staff. Developable lands are assumed to convert from vacant to their underlying zoning or comprehensive plan designation in the future, build-out land use condition.

Development of the land use data layers required consolidation of City-provided zoning and Comprehensive Plan designations into land use categories that are reflective of similar hydrologic and impervious characteristics. Table 2-4 reflects the consolidation exercise.

Table 2-4. Land Use Classifications

Data Source	City Designation	Land Use Designation
Within City Limits		
City Zoning	Expanded Commercial (EC)	Commercial
	General Commercial (C)	
	Light Industrial (LI)	Industrial
	Low Density Residential (R-1)	Low Density Residential
	Moderate Density Residential (R-4)	
	Manufactured Housing Residential (MH)	
	High Density Residential (A-1)[1]	High Density Residential
	Public Lands–Institutional (PL-I)	Institutional
	Public Lands–Utility (PL-U)	Utility
	Public Lands–Recreational (PL-R)	Parks
	Public Use Airport (PUA)	Airport
	Airport Business Park	Airport Overlay
	Airport Industrial Park	
	East Airport Employment	
Developable Lands [b]	Buildable Lands	Developable
	2040 Growth Areas	
City of Scappoose GIS, Oregon Spatial Data Library	Wetlands and Floodplain	Wetlands and Floodplain
Outside City Limits–Inside UGB		
Comprehensive Plan	Airport Employment (AE)	Airport Overlay
	Commercial (C)	Commercial
	Industrial (I)	Industrial
	Public Lands (PL)	Parks
	Manufactured Home (MH)	Low Density Residential
	Suburban Residential (SR)	
Developable Lands [b]	Buildable Lands	Developable
	2040 Growth Areas	

a. Includes areas zoned both R-4 PD and A-1 PD for planned development.

b. BC combined the two data sources and revised per City input to produce developable lands.

Impervious coverage by land use designation was established as a percentage. These impervious percentage designations were developed based on review of values from other local jurisdictions and were spot checked for accuracy in the City using aerial imagery. Impervious percentage by land use is shown in Table 2-5.

Table 2-5. Land Use and Impervious Percentages		
Land Use Designation	Impervious Percentage	Percentage of Study Area
Airport	15	7
Airport Overlay	65	1
Commercial	74	8
Developable/vacant	5	31
Forest	0	2
High Density Residential	50	1
Industrial	80	2
Institutional	57	<1
Low Density Residential	40	22
Parks	19	1
Rural Residential	5	5
Utility	5	2
Wetland and Floodplain	5	19
Total	--	**100%**

Figure 2-4 reflects the final land use coverage within the UGB for purposes of hydrologic calculations. Existing land use coverage reflects City zoning coverage and overlays (i.e., developable lands, floodplain and wetlands) for area inside of the city limits and Comprehensive Plan designations and overlays for area inside the UGB but outside city limits. For the study area outside of the UGB, BC assumed land use coverage like the zoning in nearby City areas. However, area outside the UGB is not considered subject to development within the SMP planning period. The land use coverage outside the UGB was also validated by aerial imagery. Developable lands are reflected in Figure 2-4 with hatching to indicate the underlying land use coverage, which was used and simulated to reflect expected future land use coverage.

2.4 Climate and Rainfall

Scappoose's climate is characterized by cool wet winters and warm dry summers. Most rainfall occurs between October and April. On average, December is the wettest month with an average of 7.25 inches of precipitation, nearly all of which is typically rainfall. July and August are the warmest and driest months with average high temperatures above 80 degrees Fahrenheit and less than 1 inch of rain per month. The average annual precipitation for the Portland metropolitan area ranges from 37 to 43 inches, with an average of 1.8 inches of snowfall annually. Scappoose specifically averages 42 inches of rainfall a year and 6.7 inches of snowfall annually.

In February 2019, Scappoose experienced a large rainfall event that delivered more than 4 inches of rain over a 5-day period, yielding approximately 3.1 inches in one 24-hour period. This rainfall event was used to validate model results, as discussed in see Section 4.4.

2.5 Storm Drainage Infrastructure

The City manages more than 18 miles (approximately 99,420 linear feet [LF]) of stormwater drainage pipe and culverts and approximately 3 miles (16,099 LF) of open channels/drainage ditches. Table 2-6 summarizes City-owned pipe, culvert, and open channel system assets mapped (in GIS) throughout the City. [1]

Table 2-6. System Asset Inventory–Pipe/Culvert/Ditches/Drains, City-owned

Diameter (in)	Length (ft)
N/A	21,662
1-6	4,349
8-12	53,959
14-18	19,070
20-24	11,597
27-30	1,635
36	1,719
42	1,109
48	41
60	380
Total (Pipe and Culvert)	99,422
Total (Ditch and Drain)	16,099

Table 2-7 provides a summary of the additional public stormwater assets that are owned by entities other than the City. This includes State (ODOT), County, and SDIC-owned and managed assets.

Table 2-7. System Asset Inventory–Pipe/Culvert/Ditches/Drains, Other Public

Diameter (in)	Length (ft)
N/A	3,288
1-6	2,593
8-12	3,770
14-18	3,060
20-24	8,782
27-30	0
36	0
42	0
48	0
60	0
Total (Pipe and Culvert)	21,493
Total (Ditch and Drain)	0

Note: Other Public" defined as facilities with State (ODOT), County, or SDIC ownership, as listed in GIS.

[1] Data for Table 2-6 and 2-7 was sourced on July 30, 2020, as mapped in GIS; GeoComm. N/A refers to undefined or unspecified pipe diameter. (\\bc\corp\PW_Exports\155252_Scappoose_Stormwater_Master_Plan\07_GIS\From_GeoComm\20200731_update\StormDrain.gdb.

Table 2-8 summarizes major City-owned storm structures, such as manholes, catch basins, clean outs, outfalls, and underground injection control (UICs) wells.

Figure 2-5 provides an overview of the stormwater collection system throughout the City including stormwater pipe, manholes, outfalls, and UICs.

Table 2-8. System Asset Inventory - Storm Structures, City-Owned

Facility	Number
Catch Basins (standard)	682
Catch Basins (treatment/pretreatment)	51
Clean outs	10
Ditch inlets/outlets	120
Manholes	457
Outfalls	44
UICs	56

Note: Excludes identified county, ODOT and private infrastructure.

The City's GIS data of public and private stormwater facilities, including detention and infiltration facilities, is outdated. Mapped detention facilities per Figure 2-5 reflects only those City-inventoried facilities that were able to be cross referenced with the City's GIS and does not reflect a comprehensive inventory of stormwater facilities in the city. Recommended updates to the City's GIS are discussed in Section 6.4.4.

2.6 Scappoose Drainage Improvement Company Integration

Eastern portions of the city of Scappoose and unincorporated Multnomah County are located below sea level and subject to flooding from the Columbia River via the Multnomah Channel. SDIC is a public corporation that operates a levee, drainage ditches, and pumps to provide drainage and flood control for these areas. Approximately 10 percent of the SDIC Management Area boundary falls within the Scappoose city limits (Figure 2-6).

SDIC is not a direct partner with Scappoose on this SMP but is an external stakeholder because drainage from portions of the city (specifically east of Highway 30) discharge to SDIC-managed infrastructure. Most of the City's current contributing area to SDIC is associated with overland and pipe flow from the Columbia Avenue outfalls, Columbia Commerce Center, and Elm Street outfalls. Approximately 13 percent of city area within the SDIC Management Area boundary infiltrates to groundwater and does not enter the SDIC-managed infrastructure directly.

SDIC completed an interior drainage study in 2017 to evaluate drainage inside the area protected by the levee for 100-year flood exceedance. For purposes of this SMP, this study was reviewed to confirm hydrologic methods and hydraulic system extents to better understand drainage patterns in the area. Limited background information was provided in the study related to the delineation of the total drainage area to SDIC-managed infrastructure, as the total drainage area extends beyond the delineated SDIC Management Area boundary and includes the larger Jackson Creek watershed. Jackson Creek itself does not routinely enter the Santosh Channel and thus is not consistently subject to flow management via SDIC. It is regularly diverted south to the Multnomah Channel at Highway 30, and when backwater conditions occur from the Multnomah Channel, check boards are removed to allow flow unimpeded to Santosh Channel.

The interior drainage study primarily focused on the regulated floodplain, levees, and pumping systems. The resulting modeled 100-year flood inundation extents helped inform the City's SMP. Based on the Federal Emergency Management Agency's National Flood Hazard Layer Viewer, the modeling associated with the interior drainage study has not yet been incorporated into the effective flood map, which was most recently updated in 2010.

The 1998 Plan previously described the major stormwater conveyances of Scappoose Creek, Jackson Creek, and UICs (drywells). The 1998 Plan highlighted SDIC's concern that the City's land use changes may influence stormwater and the ability of SDIC to manage overall drainage. Drainage patterns and areas generating runoff to SDIC-managed infrastructure are expected to continue as they have historically (see Figure 2-6). The volume of runoff generated by the City to SDIC-managed infrastructure during winter/spring conditions when the ground is saturated and pumping operations are initiated is not anticipated to change based on development patterns and impervious land area in the City. Development and increased impervious area coverage within the areas of the city draining to SDIC may influence the timing of runoff to SDIC-managed infrastructure.

The City's draft stormwater development standards (2020) require use of infiltration-based facilities and detention to mitigate the increased flow rate and duration of discharge from a site. Thus, pumping operations (when implemented) are not anticipated to change based on the level of development within the portion of Scappoose discharging to SDIC-managed infrastructure.

2.7 Regulatory Drivers and Framework

The Oregon DEQ is responsible for implementing provisions of the federal Clean Water Act (CWA) pertaining to stormwater discharges and surface water quality. DEQ issues water quality permits related to surface water discharges, establishes water quality criteria for waterbodies based on designated use, and conducts studies and evaluations to determine whether a waterbody adheres to water quality standards.

Regulatory drivers considered in the context of this SMP include the City's WPCF permit (issued in July 2020), the 2019 Revised Willamette Basin total maximum daily load (TMDL) for mercury, and Phase II National Pollutant Discharge Elimination System (NPDES) municipal separate storm sewer (MS4) permit requirements.

2.7.1 Water Pollution Control Facility Permit

The City owns and operates 56 UIC devices that manage stormwater runoff from public property (i.e., municipal rights of way) by infiltrating runoff into subsurface soil. The DEQ requires that UICs are registered with DEQ and authorized by rule[2] or by permit[3]. Because the City owns UICs within setbacks to water wells[4], DEQ requires that the City's UICs are authorized by permit.

In September 2017, the City applied for an Individual UIC WPCF Permit from DEQ and in June 2020 submitted a System-Wide Assessment to DEQ. The System-Wide Assessment is required by the permit and describes UIC locations, UIC construction details, distances between UICs and water wells, and identifies UICs that intersect the seasonal high groundwater table. DEQ issued the City's UIC WPCF permit (Permit No. 103247) on July 28, 2020. The permit, which has a 10-year term, expires on July 31, 2030.

2 OAR 340-044-0018

3 OAR 340-044-0035

4 Setbacks to water wells include those that are within are 500 ft or within a 2-year time-of-travel wellhead protection area.

To protect the quality of groundwater that is used as drinking water, the City's UIC WPCF permit requires corrective action for UICs located within setbacks to water wells. One type of corrective action is a Groundwater Protectiveness Demonstration (GWPD), which is a demonstration that stormwater pollutants in discharges from UICs do not reach a water well. The City submitted a GWPD to DEQ, and DEQ accepted the GWPD, in October 2020. The City's GWPD identified a protective setback distance of 255 feet (as opposed to 500 feet) for UIC placement from water wells.

The City's UIC WPCF permit requires the City to conduct annual stormwater quality sampling and prepare annual reports to document corrective actions and overall system operations, including maintenance activities. The City is also required to implement and maintain structural best management practices (BMPs) (i.e., stormwater pretreatment facilities) to reduce or eliminate pollutants from entering UICs. This SMP provides a framework for the City to implement a permit-required workplan and schedule to retrofit UICs without adequate pretreatment. See additional discussion in Section 5.

2.7.2 TMDL Applicability

A TMDL specifies the maximum amount of a pollutant load that a waterbody can receive and still meet water quality standards. As described in Section 2.1, portions of the City discharge to Jackson Creek, a tributary of the Multnomah Channel. The Multnomah Channel is referenced in the 2019 Revised Willamette Basin Mercury TMDL, and the City of Scappoose is listed as a new Designated Management Agency (DMA).

The Willamette Basin Mercury TMDL was initially issued in 2006. DEQ and EPA reissued the TMDL on February 4, 2021, and the TMDL reflects updated wasteload and load allocations (applied to DMAs) in accordance with updated fish tissue methylmercury criterion. For reference purposes, the effective TMDL is referred to as the Revised Willamette Basin Mercury TMDL (2019).

As a DMA, the City is required to develop a TMDL Implementation Plan within 18 months of TMDL issuance to outline various management strategies targeted at mercury reduction. Chapter 13 of the Revised Willamette Basin TMDL reflects the Water Quality Management Plan (WQMP), which guides DMA implementation of TMDL requirements. Per Section 13.3.1.11 and Table 13-11 of the WQMP, DEQ refers to six minimum control measures to control mercury from unpermitted urban runoff from cities with populations of 5,000 or greater (e.g., City of Scappoose). Table 2-9 outlines the required minimum control measures applicable for Scappoose. The City prepared a draft TMDL Implementation Plan for mercury in August 2022.

Minimum control measures specific to pollution prevention (operations and maintenance of stormwater facilities) and post-construction runoff controls have been considered in the project and program development for this SMP.

Table 2-9. Six Minimum Stormwater Control Measures per the Revised Willamette Basin TMDL for Mercury	
Minimum Stormwater Control Measure	Minimum Stormwater Control Measure Requirements Summary
1. Pollution Prevention and Good Housekeeping for Municipal Operations	• Operate and maintain facilities to reduce the discharge of mercury-related pollutants. • Ensure DMA-owned and operated facilities with industrial activities have coverage under a 1200-Z permit and conduct operations and maintenance activities to protect water quality. • Maintain records.
2. Public Education and Outreach	• Conduct an ongoing education and outreach program to inform the public. • Track implementation of public education and outreach and assess progress including a qualitative evaluation of one activity.
3. Public Involvement and Participation	• Implement a public involvement and participation program to provide the public with opportunities to participate in the development of control measures.
4. Illicit Discharge Detection and Elimination	• Implement and enforce a program to detect and eliminate illicit discharges. • Develop and maintain a current map of the conveyance system. • Prohibit non-stormwater discharges through enforcement of an ordinance or other legal mechanism.
5. Construction Site Runoff Control	• Refer project sites to DEQ or agent to obtain 1200-C permit coverage. • Require construction site operators to complete and implement an Erosion and Sediment Control Plan for construction project sites that result in a minimum land disturbance of 0.5 acres or more. • Require erosion controls, sediment controls, and waste materials management for qualifying construction projects. • Develop, implement, and maintain escalating enforcement procedures.
6. Post Construction Site Runoff for New and Redevelopment	• Develop, implement, and enforce a program to reduce discharge of pollutants from new and redevelopment project sites. • Target natural or predevelopment hydrologic function to retain rainfall onsite and treat the remainder of the runoff.

2.7.3 Phase II NPDES MS4 Permit

Phase II National Pollutant Discharge Elimination System (NPDES) municipal separate storm sewer system (MS4) permit coverage applies to geographic areas served by a regulated small MS4 located within a defined urbanized area in the State of Oregon. Typically, Phase II municipalities include cities with populations of 10,000 or greater.

Although the City is not a Phase II NPDES MS4 permittee currently, the Phase II NPDES MS4 permit provides guidelines and structure for management of a stormwater collection and conveyance system. Requirements of the Phase II NPDES MS4 permit align with the same six minimum measures required for TMDL compliance (see Table 2-9).

The most recent Phase II NPDES MS4 permit was issued to eligible jurisdictions on March 1, 2019. Appeals by select Phase II jurisdictions and subsequent negotiations with DEQ resulted in the reissuance of the Phase II permit in 2021. In anticipation of potential future Phase II permit requirements, the City's draft Public Works Design Standards (PWDS) were reviewed in conjunction with the current Phase II construction and post-construction requirements (see Section 3.2).

2.8 Code Review and Policy Considerations

The draft Scappoose Public Works Design Standards (PWDS) (dated November 18, 2018) outlines the City's guidelines and requirements for managing public and private stormwater and drainage infrastructure. Finalization and adoption of the draft PWDS is currently in progress; however, the draft PWDS represent the anticipated standards that will be enforced.

Although the City is not currently an NPDES MS4 permit holder, the draft PWDS were compared to construction and post-construction requirements of the Phase II NPDES MS4 Permit. The Phase II

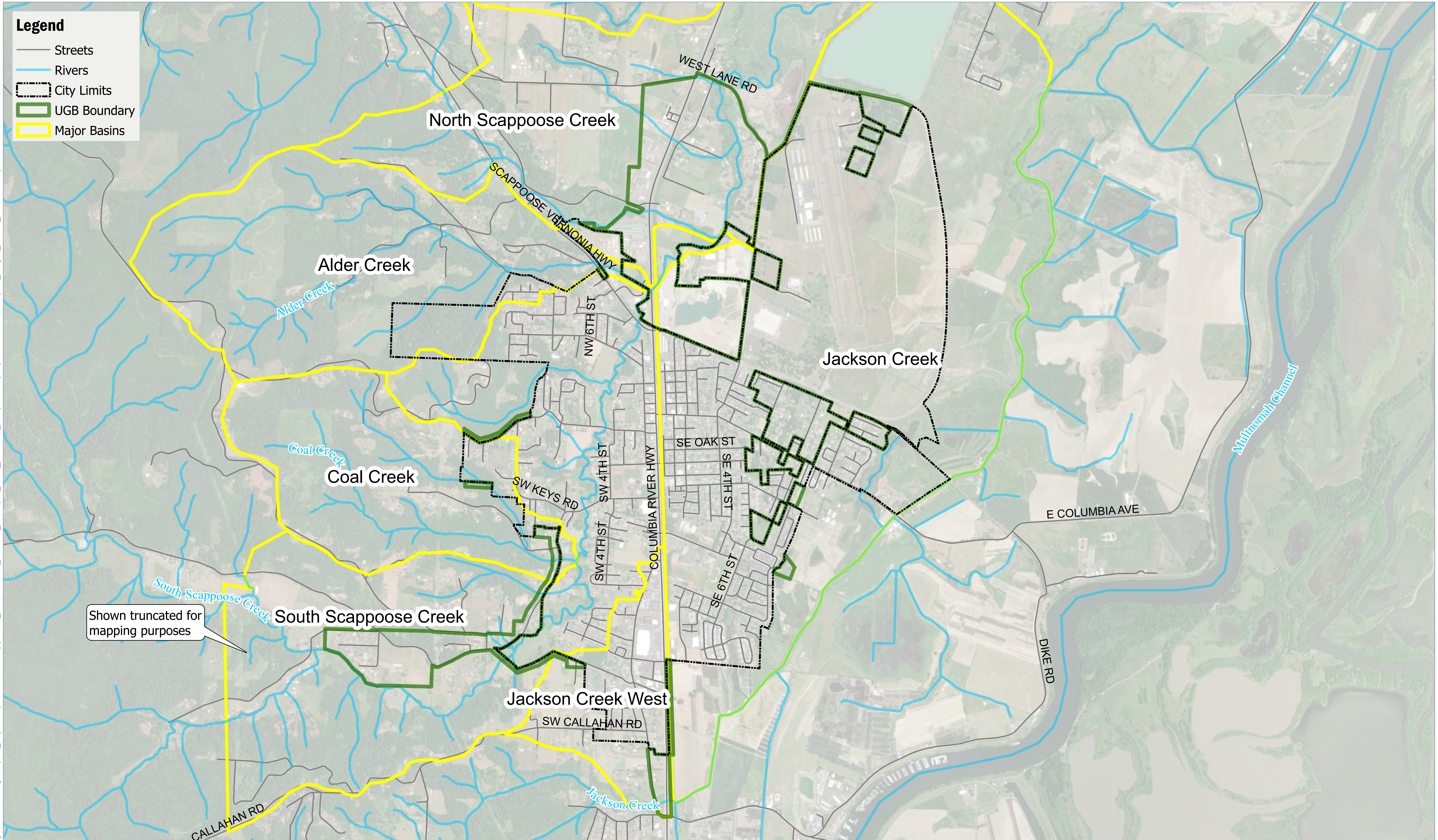
NPDES MS4 permit adheres to the construction and post-construction minimum measures as required for the City as a DMA on the Revised Willamette Basin Mercury TMDL (see Table 2-9). Thus, it provides a framework to determine policy considerations and technical gaps between the draft PWDS and typical stormwater requirements for a similar size community.

Detailed tables reflecting results of the gap analysis are included in Appendix A, Tables A-1 (Construction), A-2 (Post-Construction) and A-3 (Miscellaneous Topics associated with implementation of the City's UIC WPCF permit). In general, the draft PWDS are meeting the minimum Phase II permit requirements. However, there are select requirements where the draft PWDS requirements exceed Phase II permit requirements, and the City may consider revisiting the following stormwater policies as the PWDS are finalized:

- PWDS 2.0010 and 2.0120. The impervious area thresholds for new and redevelopment outlined in the draft PWDS (1,000 square feet) are lower (more conservative) than the Phase II NPDES MS4 permit (5,000 square feet). A lower threshold will impact staffing needs required to manage stormwater development review activities.
- PWDS 2.0120, 2.1010, and 2.2025. The draft PWDS language may limit the ability of the City to manage public and private stormwater in a single facility. Confirmation of current ownership/maintenance responsibility for facilities managing co-mingled runoff is needed, as well as consideration regarding future public-private partnerships to ensure stormwater management facilities are maintained.
- PWDS 2.0120. The water quality design storm (90 percent of the average annual rainfall) exceeds the current Phase I and Phase II NPDES MS4 permit requirements, which is 80 percent of the average annual rainfall. In the Portland-metro area, this results in a 1 inch/24-hour design storm.
- PWDS 2.1030. Maintenance activities for drywells, soakage trenches, and infiltration vaults do not align with DEQ's requirements for rule authorized UICs. The City may want to outline maintenance requirements for private UICs (requiring registration and rule authorization from DEQ, not part of the City's UIC WPCF permit).

Miscellaneous topics including infiltration testing, subsurface infiltration setbacks, and drywell capacity testing that are related to the City's UIC WPCF permit and overall UIC implementation were reviewed as well. Results are reflected in Table A-3. In addition, a UIC feasibility assessment was conducted to identify locations of the City where UICs are likely feasible based on DEQ regulatory requirements for setbacks from drinking water wells and geologic considerations, which has been used in the context of capital project planning. See Section 3.4 and refer to TM1 for additional information.

This page left intentionally blank.



Brown AND Caldwell

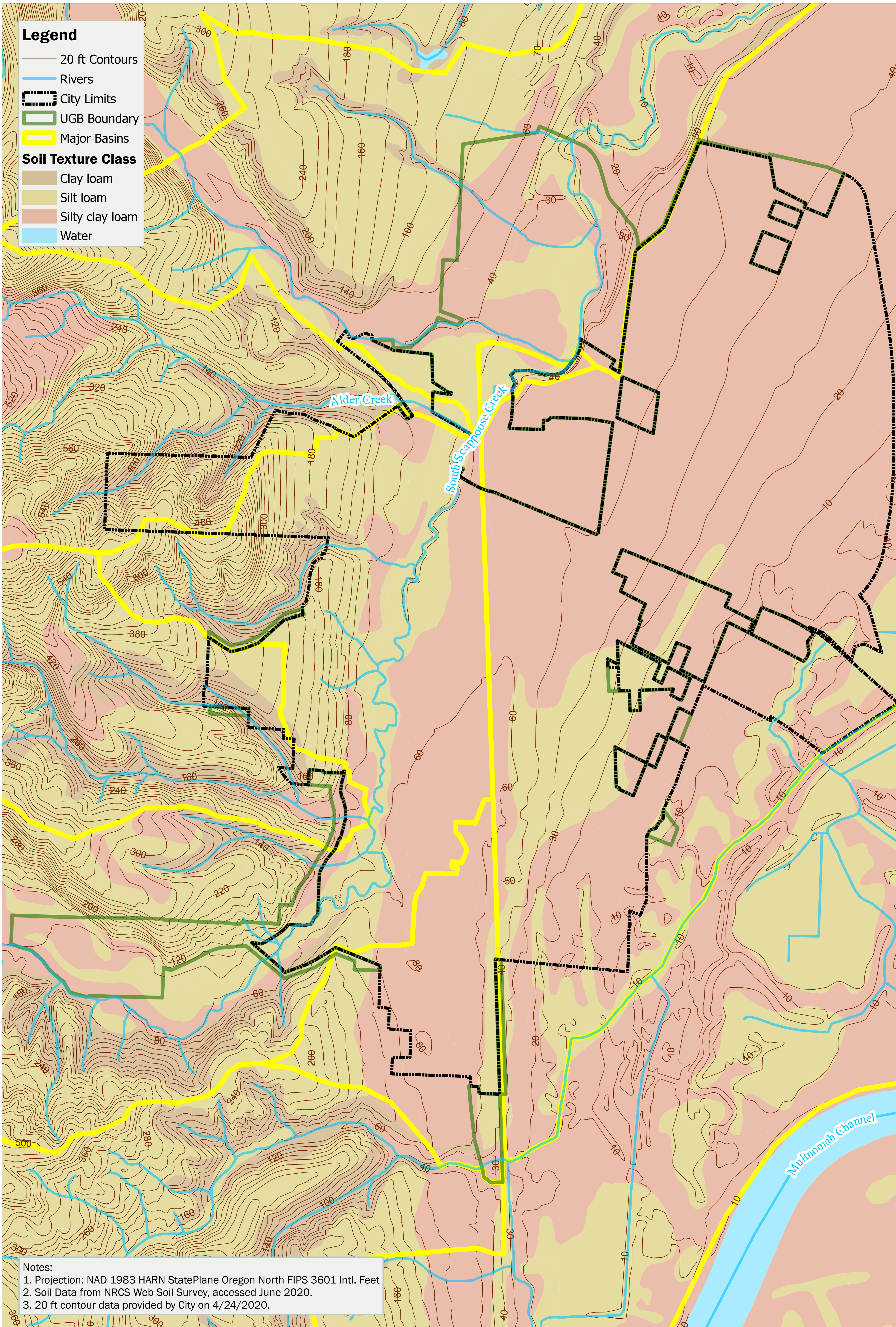
City of Scappoose

Storm Drainage Master Plan

September 2022
Project: 155252

Notes:
1. NAD 1983 HARN StatePlane Oregon North FIPS 3601 International Feet

Figure 2-2: Study Area Overview



City of Scappoose

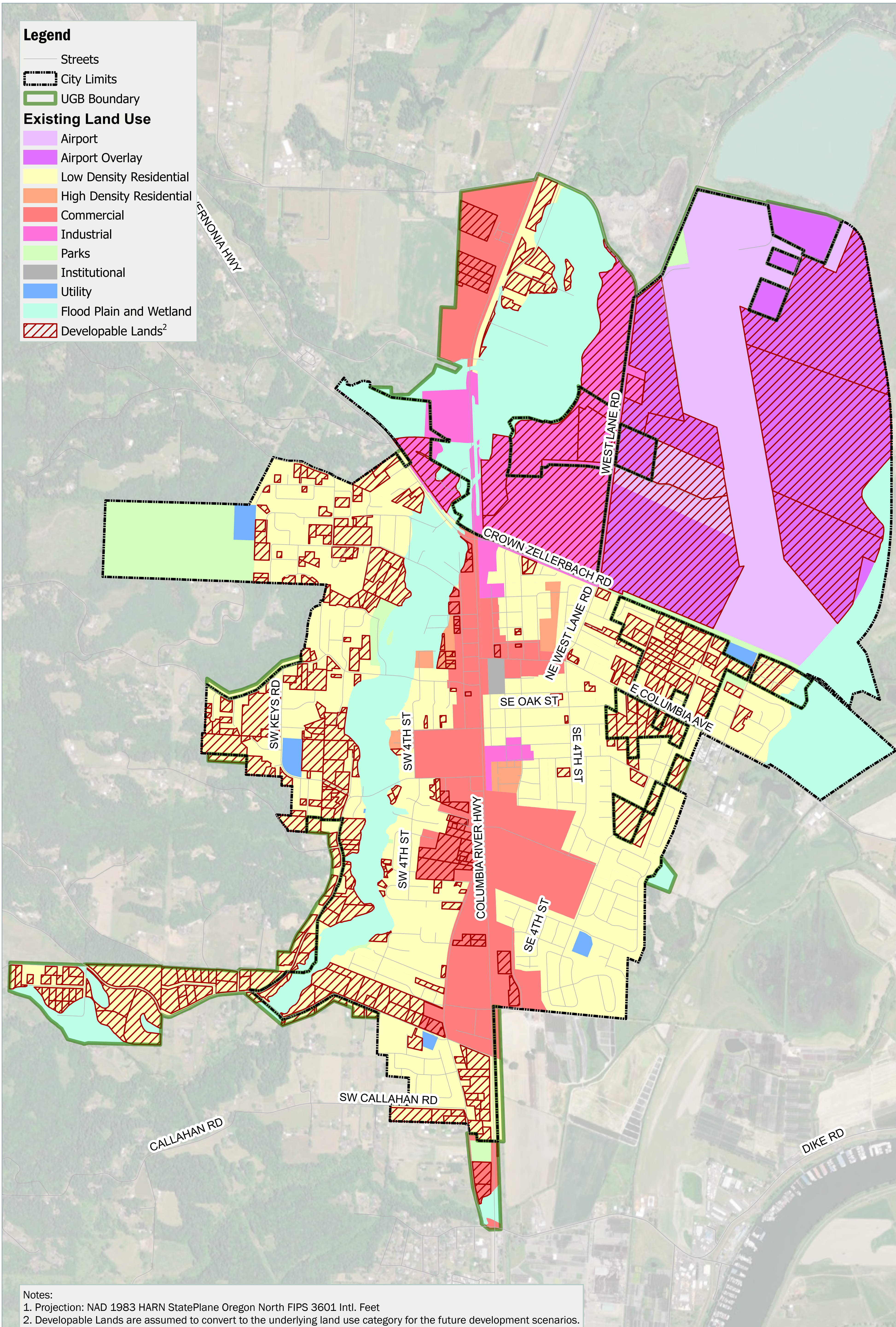
Storm Drainage Master Plan

September 2022

Project: 155252

Figure 2-3: Topography and Soils

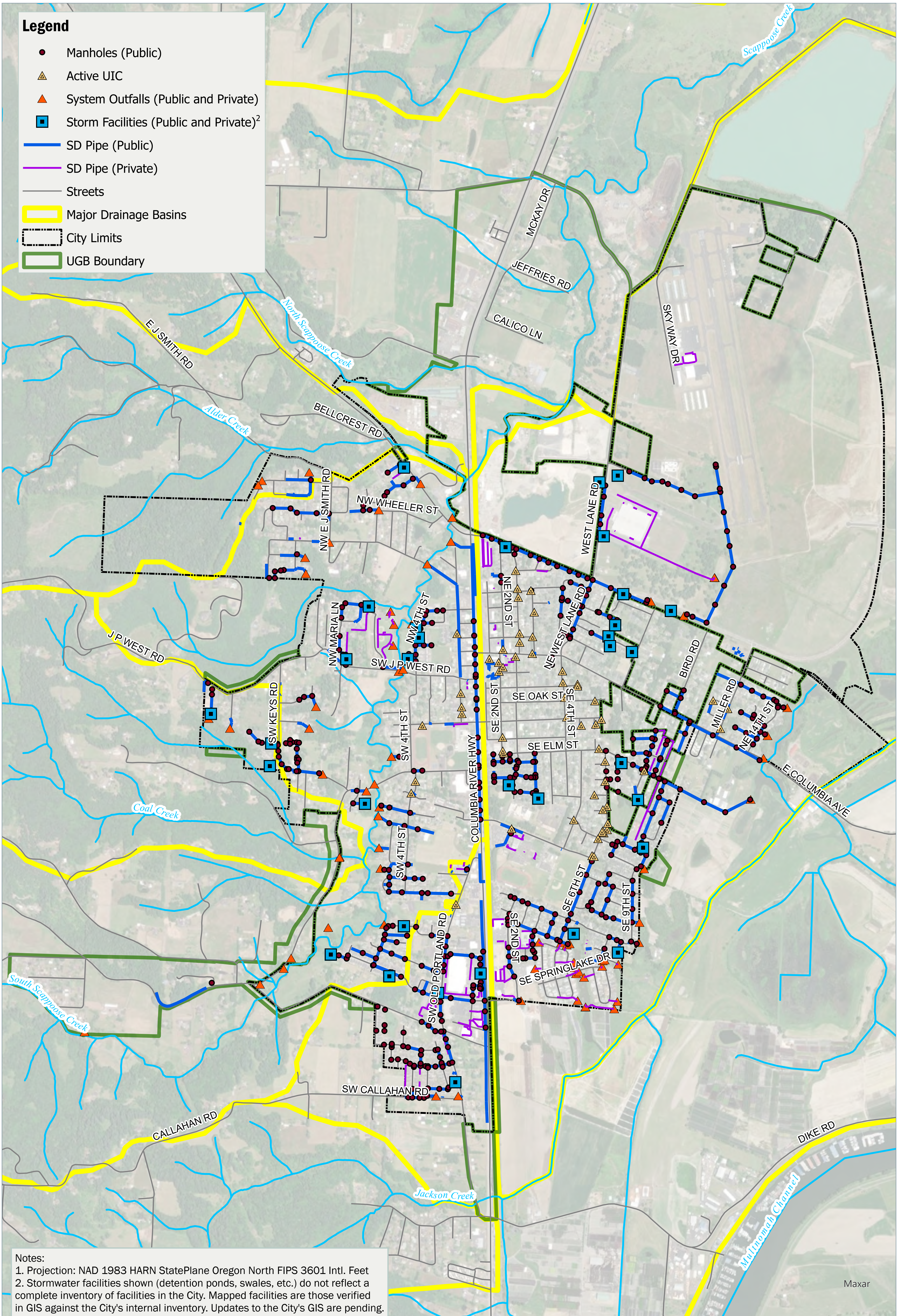
[BCDENFP01]: O:\PW_Exports\155252 - Scappoose_Stormwater_Master_Plan\07_GIS_Internal_BC\Pro Maps\SMP Document\2-3_Topography&Soils.aprx tsuesser Aug 31, 2022



City of Scappoose
Storm Drainage Master Plan
September 2022
Project: 155252

N
0 1,250 2,500 Feet

Figure 2-4: Land Use



Oct 4, 2022

tsuesser

[BCDENFP01]: O:\PW_Exports\155252 - Scappoose_Stormwater_Master_Plan\07_GIS_Internal_BC\Pro Maps\SMP Document\2-5_Asset_Overview.aprx

City of Scappoose

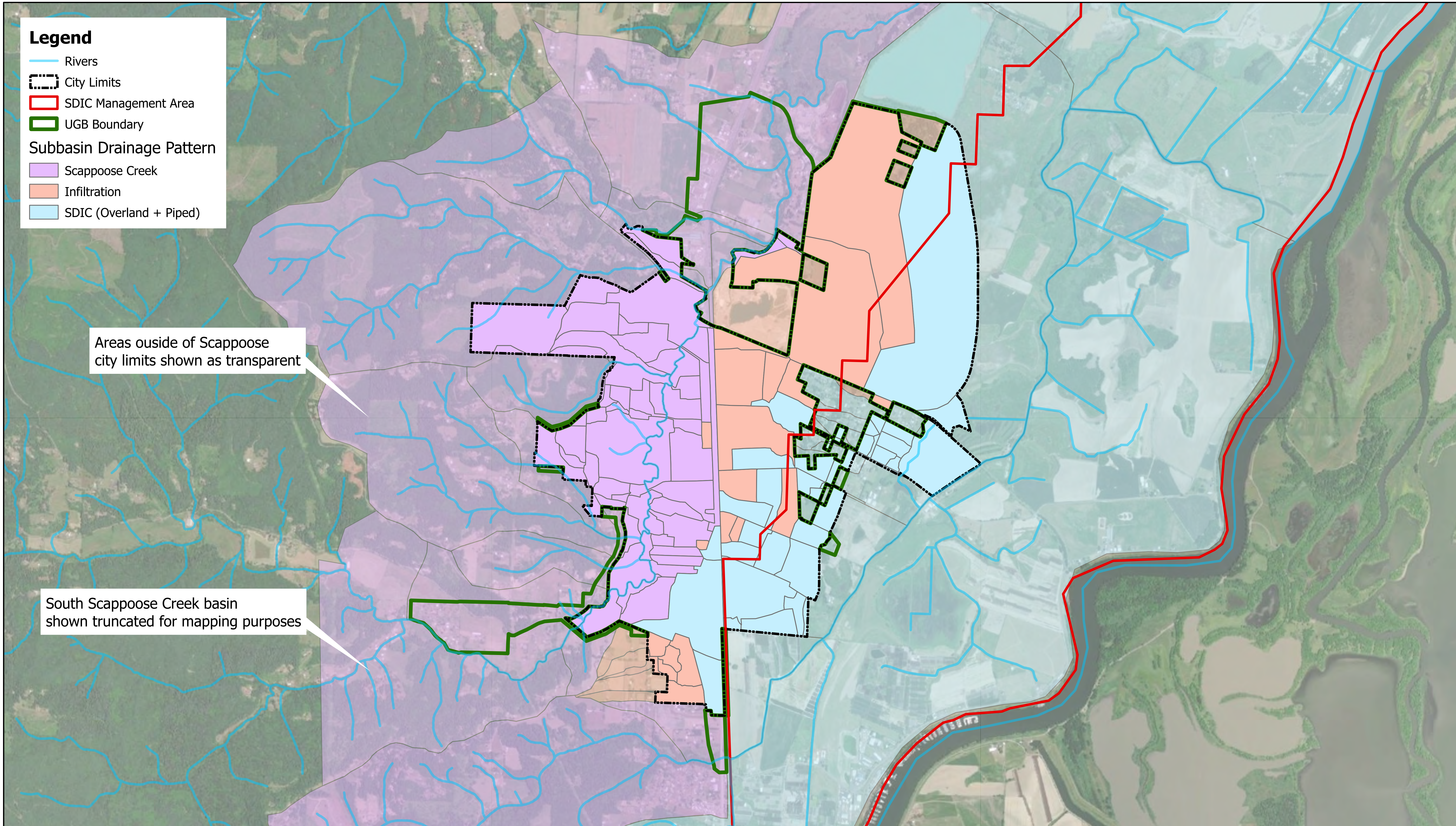
Storm Drainage Master Plan

September 2022
Project: 155252

N

0 1,250 2,500 Feet

Figure 2-5: System Overview



Brown AND Caldwell

City of Scappoose

Stormwater Masterplan

Date: 10/4/2022 1:36 PM

Notes:
1. SDIC boundary provided by City of Scappoose.
2. Areas shown as draining to SDIC include areas that discharge to the SDIC Management Area or that discharge to Jackson Creek.

Spatial Reference:
Name: NAD 1983 HARN StatePlane Oregon North FIPS 3601 Feet Intl

N

Feet
0 2,000 4,000 6,000

Figure 2-6: SDIC Drainage Overview

Section 3

Basis of Planning

This section summarizes the overall project planning process and identification of Stormwater Project Opportunity Areas, which inform the capital project and program development efforts. Identification of known and documented problem areas, stormwater retrofit opportunities, and UIC feasibility factored into this collaborative process with City staff (Engineering and Maintenance).

This project planning process allowed the City to focus resources and develop information for areas and projects most likely to be prioritized in a capital improvement program. This process also qualified project and program needs in consideration of the SMP objectives, specifically, resolving known areas of flooding and other stormwater drainage problems and expanding stormwater infrastructure to meet development and regulatory drivers.

The final Stormwater Project Opportunity list reflecting outcomes from the project planning process is included as Table 3-2 at the end of this section. Appendix B includes background documentation related to the project planning activities, including a Stormwater Problem Area and Modeling Needs matrix (Appendix B, Table B-1) and UIC inventory used to support the UIC feasibility assessment (Appendix B, Table B-2).

Referenced figures are included at the end of this section.

3.1 Problem Area Identification

The City developed this SMP using a collaborative approach with Engineering and Public Works staff to initially assess known stormwater problem areas and identify areas where infrastructure addition, replacement, or retrofit is needed to address an issue.

Problem areas were identified through a combination of City staff surveys, discussions with City engineering and maintenance staff, site visits, and review of the previous stormwater master plan. Portions of the stormwater system requiring a modeling approach to evaluate capacity limitations and project concepts were also identified through this process. A workshop was conducted with City staff following the initial problem area identification effort to confirm system locations requiring further evaluation (see Section 3.2).

3.1.1 Stormwater Surveys

In June 2020, BC prepared questionnaires (surveys) for distribution to City staff. The surveys asked for staff input related to specific locations of reported capacity deficiencies, system condition issues, frequent maintenance needs, and water quality improvement opportunities.

Two surveys were received from City Public Works and Maintenance staff on July 13, 2020. Survey responses included locations of reported capacity deficiencies, infrastructure needs, and repair/replacement (R/R) issues. Specific issues documented include standing water due to a lack of system capacity and/or infrastructure, flooding at open channels, buildup of sediment at catch basins, and damaged outfall structures.

The City Engineer provided a separate summary of potential system deficiencies by drainage basin. These locations primarily included areas where future development is anticipated and where there are reported downstream capacity concerns. In some cases, these locations overlapped with problem areas identified by Public Works/maintenance staff.

Figure 3-1 and Figure 3-2 depict the identified problem area locations per information received. Location IDs shown on these figures are consistent with documentation of problem areas (Table B-1) and subsequent Project Opportunity areas (see Table 3-2).

3.1.2 1998 Stormwater Master Plan Review

The City's 1998 Plan identified 13 recommended stormwater capital projects (CPs). Most of the recommended projects require installation of new storm piping systems for areas previously lacking public storm drain infrastructure.

BC reviewed these 13 recommended CPs against current public stormwater infrastructure documented in GIS. Where it was evident that the improvements had not been constructed, these unconstructed CPs were maintained as problem areas for additional discussion with the City. Overlap between staff-identified problem areas and these unconstructed CPs were noted. See the Stormwater Problem Area and Modeling Needs matrix (Table B-1).

3.1.3 Field Verification and Investigations

BC and City staff conducted an in-person site visit on September 2, 2020, to verify stormwater problem areas and assess potential project concepts. Maps were distributed detailing the problem areas and associated drainage infrastructure.

A total of 17 locations were visited. Locations visited included the highest priority problem areas for city staff, specifically areas where a conveyance system does not exist, where a conveyance system is undersized, and/or where existing UICs are not functioning. The site visit provided BC staff with an opportunity to discuss each problem area location with city staff and to better understand the overall drainage patterns and system to advance discussion of modeling needs and capital project concepts.

An additional site visit was conducted on July 16, 2021 to verify the configuration of stormwater infrastructure at eight locations where hydraulic modeling was being conducted. This site visit also supported the Stormwater Retrofit Analysis, and five potential retrofit locations were visited (see Section 3.3).

Results of the site visits are documented in the Stormwater Problem Area and Modeling Needs matrix (Table B-1), as well as a photo log included with the hydrologic and hydraulic model documentation (see Appendix C).

3.2 Problem Area and Modeling Extents Workshop

BC conducted a workshop with City staff on October 13, 2020, to review identified problem area locations and results of the September 2020 field investigation. The Problem Area and Modeling Needs matrix (Table B-1) was provided to City staff in advance to facilitate discussion of each location and categorize them by potential capital project development approach (project-based or programmatic). Of the 32 problem area locations, 13 locations were designated as potential project areas and 14 as potential program areas, with one area designated for both project and programmatic approaches.

An additional goal of the workshop was to establish the hydraulic modeling needs at each location. Hydraulic modeling needs were defined as Category 1, which requires detailed hydraulic modeling of existing infrastructure, and Category 2, which indicates hydraulic modeling is needed to size future infrastructure. Hydraulic modeling was not proposed for all problem areas, specifically those that will be addressed through a programmatic approach.

3.3 Stormwater Retrofit Analysis

In conjunction with the identification and qualification of problem areas, BC conducted a stormwater retrofit analysis to inform potential locations for water quality improvement and/or detention facilities in the City. Typically, stormwater retrofits are driven by a regulatory obligation. For Scappoose, the primary regulatory driver is continued compliance with the WPCF permit. Aside from this regulatory driver, stormwater retrofits to improve water quality or flow control must be coordinated with an existing problem area to be viable and implementable, given the number of identified, capacity-related problem areas requiring a capital project or program need.

As such, the City's retrofit analysis reflects the following three strategies (in order of priority):

1. UIC WPCF permit compliance
2. Incorporation of stormwater facilities (green streets/low impact development [LID]) to address local capacity issues, in conjunction with traditional stormwater system improvements
3. Regional facility installation or improvements to support improved water quality treatment and/or stormwater management for new growth

Methodology and resulting capital project or program solutions are detailed below. Table 3-2 integrates results of the retrofit analysis and associated strategy (i.e., "UIC", "Green Street", and "Regional Facility") with the identified problem area.

3.3.1 Green Street/LID Infrastructure Installation

The installation of green street/LID infrastructure (raingardens, planters, bioswales) can provide surface-based stormwater collection and conveyance support while also providing water quality treatment through sedimentation and filtration processes. Additionally, installation of green street/LID facilities, in conjunction with other stormwater system improvement needs, could help address UIC WPCF compliance.

Because the objective for the retrofit assessment is to develop multi-objective stormwater solutions, problem areas were reviewed to determine whether the incorporation of green street/LID infrastructure is feasible in conjunction with the capital project approach. Locations with identified infrastructure needs were targeted, as there is the potential to incorporate green infrastructure into the streetscape in these areas to address reported drainage problems. Both the "UIC" and the "Green Street" strategy is flagged for locations where the placement of green streets/LID facilities may also provide UIC pretreatment (see Table 3-2).

3.3.2 Regional Facility Installations or Improvements

The placement of new regional facilities is often driven by available land and a need to support future growth and development. Improvements to an existing regional facility are often related to a variety of needs including reported deficiencies, public complaints, a lack of maintenance, a need to change the function of the facility, and/or expansion of the facility to support growth and development.

For Scappoose, many of the existing regional facilities are privately held and therefore, do not appear to be viable opportunities to meet the retrofit assessment objectives. New regional facility installation opportunities were evaluated using a GIS desktop analysis and field investigations (see Section 3.1.3). Select problem area locations where future development is anticipated and where there are reported downstream capacity concerns were reviewed to confirm whether placement of a new regional facility would be viable to address the reported problems. These problem area locations were reviewed against the following retrofit criteria:

- **Public Lands**–New regional facility installations are viable in publicly owned lands, specifically areas zoned as public for either recreational or institutional use. Land acquisition is not financially feasible to support construction of a regional facility in advance of development occurring. Public lands considered viable for regional facility installation did not include public lands identified as 'utility' in the City's GIS.
- **Future Development**–The extent of vacant and developable lands upstream of the problem area was assessed to confirm whether a regional facility would provide opportunity for treatment and/or flow control for a significant amount of future development.
- **Floodplain**–Problem areas located inside or near the floodplain may not be viable locations for construction of a regional facility due to the potential permitting challenges and limited ability for the regional facility to freely discharge during storm events.
- **Slope–**Problem areas located on a steep slope area (> 15 percent) are not ideal locations for installation of a regional facility, particularly a facility that would incorporate the use of infiltration as part of the treatment processes.
- **Downstream Capacity Issue**–New regional facility installations that could address reported downstream (DS) capacity issues are preferred such that the facility could address multiple project objectives.
- **Upstream Stormwater Management Facilities**–Existing stormwater management facilities (detention, infiltration, swales) upstream (US) of the reported problem area were considered to 1) identify areas lacking treatment coverage and 2) identify whether retrofit of an existing detention facility may provide an alternative to the installation of a regional facility.

Table 3-1 outlines the results of the desktop analysis to inform new regional facility placement. Based on the criteria and site characteristics of each, Location ID 18b and 31 were identified as locations with potential to use a new regional facility to meet treatment and flow control requirements, and thus carried forward to capital project development.

Table 3-1. Stormwater Retrofit Assessment - Regional Facility Placement Analysis

Location ID	Location Description	Proposed Facility Objective (WQ, flow control, both)	Criteria						Other Facility Placement Opportunities/Notes
			1: Public Lands Available [a]	2: Developable Lands Upstream	3: Outside of Floodplain	4: Slope < 15%	5: DS Capacity Issues	6: Existing US Stormwater Management Facility(ies)[c]	
3	SE Elm/Endicott	Flow Control	N	N	Y	Y	Y	N	• No public regional facility placement potential • Existing regional facility-SD11113-DS of reported area, is reportedly undersized (no expansion potential) • Additional detention facility to installed with private development (Casswell Subdivision) in proximity
6	NW EJ Smith and NW 1st St	Flow Control	N	Y	Possibly [b]	Y	Y	N	• No public regional facility placement potential • Consider other retrofit assessment strategies
15	SW Creek View Pl	Both	N	Y	Y	Y	N	N	• No public regional facility placement potential
18b	SW J.P West Rd	Both	Y	Y	Possibly [b]	Y	N	Detention (SD0408), Swale (SD0886)	• Facility placement may need to be distributed facilities in Veterans Park as opposed to a single regional facility. • Upstream existing detention facility capacity is limited and not viable for retrofit.
23	E Columbia Avenue east of Bird Rd	Both	N	Y	Y	Y	Y	N	• No public regional facility placement potential • Consider other retrofit assessment strategies
24	Crown Zellerbach (Crown-Z) Rd	Both	N	N	Y	Y	N	N	• No public regional facility placement potential • Private development managing area north of Crown-Z Rd
28	Callahan-Dutch Canyon	Both	N	Y	Y	Y	N	Infiltration Facility (multi polylines: SD0820, SD0819, SD0824, SD0818)	• No public regional facility placement potential • Private-development driven—development currently under negotiation
29	Keys Rd Basin	Both	N	Y	Y	N	Y	Detention (SD0098, SD0102, SD0103)	• No public regional facility placement potential • Consider other retrofit assessment strategies
30	Spring Lake Park	Both	N	N	N	Y	Yes	Yes	• No public regional facility placement potential • Private-development driven--existing flow-through facility needs retrofit
31	NW EJ Smith Rd	Both	Y	Y	Possibly [b]	Y	N	N	• Facility placement is opportunistic based on Urban Renewal Program, recent City property purchase.

a. Area Zoned as public lands (recreational or institutional): does not account for tax lot information. City will need to confirm that proposed placement will not require property acquisition.
b. Depends on final siting of the facility.
c. Based on City's GIS inventory of stormwater management facilities, which is outdated (see Section 2.5).

3.4 UIC Assessment

UICs (or drywells) are vertical (commonly 4-foot-diameter, 20-feet-deep) precast concrete structures with perforations to support the exfiltration of stormwater into the subsurface soils.

UICs are not feasible in all areas of the City of Scappoose because: (1) UICs must meet Department of Environmental Quality (DEQ) regulatory requirements, and (2) UICs must be installed in permeable soils (e.g., sands and gravels). It can be challenging to meet DEQ's requirement in areas with shallow groundwater and where there is limited horizontal separation distance between the UIC and domestic wells. With respect to permeable soils, the geology in Scappoose is composed of a low permeability silt that overlays a permeable gravel. To be feasible, a UIC must penetrate the low permeability silt and encounter unsaturated, permeable gravel to support exfiltration.

3.4.1 Methodology

BC and GSI (a subcontractor on this SMP) completed a UIC feasibility assessment in February 2021 to inform locations of the city where stormwater UIC installations are feasible from a regulatory and technical (operational) perspective. UICs are readily used in the city and can be incorporated into capital project development efforts.

The feasibility assessment considered four primary criteria: 1) a minimum vertical separation distance of 5 feet from groundwater; 2) a minimum horizontal separation from water wells of 255 feet (per results of the City's GWPD) and outside of a 2-year travel time from a public supply well (if established); 3) a maximum depth of 20 feet; and 4) a minimum of 5 feet permeable gravel.

The assessment was conducted as a desktop GIS analysis. GSI initially excluded area of the City within the regulated horizontal separation from water wells. Then, GSI assessed the thickness of silt layer above permeable gravel layer and developed a contour map of shallow silt thickness using water well logs and geotechnical logs from the Oregon Water Resources Department (OWRD). New drywells are considered "not feasible" in areas where the shallow silt is over 15 feet thick, as the maximum depth drywell (20 feet) requires at least five feet of permeable gravel. Finally, GSI used the depth to seasonal high groundwater, developed previously as part of the City's WPCF permit application, to exclude areas of the City where a drywell could encounter groundwater without being able to meet the required five feet of permeable gravel.

3.4.2 Results

Figure 3-3 shows the areas of the city where new UICs may be feasible (green shading). Yellow shading represents areas where UICs are not feasible due to an inability to meet DEQ's horizontal setback to water wells. Unshaded areas represent areas where UICs are not feasible because the surface silt is over 15 feet thick or groundwater is shallow, resulting in the inability for a drywell to encounter five feet of unsaturated gravel to meet DEQ's requirement for five feet of vertical separation from groundwater. UIC feasible locations have been used in the context of capital project planning efforts.

Per Figure 3-3, UIC feasibility is primarily located in the central portion of the city (where most of the City's existing UICs have been installed) and in the northern portion of the City near the airport. The City is planning to install several municipal water supply wells near the airport, and when well locations are finalized and wells are installed, UIC feasibility in this area will likely change due to constraints related to maintaining horizontal separation distances to drinking water wells.

It should be noted that Figure 3-3 represents a planning-level evaluation and site-scale conditions may vary from what is shown.

3.5 Project Planning Results

Table 3-2 summarizes and sorts the stormwater problem areas (by Location ID) those locations where a capital project or program solution is proposed based on project planning efforts. These Project Opportunity Areas are categorized based on primary deficiency. Primary deficiencies are as follows:

- **Capacity**–Areas experiencing flooding or backwater conditions due to existing insufficient stormwater conveyance capacity.
- **Infrastructure Needs**–Areas lacking stormwater infrastructure (i.e., stormwater main, catch basins, inlets) and experiencing ponding or drainage impacts to private property. Also, areas where a regional facility to support new/redevelopment activities are designated as an infrastructure need.
- **Repair/Replacement**–Areas with functional or structural deficiencies that are potentially fixable with a programmatic approach to minor drainage improvements.
- **Maintenance**–Areas of frequent maintenance needs (i.e., clogged catch basins).
- **Water Quality**–Areas lacking water quality treatment or where water quality should be addressed.

Preliminary project concepts or potential stormwater programs are referenced for 28 of the original 32 problem area locations. Problem areas that were originally identified, but upon additional review and discussion with the City, are not anticipated to translate to a project opportunity, have been maintained in the matrix for reference (see gray shaded rows).

Following the project planning efforts, BC established full modeling extents, capturing infrastructure necessary for detailed hydraulic modeling of the Category 1 locations. Four of the Category 2 locations (per Table B-1) were changed to Category 1 to capture existing infrastructure that, would impact potential project design at the identified problem area. Modeling extents were provided to the City for review and confirmed during a coordination meeting on January 19, 2021. The final hydraulic modeling approach is reflected in Table 3-2, as well as in Figure 3-4 and Figure 3-5.

Table 3-2. Stormwater Project Opportunity Areas

Location ID	Location Description	Basin	Reported Deficiency [a]	Problem Area Source	Hydraulic Modeling Approach [b]	Problem Description	Associated UIC Issue? Y = Yes P= Possible	Associated CIP (per the 1998 MP)?	Associated Transit Project [c] (per 2016 TSP)?	Preliminary Project Concepts [d]	Project Need		Program Need [e]	Stormwater Retrofit Elements		
											Y	N		UIC	Green Street	Regional
3	SE Elm/Endicott	**Jackson Creek**	**Cap** WQ	Public Works Engineering	Category 1	• Previous modeling (by others) indicates the trunk line in SE Elm St is undersized. • Roadway flooding occurs and catch basins do not drain. • Future development flows are anticipated to exacerbate flooding, and limited detention is provided upstream.		Elm St SD System-New storm pipeline development north and south of Elm St east of 4th St.	I12, W16, B18, D14. Proposed new sidewalk along Elm from 3rd St to east UGB (medium), roadway improvements along Elm from 6th St to UGB ("aspirational")	Pipe upsizing	X					X (Possible-Casswell facility could be used)
4	SE 5th/SE High School Wy	**Jackson Creek**	**Infra** WQ	Public Works	Category 1	• Roadway flooding occurs due to existing roadside ditch with no outlet. • Proximity to school makes this a higher priority location. • Deficient (unregistered) UIC upstream of problem area may contribute to flooding (Vine and 5th)-installation of a registered UIC should be incorporated. • Limited collection system infrastructure results in standing water.	Y-UIC #37 report standing water by City staff		I8, W13, W41, B23, B19. Proposed new sidewalk on north side of HS Way to connect to 6th intersection (high priority). Proposed new sidewalk on 5th to Vine (low)	Pipe/swale installation (5th and HS Wy) and UIC (corner 5th and Vine)	X			X	X	
6	NW EJ Smith and NW 1st St	**S. Scappoose Creek**	**Cap** WQ	Public Works Engineering	Category 1	• Existing pipe on NW 1st from SW JP West Rd to NW EJ Smith Rd and outfall is likely undersized. • Future development flows (Urban Renewal) are anticipated to exacerbate flooding. • Surface facilities/green streets are not recommended due to traffic.			I11. Proposed new curb alignment at corner of 1st and JP West (high)	Pipe upsizing	X					
15	SW Creek View Place	**S. Scappoose Creek**	**R/R** Cap	Public Works Engineering	Category 1	• Future development (Bitte property) anticipated. • Storm socks in two areas may warrant more robust inspection of the outfall.			No			X	Y-Expanded Facility Maintenance			
19	NE Miller Rd on Miller playground	**Jackson Creek**	**Cap**	Public Works	Category 1	• Undersized pipe, roadway flooding occurring (maybe associated with Sunset Loop drainage-see Location ID 8/9).			W22. Proposed sidewalk on Miller from Columbia to Crown-Z (aspirational)	Pipe installation along Miller Rd that drains to Columbia may be a combined solution with Location ID 8/9.		X				
21	SE 9th/Icenogle Loop/Pioneer Crossing	**Jackson Creek**	**Maint** Cap	Public Works	Category 1	• Questionable performance of the Pioneer Crossing stormwater facility. • Sediment/organic material from trees in catch basins contribute to localized flooding.			No			X	Y-Expanded Facility Maintenance			
23	E Columbia Ave east of Bird Rd	**Jackson Creek**	**Infra** Cap WQ	Engineering Previous MP	Category 1	• Pipe along E Columbia is reported to be undersized. • Area lacks and requires a storm drainage infrastructure. • Future development (Sunset Lp) anticipated. • High groundwater prevents use of UICs.			W33, B12, I4. Proposed new sidewalk on Columbia from 4th to east UGB (aspirational), new intersection at 4th.	Pipe upsizing	X				X	
28	Callahan-Dutch Canyon Area	Jackson Creek West	**Infra** Cap	Engineering Previous MP	Category 1	• Development has put capacity pressures on existing linear retention basin (currently serving all phases of development). • Unknown drainage patterns contribute to roadway flooding/overtopping on Dutch Canyon Rd. • Additional development is anticipated (Phase IV). The existing, HOA-owned infiltration facility is planned to be rebuilt as a condition of Phase IV. Drainage on the east side of Old Portland Rd will likely "want" to drain to this facility when it develops in the future.		New conveyance system for proposed development in the Callahan-Dutch Canyon area.	D23, W1. Proposed roadway improvements and sidewalk on Old Portland Rd between Jenny Lane and Hwy 30 (medium)	Two projects: 1. Size culvert across Dutch Canyon 2. Propose pipe south along Old Portland Rd-show contributing areas and discuss limitations of infiltration facility	X					
8 and 9	NE Sunset Loop	Jackson Creek	**Cap** Infra WQ	Public Works	Category 1	• Localized flooding (roadways, driveways) extends to private property and Miller Park (see Location ID 19 in Category 1 above). • System surcharging. • Deficient/failing UIC may contribute to flooding.	P-UIC #3 and #4 report standing water. UIC #50 is nearby and likely has standing water.		W22. Proposed sidewalk on Miller from Columbia to Crown-Z (aspirational)	New pipe to connect to Columbia, which would be lowered. Analyze shallow pipe to intercept flow in Sunset Lp before lowest junction.	X			X	X	

Table 3-2. Stormwater Project Opportunity Areas																
Location ID	Location Description	Basin	Reported Deficiency [a]	Problem Area Source	Hydraulic Modeling Approach [b]	Problem Description	Associated UIC Issue? Y = Yes P= Possible	Associated CIP (per the 1998 MP)?	Associated Transit Project [c] (per 2016 TSP)?	Preliminary Project Concepts [d]	Project Need		Program Need [e]	Stormwater Retrofit Elements		
											Y	N		UIC	Green Street	Regional
18a	SW J.P. West Rd	S. Scappoose Creek	Infra WQ	Public Works	Category 2	• Lack of storm drainage infrastructure (SW JP West Rd between Hwy 30 and S. Scappoose Creek; S of JP West Rd to SW Maple St). • Trunk Line on JP West should be a high priority project. • Future development anticipated.		JP West Storm Pipeline-New storm pipeline to provide SD service and prevent SW ponding in existing developed area south of JP West Rd west of 1st St	D24, W9. Proposed roadway and sidewalk improvements on JP West between 2nd and 4th St (high)	Pipe installation on JP west between Hwy30 and creek.	X					
18b	SW J.P. West Rd from bridge across Scappoose Creek to Keys Rd	S. Scappoose Creek	Infra WQ	Engineering	Category 1	• Lack of storm drainage infrastructure (between Keys Rd and S Scappoose Creek). • Potential for regional facility placement in park. • Future development along Keys Rd anticipated. • Roadway swales/GI along the road will not work-too steep.			W8. Proposed to complete sidewalk system on JP West between Keys Rd and SW 4th St (low)	Extend pipe up JP west to Keys Rd (Location ID 29), analyze existing pipe in JP west for capacity issues. Potential regional facility in Veterans Park	X					X (possible)
29	Keys Rd Basin	S. Scappoose Creek	Infra	Engineering	Category 1	• Lack of storm drainage infrastructure (primary ditch conveyance down Keys Rd, Huser Ln, and SW EM Watts Rd). • Future development anticipated.			W6, I14. Proposed to complete sidewalk on EM Watts between 4th and Keys Rd (Low), complete sidewalk on north-south portion of Keys at top of the hill (aspirational)	Phased project: Phase 1: Extend piped conveyance from corner of Keys and EM Watts to Creek Phase 2: Connect piped conveyance to remove ditches on Keys	X					
31	NW EJ Smith (west side of Scappoose Creek.	S. Scappoose Creek	Infra WQ	Engineering	Category 2	• Lack of storm drainage infrastructure (EJ Smith Rd and tie-ins for 5th, 6th, and 7th). • Future development anticipated. • Opportunity for regional facility (water quality only most likely, not much drop or space to do flow control).			W23. Propose sidewalk along EJ Smith from 1st to Bella Vista Dr (low)	Regional facility.	X (Low Priority)					X
1	SE 6th/SE Vine	Jackson Creek	R/R Cap WQ	Public Works		• Poor drywell operation/UICs are failing and resulting in roadway flooding. • UICs are open bottom catch basins requiring maintenance or replacement. • UICs don't have pretreatment.	Y-UICs #32, #33, and #29 report standing water.	Vine St SD System-New storm pipeline to provide SD service to new and existing development north and south of Vine St east of 4th St.	W14, W17. Proposed new sidewalk between along Vine from Grant Watts to 6th (high), and along SE 6th between Vine and Elm (low)	UICs and pretreatment	X			X		
2	SW 4th/SW Maple	S. Scappoose Creek	Infra WQ	Public Works		• Localized flooding along 4th Ave and Maple due to a non-functional area drain. • Deficient UICs or lack of pipe/infrastructure may be the source. • Storm line along 4th and Day is currently plugged/failing – City working to get it TV'd.	P-UIC #39 reports standing water.		W11. Proposed sidewalk between US30 and SW 4th St. (medium)	Pipe replacement	X				X	
5	NE 1st St	Jackson Creek	Infra	Public Works		• Lack of infrastructure results in standing water • May consider UIC installation			No			X	Y–Minor Localized Drainage Improvements	X		
7	NE 2nd from Prairie to Laurel and surrounding area between NE Williams and E Columbia	Jackson Creek	Infra WQ	Public Works		• Lack of infrastructure results in standing water. • May consider UIC installation with other drainage improvements. • There is no current cohesive collection system in this area. However, this area is within the feasible UIC zone, as identified by GSI, and the GIS shows multiple working UICs in the area. • 1998 MP does NOT identify NE 2nd St as a candidate for a new storm system		Sawyer St SD System-New storm pipelines to serve existing developed northeast area that has unreliable or failing dry wells.	No			X	Y–Minor Localized Drainage Improvements	X		
10	NW View Terrace	S. Scappoose Creek	R/R	Public Works		• Steep topography and limited catch basins result in localized flooding/runoff to jump curb into residential properties.			No	Install inlet and lateral		X	Y–Minor Localized Drainage Improvements			
11	SE 9th/SE Davona	Jackson Creek	R/R	Public Works		• Functional deficiency; outfall is same level as pond and can flood.			No	Repair/replacement		X	Y–Minor Localized Drainage Improvements			

Table 3-2. Stormwater Project Opportunity Areas																
Location ID	Location Description	Basin	Reported Deficiency [a]	Problem Area Source	Hydraulic Modeling Approach [b]	Problem Description	Associated UIC Issue? Y = Yes P= Possible	Associated CIP (per the 1998 MP)?	Associated Transit Project [c] (per 2016 TSP)?	Preliminary Project Concepts [d]	Project Need		Program Need [e]	Stormwater Retrofit Elements		
											Y	N		UIC	Green Street	Regional
12	SW Crystal Springs	S. Scappoose Creek	**R/R**	Public Works		• Structural deficiency; outfall is cracking and hard to access.			No	Repair/replacement		X	Y-Minor Localized Drainage Improvements			
13	Crown-Z Rd	Jackson Creek	**Maint**	Public Works		• Catch basin sediment buildup from rock pit, debris from trees. • Reported maintenance issue.			No. S4 is nearby but is for Crown-Z multi-use path, not street.	Increased CB cleaning		X	Y-Expanded Facility Maintenance Program			
14	SE 2nd/SE Havlik	Jackson Creek	**Maint**	Public Works		• Seven filters are in catch basins. • Elevated sediment load from farm trucks requires more street sweeping.			No	Increased CB cleaning and replacement of inserts		X	Y-Expanded Facility Maintenance Program			
16	32952 SW Keys Crest Dr	S. Scappoose Creek	**R/R**	Public Works		• Reported erosion associated with use of storm socks down steep embankment. Storm socks in two areas. • More robust inspection of the outfall location is needed per City staff.			No	Increased inspection of outfall and socks.		X	Y-Expanded Facility Maintenance Program			
17	E Columbia south through Elm St to SE Rose/SE High School Wy	Jackson Creek	**Infra**	Public Works		• Area lacks and requires a storm drainage system–no storm structures currently present (see Location ID 3). • May consider UIC installation with other drainage improvements.			W18. Proposed sidewalk along SE Maple between Hwy 30 and SE 4th (Low)			X	Y–Minor Localized Drainage Improvements. Could tie into Elm St at 4th	X		
20	Veterans Park along roadsides	S. Scappoose Creek	**Cap WQ**	Public Works		• Water from existing grassy swales (water quality facility) backs up onto roadway. • City is planning a roadway improvement that removes the need for the project.			No			X	Y-Expanded Facility Maintenance Program			
22	NE West Lane Rd	Jackson Creek	**Infra**	Public Works		• UICs are unreliable in area. • No project needed if E Columbia is extended to area.		West Lane SD System-New storm pipelines to serve existing developed northeast area that has unreliable or failing dry wells.	No			X				
24	Crown-Z Rd	Jackson Creek	**Infra**	Engineering Previous MP		• Unknown drainage patterns and system (no reported issues but staff don't know the history of this area). • Active development underway.		Crown Storm Line-New storm pipeline north of existing Crown-Z Rd.	No–I3 nearby but only calls for traffic signal install at intersection.							
25	Airport Industrial Area	Jackson Creek	**Infra**	Previous MP		• Active private development underway.		Airport Industrial Area-New storm pipeline for proposed development around airport.	No							
26	Jackson Creek (exact location unclear)	Jackson Creek	**Infra**	Previous MP		• Temporary/mobile pumping units to divert excess flows from Jackson Creek to Multnomah Channel during extreme flood events were proposed in the previous MP. • Unclear if still a relevant need.			No							
27	5th, 6th, and 7th Ss between Wheeler and EJ Smith Rd	S. Scappoose Creek	**Infra**	Previous MP		• No infrastructure. • Roadways are County-owned and so no City-funded project or program anticipated.		New storm piping system along 5th, 6th, and 7th Sts between EJ Smith and Wheeler.	No							
30	Spring Lake Park Basin	Jackson Creek	**Cap WQ**	Engineering		• A private pond system built as part of the mobile home development contains an undersized culvert, which results in flooding of Spring Lake Dr. • City may consider partnering (water quality retrofit/detention facility) if homeowner associated funds culvert upsizing.			No							

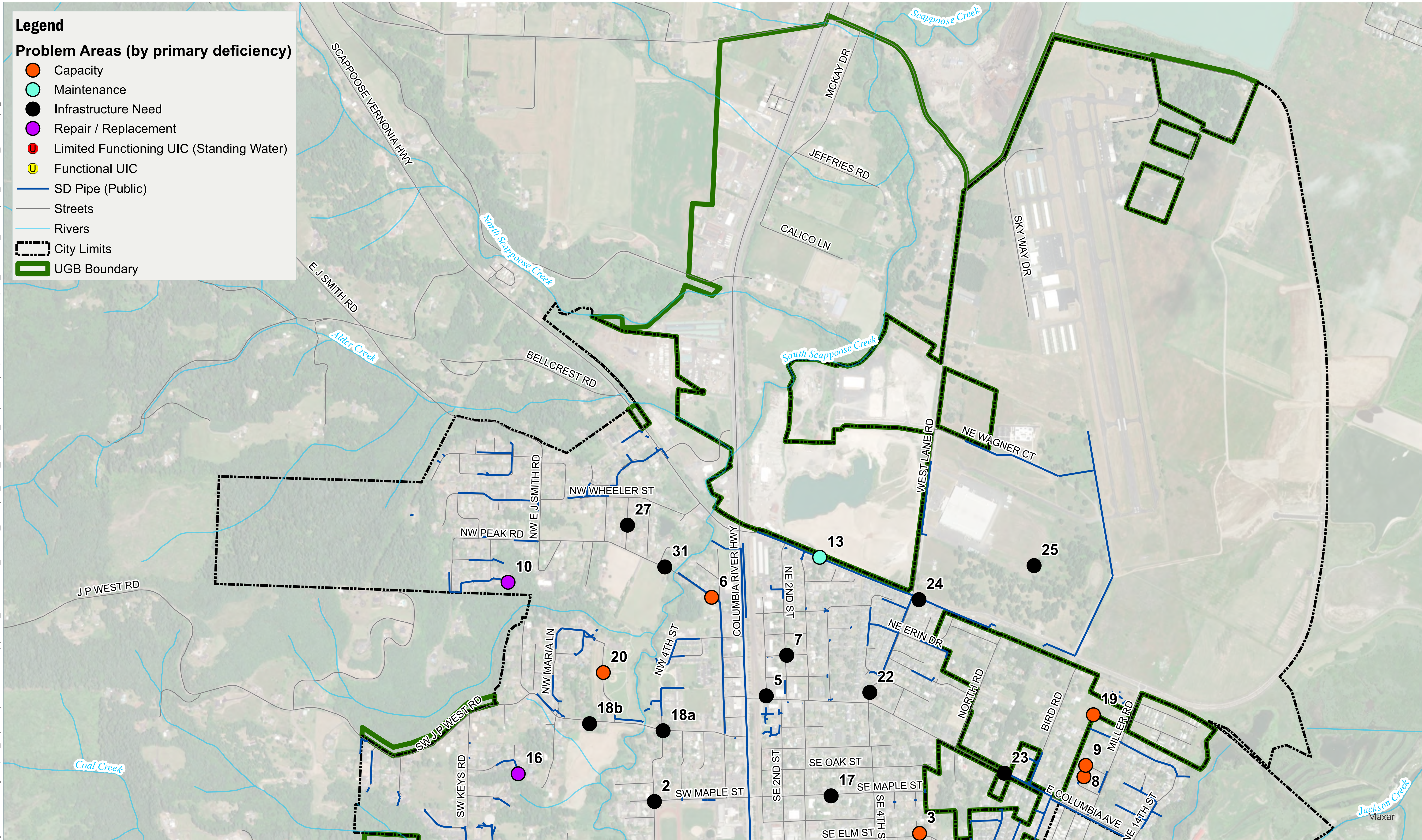
a. Legend: R/R=Repair and Replacement; Infra = Infrastructure Need (New); Cap = Capacity Issue; Maint = Chronic Maintenance Problem; WQ = Lack of water quality treatment. BOLD font indicates the mapped deficiency per Table A-1.

b. Category 1 refers to hydraulic modeling of existing infrastructure. Category 2 refers to hydraulic modeling of new or proposed infrastructure.

c. D = Driving, W = Sidewalk, I = Intersection, B = Bike. See 2016 TSP: 2016 Scappoose Transportation System Plan: Volume 1

d. Preliminary project concepts may include pipe replacement/upsize, pipe installation, drywell decommissioning, regional facility installation, water quality facility installation, or a combination thereof. Rows shaded in gray have no project or program recommendation.

e. Programmatic activity descriptions are in Section 5.X. The UIC Retrofit Program refers to the addition of pretreatment in support of existing UIC facility installations. Minor Localized Drainage Improvements refers to the installation of limited infrastructure (including UICs) to support stormwater collection and conveyance. The Expanded Facility Maintenance Program refers to an increase frequency or coverage of activities for select existing infrastructure including ponds and sock installation for outfalls discharging to steep slopes.



Brown AND Caldwell

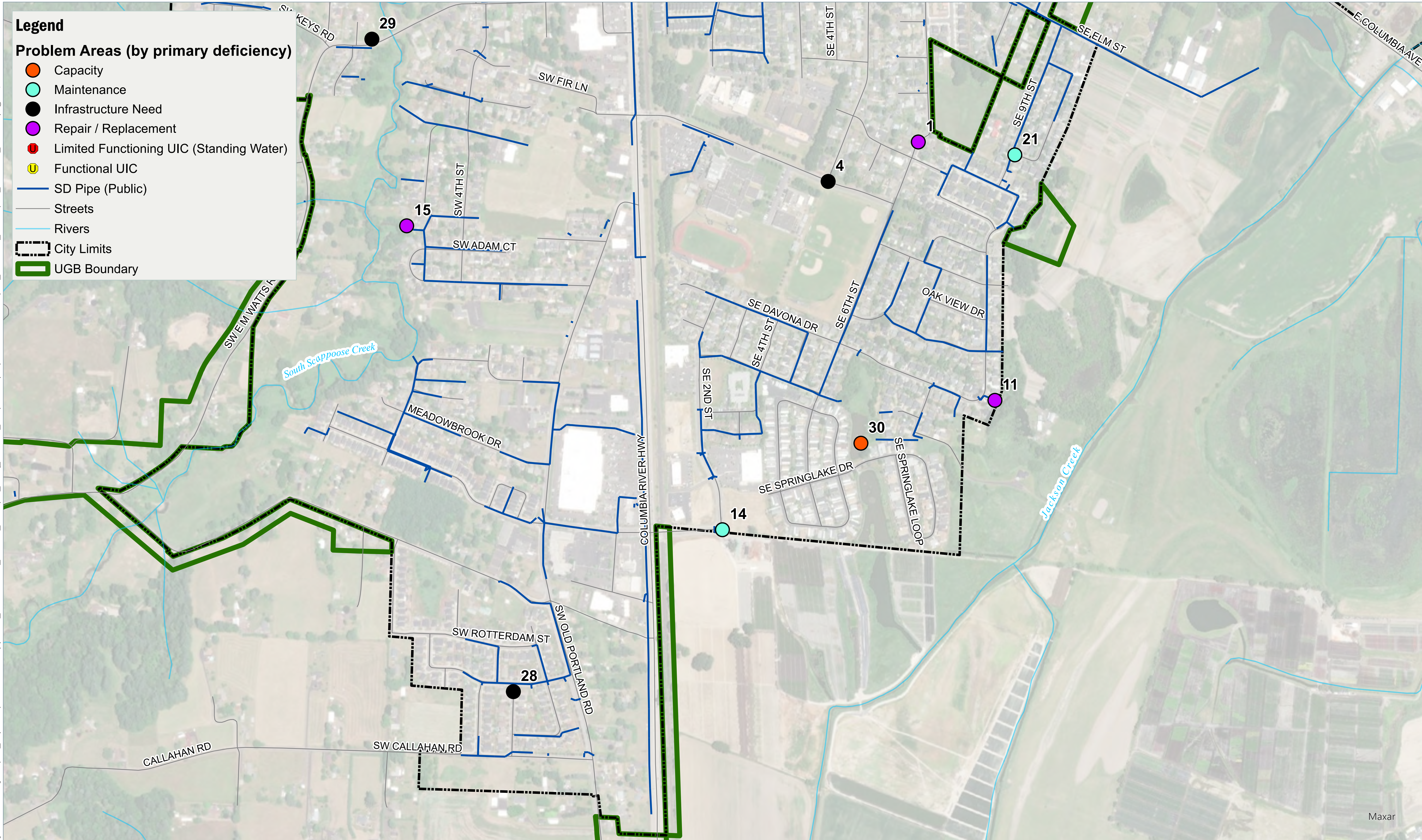
City of Scappoose

Storm Drainage Master Plan

September 2022
Project: 155252

Notes:
1. NAD 1983 HARN StatePlane Oregon North FIPS 3601 International Feet
2. Location numbering refers to Table 3-1 of the SMP.

Figure 3-2: Problem Area Locations (North)



City of Scappoose

Storm Drainage Master Plan

September 2022

Project: 155252

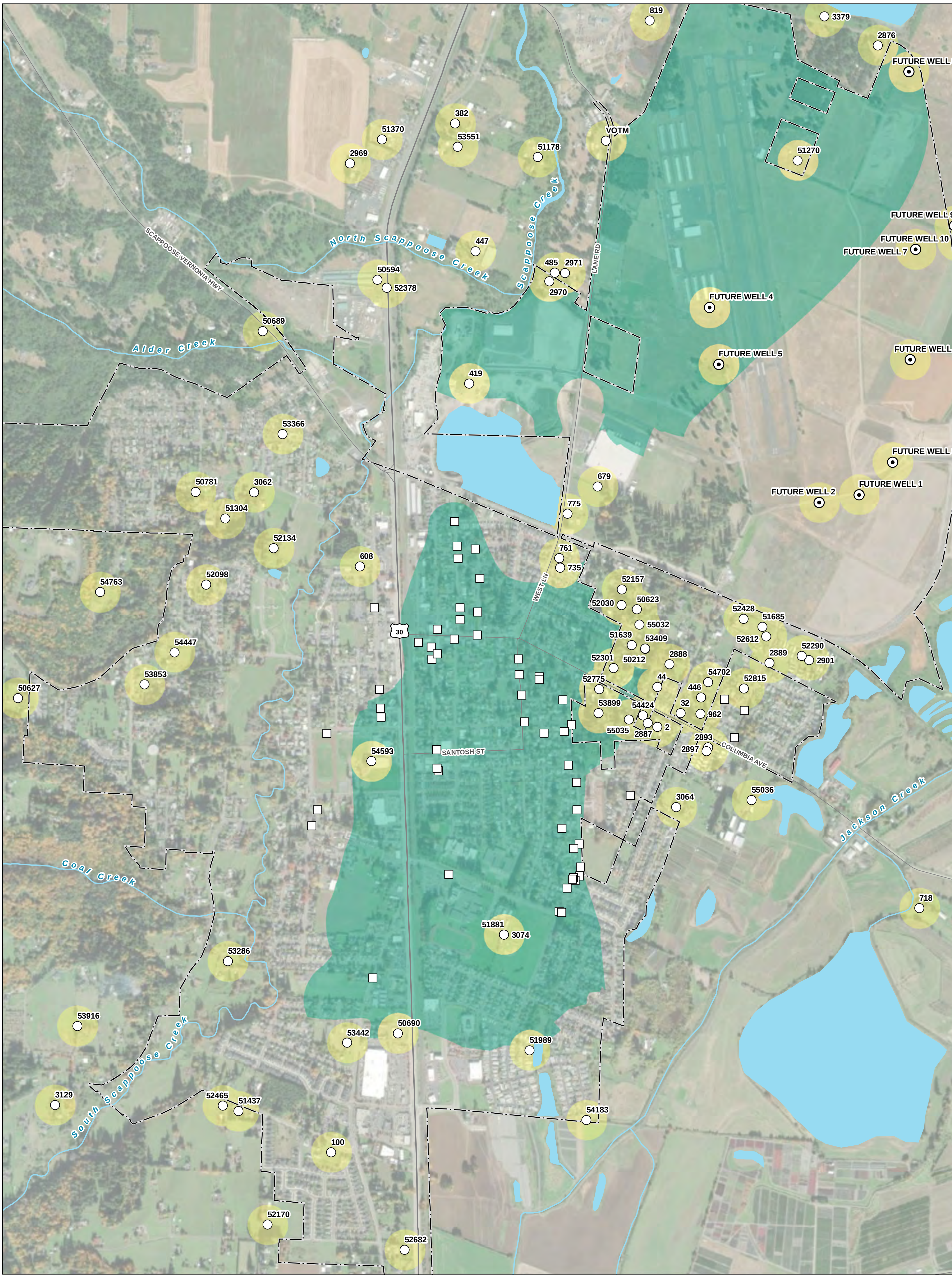
0 500 1,000 Feet

N

Notes:

1. NAD 1983 HARN StatePlane Oregon North FIPS 3601 International Feet
2. Location numbering refers to Table 3-1 of the SMP.

Figure 3-2: Problem Area Locations (South)



LEGEND

- ○ Well[1]
- □ Underground Injection Control (UIC)
- ⊙ Future Municipal Supply Well
- Feasible Drywell Area (see SMP Section 3.4)
- Not Feasible Due to Water Well Setbacks[2]

All Other Features

- City Boundary
- Major Road
- Watercourse
- Waterbody

FIGURE 3-3

UIC Feasibility Assessment

Scappoose, Oregon

Date: February 9, 2021
Data Sources: OWRD, OGCH, ESRI, USGS

N

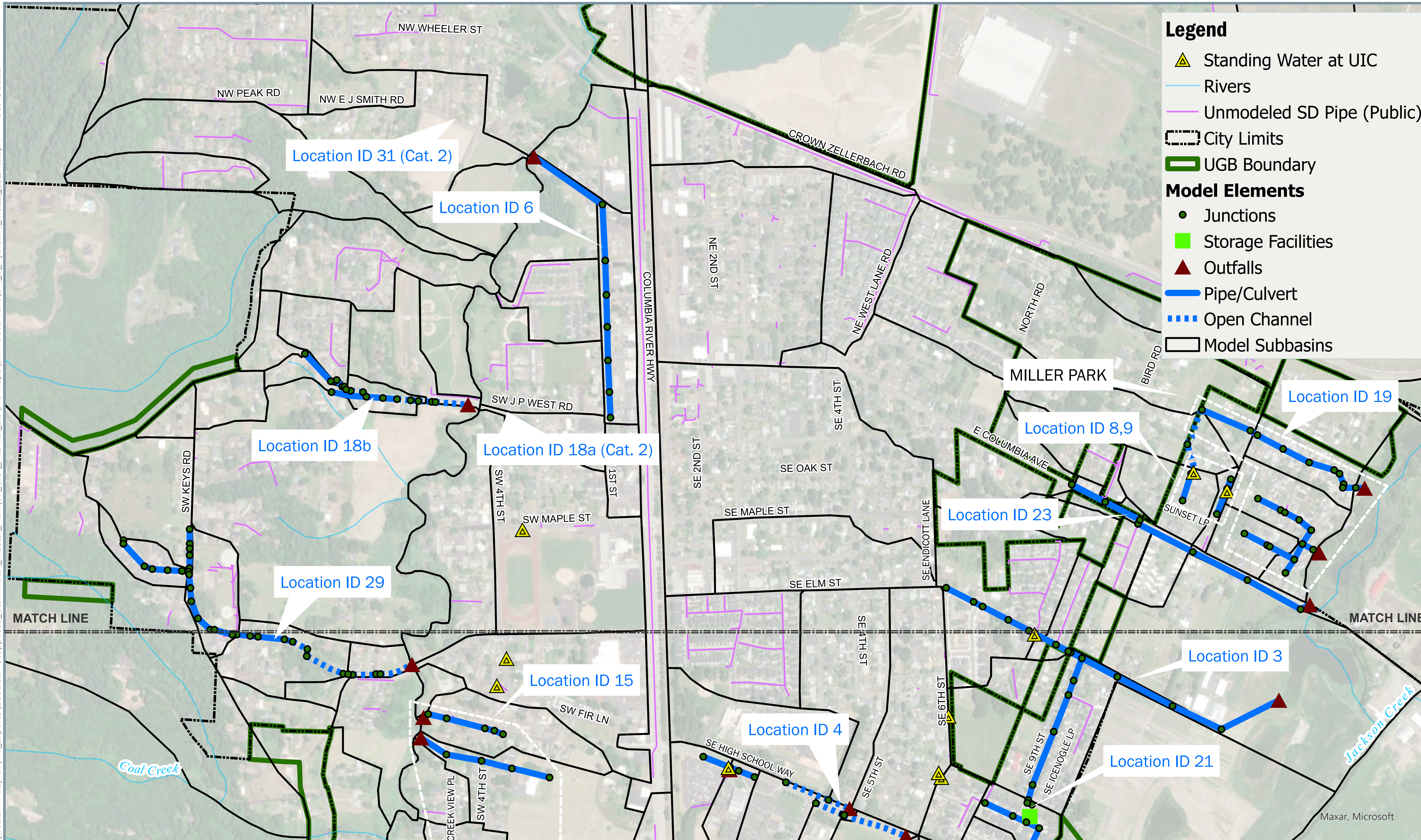
0 600 1,200 1,800
Feet

GSI Water Solutions, Inc.

NOTES

1. Wells located exactly by coordinates or approximately by property address.
2. All areas that are yellow or not shaded green are considered to be not feasible for UICs due to silt depth greater than 15 ft, insufficient vertical separation from seasonal high groundwater, and/or outside the urban growth boundary.

Document Path: Y:\0374_Brown_and_Caldwell\Source_Figures\008_Scappoose_SW_MP\Figure1_Dry_Well_Feasibility.mxd, npalmer



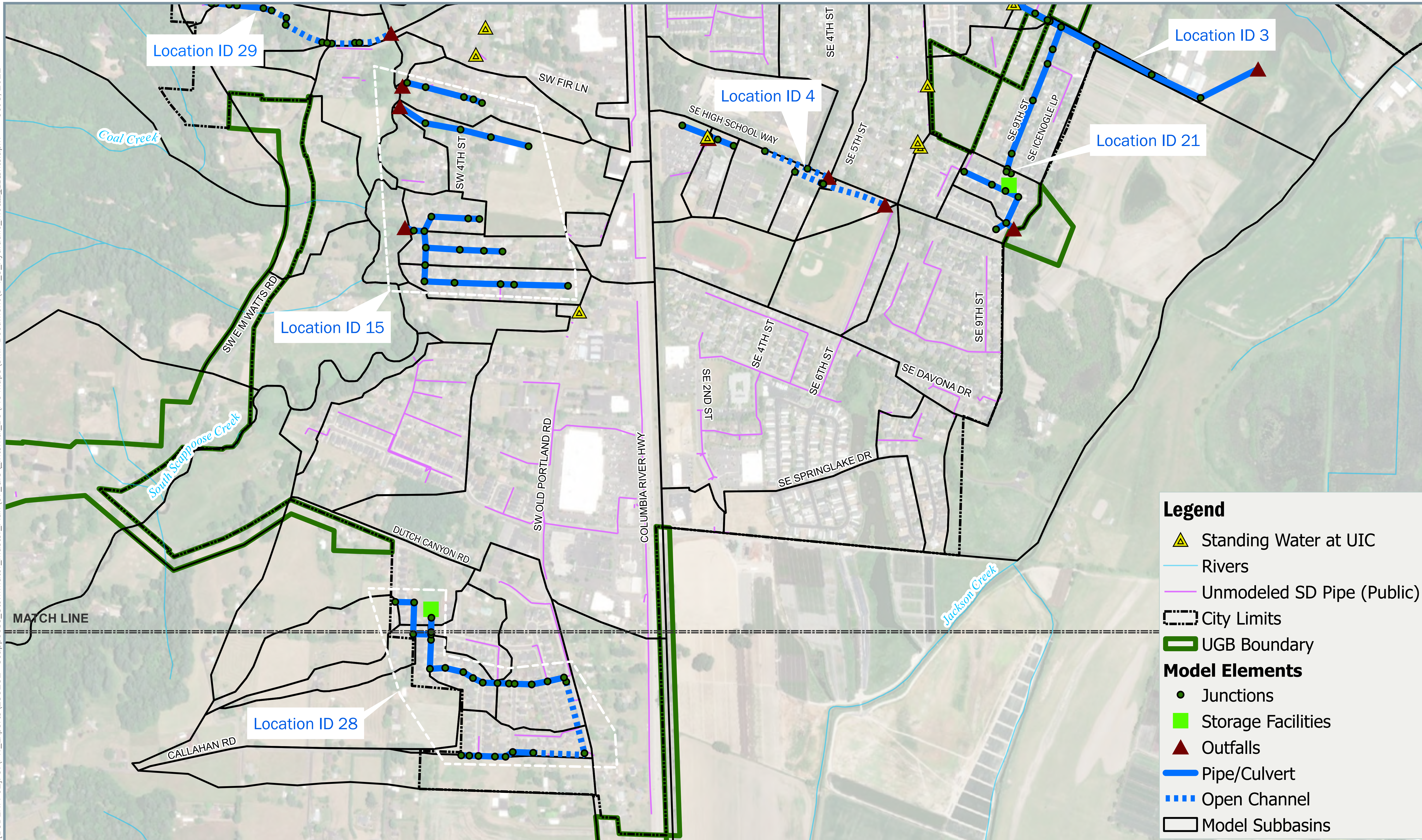
Brown AND Caldwell

City of Scappoose
Stormwater Master Plan

September 2022
Project: 155252

Notes:
1. NAD 1983 HARN StatePlane Oregon North FIPS 3601 International Feet
2. Locations 18a and 31 are Category 2 modeling locations.

Figure 3-4: Hydraulic Model Extents (North)



[BCDENFP01]: O:\PW_Exports\155252 - Scappoose_Stormwater_Master_Plan\07_GIS_Internal_BC\Pro Maps\SMP Document\3-4_5_Hydraulic_ModelExtents.aprx Oct 5, 2022

Brown AND Caldwell

City of Scappoose
Stormwater Master Plan

September 2022
Project: 155252

Notes:
1. NAD 1983 HARN StatePlane Oregon North FIPS 3601 International Feet
2. Locations 18a and 31 are Category 2 modeling locations.

Figure 3-5: Hydraulic Model Extents (South)

Section 4

Capacity Evaluation

Stormwater conveyance is the primary function of the City's storm drainage infrastructure. This section summarizes the H/H system modeling methods and results for targeted areas of the City, conducted to verify observed conveyance capacity limitations. This section also summarizes additional H/H system modeling conducted to develop capital project (CP) solutions.

A hydrologic model was built to analyze stormwater runoff conditions for the entire study area. System hydraulics were analyzed for select Category 1 Project Opportunity Areas, as identified in Section 3. A total of 12 capital project recommendations were developed following verification of capacity limitations and assessment of project alternatives in the target areas.

H/H modeling assumptions, methods and results are described in additional detail in Technical Memorandum #2 (TM2), included in this SMP as Appendix C. Referenced figures are included at the end of this section.

4.1 Modeling Approach

A PC-Storm Water Management Model (PCSWMM) model was used to simulate the hydraulic performance of select pipe and open-channel systems and evaluate the capacity limitations of City-owned stormwater infrastructure. This targeted hydraulic modeling approach was used to focus modeling resources on specific areas of the city where additional information is needed to quantify system flooding and develop project solutions.

For this SMP, the following modeling approach was used to evaluate conveyance capacity:

1. Compile a list of known and suspected Project Opportunity Areas (see Table 3-2) and identify those areas where modeling is needed to inform corrective measures.
2. Review available data (via GIS, as-builts, etc.) to identify data gaps and data required for model development.
3. Document observed data gaps in a format to support the City-obtained collection of field survey information.
4. Delineate subbasins and develop a city-wide hydrologic model to estimate stormwater runoff generated for existing and future development conditions.
5. Develop a hydraulic model of targeted areas.
6. Validate modeled flooding using historical rainfall record and anecdotal flooding information (photographs, City records).
7. Verify capacity constraints and identify potential sources or causes of flooding with City staff; and
8. Use the validated hydraulic models to simulate alternative conveyance system design and develop potential solutions to capacity problems.

4.2 Basis of Evaluation and Design

Design standards related to the sizing and design of stormwater infrastructure are described in the draft Scappoose PWDS. While the standards are typically applied to new infrastructure, they can also be used to evaluate existing infrastructure, identify capacity limitations, and size proposed capital projects.

Planning and sizing criteria are outlined in Table 4-1 and design criteria for select infrastructure components are outlined in Table 4-2 below.

Table 4-1. Scappoose Planning and Sizing Criteria

Criteria	Source	Standard
Water Quality Facility Sizing	PWDS 2.0120 (C), 2.0120 (D), 2.0230 (A)	• Provide water quality treatment for a design storm of 1.5 inch in 24 hours, 90% of the average annual rainfall. • The Simple Method may be used to size onsite water quality stormwater facilities. If designed for water quality only, use the sizing factor for Soil Type B.
Water Quantity Facility Sizing	PWDS 2.0120 (D), 2.0120 (E), 2.0230 (A) and (B), 2.0240 (B), 2.0500, 2.0540	• For facilities that cannot retain the 10-yr storm event onsite, stormwater facilities shall be sized to control post-developed flows. o 2-yr, 24-hr post-development peak flow to half of the 2-yr, 24-hr pre-development design storm peak flow. o Post-development peak flow from the 5-, 10-, 25-year, 24-hour design storm to the respective pre-development peak flows. o SBUH, SWMM. or SCS TR-55 methods are required for determination of the peak flow rate. • Overflow spillways and outlet controls must safely pass 100-yr, 24-hr event. • Curve Numbers for the pre-developed condition shall be "pasture or grass/lawn with amended soil" (NRCS Hydrologic Soil Group: Type A = 39, Type B = 61, Type C = 74, and Type D = 80). • The Simple Method may be used to size onsite water quantity facilities (see 2.0240 [B]). • The Engineered Method may be used if the water quantity facility is design by a licensed engineer.
Conveyance Pipe Sizing	PWDS 2.0120 (F), 2.0700, 2.0710, 2.0720, 2.0740	• For facilities that cannot retain the 10-yr storm event on-site, stormwater conveyance is required to an approved discharge point. • Sizing criteria (design storms) vary by drainage system element: minor, major, watercourses or bridges (see Table 9 in PWDS 2.0740). • 1-ft minimum freeboard between the hydraulic grade line and the top of the structure or finish grade is required for management of the post-development peak rate of runoff. • Conveyance design must be based on SBUH, SCS TR-55 or SWMM unless approved by City Engineer.
Open Channel System Sizing	PWDS 2.0740, 2.0760	• Open channel sizing must accommodate the 25-yr design storm. • Manning's equation is acceptable for open channel capacity determination with an US drainage area of 50 ac or less. Larger drainage areas must use HEC-RAS or an equivalent computer model.

Abbreviations:

cfs = cubic feet per second

fps = feet per second

HDPE = high density polyethylene

PVC = polyvinyl chloride

SF= square feet

Table 4-2. Stormwater Design Criteria for Public Infrastructure		
Criteria	**Source**	**Standard**
Public Storm Pipe Design	PWDS 2.0250, 2.0330, 2.0750 (A) and (B)	• Minimum pipe diameter of 10 ins. for public infrastructure. • Minimum Tc = 10 minutes. • Mean velocity = 3 fps. • n= 0.013, regardless of pipe material. Public storm drains can be constructed with concrete pipe or double wall HDPE pipe with smooth interior and corrugated exterior with watertight joints. Where additional strength is required, Class 50 Ductile Iron pipe can be used. PVC is not allowed unless approved by the City Engineer. • Minimum cover is 30 inches in paved areas and 36 inches at all other locations. Cover must be of sufficient depth to protect against damage by traffic and to drain building footings. • Minimum design slope = 1.0%; maximum slope = 20%
Culvert Design	PWDS 2.0780	• Culverts can be constructed with reinforced concrete or HDPE if material is specified as having a 75-year design life and approved by the City Engineer. • Ensure the headwater water surface elevation during the 25-yr design storm does not exceed 1.5 times the culvert diameter or remain at least 1-foot below the roadway subgrade (whichever is less).
Open Channel Design	PWDS 2.0340, 2.0740, 2.0750, 2.0760, 2.0770	• Open Channel conveyance is allowed where practical and fits within the planned future street section right of way. • Open channels easements must cover the 100-yr floodplain boundary when a 100-yr design storm is required, or 15 ft from the waterway centerline, or 10 ft from the top of the recognized bank, whichever is greater. A 15 ft wide access easement shall be provided on both sides of the channel for channel widths greater than 15 ft at the top of the recognized bank. • Open channel design must incorporate a low-flow channel designed to convey a 2-yr design storm and high-flow channel designed to convey the 25-yr design storm. • Bank stabilization shall be designed with a minimum 1 ft of freeboard, designed to manage the 25-yr flow velocities, and designed for adequate maintenance accessibility. • The open channel maximum design velocity is 6 fps. City must approve a design with a velocity greater than 8 fps. • Maximum side slopes of 2:1. • Minimum slope of 0.1%.
Public Water Quality/Quantity Facility Design	PWSD 2.0120 (D), 2.0120 (E), 2.0500, 2.0630[5], 2.0630 (B) 2.0630 (E)	• Max soil side slope = 3H:1V for rain gardens and swales. • Min orifice size = 2 in. • Max Pond embankments slope of 3H:1V. • Provide a minimum of 0.5 ft of dead storage in dry or wet ponds. • Minimum ponding depth of planter = 9 in. • Maximum ponding depth varies by facility type (i.e., planters max ponding depth = 18 in.) • A dry or wet pond forebay shall be 10 percent of the design surface area, with 0.5 ft of dead storage. • Detention Pipes can be constructed out of steel reinforced polyethylene or reinforced concrete. • Facility setback requirements range from 0 ft to 500 ft, see Table 1.
Structure Spacing	PWDS 2.0410 PWDS 2.0420	• Manhole spacing shall not be greater than 500 ft. • Catch basin spacing shall not be greater than 400 ft.

[5] See Section 2.0630 for all the design parameters for various public facility types.

Design storms are precipitation patterns typically used to evaluate the capacity of storm drainage systems and to design capital improvements for the desired level of service. Design storms evaluated in this SMP include the 2-, 5-, 10-, 25-, and 100-year recurrence interval 24-hour events. Design storms are listed in the City's draft Design Standards and are shown in below. The rainfall distribution for these design storms is based on a Unified Soil Classification System (USCS) Type IA distribution.

Table 4-3. Design Storm Depths

Design storm event	Rainfall depth, inches
2-yr, 24-hr	2.3
5-yr, 24-hr	2.8
10-yr, 24-hr	3.3
25-yr, 24-hr	3.8
100-yr, 24-hr	4.7

4.3 Hydrologic Model Development

The City-wide hydrologic model was developed using PCSWMM version 7.4 (SWMM version 5.1.015) and the RUNOFF hydrologic method. The hydrology routine in PCSWMM converts rainfall into stormwater runoff based on design storm parameters (i.e., volume and intensity of rainfall) and the following hydrologic input parameters: subbasin area, slope, width, hydraulic conductivity, initial moisture deficit, suction head, and impervious percentage.

Subbasins were delineated by hand using available data in GIS such as topography and stormwater collection system layout. A total of 124 subbasins are included in the hydrologic model and range in size from 0.4 acres to 303.2 acres with an average area of 26.1 acres. Each subbasin is named based on its respective major basin, with a sequential naming convention moving from downstream to upstream. Subbasins that are expected to exclusively infiltrate runoff are named with an "I" suffix. Delineated subbasins and subbasin naming are shown in Figure 4-1 through Figure 4-3.

Hydraulic conductivity, initial moisture deficit, and suction head were calculated for each subbasin based on soils data sourced from NRCS. Impervious percentages for each subbasin were calculated based on the respective land use coverage within the subbasin and area weighted.

Other hydrologic input parameters and modeling methods are described in additional detail in Appendix C.

4.4 Hydraulic Model Development

To evaluate flood hazards and stormwater infrastructure capacity, the PCSWMM model was used to simulate select stormwater pipe and open-channel collection systems and to calculate peak flows, water surface elevations, and velocities within the modeled infrastructure for respective design storms. The City's GIS data was used to construct the hydraulic model, and topographic surveys were conducted in November and December 2020 to rectify datum inconsistencies and fill data gaps. These data gaps included missing pipe diameters, materials, and elevations for the targeted hydraulic modeling locations per the City's GIS.

As described in Section 3.5, targeted modeling locations were identified as Category 1 and Category 2. Table 4-4 lists each Category 1 and 2 modeling location. This section summarizes the model development and results for Category 1 locations. Detailed descriptions of each modeling location are included in Appendix C.

Hydraulic model input parameters include conduit (pipe, culvert, or open channel) name, upstream (US) and downstream (DS) node information (name, invert elevation, rim elevation), conduit length, conduit slope, conduit shape, material, and diameter.

Appendix C includes description of hydraulic model parameters and Appendix C, Attachments A-2 and A-3 include the specific conduit and node information for modeled infrastructure.

Table 4-4. Hydraulic Modeling Locations

Location ID	Location Description	Modeling Category[a]	Location Used During Model Validation (Y/N)	Site Visited (Y/N)
3	SE Elm St at SE Endicott Ln	1	N	Y
4	SE High School Wy at SE 5th St	1	N	Y
6	NW EJ Smith Rd and NW 1st St	1	N	Y
8 and 9	Sunset Lp	1	Y	Y
15	SW Creek View Pl	1	N	N
18a	SW JP West Rd east of S. Scappoose Creek	2	N	Y
18b	SW JP West Rd west of S. Scappoose Creek	1	N	Y
19	Miller Park	1	Y	Y
21	SE 9th/Icenogle Lp (Pioneer Crossing)	1	Y	Y
23	E Columbia Ave	1	N	N
28	Callahan-Dutch Canyon Area	1	Y	Y
29	Keys Rd Basin	1	N	Y
31	NW EJ Smith Rd, west of S. Scappoose Creek	2	N	Y

a. *Category 1 refers to hydraulic modeling of existing infrastructure. Category 2 refers to hydraulic modeling of new or proposed infrastructure.*

4.4.1 Stormwater Facility Data

Per discussion with the City during the identification of hydraulic model extents, BC included three stormwater facilities in the hydraulic model: the Dutch Canyon retention (infiltration) facility, Dutch Canyon wetland, and Pioneer Crossing facility. These facilities were included in the modeling effort because 1) they provide flow control for a larger contributing subbasin(s) and evaluation of the facility is needed to accurately assess DS flow conditions, or 2) they were identified as a problem area used in the model validation or considered with capital project development efforts.

Detailed description of modeled stormwater facilities is included in Appendix C.

4.4.2 Model Validation

After construction of the hydraulic model in PCSWMM, model validation was conducted using a rainfall event that occurred from February 9, 2019, to February 15, 2019. The City provided time-stamped photos and videos taken during this event at locations throughout the City.

Model validation, as opposed to model calibration, was conducted because numerical flow monitoring data or flooding depth data was not available. BC compared the initial model results with the time stamped photos at four locations in the system to verify that model-predicted flooding aligned with the reported flooding at these locations.

In general, the model-predicted flooding results matched the flooding conditions seen in photographs at locations where comparisons were possible, therefore establishing a reasonable degree of confidence in model hydrologic- and hydraulic-input parameters and model performance. Adjustments to the infiltration rate for the Dutch Canyon Facility were the only model input parameter adjustments made to align the model results more closely with the field conditions during the February 2019 storm. No adjustments were made to hydrologic data.

Appendix C includes detailed descriptions of the model validation results at the specific locations in the system.

4.5 Model Results

Following model development and calibration efforts, hydrology and hydraulics were simulated for the 2-, 5-, 10-, 25-, and 100-year design storms. City standards require conveyance of the 25-year storm design event.

Hydrologic model results are tabulated in Appendix C, Attachment A. Overall, when compared to existing conditions, the hydrologic model results show increased flows during future conditions due to increased impervious area associated with anticipated development. Subbasins with the largest anticipated increases in flow due to development are in the airport overlay areas. The hydrologic model results show minimal to no increases in future flows for subbasins that are almost fully developed, such as those along Hwy 30 and in recently developed sections of the Callahan-Dutch Canyon area.

Hydraulic model results are tabulated in Appendix C, Attachment B. For the purposes of this SMP, “flooding” is defined as the hydraulic grade line reaching the node rim elevation. Although the City’s design standards require 1-ft minimum freeboard between the hydraulic grade line and the node rim elevation, flooding occurrences for the analyzed infrastructure were widespread and warranted a focus on those systems with hydraulic grade lines at or above the node rim elevation. For nodes reporting flooding, the lowest magnitude design storm to cause flooding is listed in the hydraulic results table and outlined in Table 4-5.

Model results from the 2-, and 10-year storms (i.e., representing more frequent flooding than anticipated per the City’s design standards) are also used to identify portions of the stormwater system susceptible to more frequent flooding. In general, the hydraulic model results confirm deficiencies at the capacity-limited areas identified by City staff or identified in the 1998 *Storm Drain System Master Plan* and provide additional information about potential sources of flooding.

Table 4-5 below summarizes the model estimated frequency of flooding for each modeled Category 1 system and the resulting capital project development approach. Additional discussion of model results at each location is included in Appendix C. Figure 4-4 and Figure 4-5 show the existing hydraulic modeling results and minimum flooding frequency.

Table 4-5. Capacity Evaluation Results								
Location ID	Model Location	Existing Condition Flood Frequency			Additional Project Need Considerations			Capital Project Developmen t (Y/N)
		Nodes Flooding during Storm			Safety Concern	1998 Master Plan CIP	Transit CIP [a]	
		2-yr	10-yr	25-yr				
3	SE Elm St at SE Endicott Ln	X	X	X		X	X	Y
4	SE High School Wy at SE 5th St				X		X	Y [b]
6	NW EJ Smith Rd and NW 1st St			X			X	Y
8 and 9	Sunset Lp	X	X	X	X		X	Y
15	SW Creek View Pl			X			X	N [c]
18b	SW JP West Rd, west of S. Scappoose Creek		X	X			X	Y
19	Miller Park	X	X	X	X		X	Y
21	SE 9th/Icenogle Lp/Pioneer Crossing	X	X	X				Y
23	E Columbia Ave			X			X	Y
28	Callahan-Dutch Canyon Area		X	X	X		X	Y
29	Keys Rd Basin	X	X	X			X	Y

a. Per 2016 Scappoose Transportation Master Plan.

b. Priority project due to reported flooding near both high school and elementary school.

c. This modeled flooding may be due to subbasin routing in the model, and therefore less indicative of a capacity limitation in this area.

4.6 Capital Project Model Development

BC used the hydraulic model to evaluate capital project alternatives for each location chosen for capital project development. For Category 1 locations, these efforts included improvements (i.e., upsizing or reconfiguration) using the design criteria described in Section 4.2. For Category 2 locations, new infrastructure was sized using these same criteria.

Results of the capital project model development are reflected in the final capital projects that are detailed, costed, and scheduled in Section 6.

4.6.1 Capital Project Planning Workshop

Category 1 modeling locations and preliminary capital project concepts and sizing were reviewed by BC and City staff as part of the Capital Project Planning Workshop conducted on December 6 and December 21, 2021. Sources of existing capacity deficiencies and opportunities for upsizing or reconfiguration to address deficiencies were discussed, ultimately resulting in a finalized list of locations for capital project development. Some Category 1 locations were designated as a program need rather than a project need. Category 2 model locations were also reviewed to confirm their need for continued project consideration, and initial concepts for the layout of new infrastructure were discussed.

The Project Opportunity Matrix (Table 3-2) documents the outcomes of the workshop discussions, including the final determination of project or program need.

4.6.2 Capital Project Sizing and Design Assumptions

Capital project sizing generally followed the City's draft PWDS and design criteria summarized in Table 4-1 and Table 4-2.

Detail related to application of the draft PWDS and design criteria is summarized below.

- **Capacity Projects.** Projects to construct or replace stormwater infrastructure are sized in accordance with the City's draft PWDS. Infrastructure analyzed and sized for this study included exclusively "major" elements, as defined in the City's draft PWDS, Table 9. Therefore, conveyance-related projects were sized for the 25-year, 24-hour design event under future land use conditions. Projects were designed to prevent system surcharging, except for a few special cases. Minimum cover requirements were prioritized over minimum slope requirements where necessary.
- **Water Quality Facility.** For purposes of conceptual sizing and cost estimation, the proposed regional facility was sized using an 8 percent sizing factor per the draft PWDS (see 2.024 [B] and Simple Sizing Form) and assumes 1 foot of storage depth. Preliminary sizing is intended to meet water quality and flow control requirements.
- **New Infrastructure.** Several capital projects require new infrastructure in locations where no storm system currently exists, and new infrastructure was sized in accordance with the City's draft PWDS. New infrastructure alignments are in the public right-of-way (ROW) only. However, it should be noted that final design may require additional structures, alternate alignments, or deeper/shallower infrastructure than assumed for this conceptual project design to address utility conflicts and other constraints not identified as part of this SMP. Survey will be required to verify elevations and locations.
- **Porous Pavement.** One capital project alternative proposes use of porous pavement (see Section 4.6.3). The porous pavement for the proposed alternative was designed with drain rock capable of holding full runoff volume of 25-year storm from the catchment area, and assuming a 1:1 area ratio of existing pavement to replacement porous pavement. Per the PWDS, use of porous pavement must be approved by the City Engineer and Public Works Director. Design assumptions for the proposed installation of porous pavement are discussed further in Section 6.

4.6.3 Phased Capital Projects

For certain capital projects, it may be beneficial to use a phased approach, splitting the project into two or more phases that may be funded and constructed on different timelines. This approach may be appropriate for higher-cost projects, projects for the same opportunity area but with separate, independent components, and/or projects that have partial concurrence with other planned infrastructure improvements.

During capital project development, a phased approach was deemed beneficial and proposed for projects at three opportunity area locations:

- **Location ID 23.** The E Columbia Ave storm system requires extensive replacement of existing storm pipe and installation of new storm pipe. The 2016 Scappoose Transportation Master Plan also identifies a project at the DS (east) end of the stormwater project opportunity area. Due to the length of pipe proposed, the opportunity for concurrence with the transit project, and potential concurrence with a capital project for Location IDs 8 and 9 (see Section 4.6.4), a phased approach is proposed. See Section 6 for more details about the proposed capital project.
- **Location ID 28.** The Callahan-Dutch Canyon opportunity area described in Table 3-2 contains two hydraulically independent opportunities for capital projects: a need for a culvert to convey flow

north across Dutch Canyon Road, and a need for a new storm pipe to convey flow from the existing infiltration facility and from future development in the area. These two elements may encompass different priorities, and development schedules in the area may make it advantageous to construct the separate elements are different times. Therefore, a phased approach is proposed. See Section 6 for more details about the proposed capital project.

- **Location ID 31**: Significant future development is anticipated NW EJ Smith Road area, which currently lacks major storm drainage infrastructure. There is also a potential opportunity to construct a regional water quality facility to treat runoff collected in the area. Due to the cost of constructing a regional facility, and the relative priority of constructing conveyance, a phased approach is proposed, with conveyance pipe as phase 1 and a regional water quality facility as phase 2. See Section 6 for more details about the proposed capital project.

4.6.4 Sunset Loop Alternatives Analysis

Project Opportunity Area Locations 8 and 9, which represent the Sunset Loop Area, required a more in-depth alternatives analysis during capital project development than was needed for other opportunity areas due to the complexity of local flooding sources and limited room to accommodate solutions. Localized flooding in this area occurs due to multiple factors, including failing UICs and roadway elevations (see Table 3-2). Site-specific factors also limit the potentially available solutions. The two main factors include:

- **Topography and grading.** The existing housing development on Sunset Loop was constructed in a low-lying area, such that the elevation of the roadway in Sunset Loop is lower than the surrounding area. As such, almost zero elevation change is available to drive conveyance of stormwater between the road surface in Sunset Loop and the existing storm outfalls from infrastructure on E Columbia Avenue, Heron Meadows Drive, or other adjacent systems to the receiving waters to the east.
- **High water table.** The low-lying area and proximity to the Santosh Channel and other wetlands results in high groundwater and limited capacity for infiltration in the area. The existing UICs that were intended to drain the Sunset Loop catchment area are reported failing, and the UIC Feasibility Assessment confirmed the unsuitability of this location for infiltration (see Section 3.4).

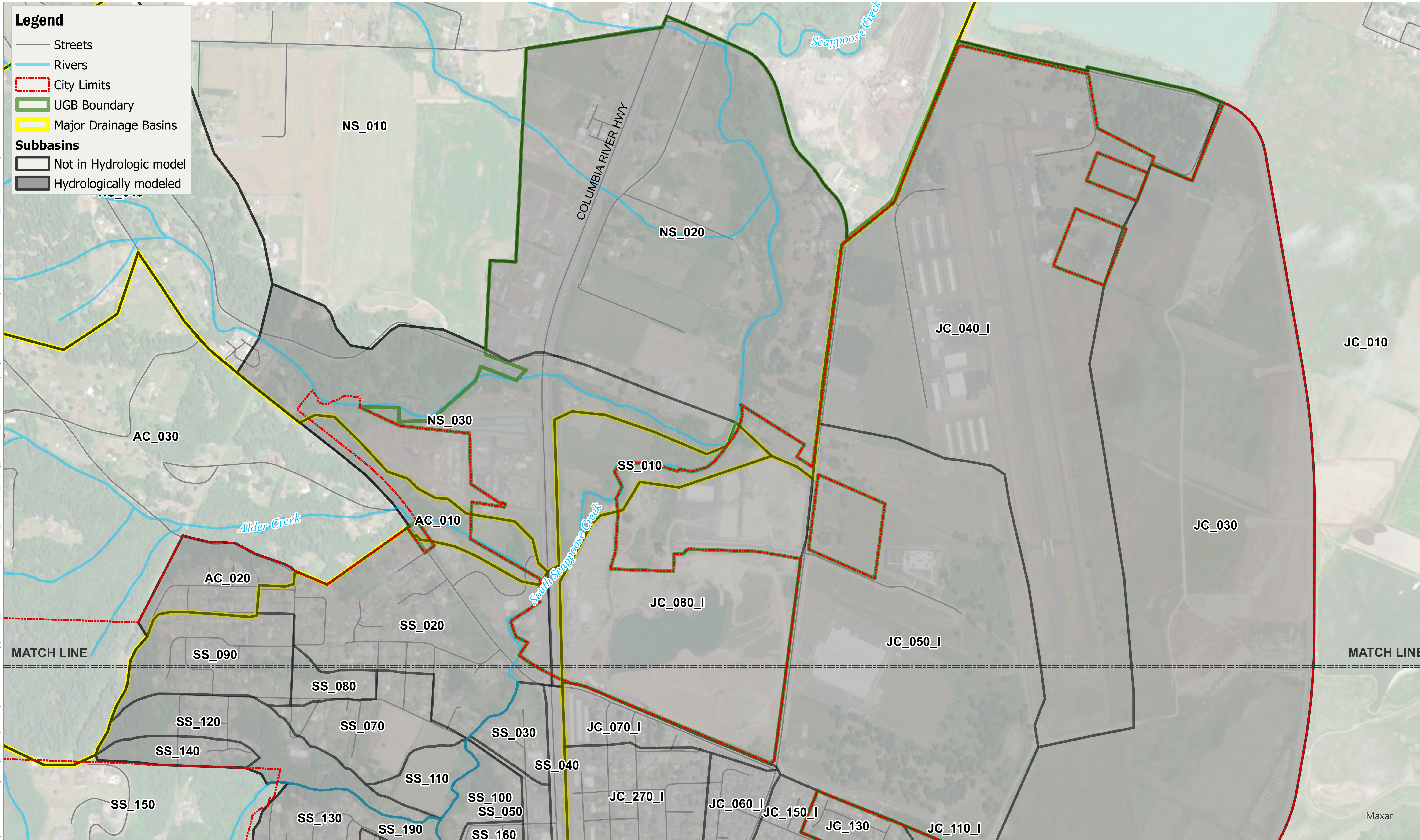
BC discussed this area with City staff and analyzed multiple potential solutions for the area. Ultimately, two alternatives were proposed, allowing for future selection of the preferred alternative based on cost, concurrency with improvements to the E Columbia Ave storm system (see Section 4.6.3), and City standards related to installation of porous pavement.

- **Alternative 1** includes the removal and replacement of the existing impervious pavement on Sunset Loop and with porous pavement–designed to infiltrate stormwater through the pavement surface and to utilize void space within the base drain rock pavement as temporary storage to reduce ponding at the street level.

- **Alternative 2** includes the installation of a storm pipe parallel to the existing pipe in E Columbia Ave to convey flows from Sunset Loop to a new outfall at the receiving waters east of the City Limits. This alternative also includes pipe replacement and installation of new storm pipe within Sunset Loop, to reroute flows currently draining to the failing UICs to the new pipe in E Columbia Ave. The new, parallel pipe would take advantage of the limited change in elevation available between Sunset Loop and the receiving waters, while disconnecting the system in Sunset Loop from the existing system in E Columbia Ave. Separation of the two systems is necessary to prevent backwater from the E Columbia Ave pipe from ponding in Sunset Loop during storm events, which would occur even if the E Columbia Ave system was not flooding, due to Sunset Loop's lower road surface elevation.

Detailed descriptions of both alternatives are included in Section 6.

This page left intentionally blank.



Brown AND Caldwell

City of Scappoose
Storm Drainage Master Plan

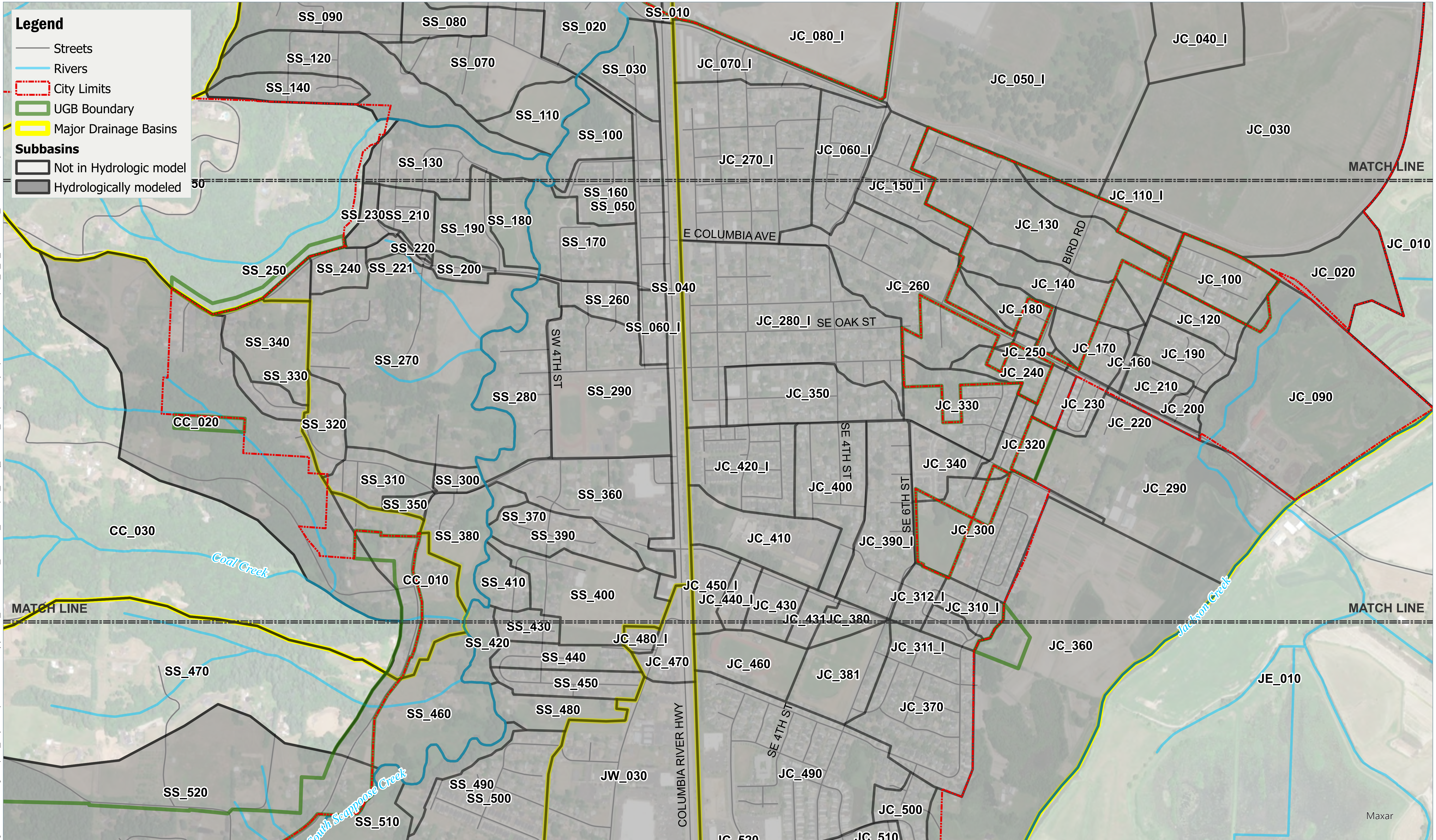
September 2022
Project: 155252

0 500 1,000 Feet

N

Notes:
1. NAD 1983 HARN StatePlane Oregon North FIPS 3601 International Feet

Figure 4-1: Subbasin Overview (North)



Brown AND Caldwell

City of Scappoose
Storm Drainage Master Plan

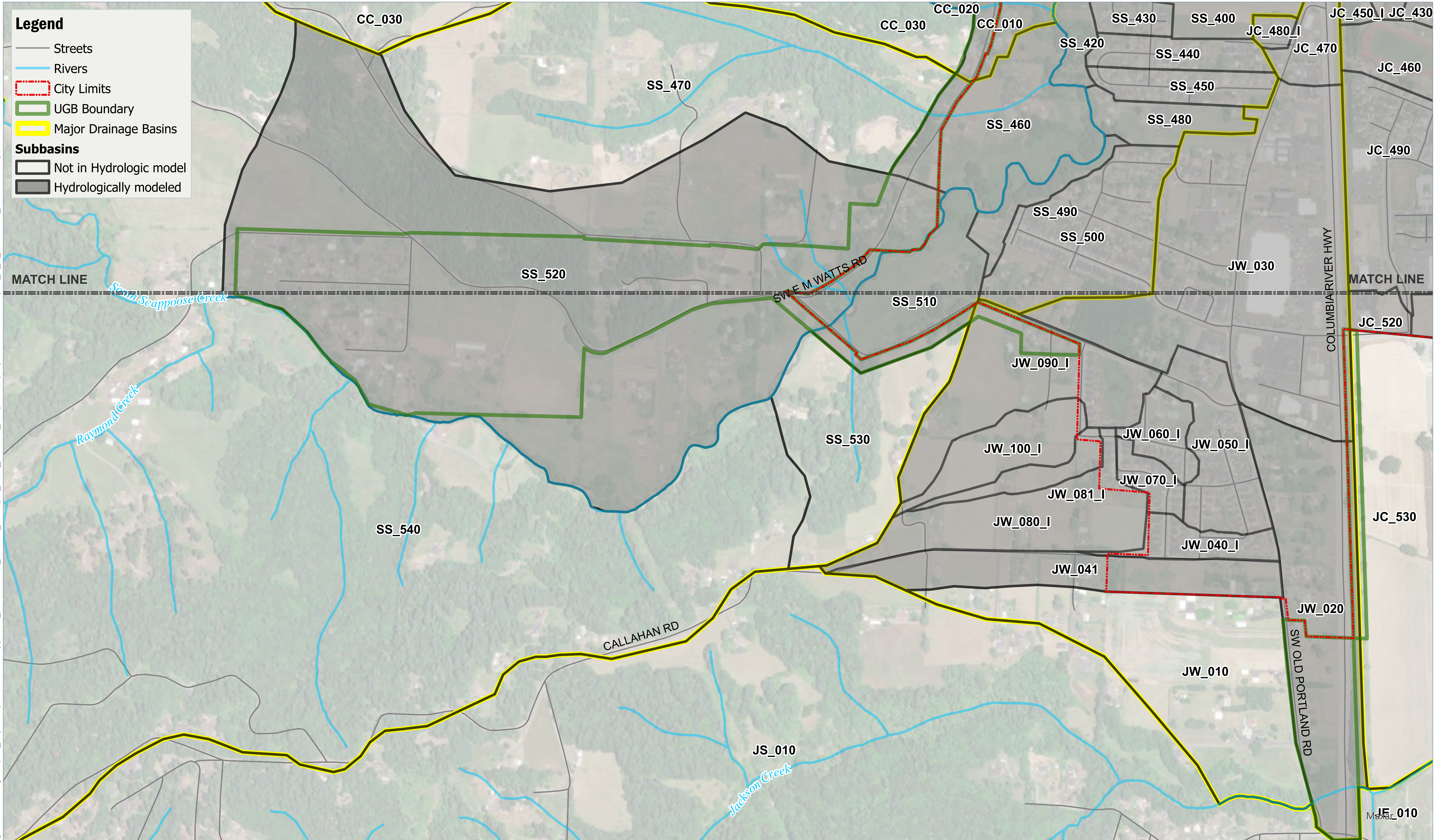
September 2022
Project: 155252

0 500 1,000 Feet

N

Notes:
1. NAD 1983 HARN StatePlane Oregon North FIPS 3601 International Feet

Figure 4-2: Subbasin Overview (Central)



Brown AND Caldwell

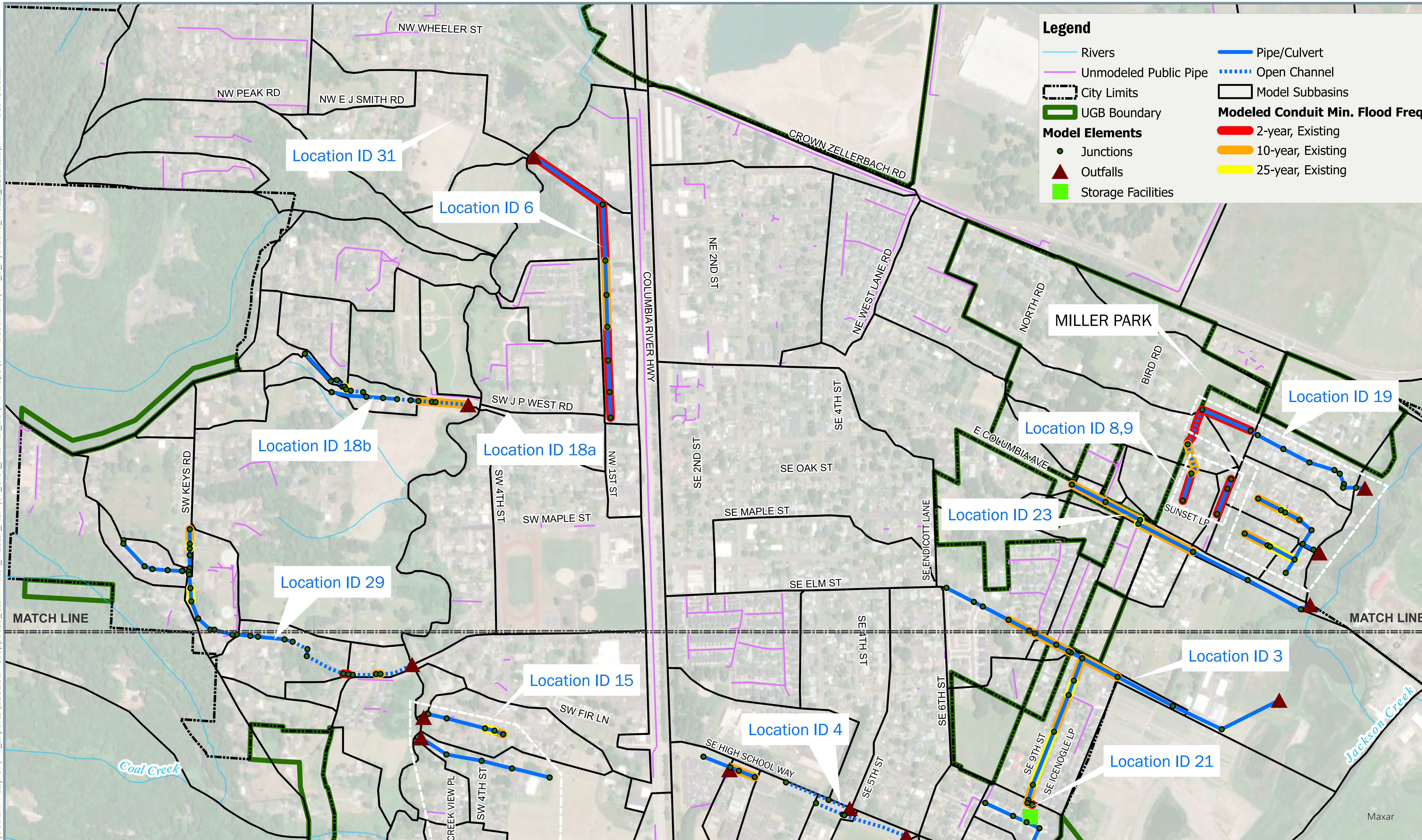
City of Scappoose

Storm Drainage Master Plan

September 2022
Project: 155252

Notes:
1. NAD 1983 HARN StatePlane Oregon North FIPS 3601 International Feet

Figure 4-3: Subbasin Overview (South)



Brown AND Caldwell

City of Scappoose

Stormwater Master Plan

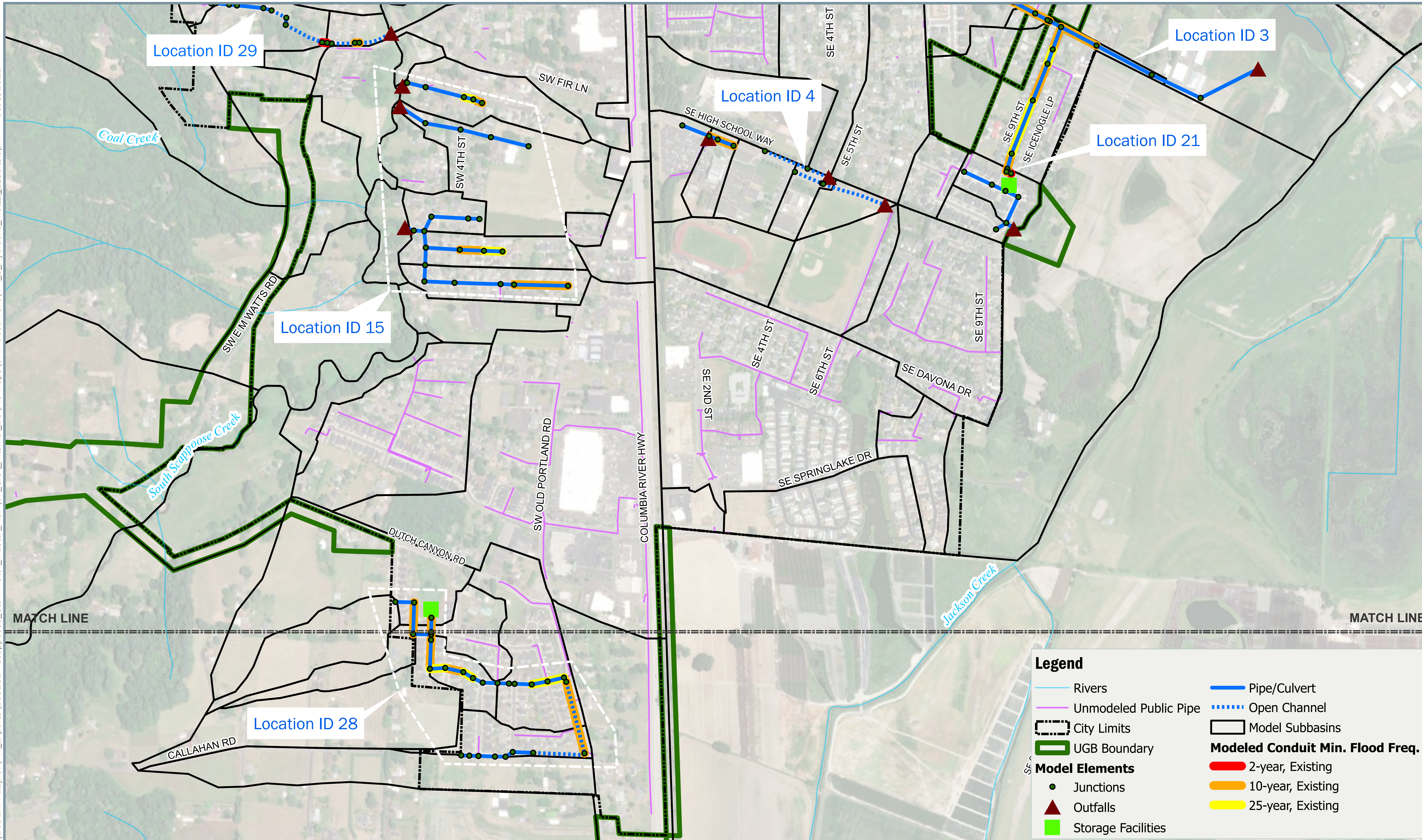
September 2022
Project: 155252

0 500 1,000 Feet

N

Notes:
1. NAD 1983 HARN StatePlane Oregon North FIPS 3601 International Feet
2. Locations 18a and 31 are Category 2 modeling locations.

Figure 4-4: Hydraulic Model Results (North)



Brown AND Caldwell

City of Scappoose
Stormwater Master Plan

September 2022
Project: 155252

0 500 1,000 Feet

N

Notes:
1. NAD 1983 HARN StatePlane Oregon North FIPS 3601 International Feet
2. Locations 18a and 31 are Category 2 modeling locations.

Figure 4-5: Hydraulic Model Results (South)

Section 5

Stormwater System Maintenance Assessment

Maintenance of the City's storm drainage system assets is important to ensure that the full life expectancy is achieved, and that the system is functioning as designed. As part of the project planning process, current stormwater maintenance activities and frequencies were confirmed with City staff and considered in conjunction with stormwater Project Opportunity Locations to determine if programmatic improvements (i.e., increased frequency, expanded program coverage, new program development) may be more effective than a capital project to meet City needs (see Section 3.5).

5.1 Maintenance Activities Overview

The City's Public Works Department is responsible for providing infrastructure maintenance and planning. Public Works staff includes Public Works Director, Utility Supervisor, Water Treatment Plant Supervisor, Wastewater Treatment Plant Supervisor, Plant Operators, Parks and Grounds Workers, Utility Workers, and a Program Analyst. Dedicated stormwater utility staff are not defined, but both the Utility Supervisor and one Utility Worker generally conduct stormwater-maintenance activities. Public Works activities related to stormwater include:

- Correction of drainage problems
- Catch basin cleaning
- Street sweeping services to City-owned streets
- Emergency assistance and repairs
- Snow and ice removal of City-owned streets
- Ground maintenance at all City properties

Under the City's UIC WPCF Permit and conditions of the Willamette Basin Mercury TMDL, certain stormwater system operation, inspection, and maintenance activities are required to address water quality improvements. Maintenance activities typically occur on a scheduled basis, but also in response to citizen and staff inquiries and requests. Specific maintenance requirements associated with implementation of the City's UIC WPCF permit are outlined in the City's TMDL Implementation Plan. Requirements of the TMDL indicate that the City is required to operate and maintain all facilities and conduct record keeping (see Table 5-1).

<table>
<tr><th colspan="5">Table 5-1. WPCF Permit-related Maintenance Requirements for the City of Scappoose</th></tr>
<tr><th rowspan="3">Activity</th><th colspan="4">Individual WPCF Permit Maintenance Activities</th></tr>
<tr><th>Catch basins</th><th>Sediment Manholes</th><th>UICs</th><th rowspan="2">Filtration Systems/Stormwater BMPs per Manufacturer Recommendations</th></tr>
<tr><th>Annual</th><th>Annual [a]</th><th>Annual [a]</th></tr>
<tr><td>Physical Maintenance</td><td>When the space between the top of sediment and outlet invert is <18 ins.</td><td>When the space between the top of sediment and outlet invert is <3 ft</td><td>If there is evidence the UIC is not functioning properly</td><td>Per manufacturer recommendations and if clogged.</td></tr>
<tr><td>Sweeping</td><td colspan="4">January to September: Monthly
October to December: Twice monthly</td></tr>
</table>

a. *For sedimentation manholes, the requirement for a visual inspection only applies if the sedimentation manhole is accessible. For UICs, the requirement for visual inspection applies if the UIC is accessible OR if there is evidence that the UIC is not functioning properly.*

During the project planning process, maintenance-related documentation from the City was reviewed and staff interviewed to confirm current maintenance activities and associated level of service. Maintenance-related documentation included street sweeping schedules, the City's Public Work Plan (2020-2021), and the City's Drainage Inspection Report.

BC also reviewed City-provided maintenance information related to existing, publicly maintained detention/retention facilities as part of the water quality retrofit assessment to evaluate whether improvements to an existing regional facility should be considered. City GIS data of both public and private stormwater facilities, such as detention, infiltration, and swale facilities, are currently outdated. Inventory of these facilities is currently maintained in a spreadsheet that includes a project name, location, tax lot information, current owner, and facility type. As such, there was limited data provided on the 'condition' of each facility or recent maintenance history.

Current stormwater maintenance activities and frequencies are outlined in Table 5-2. Current coverage and frequencies were compared to regulatory guidelines and feedback from staff during project planning (see Table 3-2) to confirm whether an implementation gap exists that may require additional resources.

Table 5-2. City Maintenance Activities (Current)

Activity	Current Coverage	Current Frequency	Implementation Gap (Y/N)
CB inspection and cleaning (public)	10% of the City	Annual	Y (Inspection coverage)
Proprietary Facility Cleaning	All facilities	1x/2 years	Y (frequency)
Street sweeping	City-wide	24 sweeps/year	N
MH cleaning (Sediment)	Not regularly conducted	N/A	Y (coverage and frequency)
UIC inspection and cleaning (public)	Not regularly conducted	N/A	Y (inspection coverage)
Public Stormwater Facility inspection and cleaning (swales)	All facilities	2x/month on average	N
Public Stormwater Facility inspection and cleaning (ponds and other facilities)[a]	Not regularly conducted	N/A	Y (coverage and frequency)
Private Stormwater Facility inspection and cleaning (ponds and other facilities)[b]	Not regularly conducted	N/A	Y (coverage and frequency)
Pipeline cleaning	Not conducted	N/A	Y

a. *Inspection of public stormwater treatment and detention facilities is required per the TMDL. City efforts should focus on pond inspection and maintenance activities.*

b. *The City does not operate a private stormwater facility maintenance program. Development of a program should include education, private facility inventory, and a mechanism to ensure that facilities are being maintained (by owner or other).*

5.2 Expanded Facility Maintenance Efforts

Project planning efforts discussed in Section 3 identified a need to conduct expanded stormwater facility maintenance activities to address select problem areas (or Project Opportunity Locations). In addition, implementation gaps based on current City maintenance activities (Table 5-2) indicate a need to expand Public Works maintenance efforts.

A staffing assessment was conducted using typical staff time estimates and required coverage and maintenance frequencies to confirm additional Public Works staff needs. Current staffing levels are considered adequate to support existing commitments, but an increase in staff resources is needed expand maintenance efforts identified under this SMP.

Appendix D, Table D-1 summarizes the comprehensive results of the maintenance-related (Public Works) staffing analysis for purposes of informing the financial evaluation. Some of the outlined maintenance-related activities may be conducted by the Public Works Department but select inspection activities (i.e., UIC inspections, private stormwater facility inspections) may be conducted by engineering staff. Therefore, results of the evaluation indicate approximately 1.0 FTE would need to be added to City staff (Public Works Department and Engineering) to support identified implementation gaps.

This page left intentionally blank.

Section 6

Capital Improvement Plan

This section summarizes the capital projects, programs, and policy recommendations identified through the master planning process, collectively comprising the City's Stormwater Capital Improvement Plan (CIP).

A total of 18 capital projects were identified to address current and future storm drainage infrastructure needs related to system capacity, flooding, lack of infrastructure, recurring maintenance, and water quality. Capital project recommendations are considered a one-time cost need and numbered in accordance with major drainage basin (i.e., JC = Jackson Creek or Santosh Channel; JW = Jackson Creek West [or west of Highway 30]; SC = South Scappoose Creek).

Six programmatic recommendations were identified, including addressing expanded facility maintenance needs (see Section 5), implementation of a CCTV program, city-wide system repair and replacement (R/R) needs, implementation of an asset management program, implementation of a UIC retrofit program, and ongoing support for localized drainage improvements. Program recommendations are intended to support ongoing asset management efforts and are considered annual costs. These city-wide programs are numbered as a general/program need (P-1, P-2, etc.).

Table 6-1 provides a comprehensive summary of the storm drainage capital improvement plan, including project and program costs and schedule. The SMP schedule is based on a 20-year implementation timeframe and is associated with identified project priorities and the "recommended" level of service (see Section 7.3). Detailed summaries of each capital project, as well as detailed maps of select locations, are included in Appendix F. Figure 6-1 and Figure 6-2, at the end of this section, provide an overview of capital project locations throughout the City by priority and category.

6.1 Summary of Recommended Actions

Project, program, and policy recommendations in this SMP are proposed to improve and enhance drainage infrastructure and water resources throughout the City, as summarized by the following recommended actions.

- Implement identified system capacity improvements (i.e., reconfiguration, rerouting, upsizing), such that existing and proposed infrastructure meets level of service standards and manages more frequent, localized system flooding.
- Retrofit existing UICs with pretreatment to meet current DEQ standards in accordance with the City's WPCF permit.
- Incorporate system configuration and condition data (i.e., stormwater facility inspection records, CCTV, survey) into a larger asset management program to allow for proactive maintenance, repair, and replacement of stormwater infrastructure.

- Formally adopt and conduct regular updates to the PWDS to ensure that guidance provided to the development community is clear and consistent with regulatory requirements.
- Clearly document capital project and program costs and schedule to inform future funding and rate analyses.

6.2 Cost Assumptions

Project costs are based on the total capital investment necessary to complete a project (i.e., engineering through construction). Program costs are more subjective in nature, qualified based on the City's current maintenance activities and annual expenditures. Staffing costs are discussed in Section 7.1.

Unit costs for project (construction) elements are based on recent bid tabs and stormwater master planning efforts and adjusted for 2021 based on a historical cost index. Cost estimates presented in this SMP are Association for the Advancement of Cost Engineering (AACE) Class 5 Conceptual Level or Project Viability Estimates. Actual costs may vary from these estimates between -50 percent to +100 percent, although changes to design may result in cost differences outside of this anticipated range.

Project cost estimates use unit cost information for construction elements and apply a 30 percent construction contingency and multipliers to account for traffic control/utility relocation (5–10 percent), erosion control (3 percent), and mobilization (10 percent). The range in traffic control/utility relocation is based on location (arterial vs. local street). Additional multipliers to account for engineering and permitting (20-30 percent) and construction administration (5 percent) are applied to the total construction cost with contingencies. The range in engineering and permitting costs is based on the anticipated permitting level of effort, such as whether in-water work is anticipated. For planning purposes, costs were rounded to the nearest $1,000.

Appendix E includes unit costs developed for this SMP and presents the planning-level cost estimates for capital projects. Cost assumptions related to program recommendations are described in Section 6.4.

Land acquisition and easements are not included in the cost estimates, as most projects are located on City property or within the City right-of-way (ROW).

Table 6-1. City Stormwater Capital Project and Program Summary													
Project No. [a]	Project Opportunity Area Location ID	Basin/ Waterbody	Project/Program Name	Objectives [c]	Location	Contributing Drainage Area, acres	Project/Program Summary	Estimated Cost [b]	SDC Eligible Cost	Project/Program Priority			
										Annual	High Priority	Medium Priority	Low Priority
JC-1	3	Jackson Creek	Elm Street Storm Improvements	• **System capacity**	SE Elm St (SE Endicott Ln to Outfall)	70.4	• Remove and replace approx. 400 LF of existing 24" pipe with 30" HDPE pipe. • Remove and replace approx. 1,860 LF of existing 24" pipe with 42" HDPE pipe. • Remove and replace ten manholes.	$2,703,000	$574,000				X
JC-2	4	Jackson Creek	High School Way Storm Improvements	• **Infrastructure need** • System condition • Water quality	SE 5th/SE High School Wy	24.2	• Remove and replace unregistered UIC at northwest corner of SE 5th Street and SE Vine St. • Install two sumped catch basins to serve as pretreatment for UIC. • Install approx. 50 LF of 24" HDPE culvert crossing SE 5th St on the north side of SE High School Wy to connect roadside ditches.	$91,000	$ -		X		
JC-3–Phase 1	23	Jackson Creek	E Columbia Ave Storm Improvements	• **Infrastructure need** • **System capacity**	E Columbia Ave (outfall to Miller Rd)	99.0	• Remove and replace approx. 980 total LF of existing 24" HDPE pipe with 54" HDPE pipe. • Remove and replace three manholes. • Replace existing outfall. • Conduct geotechnical investigation and infiltration testing to determine feasibility of UIC installation in north-western portion of catchment area, west of North Rd.	$1,793,000	$482,000		X		
JC-3–Phase 2					E Columbia Ave (Miller Rd to Bird Rd) and Bird Rd	98.0	• Upsize Existing Pipes in E Columbia Ave: o Remove and replace approx. 1,060 LF of existing 24" HDPE and CPP pipe with 54" HDPE pipe. o Remove and replace four manholes. • Add/replace pipes along Bird Rd: o Install approx. 600 LF of 24" HDPE pipe along Bird Rd. o Install approx. 210 LF of 30" HDPE pipe along Bird Rd. o Remove and replace approx. 530 LF of existing 15" HDPE pipe with 30" HDPE pipe. o Remove and replace three manholes. o Install three new manholes. o Install six new CBs and associated inlet leads.	$2,810,000	$763,000			X	
JC-3–Phase 3					E Columbia Ave (Bird Rd to North Rd) and North Rd	56.2	• Install approx. 310 LF of 36" HDPE pipe and approx. 420 LF of 30" HDPE along E Columbia Ave to extend from current upstream end of pipeline to the intersection with North Rd. • Install six new manholes. • Install 12 new CBs and associated inlet pipe. • Install approx. 360 LF of 30" HDPE pipe and approx. 1,000 LF of 24" HDPE pipe along North Rd from intersection with Columbia.	$1,556,000	$347,000			X	
JC-3–Phase 4					E Columbia Ave (North Rd to 4th St)	12.0	• Install approx. 365 LF of 18" HDPE pipe and approx. 800 LF of 12" HDPE pipe along E Columbia Ave to extend from North Rd to end at 4th St. • Install three new manholes. • Install six new CBs and associated inlet pipe.	$479,000	$128,000				X
JC-4–Alt1	8 and 9	Jackson Creek	Sunset Loop Storm Improvements Alternative #1	• **System capacity** • Maintenance • Water quality	NE Sunset Loop	8.9	• Remove existing pavement from NE Sunset Loop and excavate for installation of 37,440 SF of porous asphalt over a 24-in. deep open-graded base rock layer. Porous asphalt to infiltrate runoff from roadway, sidewalk, residential driveways, and rooftop downspouts. • Remove two existing catch basins. • Remove approx. 210 LF of existing 6" PVC.	$898,000	$ -			X	

Table 6-1. City Stormwater Capital Project and Program Summary													
Project No.[a]	Project Opportunity Area Location ID	Basin/ Waterbody	Project/Program Name	Objectives[c]	Location	Contributing Drainage Area, acres	Project/Program Summary	Estimated Cost[b]	SDC Eligible Cost	Project/Program Priority			
										Annual	High Priority	Medium Priority	Low Priority
JC-4-Alt2	8 and 9	Jackson Creek	Sunset Loop Storm Improvements Alternative #2	• **System capacity** • Maintenance	NE Sunset Loop	8.9	• Reconfigure Sunset Loop conveyance infrastructure and add parallel pipe down Columbia: o Install approx. 935 LF of 24" HDPE pipe along E Columbia Ave., parallel to existing/replaced storm pipe. o Install approx. 330 LF of 24" HDPE pipe along Miller Rd from new parallel Columbia pipe to existing structure DW03_CB02. o Install approx. 270 LF of 22" HDPE pipe on Sunset Loop between structures DW04_CB02 and DW03_CB02. o Install approx. 290 LF of 18" HDPE pipe on Sunset Loop between structures DW04_CB03 and DW03_CB01. o Remove and replace pipe approx. 200 LF of existing 6" PVC pipe with 22" HDPE pipe. o Remove and replace failing open-bottom catch basin structures with standard CBs. o Install three new manholes. o Install outfall parallel to existing outfall on north side of E. Columbia Ave.	$1,249,000	$243,000	City prioritization efforts resulted in JC-4 Alternative 1 being selected as the preferred alternative.			
JC-5	1	Jackson Creek	6th and Vine UIC Replacement	• **System condition** • Water quality	SE 6th St/SE Vine St	19.3	• Retrofit one existing bottomless CB at southwest corner of intersection of 6th and Vine. Replace the CB with a sumped CB to serve as a pretreatment structure. • Install one sumped CB as a pretreatment structure at northeast corner of intersection. • Install one new UIC at center of intersection.	$65,000	$ -		X		
JW-1-Phase 1	28	Jackson Creek West	Dutch Canyon System Improvements	• **Infrastructure need** • System capacity	Callahan-Dutch Canyon Area	142.4	• Install new storm pipe along SW Old Portland Rd: • Install a new overflow structure in the existing infiltration facility leading to the proposed 36" pipe in Old Portland Rd. • Install approx. 1700 LF of 36" HDPE pipe along SW Old Portland Rd. • Install four new manholes • Install eight new CBs and associated inlet pipe. • Install new outfall to the north bank of Jackson Creek, west of Highway 30.	$1,615,000	$1,615,000				X
JW-1-Phase 2						TBD	• Install 24" culvert across Dutch Canyon Rd at low point adjacent to existing wetland. • Install a new overflow structure in the existing wetland leading to the proposed 24" culvert.	$105,000	$66,000		X		
SC-1	6	S. Scappoose Creek	NW 1st St Storm Improvements	• **System capacity**	NW EJ Smith and NW 1st St	14.8	• Remove and replace approx. 190 LF of existing 12" pipe with 18" HDPE pipe. • Remove and replace approx. 980 LF of existing 15" pipe with 18" HDPE pipe. • Remove and replace approx. 1,040 LF of existing 15" pipe with 24" HDPE pipe. • Remove and replace seven manholes.	$1,617,000	$199,000				X
SC-2	18a	S. Scappoose Creek	JP West Rd Storm Improvements-East	• **Infrastructure need**	SW JP West Rd (S. Scappoose Creek east to SW 1st St)	8.3	• Install approx. 845 LF of 18" HDPE pipe. along SW JP West Rd between S. Scappoose Creek and SW 1st. St. • Install four new manholes. • Install a new outfall on the east bank of S. Scappoose Creek. • Install eight new catch basins and associated inlet pipes.	$517,000	$26,000		X		
SC-3	18b	S. Scappoose Creek	JP West Rd Storm Improvements-West	• **Infrastructure need** • **System capacity**	SW J.P. West Rd (S. Scappoose Creek to Keys Rd)	20.0	• Improve storm drain conveyance along JP West Rd through piping of roadside ditches, construction of a new outfall, and replacement of existing pipe. • Install new outfall on the west bank of S. Scappoose Creek. • Replace existing outfall SSC15 with a new manhole in the ROW. • Install approx. 90 LF of 18" HDPE pipe, approx. 80 LF of 24" HDPE pipe, and approx. 530 LF of 24" HDPE pipe to redirect flow from existing roadside and culverts. • Remove and replace approx. 40 LF of existing 12" pipe with 18" HDPE pipe. • Remove and replace approx. 30 LF of existing double-barreled 8" CMP pipe with a single 12" HDPE pipe. • Remove and replace approx. 20 LF of existing 12" CMP pipe with 12" HDPE pipe. • Replace or install eight additional new manholes. • Install six new catch basins, two per manhole and associated inlet leads adjacent to manholes. • Construct additional storm drain conveyance to extend piped conveyance to Keys Rd in anticipation of future development. • Install approx. 890 LF of 12" HDPE pipe along JP West Rd from structure SSC15_CB10 to intersection with Keys Rd. • Install six new manholes for new storm line to Keys Rd. • Install six new catch basins and associated inlet lead lines.	$1,103,000	$258,000		X		

Table 6-1. City Stormwater Capital Project and Program Summary

Project No. [a]	Project Opportunity Area Location ID	Basin/ Waterbody	Project/Program Name	Objectives [c]	Location	Contributing Drainage Area, acres	Project/Program Summary	Estimated Cost [b]	SDC Eligible Cost	Project/Program Priority			
										Annual	High Priority	Medium Priority	Low Priority
SC-4	29	S. Scappoose Creek	Keys Rd Storm Improvements	• **System capacity** • **Infrastructure need**	SW Keys Rd, SW Huser Ln, and EM Watts Rd	36.7	• Improve storm drain conveyance along SW Keys Rd and SW EM Watts Rd West Rd through piping of roadside ditches, construction of a new outfall, and replacement of existing pipes. • Install new outfall on the west bank of S. Scappoose Creek. • Install five new manholes. • Install approx. 280 LF of 24" HDPE to redirect flow from existing 18" CMP culvert and existing roadside ditch. • Install approx. 700 LF of 18" HDPE to redirect flow from existing culverts and roadside ditches. • Install eight new catch basins (two adjacent to each new manhole) and install associated inlet lead lines.	$657,000	$286,000			X	
SC-5–Phase 1	31	S. Scappoose Creek	EJ Smith Storm Improvements and Regional Facility	• **Infrastructure need** • **Water quality**	NW EJ Smith Rd (S. Scappoose Creek to NW Shoemaker Rd)	53.4	• Install five new manholes; ten new catch basins and associated inlet lead lines; and a new outfall on the west bank of S. Scappoose Creek. • Install approx. 790 LF of 18" HDPE pipe. • Install approx. 270 LF of 24" HDPE pipe. • Install approx. 660 LF of 30" HDPE pipe.	$1,266,000	$135,000			X	
SC-5–Phase 2							• Construct a regional water quality facility on Grabhorn property [tax lot 3N2W12BD 600].	$2,310,000	$247,000				X
SC-6	2	S. Scappoose Creek	SW 4th St Storm Improvements	• **System condition** • System capacity •	SW 4thSt/SW Maple St	30.4	• Remove and replace existing, failing storm pipe with approximately 980 LF of 30" HDPE pipe. • Install five new manholes. • Install eight new CBs and associated lateral pipe. • Remove and replace outfall to east side of S. Scappoose Creek.	$1,037,000	$10,000		X		
P-1	13, 14, 16, 20, 21	City-wide	Expanded Facility Maintenance Program	• Maintenance	City-wide	N/A	• Expanded efforts related to water quality and flow control facility maintenance for both private and publicly owned facilities. • Regulatory-driven program.	1.3 FTE[d]		X			
P-2	N/A	City-wide	CCTV Program	• System condition	City-wide	N/A	• Inspection of approximately 10% of the piped stormwater collection system annually or bi-annually (depending on LOS).	$10,000 or 20,000	N/A	X			
P-3	11, 12, 15	City-wide	Repair and Replacement Program	• System condition	City-wide	N/A	• Outfall Improvements • Prescriptive replacement of pipe over a 100-yr period. • Cost range depending on LOS.	$30,000 or 60,000	N/A	X			
P-4	N/A	City-wide	Stormwater System Asset Management Program Maintenance	• System condition	City-wide	N/A	• Refinement of City GIS (including system survey) for inclusion in the City's current asset management framework. • Evaluation of current practices and procedures (SOPs) to correlate with asset documentation needs.	$10,000	N/A	X			
P-5	N/A	City-wide	UIC Retrofit Program	• Water quality • System condition	City-wide	N/A	• Install pretreatment (two sumped catch basins) over a 10-yr implementation period upstream of existing UICs. 49 public UICs are currently without pretreatment (existing or proposed in conjunction with a CP). • Regulatory driven program.	$60,000	N/A	X			
P-6	5, 7, 10, 17	City-wide	Local Drainage Improvements Program	• Infrastructure need • System capacity	City-wide	N/A	• Installation of small-scale, localized drainage improvements (i.e., new pipe, catch basins and laterals, grading to support curb-and-gutter flow). • Cost range depending on LOS.	$25,000 or 50,000	N/A	X			
P-7	N/A	City-wide	Green Street Pilot Program	• Water quality • System capacity	City-wide	N/A	• Design and installation of opportunistic stormwater planters/ curb bump outs along streets with available ROW or at intersections to address localized ponding while providing water quality treatment. • Program is associated with the Recommended or Aspirational LOS only.	$50,000	N/A	X			
									Total	**$250,000**	**$4,711,000**	**$6,289,000**	**$9,622,000**

Notes: N/A: Not Applicable

TBD: To be Determined in conjunction with refined CP development.

a. CIP numbering reflects the following drainage basins: JC = Jackson Creek or Santosh Channel, JW = Jackson Creek West (west of Highway 30), SC = South Scappoose Creek.

b. Estimated project costs are detailed in Appendix E. A range of city-wide program costs are provided to correspond to the Level of Service (LOS) definitions detailed in Section 7.2 of the SMP.

c. The primary objective for mapping purposes is indicated in BOLD.

d. Staffing needs are outlined in Section 7.1 of the SMP. 1 FTE is estimated as$150,000 (including salary and benefits). This salary range can support both Public Works Utility 2 or Engineering Technician staffing levels.

6.3 Capital Project Recommendations

Capital projects address the following objectives: system capacity, infrastructure need, system condition, and water quality. All projects are summarized and costed in Table 6-1.

Through an integrated project development approach (see Section 3), problem areas and opportunities were consolidated by location and defined as Stormwater Project Opportunity Areas. As such, identified capital projects may address multiple objectives in a single project.

Projects to improve water quality are generally associated with existing site or facility modifications to address a pollutant source issue or to improve treatment function and are, therefore, not considered a retrofit. One exception is SC-5, Phase 2. The regional facility proposed can provide regional water quality and flow control benefits but does require property acquisition and coordination with Parks related to the redevelopment of the proposed site.

Additional detail related to capital project layout and configuration used to inform cost estimating is provided in Appendix F.

6.4 Program Recommendations and Descriptions

City-wide program development efforts also stem from the integrated project development approach. During the project planning process (Section 3), select maintenance-related, regulatory-driven, and condition-related project needs were consolidated into larger program opportunities instead of developed as multiple, stand-alone individual projects.

Table 6-1 reflects specific opportunity areas by Location ID that are applicable to the identified programs. These programs are part of the successful management of a municipal stormwater system. Implementation will provide significant savings over decades of execution through proactive maintenance, replacement, and repair. Program descriptions and cost assumptions/ ranges are summarized below in accordance with the Level of Service definitions (see Section 7.3).

6.4.1 Expanded Facility Maintenance Program (P-1)

This program stems from the project planning efforts and proactive maintenance requirements necessary to comply with the City's UIC WPCF permit and ongoing stormwater program responsibilities as a DMA on the 2021 Willamette Basin Mercury TMDL.

Maintenance activities, current and proposed frequencies, and associated staffing needs are outlined in Appendix D. The resulting recommended staffing increase is 1.3 FTE, when applying contingency to the recommended staffing increase. See Section 7.1 for additional information.

6.4.2 CCTV Program (P-2)

This program stems from the project planning efforts and City interests in developing a comprehensive asset management program for the stormwater utility (see programs P-2, P-3, and P-4). CCTV is one of the least expensive and robust methods to document, assess, and identify condition-related issues in the piped stormwater network. CCTV collection provides a snapshot in time of the infrastructure condition and provides data allowing each pipe segment to be ranked and documented. The combination of CCTV data collection and condition evaluation will provide the City with an understanding of pipes that need to be replaced in the short-, mid-, and long-term in accordance with the larger asset management program and repair and replacement program.

An annual cost ranging from $10,000 to $20,000 is reflected in the proposed CIP for this program. This program cost is based on assumed inspection of all City-owned pipe over a 10-year (specific for the Recommended and Aspirational LOS) or 20-year period (Basic LOS). A unit cost of $2.00/LF or pipe is assumed, based on a City-provided estimate of $1.50/LF and planning contingency associated with traffic control, etc.

6.4.3 Repair and Replacement (R/R) Program (P-3)

An R/R Program is used to budget the design and construction of improvements stemming from a CCTV and Asset Management Program. The gathered information and subsequent ranking of pipe and infrastructure condition will inform the locations where pipes need to be repaired or replaced in accordance with available funding and schedule. An R/R Program is key to the long-term sustainability of the stormwater collection system. An R/R program ensures that replacement is scheduled for older infrastructure nearing the end of its useful life before failure, as well as prioritizing damaged or failing pipes identified through the CCTV Program.

An annual cost of $30,000 or $60,000 is allocated for the R/R program in the proposed capital improvement program. This cost is based on the present-day annual cost estimate to replace City-owned pipes, 12 inches in diameter and larger, over a 100-year period. Based on the City's asset inventory, this requires the replacement of approximately 1,000 LF of public stormwater pipe and a present-day value of approximately $300,000. However, this estimate does not consider ongoing pipe replacement efforts in accordance with capital project development and other drainage improvements. The estimate also excludes unknowns related to pipe age and associated lifespan of plastic pipe. As such, the City opted to allocate $30,000 (10% of the annually calculated amount, specific for the Basic LOS) or $60,000 (20% of the annually calculated amount, specific to the Recommended or Aspirational LOS) for this program for budgeting purposes.

6.4.4 Stormwater System Asset Management Program Maintenance (P-4)

An Asset Management Program can provide a systematic approach to evaluating, prioritizing, and replacing assets throughout the city. The intent of this program is to identify and record the City's infrastructure assets based on system condition, age, and performance and to help reduce reactionary operations and maintenance activities. The asset management program will support the ongoing CCTV efforts (see Project P-2) and the City's R/R program (see Project P-3).

An asset management program requires assessment of current practices and procedures, review and purchase of software applications and tools, integration and refinement of GIS data, and development of procedures and documentation. Purchase and preliminary set up of an asset management program is currently budgeted in conjunction with other utilities. Specific for stormwater, this program allocates $10,000 annually to accommodate additional survey and integration of stormwater assets in GIS, as well as development of procedures and documentation.

6.4.5 UIC Pretreatment/Retrofit Program (P-5)

This program stems from the project planning efforts and proactive maintenance requirements necessary to comply with the City's UIC WPCF permit. The City's UIC WPCF permit requires the development of a Structural BMP Device Installation Plan and Schedule, which needs to reflect implementation of operational and structural best management practices (BMPs) to reduce or eliminate pollutants from entering UICs. Structural BMPs allow for separation of oil and settlement of solids and includes sumped catch basins, sedimentation manholes, and green street/LID facilities. As such, the Structural BMP Device Installation Plan must identify the existing public UICs that do not currently have adequate pretreatment and provide a schedule for installation of pretreatment.

The City's current UIC Systemwide Assessment and UIC inventory includes a total of 56 public UICs (see Appendix A-2). Three UICs have known pretreatment, and four UICs will have pretreatment in accordance with CP installations. Therefore, 49 UICs are currently identified with no known pretreatment or plan for pretreatment.

An annual cost of $60,000 is allocated for this program in the proposed capital improvement program. This recommended program cost is based the present-day cost of retrofit of the 49 UICs lacking pretreatment over a 10-year planning period. Pretreatment assumes the installation of two sumped inlets with inlet leads upstream of each UIC. Existing UICs should be reviewed and UIC pretreatment status field-verified prior to installation of pretreatment. Detailed accounting and recording of retrofit status is required for submittal to DEQ.

6.4.6 Minor Drainage Improvement Program

This program stems from the project planning efforts and the identification of drainage improvements that are not anticipated to require extensive engineering services. These improvements include installation of additional inlets and laterals (to address localized flooding or lack of infrastructure), minor regrading and replanting of conveyance ditches and swales, and replacement of sock structures on stormwater outfalls.

An annual cost ranging from $25,000 (Basic LOS) to $50,000 (Recommended and Aspirational LOS) is allocated for this program in the proposed capital improvement program.

6.4.7 Green Street Pilot Program

This program stems from the project planning efforts and the stormwater retrofit analysis. This program involves the opportunistic incorporation of green street and LID features (planters, curb bump outs) to address water quality in conjunction with other transportation or utility planning projects. Project planning efforts initially indicated opportunities to integrate green infrastructure in accordance with Project Opportunity Areas (See Table 3-2). However, site limitations (ROW width, lack of curb/gutter) often preclude many of these site-specific applications. With this program, sites may be prioritized based on the identification of local drainage issues (i.e., intersection flooding).

An annual cost of $50,000 is allocated for this program under the Recommended and Aspirational LOS in the proposed capital improvement program.

6.5 Policy Recommendations

The following policy recommendations are recommended as pertaining to the finalization of the draft Scappoose Public Works Design Standards (PWDS) or addressed through internal directives.

6.5.1 Finalization of Draft PWDS

As described in Section 2.8, the City has not finalized their draft PWDS. The draft PWDS should be finalized in conjunction with results of BC's review, including incorporation of identified policy and implementation-based recommendations to improve clarity, resolve discrepancies, and maintain consistency with typical stormwater design standards for similar sized communities. Such refinements would support water quality improvement efforts by specifying facility types and design criteria to address specific pollutants of concern for the City.

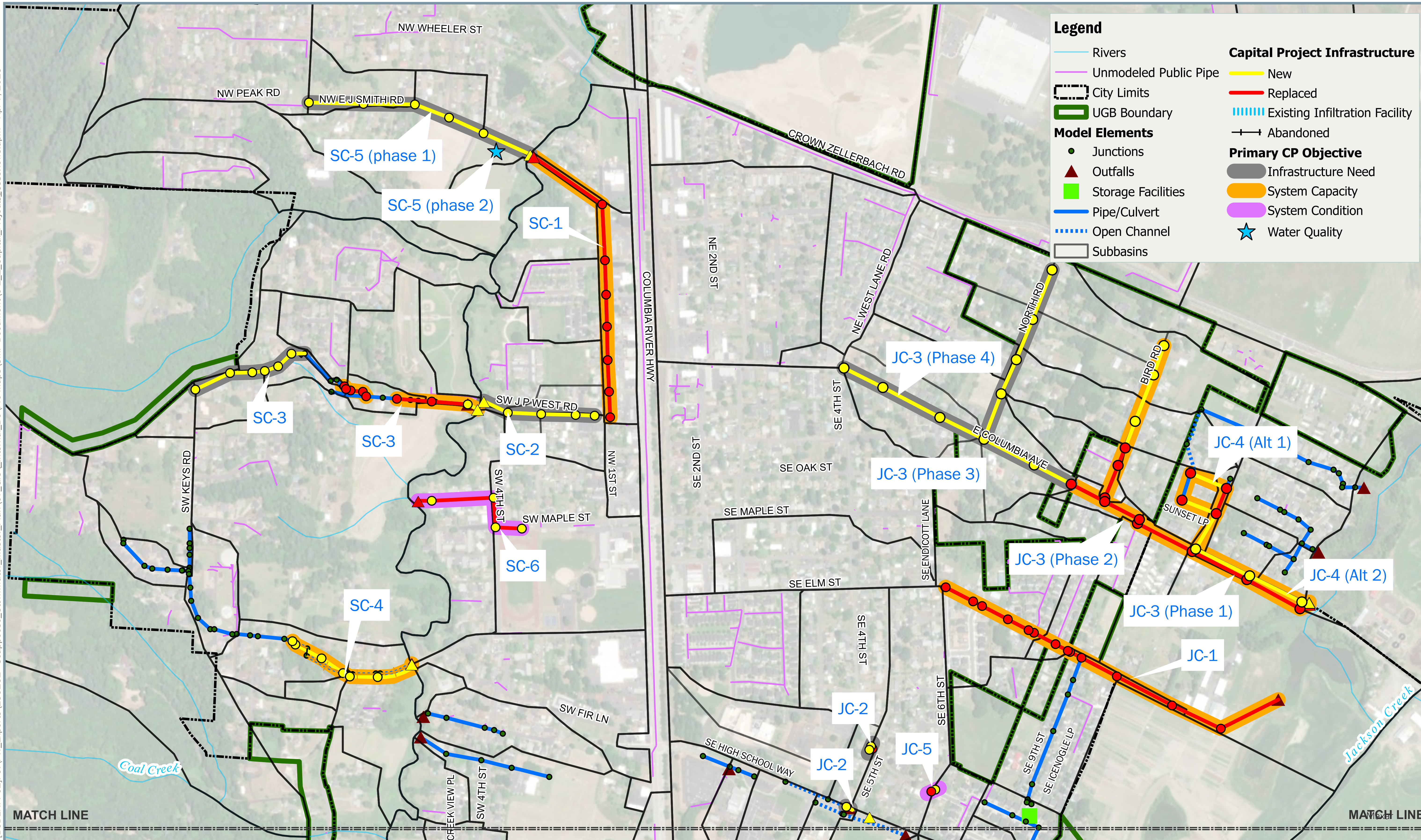
PWDS policy considerations are summarized in Section 2.8 and detailed in the Stormwater Basis of Planning TM (available separate from this SMP).

6.5.2 Stormwater Facility Maintenance Responsibility

The City's current GIS inventory of stormwater treatment and detention facilities is incomplete. Facility type (i.e., swales, raingardens, detention ponds) are not consistently referenced. Ownership information (public versus private) is not accurately recorded; therefore, facility maintenance needs cannot be fully integrated into Public Works maintenance schedules. Implementation of an asset management program, in addition to adherence to the draft PWDS, will require the identification of ownership and maintenance responsibility for each facility, as well as accurate mapping of facilities with appropriate asset information.

The City maintains a database (not linked to GIS) reflecting stormwater facility information including the name of the associated development, location (address and mapped tax ID), date created, current owner and owner contact information, and facility description. As part of this SMP effort, additional information (i.e., Facility ID) was added to the database to attempt to rectify the facility against existing GIS, and a specific facility category type was assigned based on the facility description. Such information should be used to inform updated mapping and asset management needs (see Section 6.4.4).

In addition, the City reports that inconsistent and infrequent maintenance often occurs on privately-owned facilities. In cases where the private facility is not being maintained and functionality is compromised, the City may consider a program to reassign maintenance responsibility for existing private stormwater facilities and conduct maintenance in accordance with public facility maintenance protocols and schedules. The staffing analysis (Appendix D) reflects new efforts by City Public Works staff to inspect private facilities, and these inspections, in accordance with defined asset management procedures, may inform whether City-conducted maintenance is needed.



Brown AND Caldwell

City of Scappoose

Stormwater Master Plan

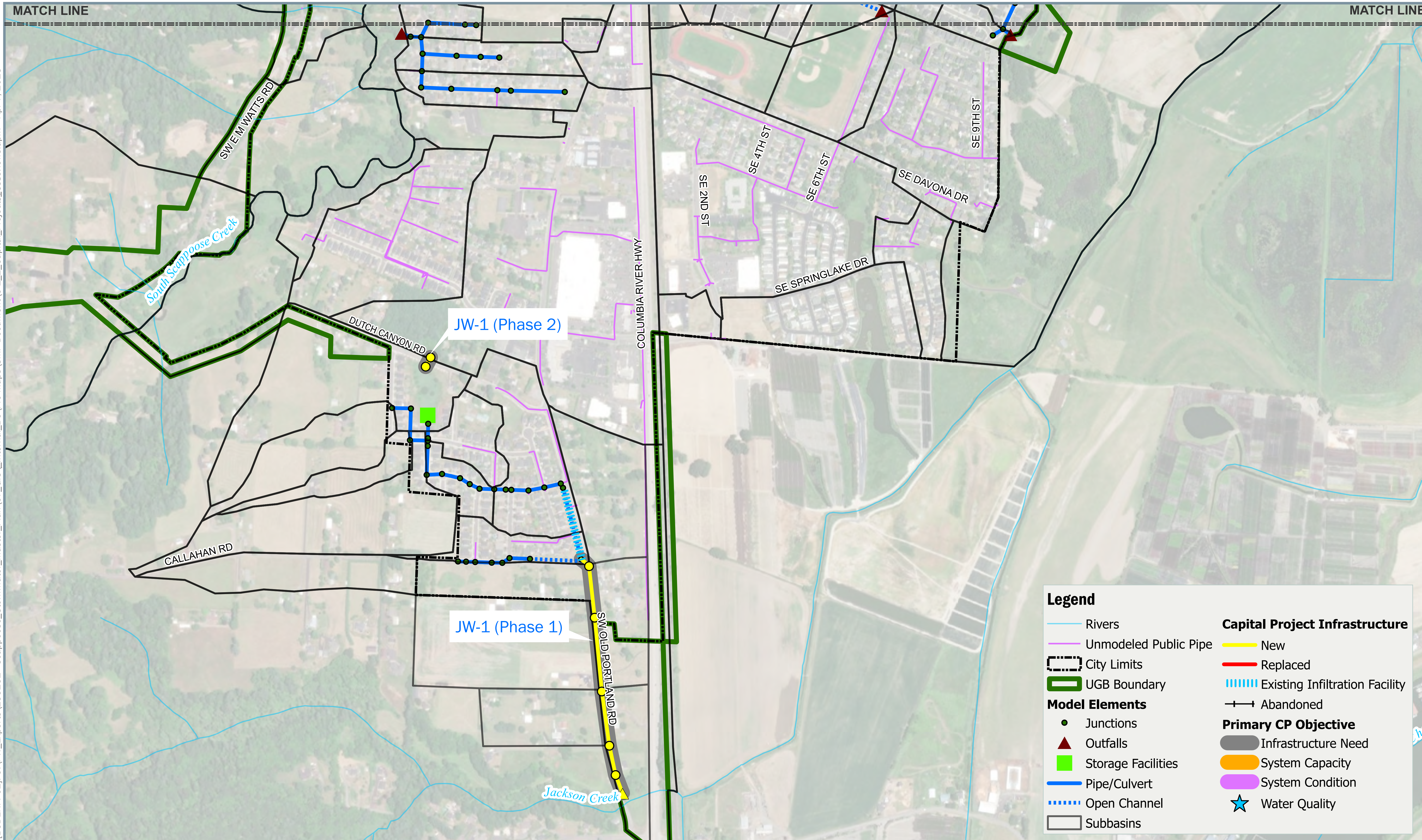
April 2023
Project: 155252

0 500 1,000 Feet

N

Notes:
1. NAD 1983 HARN StatePlane Oregon North FIPS 3601 International Feet
2. See Table 6-1 of SMP for detailed capital project information by number.

Figure 6-1: Capital Projects Overview (North)



Brown AND Caldwell

City of Scappoose

Stormwater Master Plan

April 2023
Project: 155252

Notes:
1. NAD 1983 HARN StatePlane Oregon North FIPS 3601 International Feet
2. See Table 6-1 of SMP for detailed capital project information by number.

Figure 6-2: Capital Projects Overview (South)

[BCDENFP01]: O:\PW_Exports\155252 - Scappoose_Stormwater_Master_Plan\07_GIS_Internal_BC\Pro Maps\SMP Document\6-1_2_Capital_ProjectsOverviews.aprx Apr 7, 2023

Section 7

Implementation

This SMP includes a financial evaluation to determine rate adjustments required to implement the projects and programs identified in this Plan.

This section provides an overview of staffing needs, project prioritization, and established levels of service (LOS) used to inform the stormwater utility rate and SDC evaluation. This section also summarizes results of the rate evaluation.

7.1 Staffing Needs

As described in Section 5, the City's Public Works and Engineering departments do not have adequate staff to meet current and projected stormwater operations, inspection, and maintenance needs. The financial evaluation incorporates additional public works and engineering staff to support implementation of this Plan.

The City employs 1.0 FTE in engineering (the City Engineer), whose responsibilities include development review as well as ongoing engineering and design support for Public Works operations. The City also contracts with an outside consulting engineer to supplement engineering activities. Implementation of capital projects as outlined in this Plan will require additional engineering and Public Works staff support, outside of current responsibilities, to manage consultant design efforts and support construction oversight.

As outlined in Appendix D, the staffing evaluation resulted in the identification of an additional 1.0 FTE to support current (based on the City's current asset inventory) inspection, operations and maintenance activities and address current regulatory requirements. A 30% contingency is applied to this staffing estimate to account for additional engineering and Public Works staff support in conjunction with capital projects and programs outlined in this SMP. Therefore, a recommended staffing increase of 1.3 FTE is used in the financial evaluation.

The City provided annual compensation rates, which include all wages, benefits, taxes and accruals, in November 2022 for a Utility 2 and an Engineer staff position. These rates were averaged and an annual compensation rate of $150,000 per year (see Table 6-1) was used to support proposed staffing increases in the financial evaluation.

7.2 Project Prioritization

Project prioritization is an important component of the stormwater master planning process and can provide direction in terms of sequencing projects in accordance with City objectives.

The prioritization process was initiated following project development efforts. Example prioritization criteria and scoring methods (qualitative versus quantitative) were provided to City staff to guide their internal process. The City opted to focus prioritization efforts on defining groups of high and medium priority projects rather than on the specific ranking of individual projects.

The City incorporated a weighting factor for three of the prioritization criteria to ensure that the highest priority criteria are reflected in the scores and ultimate project prioritization. The three weighted criteria were: "addresses an identified capacity problem", "addresses a safety concern/reduces potential liability", and "sequencing".

Table 7-1 summarizes the prioritization criteria used to score developed capital projects. City scoring of capital projects is reflected in Appendix G.

Table 7-1. Prioritization Criteria

Criteria	Weighting Factor (Y/N)	Scoring Definition		
		High (H) (Score = 3)	Medium (M) (Score = 2)	Lower (L) (Score = 1)
Capacity Deficiency	Y	CP addresses a flooding problem predicted by the H/H model and observed by City staff.	CP addresses a flooding problem predicted only by the H/H model.	CP may provide some flood control benefits but does not address an identified flooding problem.
Water Quality/ Regulatory Benefits	N	CP will reduce TMDL pollutant loading to receiving waters (i.e., sediment as a surrogate for mercury) through the installation of a facility or routing to an existing water quality facility.	CP incorporates pretreatment to meet WPCF permit objectives only.	CP does not provide water quality benefits.
Maintenance	N	CP will address an existing, recurring maintenance concern.	CP will address a periodic maintenance concern.	CP will not address recurring maintenance needs.
Acquisition	N	CP is located on public property and acquisition/ easement is not required.	CP requires obtaining an easement.	CP requires property acquisition.
SDC Funding Source	N	30% or greater	10-30%	<10%
Permitting Complexity	N	CP requires only local permitting.		CP involves in-water work and requires additional federal/state permitting.
Safety/ Liability	Y	CP reduces flooding risk at/near a school or for a major arterial roadway.	CP reduces flooding risk for a minor roadway.	CP does not address safety concerns.
Sequencing	Y	CP project/ project phase is required prior to subsequent project phase		CP schedule is independent of other projects/ project phasing.
Cost per Drainage Area Managed	N	Cost per drainage area (ac) is < $50,000	Cost per drainage area (ac) is between $50,001 and $99,999	Cost per drainage area (ac) is > $100,000

7.3 Level of Service Evaluation

Developing the stormwater rate evaluation requires the City to determine a level of service (LOS) consistent with the expectations of the City's stormwater program and ratepayers.

Using project cost information, program cost information, and estimated operational funding expenditures, City staff identified three LOS for stormwater-related needs (see Table 7-2 below). The LOS informs which CPs will be funded within 20-year timeframe and the level of program funding allocated. Staffing needs do not vary based on LOS. Specific to CP implementation, high priority projects will be funded over the next 20-year implementation period in accordance with the Basic LOS; high and medium priority projects will be funded over the next 20-year implementation period in accordance with the Recommended and Aspirational LOS; lower priority projects will only be implemented in accordance with the Aspirational LOS.

Table 7-2. Level of Service Definitions			
Criteria	Basic LOS	Recommended LOS	Aspirational LOS
Capital Project Implementation			
Stormwater Project Implementation (CPs)	Implement the high priority projects within the 20-year planning window.	Implement high and medium priority projects in a 20-year planning window	Implement all stormwater capital projects in a 20-year planning window
Program Implementation (Annual Cost)			
Expanded Facility Maintenance Program	See staffing below.	See staffing below.	See staffing below.
CCTV Program	Inspect 10% of the piped collection system biannually.	Inspect 10% of the piped collection system annually.	Inspect 10% of the piped collection system annually.
Repair and replacement program	Add program ($30,000/year).	Add program ($60,000/year).	Add program ($60,000/year).
Stormwater System Asset Management Program Maintenance	Refinement of GIS in support of program implementation ($10,000/ year).	Refinement of GIS in support of program implementation ($10,000/ year).	Refinement of GIS in support of program implementation ($10,000/ year).
UIC Retrofit Program	Add program (retrofit over a 10-year implementation period)	Add program (retrofit over a 10-year implementation period)	Add program (retrofit over a 10-year implementation period)
Local Drainage Improvements Program	Add program ($25,000/year)	Add program ($50,000/year)	Add program ($50,000/year)
Green Street Pilot Program	No program.	Add program ($50,000/year)	Add program ($50,000/year)
Staffing (associated with capital projects and programs) (FTE)			
Staffing (engineering and Public Works)	Increase staffing resources by 1.30 FTE to support inspection and maintenance efforts and capital project/program implementation.	Increase staffing resources by 1.30 FTE to support inspection and maintenance efforts and capital project/program implementation.	Increase staffing resources by 1.30 FTE to support inspection and maintenance efforts and capital project/program implementation.

a. *Annual cost provided by City.*

7.4 Funding Evaluation

In conjunction with development of this Plan, a financial analysis was conducted on the City's current stormwater utility rate and SDCs. The resulting financial plan provides a funding structure in accordance with the defined LOS that allow the City to implement the CPs and programs as costed and scheduled in this SMP while meeting other financial obligations and policy objectives. This financial plan also provides an updated methodology for the City's SDC.

The financial plan is provided in Appendix H.

This page left intentionally blank.

Section 8

References

Brown and Caldwell. *City of Scappoose Stormwater Master Plan Technical Memorandum #1. Stormwater Basis of Planning*. October 2021.

City of Scappoose, Oregon. Public Works Department. *Storm Drain System Master Plan.* November 1998.

City of Scappoose, Oregon. *Public Works Design Standards*. July 2002.

City of Scappoose, Oregon. Draft Public Works Design Standards (Section 2.000) (not dated).

GSI. System-wide Assessment for Individual WPCF Permit for Class V Underground Injection Control Systems, WQ File No. 125461. June 2020.

James, William. Rossman, Lewis E. James, W. Robert C. User's Guide to SWMM5, 13th Edition. CHI Press. 2010.

Meso West. Weather Conditions for KSPB. Downloaded June 8, 2021. https://mesowest.utah.edu/cgi-bin/droman/meso_base_dyn.cgi?stn=KSPB

ODEQ. Willamette Basin Mercury TMDL. February 2021.

United States Department of Agriculture, Natural Resources Conservation Service. Soil Survey (SSURGO) Database for Columbia County, Oregon. 2016.

United States Environmental Protection Agency. *Storm Water Management Model User's Manual, Version 5.1.* September 2015.

United States Environmental Protection Agency. *Storm Water Management Model Reference Manual, Volume 1–Hydrology (Revised).* January 2016.

WEST Consultants. *Draft Scappoose Drainage Improvement Company Interior Drainage Analysis*. September 2017.

Limitations

This document was prepared solely for City of Scappoose in accordance with professional standards at the time the services were performed and in accordance with the contract between City of Scappoose and Brown and Caldwell dated May 21, 2020. This document is governed by the specific scope of work authorized by City of Scappoose; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. We have relied on information or instructions provided by City of Scappoose and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

Appendices

Appendix A: Stormwater Standards Review

Appendix B: Project Planning Background

Appendix C: TM#2: Hydrology and Hydraulic Modeling Methods and Results

Appendix D: Public Works Staffing Evaluation

Appendix E: Capital Project Detailed Cost Estimates

Appendix F: Capital Project Narrative Summaries

Appendix G: Project Scoring

Appendix H: Financial Evaluation TM

Appendix A: Stormwater Standards Review

Table A-1. Post-Construction Design Standards Gap Analysis

City of Scappoose - Stormwater Master Plan
Created by J. Christofferson of Brown and Caldwell
Reviewed by A. Wieland
Includes input from M. Kohlbecker of GSI Water Solutions received on 12/29/20 and 1/20/21.
Note: The City of Scappoose, Oregon is not a Phase II Permittee. However, BC has reviewed the City's draft Public Works Standards in the context of the Phase II Permit to help identify outstanding policy

	Requirement from the NPDES Phase II General Permit	Current Status with Respect to Addressing the Requirement	Manual and/or Code Reference	Identified Gaps	Comparison to NPDES Phase II Requirements	Outstanding Policy Considerations
i.	Implementation Deadline					
	Existing Registrants No later than February 28, 2023, Existing Registrants must implement all of the required components described in Schedule A.3.e.ii-viii.	Not Applicable = N/A	N/A	N/A		
ii	Ordinance and/or Other Regulatory Mechanism					
	Through ordinance or other regulatory mechanism, to the extent allowable under state law, the permit registrant must require the following for project sites discharging stormwater to the MS4 that create or replace 5,000 square feet or more of new impervious surface area.	NOTE - ALL SUBSEQUENT STANDARDS IN PWDS ARE APPLICABLE WITHIN THE CITY OF SCAPPOOSSE CITY LIMITS Thresholds specified in the PWDS: - Stormwater quality treatment and detention facilities are required for new development and redevelopment if the project disturbs 1,000 square feet or more of new or redeveloped impervious area. Exceptions include residential structures being rebuilt due to damages; interior remodels, tenant improvements, re-roofing; pavement repair and maintenance activities; standalone projects with only safety repairs; standalone projects with only linear utility trenches, and replacing of catch basins and inlets that discharge to the same storm or drainage systems (existing connections). Applicable projects include both those on private and public property and right-of-way.	Public Works Design Standards (PWDS) Sections 2.0010 and 2.0120	None.	Exceeding requirements.	The City's thresholds for triggering treatment and detention are lower then that applied for Phase II NPDES MS4 permittees. Consider how this threshold will impact development review and staffing needs as the standards will be triggered for small project, including single family homes.
	(A) The use of stormwater controls at all qualifying sites.	The use of stormwater quality treatment and detention is required at qualifying private and public sites. Stormwater generated from impervious area on property must be managed on the same property in stormwater facilities. Stormwater that is generated within the public right-of-way must be managed in stormwater facilities on public or private property. Stormwater facilities required as a condition of development or redevelopment in the right-of-way are sized to manage stormwater from the contributing impervious area within the right-of-way, including sidewalks and driveway aprons. Stormwater facilities in the right-of-way are sized to treat stormwater from private driveways, unless they can be graded to a private treatment facility.	PWDS Sections 2.0120	None.	Meets minimum requirements.	Requiring stormwater generated from private property to be managed on the same property in facilities maintained by the property owner (see purple font in this row) may limit the City's ability to establish regional facilities to manage runoff from multiple developments (owners). This may also the limits the City's ability to set up a fee-in-lieu of program to fund regional facilities, if desired. City to consider creation of an exception in cases where a regional facility is identified for management of public and private runoff. City to confirm future ownership/ maintenance responsibilities for facilities managing co-mingled runoff. Does the City wish to continue to all public runoff to be managed in stormwater facilities on private property?
	(B) A site-specific stormwater management approach that targets natural surface or predevelopment hydrological function through the installation and long-term operation and maintenance of stormwater controls.	Stormwater must be infiltrated/retained on-site to the maximum extent feasible following a stormwater hierarchy. Full infiltration/ onsite retention of the 10-year storm is prioritized. Infiltration-limiting site conditions are identified. For sites that cannot retain the 10-year storm event on-site due to required facility surface area or depth, infiltration/ retention of the water quality design storm is required with downstream flow control. For sites where infiltration/ retention of the 10-year event is not possible, flow control is required to prevent stream channel erosion (hydromodification). Unless more specific data is available, the City assumes that channel-eroding flow is one-half of the 2-year, 24-hour pre-development design storm peak flow. To prevent hydromodification of the channel, off-site/downstream stormwater facilities is sized to retain the 25-year event and control post-developed flows. Long term O&M is required for all for treatment and detention stormwater facilities.	PWDS Sections 2.0120 (B), 2.0120 (D), 2.1000	None.	Exceeding requirements. *Note: The intent of these requirements is to address hydrology/volume and not just hydraulics/peak flow but DEQ seems to be accepting peak flow matching to address this as long as peak flow matching occurs for small storm events such as the 2-year storm.*	The City needs to confirm the objective of an infiltration-based stormwater management hierarchy and the associated infiltration standard. Is the objective to address flow control (mitigation of downstream capacity issues) or hydromodification? Are there areas of the City that may be exempt from a flow control or hydromodification objective? Inclusion of a "partial onsite/ infiltration standard", requiring retention up to the water quality storm may be problematic from an implementation perspective. The Scappoose Drainage Improvement Company's (SDIC) ditches are a topic of concern. Does that City want to increase the onsite infiltration/ retention storm event from the 10-year to the 25-year for consistency with flow control and conveyance standard? Section 2.0120 (D) reflects use of "onsite" versus "offsite" facilities for treatment and flow control. It is unclear what the distinction reflects, as offsite facilities are subject to availability. If a regional facility is available to a developer/owner, would the use of managing stormwater in those facilities not be prioritized?
	(C) Long-term operation and maintenance of stormwater controls at project sites that are under the ownership of a private entity.	Maintenance of stormwater facilities is the responsibility of the private property owner unless the facility is in public ROW or dedicated easement dedicated to the City. Stormwater facilities treating multiple private parcels shall be public and shall be located on a separate tract with easement to the City. Facilities constructed within the ROW or parcel deeded for public ownership require maintenance by the developer for a 2-year warranty period. A site-specific O&M Agreement (includes O&M Form, a Drainage Plan, and an O&M Plan) is required for non-standards maintenance activities. The O&M Agreement must be recorded with Columbia County and then submitted to the City prior to issuance of an occupancy permit. Section 2.1020 provides more details on the O&M requirements, including typical facility maintenance activities.	PWDS Sections 2.1000 through 2.1030	None.	Potential deficiency. Selective enforcement of an O&M Agreement may limit the City's ability to confirm ongoing maintenance of private facilities. Confirm rationale for this requirement.	Current ownership and maintenance responsibility language is confusing and potentially contradictory with Section 2.010 (requiring stormwater generated from a property to be managed on the same property in facilities). Recommend rectification between sections. City ownership of facilities managing multiple private parcels is a change from current policy. Confirm City ownership also means maintenance responsibility. Shared maintenance responsibility for facilities in the public ROW or easement between the City and "adjacent property owner" may present ongoing implementation challenges. Is this necessary in light of the 2-year warranty period already in effect? If an O&M Agreement is only required if non-standard maintenance activities/ facilities are proposed, then how is ongoing enforcement of private facility maintenance expected?

Table A-1. Post-Construction Design Standards Gap Analysis

	Requirement from the NPDES Phase II General Permit	Current Status with Respect to Addressing the Requirement	Manual and/or Code Reference	Identified Gaps	Comparison to NPDES Phase II Requirements	Outstanding Policy Considerations
	The permit registrant must use appropriate enforcement procedures and actions to ensure compliance with Schedule A.3.e.iv. The local ordinance or other regulatory mechanism adopted must meet the requirements of Schedule A.3.e.ii-vi.	There is no enforcement language in the PWDS.	None.	Enforcement needs to be addressed.	Needs improvement.	Does the City want to address enforcement in the PWDS? If so, policies regarding general enforcement and inspection procedures will need to be addressed.
iii	**Prioritization of Low Impact Development (LID) Requirements**					
	The permit registrant must identify, minimize or eliminate ordinance, or code and development standard barriers within their legal authority that inhibit design and implementation techniques intended to minimize impervious surfaces and reduce stormwater runoff (Low Impact Development and Green Infrastructure). Such modifications to ordinance, or codes are only required to the extent they are permitted under federal and state laws. The permit registrant must review ordinance, code and development standards for barriers by September 1, 2023. If an ordinance, code or development standard barrier is identified at any time subsequent to September 1, 2023, the applicable ordinance, code or development standard must be modified within three years.	Public facilities are required to prioritize green infrastructure on a localized scale. The stormwater management hierarchy also prioritizes use of vegetated facilities over proprietary facilities. LID/GI approaches to be used for stormwater quality treatment include porous pavement, ecoroofs, planters, rain gardens etc. (see 2.0600 Table 7: Stormwater Facility Applicability by Impervious Surface Types). Table 7 also shows the type of facility most appropriate to treatment runoff from specific impervious surface types (i.e. rooftops, driveways, sidewalks, parking lot, and street). Installation of infiltration and green infrastructure must meet both the TSS and TMDL/303(d) pollutant reduction goals. Any alternative facility being proposed must meet or exceed pollutant reduction requirements. Barriers to green infrastructure could be consistent with the infeasibility criteria for infiltration/retention facilities in 2.0120 (B): site on fill, steep slopes, season high groundwater, contaminated soils, and high-risk areas (hazardous transportation routes within Wellfield Protection area).	PWDS 2.0120 (B) and (D), 2.0600	None.	Meets minimum requirements.	Does the City want to prioritize use of vegetated facilities over proprietary? Use of LID concepts can include promotion of infiltration and other site planning concepts, as well as infiltration-based facilities. Is the City satisfied with the approach/ types of LID/GI facilities proposed in the PWDS? Are all those type of facilities allowable in the City (i.e., ecoroofs, downspout extension, etc.)? What additional barriers, if any, have been identified to the use of LID/GI in the City to date? Should those barriers/ exceptions be listed?
iv.	**Post-Construction Stormwater Management Requirements**					
	The permit registrant must develop enforceable post-construction stormwater management requirements in ordinance or other regulatory mechanism that, at a minimum, including the following technical standards:	N/A	N/A	N/A	N/A	None.
	(A) Site Performance Standard: The permit registrant must establish a site performance standard with a numeric stormwater retention requirement to target natural surface or predevelopment hydrologic function to retain rainfall on-site and minimize the offsite discharge of precipitation utilizing stormwater controls that infiltrate and evapotranspirate stormwater. This retention requirement must use one of the following: 1. Volume-based method. 2. Storm event percentile-based method. 3. Annual average runoff-based method. For projects complying with the retention requirement, the permit registrant can allow for an exception of this retention requirement in the site performance standard in instances where full compliance with this requirement cannot be achieved based on factors of technical infeasibility (see Schedule A.3.iv.D).	The PWDS requires stormwater to be retained onsite through 1) reducing or eliminating impervious surfaces, 2) enhance tree canopy, 3) infiltration of stormwater into the ground, 4) storage of water in layers of topsoil and evaporation or evapotranspiration. The PWDS promotes the management of stormwater locally and the retention requirement uses the storm event percentile method (10-year storm event) on-site without overflow unless the site demonstrates a specific condition (i.e site on fill, steep slopes, season high groundwater, contaminated soils, high-risk areas). The PWDS allows the use of a "Simple Method" which uses pre-defined sizing factors to size stormwater facilities to retain up to the 10-year event and a "Engineered Method" which uses hydraulic and hydrologic calculations to size a facility.	PWDS 2.0120 PWDS 2.0230	None.	Meets minimum requirements.	None.
	(B) Treatment Standard For projects that are unable to fully meet the retention requirement, the remainder of the rainfall/runoff associated with this retention requirement must be treated prior to discharge with a structural stormwater control. This stormwater structural control must be designed to remove, at minimum, 80 percent of the total suspended solids. In treating the stormwater discharge offsite, the permit registrant must give priority to using green infrastructure before considering other structural stormwater controls. This runoff discharged offsite must target natural surface or predevelopment hydrologic function.	The PWDS requires treatment for all projects meeting the 1,000 sqft threshold. The PWDS requires the pollutant reduction requirement for stormwater treatment is 90 percent of the average annual rainfall (1.5" over 24 hours). The proposed facilities must reduce TSS by 70% and treat any pollutants of concern established in a TMDL or that are on the DEQ's 303(d) list of impaired waters. Installation of infiltration and green infrastructure is encouraged and are assumed to meet the pollutant reduction (TSS reduction) goals. The requirements do not consider the predeveloped condition. The PWDS include a stormwater management hierarchy that incorporates variable treatment requirements.	PWDS 2.0120 (C) and (D)	PWDS does not currently meet the TSS reduction requirement of 80%.	Meets minimum requirements.	Is it necessary to list a pollutant reduction goal if there are not applicable TMDL/ 303(d) listings as pertain to Gresham, who has TMDL and 303(d) listings? The water quality design storm (90% of the average annual rainfall) exceeds Phase I requirements. Was a rainfall analysis conducted recently to confirm the 1.5" design storm?
	(C) Structural Stormwater Control Design and Specifications The permit registrant must provide a description of all allowable structural stormwater controls including site-specific design requirements, design requirements that do not inhibit maintenance, conditions where each control applies, and operation and maintenance standards for each control. The permit registrant must identify conditions where the implementation of green infrastructure or equivalent approaches may be impracticable. A permit registrant may adopt specifications created by another entity that complies with this requirement.	PWDS 2.012 (D) includes conditions where use of an onsite facility may be impractical (requires more than 10% of the surface area of the site), and includes a hierarchy based on prioritizing vegetated facilities. PWDS 2.0620 lists measures for impervious surface reduction which are porous pavement and ecoroofs. PWDS 2.063 provides detailed design requirements for vegetated stormwater facilities including facility geometry, slope, plumbing, soil amendment/mulch and planting requirements. PWDS 2.1030 provides O&M standards for each facility.	PWDS 2.012 PWDS 2.0620 PWDS 2.1030	Prioritization and definition of LID/GI for treatment is not clearly described in the stormwater hierarchy discussion in PWDS 2.012(D). The requirements for runoff discharged offsite for treatment facilities are based on a specified water quality design flow.	Needs improvement.	Prioritization and definition of LID/GI for treatment is not explicitly clear as written in the current stormwater hierarchy. Does the City feel they need to prioritize vegetated stormwater facilities, if infiltration is already proposed? Should this hierarchy be simplified and more explicitly address LID/GI?

Table A-1. Post-Construction Design Standards Gap Analysis

	Requirement from the NPDES Phase II General Permit	Current Status with Respect to Addressing the Requirement	Manual and/or Code Reference	Identified Gaps	Comparison to NPDES Phase II Requirements	Outstanding Policy Considerations
	(D) Allowance for Alternative Compliance The permit registrant may allow alternatives for projects to comply with the retention requirement at a project site based on factors of technical infeasibility or site constraints. Such feasibility or constraint factors may include, but are not limited to, shallow bedrock, high groundwater, groundwater contamination, soil instability as documented by geotechnical analysis, or a land use that is inconsistent with capture, reuse and/or infiltration of stormwater. The determination that full compliance cannot be achieved at the project site must be based on review criteria considering multiple factors and cannot be based solely on the difficulty or cost. For project sites requesting alternative compliance, the permit registrant must require and subsequently review the written technical justification as to evaluate the technical infeasibility or site constraints, which prevent the onsite management of the runoff amount stipulated in the stormwater retention requirement or a portion thereof. Where alternative compliance is utilized, runoff must comply with the treatment standard. The written technical justification must be in the form of a site-specific hydrologic or design analysis conducted and endorsed by an Oregon registered Professional Engineer or Oregon Certified Engineering Geologist. If the permit registrant agrees that alternative compliance with the retention requirement is necessary, the permit registrant must require that the site operator use one or more of the stormwater mitigation options outlined in the Stormwater Mitigation Options below.	The PWDS allows stormwater to be managed more locally and sized to manage the 10-year storm event. Requirements for onsite infiltration/retention of the 10-year storm event on-site without overflow is required unless the site demonstrates a specific condition (i.e site on fill, steep slopes, season high groundwater, contaminated soils, high-risk areas). In areas where water cannot be fully infiltrated/retained on-site (which is defined as retaining the 10-year event without overflow), stormwater shall be managed following the hierarchy in PWDS 2.0120 (D). In areas where one of the special conditions listed deems infiltration infeasible, water quality treatment (filtration) using vegetated facilities shall be maximized. Demonstrating that full retention/infiltration is infeasible requires providing site-specific infiltration test results.	PWDS 2.0120 (B) and PWDS 2.0120 (D)	None.	Meets minimum requirements.	
	(E) Stormwater Mitigation Options Before allowing alternative compliance with the retention requirement, the permit registrant must establish stormwater mitigation options for alternative compliance, including institutional standards and management systems to value, estimate, and account for how these mitigation projects retain the unmet volume of the stormwater specified in this retention requirement. The mitigation project or site must be within the same subwatershed as the site undergoing development. Stormwater mitigation options must include one or more of the following for alternative compliance: 1. Offsite Mitigation Offsite mitigation includes meeting the retention requirement at another location, the use of a stormwater mitigation bank program, or the use of stormwater payment-in-lieu program. 2. Groundwater Replenishment Projects Groundwater replenishment projects include implementing a project that the permit registrant has determined to provide an opportunity to replenish regional groundwater supplies. 3. Treatment Equivalent to the Retention Requirement Treatment Equivalent to the retention requirement establishes treatment requirements that attain the equivalent water quality benefits as onsite retention of stormwater from new development or redevelopment sites using a continuous simulation hydrologic model or other evaluation tool.	PWDS 2.0120 (D) provides a detailed stormwater management hierarchy that allows for stormwater mitigation options, including off-site mitigation.	PWDS 2.0120 (D)	None.	Meets minimum requirements.	The ability to allow for off-site mitigation depends on the identification of regional facilities to support the development as described above. Consider the need to define onsite vs offsite facilities.
v.	Post-Construction Site Runoff Plan Review					
	The ordinance or other regulatory mechanism must include procedures for the permit registrant's review and approval of structural stormwater control plans for new development and redevelopment projects. At a minimum, the permit registrant must review and approve plans for structural stormwater controls at new development and redevelopment sites that result from a land disturbance of one or more acres (or that disturb less than one acre, if it is part of a "common plan of development or sale" disturbing one or more acres); and sites that use alternative compliance to meet the retention requirement, before the start of the project. The permit registrant must review plans for consistency with the ordinance/regulatory mechanism and specifications required by Schedule A.3.e.vi. The permit registrant must not approve or recommend for approval any plans for structural controls that do not meet minimum requirements to meet Schedule A.3.e.iv and Schedule A.3.e.vi.	In order to demonstrate compliance with stormwater requirements in the PWDS, the following forms, plans or information are required to be included in the permit application and will vary depending on if the simply method or engineering method is applied: EPSC Plan, Simple Sizing Form, Drainage Plan, Stormwater Report, Infiltration Testing, Facility Planting Plan, and O&M Plan.	PWDS 2.0240	None.	Meets minimum requirements.	Does the existing list of items required to be submitted on a new project sufficient for the City?
vi.	Long-Term Operation and Maintenance (O&M)					
	The permit registrant must maintain an inventory and implement a strategy to ensure that all stormwater controls are operated and maintained to meet the site performance standard in Schedule A.3.e.iv. This strategy must, at minimum, include the following:	N/A - See below	N/A - See below	N/A - See below	N/A - See below	

Table A-1. Post-Construction Design Standards Gap Analysis

	Requirement from the NPDES Phase II General Permit	Current Status with Respect to Addressing the Requirement	Manual and/or Code Reference	Identified Gaps	Comparison to NPDES Phase II Requirements	Outstanding Policy Considerations
	(A) Legal authority allowing the permit registrant to inspect and require effective operation and maintenance of privately owned and operated stormwater controls.	For stormwater facilities on a private parcel shall be privately owned and maintained. City staff may periodically inspect facility/structures and require a private owner to conduct maintenance to ensure the facility is still providing the water quality, conveyance, flow control and/or retention/detention function as designed. Stormwater facilities treating multiple private parcels shall be public. Publicly or privately financed projects constructed within the public ROW, or on parcels deeded for public ownership, shall be maintained following the 2-year warranty period. City inspectors will inspect stormwater facilities (structures and vegetation) at the end of 2-year warranty period. The City will provide inspection and some general maintenance (e.g. sediment and garbage removal) during the warrantee period, but because maintenance related to weeds, soil, mulch and plant pruning might affect the survival of plants. City personnel will not perform maintenance activities, or arrange for contractor-performed maintenance, during the 2-year warranty period unless the developer has entered into an agreement to compensate the City for taking on this work.	PWDS 2.1010, PWDS 2.2025	None.	Meets minimum requirements.	Maintenance responsibility as outlined in PWDS 2.1010 appears inconsistent with the City ownership distinctions in 2.012. Current maintenance responsibilities seem inconsistent with current practices. Specifically, that facilities managing multiple private parcels are public; privately financed projects adhere to a two year warranty period and then become public; and shared maintenance responsibilities between public and adjacent property owners. Inclusion of these guidelines will not be relevant if the City has not adopted that definition of public and private facilities. Is the City's current O&M inspection program working well? Are their additional items that should be added to the PWDS on this topic?
	(B) Inspection procedures and an inspection schedule ensuring compliance with the O&M requirements of each stormwater control operated by the permit registrant and by other private entities.	PWDS 2.1030 includes maintenance schedule requirements.	PWDS 2.1030	None.	Meets minimum requirements.	
	(C) A tracking mechanism for documenting inspections and the O&M requirements for each stormwater control. This tracking mechanism must document enforcement actions and compliance response. For stormwater controls that include vegetation, the O&M requirements must at minimum include requirements to maintain and/or replace vegetation to ensure the functionality of this control. For stormwater controls that include soils in the treatment process, O&M requirements must at minimum include requirements to maintain soil permeability.	Per PWDS 2.1010, private facilities constructed using standard facility design criteria don't need to create an O&M Plan or record a form. Only facilities without standard maintenance activities need to create an O&M Agreement (which includes the Form, Drainage Plan, and O&M Plan) for record with the County. Per PWDS 2.1030, all facility operators are required to keep an inspection and maintenance log. The log must include a record date, description, and contractor (if applicable) for all repairs, landscape maintenance, and facility cleanout activities. Keep work orders and invoices on file and make available upon request of the City inspector. PWDS 2.1030 - Facility specific maintenance activities - includes specific maintenance indicators, associated corrective action and annual maintenance schedule.	PWDS 2.1010 and 2.1030	Documentation regarding a tracking mechanism for documenting enforcement actions and compliance was not provided.	Needs improvement.	Without a mandatory O&M Agreement being submitted with *each* facility (not just those that don't follow standard facility design requirements), how is the City tracking private maintenance responsibilities? Following up on maintenance activities? How are owners to know what their requirements are? Does the City want to address enforcement in the PWDS? If so, policies regarding enforcement and inspection procedures regarding long term operation and maintenance will need to be addressed. The PWDS language regarding maintenance for drywells, soakage trenches, and infiltration vaults does not directly align with DEQ requirements for UICs. The City should consider a seperate documentation to outline maintenance requirements for private UICs (meeting rule authorization criteria) and public UICs (subject to the WPCF permit). Considerations include: (1) Private UICs (that obtain a permit and rule authorization) and are considered high risk ("High Risk" means surfaces that experience over 1,000 trips per day (TPD) or have commercial/industrial facilities that use hazardous materials and toxic chemicals) require twice yearly maintenance. (2) Public UICs subject to WPCF Permit requirements also require monthly sweeping from January to September; 2x month sweeping October to December; annual catch basin inspections; and catch basin cleaning when sediment levels reach a certain threshold.
	(D) Reporting requirements for privately owned and operated stormwater controls that document compliance with the O&M requirement in Schedule A.3.f.	Inspection and Maintenance logs are required for all stormwater facilities	PWDS 2.1030	None.	Meets minimum requirements.	
	(E) The location of all public and private stormwater controls installed in compliance with this permit must be included with the MS4 Map.	Procedural	There is no current stormwater facilities map or link to mapping in the PWDS.			
vii.	Training and Education					
	The permit registrant must ensure that staff responsible for performing post-construction runoff site plan reviews, administrating the alternative compliance program, or performing O&M practices or evaluating compliance with long-term O&M requirements are trained or otherwise qualified to conduct such activities.	Procedural	N/A	N/A	N/A - See below	N/A
	The permit registrant must provide orientation and training to all new staff working to implement the post-construction runoff control program within 30 days of their assignment to this program. All staff must receive training at least once during the permit term. Permit registrant must provide follow-up training as procedures and/or technology utilized in this program change.	Procedural	N/A	N/A	N/A	N/A
viii.	Tracking and Assessment					
	The permit registrant must maintain records for activities to meet the requirements of the Post-Construction Site Runoff program requirements and include a descriptive summary of their activities in the corresponding Annual Report.	Procedural	N/A	N/A	N/A	N/A

Table A-2. Construction Design Standards Gap Analysis

City of Scappoose - Stormwater Master Plan
Created by J. Christofferson of Brown and Caldwell
Reviewed by A. Wieland
Includes input from M. Kohlbecker of GSI Water Solutions received on 12/29/20.

Note: The City of Scappoose, Oregon is not a Phase II Permittee. However, BC has reviewed the City's draft Public Works Standards in the context of the Phase II Permit to help identify outstanding policy considerations.

	Requirement from the Phase II Permit	Current Status with Respect to Addressing the Requirement's of the Phase II Permit	Manual and/or Code Reference	Identified Gaps	Comparison to NPDES Phase II Requ	Outstanding Policy Considerations
i.	**Implementation Dates**					
	Existing Registrants No later than February 28, 2023, Existing Registrants must implement all of the required components described in Schedule A.3.d.ii-ix.	Not Applicable = N/A	N/A	N/A	N/A	N/A
ii	**Ordinance and/or Other Regulatory Mechanism**					
	Through ordinance or other regulatory mechanism, to the extent allowable under state law, the permit registrant must require erosion controls, sediment controls, and waste materials management controls to be used and maintained at all qualifying construction projects from initial clearing through final stabilization to reduce pollutants in stormwater discharges to the MS4 from construction sites. The permit registrant must require construction site operators to complete and implement an Erosion and Sediment Control Plan (ESCP) for construction project sites that results in a minimum land disturbance of: (A) For Large Communities, 7,000 square feet or more; and (B) For Small Communities, 10,890 square feet (a quarter of an acre) or more. Note - Scappoose would be defined as small community until they hit a population of 10,000 people. 2019 population was 7,564 (https://www.census.gov/quickfacts/scappoosecityoregon). The permit registrant must use appropriate enforcement procedures and actions to ensure compliance with Schedule A.3.d.ii-vi.	Public Works Design Standards (PWDS) 2.0110 requires: 1. Erosion and prevention control on all land-disturbing activities, regardless of whether that property is involved in a construction or development activity. 2. Construction activities disturbing 1,000 square feet or more will be subject to EPSC inspection procedures. 3. Construction sites disturbing more than one acres or are part of a common plan of development that will ultimately disturb one or more acres are required to obtain a DEQ 1200-C Construction Stormwater Permit. Note: The City does not currently have an Erosion Control Permit per City comments in draft PWDS.	PWDS 2.0110	N/A	Needs improvement.	Although the threshold for requiring an erosion and sediment control inspections is less than the regulatory threshold (10,890 sq. ft.), it is unclear how an ESCP is submitted for sites < 1 acre. Consider an alternative (more local) source for ESC BMPs.
iii	**Compliance with Other NPDES Permits**					
	For construction projects that disturb one or more acres (or that disturb less than one acre, if it is part of a "common plan of development or sale" disturbing one or more acres), the permit registrant must refer project sites to DEQ, or the appropriate DEQ agent, to obtain NPDES Construction Stormwater Permit coverage. The NPDES Construction Stormwater General Permit requirements are in addition to the permit registrant's construction site runoff control requirements identified in this permit (Schedule A.3.d.iv).	Construction activities disturbing 1,000 square feet or more will be subject to EPSC inspection procedures. Construction sites disturbing more than one acres or are part of a common plan of development that will ultimately disturb one or more acres are required to obtain a DEQ 1200-C Construction Stormwater Permit. The standard for all land in Scappoose is that sediment must not leave a site.	PWDS 2.0110	None.	Meets minimum requirements.	
iv.	**Erosion and Sediment Control Plans**					
	The permit registrant must maintain written specifications that address the proper installation and maintenance of such controls during all phases of construction activity occurring in their coverage area. At a minimum, the written specifications must include an ESCP template, worksheet or similar document (henceforth referred to as Erosion and Sediment Control Plan or ESCP) for construction site operators to document how erosion, sediment, and waste material management controls will be implemented at the construction project site. At a minimum, through ordinance or other regulatory mechanism the permit registrant must:	The Erosion and Sedimentation Control Plan (ESCP) requirements is a list of items that must be checked off as provided in the Erosion and Sediment Control Plan. This checklist is a required component of the ESCP submission. The plans must include 1) Preserve Vegetation/Mark Clearing Limits 2) Construction Entrance Protection 3) Perimeter Control 4) Storm Drain Inlet Protection 5) Soil and Slope Protection 6) Control Runoff (may not apply for Single-Family/Duplex Sites 7) Sediment Containment and Removal (not applicable for Single-Family/Duplex Sites) 8) Soil Stockpile Management (may not apply for Single-Family Duplex Sites 9) Construction Site Pollution Prevention. The Clear Water Services Erosion Prevention and Sediment Control Planning and Design Manual contains details on what needs to be included in the EPSC plan and BMPs to address the minimum requirements above.	PWDS 2.0240 (A)	None.	Meets minimum requirements.	Confirm that the ESC BMPs per the CWS Erosion Prevention and Sediment Control Planning and Design Manual meets the City's needs and intent.
	(A) Provide the construction site operator an Erosion and Sediment Control Plan template prior to beginning construction/land disturbance;	An ESCP Template is not included in the PWDS.	None.	An ESCP template is not included in the	Needs improvement.	Does the City want to provide a ESCP template? Or is continuing to reference the CWS Manual for erosion control sufficient? The CWS Manual has well developed erosion control standards and BMP details.
	(B) Require construction site operator to complete a site-specific Erosion and Sediment Control Plan prior to beginning construction/land disturbance;	An erosion and sediment control plan is required prior to any ground clearing activity or work being conducted on site. The EPSC plan must be submitted and approved by the City.	PWDS 2.0240 (A)	None.	Meets minimum requirements.	
	(C) Require the Erosion and Sediment Control Plan be maintained and updated as site conditions change, or as needed; and	Explicit requirements to maintain and update plans are not included in the PWDS.	N/A	Explicit requirements to maintain and update plans are not included in the ESCP	Needs improvement.	Does the City want to add explicit requirements in the PWDS to have ESCP maintained and updated as things change onsite?
	(D) Require Erosion and Sediment Control Plans to be kept on site and made available for review by the permit registrant, DEQ, or another administrating entity	Explicit requirements to retain plans onsite and make plans available are not included in the PWDS.	N/A	Explicit requirements to retain plans onsite and make plans available are not included in the PWDS.	Needs improvement.	Does the City want to add explicit requirements in the PWDS to be keep ESCP Plans on site and made available for review by the permit registrant, DEQ, or another administrating entity?
	The Erosion and Sediment Control Plan must, at a minimum consist of sizing criteria, performance criteria, design specifications, and guidance on selection and placement of controls, and specifications for long term operation and maintenance, including appropriate inspection interval and self-inspection checklists for use by the construction site operator.	The plans must include 1) Preserve Vegetation/Mark Clearing Limits 2) Construction Entrance Protection 3) Perimeter Control 4) Storm Drain Inlet Protection 5) Soil and Slope Protection 6) Control Runoff (may not apply for Single-Family/Duplex Sites 7) Sediment Containment and Removal (not applicable for Single-Family/Duplex Sites) 8) Soil Stockpile Management (may not apply for Single-Family Duplex Sites 9) Construction Site Pollution Prevention. The PWDS references the Clean Water Services Erosion Prevention and Sediment Control Plan and Design Manual that includes details on BMPs and the EPSC Plan requirements that meet the requirements of the Permit.	PWDS 2.0240 (A)	None.	Meets minimum requirements.	
v.	**Erosion and Sediment Control Plans Review**					
	At a minimum, the permit registrant must review Erosion and Sediment Control Plans from construction projects that will result in land disturbance of one or more acres (or that disturb less than one acre, if it is part of a "common plan of development or sale" disturbing one or more acres) using a checklist or similar document to determine compliance with the ordinance or other regulatory mechanism required. Erosion and Sediment Control Plan review procedures must include consideration of the construction activities' potential water quality impacts, and, in accordance with applicable state and local public notice requirements.	Procedural	NA	NA	NA	N/A

Table A-2. Construction Design Standards Gap Analysis

	Requirement from the Phase II Permit	Current Status with Respect to Addressing the Requirement's of the Phase II Permit	Manual and/or Code Reference	Identified Gaps	Comparison to NPDES Phase II Requ	Outstanding Policy Considerations
vi.	Construction Site Inspections					
	The permit registrant must inspect construction sites to ensure compliance with Schedule A.4.d.iii-iv.	Procedural	NA	NA	NA	
	(A) Minimum Triggers for Inspection. At a minimum, the permit registrant must inspect construction sites if: 1) The construction activity will result in land disturbance of one or more acres (or that disturb less than one acre, if it is part of a "common plan of development or sale" disturbing one or more acres). Each site must be inspected at least once during the permit term; 2) Sediment is visible or reported in stormwater discharge or dewatering activities from the construction site; or 3) A complaint or report is received. At minimum, the permit registrant must respond to the initial complaint if more than one report or complaint is received.	Procedural	NA	NA	NA	N/A
	(B) Minimum Inspection Documentation Requirements. If the permit registrant inspects a construction site, at a minimum the site inspection must include and document the following: 1) A review and evaluation of the ESCP to determine if the described control measures were installed, implemented and maintained properly; 2) An assessment of the site's compliance with the permit registrant's ordinances or requirements, including the implementation and maintenance of required control measures; 3) Visual observations and documentation of any existing or potential nonstormwater discharges, illicit connections, and/or discharge of pollutants from the site. Documentation of recommendations to the construction site operator for follow-up; 4) If necessary, education or instruction provided to the construction site operator related to additional stormwater pollution prevention practices to comply with the approved ESCP; and 5) A written or electronic inspection report, including documentation of all necessary follow-up actions (i.e., re-inspection, enforcement) to ensure compliance with their applicable requirements.	Procedural	NA	NA	NA	N/A
	(C) Inspection Requirements for Existing Large Communities In addition to Schedule A.3.d.vi.A, existing Large Communities must inspect at least 25% of the qualifying new construction sites that disturb less one at least once during the permit term to ensure compliance with the site's ESCP.	Procedural	NA	NA	NA	N/A
vii.	Enforcement Procedures					
	The permit registrant must develop, implement and maintain a written escalating enforcement and response procedure for all qualifying construction sites. The procedure must address repeat violations through progressively stricter response, as needed, to achieve compliance. The escalating enforcement and response procedure must describe how the permit registrant will use enforcement techniques to ensure compliance. The enforcement procedures must include timelines for compliance and, when formulating response procedures, must consider factors such as the amount of pollutant discharged, the type of pollutant discharge, and whether the discharge was intentional or accidental. For Existing Registrants, the escalating enforcement procedure must be submitted with the third Annual Report. New Registrants must submit the escalating enforcement procedure by September 1, 2023.	The PWDS's Construction Erosion and Sediment Control language does not address enforcement.	PWDS	No existing enforcement language for Construction Erosion and Sediment Control components of the PWDS.	No.	Does the City want to address enforcement of Construction Erosion and Sediment Control components of the PWDS with a series of escalating violations for noncompliance? Consider policies around repeat violations, deadline for remediation and consideration of factors such as the amount of pollutant discharged.
viii.	Construction Runoff Control Training and Education					
	The permit registrant must ensure that all staff responsible for ESCP reviews, site inspections, and enforcement of the permit registrant's requirements are trained or otherwise qualified to conduct such activities. The permit registrant must provide orientation and training to all new staff working to implement the Construction Runoff Control program within 30 days of their assignment to this program. The permit registrant must be properly trained and knowledgeable in the technical understanding of erosion, sediment, and waste material management controls to conduct such ESCP reviews and inspections. All staff must receive training at least once during the permit term. The permit registrant must provide follow-up training as procedures and/or technology utilized in this program change.	Procedural	NA	NA	NA	
ix.	Tracking and Assessment					
	The permit registration must track implementation of Construction Site Runoff program's required activities. In each corresponding Annual Report, the permit registrant must assess their progress toward implementing the Construction Site Runoff program's control measures.	Procedural	NA	NA	NA	

Cells shaded in this color indicate that the requirement in the permit is not one that is typically addressed in code or standards. The City's plan to meet these requirements should be covered in their Stormwater Management Plan.

Table A-3. UIC-related Design Standards Review

City of Scappoose - Stormwater Master Plan
Created by J. Christofferson of Brown and Caldwell
Reviewed by A. Wieland
Includes input from M. Kohlbecker of GSI Water Solutions received on 12/29/20.

Last Updated 1/4/2021
Note: The City of Scappoose, Oregon is not a Phase II Permittee. However, BC has reviewed the City's draft Public Works Standards in the context of the Phase II Permit to help identify outstanding policy considerations.

	Miscellaneous Stormwater Topics	Manual and/or Code Reference	Current Draft Proposed Language	Proposed Language Change from GSI (see underline or strikethrough)	Policy Considerations/ Notes
i.	**Infiltration Testing**				
	Infiltration testing is required for any project proposing to use the Engineered Method. Sites using the Simple Sizing Form can use the assumed infiltration rates based on the hydrologic soil type. It is recommended, but not required, that projects following the Simple Method that will be adding more than 10,000 sf of impervious perform an infiltration test. An infiltration test is also required for sites trying to demonstrate that on-site infiltration is infeasible per section 2.0120.B.	PWDS 2.024 (F)	An infiltration test data form is included at the end of this section. The most reliable infiltration rates are determined using either the falling head percolation test procedure (Design Manual – Onsite Wastewater Treatment and Disposal Systems, EPA 1980) or the double ring infiltrometer test (ASTM D3385), and follow the following guidance:	N/A	Scappoose is unique in that they reference the EPA (1980) and ASTM D3385 methods directly; most municipalities develop an infiltration testing approach that is based on these methods. The reason most municipalities take this approach is that they avoid the nuances of each method. For example, EPA (1980) and ASTM D3385 allow the engineer to use his/her judgement about the duration of the length of the presoak period. Most City standards will simply specify a presoak period of 4 hours, regardless of whether is it necessary or not. It is easier to review whether presoak was conducted for 4 hours than whether the engineer's judgement was correct. The City should be comfortable deferring to the engineer's judgement on the particulars of each test (as referenced in the methods) if they aren't specifying their own protocols.
		PWDS 2.0240.(F).b	b.☐All infiltration test measurements shall be made during the period when groundwater level is expected to be at its maximum.	Remove this requirement.	Recommend deleting. This is not practical because infiltration tests could only be performed from February to May. This requirement is not common in other PW standards.
		PWDS 2.0240.(F).d	d.☐The test shall be made at the bottom elevation of the proposed facility;	d. For surface infiltration facilities, the test shall be made at the bottom elevation of the proposed facility, and for drywells, the test shall be made at the depth horizon that is targeted for infiltration ;	Text added for clarity because for drywells, the goal is to test a geologic layer which may not correspond with the total depth of the drywell.
		PWDS 2.0240.(F).e	e. The test hole or apparatus must be maintained at depths above the test elevation for a period not less than 4 hours to establish saturated conditions.	e.☐~~The~~ Water must be maintained in the test hole or apparatus ~~must be maintained~~ at a depth and for a duration that is ~~above the test elevation~~ specified by the method in EPA (1980) or ASTM D3385 ~~for a period not less than 4 hours to establish saturated conditions~~.	Note that EPA (1980) and ASTM D3385 specify a depth and duration; and we risk contradicting these documents if we specify depth and duration here.
	Infiltration Test Data Form	PWDS 2.0240.(H)	N/A	The columns for "measurement" and "drop in water level" should be measured in inches as opposed to feet.	Inches and not feet are a more common measure of change.
ii.	**Stormwater Quality Treatment - Applicability**				
	The table below (Table 7) shows stormwater facility applicability by impervious surface type. Facilities in green are options the City prefers. Yellow facilities may also be proposed but may require approvals or additional pre-treatment (e.g. drywell being used for non-roof runoff). Red facilities are allowed, but Stormwater Report must detail rationale for proposing these facilities.	PWDS 2.0610 (Table 7)	Table 7, footnote 2. Stormwater generated from anything other than residential roof area must be pre-treated with more than a silt basin, and also needs to be registered with DEQ . The surface vegetated facilities in section 2.0630 are typically deemed adequate pre-treatment.	Table 7, footnote 2. Stormwater generated from anything other than single-family or small multi-family (up to two attached units) residential roof area must be pre-treated with more than a silt basin, and also needs to be registered with DEQ . The surface vegetated facilities in section 2.0630 are typically deemed adequate pre-treatment.	Text added to align this footnote with language in 2.0640
ii.	**Subsurface Infiltration Facilities - Applicability**				
	Drywells, soakage trenches, and infiltration vaults/chambers are considered to be Underground Injection Control (UIC) devices, which are regulated by DEQ. Owners or operators of new and existing public or private UICs are required to register and provide site inventory data to DEQ.	PWDS 2.0640 (A), PWDS 2.0640 (B), PWDS 2.0640 (C)	Public Works Design Standards (PWDS) 2.0640 (A): Drywells, Applicability: ....All public and private drywells need to meet DEQ's rules authorization standards, which requires a minimum of 5 feet of vertical separation between the bottom of the drywell and seasonal high groundwater. PWDS 2.0640 (B): Soakage Trench, Applicability: ...All soakage trenches need to meet DEQ's rules authorization, which requires a minimum of 5 feet of vertical separation between the bottom of the trench and seasonal high groundwater. PWDS 2.0640 (C): Infiltration Trench, Applicability: ...Infiltration vaults need to meet DEQ's rules authorization, which requires a minimum of 5 feet of vertical separation between the bottom of the trench and seasonal high groundwater.	Public Works Design Standards (PWDS) 2.0640 (A): Drywells, Applicability: ....All public and private drywells need to meet DEQ's rules authorization or WPCF permit standards~~, which requires a minimum of 5 feet of vertical separation between the bottom of the drywell and seasonal high groundwater.~~ PWDS 2.0640 (B): Soakage Trench, Applicability: ...All soakage trenches need to meet DEQ's rules authorization or WPCF permit standards, ~~which requires a minimum of 5 feet of vertical separation between the bottom of the trench and seasonal high groundwater.~~ PWDS 2.0640 (C): Infiltration Trench, Applicability: ...Infiltration vaults need to meet DEQ's rules authorization or WPCF permit standards, ~~which requires a minimum of 5 feet of vertical separation between the bottom of the trench and seasonal high groundwater.~~	DEQ rules require that UICs meet rule authorization standards OR WPCF permit standards. What if a UIC owner cannot meet rule authorization standards (requiring the 5' of seperation), but meets DEQ's WPCF permit standards? The suggested edit addresses this possibility.
iii.	**Subsurface Infiltration Facilities - Setbacks**				
	Infiltration vaults are typically a horizontal perforated pipe, or proprietary open-bottomed corrugated plastic stormwater chamber which provides a temporary subsurface storage area for stormwater before it infiltrates. Most of these devices are made of high-density polypropylene or polyethylene (HPDE) installed in a rock trench that is a hybrid between a drywell and a soakage trench. Infiltration vaults are typically 10 feet on center from all foundations and 5 feet from property lines.	PWDS 2.0640 (C)	PWDS 2.0640 (C): Infiltration Vault, Setbacks: Infiltration vaults are typically 10 feet on center from all foundations and 5 feet from property lines. The bottom of the drain rock must be a minimum of 5 feet from permanent groundwater.	PWDS 2.0640 (C): Infiltration Vault, Setbacks: Infiltration vaults are typically 10 feet on center from all foundations and 5 feet from property lines. The bottom of the drain rock must be a minimum of 5 feet from ~~permanent~~ seasonal high groundwater to meet DEQ rule authorization requirements.	Edits reflect consistency with rule authorization criteria.
iv.	**Drywell Capacity Testing**				
	Drywell capacity testing is proposed before paving occurs.	PWDS 2.0640 (A)	PWDS 2.0640 (A): Testing: Testing - All newly constructed stormwater drywells (sumps) shall be tested prior to paving in order to determine their in-place capacity. Testing of both new and existing drywells shall follow the procedure outlined below: a.☐Fill sump with water at an initial rate equivalent to the minimum required flow rate for the sump, or 300 GPM, whichever is less, and record the water surface elevation below the sump rim after 5 minutes. Maintain the initial flow rate, recording the water surface elevation every five minutes until it stabilizes. b.☐After the water surface elevation stabilizes, increase the flow rate by 300 GPM and record the water elevation as in step 1.	N/A	Need to ensure that City fire hydrants can produce a rate of 300 GPM for testing. Consider adjusting language to say : " . . . or until maximum water source capacity is reached"?

Appendix B: Project Planning Background

Table B-1. Problem Area and Modeling Needs Matrix

Location ID	Location Description	Reported Deficiency[1]	City Problem Description	Associated UIC Issue? Y = Yes P= Possible	Associated CIP (per the 1998 MP)?	Site Visit Notes (9/2/20)	Workshop Notes (10/13/20)	Potential CIP (Project)	Potential CIP (Program)[2]	Hydraulic Modeling Needed[3]	WQ Retrofit Opportunity (by Strategy)			Source
											UIC	Green Street	Regional	
1	SE 6th/SE Vine	**R/R** Cap WQ	Roadway flooding: 4 catch basins serving as drywells do not drain well and allow road to flood. Poor drywell operation.	Y - Multiple UICs do not drain well in the area. UICs #32, #33, and #29 report 6", 3", and 2" of standing water, respectively, at this location. These locations are open bottom catch basins.	Vine Street SD System - New storm pipeline to provide SD service to new and existing development north and south of Vine Street east of 4th St.	9-2 (afternoon) - UICs (catch basins) in this location are failing. UIC may require rehab such as cleaning and updating with pretreatment. Need to make sure any storm projects are coordinated with transportation/roadway projects. Use of UICs appears feasible in location.	Programmatic approach for UIC installation with minor drainage improvements. Drywells are open-bottom CBs and need maintenance or replacement.		Minor Localized Drainage Improvements, or UIC Retrofit Program		X			D. Nassimbene Survey
2	SW 4th/SW Maple	**Infra** WQ	A drain with poor performance floods during rain events. Unclear if a UIC or lack of pipe/ infrastructure is causing the localized flooding.	P-UIC #39 reports 3" of standing water at this approximate location.		9-2 (morning) - This is a low spot at the intersection that collects a relatively small area. Potential for planter/swale along 4th and or Maple to infiltrate and decommission existing UIC. No surrounding collection system. Cars often are parked along 4th street so this needs to be considered. Other options include piping to the creek or replacing the UIC with a new one and providing pretreatment. Ground water depth may be an issue.	Phased approach to installation of a surface facility to collect and infiltrate runoff, with potential to install a new conveyance system down Maple. No net development anticipated in the area. Soils are poor for infiltration. Adequate ROW for a facility is a concern. Football field flood periodically.		Minor Localized Drainage Improvements, or UIC Retrofit Program		X	X		D. Nassimbene Survey
3	SE Elm/Endicot	**Cap** WQ	Roadway flooding: catch basin does not drain (French drain). This area also will receive future development flows, and only the Casswell Subdivision includes retention (detention). Other developments provide WQ but no detention. Discharges to SDIC (100-year issues).		Elm Street SD System - New storm pipeline to provide SD service to new and existing development north and south of Elm Street east of 4th St.	9-2 (afternoon) – Existing French drain has failed. Localized flooding impacting several homes. Existing pipe in Elm could be extended to 4th to pick up drainage in the area. The existing pipe in Elm may be undersized currently and likely needs to be upsized to the outfall. Roadway improvements may be needed to included curb/gutter to collect roadway runoff in this area. Need to confirm with City whether analysis to the 100-year is required.	Yes Category 1–Model existing pipe to outlet. New pipe to 4th St A previous model determined that the main along Elm is undersized (this is supported by anecdotal evidence). Regional facility in the area does not have adequate capacity to support increased development. Future development expected to add capacity need.	Yes		Y - Category 1			X (Possible)	D. Nassimbene Survey Chris–CIP Opp Area #10
4	SE 5th/SE High School Way	**Infra** WQ	No infrastructure results in standing water. Suggestion to install swale from SE High School Way to SE Rose to limit flooding. Available public property or ROW. Solution may include WQ.			9-2 (afternoon) – A 'natural' roadside swale collects runoff and the swale ends at 5th Street where a pond forms during wet weather. There is currently nowhere for the water to go. Upstream deficient UIC contributes to roadway flooding. Need to verify the ROW in this area to ensure this is public space.	Yes Category 1–model ditch. Modeling the ditch along H.S. Way to see if capacity is adequate to convey flow to system along 6th would be helpful. Swale along H.S. Way is a possibility, or potentially drywells in the area.	Yes		Y - Category 1	X	X		D. Nassimbene/ T. Jadrnak Survey
5	NE 1st St	**Infra**	No infrastructure results in standing water.			NA–Confirm problem source and need	Programmatic approach for UIC installation with minor drainage improvements.		Minor Localized Drainage Improvements		X			D. Nassimbene Survey

1 Legend: R/R=Repair and Replacement; Infra = Infrastructure Need (New); Cap = Capacity Issue; Maint = Chronic Maintenance Problem; WQ = Lack of water quality treatment. BOLD font indicates the mapped deficiency per Table A-1.

2 Programmatic activities are being defined. The UIC Retrofit Program refers to the addition of pretreatment in support of existing UIC facility installations. Minor Localized Drainage Improvements refers to the installation of limited infrastructure (including UICs) to support stormwater collection and conveyance. The Expanded Facility Maintenance Program refers to an increase frequency or coverage of activities for select existing infrastructure. Outfall Rehab refer to the increased inspection frequency and sock installation for outfalls discharging to steep slopes.

3 Category 1 refers to hydraulic modeling of existing infrastructure. Category 2 refers to hydraulic modeling of new or proposed infrastructure.

Table B-1. Problem Area and Modeling Needs Matrix

Location ID	Location Description	Reported Deficiency[1]	City Problem Description	Associated UIC Issue? Y = Yes P= Possible	Associated CIP (per the 1998 MP)?	Site Visit Notes (9/2/20)	Workshop Notes (10/13/20)	Potential CIP (Project)	Potential CIP (Program)[2]	Hydraulic Modeling Needed[3]	WQ Retrofit Opportunity (by Strategy)			Source
											UIC	Green Street	Regional	
6	NW EJ Smith and NW 1st Street	**Cap** WQ	**Existing pipe is likely undersized and lots adjacent to road that tie into existing infrastructure will cause additional flooding or surcharge.**			9-2 (morning) It was suggested by city staff the pipe in NW 1st and EJ Smith should be modeled to determine its capacity so when development occurs in this area the conveyance capacity is known and decisions can be made based on that.	**Yes Category 1–model pipe along 1st.** Urban Renewal renewal program in place for area–could support street-level LID improvements. Significant development expected. City not currently collecting SDCs in this area, undersized pipe could justify this.	Yes		Y - Category 1		X		D. Nassimbene Survey Chris–CIP Opp Area #7
7	NE 2nd from Prairie to Laurel and surrounding area between NE Williams and E Columbia	**Infra** WQ	No infrastructure results in standing water.		Sawyer Street SD System - New storm pipelines to serve existing developed northeast area that has unreliable or failing dry wells.	NA–Confirm problem source and need	Programmatic approach for UIC installation with minor drainage improvements.		Minor Localized Drainage Improvements		X			D. Nassimbene Survey
8	NE Sunset Loop	**Cap** Infra WQ	System surcharging. Open channel: shallow, does not drain properly, floods during sustained rain.	P - UIC #3 and #4 are in the area and report standing water. UIC #50 is nearby and likely has standing water.		9-2 (afternoon) - UICs do not infiltrate, roadway and driveways flood. A 'path' to the north has been constructed to allow flood waters to drain to Miller city park where it is collected and conveyed east to the Heron Meadows system. Solution could include new pipe to collect runoff with two route options; build new conveyance east to NE Egret Ln or to Miller Road then to E Columbia. The UIC in Miller Road is not functioning well so the latter may be a better option.	**Yes Category 2.** Size conveyance system: south to E Columbia, N to Heron Meadows, or E to stub out are options to investigate. S to Columbia is likely the preferred method (takes care of UIC and no need for easement). Chris indicated the elevations may be more favorable going east.	Yes		Y - Category 2	X	X		D. Nassimbene Survey
9	NE Sunset Loop	**Cap**	Open channel: "more of a walkway", floods during heavy rain, high water table.			See notes for ID #8.		Yes		Y- Category 2	X	X		D. Nassimbene Survey
10	NW View Terrace	**R/R**	Functional/structural deficiency: catch basin/discharge at end of the road is sinking/bad pipe.			9-2 (morning) - Steep roadways and one inlet plugs with leaves and debris which cause the runoff to jump the curb and cause problems downstream as the runoff bypasses the piped infrastructure and drains overland causing erosion.	Programmatic approach–good candidate for minor drainage improvements to replace or add inlet to allow leaves and debris to be collected and conveyed and allow the fast-moving water to be collected.		Minor Localized Drainage Improvements					D. Nassimbene Survey
11	SE 9th/SE Davona	**R/R**	Functional deficiency: outfall is same level as pond/can flood.			NA– Confirm problem source and need	Programmatic approach–good candidate for minor drainage improvements.		Minor Localized Drainage Improvements					D. Nassimbene Survey
12	SW Crystal Springs	**R/R**	Structural deficiency: outfall is cracking and hard to access.			NA– Confirm problem source and need			Minor Localized Drainage Improvements					D. Nassimbene Survey
13	Crown Zellerbach Road	**Maint**	Catch basin sediment buildup from rock pit, debris from trees.			9-2 (afternoon) likely no project at this location. This is largely a maintenance issue. This area has improved roads.	Maintenance issue		Expanded Facility Maintenance Program					D. Nassimbene Survey
14	SE 2nd/SE Havlik	**Maint**	7 filters in located in catch basins. Sediment from farm trucks requires more street sweeping.			NA - drainage from HWY 30 and Havlik would collect at the corner of 2nd and Havlik..	Maintenance issue		Expanded Facility Maintenance Program					D. Nassimbene Survey

Table B-1. Problem Area and Modeling Needs Matrix

Location ID	Location Description	Reported Deficiency[1]	City Problem Description	Associated UIC Issue? Y = Yes P= Possible	Associated CIP (per the 1998 MP)?	Site Visit Notes (9/2/20)	Workshop Notes (10/13/20)	Potential CIP (Project)	Potential CIP (Program)[2]	Hydraulic Modeling Needed[3]	WQ Retrofit Opportunity (by Strategy)			Source
											UIC	Green Street	Regional	
15	SW Creek View Place	R/R	Storm socks in two areas. City staff currently inspect socks 2x/ year. Only have had to replace 1 sock in 13 years, but a more robust inspection of the outfall location would be preferred. Bitte property to develop. Need to model drainage system to determine conveyance routing.			N/A	A project and a program are proposed to address this area. **Yes Category 1–model system.** Capacity issues identified at outfall. Need to confirm whether only the portion along SW Park Pl should be modeled or also system along Adams Ct and Sequoia St	Yes	Outfall rehab/ sock replacement	Y - Category 1				D. Nassimbene Survey Chris–CIP Opp Area #4
16	32952 SW Keys Crest Drive	R/R	Storm socks in two areas. Storm water is running down storm sock to ditch at bottom of hill. Outfall causing bank erosion. City staff currently inspect socks 2x/ year. Only have had to replace 1 sock in 13 years, but a more robust inspection of the outfall location would be preferred.			9-2 (morning) - Large scour hole has a result of the sock discharging at the bottom of the hill. There is currently no eminent danger to property. However, the scour hole will make the bank unstable and eventually will start to sluff. This should be monitored as a minimum. A permanent fix is likely expensive and likely will not be included as part of this study.	Potential to ramp up maintenance program for more inspection/ replacement. Has been replaced once or twice in 13 years.		Outfall rehab/ sock replacement					D. Nassimbene Survey
17	E Columbia south through Elm St to SE Rose/SE High School Way	Infra	Area lacks and requires a storm drainage system–no storm structures currently present.			Overlap with Location ID#4. Some of this area was visited during the site visit but did not specifically address this comment as there is no infrastructure to observe.	Programmatic approach for UIC installation with minor drainage improvements.		Minor Localized Drainage Improvements		X			D. Nassimbene Survey
18a	SW J.P. West Rd (south to SW Maple)	Infra WQ	Area lacks and requires a storm drainage system–no storm structures currently present.		JP West Storm Pipeline - New storm pipeline to provide SD service and prevent SW ponding in existing developed area south of JP West Rd west of 1st St	9-2 (morning) - Potential for roadway and storm along JP W Rd from 4th to Hwy 30. This could provide a future tie in location for roads to the south of JP W Road. Some treatment was constructed with the new bridge that could be incorporated into the storm design if the roadway was improved.	**Yes Category 2–size pipe along JP West east of creek to Hwy 30. Also size pipe up JP West up to Keys Rd on west side.** Potential development along Keys road and east of creek. Need to delineate basins to determine how much of Keys road drains south to Coal Creek vs. north to JP West. JP West is a priority for transportation improvements east of the creek.	Yes		Y - Category 2		X		D. Nassimbene Survey
18b	SW J.P. West Rd from bridge across Scappoose Creek to Keys Road	Infra WQ				9-2 (morning) - W of the bridge, Chris N identified as a possible regional facility opportunity. Current LOMR in progress with subdivision/ private development. Would require collection system W of 4th street as well.	**Yes Category 2–Same as l8a.** This was added as a separate problem area during the workshop, as the scope expanded to potentially capture future development and capitalize on existing planned development. Proposed discharge location shall extend south along Keys Road	Yes		Y - Category 2				Chris–CIP Opp Area #2
19	NE Miller Rd on Miller playground	Cap	Undersized pipe, roadway flooding.			9-2 (afternoon) - This problem area is likely caused by the Sunset loop drainage problem. There is also a failing UIC along Miller Road south of Sunset Loop. A new storm line along Miller Road that drains to Columbia may solve multiple problem areas. A CIP at Location ID 9 and 10 may alleviate the need for a CIP at this location.	**Yes Category 1–Model along Heron Meadows coming out of Miller Park** Need to investigate this area further to find proposed solution. Areas west of Bird Ave, could drain to "magic black hole" along Crown Z. Need to confirm whether issues all stem from Sunset Loop area. Heron Meadows trunk line surfaces at Miller Park, might need to be regraded if extended to Bird.	Yes		Y - Category 1		X		T. Jadrnak Survey

Table B-1. Problem Area and Modeling Needs Matrix														
Location ID	Location Description	Reported Deficiency[1]	City Problem Description	Associated UIC Issue? Y = Yes P= Possible	Associated CIP (per the 1998 MP)?	Site Visit Notes (9/2/20)	Workshop Notes (10/13/20)	Potential CIP (Project)	Potential CIP (Program)[2]	Hydraulic Modeling Needed[3]	WQ Retrofit Opportunity (by Strategy)			Source
											UIC	Green Street	Regional	
20	Veterans Park along roadsides	**Cap** WQ	Open channel issue: water backs up onto roadway.			9-2 (morning) - Grassy swale needs to be regraded to allow water to exit the roadway and enter the facility. The swale needs to be deeper to account for some storage and to ensure the runoff and flow into the swale from the road and not have grass or debris block the curb inlets.	Intent of existing grassed ditch was to serve a WQ purpose–want to keep WQ benefit there. Per Dave, the City is currently planning a roadway improvement here that would remove the need for this project in the MP.	NA	NA			X		T. Jadrnak Survey
21	SE 9th/Icenogle Loop/ Pioneer Crossing	**Maint**	Sediment/organic material from trees in catch basins.			NA	Maintenance issue		Expanded Facility Maintenance Program	Y – Category 1				T. Jadrnak Survey
22	NE West Lane Rd	**Infra**	Need to add catch basin–available public property or ROW.		West Lane SD System - New storm pipelines to serve existing developed northeast area that has unreliable or failing dry wells.	NA	Programmatic approach for UIC installation with minor drainage improvements. This could also be resolved if E Columbia is extended west to this location		Yes –Minor drainage improvement program		X			T. Jadrnak Survey
23	E Columbia Ave east of Bird Road	**Infra** WQ	Area lacks and requires a storm drainage system–no storm structures currently present.		Columbia Avenue SD system - New storm pipeline to provide SD service to new and existing development north and south of Columbia Ave east of 6th St.	9-2 (morning) we did not visit this location but discussed it. The existing conveyance line may need to be upsized and extended to address future development needs in the area and/or correct Sunset Loop. High groundwater prevents use of UICs.	**Yes Category 1–Model existing and size pipe up to 4th.** Need to understand capacity of this pipe for issues in surrounding area.	Yes		Y - Category 1		X		1998 Master Plan Chris–CIP Opp Area #9
24	Crown Zellerbach Road	**Infra**			Crown Storm Line - New storm pipeline to provide SD service to area proposed for industrial development north of existing Crown Zellerbach Road.	9-2 (afternoon) long linear 'channel' that is about 10 feet deep with rock on the bottom along the old CZ Road which is now a trail. The 'channel' appears to have a pipe, that runs along CZ road nearly to HWY 30, that discharges into this channel. City staff do not know the history behind this and mention seeing water in it but not much. There is another pipe discharging to it near the middle from the north.	"Magic Black Hole" Subbasin delineation will inform area draining to vicinity and what could be routed there in the future with additional infrastructure. No immediate project need.	NA	NA					1998 Master Plan Chris–CIP Opp Area #8
25	Airport Industrial Area	**Infra**			Airport Industrial Area - New storm pipeline to provide SD service for proposed development around airport.	9-2 (afternoon) This is likely not needed with the planned private development and associated road and storm infrastructure.	Likely addressed with current development master plan. Refer OTAKs drainage report for more info as needed. No immediate project need.	NA	NA					1998 Master Plan
26	Jackson Creek (exact location unclear)	**Infra**			Temporary/mobile pumping units to divert excess flows from Jackson Creek to Multnomah Channel during extreme flood events.	Confirm relevancy? This sounds like a project SDIC might take on but well outside city limits.	Likely on the list because of relevance to SDIC. Chris felt this project was added at the request of SDIC. Dave expressed concern about including in MP (sets incorrect precedence). No immediate project need.	NA	NA					1998 Master Plan
27	5th, 6th, and 7th Streets between Wheeler and EJ Smith Road	**Infra**	No infrastructure.		New storm piping system to provide storm drainage service to existing development along 5th, 6th, and 7th Streets between EJ Smith and Wheeler.	9-2 (morning) These are county roads (per Dave during site visit) and therefore will likely not receive any improvements from the city.	City may install a facility in park space along EJ Smith (at Location ID #31)	NA	NA					1998 Master Plan

Table B-1. Problem Area and Modeling Needs Matrix

Location ID	Location Description	Reported Deficiency[1]	City Problem Description	Associated UIC Issue? Y = Yes P= Possible	Associated CIP (per the 1998 MP)?	Site Visit Notes (9/2/20)	Workshop Notes (10/13/20)	Potential CIP (Project)	Potential CIP (Program)[2]	Hydraulic Modeling Needed[3]	WQ Retrofit Opportunity (by Strategy)			Source
											UIC	Green Street	Regional	
28	Callahan-Dutch Canyon Area	Infra Cap			New combined open channel/pipe conveyance system to provide SD service for proposed development in the Callahan-Dutch Canyon area.	9-2 (morning)–2 areas identified per Chris N as retrofit opportunities. Large area of system rerouting and private facilities utilizing high infiltration rates to support considerable drainage area discharging to it. Existing infiltration facility and 72" sediment manhole in Callahan Road area. Receives runoff from privately developed subdivisions. The facility is currently private owned/managed by an HOA. North into Dutch Canyon, there is a need to include a crossing through private property (property owner won't allow) to restore historic drainage patterns. Developers are currently negotiating Phase 4 of development in this area. Need to consider future development of commercial property off Old Portland Road.	Opportunity to provide a third-party estimate for capacity of existing facility. Issue #1–existing pipe was sized for the original development, so potentially undersized. Issue #2–facility is not under public ownership but is pseudo-public. Hydraulic modeling and subbasin refinement needed to confirm facility expansion potential and CIPs for rerouting. Confirm applicability of 1998 CIP. Development is being allowed to discharge to existing Callahan infiltration facility. Should we explore drainage needs for Dutch Canyon.	Yes		Y - Category 1				1998 Master Plan Chris–CIP Opp Area #5 and 6
29	**Keys Road Basin**	**Infra**	Small, undeveloped lot that may provide opportunity for regional storm facility.			Not visited. Need to confirm whether regional facility placement can accommodate upstream development (existing or future). Is there a water quality or detention need?	Upstream development. The conveyance down Keys road ends and turns into ditches. These ditches get overwhelmed during storm events and runoff flows across the road. **Category 2 - Model the line along Keys road.** Could be beneficial to extend piped conveyance all the way to creek from existing line on Keys. Development north could tie in. Maybe a facility at the downstream end to support the small tributaries.	Yes		Y - Category 2			X (Possible)	Chris–CIP Opp Area #3
30	Spring Lake Park Basin	Cap WQ	A flow through pond that is privately owned. Built as part of the mobile home development. Undeveloped area north of Spring Lake Pond is City owned area that receives drainage from two pipe systems, infiltrates or remains as surface water.			9-2 (afternoon) no real treatment or detention occurring. This is a flow through facility. Likely some passive treatment as the water slows and particles settle out. The culvert separating the two ponds is undersized causing the water surface in the upstream pond to rise during large events.	Undersized culvert leads to the south pond (SpringLake community may need to upsize)., which includes overflow pipe. Spring Lake Dr. Road between the two ponds floods often. North of north pond may be an opportunity to retrofit the existing area for improved water quality and/or flow control. No project opportunity. City would consider partnering with private development if they are going to upsize the culvert.	NA	NA					Chris–CIP Opp Area #11
31	NW EJ Smith (west side of Scappoose Creek.	Infra WQ				9-2 (morning)–Location identified as a CIP opportunity by Chris N. City purchased vacant parcel for ballfield development. May incorporate piped conveyance from upstream ditch to offline regional water quality facility in conjunction with half street improvements. City to confirm whether detention should be provided.	Retrofit opportunity–model extents should include sizing a pipe along EJ Smith road. Infrastructure would include manholes to capture future infr. along 5th, 6th, 7th. Lots of developable land along this area that will develop to the west (upstream) of the park. City may install a facility at park space along EJ Smith.	Yes		Y - Category 2			X	Chris N.–CIP Opp Area #1

Table B-2. UIC Inventory

City ID NO.	DEQ FACILITY NO.	AREA	LOCATION	Coordinates: LATITUDE	Coordinates: LONGITUDE	Direct Discharge Evaluation: UIC Depth (feet)	Direct Discharge Evaluation: Depth to Seasonal High Groundwater (feet)	Direct Discharge Evaluation: Vertical Separation Distance (feet)	Direct Discharge Evaluation: Discharges Directly to Groundwater?	Water Well Setbacks: Within Two-Year Time of Travel?	Water Well Setbacks: Within 500 Feet of Water Well?	Water Well Setbacks: Well ID(s)	2035 Peak Afternoon Traffic Volume	Traffic Category (TPD)	Prohibited Under 340-OAR 044-0015(2)?	TYPE	BMP (Y/N)	COMMENTS
Active UICs																		
1	11686-1	NE Sawyer & NE Prairie	Intersection of Sawyer & Prairie	45.758519	-122.874269	20.0	32	12.2	No	No	No		LTR	< 1,000	No	DW	N	3-18x22" CB into GIS DW#24
3	11686-3	NE Miller & NE Sunset Loop	Miller Rd. between Sunset Loop	45.755413	-122.861054	7.5	8	0.3	No	Yes	Yes	52815, 446	LTR	<1,000	No	DW	N	3-CB's discharge into GIS DW#14
4	11686-4	NE Sunset Loop	NW corner of Sunset Loop	45.755774	-122.862044	7.0	8	1.2	No	Yes	Yes	52815, 54702, 446, 962	LTR	<1,000	No	DW	N	4-CB's discharge into GIS DW#16
5	11686-5	52656 NE Sawyer	52656 NE Sawyer	45.759677	-122.874207	20.0	30	10.2	No	No	No		LTR	<1,000	No	DW	N	3-CB's discharge into GIS DW#25 Need to verify type of discharge - Shown as a drywell on the asbuilt plans.
6	11686-6	NE Sawyer & NE Williams	Intersection of NE Sawyer & Williams	45.760686	-122.874475	20.0	29	8.5	No	No	No		LTR	<1,000	No	DW	N	3-CB's discharge into GIS DW#05
7	11686-7	NE Williams & NE Third	Intersection of Williams & Third	45.760759	-122.875373	20.0	31	10.7	No	No	No		LTR	<1,000	No	DW	N	2-CB's discharge into Sed? MH into GIS DW#04
8	11686-8	NE Third & NE Prairie (North)	North of intersection 3rd & Prairie	45.758652	-122.875141	20.0	28	7.5	No	No	No		LTR	<1,000	No	IT	N	1-18x22" CB into pipe headed east
9	11686-9	NE Third & NE Prairie (South)	South of intersection 3rd & Prairie	45.758241	-122.875118	20.0	34	13.7	No	No	No		LTR	<1,000	No	DW	N	1-24x30" CB into DW
10	11686-10	NE 3rd -Btwn Williams& Laurel	3rd St between Wms & Laural	45.760346	-122.875304	20.0	34	13.8	No	No	No		LTR	<1,000	No	IT	N	1-18x22" CB into pipe headed east
11	11686-11	52765 NE 3rd Street	Driveway approach	45.761600	-122.875531	20.0	34	13.8	No	No	No		LTR	<1,000	No	CB	N	
12	11686-12	NE 2nd& E. Columbia	2nd Street N of Columbia	45.757886	-122.876227	20.0	34	13.7	No	No	No		>2,500	>1,000	No	DW	N	1-CB into GIS DW#23
13	11686-13	SE 2nd @ City Hall	2nd Street S of Columbia	45.757270	-122.876492	20.0	34	13.6	No	No	No		>2,500	>1,000	No	DW	N	3-CB's discharge into GIS DW#30
14	11686-14	SE 2nd @ Library	2nd Street @ Library	45.756852	-122.876451	20.0	34	13.7	No	No	No		>2,500	>1,000	No	DW	N	2-CB's discharge into GIS DW#22
15	11686-15	SE 2nd & Maple	Adjacent to 33601 SE Maple	45.757050	-122.876194	20.0	34	13.7	No	No	No		LTR	<1,000	No	IT	N	1-18x24" CB to pipe east
16	11686-16	SE 2nd & Santosh	2nd & Santosh	45.753760	-122.876081	20.0	30	9.6	No	No	No		LTR	<1,000	No	DW	Stormfilter	2 CB - One CB treated with filter, the other discharges directly to the DW via 8-in PVC 3034
17	11686-17	SE 2nd & Elm	NE Corner behind Sidewalk	45.753031	-122.875966	20.0	30	9.9	No	No	No		>2,500	>1,000	No	DW	N	3-18x22" CB's into DW (in SW)
18	11686-18	SE 2nd & Elm	N of 2nd & Elm intersection	45.753125	-122.876040	20.0	31	11.2	No	No	No		>2,500	>1,000	No	DW	N	Overflow from 18x22" CB at NE curb return
19	11686-19	52462 SE 4th	Adjacent to SE 52462 property	45.756953	-122.872198	20.0	26	5.9	No	No	No		LTR	<1,000	No	DW	N	2-CB's on both sides of the SE 4th into one DW
20	11686-20	SE 4th & SE Myrtle	Adjacent to NE curb return	45.756411	-122.872147	20.0	29	9.0	No	No	No		LTR	<1,000	No	DW	N	3-CB's CB at SW, NW and NE curb return into one DW
21	11686-21	SE 4th & SE Maple	4th & Maple	45.754797	-122.871819	20.0	31	11.0	No	No	No		>5,000	>1,000	No	DW	N	GIS DW#21
22	11686-22	SE Maple E of 4th	Maple E of 4th at end	45.754744	-122.869503	20.0	30	10.1	No	No	Yes	53899	LTR	<1,000	No	DW	N	2 CB's into GIS DW#10
23	11686-23	SE Cypress	Cypress	45.754504	-122.869862	20.0	30	10.0	No	No	Yes	53899	LTR	<1,000	No	DW	N	2-CB's discharge into GIS DW#20
24	11686-24	SE Ironwood	Ironwood	45.754432	-122.870837	20.0	30	9.7	No	No	No		LTR	<1,000	No	DW	N	2-CB's discharge into GIS DW#19
25	11686-25	SE 4th & Oak	DW adjacent to 52390	45.755712	-122.871987	20.0	30	10.4	No	No	No		LTR	<1,000	No	DW	N	1-CB at NE curb return into DW
26	11686-26	SE Patricia Way	SW corner of Patricia Way and SE 6th	45.752778	-122.869167	20.0	29	8.9	No	No	No		>10,000	>1,000	No	CB	N	No BMP - CB discharges directly
27	11686-27	SE Terri Way	SW corner of Terri Way and SE 6th	45.7518350	-122.8691226	20.0	29	8.9	No	No	No		>10,000	>1,000	No	DW	N	2-CB's at SW and NW CR into GIS DW#17
28	11686-28	SE Fay Way	end of cul-de-sac	45.751185	-122.869820	11.7	27	15.3	No	No	No		LTR	<1,000	No	DW	N	1-CB into GIS DW#09
29	11686-29	SE 6th N of Everett Way	On 6th adjacent to 33905	45.750666	-122.868954	18.5	27	8.6	No	No	No		>10,000	>1,000	No	DW	N	1-CB discharges into GIS DW#28
30	11686-30	SE Everett Way	On Everett adjacent to 33905	45.750505	-122.869214	8.5	28	19.1	No	No	No		LTR	<1,000	No	DW	N	2-CB's discharge into GIS DW#11
31	11686-31	SE 6th	51946 SE 6th (N)	45.749569	-122.868893	12.0	28	15.6	No	No	No		>10,000	>1,000	No	CB	N	No BMP - CB discharges directly
32	11686-32	SE 6th St	51946 SE 6th (S)	45.749415	-122.869110	12.0	28	16.4	No	No	No		>10,000	>1,000	No	CB	N	No BMP - CB discharges directly
33	11686-33	SE 6th St	51955 SE 6th	45.749511	-122.869190	11.3	28	16.8	No	No	No		>10,000	>1,000	No	CB	N	No BMP - CB discharges directly
34	11686-34	SE 6th St	51937 SE 6th	45.749452	-122.869234	2.5	33	30.3	No	No	No		>10,000	>1,000	No	CB	N	No BMP - CB discharges directly
35	11686-35	SE 6th & High School Way (NW)	NW corner of SE 6th & High School Way	45.748332	-122.869852	3.5	30	26.6	No	No	No		>10,000	>1,000	No	CB	N	This location may discharge to perf pipe in gravel swale along the north side of SE HS Way
36	11686-36	SE 6th & High School Way (NE)	NE corner of SE 6th & High School Way	45.748300	-122.869725	3.5	21	18.0	No	No	No		>10,000	>1,000	No	CB	N	May drain to the same IT along the north side of SE HS Way
37	11686-37	High School Way	High School Way entrance to faculty parking lot	45.749489	-122.875299	13.5	32	18.2	No	No	No		>10,000	>1,000	No	IT		5-CB's discharge into a sed MH then to sand filter (outside of ROW in easement?)
38	11686-38	NW 1st N of Prairie	NW 1st North of Prairie	45.758561	-122.879339	7.7	28	20.6	No	No	No		LTR	<1,000	No	CB	N	
39	11686-39	SW 4th & Maple	SE curb return	45.754206	-122.881484	10.3	28	18.1	No	No	No		>5,000	>1,000	No	DW	N	1-CB discharges into DW
40	11686-40	E. Columbia & NE Sawyer	NW curb return	45.757734	-122.874259	20.0	25	5.5	No	No	No		>10,000	>1,000	No	DW	N	GIS DW#06 - Need to confirm discharge location at the NW curb return
41	11686-41	SE Myrtle - northside	33824 SE Myrtle (end of the street)	45.756362	-122.871163	20.0	32	11.8	No	No	No		LTR	<1,000	No	DW	N	No drywell found near this CB
42	11686-42	SE Myrtle - southside	33825 SE Myrtle (end of the street)	45.756268	-122.871158	5.0	18	13.5	No	No	No		LTR	<1,000	No	DW	N	No drywell found near this CB
43	11686-43	33894 SE Oak	End of SE Oak (south side)	45.755593	-122.869964	13.0	19	5.5	No	No	Yes	52775, 53899	LTR	<1,000	No	DW	N	Catch basin to drywell
44	11686-44	52386 SW 1st Street	Northwest corner of the lot	45.755770	-122.878970	20.0	22	2.0	No	No	No		>3,500	>1,000	No	DW	N	Catch basin to drywell
45	11686-45	SW Evergreen & SW 4th St	33295 SW Evergreen	45.751018	-122.882096	11.5	33	21.4	No	No	No		LTR	<1,000	No	DW	N	4-CB's discharge into GIS DW#3
46	11686-46	52105 SW 4th	south of EM Watts	45.751576	-122.881840	8.0	8	0.4	No	No	No		>5,000	>1,000	No	DW	N	2-CB's discharge into GIS DW#18
47	11686-47	SE Elm & SE 8th Court	SE Elm & SE 8th Ct. intersection	45.752385	-122.866524	9.3	34	24.7	No	No	No		LTR	<1,000	No	DW	N	2-CB's discharge into GIS DW#12, need to ask PW where the DW is located
49	11686-49	Columbia Ave.& SE 3rd	Landscaping/Rock(in right-of-way)	45.757569	-122.875379	20.0	33	12.9	No	No	No		>10,000	>1,000	No	IT	Y	The catch basin has a sump and is trapped
50	11686-50	34293 NE Sunset Loop	South east corner of property in Miller Rd ROW	45.754470	-122.861503	20.0	32	12.5	No	Yes	No	2897, 2893	>3,500	>1,000	No	DW	N	2-CB's discharge into GIS DW#15 - No sump in CB's
65	11686-65	Old Portland Road	51711 SW Old Pdx Rd. (in the ROW)	45.745858	-122.878876	3.0	34	31.0	No	No	No		>7,500	>1,000	No	DW	N	Unconvential DW with grated opening not attached
66		SW 1st	At back of 52347 Columbia River Hwy	45.754814	-122.878853	20.0	30	10.5	No	No	No		>3,500	>1,000	No	CB	N	No BMP - CB discharges directly
67		SW 1st	At back of 52313 Columbia River Hwy	45.755128	-122.878889	20.0	27	7.5	No	No	No		>3,500	>1,000		CB	N	No BMP - CB discharges directly
68		33568 E Columbia Ave	Police station parking lot	45.757423	-122.877125	20.0	28	7.8	No	No	No		LTR	<1,000	No	DW	N	4 CB into DW#31 (drains the parking lot, half of Heritage Park and overflow from the fountain swale
69		52226 SE Endicott Ln	Behind the curb on SE Elm	45.753361	-122.869604	3.0	30	27.5	No	No	No		>7,500	>1,000		DW	N	1-CB discharges into a DW (could not find)

City ID NO.	DEQ FACILITY NO.	AREA	LOCATION	Coordinates		Direct Discharge Evaluation				Water Well Setbacks			2035 Peak Afternoon Traffic Volume	Traffic Category (TPD)	Prohibited Under 340-OAR 044-0015(2)?	TYPE	BMP (Y/N)	COMMENTS
				LATITUDE	LONGITUDE	UIC Depth (feet)	Depth to Seasonal High Groundwater (feet)	Vertical Separation Distance (feet)	Discharges Directly to Groundwater?	Within Two-Year Time of Travel?	Within 500 Feet of Water Well?	Well ID(s)						
70		SE 6th	51999 SE 6th St	45.749875	-122.868861	20.0	27	7.5	No	No	No		>10,000	>1,000	No	DW	N	1-CB's discharge into GIS DW#29
71		SE Vine and 6th	33898 SE Vine	45.749137	-122.869486	20.0	28	8.0	No	No	No		LTR	<1,000	No	CB	N	No BMP - CB discharges directly
		SE Vine and 5th	Intersection of SE Vine and SE 5th		-	-	-	-	-	-	-	-	-	-	-	-	-	Specifications unknown, identified by City during master plan efforts
Inactive UICs, UICs That Do Not Exist, Or Structures That Are Not UICs																		
2	11686-2	E Columbia & NE Miller	Miller Rd. N of Columbia	45.754167	122.861111	20.0										DW		Not installed per plan
48	11686-48	Columbia Ave. & SE 2nd	Landscaping												No			
51	11686-51	NE 1st St. Apartments	located behind apartments												No			
52	11686-52	NE 2nd & Crown Z Road	NE Corner												No			
53	11686-53	NE Erin Drive	End of street												No			
54	11686-54	SE Sauer Ct	End of street												No			
55	11686-55	SE 3rd & June Ln.	West side of 3rd												No			
56	11686-56	SW Rogers Road	South side (3)												No			
57	11686-57	SW Sycamore St.	off Old Portland Road (in right-of-way)	45.7491137	122.8773022	20.0	34	13.9	No	No	No		49,500	>1,000	No			Street drains to curb cuts to surface infiltration - should not be considered a DW by DEQ definition
60	11686-60	Elm Crossing	SE Elm and 8th Ct (south end)	45.746504	122.869098	13.5	16	2.5	No	No	No		LTR	<1,000	No			Confirmed via asbuilts - drains to retention basin
61	11686-61	SE 6th & High School Way	North side of High School Way	45.748333	122.869722	3.0	15	12.1	No	No	No		9,500	>1,000	No			Duplicate of UIC 35
62	11686-62	JP West & Maria	on JP West Rd.	45.756835	-122.886887	20.0									No			Detention facility only - no infiltration
63	11686-63	NE 1st & NE Watts	By CDC Building	45.759125	-122.876287	20.0									No			Retention basin

Table B-2. UIC Inventory

NOTES

BMP = Best Management Practice
CB = Catch basin infiltrates or no drywell present
CFS = cubic feet per second
DW = Drywell
IT = Infiltration Trench
LTR = Low Traffic Residential (drains residential side streets)
TPD = Vehicle Trips Per Day (Numerical traffic data are 2035 future base (average) PM Peak Hour Traffic Volumes)
UIC = Underground Injection Control

WITHIN WATER WELL SETBACK
DISCHARGE DIRECT TO GROUNDWATER

Appendix C: TM#2: Hydrology and Hydraulic Modeling Methods and Results

6500 S Macadam Avenue, Suite 200
Portland, OR 97239

T: 503.244.7005

Technical Memorandum

Prepared for: City of Scappoose

Project Title: Stormwater Master Plan

Project No.: 155252

Technical Memorandum No. 2

Subject: Hydrology and Hydraulic Modeling Methods and Results

Date: November 2, 2021 (DRAFT)

September 16, 2022 (FINAL)

To: Chris Negelspach, P.E., City of Scappoose

From: Thomas Suesser
Ryan Retzlaff
Angela Wieland, P.E.

Prepared by: ______________________
Thomas Suesser, E.I.T.

Reviewed by: ______________________
Angela Wieland, P.E.

Limitations:

Table of Contents

List of Tables

Section 1: Introduction

The City of Scappoose (City) is developing a Stormwater Master Plan (SMP) to improve understanding of system characteristics and infrastructure in the City. The SMP will support the development and prioritization of stormwater capital projects to address conveyance, capacity, maintenance, and water quality for existing and future development. The SMP requires a clear understanding of existing and future runoff conditions across the City to identify both current and long-term stormwater project needs.

The City's previous Storm Drain System Master Plan was completed in November 1998. Since then, development activities in the City have altered stormwater flow rates and drainage patterns. *Technical Memorandum #1, Stormwater Basis of Planning* (TM1), prepared in March 2021, identified specific areas of the city where a hydrologic and hydraulic (H&H) evaluation was needed to identify capacity issues and evaluate project opportunities.

This Technical Memorandum #2 (TM2) documents the methodology used to model H&H for the specific areas of concern in the city. TM2 is organized as follows:

Section 2: Stormwater Standards and Criteria. Outlines applicable stormwater design standards and criteria used to evaluate the performance of the storm drainage system.

Section 3: Hydrologic Model Development. Outlines hydrologic modeling assumptions and methodology.

Section 4: Hydraulic Model Development. Outlines hydraulic modeling assumptions and methodology.

Section 5: Model Refinement and Results. Provides an overview of H&H model quality control, validation, refinement, and H&H results.

Prior to H&H modeling efforts, Brown and Caldwell (BC) conducted preliminary project identification needs through staff surveys, interviews, and a workshop. Modeling extents and approaches were discussed. These efforts are detailed in TM1.

Section 2: Stormwater Design Standards and Criteria

BC reviewed the City's current Public Works Design Standards (PWDS) dated November 18, 2018, to establish planning criteria relevant to the analysis of the City's stormwater system. This review is detailed in Section 3.2 of TM1. While these planning criteria are typically applied to new infrastructure, they can also be used as the basis of design or level of service for the SMP. Table 1 below, which is also provided in TM1, lists the applicable planning and sizing criteria used to identify areas where the City's stormwater system has capacity limitations.

For additional details and background information on the City's design standards and planning criteria, refer to Section 3.2 of TM1.

Table 1. Scappoose Planning and Sizing Criteria		
Criteria	Source	Standard
Water Quality Facility Sizing	PWDS 2.0120 (C), 2.0120 (D), 2.0230 (A)	• Provide water quality treatment for a design storm of 1.5 inches in 24 hours, 90% of the average annual rainfall. • The Simple Method may be used to size onsite water quality stormwater facilities. If designed for water quality only, use the sizing factor for Soil Type B.

Water Quantity Facility Sizing	PWDS 2.0120 (D), 2.0120 (E), 2.0230 (A) and (B), 2.0240 (B), 2.0500, 2.0540	• For facilities that cannot retain the 10-year storm event onsite, stormwater facilities shall be sized to control post-developed flows.
		  • 2-year, 24-hour post-development peak flow to half of the 2-year, 24-hour pre-development design storm peak flow.
		  • Post-development peak flow from the 5-, 10-, 25-year, 24-hour design storm to the respective pre-development peak flows.
		  • SBUH, SWMM. or SCS TR-55 methods are required for determination of the peak flow rate.
		• Overflow must safely pass 100-year, 24-hour event.
		• Curve Numbers for the pre-developed condition shall be “pasture or grass/lawn with amended soil” (NRCS Hydrologic Soil Group: Type A = 39, Type B = 61, Type C = 74, and Type D = 80).
		• The Simple Method may be used to size onsite water quantity facilities.
		• The Engineered Method may be used if the water quantity facility is design by a licensed engineer.

Conveyance Pipe Sizing	PWDS 2.0120 (F), 2.0700, 2.0710, 2.0720, 2.0740	• For facilities that cannot retain the 10-year storm event onsite, stormwater conveyance is required to an approved discharge point. • Sizing criteria (design storms) vary by drainage system element: minor, major, watercourses, or bridges (see Table 9 in PWDS 2.0740). • 1-ft minimum freeboard between the HGL and the top of the structure or finish grade is required for management of the post-development peak rate of runoff. • Conveyance design must be based on SBUH, SCS TR-55, or SWMM unless approved by City Engineer.
Culvert Sizing	PWDS 2.0780	• Ensure the headwater water surface elevation during the 25-year design storm does not exceed 1.5 times the culvert diameter or remain at least 1-ft below the roadway subgrade, whichever is less.
Open Channel System Sizing	PWDS 2.0740, 2.0760	• Open channel sizing must accommodate the 25-year design storm. • Manning’s equation is acceptable for open channel capacity determination with an upstream drainage area of 50 acres or less. Larger drainage areas must use HEC-RAS or an equivalent computer model.

Abbreviations:

HEC-RAS = Hydrological Engineering Center’s River Analysis System

HGL = hydraulic grade line

NRCS = National Resources Conservation Service

SBUH = Santa Barbara Urban Hydrograph

SCS = Soil Conservation Service

SWMM = Storm Water Management Model

TR-55 = Technical Release 55

Section 3: Hydrologic Model Development

The hydrologic model was developed using PC-Storm Water Management Model (PCSWMM) version 7.4 (SWMM version 5.1.015). The RUNOFF, SBUH, and TR-55 methods were evaluated for suitability to address the specific needs of the Scappoose drainage infrastructure. The RUNOFF method was selected due to its simplicity and ability to integrate the Green-Ampt method for calculating infiltration. The necessary parameters for the RUNOFF method when utilizing the Green-Ampt method for infiltration include subbasin area, slope, width, hydraulic conductivity, initial moisture deficit, suction head, and impervious percentage. The hydrology routine in PCSWMM converts rainfall into stormwater runoff based on design storm parameters (i.e., volume and intensity of rainfall) and the hydrologic input parameters listed above.

This section includes detailed descriptions of the methodology used in determining each of the hydrology model input parameters.

3.1 Subbasin Delineation

The major hydrologic basins in the study area include South Scappoose Creek, North Scappoose Creek, Jackson Creek, Alder Creek, Coal Creek, and the Multnomah/Santosh Channels. BC delineated these major hydrologic basins for the City prior to the project kickoff meeting held on June 15, 2020. Following establishment of the hydraulic model extents during the Problem Area and Modeling Extents Workshop (October 2020), these major hydrologic basins were subdivided into subbasins.

All major basins and subbasins were delineated manually in ArcGIS using available topographic Light Detection and Ranging (LiDAR) and contour data, storm system geographic information system (GIS) data, aerial imagery, and City feedback. Subbasins were delineated for the entire City for use in creating a city-wide hydrologic model. Subbasins in areas contributing to the hydraulic model extents were delineated with more detail, as required, for modeling.

The subbasin delineation was initially presented to the City during a coordination call on January 19, 2021, and detailed maps were subsequently sent to the City for review. Following receipt of feedback from the City, BC revised the subbasin delineation with specific attention paid to the Callahan-Dutch Canyon area. Subsequent, minor subbasin refinements were made in May 2022 in conjunction with hydraulic modeling efforts.

A total of 138 subbasins are defined for the City, 124 of which are hydrologically modeled. The remaining 14 subbasins are not hydrologically modeled because they drain directly to Scappoose Creek and its tributaries, or to Jackson Creek, and do not interact with City infrastructure. Except for subbasin AC_030, the subbasins not hydrologically modeled also fall outside of the city limits and urban growth boundary (UGB). Subbasin AC_030 falls partially in an area within the city limits not expected to develop during the planning window. The hydrologically-modeled subbasins range in size from 0.4 acres to 303.2 acres with an average area of 26.1 acres.

The major basin and subbasin boundaries are shown in Attachment B, Figures B-1, B-2, and B-3.

Each subbasin is named based on its respective major basin, with a sequential naming convention moving from downstream to upstream. Subbasins that are expected to exclusively infiltrate runoff are named with an “I” suffix. For example, the fifth subbasin upstream within the South Scappoose Creek basin and draining to an underground injection control (UIC) would be named “SS_050_I”. The third numerical digit is increased as the original subbasin is further subdivided from the initial delineation. The hydrologic parameters for each subbasin (i.e., area, slope, hydraulic conductivity, initial moisture deficit, average capillary suction, and impervious percentage) are listed in Attachment A, Table A-1.

Subbasin naming is also shown in Attachment B, Figures B-1, B-2, and B-3.

3.2 Width and Slope

The RUNOFF method simplifies each subbasin into a rectangular shape based on the measured subbasin area and width. The slope is calculated separately, unique to each subbasin.

To calculate width, BC generated longest flow path lines for each subbasin in GIS using an automated GIS process that approximates the flow path line as the straight-line distance between the highest and lowest elevation points in the subbasin. The slope is calculated using the length of the flow path line and high- and low-point elevations. The high and low points were determined from available LiDAR data, except for eight subbasins that extend beyond available LiDAR coverage. For these eight subbasins, flow path lines and maximum elevations were estimated manually using 20-ft contour data provided by the City. Flow path lines for 29 subbasins were also manually edited when the automated process did not accurately measure the flow path. Subbasin areas were divided by the length of the flow path line to obtain values for subbasin width.

3.3 Infiltration Conditions and Soils

Soil classification and infiltration are important characteristics to consider when developing and evaluating runoff flow rates and volumes for subbasins. Soil classifications within the study area were identified using the Natural Resources Conservation Service (NRCS) Soil Survey. Soil information is based upon data obtained from a 2016 publication from the U.S. Department of Agriculture, NRCS titled “Soil Survey (SSURGO) Database for Columbia County, Oregon.”

There are multiple methods that can be used to simulate infiltration associated with each soil type. For this project, the Green Ampt method was selected. The Green Ampt method was selected for its ability to be applied city-wide and for its use of parameters related to infiltration that can be sourced from available soil data without the need for field work. Infiltration variability throughout the City is a critical component of Scappoose’s stormwater runoff characteristics.

The Green Ampt method requires the following input parameters for each soil texture classification:

- **Average Capillary Suction.** A measure of the water transport through soils due to surface tension acting in soil pores.
- **Initial Moisture Deficit.** The fractional difference between soil porosity and actual moisture content.
- **Saturated Hydraulic Conductivity.** A physical parameter reflective of the rate at which water moves through saturated soil.

All input parameters for soil texture classifications relevant to the study area were derived from published reference values provided in the Environmental Protection Agency’s (EPA) *Storm Water Management Model* (SWMM) *Reference Manual, Volume I Hydrology* (Revised), January 2016. These values are shown in Table 2 below. The NRCS Soil Survey lists additional soil texture classes that are not included in the SWMM Manual and in these cases, the soil textures were consolidated into the most appropriate class, as listed in Table 2. An area-weighted average value was assigned to each subbasin for each input parameter based on the distribution of soil type within the subbasin.

The average input parameters for each subbasin are listed in Attachment A, Table A-1. Attachment B, Figure B-4, illustrates the topography and soils of the Scappoose study area.

Table 2. City-Wide Soil Characteristics			
Soil Texture Class	Saturated Hydraulic Conductivity, inches/hour	Initial Moisture Deficit	Average Capillary Suction, inches
Clay loam	0.04	0.24	8.22
Silt loam	0.26	0.32	6.57
Silty clay loam	0.04	0.28	10.75

Note: The initial moisture deficit for silty clay loam is not listed in the EPA SWMM Model Reference Manual and is therefore estimated based on the typical ratio of listed Effective Porosity to listed Moisture Deficit values for other soil texture classes. See EPA SWMM Model Reference Manual, 2016, page 114.

3.4 Land Use and Impervious Percentage

Area-weighted impervious percentages were assigned to each subbasin based on the associated land use coverage in Scappoose. Land use coverage was developed from City zoning, comprehensive plan designations, developable lands, and floodplain and wetland areas. The process of developing this land use coverage is summarized in TM1. A summary of impervious percentage for each land use category is provided in Table 3.

Table 3. Summary of Modeled Land Use Categories and Impervious Percentages	
Modeled Land Use Category	Impervious Percentage
Commercial	74
Industrial	80
Low Density Residential	40
High Density Residential	50
Institutional	57
Utility	5
Parks	19
Airport	15
Airport overlay	65
Developable	5
Wetlands and floodplain	5

An area-weighted average impervious percentage by subbasin was calculated for both existing and future development conditions based on the contributing land use and associated impervious percentage. The future development condition is based on the conversion of developable lands to their underlying zoning or comprehensive plan designation.

The existing and future impervious percentage for each subbasin is listed in Attachment A, Table A-1.

3.5 Design Storms

Design storms are defined as precipitation patterns typically used to evaluate the capacity of storm drainage systems and to design capital improvements for the desired level of service.

Design storms used for this study included the 2-, 5-, 10-, 25-, and 100-year recurrence interval 24-hour events. The rainfall distribution for these design storms is based on a Unified Soil Classification System (USCS) Type IA, 24-hour distribution, which is applicable to western Oregon, Washington, and northwestern California. Stormwater infrastructure analyzed for this study includes exclusively “major” elements, according to the City’s draft Public Works Design Standards (dated November 18, 2018) and must therefore be sized to convey the 25-year event.

Table 4 shows the design storm rainfall depths used in the hydrology model, as listed in the City’s draft Design Standards.

Table 4. Design Storm Depths

Design Storm Event	Rainfall Depth, inches
2-year, 24-hour	2.3
5-year, 24-hour	2.8
10-year, 24-hour	3.3
25-year, 24-hour	3.8
100-year, 24-hour	4.7

Section 4: Hydraulic Model Development

To evaluate the capacity limitations of City-owned stormwater infrastructure, the PCSWMM model was used to simulate the hydraulic performance of select pipe and open-channel systems. This targeted hydraulic modeling approach was used to focus resources on specific areas of the city where additional information is needed to quantify system flooding and develop project solutions. Targeted modeling areas are based on the identification of problem areas and feedback from the City. Hydraulic model development was split into the following categories:

- Category 1–detailed hydraulic modeling of existing infrastructure
- Category 2–hydraulic modeling to size future proposed infrastructure

TM2 focuses on the Category 1 locations and the related modeling efforts to this point. Descriptions of Category 2 modeling locations are included in Section 4.2; category 2 sites were not analyzed and are not included in this TM. For more detail on the identification of targeted modeling areas and the process by which model extents were developed and split into the two categories, see TM1.

This section summarizes the two modeling categories and locations, the data processing steps taken to build the PCSWMM model from City GIS data for Category 1 locations, and input parameters used to characterize the hydraulic conditions of the modeled system. The location and extent of the hydraulic models are provided in Attachment B, Figures B-5 and B-6.

4.1 Category 1 Modeling Locations

Category 1 modeling areas are those where detailed hydraulic models are established to evaluate existing infrastructure. Eight areas were initially identified and documented in TM1, (see Attachment A-1), and four additional areas were included as the hydraulic model was being developed. All are depicted with blue callout text in Attachment B of this TM2, in Figures B-5 and B-6.

- **Location ID 3–SE Elm Street at SE Endicott Lane.** This stormwater system extends from the end of SE Elm Street, at the system outfall, to SE Endicott Lane. Previous modeling, performed by others to support development plans suggests that the trunk line in SE Elm Street is undersized, which is supported by anecdotal evidence. This location was identified in City staff surveys and in the 1998 *Storm Drain System Master Plan* Capital Improvement Project (CIP) list. Future development in the area is anticipated to exacerbate existing system flooding. See Attachment B, Figure B-7, for model extents.
- **Location ID 4–SE High School Way at SE 5th Street.** This location includes a roadside ditch along the north side of SE High School Way, which ends at SE 5th Street. Flooding occurs at this intersection, as there is no outlet for the ditch. A low-lying area that drains to a UIC (City ID No. 37, Oregon Department of Environmental Quality Facility No. 11686-37) upstream of the problem area and a ditch along the south side of SE High School Way were also included in the model to better represent drainage patterns in the area. This UIC is listed as “deficient” with standing water and may be contributing to the flooding. This location was identified in City staff surveys. See Attachment B, Figure B-8, for model extents.
- **Location ID 6–NW EJ Smith Road and NW 1st Street.** This location includes the existing pipe along NW 1st Street from SW JP West Road to NW EJ Smith Road, and down NW EJ Smith Road to the outfall at South Scappoose Creek. The pipe is suspected to be undersized, and an urban renewal program is in place for this area that will likely bring new development that will tie into the existing system. This location was identified in City staff surveys. See Attachment B, Figure B-9, for model extents.
- **Location IDs 8 and 9–Sunset Loop.** This location includes failing UICs on Sunset Loop and Miller Road, which contribute to standing water. Localized flooding extends down a walking path through private property to Miller Park (see Location ID 19 in Category 1 above). Additional modeling is proposed to evaluate alternative configurations and size conveyance pipes to address the flooding issues in Sunset Loop. This location was identified in City staff surveys. See Attachment B, Figure B-10, for model extents.
- **Location ID 15–SW Creek View Place.** This location includes existing stormwater infrastructure that drains west along SW Rogers Road, SW Meadow Drive, SW Park Place, SW Adam Court, and SW Sequoia Street and outfall into South Scappoose Creek. Capacity issues have been identified at the outfall. The adjacent undeveloped Bitte property, located between SW 4th Street and SW Old Portland Road, is anticipated to be developed and further exacerbate existing capacity issues. This location was identified in City staff surveys. See Attachment B, Figure B-11, for model extents.
- **Location ID 18b–SW JP West Road west of South Scappoose Creek.** This location includes SW JP West Road between Keys Road and South Scappoose Creek. The stormwater infrastructure in this area consists of a combination of short stretches of pipe, culverts, and roadside ditches. Infrastructure is lacking at the upstream end from NW Eastview Drive to Keys Road, and roadside ditches are overgrown in the flat portion before outfall to the creek. This location was identified in City staff surveys. See Attachment B, Figure B-12, for model extents.
- **Location ID 19–Miller Park.** The existing stormwater pipe that runs through Miller Park and connects to the Heron Meadows trunk line, as well as the stormwater system along NE Egret Lane and NE Raenna Lane that outfalls east of NE 14th Street, was modeled to understand the source of flooding reported in Miller Park and on Miller Road. Runoff flowing overland from the reported issue at NE Sunset Loop (see Location ID 8 and 9 Modeling Areas) is contributing to the flooding at Miller Park and may contribute to Miller Road flooding. Potential improvement efforts in the Sunset Loop and Miller Park area may impact,

and/or be impacted by, the Heron Meadows trunk line capacity and infrastructure in the general area north of E Columbia Avenue and east of Bird Road. This location was identified in City staff surveys. See Attachment B, Figure B-10, for model extents.

- **Location ID 21–SE 9th/Icenogle Loop (Pioneer Crossing).** This area was modeled to better understand drainage patterns and conveyance capacity upstream and downstream of the Pioneer Crossing Facility, located at the corner of SE 9th Street and SE Vine Street. This area consists of the existing pipe along SE 9th Street from SE Elm Street to SE Vine Street, as well as the Pioneer Crossing facility. There is a secondary, high flow, outfall on SE 9th Street near the intersection with SE Uhlman Lane, which was also included in the model. See Attachment B, Figure B-7, for model extents.
- **Location ID 23–E Columbia Avenue.** Infrastructure along E Columbia Avenue, starting just west of Bird Road and extending east to its outfall is reported to be undersized for existing conditions. There is anticipated future development in the area which will increase conveyance capacity needs. Depending upon solutions to address the Sunset Loop problem area (see Location IDs 8 and 9 Modeling Areas), this system may require additional evaluation and upsizing to accommodate this area. This location was identified in City staff surveys and in the 1998 *Storm Drain System Master Plan*. See Attachment B, Figure B-10, for model extents.
- **Location ID 28–Callahan-Dutch Canyon Area.** Development in the Callahan-Dutch Canyon area has regularly occurred since 2007. Runoff from Phase III of the development (2019) is conveyed to a manhole that splits the flow, with half directed to an existing wetland and half to the existing linear retention (infiltration) basin. A StormFilter™ vault provides water quality prior to discharge to the wetland. Runoff from Phases I and II are conveyed directly to the retention (infiltration) basin. Additional development is anticipated, and the capacity of the existing wetland and retention facility is currently unknown. Additionally, natural drainage patterns west of the wetland result in flow overtopping Dutch Canyon Road. Modeling is needed to evaluate the capacity of the system as a whole and size future infrastructure (i.e., culverts) to improve conveyance and reduce roadway flooding at multiple locations within the system.

  Flooding of the infiltration facility was reported during the February 2019 storm event and retrofit of the existing retention (infiltration) facility may be required to accommodate future development. This location was identified in City staff surveys and in the 1998 *Storm Drain System Master Plan*. See Attachment B, Figure B-13, for model extents.
- **Location ID 29–Keys Road Basin.** This location consists of existing stormwater infrastructure and ditch conveyance along Keys Road, Huser Lane, and SW EM Watts Road, which drain east and outfall into South Scappoose Creek. Capacity issues have been reported and future development is anticipated in the catchment area. This location was identified in City staff surveys. See Attachment B, Figure B-14, for model extents.

4.2 Category 2 Modeling Locations

Category 2 modeling locations reflect areas where sizing of new or proposed infrastructure is needed to eliminate an existing problem area. There is limited or no existing infrastructure to evaluate, and as such, hydraulic modeling for these locations will be addressed with CIP development and documented in the SMP. These areas are further detailed in TM1, Attachment A-1. Locations 8, 9, 18b, and 29 were initially designated as Category 2 in TM1 but changed to Category 1 during the hydraulic modeling effort.

- **Location ID 18a–SW JP West Road east of South Scappoose Creek.** This location includes SW JP West Road between Hwy 30 and South Scappoose Creek and the area south of JP West Road to SW Maple Street, all of which currently lack stormwater infrastructure. SW JP West Road is a priority for transportation improvements east of the creek, and development is anticipated in the area. This location was identified in City staff surveys and in the 1998 *Storm Drain System Master Plan*.

- **Location ID 31–NW EJ Smith Road west of South Scappoose Creek.** This location consists of the section of NW EJ Smith Road between NW Shoemaker Road and South Scappoose Creek, which currently lacks stormwater infrastructure. A large, City-owned parcel of land provides a potential opportunity for a new regional facility to accommodate significant development anticipated in the area. This location was identified in City staff surveys.

4.3 Conveyance Naming Conventions

Storm structures, including manholes, catch basins, ditch inlets, and discharges (which include outfalls and ditch outlets), are identified in the City's GIS database by their Facility ID. The Facility IDs of the outfalls are typically given a three- to five-letter ID, such as "SD03" or "PND03", with the letters corresponding to the outfall type. The Facility IDs for the remaining structures in the system that drain to that outfall are comprised of the outfall ID followed by a suffix based on the node structure type. For example, manholes upstream of outfall "PND03" would be called "PND03_MH01", "PND03_MH02", etc. The suffix assigned to catch basins is "CB##".

The City's conduits, which include pipes, culverts, ditches, drains, swales, detention facilities, and infiltration facilities, each have a unique Facility ID with the form "SD####". The conduit IDs are not related to the structure IDs.

In the model, the GIS Facility IDs for links and nodes are preserved as the conduit/node name. However, based on field survey results and to accommodate flow routing and complete hydraulic modeling, conduits or nodes were added to the model that did not previously exist in the City's GIS database. For these manually added nodes, the outfall-based naming convention for each branch of the system was preserved and a suffix of "N##" was added. Manually added conduits not included in the City's GIS were named by the upstream node name followed by an underscore and the downstream node name.

4.4 Datum

All data used in modeling efforts are assumed to be in North American Vertical Datum of 1988 (NAVD 88). City GIS data originally in other datums were converted to NAVD 88, according to the process detailed in TM1.

4.5 Survey Needs and Data Processing

Based on the modeling extents established after the workshop held on October 13, 2020, BC created a spreadsheet of survey needs required to fill data gaps, which included missing pipe diameters, materials, and invert elevations. Survey needs were generated only for infrastructure within the Category 1 model extents and where interpolation or engineering judgement could not be used to rectify data gaps. The survey needs spreadsheet also included structures whose rim elevations would inform decisions related to datum resolution discrepancies described in Section 2.2.1 of TM1.

The survey needs spreadsheet was sent to the City on November 25, 2020. It was returned on January 6, 2021, with the requested surveyed data collected by a surveyor contracted by the City. BC manually entered the surveyed data into GIS to create the final set of GIS data used for the hydraulic model build.

Before importing the pipe system GIS data into PCSWMM, several GIS operations were used to populate the attributes necessary for the model build. First, fittings or direct connections, which do not have unique IDs in the City's GIS, were assigned IDs based on the nomenclature of their system branch. Next, an automated method was used to assign the upstream and downstream node IDs to each conduit. Finally, vertical data was associated with the PCSWMM structures and any remaining missing node rim elevations were filled using LiDAR.

BC staff conducted a supplementary site visit on July 16, 2021, to verify a few inconsistencies with the system configuration in select locations and to document some infrastructure details before finalizing the existing conditions model. Data collected (i.e., culverts and ditch dimensions, infrastructure depths and associated invert elevations, and overall drainage patterns) were used to verify pipe routing. Relevant photos and notes from the site visit are documented in Attachment C of this TM.

4.6 Hydraulic Input Parameters

PCSWMM hydraulic input parameters include conduit (i.e., pipe/culvert or open channel) name, upstream (i.e., US) and downstream (i.e., DS) node information (i.e., name, invert elevation, rim elevation), conduit length, conduit slope, conduit shape, material, and diameter. The following sections describe the model input parameters required for development of the hydraulic models. Refer to Tables A-2 and A-3 in Attachment A for conduit and node parameters for modeled infrastructure.

4.6.1 Node Data

Model nodes include structures such as manholes, catch basins, outfalls, and fittings, as defined in the City's GIS. Other relevant connection points in the system not defined in the GIS are included in the model as nodes. Model node attributes are listed in Table 5.

Table 5. Model Node Attributes

Attribute	Value
ID	The ID is maintained from the City's GIS or assigned based on the nomenclature of the system branch.
Invert elevation	Invert elevation of the junction in feet.
Rim elevation	Elevation at the ground level in feet.
Ponded area	Area anticipated to be occupied by ponded water atop the junction after flooding occurs, in square feet. For modeling, this allows ponded water to be stored and subsequently returned to the drainage system when capacity exists.
Invert interpolated	Custom field added by BC to record where interpolation was used to fill a missing invert elevation. "1" indicates the invert elevation was filled using linear interpolation.

4.6.2 Conduit Data

Model conduits include pipes, culverts, and open channels. The length of each modeled conduit was originally provided in the City's GIS. Where conduits were extended or combined with other segments as necessary to ensure continuity in the system, revised conduit lengths were directly calculated using GIS. Conduit slopes are calculated in PCSWMM using the inlet and outlet elevations as well as the conduit length. Manning's roughness coefficient "n" is dependent on the surface material of the conduit.

Table 6 provides a list of the roughness values used.

Table 6. Conduit Model Roughness	
	Manning's *n* roughness coefficient:
Pipe Material and Open Channel	• Concrete pipe (C): 0.013 • Corrugated metal pipe (CMP): 0.024 • Corrugated Polyethylene Pipe (CPP): 0.020 • Ductile Iron Pipe (DI): 0.013 • HDPE: 0.011 • PVC: 0.011 • C900: 0.011 • SRP: 0.013 • Open channel–ditches/path: 0.030 • Open channel–infiltration facility: 0.03

4.6.3 Stormwater Facility Data

Per discussion with the City during the identification of model extents, BC included three stormwater facilities in the hydraulic model (i.e., Dutch Canyon retention (infiltration) facility, Dutch Canyon wetland, and Pioneer Crossing facility).

The Dutch Canyon infiltration facility was modeled as a linear storage facility with the dimensions listed in design reports provided by the City. The infiltration component was modeled utilizing the design infiltration rate of 160 inches per hour (in/hr). The infiltration rate was modified during the validation process down to 45 in/hr (see Section 5.2 of this TM for more detail).

The Dutch Canyon wetland was modeled as a storage facility using available as-built plans and LiDAR data flown in 2020. A constant infiltration rate of approximately 48 in/hr was assumed to account for the infiltration that occurs in the area, as no measured rate was provided.

The Pioneer Crossing facility is a combined, water quality, infiltration, and detention facility. However, the facility was modeled only as a detention facility for a conservative approach and no infiltration data was available. This approach was validated by comparing model results during the February 2019 storm event to photographs taken of the facility during this event. Both the model results and the photos revealed no flooding during the storm event (see Section 5.2 of this TM for more detail).

Table 7 lists source data and model information for each of the three storage or infiltration elements used to represent stormwater features.

Table 7. Modeled Storage or Infiltration Elements			
Storage Node	Location	Source Geometry Data	Modeling Approach
Dutch Canyon infiltration facility	Along SW Old Portland Road between SW Holland Drive and SW Callahan Road	• Geometry and design infiltration rate from Dutch Canyon Phase I storm report • Geometry verification during site visit on July 16, 2021 • Infiltration rate adjusted from design rate of 160 in/hr to 45 in/hr during model validation[a]	Linear Storage with infiltration
Dutch Canyon wetland	Between SW Dutch Canyon Road and SW Rotterdam Street, east of SW Randstad Street	• Extents approximated from as-built plans for Dutch Canyon Estates[a] • Stage-storage curve extracted via CAD surface created from LiDAR • Infiltration rate of 48 in/hr	Storage with infiltration
Pioneer Crossing facility	Corner of SE 9th Street and SE Vine Street	• Pioneer Crossing No. 2 as-built plans • No infiltration assumed	Storage only (detention)

a. See Section 5.2 of this TM.

Section 5: Model Quality Control, Refinement, and Results

PCSWMM was used to simulate the 2-, 5-, 10-, and 25-year, 24-hour design events for current and future development conditions. Hydrologic and hydraulic results of the model simulations are tabulated in Attachment A, Table A-1 for hydrology and Tables A-2 and A-3 for hydraulics.

5.1 Model Quality Control

A comprehensive model review was conducted on July 26, 2021, following the model build and incorporation of survey data collected during the July 16, 2021, site visit. This review included both hydrology and hydraulics. The hydrology review and hydrologic revisions to the model were made prior to the hydraulics review. Notes from model reviews were tracked in a quality assurance/quality control spreadsheet to ensure completeness.

System hydrology was reviewed to ensure subbasins were delineated to a scale necessary to inform the needed hydraulic model level of detail. Hydrologic input parameters by subbasin were verified against GIS calculations to ensure parameter values are consistent with the supporting spatial, topographic, soil, and land use data.

The hydraulic model review included review of the hydraulic profile of the conveyance systems, confirmation of rim and invert data, application and use of weirs, orifices, and other infrastructure that require a more detailed modeling approach.

5.2 Model Validation

Model validation was conducted using a rainfall event that occurred from February 9, 2019, to February 15, 2019. The City provided time-stamped photos and videos taken during this event at locations throughout the City. The rainfall record from February 9, 2019–February 15, 2019, for the Scappoose Industrial Airpark (station KSPB) was obtained from Meso West, a database maintained by the University of Utah in partnership with the National Oceanic and Atmospheric Administration. Using an R script, BC transformed the data into 15-minute intervals to ensure compatibility with PCSWMM. Then, BC verified that hourly, daily, and full period-of-record rainfall totals for the transformed data matched the raw data. This rainfall record was then run through the model to produce results for comparison with flooding photos.

Table lists characteristics of the validation storm.

Table 8. Validation Storm Characteristics	
Parameter	**Value**
Date Range	2/9/2019–2/15/2019
Rain Gage	Scappoose Industrial Airpark (KPSB)
Peak Intensity, in/hr	0.29
Total Rainfall Depth, inches	4.04

Model validation, as opposed to model calibration, was conducted because numerical flow monitoring data or flooding depth data was not available. BC compared the initial model results with the time stamped photos at four locations in the system to verify that the model also reported sustained node flooding at consistent locations. In general, the comparison of modeling results matched the flooding conditions seen in photographs at locations where comparisons were possible, therefore establishing a reasonable degree of confidence in model hydrologic- and hydraulic-input parameters and model performance.

- **Sunset Loop.** Model results confirmed surcharged catch basins in the roadway on Sunset Loop and the adjacent stretch of Miller Road resulting from failed UICs.
- **Miller Park.** Standing water observed at Miller Park and documented in photos was confirmed by model results.
- **Pioneer Crossing.** Model results for the Pioneer Crossing facility were compared to photos of the facility, which showed standing water but no overtopping. Results were consistent with photo documentation, showing ponded water in the facility but no overtopping. Section 4.6.3 provides more information on the model methodology for this facility.
- **Dutch Canyon Facility.** Photographs and video from the 2019 storm showed flooding from the south end of the Dutch Canyon Facility. Initial model results using the design infiltration rate of 160 in/hr did not show flooding of the facility during the validation rainfall event. Therefore, the modeled infiltration rate was reduced until results showed flooding at the facility during the same time period that flooding was photographed, at approximately 9 a.m. on February 12, 2019. The final infiltration rate used to model the facility was 45 in/hr, which represents approximately 28 percent of the reported design infiltration rate. This discrepancy is consistent with anecdotal evidence provided by the City of reduced facility performance.

Adjustments to the infiltration rate for the Dutch Canyon Facility were the only adjustments made to the model input parameters based on the model validation effort. No adjustments were made to hydrologic data.

5.3 Hydrologic Model Results

The hydrologic model results show that future land use conditions (and associated increased imperviousness) result in increased peak flows. The increase in peak flows is most significant during the 2-year storm and gradually becomes less pronounced with larger storm events. As the only change in hydrology between the existing and future condition is the shifted impervious percentages representing the conversion or development of developable (vacant) land to the underlining zoning category, the increase in peak flows for a given subbasin is due entirely to anticipated future development and the resulting increase in impervious percentage.

Among the largest increases in flow due to development are the subbasins in the airport overlay areas, which have large, currently undeveloped areas that are predicted to shift to Airport Business Park, Airport Industrial Park, or Airport Employment zoning, significantly increasing the impervious area.

The area between North Road and Miller Road, bounded to the south by E Columbia Avenue, also shows significant increases in future flows due to development, as does the area west of Keys Road.

The hydrologic model results show minimal to no increases in future flows for subbasins that are almost fully developed, such as those along Hwy 30 and in recently developed sections of the Callahan-Dutch Canyon area.

Results of the hydrologic simulations for all events and subbasins are tabulated in Attachment A, Table A-1. Results are displayed as maximum flows within each subbasin for each design storm. Attachment A, Table A-1 also provides the percent increase in peak flow between the existing and future development conditions for each subbasin.

5.4 Hydraulic Model Results

For the purposes of this study, “flooding” is defined as the hydraulic grade line reaching the node rim elevation. While the City’s design standards require 1-ft minimum freeboard between the hydraulic grade line and the node rim elevation, flooding occurrences for the analyzed infrastructure were widespread and warranted a focus on those system with hydraulic grade lines at or above the node rim elevation.

The infrastructure modeled in this study is primarily evaluated for the 25-year storm design event, per City standards. Therefore, model results from simulating the 25-year storm are the focus of the discussion below and figures depicting model results. Additionally, information regarding results from the 2-, 5-, and 10-year storms is also included to identify portions of the stormwater system susceptible to more frequent flooding.

In general, the hydraulic model results confirm deficiencies at the problem areas and capacity-limited areas identified by City staff or identified in the 1998 *Storm Drain System Master Plan* and provide additional information about potential sources of flooding.

Hydraulic modeling results are tabulated in Attachment A, Tables A-2 and A-3. Results are displayed as the maximum water surface elevation and maximum peak flows for existing and future conditions for each modeled conduit. Discussion of hydraulic model results for each of the Category 1 modeling areas is included below. Model nodes that report flooding during the 25-year storm and their connected conduits are shown in Attachment B, Figures B-7 through B-12.

- **Location ID 3–SE Elm Street at SE Endicott Lane.** Existing condition hydraulic model results confirm capacity issues from the south end of SE 9th Street to SE Casswell Drive. The existing 24-inch main in SE Elm Street shows significant node flooding during the 25-year storm, starting downstream of SE 9th Street. Nodes between SE 9th Street and SE Casswell report flooding during the 5-year storm. Model hydraulic grade line (HGL) results indicate the entire line may be under capacity, rather than one constricting pipe causing backwater conditions. See Attachment B, Figure B-7.
- **Location ID 4–SE High School Way at SE 5th Street.** Initial existing condition hydraulic model results do not report flooding at the ditch along the north side of SE High School Way during any storm under either existing or future land use conditions. This likely indicates that future subbasin revisions are necessary to incorporate flow from the subbasin that contains Otto Peterson and Grant Watts elementary schools in order to replicate reported capacity deficiencies in this area. See Attachment B, Figure B-8.
- **Location ID 6–NW EJ Smith Road and NW 1st Street.** Existing condition hydraulic model results are consistent with reported capacity issues at the corner of NW EJ Smith Road and NW 1st Street, with node flooding beginning in the 5-year storm event. With existing capacity issues and development expected, conduit upsizing is likely necessary. Flooding is also reported at the upstream nodes in the line starting

during the 5-year storm event, which may be due to subbasin outlet node placement. Review of hydraulic profile results for the 25-year event suggest that the main capacity limitation occurs when the line turns onto NW EJ Smith Road and the pipe grade flattens. See Attachment B, Figure B-9.

- **Location IDs 8 and 9–Sunset Loop.** Existing condition hydraulic model results in this area report flooding during the 2-year existing condition scenario at the failing UIC locations on Sunset Loop, which overflow to Miller Park via the concrete walkway between 34353 and 34361 NE Sunset Loop. The severity of flooding is increased during the future condition. One limitation of the model that should be noted is that zero infiltration was assumed at these failing UICs. See Attachment B, Figure B-10, for model extents.
- **Location ID 15–SW Creek View Place.** Existing condition hydraulic model results in this area show flooding at the upstream ends of each branch of the system, starting at varying storms. Flooding is not reflected at the downstream ends near the outfall as was initially reported. This modeled flooding may be due to subbasin routing in the model, and therefore less indicative of a capacity limitation in this area. No additional nodes flood in the future condition, and the minimum flooding storm remains unchanged in the future for five of six nodes that flood in the existing condition. Therefore, anticipated development in this area is not significantly affecting the degree of modeled flooding. See Attachment B, Figure B-11.
- **Location ID 18b–SW JP West Road west of South Scappoose Creek.** Existing condition hydraulic model results show flooding at select nodes in the system during the 5-, 10-, or 25-year storm. Capacity restrictions for this area are therefore less of a concern than the lack of infrastructure at the upstream end of the system and lack of piped infrastructure at the downstream end. Significant anticipated development in the area is expected to worsen flooding in the future condition, with nodes flooding at increased frequency, although no additional nodes are predicted to flood. See Attachment B, Figure B-12, for model extents.
- **Location ID 19–Miller Park.** Existing condition hydraulic model results are consistent with observed flooding issues. The model reports flooding where the Heron Meadows trunk line daylights in Miller Park during the 2-year storm, as well as on the NE Egret Lane and NE Raenna Lane branches beginning during the 5-year storm. This flooding may be due to capacity limitations in the system. See Attachment B, Figure B-10.
- **Location ID 21–SE 9th/Icenogle Loop (Pioneer Crossing).** Existing condition hydraulic results for the SE 9th Street system and Pioneer Crossing facility show widespread flooding during the 25-year storm. However, the reported hydraulic grade line indicates that this "flooding" is due to backwater from the capacity issue in the SE Elm Street system mentioned above (Location ID 3 above). In reality, flooding would likely occur along Elm Street, allowing water to leave the system and not back up into the SE 9th Street system.

  Model validation efforts indicates the Pioneer Crossing facility had adequate capacity during the February 2019 storm event, which is consistent with documented pictures from the event. Model results also show the facility to have adequate capacity to manage flows from the 25-year storm event in both the existing and future land use condition, as no backwater is observed in the system upstream of the facility. See Attachment B, Figure B-7.
- **Location ID 23–E Columbia Avenue.** Existing condition hydraulic results for this location are consistent with reported capacity issues. The existing main shows significant roadway node flooding in the 25-year storm, starting just downstream of Miller Road. Single nodes at the most upstream point in the system and at the corners of Miller Road, SE Tyler Street, and Bird Road show flooding during the 5-year storm event. One additional node shows flooding during the 10-year storm event, before the entire system shows as under capacity during the 25-year storm event. Model HGL results indicate that the entire line may be under capacity, rather than one constricting pipe causing backwater. See Attachment B, Figure B-10.

- **Location ID 28–Callahan-Dutch Canyon Area.** Existing infrastructure was modeled for this location and used to validate model assumptions, as discussed in Section 5.2. Model results showed flooding from the Dutch Canyon Infiltration Facility during the 25-year storm, which is consistent with City observations during large events, such as the February 2019 storm.

  The model also reports capacity issues along SW Holland Drive and in the upstream area surrounding the control structure at the corner of SW Rotterdam Street and SW Holland Drive (node INF10_MH42) and the wetland itself. A single node (INF10_MH39) reports flooding during the 5-year storm event, which may be due to a relatively low rim elevation. More nodes around the control structure and at the upstream end of the infiltration facility show flooding during the 10-year storm event.

  The v-ditch that conveys flow from the control structure to the wetland may be limiting capacity as modeled. In reality, flow to this v-ditch would spill over into the wetland and not cause backwater conditions. Lack of infiltration data for the wetland is a limitation of this model, which may also contribute to the reported flooding. See Attachment B, Figure B-13.

  Future infrastructure to support future development in the Callahan-Dutch Canyon areas will be sized during Category 2 modeling.
- **Location ID 29–Keys Road Basin.** Existing condition hydraulic model results in this area show flooding at select capacity restriction points, both at the upstream end of the system and at two culverts along SW EM Watts Road. The flooding at the upstream end may be due to subbasin routing in the model, and therefore less indicative of a capacity limitation in this area. However, the culverts flooding along EM Watts are shown to be undersized, flooding during the 2- and 10-year storms in the existing condition, respectively. Flooding at these locations is not expected to significantly worsen in the future condition. See Attachment B, Figure B-14, for model extents.

5.5 Proposed Capital Project Development and Next Steps

Category 1 modeling locations and modeling results will be reviewed in detail as part of the City's CIP Planning Workshop. This workshop will confirm system upsizing needs and reconfiguration approaches to alleviate existing capacity deficiencies. Additionally, Category 2 model locations will be reviewed to confirm their need for continued consideration in the City's stormwater CIP. As part of the capital project development efforts, it is anticipated that additional modeling will be required to size and reconfigure select areas of the City's stormwater collection system.

Due to funding limitations, the City may prioritize certain Category 1 and 2 locations (and capital project needs) to ensure the highest priority locations are addressed within a defined timeframe. Based on the hydraulic model evaluation described in Section 5.4, the following Category 1 locations should be considered in the development of capital projects:

- location ID: 3 - SE Elm Street,
- location ID: 4 - SE High School Way and 5th Street,
- location ID: 6 - NW EJ Smith Road and NW 1st Street,
- location IDs: 8 and 9 - Sunset Loop,
- location ID: 18b - SW JP West Road west of South Scappoose Creek,
- location ID: 23 - E Columbia Avenue,
- location ID: 28 - Callahan-Dutch Canyon Area,
- location ID: 29 - Keys Road Basin

Location ID:15-SW Creek View Place, location ID:19-Miller Park, and location ID:21-SE 9th and Icenogle Loop likely do not require a capital project. SW Creek View Place should be evaluated upon development of the Bitte Property. Miller Park drainage has been addressed by the city however NE Sunset Loop contributes to the Miller Park flooding and therefore should be corrected. SE 9th and Icenogle Loop should be evaluated as part of the SE Elm Street project evaluation to verify conveyance capacity.

Project descriptions and detailed cost information will be developed for those highest priority capital projects. Additional information regarding the capital project development and prioritization process will be included in the SMP and accompanying stormwater utility rate and system development charge evaluation.

References

City of Scappoose, Oregon. Public Works Department. *Storm Drain System Master Plan.* November 1998.

Meso West. Weather Conditions for KSPB. Downloaded June 8, 2021. https://mesowest.utah.edu/cgi-bin/droman/meso_base_dyn.cgi?stn=KSPB

United States Department of Agriculture, Natural Resources Conservation Service. Soil Survey (SSURGO) Database for Columbia County, Oregon. 2016.

United States Environmental Protection Agency. *Storm Water Management Model User's Manual, Version 5.1.* September 2015.

United States Environmental Protection Agency. *Storm Water Management Model Reference Manual, Volume 1–Hydrology (Revised).* January 2016.

Attachment A: Hydrologic and Hydraulic Model Results

Table A-1. Hydrologic Model Results																							
				Impervious Area			Infiltration Parameters			Existing Subbasin Peak Flow (cfs)					Future Subbasin Peak Flow (cfs)					Percent Change in Subbasin Peak Flow (cfs)				
Subbasin Name	Outlet Node*	Area (acres)	Average Slope (%)	Existing Land Use (%)	Future Land Use (%)	Increase (%)	Saturated Hydraulic Conductivity (in/hr)	Initial Moisture Deficit (frac)	Average Capillary Suction (in)	2-yr, 24-hr	5-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr	2-yr, 24-hr	5-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr	2-yr, 24-hr	5-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr
AC_010	OF1	17.78	1.2	9.5	31.1	21.6	0.24	0.32	6.95	1.6	2.5	3.5	4.8	7.9	3.4	4.7	6.1	7.7	11.3	111%	91%	74%	62%	44%
AC_020	OF1	15.78	23.2	32.9	39.6	6.7	0.23	0.31	6.79	5.6	7.6	9.6	11.6	15.2	5.9	8.0	10.0	12.0	15.5	6%	5%	4%	3%	2%
CC_010	OF1	20.06	7.9	15.6	33.6	18.0	0.12	0.29	9.23	6.8	9.4	9.5	9.2	14.2	8.0	10.5	11.3	11.5	16.4	17%	12%	18%	26%	16%
CC_020	OF1	86.00	7.4	6.2	13.6	7.4	0.16	0.29	7.44	11.0	17.9	26.8	36.5	54.1	14.2	21.6	31.0	40.9	58.8	30%	21%	16%	12%	9%
JC_020	OF1	15.70	1.1	5.1	5.1	0.0	0.10	0.29	9.58	3.0	3.4	3.2	4.7	7.7	3.0	3.4	3.2	4.7	7.7	0%	0%	0%	0%	0%
JC_030	OF1	303.24	0.7	7.5	49.6	42.1	0.04	0.28	10.75	18.8	29.3	43.5	63.0	105.3	62.2	84.0	109.3	138.6	195.2	231%	187%	151%	120%	85%
JC_040_I	OF1	257.35	0.7	19.1	33.3	14.2	0.04	0.28	10.75	27.1	38.3	52.2	70.1	107.7	38.8	53.1	70.2	91.0	133.2	43%	39%	34%	30%	24%
JC_050_I	OF1	171.41	1.8	7.7	51.1	43.4	0.05	0.28	10.63	15.1	25.5	39.3	57.2	93.4	47.6	65.0	84.6	106.2	145.0	215%	155%	115%	86%	55%
JC_060_I	OF1	13.42	1.4	40.2	40.3	0.1	0.04	0.28	10.75	4.8	6.6	8.5	10.2	13.3	4.8	6.6	8.5	10.2	13.3	0%	0%	0%	0%	0%
JC_070_I	OF1	12.20	0.7	54.9	59.7	4.8	0.04	0.28	10.75	3.9	5.3	6.8	8.4	11.2	4.1	5.5	7.1	8.6	11.4	5%	4%	4%	2%	2%
JC_080_I	OF1	107.48	4.1	7.8	80.0	72.2	0.04	0.28	10.74	18.8	32.1	47.3	63.1	88.6	49.7	63.0	76.1	88.9	112.4	164%	96%	61%	41%	27%
JC_090	OF1	54.73	1.6	5.1	5.1	0.0	0.13	0.30	9.14	13.2	20.1	24.8	28.1	28.4	13.2	20.1	24.8	28.1	28.4	0%	0%	0%	0%	0%
JC_100	OF1	10.96	1.0	12.3	32.6	20.3	0.04	0.28	10.75	2.0	3.3	4.7	6.3	8.9	3.1	4.4	5.9	7.5	10.0	54%	36%	26%	18%	12%
JC_110_I	OF1	7.94	1.7	6.6	26.9	20.3	0.08	0.29	9.99	1.0	1.2	1.9	2.6	4.4	1.8	2.2	3.0	3.8	5.7	78%	84%	59%	48%	30%
JC_120	PND03_MH03	6.26	0.2	39.7	39.7	0.0	0.04	0.28	10.75	1.7	2.3	3.1	3.9	5.4	1.7	2.3	3.1	3.9	5.4	0%	0%	0%	0%	0%
JC_130	PND03_N01	33.54	1.7	16.9	38.9	22.0	0.06	0.28	10.35	4.6	6.9	10.0	13.7	21.5	8.1	11.1	14.8	18.9	26.9	75%	62%	48%	38%	25%
JC_140	OF1	13.76	1.8	17.2	39.6	22.3	0.07	0.29	10.17	2.0	3.3	4.5	6.2	9.6	3.6	5.0	6.5	8.3	11.7	75%	54%	44%	34%	21%
JC_150_I	OF1	13.85	1.9	32.8	40.0	7.1	0.04	0.28	10.75	4.1	6.0	7.9	9.8	12.9	4.5	6.4	8.3	10.2	13.3	10%	8%	5%	4%	3%
JC_160	DW03_CB02	1.34	0.9	40.0	40.0	0.0	0.04	0.28	10.75	0.5	0.7	0.9	1.1	1.4	0.5	0.7	0.9	1.1	1.4	0%	0%	0%	0%	0%
JC_170	DW04_CB02	7.51	1.6	30.8	40.0	9.2	0.04	0.28	10.75	2.6	3.7	4.8	5.8	7.5	2.9	3.9	5.0	6.0	7.7	9%	5%	5%	3%	2%
JC_180	D04_MH10	6.40	2.1	26.9	40.0	13.1	0.11	0.29	9.35	2.4	3.1	3.3	3.3	4.9	2.7	3.4	3.7	3.9	5.4	11%	9%	12%	16%	11%
JC_190	PND04_MH02	7.59	0.9	32.6	38.5	5.9	0.04	0.28	10.75	2.3	3.4	4.4	5.5	7.2	2.5	3.6	4.6	5.6	7.3	9%	6%	4%	3%	2%
JC_200	PND04_MH06	2.17	2.2	37.2	37.2	0.0	0.05	0.28	10.65	0.8	1.2	1.5	1.7	2.2	0.8	1.2	1.5	1.7	2.2	0%	0%	0%	0%	0%
JC_210	PND04_MH01	4.73	2.1	35.8	40.0	4.2	0.04	0.28	10.75	1.8	2.5	3.2	3.8	4.9	1.9	2.6	3.2	3.8	4.9	3%	2%	2%	1%	1%
JC_220	D04_MH05	1.21	1.3	32.8	32.8	0.0	0.06	0.28	10.39	0.4	0.5	0.7	0.9	1.2	0.4	0.5	0.7	0.9	1.2	0%	0%	0%	0%	0%
JC_230	D04_MH03	3.97	0.8	9.6	9.9	0.3	0.04	0.28	10.75	1.0	1.6	2.2	2.8	3.7	1.1	1.7	2.2	2.8	3.7	1%	1%	0%	0%	0%
JC_240	D04_MH01	8.19	1.4	19.2	40.0	20.8	0.10	0.29	9.57	2.4	2.8	2.8	3.7	5.5	3.1	3.6	3.9	4.9	6.7	29%	31%	40%	31%	22%
JC_250	D04_MH12	2.03	2.9	26.9	40.0	13.1	0.07	0.29	10.21	0.6	0.9	1.2	1.5	1.9	0.7	1.0	1.3	1.5	2.0	17%	11%	9%	6%	4%
JC_260	D04_MH11	32.27	1.7	30.6	41.6	11.1	0.11	0.29	9.42	8.6	12.2	13.5	13.6	20.4	10.0	13.8	15.6	16.2	23.3	17%	13%	15%	19%	14%
JC_270_I	OF1	42.35	1.1	51.9	53.1	1.2	0.04	0.28	10.75	15.1	20.7	26.3	31.9	41.3	15.3	20.9	26.5	32.1	41.5	1%	1%	1%	1%	0%
JC_280_I	OF1	52.41	1.4	47.0	47.6	0.6	0.08	0.29	10.05	14.9	18.1	23.8	29.0	40.9	15.0	18.3	23.9	29.2	41.1	1%	1%	1%	1%	0%
JC_290	OF1	49.40	0.5	5.0	5.0	0.0	0.10	0.29	9.53	4.5	6.4	5.3	7.5	12.5	4.5	6.4	5.3	7.5	12.5	0%	0%	0%	0%	0%
JC_300	PND07_MH16	23.98	0.8	25.0	38.9	14.0	0.07	0.29	10.22	4.1	6.0	8.0	10.6	16.2	5.6	7.9	10.2	13.0	18.7	38%	31%	27%	22%	15%
JC_310_I	PND07_MH37	4.52	1.9	39.7	40.0	0.3	0.08	0.29	10.05	1.7	2.0	2.7	3.2	4.3	1.7	2.0	2.7	3.2	4.3	0%	0%	0%	0%	0%
JC_311_I	PND07_MH46	2.84	2.6	40.0	40.0	0.0	0.05	0.28	10.62	1.1	1.5	1.9	2.3	2.9	1.1	1.5	1.9	2.3	2.9	0%	0%	0%	0%	0%
JC_312_I	PND07_MH39	4.32	1.7	39.8	40.0	0.3	0.09	0.29	9.85	1.8	1.9	2.5	3.2	4.1	1.8	1.9	2.5	3.2	4.1	0%	1%	0%	0%	0%
JC_320	PND07_MH27	6.83	1.2	25.0	40.0	15.0	0.04	0.28	10.75	1.9	2.9	3.9	4.8	6.4	2.4	3.3	4.3	5.2	6.7	22%	15%	10%	7%	6%
JC_330	PND07_MH08	14.88	2.0	25.0	40.0	15.0	0.17	0.30	8.36	4.3	6.1	8.0	9.9	12.8	5.2	7.1	9.0	10.8	13.8	22%	16%	12%	9%	8%
JC_340	PND13_MH04	7.03	1.9	32.8	40.0	7.2	0.17	0.30	8.35	2.5	3.4	4.3	5.1	6.5	2.7	3.6	4.4	5.3	6.8	8%	5%	4%	3%	3%
JC_350	PND13_MH04	17.64	1.8	46.2	46.2	0.0	0.17	0.30	8.29	6.0	8.1	10.3	12.5	16.2	6.0	8.1	10.3	12.5	16.2	0%	0%	0%	0%	0%
JC_360	OF1	99.41	1.6	6.0	6.0	0.0	0.12	0.30	9.23	26.1	38.7	38.5	33.0	55.3	26.1	38.7	38.5	33.0	55.3	0%	0%	0%	0%	0%
JC_370	OF1	27.31	1.6	39.9	39.9	0.0	0.04	0.28	10.74	9.1	12.8	16.6	20.2	26.3	9.1	12.8	16.6	20.2	26.3	0%	0%	0%	0%	0%
JC_380	PND01_D02	3.50	2.4	73.7	73.7	0.0	0.18	0.31	8.06	1.7	2.1	2.5	3.0	3.7	1.7	2.1	2.5	3.0	3.7	0%	0%	0%	0%	0%
JC_381	OF1	12.96	4.4	63.5	63.5	0.0	0.04	0.28	10.75	6.0	7.8	9.4	11.0	13.9	6.0	7.8	9.4	11.0	13.9	0%	0%	0%	0%	0%
JC_390_I	OF1	19.25	1.1	40.3	40.3	0.0	0.26	0.32	6.66	4.8	6.5	8.4	10.4	14.6	4.8	6.5	8.4	10.4	14.6	0%	0%	0%	0%	0%
JC_400	OF1	16.84	1.6	40.1	41.6	1.5	0.26	0.32	6.57	4.6	6.2	8.0	9.9	13.7	4.7	6.3	8.1	10.1	13.9	2%	2%	2%	2%	1%
JC_410	OF1	15.69	2.4	74.0	74.0	0.0	0.22	0.31	7.42	6.8	8.7	10.6	12.4	15.8	6.8	8.7	10.6	12.4	15.8	0%	0%	0%	0%	0%
JC_420_I	OF1	17.05	2.2	48.5	48.5	0.0	0.21	0.31	7.61	6.0	8.1	10.2	12.3	16.1	6.0	8.1	10.2	12.3	16.1	0%	0%	0%	0%	0%
JC_430	PND02_N03	5.90	3.4	74.0	74.0	0.0	0.26	0.32	6.57	2.8	3.5	4.2	5.0	6.2	2.8	3.5	4.2	5.0	6.2	0%	0%	0%	0%	0%
JC_431	PND01_N01	2.99	2.6	74.0	74.0	0.0	0.26	0.32	6.58	1.4	1.8	2.2	2.5	3.2	1.4	1.8	2.2	2.5	3.2	0%	0%	0%	0%	0%
JC_440_I	DW37_CB04	3.57	6.1	74.0	74.0	0.0	0.18	0.31	8.01	1.8	2.3	2.7	3.1	3.9	1.8	2.3	2.7	3.1	3.9	0%	0%	0%	0%	0%
JC_450_I	DW37_CB01	5.90	4.5	74.0	74.0	0.0	0.06	0.28	10.35	2.8	3.6	4.3	5.0	6.4	2.8	3.6	4.3	5.0	6.4	0%	0%	0%	0%	0%
JC_460	OF1	10.44	2.6	70.2	70.2	0.0	0.17	0.30	8.32	4.8	6.1	7.3	8.6	10.9	4.8	6.1	7.3	8.6	10.9	0%	0%	0%	0%	0%
JC_470	OF1	7.13	1.3	71.2	72.0	0.7	0.04	0.28	10.75	3.3	4.2	5.1	6.0	7.6	3.3	4.2	5.1	6.0	7.6	1%	0%	0%	0%	0%
JC_480_I	OF1	1.58	3.7	67.4	69.6	2.2	0.04	0.28	10.75	0.8	1.0	1.2	1.4	1.7	0.8	1.0	1.2	1.4	1.7	1%	1%	1%	1%	1%
JC_490	OF1	51.46	2.3	43.7	46.9	3.3	0.12	0.30	9.19	18.9	25.3	28.2	30.0	39.8	19.4	25.8	29.0	31.0	41.1	3%	2%	3%	4%	3%
JC_500	OF1	7.84	1.4	40.0	40.0	0.0	0.04	0.28	10.75	2.5	3.6	4.7	5.7	7.5	2.5	3.6	4.7	5.7	7.5	0%	0%	0%	0%	0%
JC_510	OF1	16.02	2.2	45.3	45.3	0.0	0.10	0.29	9.64	6.1	7.5	8.2	10.3	13.9	6.1	7.5	8.2	10.3	13.9	0%	0%	0%	0%	0%
JC_520	OF1	3.01	4.4	49.4	74.0	24.6	0.15	0.30	8.74	1.4	1.8	2.1	2.5	2.8	1.5	1.9	2.3	2.6	3.1	10%	7%	6%	5%	10%
JW_020	OF1	38.89	1.5	22.6	41.4	18.8	0.15	0.30	8.70	7.6	11.2	15.3	19.6	17.7	10.6	14.7	19.1	23.7	24.2	39%	31%	25%	21%	37%
JW_030	OF1	75.48	2.0	55.0	61.6	6.7	0.06	0.28	10.33	21.9	29.1	37.6	46.8	64.3	23.7	31.2	40.0	49.3	66.6	8%	7%	6%	5%	4%
JW_040_I	INF10_CB26	5.90	2.5	37.4	37.4	0.0	0.04	0.28	10.75	1.8	2.6	3.4	4.2	5.6	1.8	2.6	3.4	4.2	5.6	0%	0%	0%	0%	0%
JW_041	OF1	18.63	5.5	7.0	19.8	12.8	0.13	0.30	9.03	3.5	5.6	7.8	7.6	7.9	4.7	6.9	9.1	9.3	10.2	32%	22%	17%	22%	28%
JW_050_I	INF10_MH05	14.84	3.7	32.9	43.0	10.1	0.04	0.28	10.75	5.1	7.3	9.3	11.3	14.7	5.7	7.7	9.8	11.8	15.2	11%	7%	5%	4%	3%
JW_060_I	INF10_MH20	5.34	8.1	30.0	37.9	7.9	0.04	0.28	10.75	2.2	2.9	3.6	4.3	5.5	2.3	3.0	3.7	4.4	5.6	5%	3%	2%	2%	1%
JW_070_I	INF10_MH21	3.75	5.5	39.5	39.5	0.0	0.04	0.28	10.75	1.6	2.1	2.6	3.1	3.9	1.6	2.1	2.6	3.1	3.9	0%	0%	0%	0%	0%
JW_080_I	INF10_MH39	21.00	7.2	7.3	7.3	0.0	0.14	0.30	8.84	4.6	7.3	10.0	12.5	10.7	4.6	7.3	10.0	12.5	10.7	0%	0%	0%	0%	0%
JW_081_I	INF10_MH44	4.57	7.0	8.1	8.1	0.0	0.12	0.30	9.22	1.4	2.0	2.1	1.9	3.0	1.4	2.0	2.1	1.9	3.0	0%	0%	0%	0%	0%
JW_090_I	INF10_N01	25.69	7.1	14.9	17.9	3.1	0.19	0.31	7.91	5.7	8.6	11.9	15.2	21.0	6.1	9.0	12.3	15.6	21.4	6%	5%	4%	3%	2%
JW_100_I	INF10_MH47	10.76	7.6	6.0	6.0	0.0	0.19	0.31	7.95	2.2	3.5	4.9	6.3	8.7	2.2	3.5	4.9	6.3	8.7	0%	0%	0%	0%	0%
NS_020	OF1	217.10	0.9	21.2	40.5	19.3	0.11	0.29	9.46	40.8	56.1	67.7	67.7	105.5	57.9	77.0	92.9	98.4	141.9	42%	37%	37%	45%	34%

Table A-1. Hydrologic Model Results

Subbasin Name	Outlet Node*	Area (acres)	Average Slope (%)	Impervious Area			Infiltration Parameters			Existing Subbasin Peak Flow (cfs)					Future Subbasin Peak Flow (cfs)					Percent Change in Subbasin Peak Flow (cfs)				
				Existing Land Use (%)	Future Land Use (%)	Increase (%)	Saturated Hydraulic Conductivity (in/hr)	Initial Moisture Deficit (frac)	Average Capillary Suction (in)	2-yr, 24-hr	5-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr	2-yr, 24-hr	5-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr	2-yr, 24-hr	5-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr
NS_030	OF1	100.12	3.5	19.5	19.8	0.3	0.14	0.30	8.78	19.4	29.0	39.7	42.6	43.7	19.5	29.2	39.8	42.8	44.0	1%	1%	0%	1%	1%
SS_010	OF1	29.70	4.4	10.2	28.5	18.3	0.20	0.31	7.76	9.1	12.9	16.7	20.5	27.2	10.8	14.5	18.4	22.2	28.8	18%	13%	11%	8%	6%
SS_020	OF1	66.51	5.6	21.6	34.6	12.9	0.20	0.31	7.70	14.3	20.7	28.1	36.6	51.6	18.3	25.3	33.2	41.7	56.6	28%	23%	18%	14%	10%
SS_030	OF1	8.96	2.8	20.0	29.9	9.9	0.08	0.29	10.04	2.4	2.7	4.0	5.0	7.3	2.7	3.2	4.5	5.5	7.7	17%	18%	12%	10%	6%
SS_040	OF1	19.67	0.4	71.1	72.8	1.7	0.04	0.28	10.75	5.4	7.1	9.1	11.2	15.1	5.4	7.2	9.2	11.3	15.1	1%	1%	1%	1%	0%
SS_051	SSC17_F07	7.80	2.5	72.4	74.0	1.6	0.04	0.28	10.75	3.6	4.6	5.6	6.5	8.3	3.6	4.6	5.6	6.6	8.3	1%	1%	0%	0%	0%
SS_052	SSC17_F02	7.02	2.5	47.4	63.5	16.2	0.05	0.28	10.57	2.6	3.5	4.5	5.4	7.1	3.0	3.9	4.9	5.8	7.4	16%	11%	9%	6%	4%
SS_060_I	OF1	4.01	3.3	71.4	74.0	2.6	0.04	0.28	10.75	2.0	2.5	3.0	3.5	4.4	2.0	2.5	3.0	3.5	4.4	1%	1%	1%	1%	0%
SS_070	OF1	21.44	7.5	20.2	37.1	17.0	0.20	0.31	7.69	5.4	7.8	10.5	13.3	18.1	7.0	9.5	12.2	15.0	19.7	30%	22%	17%	12%	8%
SS_080	OF1	5.84	10.2	14.0	40.0	26.0	0.26	0.32	6.57	1.5	2.2	2.9	3.6	5.0	2.1	2.8	3.5	4.3	5.6	39%	27%	21%	17%	12%
SS_090	OF1	26.08	18.3	30.3	36.9	6.5	0.26	0.32	6.57	7.5	10.4	13.6	16.9	22.8	8.2	11.2	14.4	17.6	23.7	10%	8%	6%	4%	4%
SS_100	OF1	7.45	2.3	5.4	5.4	0.0	0.25	0.32	6.37	1.3	2.1	3.0	3.9	5.7	1.3	2.1	3.0	3.9	5.7	0%	0%	0%	0%	0%
SS_110	OF1	8.68	3.3	5.1	19.3	14.2	0.15	0.30	8.61	2.2	3.4	4.5	5.6	5.9	2.7	3.9	5.0	6.0	6.7	23%	14%	10%	8%	12%
SS_120	OF1	24.07	13.4	27.9	35.0	7.1	0.18	0.29	7.40	6.6	9.3	12.4	15.4	20.7	7.3	10.1	13.2	16.2	21.5	12%	9%	7%	5%	4%
SS_130	OF1	16.70	7.8	26.6	33.7	7.0	0.23	0.32	7.07	4.4	6.2	8.2	10.3	14.2	4.9	6.8	8.8	10.9	14.7	12%	10%	7%	6%	4%
SS_140	OF1	7.72	27.3	25.9	34.8	8.9	0.21	0.30	6.94	2.6	3.5	4.5	5.5	7.3	2.8	3.7	4.8	5.8	7.5	9%	6%	6%	4%	3%
SS_160	OF1	6.75	2.7	18.0	20.1	2.1	0.21	0.31	7.49	1.8	2.7	3.5	4.4	5.9	1.9	2.7	3.6	4.5	5.9	3%	2%	2%	1%	1%
SS_170	OF1	13.38	2.0	22.7	28.4	5.7	0.20	0.31	7.68	3.3	4.8	6.4	8.2	11.2	3.7	5.1	6.8	8.6	11.5	11%	8%	7%	5%	3%
SS_180	OF1	6.32	5.0	6.1	6.1	0.0	0.26	0.32	6.64	1.6	2.4	3.1	3.9	5.4	1.6	2.4	3.1	3.9	5.4	0%	0%	0%	0%	0%
SS_190	OF1	9.30	5.1	16.9	26.1	9.2	0.15	0.30	8.73	3.0	4.2	5.4	6.5	6.5	3.3	4.5	5.7	6.8	7.1	10%	7%	5%	4%	8%
SS_200	SSC15_CB12	2.46	6.3	26.8	34.9	8.0	0.14	0.30	8.93	1.0	1.3	1.6	1.9	2.1	1.1	1.4	1.7	1.9	2.2	5%	3%	3%	3%	5%
SS_210	SSC15_MH05	5.68	11.6	38.7	40.0	1.3	0.26	0.32	6.57	2.1	2.8	3.5	4.2	5.5	2.1	2.8	3.5	4.2	5.5	1%	1%	1%	1%	0%
SS_220	SSC15_CB08	0.34	12.4	40.0	40.0	0.0	0.26	0.32	6.57	0.1	0.2	0.2	0.3	0.3	0.1	0.2	0.2	0.3	0.3	0%	0%	0%	0%	0%
SS_221	SSC15_N01	1.75	13.7	29.7	40.0	10.3	0.26	0.32	6.57	0.6	0.8	1.0	1.2	1.6	0.6	0.9	1.1	1.3	1.7	12%	10%	7%	5%	4%
SS_230	SSC15_CB10	3.05	11.3	30.6	40.0	9.5	0.26	0.32	6.57	1.0	1.4	1.8	2.2	2.9	1.1	1.5	1.9	2.3	3.0	11%	8%	6%	4%	3%
SS_240	OF1	4.46	7.0	19.2	40.0	20.8	0.26	0.32	6.57	1.3	1.8	2.4	2.9	4.0	1.6	2.2	2.7	3.3	4.3	26%	19%	16%	12%	8%
SS_250	OF1	2.26	5.3	32.2	40.0	7.8	0.26	0.32	6.57	0.7	1.0	1.3	1.6	2.1	0.8	1.1	1.4	1.7	2.2	8%	7%	5%	4%	3%
SS_260	OF1	5.67	2.6	46.8	47.5	0.7	0.05	0.28	10.63	2.0	2.8	3.6	4.3	5.7	2.1	2.8	3.6	4.4	5.7	1%	1%	1%	0%	0%
SS_270	OF1	64.38	8.6	15.4	27.2	11.7	0.25	0.32	6.84	12.1	18.3	25.4	33.3	48.5	15.8	22.4	29.9	37.8	52.8	30%	23%	18%	14%	9%
SS_280	OF1	18.88	1.2	25.8	26.5	0.8	0.13	0.30	9.12	5.2	7.4	9.6	10.2	11.1	5.2	7.5	9.7	10.3	11.2	1%	1%	1%	1%	1%
SS_290	OF1	30.38	1.4	64.3	64.9	0.6	0.04	0.28	10.75	12.6	16.6	20.5	24.3	31.0	12.7	16.6	20.6	24.3	31.0	0%	0%	0%	0%	0%
SS_300	SSC09_CB18	2.94	7.3	20.9	20.9	0.0	0.14	0.30	8.90	1.2	1.6	2.0	2.2	2.5	1.2	1.6	2.0	2.2	2.5	0%	0%	0%	0%	0%
SS_310	SSC09_D11	8.79	12.6	23.8	39.8	15.9	0.23	0.31	6.91	2.7	3.8	4.9	6.0	8.0	3.2	4.3	5.4	6.6	8.5	19%	13%	11%	9%	6%
SS_320	SSC09_MH09	6.51	4.5	13.4	15.7	2.3	0.22	0.31	6.86	1.6	2.4	3.2	4.0	5.5	1.6	2.4	3.2	4.1	5.6	4%	3%	2%	1%	1%
SS_330	SSC09_F02	3.72	9.5	31.8	40.0	8.2	0.14	0.28	7.47	1.6	2.1	2.6	3.0	3.4	1.7	2.2	2.6	3.1	3.5	4%	3%	2%	2%	3%
SS_340	SSC09_N01	13.09	2.6	16.5	40.0	23.6	0.26	0.32	6.57	2.4	3.6	5.1	6.6	9.7	3.9	5.3	6.9	8.5	11.5	61%	46%	35%	28%	18%
SS_350	SSC09_D07	1.62	15.1	9.2	40.0	30.8	0.19	0.31	7.82	0.6	0.8	1.0	1.2	1.5	0.7	0.9	1.1	1.3	1.6	24%	17%	12%	9%	7%
SS_360	OF1	22.64	1.2	46.1	59.5	13.4	0.04	0.28	10.68	6.5	9.0	11.8	14.9	20.1	7.7	10.3	13.2	16.2	21.2	18%	15%	12%	9%	6%
SS_370	OF1	1.66	5.4	10.3	18.6	8.3	0.17	0.30	8.23	0.6	0.8	1.0	1.2	1.6	0.6	0.8	1.1	1.3	1.6	5%	5%	3%	2%	2%
SS_380	OF1	9.58	4.8	14.2	19.2	4.9	0.10	0.29	9.65	3.3	4.0	4.1	5.5	7.6	3.5	4.2	4.3	5.7	7.8	5%	5%	6%	4%	3%
SS_390	SSC08_CB05	10.54	3.4	29.5	37.5	8.0	0.05	0.28	10.49	3.3	4.6	6.1	7.5	10.1	3.6	4.9	6.4	7.9	10.4	10%	7%	5%	5%	3%
SS_400	SSC07_F01	19.99	1.8	20.2	64.9	44.7	0.04	0.28	10.68	4.0	6.2	8.8	11.6	16.4	7.8	10.4	13.0	15.6	19.9	97%	68%	49%	34%	22%
SS_410	OF1	4.89	5.1	24.3	24.4	0.1	0.14	0.30	8.92	2.0	2.7	3.3	3.7	4.1	2.0	2.7	3.3	3.7	4.1	0%	0%	0%	0%	0%
SS_420	OF1	4.14	3.5	6.8	9.5	2.7	0.21	0.31	7.58	1.0	1.5	2.1	2.6	3.5	1.1	1.6	2.1	2.7	3.6	5%	3%	2%	2%	1%
SS_430	SSC04_F01	3.82	1.2	32.2	41.8	9.6	0.04	0.28	10.71	1.2	1.7	2.3	2.8	3.7	1.4	1.9	2.4	2.9	3.8	13%	9%	6%	4%	4%
SS_440	SSC04_MH03	7.20	4.3	35.7	40.5	4.8	0.04	0.28	10.73	2.9	4.0	4.9	5.8	7.5	3.0	4.0	5.0	5.9	7.5	3%	2%	1%	1%	1%
SS_450	SSC04_MH10	7.47	0.6	36.1	40.4	4.2	0.04	0.28	10.67	2.0	2.9	3.9	4.9	6.7	2.2	3.1	4.1	5.1	6.8	7%	5%	4%	3%	2%
SS_460	OF1	26.33	5.1	8.8	22.2	13.4	0.19	0.31	7.97	5.8	8.8	12.3	15.8	21.7	7.4	10.5	14.0	17.4	23.1	28%	19%	13%	10%	7%
SS_480	OF1	7.37	4.6	36.3	36.4	0.0	0.07	0.29	10.11	2.5	3.3	4.4	5.3	7.1	2.5	3.3	4.4	5.3	7.1	0%	0%	0%	0%	0%
SS_490	OF1	5.67	5.5	17.4	26.2	8.8	0.21	0.31	7.17	1.4	2.1	2.8	3.6	4.8	1.7	2.3	3.0	3.8	5.0	15%	11%	8%	6%	4%
SS_500	OF1	25.34	3.9	30.9	40.0	9.1	0.13	0.30	9.03	9.1	12.3	15.4	16.7	19.1	9.9	13.1	16.2	17.8	20.6	9%	6%	5%	6%	8%
SS_510	OF1	19.32	8.7	6.7	22.8	16.2	0.18	0.30	7.53	5.4	7.9	10.5	12.9	17.1	6.5	9.0	11.5	13.8	18.2	21%	14%	9%	7%	6%
SS_520	OF1	224.02	7.2	6.3	16.3	10.0	0.21	0.31	7.57	21.5	34.5	50.9	73.1	117.8	33.0	48.4	66.9	90.5	136.9	54%	40%	31%	24%	16%

Notes:

* = Outlet Node OF1 is a placeholder used to simulate basins for hydrologic resuts only. These basins are not routed to current hydraulic model.

Table A-2. Hydraulic Model Results - Existing Condition																													
Conduit			Conduit Attributes						Conduit Capacity**	Existing Peak Flow (cfs)					Invert Elevation (ft)		Rim Elevation (ft)		Existing Max Hydraulic Grade Line (ft)***										When Hydraulically Deficient (Ex)
																			2-yr, 24-hr		5-yr, 24-hr		10-yr, 24-hr		25-yr-, 24-hr		100-yr, 24-hr		
US Node	DS Node	Name	Type	Shape	Diameter (ft) / Max. Width (ft)	Depth (ft)	Conduit Length (ft)	Slope (%)	(cfs)	2-yr, 24-hr	5-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	(NF = Not Flooding)
Callahan-Dutch Canyon Area (Problem Area 28)																													
INF10_CB26	INF10_MH15	SD0981	CONDUIT	CIRCULAR	1	-	59.8	0.4847	2.48	1.8	2.6	3.4	4.2	4.8	77.8	77.4	82.8	82.6	78.4	77.9	78.6	78.0	79.7	79.1	82.6	81.8	82.8	82.6	100-yr, 24-hr
INF10_D03	INF10_D04	SD0764	CONDUIT	TRAPEZOIDAL	3	10.00	386.4	2.7181	242.55	1.8	2.6	3.4	4.2	4.5	73.7	63.2	76.7	66.5	73.9	66.5	73.9	66.5	74.0	66.5	74.0	66.5	75.7	66.5	NF
INF10_D04	DC_INFIL_OF	DC_INFIL	OUTLET	-	-	-	-	-	-	5.2	5.2	5.2	5.2	5.2	63.2	63.2	66.5	63.2	66.5	63.2	66.5	63.2	66.5	63.2	66.5	63.2	66.5	63.2	2-yr, 24-hr
INF10_D06	INF10_D04	INF10_D06_INF10_D04	CONDUIT	TRAPEZOIDAL	3.33	19.32	560	0.2607	193.18	15.3	19.2	21.0	19.2	19.5	63.2	63.2	68.0	66.5	67.0	66.5	68.0	66.5	68.0	66.5	68.0	66.5	68.0	66.5	5-yr, 24-hr
INF10_MH01	INF10_MH07	SD0779	CONDUIT	CIRCULAR	1	-	64	0.6563	2.89	1.8	2.6	3.4	4.2	4.5	75.4	74.7	79.8	78.4	76.0	75.3	76.2	75.5	76.6	76.1	78.0	77.1	78.5	77.5	NF
INF10_MH02	INF10_MH03	SD0771	CONDUIT	CIRCULAR	2	-	42	0.9283	21.8	11.2	14.0	16.2	17.3	18.3	69.7	69.3	76.3	75.2	70.8	70.5	71.0	70.7	71.5	71.6	74.0	73.9	75.8	75.2	NF
INF10_MH03	INF10_MH04	SD0772	CONDUIT	CIRCULAR	2	-	126.9	0.4963	15.94	11.2	14.0	16.2	17.3	18.3	69.3	68.5	75.2	73.3	70.5	69.5	70.7	69.6	71.6	71.4	73.9	73.3	75.2	73.3	100-yr, 24-hr
INF10_MH04	INF10_MH06	SD0773	CONDUIT	CIRCULAR	2	-	119.7	1.0023	22.65	11.2	14.0	16.2	17.3	18.2	68.5	66.9	73.3	72.2	69.5	67.7	69.6	69.2	71.4	71.3	73.3	72.2	73.3	72.2	25-yr, 24-hr
INF10_MH05	INF10_D06	SD0776	CONDUIT	CIRCULAR	2.5	-	36.2	1.1873	44.69	15.9	21.0	25.0	28.5	32.5	65.1	63.2	70.2	68.0	67.1	67.0	69.1	68.0	70.2	68.0	70.2	68.0	70.2	68.0	10-yr, 24-hr
INF10_MH06	INF10_MH05	SD0775	CONDUIT	CIRCULAR	2.5	-	125.3	1.4051	48.62	11.2	14.0	16.2	17.1	18.1	66.9	65.1	72.2	70.2	67.7	67.1	69.2	69.1	71.3	70.2	72.2	70.2	72.2	70.2	25-yr, 24-hr
INF10_MH07	INF10_D03	SD0767	CONDUIT	CIRCULAR	1	-	151.8	0.6586	2.89	1.8	2.6	3.4	4.2	4.5	74.7	73.7	78.4	76.7	75.3	73.9	75.5	73.9	76.1	74.0	77.1	74.0	77.5	75.7	NF
INF10_MH15	INF10_MH16	SD0982	CONDUIT	CIRCULAR	1	-	67.7	1.1231	3.78	1.8	2.6	3.4	4.2	4.5	77.4	76.5	82.6	82.5	77.9	77.1	78.0	77.3	79.1	78.5	81.8	80.8	82.6	81.7	100-yr, 24-hr
INF10_MH16	INF10_MH17	SD0983	CONDUIT	CIRCULAR	1	-	122.8	0.6514	2.88	1.8	2.6	3.4	4.2	4.5	76.5	75.7	82.5	81.1	77.1	76.4	77.3	76.6	78.5	77.4	80.8	79.1	81.7	79.7	NF
INF10_MH17	INF10_MH01	SD0765	CONDUIT	CIRCULAR	1	-	78.3	0.3319	2.05	1.8	2.6	3.4	4.2	4.5	75.7	75.4	81.1	79.8	76.4	76.0	76.6	76.2	77.4	76.6	79.1	78.0	79.7	78.5	NF
INF10_MH20	INF10_MH23	SD0988	CONDUIT	CIRCULAR	1.5	-	109.6	0.6114	8.21	11.3	14.0	16.2	17.3	18.3	71.3	70.5	80.7	78.6	73.3	71.6	73.9	71.7	74.6	71.9	75.3	74.1	76.9	75.9	NF
INF10_MH21	INF10_MH22	SD0986	CONDUIT	CIRCULAR	1.5	-	84.3	0.4747	7.24	9.3	11.7	13.4	14.7	14.2	72.6	72.1	77.4	79.6	74.6	74.0	75.9	74.9	77.1	75.8	77.4	76.4	77.4	77.8	25-yr, 24-hr
INF10_MH22	INF10_MH20	SD0987	CONDUIT	CIRCULAR	1.5	-	80.1	0.6493	8.46	9.3	11.7	13.4	14.7	14.2	72.1	71.3	79.6	80.7	74.0	73.3	74.9	73.9	75.8	74.6	76.4	75.3	77.8	76.9	NF
INF10_MH23	INF10_MH02	SD0770	CONDUIT	CIRCULAR	2	-	84.8	0.6955	18.87	11.1	14.0	16.2	17.3	18.3	70.5	69.7	78.6	76.3	71.6	70.8	71.7	71.0	71.9	71.5	74.1	74.0	75.9	75.8	NF
INF10_MH39	INF10_MH21	SD1093	CONDUIT	CIRCULAR	1.5	-	137.1	0.248	5.23	8.0	10.6	12.3	13.3	12.7	72.9	72.6	75.9	77.4	75.6	74.6	75.9	75.9	75.9	77.1	75.9	77.4	75.9	77.4	5-yr, 24-hr
INF10_MH40	INF10_MH39	SD1094	CONDUIT	CIRCULAR	1.5	-	114.1	0.5695	7.93	3.5	4.8	5.5	5.7	7.2	73.6	72.9	79.4	75.9	76.2	75.6	78.1	75.9	79.0	75.9	79.4	75.9	79.4	75.9	25-yr, 24-hr
INF10_MH41	INF10_MH40	SD1095	CONDUIT	CIRCULAR	1.5	-	214.8	0.4981	7.41	3.5	4.8	5.5	5.2	7.2	74.7	73.6	77.7	79.4	75.5	76.2	77.6	78.1	77.7	79.0	77.7	79.4	77.7	79.4	10-yr, 24-hr
INF10_MH42	DC_J1	DC_OR1	ORIFICE	-	-	-	-	-	-	0.2	0.3	5.1	1.9	7.6	71.5	73.5	78.4	78.4	75.8	75.3	77.7	77.7	78.4	77.7	78.4	78.4	78.4	77.7	10-yr, 24-hr
INF10_MH42	DC_J1	DC_Weir1	WEIR	-	-	-	-	-	-	0.0	1.7	1.9	5.0	1.9	71.5	73.5	78.4	78.4	75.8	75.3	77.7	77.7	78.4	78.4	78.4	77.7	78.4	78.4	10-yr, 24-hr
INF10_MH42	INF10_MH41	SD1096	CONDUIT	CIRCULAR	1.33	-	39.4	0.7364	6.58	3.4	4.1	0.3	0.3	0.3	71.5	74.7	78.4	77.7	75.8	75.5	77.7	77.6	78.4	78.4	78.4	78.4	78.4	78.4	10-yr, 24-hr
INF10_MH43	INF10_N01	SD1098	CONDUIT	CIRCULAR	1.33	-	106	3.2659	13.86	0.2	1.9	2.5	4.4	8.1	71.3	71.3	78.0	74.5	74.9	74.5	77.7	74.5	78.0	74.5	78.0	74.5	78.0	74.5	10-yr, 24-hr
INF10_MH44	INF10_MH42	SD1099	CONDUIT	CIRCULAR	1.25	-	133.5	0.322	3.67	3.6	5.5	6.2	5.9	7.5	75.6	71.5	84.5	78.4	76.5	75.8	78.6	77.7	81.0	78.4	81.7	78.4	83.8	78.4	NF
INF10_MH47	INF10_MH48	SD1104	CONDUIT	CIRCULAR	1	-	139.9	6.7914	9.28	2.2	3.5	4.9	6.3	8.2	86.4	76.7	91.9	82.7	86.7	77.5	86.8	82.7	87.0	82.7	89.9	82.7	91.9	82.7	100-yr, 24-hr
INF10_MH48	INF10_MH44	SD1105	CONDUIT	CIRCULAR	1	-	235	0.3999	2.25	2.2	3.5	4.4	4.6	5.0	76.7	75.6	82.7	84.5	77.5	76.5	82.7	78.6	82.7	81.0	82.7	81.7	82.7	83.8	10-yr, 24-hr
INF10_N01	DC_Wetland	INF10_N01_DC_Wetland	CONDUIT	TRIANGULAR	0.5	3.00	28	3.2696	2.57	5.3	7.0	7.9	8.5	9.4	71.3	69.0	74.5	74.5	74.5	70.2	74.5	70.8	74.5	71.3	74.5	71.7	74.5	72.4	2-yr, 24-hr
DC_J1	INF10_MH43	SD1097	CONDUIT	CIRCULAR	1.33	-	18	2.056	10.93	0.2	1.9	2.2	2.2	4.9	73.5	71.3	78.4	78.0	75.3	74.9	77.7	77.7	78.4	78.0	78.4	78.0	78.4	78.0	10-yr, 24-hr
DC_Wetland	DC_Wetland_OF	DC_Wetland_INFIL	OUTLET	-	-	-	-	-	-	2.0	2.0	2.0	2.0	2.0	69.0	69.0	74.5	69.0	70.2	69.0	70.8	69.0	71.3	69.0	71.7	69.0	72.4	69.0	NF
SW Creek View Place/4th Ave Systems (Problem Area 15)																													
SSC04_CB20	SSC04_MH12	SD0455	CONDUIT	CIRCULAR	1.75	-	119.5	0.1758	6.64	1.2	1.8	2.3	2.8	3.6	56.6	56.3	62.0	59.8	57.3	57.2	57.5	57.4	57.6	57.5	57.6	57.6	57.8	57.7	NF
SSC04_F01	SSC04_MH11	SD0457	CONDUIT	CIRCULAR	1.25	-	82.7	0.8827	6.07	1.2	1.7	2.3	2.8	3.7	58.8	58.0	60.0	63.9	59.1	58.4	59.2	58.5	59.3	58.6	59.4	58.7	59.5	58.8	NF
SSC04_MH01	SSC04_MH04	SD0447	CONDUIT	CIRCULAR	1	-	252.4	0.4438	2.37	2.9	3.8	4.0	4.2	4.5	58.0	56.8	65.6	62.3	60.1	57.7	62.0	58.0	62.9	58.1	62.8	58.2	63.7	58.4	NF
SSC04_MH02	SSC04_MH01	SD0448	CONDUIT	CIRCULAR	1	-	179	0.4971	2.51	2.9	3.8	4.0	4.2	4.5	58.9	58.0	62.3	65.6	61.1	60.1	62.3	62.0	62.3	62.9	62.3	62.8	62.3	63.7	5-yr, 24-hr
SSC04_MH03	SSC04_MH02	SD0449	CONDUIT	CIRCULAR	1	-	138.1	0.5068	2.54	2.9	4.0	4.9	5.2	5.7	59.6	58.9	65.6	62.3	62.0	61.1	64.1	62.3	65.6	62.3	65.6	62.3	65.6	62.3	25-yr, 24-hr
SSC04_MH04	SSC04_MH12	SD0446	CONDUIT	CIRCULAR	1.5	-	123	0.3902	6.56	4.7	6.5	7.0	7.6	8.3	56.8	56.3	62.3	59.8	57.7	57.2	58.0	57.4	58.1	57.5	58.2	57.6	58.4	57.7	NF
SSC04_MH05	SSC04_MH04	SD0445	CONDUIT	CIRCULAR	1.25	-	129.7	0.3933	4.05	2.0	2.9	3.1	3.4	3.9	57.4	56.8	65.6	62.3	58.0	57.7	58.2	58.0	58.3	58.1	58.4	58.2	58.8	58.4	NF
SSC04_MH06	SSC04_MH05	SD0443	CONDUIT	CIRCULAR	1.25	-	121.1	0.3962	4.07	2.0	2.8	3.0	3.4	3.9	57.9	57.4	65.6	65.6	58.5	58.0	58.6	58.2	58.7	58.3	58.8	58.4	59.2	58.8	NF
SSC04_MH07	SSC04_MH06	SD0442	CONDUIT	CIRCULAR	1.25	-	223.7	0.3933	4.05	2.0	2.9	3.0	3.4	3.9	58.7	57.9	65.0	65.6	59.4	58.5	59.5	58.6	59.6	58.7	59.6	58.8	59.9	59.2	NF
SSC04_MH08	SSC04_MH07	SD0441	CONDUIT	CIRCULAR	1	-	341.6	0.3015	1.96	2.0	2.9	3.0	3.4	3.9	59.8	58.7	65.0	65.0	60.7	59.4	63.7	59.5	64.7	59.6	64.9	59.6	65.0	59.9	NF
SSC04_MH09	SSC04_MH08	SD0440	CONDUIT	CIRCULAR	1	-	100.2	0.2994	1.95	2.0	2.9	3.0	3.4	3.9	60.2	59.8	65.6	65.0	61.0	60.7	64.6	63.7	64.7	64.7	64.9	64.9	65.1	65.0	NF
SSC04_MH10	SSC04_MH09	SD0438	CONDUIT	CIRCULAR	1	-	400	0.275	1.87	2.0	2.9	3.0	3.4	3.9	61.4	60.2	64.9	65.6	62.4	61.0	64.9	64.6	64.9	64.7	64.9	64.9	64.9	65.1	10-yr, 24-hr
SSC04_MH11	SSC04_CB20	SD0456	CONDUIT	CIRCULAR	1.5	-	273.7	0.3909	6.57	1.2	1.7	2.3	2.8	3.7	58.0	56.6	63.9	62.0	58.4	57.3	58.5	57.5	58.6	57.6	58.7	57.6	58.8	57.8	NF
SSC04_MH12	SSC04_MH13	SD0454	CONDUIT	CIRCULAR	1.75	-	78.3	0.3958	9.97	5.9	8.2	9.2	10.0	11.4	56.3	55.9	59.8	64.1	57.2	56.8	57.4	57.0	57.5	57.1	57.6	57.2	57.7	57.3	NF
SSC04_MH13	SSC04	SD0453	CONDUIT	CIRCULAR	1.75	-	70	0.4	10.02	5.9	8.2	9.2	10.0	11.4	55.9	55.6	64.1	57.4	56.8	56.5	57.0	56.7	57.1	56.7	57.2	56.8	57.3	56.9	NF
SSC07_F01	SSC07_MH03	SD0502	CONDUIT	CIRCULAR	1.75	-	287.3	0.5326	11.56	4.0	6.2	8.7	11.6	16.4	55.1	53.5	61.2	60.7	55.8	54.3	56.0	54.5	56.2	54.7	56.5	55.0	60.3	57.2	NF
SSC07_MH01	SSC07_MH02	SD0500	CONDUIT	CIRCULAR	2	-	265.2	0.1848	9.72	3.9	6.1	8.7	11.5	16.4	51.8	51.3	62.3	62.3	52.7	52.1	53.0	52.3	53.2	52.5	53.6	52.8	54.7	53.3	NF
SSC07_MH02	SSC07	SD0499	CONDUIT	CIRCULAR	2	-	225.8	0.3189	12.78	3.9	6.1	8.7	11.5	16.2	51.3	50.6	62.3	52.6	52.1	51.3	52.3	51.5	52.5	51.7	52.8	51.8	53.3	52.1	NF
SSC07_MH03	SSC07_MH01	SD0501	CONDUIT	CIRCULAR	1.75	-	232	0.5086	11.3	3.9	6.1	8.7	11.5	16.4	53.5	51.8	60.7	62.3	54.3	52.7	54.5	53.0	54.7	53.2	55.0	53.6	57.2	54.7	NF
SSC08_CB02	SSC08_MH03	SD0510	CONDUIT	CIRCULAR	1	-	293.6	0.4087	2.28	3.3	3.9	4.3	4.6	5.1	50.4	49.2	59.1	55.0	53.2	50.7	55.2	51.6	56.4	52.1	57.4	52.4	59.1	53.2	100-yr, 24-hr
SSC08_CB05	SSC08_MH01	SD0514	CONDUIT	CIRCULAR	1	-	69.8	3.7722	6.92	3.3	3.9	4.3	5.7	7.1	53.4	50.7	56.5	57.5	54.2	53.8	56.5	56.1	56.5	57.5	56.5	57.5	56.5	57.5	5-yr, 24-hr
SSC08_MH01	SSC08_CB02	SD0512	CONDUIT	CIRCULAR	1	-	71.9	0.2922	1.93	3.3	3.9	4.3	4.6	5.3	50.7	50.4	57.5	59.1	53.8	53.2	56.1	55.2	57.5	56.4	57.5	57.4	57.5	59.1	25-yr, 24-hr
SSC08_MH02	SSC08	SD0507	CONDUIT	CIRCULAR	1	-	42.4	0.4241	2.32	3.3	3.9	4.3	4.6	5.1	48.7	48.5	56.1	49.5	49.6	49.3	49.9	49.3	50.1	49.4	50.2	49.4	50.3	49.4	NF
SSC08_MH03	SSC08_MH02	SD0508	CONDUIT	CIRCULAR	1	-	140.7	0.4123	2.29	3.3	3.9	4.3	4.6	5.1	49.2	48.7	55.0	56.1	50.7	49.6	51.6	49.9	52.1	50.1	52.4	50.2	53.2	50.3	NF
Keys Road Basin (Problem Area 29)																													
SSC09_CB08	SSC09_CB09	SD0562	CONDUIT	CIRCULAR	1	-	57.8	8.7346	10.53	5.3	6.5	7.5	8.4	8.6	166.2	161.2	169.5	163.9	166.7	161.6	166.8	161.6	166.9	161.7	166.9	161.7	166.9	161.7	NF
SSC09_CB09	SSC09_MH01	SD0561	CONDUIT	CIRCULAR	1.25	-	197.6	11.8574	22.24	5.3	6.5	7.5	8.4	8.6	161.2	137.7	163.9	141.1	161.6	138.1	161.6	138.1	161.7	138.1	161.7	138.2	161.7	138.2	NF
SSC09_CB16	SSC09_N04	SD0566_1	CONDUIT	CIRCULAR	1	-	37.2	9.3903	3.55	4.5	5.4	6.2	7.1	8.3	70.7	67.2	73.2	70.3	73.2	67.6	73.2	67.7	73.2	67.7	73.2	67.8	73.2	67.9	2-yr, 24-hr
SSC09_CB18	SSC09_D08	SD0567	CONDUIT	CIRCULAR	1.5	-	32.3	1.4226	4.07	5.9	6.9	7.4	8.0	8.9	55.1	54.7	57.1	56.7	56.4	55.2	57.0	55.2	57.1	55.2	57.1	55.3	57.1	55.3	10-yr, 24-hr
SSC09_CB19	SSC09_D09	SD0714	CONDUIT	CIRCULAR	0.83	-	35.2	0.5991	1.69	2.4	2.7	3.5	4.1	5.0	215.3	215.1	216.8	216.5	216.0	215.4	216.2	215.5	216.6	215.5	216.8	215.6	216.8	216.5	25-yr, 24-hr
SSC09_CB20	SSC09_F01	SD0716	CONDUIT	CIRCULAR	1	-	96.1	1.2109	3.92	2.2	2.8	3.5	4.1	5.4	211.3	210.1	213.7	211.1	211.8	210.5	211.9	210.5	212.0	210.6	212.1	210.8	213.7	211.1	100-yr, 24-hr
SSC09_D07	SSC09_CB18	SD0590	CONDUIT	TRAPEZOIDAL	1.17	7.01	173.7	5.1205	31.75	4.8	5.6	6.4	7.3	8.4	64.0	55.1	65.8	57.1	64.5	56.4	64.5	57.0	64.6	57.1	64.6	57.1	64.6	57.1	NF
SSC09_D08	SSC09	SD0591	CONDUIT	TRAPEZOIDAL	1.17	7.01	248.9	5.8481	33.93	5.9	6.9	7.4	8.0	8.9	54.7	40.1	56.7	41.3	55.2	40.6	55.2	40.7	55.2	40.7	55.3	40.7	55.3	40.8	NF
SSC09_D09	SSC09_CB20	SD0715	CONDUIT	CIRCULAR	0.83	-	49.5	7.741	6.09	2.4	2.7	3.5	4.1	5.1	215.1	211.3	216.5	213.7	215.4	211.8	215.5	211.9	215.5	212.0	215.6	212.1	216.5	213.7	100-yr, 24-hr
SSC09_D10	SSC09_N05	SD0740	CONDUIT	TRAPEZOIDAL	2.5	8.00	122.2	13.9846	272.14	5.3	6.5	7.5	8.4	8.6	130.6	113.7	133.1	116.2	131.0	114.5	131.0	114.6	131.0	114.7	131.0	114.8	131.1	114.8	NF
SSC09_D11	SSC09_CB16	SD0588	CONDUIT	TRAPEZOIDAL	2.5	8.00	300.8	12.5402	193.27	8.0	10.2	12.2	13.8	16.5	108.1	70.7	110.6	73.2	108.6	73.2	108.7	73.2	108.7	73.2	108.8	73.2	108.8	73.2	NF
SSC09_F01	SSC09_MH10	SD0094	CONDUIT	CIRCULAR	1	-	26.5	9.3883	7.1	2.2	2.8	3.5	4.2	6.5	210.1	203.3	211.1	210.9	210.5	204.4	210.5	204.9	210.6	206.5	210.8	210.0	211.1	210.9	100-yr, 24-hr
SSC09_F02	SSC09_MH08	SD0101	CONDUIT	CIRCULAR	1	-	26	4.3074	7.39	1.6	2.1	2.6	3.0	3.4	230.6	229.5	236.0	236.1	230.9	229.8	231.0	229.8	231.0	229.9	231.1	229.9	231.1	229.9	NF
SSC09_MH01	SSC09_D10	SD0742	CONDUIT	CIRCULAR	1.5	-	62.9	11.2216	35.19	5.3	6.5	7.5	8.4	8.6	137.7	130.6	141.1	133.1	138.1	131.0	138.1	131.0	138.1	131.0	138.2	131.0	138.2	131.1	NF
SSC09_MH02	SSC09_CB08	SD0735	CONDUIT	CIRCULAR	1	-	100.6	7.0531	9.46	5.3	6.5	7.5	8.4	8.6	173.6	166.2	179.1	169.5	174.2	166.7	174.2	166.8	174.3	166.9	174.4	166.9	174.4	166.9	NF
SSC09_MH03	SSC09_MH02	SD0736	CONDUIT	CIRCULAR	1	-	31.8	6.5807	9.14	5.3	6.5	7.5	8.4	8.6	176.0	173.6	183.1	179.1	176.6	174.2	176.7	174.2	176.7	174.3	176.8	174.4	176.8	174.4	NF
SSC09_MH04	SSC09_MH06	SD0738	CONDUIT	CIRCULAR	1	-	29.6	8.579	10.44	5.4	6.5	7.5	8.4	8.6	188.3	185.6	194.5	193.0	188.8	186.2	188.8	186.3	188.9	186.4	188.9	186.5	189.0	186.5	NF
SSC09_MH05	SSC09_MH07	SD0559	CONDUIT	CIRCULAR	1	-	136.7	3.7848	6.93	5.4	6.5	7.5	8.4	8.7	199.9	194.6	205.1	199.9	200.5	195.2	200.6	195.3	204.7	195.4	203.9	195.4	205.1	198.8	NF
SSC09_MH06	SSC09_MH03	SD0737	CONDUIT	CIRCULAR	1	-	138.6	5.1151	8.06	5.3	6.5	7.5	8.4	8.6	185.6	176.0	193.0	183.1	186.2	176.6	186.3	176.7	186.4	176.7	186.5	176.8	186.5	176.8	NF
SSC09_MH07	SSC09_MH04	SD0563	CONDUIT	CIRCULAR	1	-	123.9	5.0432	8	5.4	6.5	7.5	8.4	8.6	194.6	188.3	199.9	194.5	195.2	188.8	195.3	188.8	195.4	188.9	195.4	188.9	198.8	189.0	NF
SSC09_MH08	SSC09_MH14	SD0100	CONDUIT	CIRCULAR	1	-	229.4	4.7918	7.8	1.6	2.1	2.6	3.0	3.4	229.5	218.5	236.1	224.6	229.8	218.9	229.8	219.0	229.9	219.1	229.9	219.1	229.9	219.2	NF
SSC09_MH09	SSC09_MH05	SD0560	CONDUIT	CIRCULAR	1	-	98.4	2.9172	6.09	5.4	6.5	7.6	8.4	8.7	202.8	199.9	208.7	205.1	203.6	200.5	204.2	200.6	207.0	204.7	208.7	203.9	208.7	205.1	25-yr, 24-hr
SSC09_MH10	SSC09_MH12	SD0093	CONDUIT	CIRCULAR	1.25	-	22.5	0.1778	1.77	3.8	4.6	5.5	6.2	7.1	203.3	203.3	210.9	210.8	204.4	204.1	204.9	204.7	206.5	206.3	210.0	209.6	210.9	210.8	100-yr, 24-hr
SSC09_MH11	SSC09_MH10	SD0095	CONDUIT	CIRCULAR	1.25	-	44.7	0.492	2.95	1.6	2.0	2.1	2.3	3.8	203.5	203.3	212.1	210.9	204.5	204.4	205.0	204.9	206.6	206.5	210.1	210.0	211.5	210.9	NF
SSC09_MH12	SSC09_MH09	SD0092	CONDUIT	CIRCULAR	1.25	-	100.9	0.4459	4.31	3.8	4.6	5.5	6.2	7.1	203.3	202.8	210.8	208.7	204.1	203.6	204.7	204.2	206.3	207.0	209.6	208.7	210.8	208.7	100-yr, 24-hr
SSC09_MH13	SSC09_N03	SD0096	CONDUIT	CIRCULAR	1	-	114	6.2113	8.88	1.6	2.1	2.6	3.0	3.4	215.7	203.5	223.5	212.1	216.0	204.5	216.0	205.0	216.0	206.6	216.1	210.1	216.1	211.5	NF

Table A-2. Hydraulic Model Results - Existing Condition																														
Conduit			Conduit Attributes						Conduit Capacity**	Existing Peak Flow (cfs)					Invert Elevation (ft)		Rim Elevation (ft)		Existing Max Hydraulic Grade Line (ft)***										When Hydraulically Deficient (Ex)
																			2-yr, 24-hr		5-yr, 24-hr		10-yr, 24-hr		25-yr-, 24-hr		100-yr, 24-hr		
US Node	DS Node	Name	Type	Shape	Diameter (ft) / Max. Width (ft)	Depth (ft)	Conduit Length (ft)	Slope (%)	(cfs)	2-yr, 24-hr	5-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	(NF = Not Flooding)
SSC09_MH14	SSC09_MH13	SD0099	CONDUIT	CIRCULAR	1	-	61.3	1.5166	4.39	1.6	2.1	2.6	3.0	3.4	218.5	215.7	224.6	223.5	218.9	216.0	219.0	216.0	219.1	216.0	219.1	216.1	219.2	216.1	NF
SSC09_N01	SSC09_CB19	SD0713	CONDUIT	CIRCULAR	0.83	-	108.2	0.6	1.7	2.2	2.8	3.5	4.2	5.6	215.9	215.3	217.0	216.8	217.0	216.0	217.0	216.2	217.0	216.6	217.0	216.8	217.0	216.8	5-yr, 24-hr
SSC09_N02	SSC09_MH11	SD0097	CONDUIT	CIRCULAR	3	-	4	0.0253	10.6	1.6	2.0	2.1	2.3	3.7	203.5	203.5	212.1	212.1	204.5	204.5	205.0	205.0	206.6	206.6	210.1	210.1	211.5	211.5	NF
SSC09_N03	SSC09_N02	SD0098	CONDUIT	CIRCULAR	6	-	106.8	9e-04	7.02	1.6	2.3	2.5	2.6	3.5	203.5	203.5	212.1	212.1	204.5	204.5	205.0	205.0	206.6	206.6	210.1	210.1	211.5	211.5	NF
SSC09_N04	SSC09_D07	SD0566_2	CONDUIT	RECT_CLOSED	1.5	2.00	34.2	9.3883	19.41	4.5	5.4	6.2	7.1	8.3	67.2	64.0	70.3	65.8	67.6	64.5	67.7	64.5	67.7	64.6	67.8	64.6	67.9	64.6	NF
SSC09_N05	SSC09_D11	SD0743	CONDUIT	CIRCULAR	1.5	-	52.8	10.6863	11.16	5.3	6.5	7.5	8.4	8.6	113.7	108.1	116.2	110.6	114.5	108.6	114.6	108.7	114.7	108.7	114.8	108.8	114.8	108.8	NF
SW J.P. West Road System (Problem Area 18b)																														
SSC15_CB06	SSC15_MH05	SD0189	CONDUIT	CIRCULAR	1	-	16.5	1.27	2.17	1.2	1.6	2.0	2.5	3.2	89.4	86.3	97.4	93.6	91.8	91.7	92.1	91.9	92.3	92.1	94.0	93.6	95.8	93.6	NF
SSC15_CB07	SSC15_CB06	SD0190	CONDUIT	CIRCULAR	1	-	64.2	8.508	10.39	1.2	1.6	2.0	2.4	3.2	94.9	89.4	99.4	97.4	95.1	91.8	95.1	92.1	95.2	92.3	95.2	94.0	96.3	95.8	NF
SSC15_CB08	SSC15_CB07	SD0191	CONDUIT	CIRCULAR	1	-	45.5	16.381	14.42	1.2	1.6	2.0	2.4	3.2	102.4	94.9	105.5	99.4	102.6	95.1	102.6	95.1	102.7	95.2	102.7	95.2	102.7	96.3	NF
SSC15_CB10	SSC15_CB08	SD0192	CONDUIT	CIRCULAR	1	-	280.4	11.6123	12.14	1.0	1.4	1.8	2.2	2.9	134.9	102.4	139.6	105.5	135.1	102.6	135.2	102.6	135.2	102.7	135.2	102.7	135.3	102.7	NF
SSC15_CB11	SSC15_D03	SD0702	CONDUIT	CIRCULAR	1	-	41.8	1.3149	4.83	3.2	4.3	5.7	6.4	7.3	73.3	72.8	76.3	75.3	73.9	73.1	74.1	73.2	74.3	73.2	74.5	73.3	74.9	73.3	NF
SSC15_CB12	SSC15_D04	SD0700	CONDUIT	CIRCULAR	2	-	105	5.4316	52.72	4.8	6.4	8.2	9.5	10.9	60.9	56.2	65.9	59.2	62.3	56.7	62.4	56.8	62.4	56.9	62.5	56.9	62.5	57.0	NF
SSC15_CB13	SSC15_D05	SD0698	CONDUIT	CIRCULAR	2	-	58	4.4161	47.54	4.8	6.4	8.1	9.5	11.5	52.3	49.7	54.3	51.7	52.7	51.0	52.8	51.7	52.9	51.7	52.9	51.7	53.4	51.7	NF
SSC15_CB14	SSC15_D06	SD0718	CONDUIT	CIRCULAR	2	-	27	0.4895	15.83	4.4	5.7	6.6	7.7	8.6	48.9	48.8	50.9	50.8	50.8	50.8	50.9	50.8	50.9	50.8	50.9	50.8	50.9	50.8	5-yr, 24-hr
SSC15_D02	SSC15_CB11	SSC15_D02_SSC15_CB11	CONDUIT	TRAPEZOIDAL	0.83	7.00	92	11.2221	32.99	3.2	4.3	5.5	6.4	7.3	83.6	73.3	84.6	76.3	83.9	73.9	83.9	74.1	84.0	74.3	84.0	74.5	84.0	74.9	NF
SSC15_D03	SSC15_CB12	SD0701	CONDUIT	CIRCULAR	2	-	123.5	8.8484	67.29	3.8	5.1	6.5	7.6	8.8	72.8	60.9	75.3	65.9	73.1	62.3	73.2	62.4	73.2	62.4	73.3	62.5	73.3	62.5	NF
SSC15_D04	SSC15_CB13	SD0699	CONDUIT	TRAPEZOIDAL	1	6.00	101.5	3.8671	22.83	4.8	6.4	8.1	9.5	10.9	56.2	52.3	59.2	54.3	56.7	52.7	56.8	52.8	56.9	52.9	56.9	52.9	57.0	53.4	NF
SSC15_D05	SSC15_CB14	SD0697	CONDUIT	TRAPEZOIDAL	1	6.00	100	0.8199	7.89	4.6	6.2	7.3	8.4	9.5	49.7	48.9	51.7	50.9	51.0	50.8	51.7	50.9	51.7	50.9	51.7	50.9	51.7	50.9	10-yr, 24-hr
SSC15_D06	SSC15	SD0717	CONDUIT	TRAPEZOIDAL	1	6.00	241.7	0.2036	3.93	4.1	5.2	6.1	7.0	8.2	48.8	48.3	50.8	49.3	50.8	48.8	50.8	48.9	50.8	48.9	50.8	49.0	50.8	49.0	5-yr, 24-hr
SSC15_MH05	SSC15_MH06	SD0188	CONDUIT	CIRCULAR	0.67	-	26	13.5921	2.42	0.2	1.3	2.4	3.6	4.0	86.3	86.0	93.6	90.3	91.7	86.4	91.9	86.5	92.1	86.6	93.6	86.6	93.6	86.7	25-yr, 24-hr
SSC15_MH05	SSC15_MH06	SD0187	CONDUIT	CIRCULAR	0.67	-	23.5	0.6373	0.52	3.0	3.1	3.1	2.9	3.3	86.3	86.0	93.6	90.3	91.7	86.4	91.9	86.5	92.1	86.6	93.6	86.6	93.6	86.7	25-yr, 24-hr
SSC15_MH06	SSC15_D02	SD0473	CONDUIT	CIRCULAR	1	-	35.8	6.6365	9.18	3.2	4.3	5.5	6.4	7.3	86.0	83.6	90.3	84.6	86.4	83.9	86.5	83.9	86.6	84.0	86.6	84.0	86.7	84.0	NF
SSC15_N01	SSC15_D03	SSC15_N01_SSC15_D03	CONDUIT	CIRCULAR	1.5	-	260.8	8.8353	31.22	0.6	0.8	1.0	1.2	1.6	95.8	72.8	99.3	75.3	95.9	73.1	95.9	73.2	95.9	73.2	96.0	73.3	96.0	73.3	NF
NW E.J. Smith and SW 1st St (Problem Area 6)																														
SSC17_F01	SSC17	SD0466	CONDUIT	CIRCULAR	1.25	-	619.8	0.0419	0.72	3.2	3.3	3.5	3.6	3.8	47.5	47.2	52.2	48.5	52.2	48.0	52.2	48.0	52.2	48.0	52.2	48.0	52.2	48.0	2-yr, 24-hr
SSC17_F02	SSC17_F01	SD0465	CONDUIT	CIRCULAR	1.25	-	415.9	1.1902	3.82	3.6	3.9	4.1	4.3	4.4	52.7	47.5	56.4	52.2	56.4	52.2	56.4	52.2	56.4	52.2	56.4	52.2	56.4	52.2	2-yr, 24-hr
SSC17_F03	SSC17_F02	SD0464	CONDUIT	CIRCULAR	1.25	-	255.3	0.4191	2.27	2.2	2.3	2.5	2.5	2.6	53.9	52.7	59.5	56.4	59.5	56.4	59.5	56.4	59.5	56.4	59.5	56.4	59.5	56.4	10-yr, 24-hr
SSC17_F04	SSC17_F03	SD0463	CONDUIT	CIRCULAR	1.25	-	237.2	0.3962	2.2	2.3	2.3	2.4	2.4	2.5	54.9	53.9	60.2	59.5	60.2	59.5	60.2	59.5	60.2	59.5	60.2	59.5	60.2	59.5	10-yr, 24-hr
SSC17_F05	SSC17_F04	SD0462	CONDUIT	CIRCULAR	1.25	-	248.7	0.394	2.2	2.4	2.5	2.4	2.3	2.5	56.0	54.9	60.0	60.2	60.0	60.2	60.0	60.2	60.0	60.2	60.0	60.2	60.0	60.2	2-yr, 24-hr
SSC17_F06	SSC17_F05	SD0461	CONDUIT	CIRCULAR	1.25	-	235.1	0.3999	2.21	2.5	2.8	2.7	2.6	2.9	57.0	56.0	61.1	60.0	61.1	60.0	61.1	60.0	61.1	60.0	61.1	60.0	61.1	60.0	2-yr, 24-hr
SSC17_F07	SSC17_F06	SD0460	CONDUIT	CIRCULAR	1	-	189.7	0.4585	1.31	2.7	2.8	3.1	3.5	4.0	58.0	57.0	62.2	61.1	62.2	61.1	62.2	61.1	62.2	61.1	62.2	61.1	62.2	61.1	2-yr, 24-hr
NE Sunset Loop/NE Miller Road/Miller Park/NE 14th (Problem Areas 8, 9, 19)																														
PND03_CB03	PND03_MH01	SD0324	CONDUIT	CIRCULAR	1.5	-	62	0.2901	5.66	4.2	5.0	5.8	6.7	8.2	11.1	10.9	15.2	15.0	12.1	11.9	12.2	12.1	13.2	13.0	14.5	14.3	15.2	15.0	100-yr, 24-hr
PND03_MH01	PND03_MH02	SD0321	CONDUIT	CIRCULAR	1.5	-	216.5	0.2956	5.71	4.2	5.1	5.8	6.7	8.3	10.9	10.3	15.0	16.2	11.9	11.3	12.1	11.7	13.0	12.5	14.3	13.6	15.0	15.5	100-yr, 24-hr
PND03_MH02	PND03_MH03	SD0322	CONDUIT	CIRCULAR	1.5	-	217.9	0.3029	5.78	4.2	5.1	5.8	6.7	8.3	10.3	9.6	16.2	15.0	11.3	10.8	11.7	11.3	12.5	12.0	13.6	13.0	15.5	14.4	NF
PND03_MH03	PND03_MH04	SD0323	CONDUIT	CIRCULAR	1.5	-	193.7	0.2995	5.75	5.6	6.8	7.7	8.9	10.4	9.6	9.1	15.0	14.1	10.8	10.2	11.3	10.5	12.0	10.9	13.0	11.6	14.4	12.5	NF
PND03_MH04	PND03_MH05	SD0326	CONDUIT	CIRCULAR	1.5	-	47.9	0.3343	6.07	5.6	6.8	7.7	8.9	10.4	9.1	8.9	14.1	13.8	10.2	10.1	10.5	10.3	10.9	10.7	11.6	11.3	12.5	12.0	NF
PND03_MH05	PND03_MH06	SD0327	CONDUIT	CIRCULAR	1.5	-	83.3	0.3	5.75	5.6	6.8	7.7	8.9	10.4	8.9	8.7	13.8	13.3	10.1	9.8	10.3	10.0	10.7	10.2	11.3	10.7	12.0	11.2	NF
PND03_MH06	PND03_MH07	SD0328	CONDUIT	CIRCULAR	1.5	-	27.5	0.2543	5.3	5.6	6.8	7.7	8.9	10.4	8.7	8.6	13.3	13.2	9.8	9.7	10.0	9.9	10.2	10.1	10.7	10.5	11.2	11.0	NF
PND03_MH07	PND03_MH08	SD0329	CONDUIT	CIRCULAR	1.5	-	96.1	0.2704	5.46	5.6	6.8	7.7	8.9	10.4	8.6	8.3	13.2	14.1	9.7	9.3	9.9	9.5	10.1	9.6	10.5	9.8	11.0	10.0	NF
PND03_MH08	PND03	SD0330	CONDUIT	CIRCULAR	1.5	-	65	0.3077	5.83	5.6	6.8	7.7	8.9	10.4	8.3	8.1	14.1	9.6	9.3	9.0	9.5	9.1	9.6	9.2	9.8	9.3	10.0	9.3	NF
PND03_N01	PND03_CB03	SD0724	CONDUIT	CIRCULAR	1.25	-	390.7	0.2995	3.54	4.2	5.0	5.8	6.7	8.2	12.3	11.1	13.5	15.2	13.5	12.1	13.5	12.2	13.5	13.2	13.5	14.5	13.5	15.2	2-yr, 24-hr
PND03_N02	PND03_N01	PND03_N02_PND03_N01	CONDUIT	RECT_OPEN	0.5	4.00	282.2	0.1878	2.33	1.3	2.0	2.6	4.2	6.8	12.8	12.3	13.3	13.5	13.3	13.5	13.3	13.5	13.3	13.5	13.3	13.5	13.3	13.5	2-yr, 24-hr
DW03_CB02	DW03_CB01	SD0484	CONDUIT	CIRCULAR	0.5	-	202.2	0.4205	0.36	0.3	0.3	0.4	0.4	0.5	15.8	14.2	17.2	16.6	17.2	16.6	17.2	16.6	17.2	16.6	17.2	16.6	17.2	16.6	2-yr, 24-hr
DW03_CB03	DW03_CB01	SD0920	CONDUIT	CIRCULAR	0.5	-	76.5	1.0982	0.59	0.1	0.2	0.2	0.2	0.2	15.0	14.2	15.8	16.6	15.8	16.6	15.8	16.6	15.8	16.6	15.8	16.6	15.8	16.6	2-yr, 24-hr
DW04_CB02	DW04_CB03	SD0485	CONDUIT	CIRCULAR	0.5	-	210.5	0.5037	0.4	0.8	1.0	1.1	1.2	1.4	12.9	11.6	14.5	13.7	14.5	13.7	14.5	13.7	14.5	13.7	14.5	13.7	14.5	13.7	2-yr, 24-hr
DW04_CB03	PND03_N02	DW04_PND03_N02	CONDUIT	RECT_OPEN	0.5	4.00	216.3	0.1849	2.31	0.9	1.4	1.7	1.9	2.2	11.6	12.8	13.7	13.3	13.7	13.3	13.7	13.3	13.7	13.3	13.7	13.3	13.7	13.3	5-yr, 24-hr
PND04_F01	PND04_MH10	SD0340	CONDUIT	CIRCULAR	1	-	35.5	0.2534	1.79	2.3	2.7	3.2	3.7	3.9	11.2	11.1	14.8	13.6	13.7	13.6	14.1	13.6	14.8	13.6	14.8	13.6	14.8	13.6	25-yr, 24-hr
PND04_F02	PND04_MH08	SD0337	CONDUIT	CIRCULAR	1	-	21.4	0.2804	1.23	1.8	2.4	2.6	2.8	3.1	11.1	11.0	14.8	14.8	13.0	12.9	14.4	14.1	14.8	14.6	14.8	14.8	14.8	14.8	25-yr, 24-hr
PND04_MH01	PND04_F02	SD0298	CONDUIT	CIRCULAR	1	-	189.7	0.3953	2.24	1.8	2.4	2.6	3.0	3.6	11.8	11.1	15.0	14.8	13.8	13.0	15.0	14.4	15.0	14.8	15.0	14.8	15.0	14.8	5-yr, 24-hr
PND04_MH02	PND04_F01	SD0300	CONDUIT	CIRCULAR	1	-	189.3	0.3328	2.06	2.3	2.7	3.2	3.9	4.8	11.8	11.2	14.5	14.8	14.5	13.7	14.5	14.1	14.5	14.8	14.5	14.8	14.5	14.8	5-yr, 24-hr
PND04_MH03	PND04_MH04	SD0331	CONDUIT	CIRCULAR	1.5	-	89.9	0.3003	5.76	5.0	5.9	6.3	6.7	7.2	9.5	9.3	14.2	14.6	10.6	10.2	10.7	10.3	10.7	10.3	10.8	10.4	10.9	10.4	NF
PND04_MH04	PND04	SD0332	CONDUIT	CIRCULAR	1.5	-	50	0.3	5.75	5.0	5.9	6.3	6.7	7.2	9.3	9.1	14.6	10.6	10.2	10.0	10.3	10.0	10.3	10.1	10.4	10.1	10.4	10.1	NF
PND04_MH05	PND04_MH03	SD0333	CONDUIT	CIRCULAR	1	-	131.1	0.2974	1.94	2.7	3.5	3.8	4.1	4.5	10.4	9.5	13.1	14.2	11.5	10.6	12.2	10.7	12.8	10.7	12.9	10.8	13.0	10.9	NF
PND04_MH06	PND04_MH05	SD0334	CONDUIT	CIRCULAR	1	-	118.5	0.3208	2.02	0.9	1.2	1.5	1.7	2.2	10.8	10.4	14.5	13.1	11.6	11.5	12.2	12.2	14.3	12.8	14.5	12.9	14.5	13.0	NF
PND04_MH07	PND04_MH03	SD0335	CONDUIT	CIRCULAR	1	-	121.1	0.2972	1.94	2.3	2.5	2.7	2.9	3.2	10.4	9.5	14.0	14.2	11.3	10.6	11.4	10.7	11.5	10.7	11.6	10.8	11.8	10.9	NF
PND04_MH08	PND04_MH05	SD0336	CONDUIT	CIRCULAR	1	-	206.3	0.3006	1.27	1.8	2.4	2.6	2.7	2.9	11.0	10.4	14.8	13.1	12.9	11.5	14.1	12.2	14.6	12.8	14.8	12.9	14.8	13.0	25-yr, 24-hr
PND04_MH09	PND04_MH07	SD0338	CONDUIT	CIRCULAR	1	-	117.9	0.2459	1.15	2.3	2.5	2.7	2.9	3.2	10.7	10.4	15.0	14.0	12.8	11.3	12.8	11.4	13.1	11.5	13.4	11.6	14.1	11.8	NF
PND04_MH10	PND04_MH09	SD0339	CONDUIT	CIRCULAR	1	-	119.3	0.3018	1.27	2.3	2.5	2.7	2.9	3.2	11.1	10.7	13.6	15.0	13.6	12.8	13.6	12.8	13.6	13.1	13.6	13.4	13.6	14.1	5-yr, 24-hr
E Columbia Ave east of Bird Rd (Problem Area 23)																														
D04_MH01	D04_MH03	SD0179	CONDUIT	CIRCULAR	2	-	456.1	0.0877	6.7	13.9	15.8	16.2	16.5	19.1	11.2	10.7	17.6	17.5	17.5	15.7	17.6	17.5	17.6	17.1	17.6	17.5	17.6	17.5	5-yr, 24-hr
D04_MH03	D04_MH04	SD0180	CONDUIT	CIRCULAR	2	-	456.2	0.1491	8.73	15.0	17.0	17.5	18.0	20.5	10.7	9.9	17.5	17.6	15.7	15.4	17.5	17.6	17.1	17.6	17.5	17.6	17.5	17.6	100-yr, 24-hr
D04_MH04	D04_MH05	SD0181	CONDUIT	CIRCULAR	2	-	449.9	0.1578	8.99	15.0	17.0	17.5	18.0	20.5	9.9	9.1	17.6	15.1	15.4	10.8	17.6	11.0	17.6	11.1	17.6	11.2	17.6	11.3	NF
D04_MH05	D04	SD0182	CONDUIT	CIRCULAR	2	-	75	0.16	9.05	15.3	17.4	18.0	18.6	20.9	9.1	9.0	15.1	11.0	10.8	10.4	11.0	10.5	11.1	10.5	11.2	10.5	11.3	10.6	NF
D04_MH10	D04_MH12	SD0858	CONDUIT	CIRCULAR	2	-	289.7	0.1864	6.35	11.0	13.7	14.1	13.7	16.4	12.2	11.5	19.0	18.6	19.0	17.6	19.0	18.2	19.0	18.6	19.0	18.6	19.0	18.6	5-yr, 24-hr
D04_MH11	D04_MH10	SD0849	CONDUIT	CIRCULAR	2	-	280.3	0.3782	9.04	8.6	11.4	11.6	11.4	15.1	13.3	12.2	21.3	19.0	20.6	19.0	21.3	19.0	21.3	19.0	21.3	19.0	21.3	19.0	5-yr, 24-hr
D04_MH12	D04_MH01	SD0857	CONDUIT	CIRCULAR	2	-	32.1	1.0277	22.93	13.2	13.8	14.2	13.8	16.5	11.5	11.2	18.6	17.6	17.6	17.5	18.2	17.6	18.6	17.6	18.6	17.6	18.6	17.6	25-yr, 24-hr
SE Elm/Endicott/Pioneer Crossing/9th/Icenogle Loop (Problem Areas 3, 21)																														
PND07_CB45	PND07_MH35	SD1029	CONDUIT	CIRCULAR	1.25	-	35.3	-3.3692	11.86	5.0	6.3	6.9	6.9	9.6	15.4	16.6	17.5	18.7	17.5	17.9	17.5	18.7	17.5	18.7	17.5	18.7	17.5	18.7	2-yr, 24-hr
PND07_CB46	PND07_CB45	SD1030	CONDUIT	CIRCULAR	1	-	4.5	0.2216	1.68	4.9	5.2	5.2	5.2	5.2	14.0	15.4	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	2-yr, 24-hr
PND07_MH08	PND07_MH27	SD0049	CONDUIT	CIRCULAR	2	-	180.9	2.1229	21.42	12.4	14.2	15.7	17.6	18.9	16.0	12.2	21.2	20.2	20.5	19.2	21.2	20.2	21.2	20.2	21.2	20.2	21.2	20.2	5-yr, 24-hr
PND07_MH09	PND07_MH08	SD0047	CONDUIT	CIRCULAR	2	-	44.7	0.2461	7.3	8.1	9.6	10.2	11.4	12.6	16.2	16.0	21.2	21.2	20.6	20.5	21.2	21.2	21.2	21.2	21.2	21.2	21.2	21.2	5-yr, 24-hr
PND07_MH10	PND07_MH09	SD0048	CONDUIT	CIRCULAR	2	-	173.3	0.1501	5.7	8.1	11.3	12.4	13.4	14.5	16.4	16.2	23.1	21.2	21.4	20.6	23.1	21.2	23.1	21.2	23.1	21.2	23.1	21.2	5-yr, 24-hr
PND07_MH11	PND07_MH16	SD0104	CONDUIT	CIRCULAR	2	-	94.5	0.3705	13.77	14.3	16.4	17.9	19.7	21.7	12.2	11.9	22.4	19.2	18.1	17.6	19.3	18.8	20.2	19.2	21.3	19.2	22.4	19.2	100-yr, 24-hr
PND07_MH16	PND07_MH17	SD0105	CONDUIT	CIRCULAR	2	-	296.6	0.1517	8.81	17.0	18.1	18.8	19.5	21.0	11.9	11.0	19.2	19.6	17.6	16.1	18.8	17.7	19.2	19.6	19.2	18.6	19.2	19.6	10-yr, 24-hr
PND07_MH17	PND07_MH18	SD0106	CONDUIT	CIRCULAR	2	-	463.2	0.3735	13.83	17.0	18.1	18.8	19.5	20.8	11.0	9.2	19.6	17.8	16.1	13.9	17.7	14.8	19.6	15.1	18.6	14.9	19.6	15.8	100-yr, 24-hr
PND07_MH18	PND07_MH19	SD0107	CONDUIT	CIRCULAR	2	-	401.4	0.1993	10.1	17.0	18.1	18.8	19.5	20.8	9.2	8.4	17.8	15.6	13.9	12.0	14.8	12.9	15.1	12.4	14.9	12.9	15.8	12.6	NF
PND07_MH19	PND07_MH20	SD0108	CONDUIT	CIRCULAR	2	-	477	0.3417	13.22	17.0	18.1	18.8	19.5	20.8	8.4	6.8	15.6	8.8	12.0	8.3	12.9	8.3	12.4	8.4	12.9	8.4	12.6	8.4	NF
PND07_MH21	PND07_MH16	SD0109	CONDUIT	CIRCULAR	2	-	177	0.6273	17.92	6.0	7.0	7.5	8.0	12.5	13.0	11.9	18.9	19.2	18.2	17.6	18.8	18.8	18.9	19.2	18.9	19.2	18.9	19.2	10-yr, 24-hr
PND07_MH22	PND07_MH21	SD0110	CONDUIT	CIRCULAR	2	-	114	0.5261	16.41	6.0	7.0	7.5	7.4	11.1	13.6	13.0	19.5	18.9	18.5	18.2	18.9	18.8	19.5	18.9	19.5	18.9	19.5	18.9	25-yr, 24-hr
PND07_MH23	PND07_MH22	SD0111	CONDUIT	CIRCULAR	2	-	292.5	0.1949	9.99	5.9	7.0	7.5	7.4	10.2	14.2	13.6	18.7	19.5	18.7	18.5	18.7	18.9	18.7	19.5	18.7	19.5	18.7	19.5	5-yr, 24-hr
PND07_MH24	PND07_MH23	SD0112	CONDUIT	CIRCULAR	2	-	424.9	0.1977	10.06	5.0	6.9	7.6	9.0	9.8	15.0	14.2	19.3	18.7	19.3	18.7	19.3	18.7	19.3	18.7	19.3	18.7	19.3	18.7	25-yr, 24-hr
PND07_MH27	PND07_MH33	SD0808	CONDUIT	CIRCULAR	2	-	103.9	0.001	0.46	14.3	16.5	17.9	20.0	22.0	12.2	12.2	20.2	18.9	19.2	18.3	20.2	18.9	20.2	18.9	20.2	18.9	20.2	18.9	5-yr, 24-hr

Table A-2. Hydraulic Model Results - Existing Condition																												
Conduit			Conduit Attributes						Conduit Capacity** (cfs)	Existing Peak Flow (cfs)					Invert Elevation (ft)		Rim Elevation (ft)		Existing Max Hydraulic Grade Line (ft)***										When Hydraulically Deficient (Ex) (NF = Not Flooding)
																			2-yr, 24-hr		5-yr, 24-hr		10-yr, 24-hr		25-yr-, 24-hr		100-yr, 24-hr		
US Node	DS Node	Name	Type	Shape	Diameter (ft) / Max. Width (ft)	Depth (ft)	Conduit Length (ft)	Slope (%)		2-yr, 24-hr	5-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	
PND07_MH33	PND07_MH11	SD0809	CONDUIT	CIRCULAR	2	-	18.7	0.0053	1.07	14.3	16.4	17.9	19.7	21.7	12.2	12.2	18.9	22.4	18.3	18.1	18.9	19.3	18.9	20.2	18.9	21.3	18.9	22.4	5-yr, 24-hr
PND07_MH34	PND07_MH24	SD0113	CONDUIT	CIRCULAR	2	-	117	0.7266	19.28	5.0	6.4	7.2	7.9	9.7	15.7	15.0	19.1	19.3	18.3	19.3	19.1	19.3	19.1	19.3	19.1	19.3	19.1	19.3	10-yr, 24-hr
PND07_MH35	PND07_MH34	SD1028	CONDUIT	CIRCULAR	1.5	-	22.4	4.064	21.18	5.8	6.3	7.1	7.9	9.6	16.6	15.7	18.7	19.1	17.9	18.3	18.7	19.1	18.7	19.1	18.7	19.1	18.7	19.1	5-yr, 24-hr
PND07_MH37	PioneerCrossing	SD1034	CONDUIT	CIRCULAR	1.5	-	50.1	0.6587	8.53	4.5	5.2	6.2	7.0	8.0	15.6	15.1	19.2	19.0	17.8	17.7	18.9	18.9	19.0	19.0	19.1	19.0	19.2	19.0	NF
PND07_MH38	PND07_MH37	SD1035	CONDUIT	CIRCULAR	1.5	-	110.7	0.3523	6.23	1.7	1.9	2.6	3.2	4.1	16.1	15.6	19.8	19.2	17.8	17.8	18.9	18.9	19.1	19.0	19.2	19.1	19.4	19.2	NF
PND07_MH39	PND07_MH38	SD1036	CONDUIT	CIRCULAR	1.25	-	227.4	0.3958	4.06	1.8	1.9	2.6	3.2	4.1	17.3	16.1	20.9	19.8	17.9	17.8	18.9	18.9	19.2	19.1	20.2	19.2	20.9	19.4	NF
PND07_MH44	PND07_MH37	SD1042	CONDUIT	CIRCULAR	1	-	105.3	0.1899	1.55	1.0	1.3	1.5	1.7	1.6	16.0	15.6	19.5	19.2	17.8	17.8	18.8	18.9	18.9	19.0	19.0	19.1	19.1	19.2	NF
PND07_MH45	PND07_D03	SD1045	CONDUIT	CIRCULAR	1	-	70.1	3.0256	6.2	0.0	1.7	2.5	3.5	4.3	17.0	16.0	21.1	17.0	17.8	16.0	18.5	16.4	18.6	16.5	18.7	16.6	18.8	16.6	NF
PND07_MH45	PND07_MH44	SD1043	CONDUIT	CIRCULAR	1	-	212.3	0.391	2.23	1.0	1.3	1.5	1.7	1.6	17.0	16.0	21.1	19.5	17.8	17.8	18.5	18.8	18.6	18.9	18.7	19.0	18.8	19.1	NF
PND07_MH46	PND07_MH45	SD1044	CONDUIT	CIRCULAR	1	-	89.4	0.3244	2.03	1.1	1.5	1.9	2.3	2.9	17.5	17.0	21.8	21.1	18.0	17.8	18.5	18.5	18.8	18.6	19.0	18.7	19.4	18.8	NF
PND13_MH02	PND07_MH10	SD1114	CONDUIT	CIRCULAR	2	-	215.3	1.2172	24.96	8.3	11.4	14.5	17.8	21.0	19.3	16.4	28.0	23.1	20.9	21.4	23.6	23.1	25.6	23.1	28.0	23.1	28.0	23.1	100-yr, 24-hr
PND13_MH03	PND13_MH02	SD1115	CONDUIT	CIRCULAR	2	-	74.7	3.0254	39.35	8.4	11.4	14.5	17.7	21.4	22.9	19.3	28.7	28.0	23.5	20.9	23.7	23.6	25.8	25.6	28.7	28.0	28.7	28.0	100-yr, 24-hr
PND13_MH04	PND13_MH03	SD1116	CONDUIT	CIRCULAR	2	-	228.8	1.6045	28.66	8.4	11.4	14.6	17.7	22.7	26.8	22.9	35.9	28.7	27.5	23.5	27.7	23.7	27.8	25.8	31.8	28.7	32.6	28.7	NF
PioneerCrossing	PND07_CB45	PioneerCrossing_DI-A1.2	WEIR	-	-	-	-	-	-	0.6	2.7	5.2	3.8	4.8	15.1	15.4	19.0	17.5	17.7	17.5	18.9	17.5	19.0	17.5	19.0	17.5	19.0	17.5	10-yr, 24-hr
PioneerCrossing	PND07_CB46	PioneerCrossing_DI-A1.1	WEIR	-	-	-	-	-	-	4.7	4.7	3.4	4.7	5.5	15.1	14.0	19.0	17.5	17.7	17.5	18.9	17.5	19.0	17.5	19.0	17.5	19.0	17.5	10-yr, 24-hr
SE 5th/SE High School Way (Problem Area 4)																													
DW37_CB01	DW37_CB02	SD0291	CONDUIT	CIRCULAR	1	-	214.4	4.4343	7.5	2.8	3.6	4.3	5.0	6.5	48.6	39.1	53.4	43.7	49.0	42.6	49.1	43.2	49.2	43.7	49.3	43.7	53.4	43.7	NF
DW37_CB02	DW37_MH01	SD0294	CONDUIT	CIRCULAR	1	-	18.4	1.0867	1.21	4.6	5.1	5.4	5.8	6.3	39.1	38.9	43.7	39.9	42.6	39.8	43.2	39.8	43.7	39.8	43.7	39.8	43.7	39.9	10-yr, 24-hr
DW37_CB03	DW37_CB02	SD0292	CONDUIT	CIRCULAR	1	-	68.4	0.9794	3.53	1.8	2.6	3.0	3.2	3.3	39.8	39.1	43.2	43.7	42.8	42.6	43.2	43.2	43.2	43.7	43.2	43.7	43.2	43.7	5-yr, 24-hr
DW37_CB04	DW37_CB03	SD0293	CONDUIT	CIRCULAR	1	-	126.4	0.4983	2.51	1.8	2.5	2.7	2.7	2.8	40.5	39.8	43.1	43.2	43.1	42.8	43.1	43.2	43.1	43.2	43.1	43.2	43.1	43.2	5-yr, 24-hr
PND01_CB48	PND01_D02	SD0288	CONDUIT	CIRCULAR	1	-	11.7	1.0222	3.6	1.4	1.8	2.2	2.5	3.2	25.9	25.7	26.9	26.9	26.4	26.3	26.4	26.4	26.5	26.4	26.5	26.5	26.6	26.6	NF
PND01_D02	PND01_CB47	SD0289	CONDUIT	TRAPEZOIDAL	1	6.00	483.6	1.0609	11.96	3.1	3.9	4.7	5.5	6.9	25.7	20.6	26.9	21.6	26.3	21.1	26.4	21.1	26.4	21.2	26.5	21.2	26.6	21.3	NF
PND01_N01	PND01_CB48	SD0290	CONDUIT	TRAPEZOIDAL	1	6.00	216.2	1.9196	16.09	1.4	1.8	2.2	2.5	3.2	30.0	25.9	33.5	26.9	30.3	26.4	30.4	26.4	30.4	26.5	30.4	26.5	30.5	26.6	NF
PND02_N02	PND02_N01	PND02_N02_PND02_N01	CONDUIT	TRAPEZOIDAL	1	7.00	167.7	4.0725	28.68	2.8	3.5	4.2	5.0	6.2	31.8	25.0	32.8	26.0	32.1	25.3	32.2	25.3	32.2	25.4	32.2	25.4	32.3	25.5	NF
PND02_N03	PND02_N02	PND02_N03_PND02_N02	CONDUIT	TRAPEZOIDAL	1	7.00	341.9	2.4093	22.06	2.8	3.5	4.2	5.0	6.2	40.1	31.8	41.1	32.8	40.4	32.1	40.5	32.2	40.5	32.2	40.5	32.2	40.6	32.3	NF

Notes:

** = The conduit capacity is calculated in PC SWMM using Manning's formula. The calculation is based on an assumption of steady uniform flow. Under various hydraulic circumstances (e.g. critical flow), the actual pipe capacity can exceed this reported value.

*** = HGL values for flooding nodes were set to the node rim elevation.

Table A-3. Hydraulic Model Results - Future Condition

Conduit			Conduit Attributes						Conduit Capacity**	Future Peak Flow (cfs)					Invert Elevation (ft)		Rim Elevation (ft)		Future Max Hydraulic Grade Line (ft)***										When Hydraulically Deficient (Fu)
																			2-yr, 24-hr		5-yr, 24-hr		10-yr, 24-hr		25-yr-, 24-hr		100-yr, 24-hr		
US Node	DS Node	Name	Type	Shape	Diameter (ft) / Max. Width (ft)	Depth (ft)	Conduit Length (ft)	Slope (%)	(cfs)	2-yr, 24-hr	5-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	(NF = Not Flooding)
Callahan-Dutch Canyon Area (Problem Area 28)																													
INF10_CB26	INF10_MH15	SD0981	CONDUIT	CIRCULAR	1	-	59.8	0.4847	2.48	1.8	2.6	3.4	4.2	4.8	77.8	77.4	82.8	82.6	78.4	77.9	78.6	78.0	79.6	79.1	82.6	81.8	82.8	82.6	100-yr, 24-hr
INF10_D03	INF10_D04	SD0764	CONDUIT	TRAPEZOIDAL	3	10.00	386.4	2.7181	242.55	1.8	2.6	3.4	4.2	4.5	73.7	63.2	76.7	66.5	73.9	66.5	73.9	66.5	74.0	66.5	74.0	66.5	75.9	66.5	NF
INF10_D04	DC_INFIL_OF	DC_INFIL	OUTLET	-	-	-	-	-	-	5.2	5.2	5.2	5.2	5.2	63.2	63.2	66.5	63.2	66.5	63.2	66.5	63.2	66.5	63.2	66.5	63.2	66.5	63.2	2-yr, 24-hr
INF10_D06	INF10_D04	INF10_D06_INF10_D04	CONDUIT	TRAPEZOIDAL	3.33	19.32	560	0.2607	193.18	15.7	19.6	21.3	18.3	19.7	63.2	63.2	68.0	66.5	67.2	66.5	68.0	66.5	68.0	66.5	68.0	66.5	68.0	66.5	5-yr, 24-hr
INF10_MH01	INF10_MH07	SD0779	CONDUIT	CIRCULAR	1	-	64	0.6563	2.89	1.8	2.6	3.4	4.2	4.5	75.4	74.7	79.8	78.4	76.0	75.3	76.2	75.5	76.6	76.1	78.0	77.1	78.5	77.5	NF
INF10_MH02	INF10_MH03	SD0771	CONDUIT	CIRCULAR	2	-	42	0.9283	21.8	11.3	14.0	16.3	17.3	18.3	69.7	69.3	76.3	75.2	70.8	70.5	71.0	70.7	73.8	73.6	74.2	74.1	76.0	75.2	NF
INF10_MH03	INF10_MH04	SD0772	CONDUIT	CIRCULAR	2	-	126.9	0.4963	15.94	11.2	14.0	16.3	17.3	18.3	69.3	68.5	75.2	73.3	70.5	69.5	70.7	69.6	73.6	72.9	74.1	73.3	75.2	73.3	100-yr, 24-hr
INF10_MH04	INF10_MH06	SD0773	CONDUIT	CIRCULAR	2	-	119.7	1.0023	22.65	11.2	14.0	16.3	17.3	18.1	68.5	66.9	73.3	72.2	69.5	67.7	69.6	69.3	72.9	72.2	73.3	72.2	73.3	72.2	25-yr, 24-hr
INF10_MH05	INF10_D06	SD0776	CONDUIT	CIRCULAR	2.5	-	36.2	1.1873	44.69	16.5	21.6	25.5	28.9	32.9	65.1	63.2	70.2	68.0	67.2	67.2	69.3	68.0	70.2	68.0	70.2	68.0	70.2	68.0	10-yr, 24-hr
INF10_MH06	INF10_MH05	SD0775	CONDUIT	CIRCULAR	2.5	-	125.3	1.4051	48.62	11.2	14.1	16.3	17.1	18.1	66.9	65.1	72.2	70.2	67.7	67.2	69.3	69.3	72.2	70.2	72.2	70.2	72.2	70.2	25-yr, 24-hr
INF10_MH07	INF10_D03	SD0767	CONDUIT	CIRCULAR	1	-	151.8	0.6586	2.89	1.8	2.6	3.4	4.2	4.5	74.7	73.7	78.4	76.7	75.3	73.9	75.5	73.9	76.1	74.0	77.1	74.0	77.5	75.9	NF
INF10_MH15	INF10_MH16	SD0982	CONDUIT	CIRCULAR	1	-	67.7	1.1231	3.78	1.8	2.6	3.4	4.2	4.5	77.4	76.5	82.6	82.5	77.9	77.1	78.0	77.3	79.1	78.5	81.8	80.8	82.6	81.7	100-yr, 24-hr
INF10_MH16	INF10_MH17	SD0983	CONDUIT	CIRCULAR	1	-	122.8	0.6514	2.88	1.8	2.6	3.4	4.2	4.5	76.5	75.7	82.5	81.1	77.1	76.4	77.3	76.6	78.5	77.4	80.8	79.1	81.7	79.8	NF
INF10_MH17	INF10_MH01	SD0765	CONDUIT	CIRCULAR	1	-	78.3	0.3319	2.05	1.8	2.6	3.4	4.2	4.5	75.7	75.4	81.1	79.8	76.4	76.0	76.6	76.2	77.4	76.6	79.1	78.0	79.8	78.5	NF
INF10_MH20	INF10_MH23	SD0988	CONDUIT	CIRCULAR	1.5	-	109.6	0.6114	8.21	11.3	14.0	16.3	17.3	18.4	71.3	70.5	80.7	78.6	73.3	71.6	74.0	71.8	74.6	71.9	75.5	74.4	77.1	76.1	NF
INF10_MH21	INF10_MH22	SD0986	CONDUIT	CIRCULAR	1.5	-	84.3	0.4747	7.24	9.2	11.8	13.5	14.7	13.9	72.6	72.1	77.4	79.6	74.7	74.0	75.9	74.9	77.1	75.8	77.4	76.6	77.4	78.0	25-yr, 24-hr
INF10_MH22	INF10_MH20	SD0987	CONDUIT	CIRCULAR	1.5	-	80.1	0.6493	8.46	9.3	11.8	13.5	14.7	13.9	72.1	71.3	79.6	80.7	74.0	73.3	74.9	74.0	75.8	74.6	76.6	75.5	78.0	77.1	NF
INF10_MH23	INF10_MH02	SD0770	CONDUIT	CIRCULAR	2	-	84.8	0.6955	18.87	11.2	14.0	16.3	17.3	18.4	70.5	69.7	78.6	76.3	71.6	70.8	71.8	71.0	71.9	73.8	74.4	74.2	76.1	76.0	NF
INF10_MH39	INF10_MH21	SD1093	CONDUIT	CIRCULAR	1.5	-	137.1	0.248	5.23	8.0	10.8	12.4	13.3	12.6	72.9	72.6	75.9	77.4	75.8	74.7	75.9	75.9	75.9	77.1	75.9	77.4	75.9	77.4	5-yr, 24-hr
INF10_MH40	INF10_MH39	SD1094	CONDUIT	CIRCULAR	1.5	-	114.1	0.5695	7.93	3.5	4.8	5.5	5.6	7.2	73.6	72.9	79.4	75.9	76.3	75.8	78.3	75.9	79.0	75.9	79.4	75.9	79.4	75.9	25-yr, 24-hr
INF10_MH41	INF10_MH40	SD1095	CONDUIT	CIRCULAR	1.5	-	214.8	0.4981	7.41	3.5	4.8	5.5	5.2	7.2	74.7	73.6	77.7	79.4	75.5	76.3	77.7	78.3	77.7	79.0	77.7	79.4	77.7	79.4	5-yr, 24-hr
INF10_MH42	DC_J1	DC_OR1	ORIFICE	-	-	-	-	-	-	0.2	0.3	5.3	5.1	7.7	71.5	73.5	78.4	78.4	75.8	75.3	77.9	77.9	78.4	77.7	78.4	77.7	78.4	77.7	10-yr, 24-hr
INF10_MH42	DC_J1	DC_Weir1	WEIR	-	-	-	-	-	-	0.0	1.6	0.3	1.7	2.0	71.5	73.5	78.4	78.4	75.8	75.3	77.9	77.9	78.4	78.4	78.4	78.4	78.4	78.4	10-yr, 24-hr
INF10_MH42	INF10_MH41	SD1096	CONDUIT	CIRCULAR	1.33	-	39.4	0.7364	6.58	3.4	4.3	1.8	0.3	0.3	71.5	74.7	78.4	77.7	75.8	75.5	77.9	77.7	78.4	78.4	78.4	78.4	78.4	78.4	10-yr, 24-hr
INF10_MH43	INF10_N01	SD1098	CONDUIT	CIRCULAR	1.33	-	106	3.2659	13.86	0.2	1.8	2.9	4.8	8.4	71.3	71.3	78.0	74.5	75.0	74.5	77.9	74.5	78.0	74.5	78.0	74.5	78.0	74.5	10-yr, 24-hr
INF10_MH44	INF10_MH42	SD1099	CONDUIT	CIRCULAR	1.25	-	133.5	0.322	3.67	3.6	5.5	6.2	5.9	7.5	75.6	71.5	84.5	78.4	76.5	75.8	78.8	77.9	80.6	78.4	81.8	78.4	83.9	78.4	NF
INF10_MH47	INF10_MH48	SD1104	CONDUIT	CIRCULAR	1	-	139.9	6.7914	9.28	2.2	3.5	4.9	6.3	8.2	86.4	76.7	91.9	82.7	86.7	77.5	86.8	82.7	87.0	82.7	90.0	82.7	91.9	82.7	100-yr, 24-hr
INF10_MH48	INF10_MH44	SD1105	CONDUIT	CIRCULAR	1	-	235	0.3999	2.25	2.2	3.5	4.3	4.6	5.0	76.7	75.6	82.7	84.5	77.5	76.5	82.7	78.8	82.7	80.6	82.7	81.8	82.7	83.9	10-yr, 24-hr
INF10_N01	DC_Wetland	INF10_N01_DC_Wetland	CONDUIT	TRIANGULAR	0.5	3.00	28	3.2696	2.57	5.4	7.1	7.9	8.6	9.4	71.3	69.0	74.5	74.5	74.5	70.3	74.5	70.9	74.5	71.3	74.5	71.8	74.5	72.5	2-yr, 24-hr
DC_J1	INF10_MH43	SD1097	CONDUIT	CIRCULAR	1.33	-	18	2.056	10.93	0.2	1.8	2.0	2.5	5.1	73.5	71.3	78.4	78.0	75.3	75.0	77.9	77.9	78.4	78.0	78.4	78.0	78.4	78.0	10-yr, 24-hr
DC_Wetland	DC_Wetland_OF	DC_Wetland_INFIL	OUTLET	-	-	-	-	-	-	2.0	2.0	2.0	2.0	2.0	69.0	69.0	74.5	69.0	70.3	69.0	70.9	69.0	71.3	69.0	71.8	69.0	72.5	69.0	NF
SW Creek View Place/4th Ave Systems (Problem Area 15)																													
SSC04_CB20	SSC04_MH12	SD0455	CONDUIT	CIRCULAR	1.75	-	119.5	0.1758	6.64	1.3	1.9	2.4	2.9	3.8	56.6	56.3	62.0	59.8	57.3	57.3	57.5	57.5	57.6	57.5	57.7	57.6	57.8	57.8	NF
SSC04_F01	SSC04_MH11	SD0457	CONDUIT	CIRCULAR	1.25	-	82.7	0.8827	6.07	1.4	1.9	2.4	2.9	3.8	58.8	58.0	60.0	63.9	59.2	58.5	59.2	58.5	59.3	58.6	59.4	58.7	59.5	58.8	NF
SSC04_MH01	SSC04_MH04	SD0447	CONDUIT	CIRCULAR	1	-	252.4	0.4438	2.37	3.0	3.8	4.0	4.2	4.5	58.0	56.8	65.6	62.3	60.5	57.7	61.9	58.0	62.9	58.1	63.8	58.2	63.5	58.4	NF
SSC04_MH02	SSC04_MH01	SD0448	CONDUIT	CIRCULAR	1	-	179	0.4971	2.51	3.0	3.8	4.0	4.2	4.5	58.9	58.0	62.3	65.6	61.5	60.5	62.3	61.9	62.3	62.9	62.3	63.8	62.3	63.5	5-yr, 24-hr
SSC04_MH03	SSC04_MH02	SD0449	CONDUIT	CIRCULAR	1	-	138.1	0.5068	2.54	3.0	4.0	5.0	5.2	5.7	59.6	58.9	65.6	62.3	62.5	61.5	64.2	62.3	65.6	62.3	65.6	62.3	65.6	62.3	10-yr, 24-hr
SSC04_MH04	SSC04_MH12	SD0446	CONDUIT	CIRCULAR	1.5	-	123	0.3902	6.56	4.9	6.5	7.1	7.6	8.4	56.8	56.3	62.3	59.8	57.7	57.3	58.0	57.5	58.1	57.5	58.2	57.6	58.4	57.8	NF
SSC04_MH05	SSC04_MH04	SD0445	CONDUIT	CIRCULAR	1.25	-	129.7	0.3933	4.05	2.1	2.9	3.2	3.4	3.9	57.4	56.8	65.6	62.3	58.0	57.7	58.2	58.0	58.3	58.1	58.5	58.2	58.8	58.4	NF
SSC04_MH06	SSC04_MH05	SD0443	CONDUIT	CIRCULAR	1.25	-	121.1	0.3962	4.07	2.1	2.9	3.1	3.4	3.9	57.9	57.4	65.6	65.6	58.5	58.0	58.6	58.2	58.7	58.3	58.8	58.5	59.3	58.8	NF
SSC04_MH07	SSC04_MH06	SD0442	CONDUIT	CIRCULAR	1.25	-	223.7	0.3933	4.05	2.1	2.9	3.1	3.4	3.9	58.7	57.9	65.0	65.6	59.4	58.5	59.5	58.6	59.6	58.7	59.6	58.8	60.1	59.3	NF
SSC04_MH08	SSC04_MH07	SD0441	CONDUIT	CIRCULAR	1	-	341.6	0.3015	1.96	2.1	2.9	3.1	3.4	3.9	59.8	58.7	65.0	65.0	60.8	59.4	63.1	59.5	64.5	59.6	65.0	59.6	65.0	60.1	NF
SSC04_MH09	SSC04_MH08	SD0440	CONDUIT	CIRCULAR	1	-	100.2	0.2994	1.95	2.1	2.9	3.1	3.4	3.9	60.2	59.8	65.6	65.0	61.1	60.8	63.4	63.1	64.6	64.5	65.4	65.0	65.4	65.0	NF
SSC04_MH10	SSC04_MH09	SD0438	CONDUIT	CIRCULAR	1	-	400	0.275	1.87	2.2	2.9	3.1	3.4	3.9	61.4	60.2	64.9	65.6	62.5	61.1	64.9	63.4	64.9	64.6	64.9	65.4	64.9	65.4	10-yr, 24-hr
SSC04_MH11	SSC04_CB20	SD0456	CONDUIT	CIRCULAR	1.5	-	273.7	0.3909	6.57	1.3	1.9	2.4	2.9	3.8	58.0	56.6	63.9	62.0	58.5	57.3	58.5	57.5	58.6	57.6	58.7	57.7	58.8	57.8	NF
SSC04_MH12	SSC04_MH13	SD0454	CONDUIT	CIRCULAR	1.75	-	78.3	0.3958	9.97	6.2	8.4	9.3	10.1	11.5	56.3	55.9	59.8	64.1	57.3	56.9	57.5	57.0	57.5	57.1	57.6	57.2	57.8	57.3	NF
SSC04_MH13	SSC04	SD0453	CONDUIT	CIRCULAR	1.75	-	70	0.4	10.02	6.2	8.4	9.3	10.1	11.5	55.9	55.6	64.1	57.4	56.9	56.5	57.0	56.7	57.1	56.7	57.2	56.8	57.3	56.9	NF
SSC07_F01	SSC07_MH03	SD0502	CONDUIT	CIRCULAR	1.75	-	287.3	0.5326	11.56	7.8	10.4	13.0	15.6	18.4	55.1	53.5	61.2	60.7	56.1	54.6	56.4	54.8	57.0	55.2	59.3	56.9	61.2	58.6	100-yr, 24-hr
SSC07_MH01	SSC07_MH02	SD0500	CONDUIT	CIRCULAR	2	-	265.2	0.1848	9.72	7.8	10.3	12.9	15.6	18.4	51.8	51.3	62.3	62.3	53.1	52.4	53.4	52.7	53.8	52.9	54.3	53.2	55.5	53.7	NF
SSC07_MH02	SSC07	SD0499	CONDUIT	CIRCULAR	2	-	225.8	0.3189	12.78	7.8	10.3	12.9	15.5	18.4	51.3	50.6	62.3	52.6	52.4	51.6	52.7	51.8	52.9	51.9	53.2	52.0	53.7	52.1	NF
SSC07_MH03	SSC07_MH01	SD0501	CONDUIT	CIRCULAR	1.75	-	232	0.5086	11.3	7.8	10.3	12.9	15.6	18.4	53.5	51.8	60.7	62.3	54.6	53.1	54.8	53.4	55.2	53.8	56.9	54.3	58.6	55.5	NF
SSC08_CB02	SSC08_MH03	SD0510	CONDUIT	CIRCULAR	1	-	293.6	0.4087	2.28	3.6	4.0	4.4	4.7	5.1	50.4	49.2	59.1	55.0	54.2	51.2	55.4	51.7	56.6	52.2	57.6	52.5	59.1	53.2	100-yr, 24-hr
SSC08_CB05	SSC08_MH01	SD0514	CONDUIT	CIRCULAR	1	-	69.8	3.7722	6.92	3.6	4.0	4.8	5.9	7.3	53.4	50.7	56.5	57.5	55.7	55.0	56.5	56.3	56.5	57.5	56.5	57.5	56.5	57.5	5-yr, 24-hr
SSC08_MH01	SSC08_CB02	SD0512	CONDUIT	CIRCULAR	1	-	71.9	0.2922	1.93	3.6	4.0	4.4	4.7	5.5	50.7	50.4	57.5	59.1	55.0	54.2	56.3	55.4	57.5	56.6	57.5	57.6	57.5	59.1	10-yr, 24-hr
SSC08_MH02	SSC08	SD0507	CONDUIT	CIRCULAR	1	-	42.4	0.4241	2.32	3.6	4.0	4.4	4.7	5.1	48.7	48.5	56.1	49.5	49.8	49.3	49.9	49.3	50.1	49.4	50.2	49.4	50.3	49.4	NF
SSC08_MH03	SSC08_MH02	SD0508	CONDUIT	CIRCULAR	1	-	140.7	0.4123	2.29	3.6	4.0	4.4	4.7	5.1	49.2	48.7	55.0	56.1	51.2	49.8	51.7	49.9	52.2	50.1	52.5	50.2	53.2	50.3	NF
Keys Road Basin (Problem Area 29)																													
SSC09_CB08	SSC09_CB09	SD0562	CONDUIT	CIRCULAR	1	-	57.8	8.7346	10.53	6.0	7.0	7.7	8.6	8.7	166.2	161.2	169.5	163.9	166.8	161.6	166.8	161.7	166.9	161.7	166.9	161.7	166.9	161.7	NF
SSC09_CB09	SSC09_MH01	SD0561	CONDUIT	CIRCULAR	1.25	-	197.6	11.8574	22.24	6.0	7.0	7.7	8.6	8.7	161.2	137.7	163.9	141.1	161.6	138.1	161.7	138.1	161.7	138.2	161.7	138.2	161.7	138.2	NF
SSC09_CB16	SSC09_N04	SD0566_1	CONDUIT	CIRCULAR	1	-	37.2	9.3903	3.55	5.0	5.9	6.7	7.6	8.7	70.7	67.2	73.2	70.3	73.2	67.7	73.2	67.7	73.2	67.8	73.2	67.8	73.2	67.9	2-yr, 24-hr
SSC09_CB18	SSC09_D08	SD0567	CONDUIT	CIRCULAR	1.5	-	32.3	1.4226	4.07	6.2	7.1	7.7	8.3	9.3	55.1	54.7	57.1	56.7	56.5	55.2	57.1	55.2	57.1	55.2	57.1	55.3	57.1	55.3	10-yr, 24-hr
SSC09_CB19	SSC09_D09	SD0714	CONDUIT	CIRCULAR	0.83	-	35.2	0.5991	1.69	2.9	3.6	4.3	4.9	5.5	215.3	215.1	216.8	216.5	216.3	215.5	216.7	215.5	216.8	215.6	216.8	215.8	216.8	216.5	10-yr, 24-hr
SSC09_CB20	SSC09_F01	SD0716	CONDUIT	CIRCULAR	1	-	96.1	1.2109	3.92	2.9	3.6	4.3	4.9	5.8	211.3	210.1	213.7	211.1	211.9	210.5	212.0	210.6	212.1	210.7	213.5	211.1	213.7	211.1	100-yr, 24-hr
SSC09_D07	SSC09_CB18	SD0590	CONDUIT	TRAPEZOIDAL	1.17	7.01	173.7	5.1205	31.75	5.2	6.1	7.0	7.8	8.9	64.0	55.1	65.8	57.1	64.5	56.5	64.5	57.1	64.6	57.1	64.6	57.1	64.6	57.1	NF
SSC09_D08	SSC09	SD0591	CONDUIT	TRAPEZOIDAL	1.17	7.01	248.9	5.8481	33.93	6.2	7.1	7.7	8.3	9.3	54.7	40.1	56.7	41.3	55.2	40.7	55.2	40.7	55.2	40.7	55.3	40.7	55.3	40.8	NF
SSC09_D09	SSC09_CB20	SD0715	CONDUIT	CIRCULAR	0.83	-	49.5	7.741	6.09	2.9	3.6	4.3	4.9	5.3	215.1	211.3	216.5	213.7	215.5	211.9	215.5	212.0	215.6	212.1	215.8	213.5	216.5	213.7	100-yr, 24-hr
SSC09_D10	SSC09_N05	SD0740	CONDUIT	TRAPEZOIDAL	2.5	8.00	122.2	13.9846	272.14	6.0	7.0	7.7	8.6	8.7	130.6	113.7	133.1	116.2	131.0	114.6	131.0	114.6	131.0	114.7	131.1	114.8	131.1	114.8	NF
SSC09_D11	SSC09_CB16	SD0588	CONDUIT	TRAPEZOIDAL	2.5	8.00	300.8	12.5402	193.27	9.1	11.0	12.8	14.6	17.0	108.1	70.7	110.6	73.2	108.6	73.2	108.7	73.2	108.7	73.2	108.8	73.2	108.8	73.2	NF
SSC09_F01	SSC09_MH10	SD0094	CONDUIT	CIRCULAR	1	-	26.5	9.3883	7.1	2.9	3.6	4.3	5.8	6.7	210.1	203.3	211.1	210.9	210.5	204.5	210.6	205.7	210.7	207.9	211.1	210.6	211.1	210.9	25-yr, 24-hr
SSC09_F02	SSC09_MH08	SD0101	CONDUIT	CIRCULAR	1	-	26	4.3074	7.39	1.7	2.2	2.6	3.1	3.5	230.6	229.5	236.0	236.1	230.9	229.8	231.0	229.8	231.0	229.9	231.1	229.9	231.1	230.0	NF
SSC09_MH01	SSC09_D10	SD0742	CONDUIT	CIRCULAR	1.5	-	62.9	11.2216	35.19	6.0	7.0	7.7	8.6	8.7	137.7	130.6	141.1	133.1	138.1	131.0	138.1	131.0	138.2	131.0	138.2	131.1	138.2	131.1	NF
SSC09_MH02	SSC09_CB08	SD0735	CONDUIT	CIRCULAR	1	-	100.6	7.0531	9.46	6.0	7.0	7.7	8.6	8.7	173.6	166.2	179.1	169.5	174.2	166.8	174.3	166.8	174.3	166.9	174.4	166.9	174.4	166.9	NF
SSC09_MH03	SSC09_MH02	SD0736	CONDUIT	CIRCULAR	1	-	31.8	6.5807	9.14	6.0	7.0	7.7	8.6	8.7	176.0	173.6	183.1	179.1	176.6	174.2	176.7	174.3	176.8	174.3	176.8	174.4	176.8	174.4	NF
SSC09_MH04	SSC09_MH06	SD0738	CONDUIT	CIRCULAR	1	-	29.6	8.579	10.44	6.0	7.0	7.7	8.6	8.7	188.3	185.6	194.5	193.0	188.8	186.3	188.9	186.3	188.9	186.4	188.9	186.5	189.0	186.5	NF
SSC09_MH05	SSC09_MH07	SD0559	CONDUIT	CIRCULAR	1	-	136.7	3.7848	6.93	6.0	7.1	7.7	8.6	8.7	199.9	194.6	205.1	199.9	200.6	195.2	200.7	195.3	204.1	195.4	204.1	195.5	205.1	198.8	NF
SSC09_MH06	SSC09_MH03	SD0737	CONDUIT	CIRCULAR	1	-	138.6	5.1151	8.06	6.0	7.0	7.7	8.6	8.7	185.6	176.0	193.0	183.1	186.3	176.6	186.3	176.7	186.4	176.8	186.5	176.8	186.5	176.8	NF
SSC09_MH07	SSC09_MH04	SD0563	CONDUIT	CIRCULAR	1	-	123.9	5.0432	8	6.0	7.0	7.7	8.6	8.7	194.6	188.3	199.9	194.5	195.2	188.8	195.3	188.9	195.4	188.9	195.5	188.9	198.8	189.0	NF
SSC09_MH08	SSC09_MH14	SD0100	CONDUIT	CIRCULAR	1	-	229.4	4.7918	7.8	1.7	2.2	2.6	3.1	3.5	229.5	218.5	236.1	224.6	229.8	218.9	229.8	219.0	229.9	219.1	229.9	219.1	230.0	219.2	NF
SSC09_MH09	SSC09_MH05	SD0560	CONDUIT	CIRCULAR	1	-	98.4	2.9172	6.09	6.0	7.0	7.7	8.6	8.7	202.8	199.9	208.7	205.1	203.6	200.6	204.8	200.7	207.0	204.1	208.7	204.1	208.7	205.1	25-yr, 24-hr
SSC09_MH10	SSC09_MH12	SD0093	CONDUIT	CIRCULAR	1.25	-	22.5	0.1778	1.77	4.4	5.2	6.1	6.9	7.3	203.3	203.3	210.9	210.8	204.5	204.3	205.7	205.3	207.9	207.5	210.6	210.2	210.9	210.8	100-yr, 24-hr
SSC09_MH11	SSC09_MH10	SD0095	CONDUIT	CIRCULAR	1.25	-	44.7	0.492	2.95	1.7	1.9	2.0	3.3	4.0	203.5	203.3	212.1	210.9	204.6	204.5	205.7	205.7	207.9	207.9	210.9	210.6	211.8	210.9	NF
SSC09_MH12	SSC09_MH09	SD0092	CONDUIT	CIRCULAR	1.25	-	100.9	0.4459	4.31	4.4	5.2	6.1	6.8	7.3	203.3	202.8	210.8	208.7	204.3	203.6	205.3	204.8	207.5	207.0	210.2	208.7	210.8	208.7	100-yr, 24-hr
SSC09_MH13	SSC09_N03	SD0096	CONDUIT	CIRCULAR	1	-	114	6.2113	8.88	1.7	2.2	2.6	3.1	3.5	215.7	203.5	223.5	212.1	216.0	204.6	216.0	205.7	216.0	207.9	216.1	210.9	216.1	211.8	NF
SSC09_MH14	SSC09_MH13	SD0099	CONDUIT	CIRCULAR	1	-	61.3	1.5166	4.39	1.7	2.2	2.6	3.1	3.5	218.5	215.7	224.6	223.5	218.9	216.0	219.0	216.0	219.1	216.0	219.1	216.1	219.2	216.1	NF
SSC09_N01	SSC09_CB19	SD0713	CONDUIT	CIRCULAR	0.83	-	108.2	0.6	1.7	2.9	3.6	4.4	5.1	6.4	215.9	215.3	217.0	216.8	217.0	216.3	217.0	216.7	217.0	216.8	217.0	216.8	217.0	216.8	2-yr, 24-hr

Table A-3. Hydraulic Model Results - Future Condition

Conduit			Conduit Attributes						Conduit Capacity** (cfs)	Future Peak Flow (cfs)					Invert Elevation (ft)		Rim Elevation (ft)		Future Max Hydraulic Grade Line (ft)***										When Hydraulically Deficient (Fu) (NF = Not Flooding)
																			2-yr, 24-hr		5-yr, 24-hr		10-yr, 24-hr		25-yr-, 24-hr		100-yr, 24-hr		
US Node	DS Node	Name	Type	Shape	Diameter (ft) / Max. Width (ft)	Depth (ft)	Conduit Length (ft)	Slope (%)		2-yr, 24-hr	5-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	
SSC09_N02	SSC09_MH11	SD0097	CONDUIT	CIRCULAR	3	-	4	0.0253	10.6	1.7	1.9	2.0	3.2	3.8	203.5	203.5	212.1	212.1	204.6	204.6	205.7	205.7	207.9	207.9	210.9	210.9	211.8	211.8	NF
SSC09_N03	SSC09_N02	SD0098	CONDUIT	CIRCULAR	6	-	106.8	9e-04	7.02	1.7	2.3	2.4	3.0	3.6	203.5	203.5	212.1	212.1	204.6	204.6	205.7	205.7	207.9	207.9	210.9	210.9	211.8	211.8	NF
SSC09_N04	SSC09_D07	SD0566_2	CONDUIT	RECT_CLOSED	1.5	2.00	34.2	9.3883	19.41	5.0	5.9	6.7	7.6	8.7	67.2	64.0	70.3	65.8	67.7	64.5	67.7	64.5	67.8	64.6	67.8	64.6	67.9	64.6	NF
SSC09_N05	SSC09_D11	SD0743	CONDUIT	CIRCULAR	1.5	-	52.8	10.6863	11.16	6.0	7.0	7.7	8.6	8.7	113.7	108.1	116.2	110.6	114.6	108.6	114.6	108.7	114.7	108.7	114.8	108.8	114.8	108.8	NF
SW J.P. West Road System (Problem Area 18b)																													
SSC15_CB06	SSC15_MH05	SD0189	CONDUIT	CIRCULAR	1	-	16.5	1.27	2.17	1.3	1.7	2.1	2.5	3.3	89.4	86.3	97.4	93.6	91.9	91.8	92.1	92.0	92.4	92.2	94.1	93.6	96.0	93.6	NF
SSC15_CB07	SSC15_CB06	SD0190	CONDUIT	CIRCULAR	1	-	64.2	8.508	10.39	1.3	1.7	2.1	2.5	3.3	94.9	89.4	99.4	97.4	95.1	91.9	95.1	92.1	95.2	92.4	95.2	94.1	96.4	96.0	NF
SSC15_CB08	SSC15_CB07	SD0191	CONDUIT	CIRCULAR	1	-	45.5	16.381	14.42	1.3	1.7	2.1	2.5	3.3	102.4	94.9	105.5	99.4	102.6	95.1	102.6	95.1	102.7	95.2	102.7	95.2	102.7	96.4	NF
SSC15_CB10	SSC15_CB08	SD0192	CONDUIT	CIRCULAR	1	-	280.4	11.6123	12.14	1.1	1.5	1.9	2.3	3.0	134.9	102.4	139.6	105.5	135.2	102.6	135.2	102.6	135.2	102.7	135.2	102.7	135.3	102.7	NF
SSC15_CB11	SSC15_D03	SD0702	CONDUIT	CIRCULAR	1	-	41.8	1.3149	4.83	3.3	4.5	5.9	6.5	7.4	73.3	72.8	76.3	75.3	74.0	73.1	74.1	73.2	74.3	73.2	74.5	73.3	74.9	73.3	NF
SSC15_CB12	SSC15_D04	SD0700	CONDUIT	CIRCULAR	2	-	105	5.4316	52.72	5.0	6.7	8.4	9.6	11.0	60.9	56.2	65.9	59.2	62.3	56.7	62.4	56.8	62.5	56.9	62.5	56.9	62.5	57.0	NF
SSC15_CB13	SSC15_D05	SD0698	CONDUIT	CIRCULAR	2	-	58	4.4161	47.54	5.0	6.7	8.4	9.6	12.4	52.3	49.7	54.3	51.7	52.7	51.1	52.8	51.7	52.9	51.7	52.9	51.7	53.5	51.7	NF
SSC15_CB14	SSC15_D06	SD0718	CONDUIT	CIRCULAR	2	-	27	0.4895	15.83	4.8	5.9	6.8	7.8	8.8	48.9	48.8	50.9	50.8	50.9	50.8	50.9	50.8	50.9	50.8	50.9	50.8	50.9	50.8	5-yr, 24-hr
SSC15_D02	SSC15_CB11	SSC15_D02_SSC15_CB11	CONDUIT	TRAPEZOIDAL	0.83	7.00	92	11.2221	32.99	3.3	4.5	5.6	6.5	7.4	83.6	73.3	84.6	76.3	83.9	74.0	83.9	74.1	84.0	74.3	84.0	74.5	84.0	74.9	NF
SSC15_D03	SSC15_CB12	SD0701	CONDUIT	CIRCULAR	2	-	123.5	8.8484	67.29	4.0	5.3	6.8	7.7	8.9	72.8	60.9	75.3	65.9	73.1	62.3	73.2	62.4	73.2	62.5	73.3	62.5	73.3	62.5	NF
SSC15_D04	SSC15_CB13	SD0699	CONDUIT	TRAPEZOIDAL	1	6.00	101.5	3.8671	22.83	5.0	6.7	8.4	9.6	11.1	56.2	52.3	59.2	54.3	56.7	52.7	56.8	52.8	56.9	52.9	56.9	52.9	57.0	53.5	NF
SSC15_D05	SSC15_CB14	SD0697	CONDUIT	TRAPEZOIDAL	1	6.00	100	0.8199	7.89	4.8	6.5	7.4	8.6	9.6	49.7	48.9	51.7	50.9	51.1	50.9	51.7	50.9	51.7	50.9	51.7	50.9	51.7	50.9	10-yr, 24-hr
SSC15_D06	SSC15	SD0717	CONDUIT	TRAPEZOIDAL	1	6.00	241.7	0.2036	3.93	4.3	5.4	6.3	7.2	8.4	48.8	48.3	50.8	49.3	50.8	48.8	50.8	48.9	50.8	49.0	50.8	49.0	50.8	49.1	2-yr, 24-hr
SSC15_MH05	SSC15_MH06	SD0188	CONDUIT	CIRCULAR	0.67	-	26	13.5921	2.42	0.3	1.4	2.5	3.6	4.0	86.3	86.0	93.6	90.3	91.8	86.4	92.0	86.5	92.2	86.6	93.6	86.6	93.6	86.7	25-yr, 24-hr
SSC15_MH05	SSC15_MH06	SD0187	CONDUIT	CIRCULAR	0.67	-	23.5	0.6373	0.52	3.0	3.1	3.1	2.9	3.4	86.3	86.0	93.6	90.3	91.8	86.4	92.0	86.5	92.2	86.6	93.6	86.6	93.6	86.7	25-yr, 24-hr
SSC15_MH06	SSC15_D02	SD0473	CONDUIT	CIRCULAR	1	-	35.8	6.6365	9.18	3.3	4.5	5.6	6.5	7.4	86.0	83.6	90.3	84.6	86.4	83.9	86.5	83.9	86.6	84.0	86.6	84.0	86.7	84.0	NF
SSC15_N01	SSC15_D03	SSC15_N01_SSC15_D03	CONDUIT	CIRCULAR	1.5	-	260.8	8.8353	31.22	0.6	0.9	1.1	1.3	1.7	95.8	72.8	99.3	75.3	95.9	73.1	95.9	73.2	95.9	73.2	96.0	73.3	96.0	73.3	NF
NW E.J. Smith and SW 1st St (Problem Area 6)																													
SSC17_F01	SSC17	SD0466	CONDUIT	CIRCULAR	1.25	-	619.8	0.0419	0.72	3.3	3.4	3.5	3.7	3.9	47.5	47.2	52.2	48.5	52.2	48.0	52.2	48.0	52.2	48.0	52.2	48.0	52.2	48.0	2-yr, 24-hr
SSC17_F02	SSC17_F01	SD0465	CONDUIT	CIRCULAR	1.25	-	415.9	1.1902	3.82	3.7	4.0	4.2	4.3	4.5	52.7	47.5	56.4	52.2	56.4	52.2	56.4	52.2	56.4	52.2	56.4	52.2	56.4	52.2	2-yr, 24-hr
SSC17_F03	SSC17_F02	SD0464	CONDUIT	CIRCULAR	1.25	-	255.3	0.4191	2.27	2.3	2.3	2.4	2.4	2.5	53.9	52.7	59.5	56.4	59.5	56.4	59.5	56.4	59.5	56.4	59.5	56.4	59.5	56.4	10-yr, 24-hr
SSC17_F04	SSC17_F03	SD0463	CONDUIT	CIRCULAR	1.25	-	237.2	0.3962	2.2	2.3	2.3	2.3	2.3	2.4	54.9	53.9	60.2	59.5	60.2	59.5	60.2	59.5	60.2	59.5	60.2	59.5	60.2	59.5	5-yr, 24-hr
SSC17_F05	SSC17_F04	SD0462	CONDUIT	CIRCULAR	1.25	-	248.7	0.394	2.2	2.3	2.4	2.3	2.3	2.5	56.0	54.9	60.0	60.2	60.0	60.2	60.0	60.2	60.0	60.2	60.0	60.2	60.0	60.2	2-yr, 24-hr
SSC17_F06	SSC17_F05	SD0461	CONDUIT	CIRCULAR	1.25	-	235.1	0.3999	2.21	2.5	2.6	2.6	2.6	2.9	57.0	56.0	61.1	60.0	61.1	60.0	61.1	60.0	61.1	60.0	61.1	60.0	61.1	60.0	2-yr, 24-hr
SSC17_F07	SSC17_F06	SD0460	CONDUIT	CIRCULAR	1	-	189.7	0.4585	1.31	2.6	2.8	3.1	3.5	4.0	58.0	57.0	62.2	61.1	62.2	61.1	62.2	61.1	62.2	61.1	62.2	61.1	62.2	61.1	2-yr, 24-hr
NE Sunset Loop/NE Miller Road/Miller Park/NE 14th (Problem Areas 8, 9, 19)																													
PND03_CB03	PND03_MH01	SD0324	CONDUIT	CIRCULAR	1.5	-	62	0.2901	5.66	5.4	5.8	6.7	7.6	8.9	11.1	10.9	15.2	15.0	12.3	12.1	13.2	13.0	14.6	14.3	15.2	15.0	15.2	15.0	25-yr, 24-hr
PND03_MH01	PND03_MH02	SD0321	CONDUIT	CIRCULAR	1.5	-	216.5	0.2956	5.71	5.4	5.8	6.7	7.7	9.1	10.9	10.3	15.0	16.2	12.1	11.6	13.0	12.4	14.3	13.5	15.0	14.5	15.0	16.2	25-yr, 24-hr
PND03_MH02	PND03_MH03	SD0322	CONDUIT	CIRCULAR	1.5	-	217.9	0.3029	5.78	5.4	5.9	6.7	7.7	9.1	10.3	9.6	16.2	15.0	11.6	11.2	12.4	11.8	13.5	12.8	14.5	13.7	16.2	15.0	100-yr, 24-hr
PND03_MH03	PND03_MH04	SD0323	CONDUIT	CIRCULAR	1.5	-	193.7	0.2995	5.75	6.7	7.5	8.7	9.7	11.0	9.6	9.1	15.0	14.1	11.2	10.5	11.8	10.8	12.8	11.5	13.7	12.1	15.0	12.9	100-yr, 24-hr
PND03_MH04	PND03_MH05	SD0326	CONDUIT	CIRCULAR	1.5	-	47.9	0.3343	6.07	6.7	7.5	8.7	9.7	11.0	9.1	8.9	14.1	13.8	10.5	10.3	10.8	10.6	11.5	11.1	12.1	11.7	12.9	12.4	NF
PND03_MH05	PND03_MH06	SD0327	CONDUIT	CIRCULAR	1.5	-	83.3	0.3	5.75	6.7	7.5	8.7	9.7	11.0	8.9	8.7	13.8	13.3	10.3	10.0	10.6	10.2	11.1	10.5	11.7	11.0	12.4	11.5	NF
PND03_MH06	PND03_MH07	SD0328	CONDUIT	CIRCULAR	1.5	-	27.5	0.2543	5.3	6.7	7.5	8.7	9.7	11.0	8.7	8.6	13.3	13.2	10.0	9.9	10.2	10.0	10.5	10.4	11.0	10.8	11.5	11.2	NF
PND03_MH07	PND03_MH08	SD0329	CONDUIT	CIRCULAR	1.5	-	96.1	0.2704	5.46	6.7	7.5	8.7	9.7	11.0	8.6	8.3	13.2	14.1	9.9	9.5	10.0	9.6	10.4	9.7	10.8	9.9	11.2	10.1	NF
PND03_MH08	PND03	SD0330	CONDUIT	CIRCULAR	1.5	-	65	0.3077	5.83	6.7	7.5	8.7	9.7	11.0	8.3	8.1	14.1	9.6	9.5	9.1	9.6	9.2	9.7	9.2	9.9	9.3	10.1	9.4	NF
PND03_N01	PND03_CB03	SD0724	CONDUIT	CIRCULAR	1.25	-	390.7	0.2995	3.54	5.4	5.8	6.6	7.4	9.8	12.3	11.1	13.5	15.2	13.5	12.3	13.5	13.2	13.5	14.6	13.5	15.2	13.5	15.2	2-yr, 24-hr
PND03_N02	PND03_N01	PND03_N02_PND03_N01	CONDUIT	RECT_OPEN	0.5	4.00	282.2	0.1878	2.33	1.9	3.0	4.6	6.0	8.3	12.8	12.3	13.3	13.5	13.3	13.5	13.3	13.5	13.3	13.5	13.3	13.5	13.3	13.5	2-yr, 24-hr
DW03_CB02	DW03_CB01	SD0484	CONDUIT	CIRCULAR	0.5	-	202.2	0.4205	0.36	0.3	0.3	0.4	0.4	0.5	15.8	14.2	17.2	16.6	17.2	16.6	17.2	16.6	17.2	16.6	17.2	16.6	17.2	16.6	2-yr, 24-hr
DW03_CB03	DW03_CB01	SD0920	CONDUIT	CIRCULAR	0.5	-	76.5	1.0982	0.59	0.1	0.2	0.2	0.2	0.2	15.0	14.2	15.8	16.6	15.8	16.6	15.8	16.6	15.8	16.6	15.8	16.6	15.8	16.6	2-yr, 24-hr
DW04_CB02	DW04_CB03	SD0485	CONDUIT	CIRCULAR	0.5	-	210.5	0.5037	0.4	0.8	0.9	1.1	1.2	1.4	12.9	11.6	14.5	13.7	14.5	13.7	14.5	13.7	14.5	13.7	14.5	13.7	14.5	13.7	2-yr, 24-hr
DW04_CB03	PND03_N02	DW04_PND03_N02	CONDUIT	RECT_OPEN	0.5	4.00	216.3	0.1849	2.31	1.2	1.6	1.8	1.9	2.6	11.6	12.8	13.7	13.3	13.7	13.3	13.7	13.3	13.7	13.3	13.7	13.3	13.7	13.3	2-yr, 24-hr
PND04_F01	PND04_MH10	SD0340	CONDUIT	CIRCULAR	1	-	35.5	0.2534	1.79	2.4	2.8	3.3	3.7	3.9	11.2	11.1	14.8	13.6	13.8	13.6	14.2	13.6	14.8	13.6	14.8	13.6	14.8	13.6	10-yr, 24-hr
PND04_F02	PND04_MH08	SD0337	CONDUIT	CIRCULAR	1	-	21.4	0.2804	1.23	1.9	2.4	2.6	2.8	3.1	11.1	11.0	14.8	14.8	13.1	13.0	14.4	14.2	14.8	14.6	14.8	14.8	14.8	14.8	10-yr, 24-hr
PND04_MH01	PND04_F02	SD0298	CONDUIT	CIRCULAR	1	-	189.7	0.3953	2.24	1.9	2.4	2.7	3.0	3.7	11.8	11.1	15.0	14.8	13.9	13.1	15.0	14.4	15.0	14.8	15.0	14.8	15.0	14.8	5-yr, 24-hr
PND04_MH02	PND04_F01	SD0300	CONDUIT	CIRCULAR	1	-	189.3	0.3328	2.06	2.4	2.8	3.3	4.0	4.9	11.8	11.2	14.5	14.8	14.5	13.8	14.5	14.2	14.5	14.8	14.5	14.8	14.5	14.8	5-yr, 24-hr
PND04_MH03	PND04_MH04	SD0331	CONDUIT	CIRCULAR	1.5	-	89.9	0.3003	5.76	5.1	5.9	6.3	6.7	7.2	9.5	9.3	14.2	14.6	10.6	10.2	10.7	10.3	10.7	10.4	10.8	10.4	10.9	10.4	NF
PND04_MH04	PND04	SD0332	CONDUIT	CIRCULAR	1.5	-	50	0.3	5.75	5.1	5.9	6.3	6.7	7.2	9.3	9.1	14.6	10.6	10.2	10.0	10.3	10.0	10.4	10.1	10.4	10.1	10.4	10.1	NF
PND04_MH05	PND04_MH03	SD0333	CONDUIT	CIRCULAR	1	-	131.1	0.2974	1.94	2.7	3.5	3.9	4.1	4.5	10.4	9.5	13.1	14.2	11.6	10.6	12.1	10.7	12.9	10.7	13.0	10.8	12.9	10.9	NF
PND04_MH06	PND04_MH05	SD0334	CONDUIT	CIRCULAR	1	-	118.5	0.3208	2.02	0.9	1.2	1.5	1.7	2.2	10.8	10.4	14.5	13.1	11.6	11.6	12.5	12.1	14.5	12.9	14.5	13.0	14.5	12.9	NF
PND04_MH07	PND04_MH03	SD0335	CONDUIT	CIRCULAR	1	-	121.1	0.2972	1.94	2.4	2.5	2.7	2.9	3.2	10.4	9.5	14.0	14.2	11.3	10.6	11.4	10.7	11.5	10.7	11.6	10.8	11.8	10.9	NF
PND04_MH08	PND04_MH05	SD0336	CONDUIT	CIRCULAR	1	-	206.3	0.3006	1.27	1.9	2.4	2.6	2.7	2.9	11.0	10.4	14.8	13.1	13.0	11.6	14.2	12.1	14.6	12.9	14.8	13.0	14.8	12.9	25-yr, 24-hr
PND04_MH09	PND04_MH07	SD0338	CONDUIT	CIRCULAR	1	-	117.9	0.2459	1.15	2.4	2.5	2.7	2.9	3.2	10.7	10.4	15.0	14.0	12.5	11.3	12.8	11.4	13.1	11.5	13.5	11.6	14.1	11.8	NF
PND04_MH10	PND04_MH09	SD0339	CONDUIT	CIRCULAR	1	-	119.3	0.3018	1.27	2.4	2.5	2.7	2.9	3.2	11.1	10.7	13.6	15.0	13.6	12.5	13.6	12.8	13.6	13.1	13.6	13.5	13.6	14.1	5-yr, 24-hr
E Columbia Ave east of Bird Rd (Problem Area 23)																													
D04_MH01	D04_MH03	SD0179	CONDUIT	CIRCULAR	2	-	456.1	0.0877	6.7	15.2	16.6	17.1	17.5	20.4	11.2	10.7	17.6	17.5	17.6	17.5	17.6	17.5	17.6	17.5	17.6	17.5	17.6	17.5	5-yr, 24-hr
D04_MH03	D04_MH04	SD0180	CONDUIT	CIRCULAR	2	-	456.2	0.1491	8.73	16.2	17.6	18.2	18.8	21.6	10.7	9.9	17.5	17.6	17.5	17.6	17.5	17.6	17.5	17.6	17.5	17.6	17.5	17.6	100-yr, 24-hr
D04_MH04	D04_MH05	SD0181	CONDUIT	CIRCULAR	2	-	449.9	0.1578	8.99	16.2	17.6	18.2	18.8	21.6	9.9	9.1	17.6	15.1	17.6	10.9	17.6	11.1	17.6	11.2	17.6	11.2	17.6	11.4	NF
D04_MH05	D04	SD0182	CONDUIT	CIRCULAR	2	-	75	0.16	9.05	16.6	18.0	18.6	19.3	22.0	9.1	9.0	15.1	11.0	10.9	10.5	11.1	10.5	11.2	10.5	11.2	10.6	11.4	10.7	NF
D04_MH10	D04_MH12	SD0858	CONDUIT	CIRCULAR	2	-	289.7	0.1864	6.35	12.2	14.0	14.3	14.2	17.9	12.2	11.5	19.0	18.6	19.0	17.8	19.0	18.6	19.0	18.6	19.0	18.6	19.0	18.6	2-yr, 24-hr
D04_MH11	D04_MH10	SD0849	CONDUIT	CIRCULAR	2	-	280.3	0.3782	9.04	10.0	11.6	12.6	12.7	16.8	13.3	12.2	21.3	19.0	21.3	19.0	21.3	19.0	21.3	19.0	21.3	19.0	21.3	19.0	5-yr, 24-hr
D04_MH12	D04_MH01	SD0857	CONDUIT	CIRCULAR	2	-	32.1	1.0277	22.93	13.0	14.2	14.8	14.7	17.7	11.5	11.2	18.6	17.6	17.8	17.6	18.6	17.6	18.6	17.6	18.6	17.6	18.6	17.6	5-yr, 24-hr
SE Elm/Endicott/Pioneer Crossing/9th/Icenogle Loop (Problem Areas 3, 21)																													
PND07_CB45	PND07_MH35	SD1029	CONDUIT	CIRCULAR	1.25	-	35.3	-3.3692	11.86	5.8	6.6	7.0	7.6	10.3	15.4	16.6	17.5	18.7	17.5	18.2	17.5	18.7	17.5	18.7	17.5	18.7	17.5	18.7	2-yr, 24-hr
PND07_CB46	PND07_CB45	SD1030	CONDUIT	CIRCULAR	1	-	4.5	0.2216	1.68	5.2	5.4	5.4	5.5	5.2	14.0	15.4	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	2-yr, 24-hr
PND07_MH08	PND07_MH27	SD0049	CONDUIT	CIRCULAR	2	-	180.9	2.1229	21.42	13.0	14.2	16.0	17.6	19.0	16.0	12.2	21.2	20.2	21.2	19.9	21.2	20.2	21.2	20.2	21.2	20.2	21.2	20.2	5-yr, 24-hr
PND07_MH09	PND07_MH08	SD0047	CONDUIT	CIRCULAR	2	-	44.7	0.2461	7.3	8.5	9.1	10.2	11.4	12.6	16.2	16.0	21.2	21.2	21.2	21.2	21.2	21.2	21.2	21.2	21.2	21.2	21.2	21.2	2-yr, 24-hr
PND07_MH10	PND07_MH09	SD0048	CONDUIT	CIRCULAR	2	-	173.3	0.1501	5.7	8.5	11.1	11.9	13.3	14.0	16.4	16.2	23.1	21.2	22.4	21.2	23.1	21.2	23.1	21.2	23.1	21.2	23.1	21.2	5-yr, 24-hr
PND07_MH11	PND07_MH16	SD0104	CONDUIT	CIRCULAR	2	-	94.5	0.3705	13.77	15.3	16.5	18.1	19.9	21.9	12.2	11.9	22.4	19.2	18.7	18.3	19.7	19.2	20.6	19.2	21.8	19.2	22.4	19.2	100-yr, 24-hr
PND07_MH16	PND07_MH17	SD0105	CONDUIT	CIRCULAR	2	-	296.6	0.1517	8.81	17.5	18.4	19.1	19.9	21.6	11.9	11.0	19.2	19.6	18.3	16.8	19.2	18.3	19.2	19.6	19.2	18.7	19.2	19.6	5-yr, 24-hr
PND07_MH17	PND07_MH18	SD0106	CONDUIT	CIRCULAR	2	-	463.2	0.3735	13.83	17.5	18.4	19.1	19.9	21.1	11.0	9.2	19.6	17.8	16.8	14.0	18.3	14.6	19.6	15.4	18.7	15.2	19.6	16.0	100-yr, 24-hr
PND07_MH18	PND07_MH19	SD0107	CONDUIT	CIRCULAR	2	-	401.4	0.1993	10.1	17.5	18.4	19.1	19.9	21.1	9.2	8.4	17.8	15.6	14.0	11.9	14.6	12.7	15.4	12.6	15.2	13.0	16.0	12.5	NF
PND07_MH19	PND07_MH20	SD0108	CONDUIT	CIRCULAR	2	-	477	0.3417	13.22	17.5	18.4	19.1	19.9	21.1	8.4	6.8	15.6	8.8	11.9	8.3	12.7	8.4	12.6	8.4	13.0	8.4	12.5	8.5	NF
PND07_MH21	PND07_MH16	SD0109	CONDUIT	CIRCULAR	2	-	177	0.6273	17.92	6.4	7.2	7.5	9.6	13.9	13.0	11.9	18.9	19.2	18.3	18.3	18.9	19.2	18.9	19.2	18.9	19.2	18.9	19.2	5-yr, 24-hr
PND07_MH22	PND07_MH21	SD0110	CONDUIT	CIRCULAR	2	-	114	0.5261	16.41	6.4	7.2	7.5	8.7	12.0	13.6	13.0	19.5	18.9	18.4	18.3	19.2	18.9	19.5	18.9	19.5	18.9	19.5	18.9	10-yr, 24-hr
PND07_MH23	PND07_MH22	SD0111	CONDUIT	CIRCULAR	2	-	292.5	0.1949	9.99	6.4	7.1	7.5	8.1	11.0	14.2	13.6	18.7	19.5	18.7	18.4	18.7	19.2	18.7	19.5	18.7	19.5	18.7	19.5	5-yr, 24-hr
PND07_MH24	PND07_MH23	SD0112	CONDUIT	CIRCULAR	2	-	424.9	0.1977	10.06	6.1	7.1	8.4	9.1	10.5	15.0	14.2	19.3	18.7	19.3	18.7	19.3	18.7	19.3	18.7	19.3	18.7	19.3	18.7	10-yr, 24-hr
PND07_MH27	PND07_MH33	SD0808	CONDUIT	CIRCULAR	2	-	103.9	0.001	0.46	15.3	16.5	18.3	20.2	22.2	12.2	12.2	20.2	18.9	19.9	18.9	20.2	18.9	20.2	18.9	20.2	18.9	20.2	18.9	5-yr, 24-hr

Table A-3. Hydraulic Model Results - Future Condition

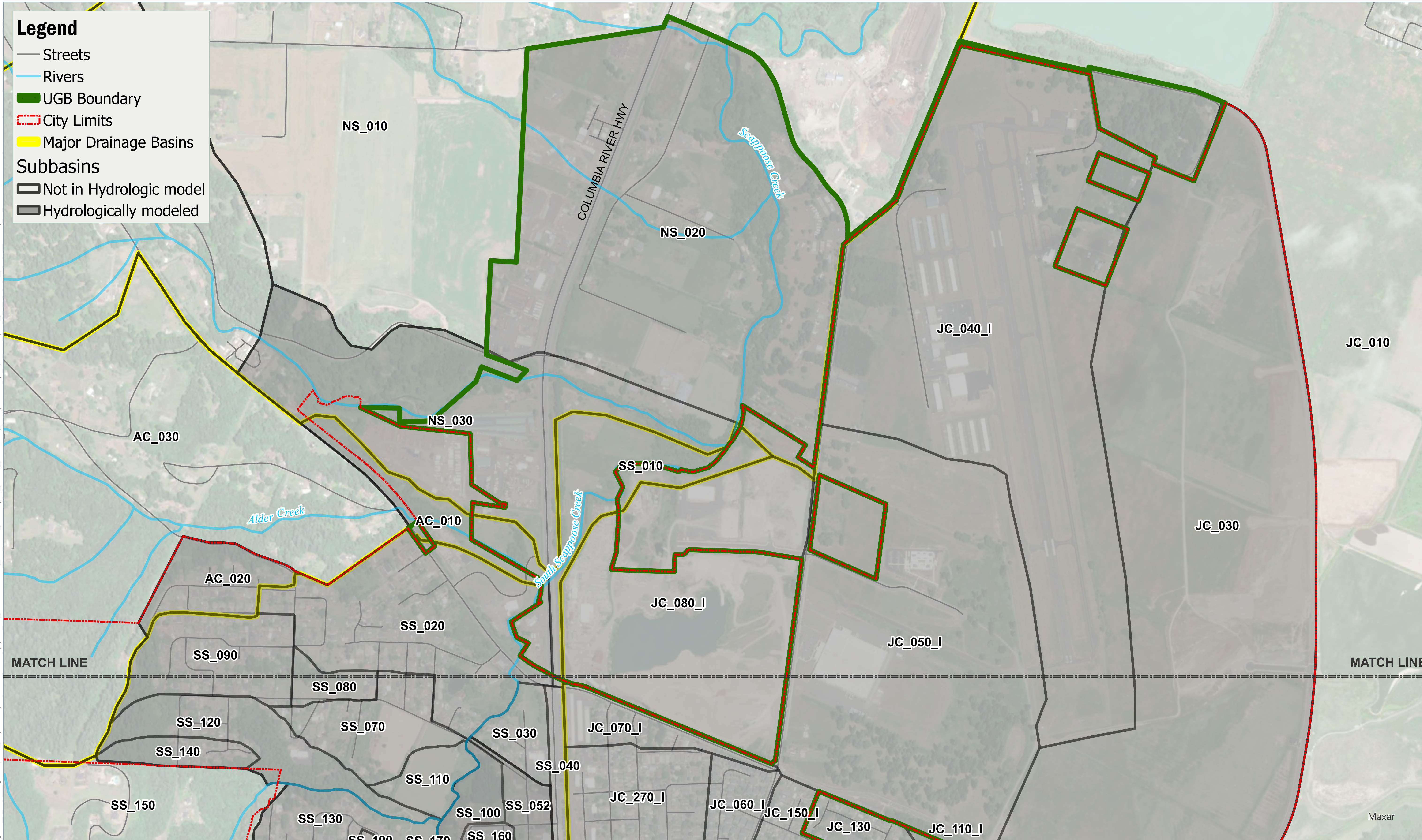
Conduit			Conduit Attributes						Conduit Capacity** (cfs)	Future Peak Flow (cfs)					Invert Elevation (ft)		Rim Elevation (ft)		Future Max Hydraulic Grade Line (ft)***										When Hydraulically Deficient (Fu) (NF = Not Flooding)
																			2-yr, 24-hr		5-yr, 24-hr		10-yr, 24-hr		25-yr-, 24-hr		100-yr, 24-hr		
US Node	DS Node	Name	Type	Shape	Diameter (ft) / Max. Width (ft)	Depth (ft)	Conduit Length (ft)	Slope (%)		2-yr, 24-hr	5-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	
PND07_MH33	PND07_MH11	SD0809	CONDUIT	CIRCULAR	2	-	18.7	0.0053	1.07	15.3	16.5	18.1	19.9	21.8	12.2	12.2	18.9	22.4	18.9	18.7	18.9	19.7	18.9	20.6	18.9	21.8	18.9	22.4	5-yr, 24-hr
PND07_MH34	PND07_MH24	SD0113	CONDUIT	CIRCULAR	2	-	117	0.7266	19.28	5.9	6.7	7.5	8.0	10.3	15.7	15.0	19.1	19.3	19.1	19.3	19.1	19.3	19.1	19.3	19.1	19.3	19.1	19.3	10-yr, 24-hr
PND07_MH35	PND07_MH34	SD1028	CONDUIT	CIRCULAR	1.5	-	22.4	4.064	21.18	5.8	6.5	7.1	8.1	10.3	16.6	15.7	18.7	19.1	18.2	19.1	18.7	19.1	18.7	19.1	18.7	19.1	18.7	19.1	5-yr, 24-hr
PND07_MH37	PioneerCrossing	SD1034	CONDUIT	CIRCULAR	1.5	-	50.1	0.6587	8.53	4.4	5.0	5.9	6.7	7.5	15.6	15.1	19.2	19.0	18.3	18.2	19.0	19.0	19.0	19.0	19.1	19.0	19.2	19.0	NF
PND07_MH38	PND07_MH37	SD1035	CONDUIT	CIRCULAR	1.5	-	110.7	0.3523	6.23	1.8	1.9	2.5	3.2	4.1	16.1	15.6	19.8	19.2	18.3	18.3	19.0	19.0	19.1	19.0	19.2	19.1	19.4	19.2	NF
PND07_MH39	PND07_MH38	SD1036	CONDUIT	CIRCULAR	1.25	-	227.4	0.3958	4.06	1.8	1.9	2.5	3.2	4.1	17.3	16.1	20.9	19.8	18.3	18.3	19.1	19.0	19.3	19.1	20.1	19.2	20.6	19.4	NF
PND07_MH44	PND07_MH37	SD1042	CONDUIT	CIRCULAR	1	-	105.3	0.1899	1.55	1.0	1.4	1.5	1.5	1.4	16.0	15.6	19.5	19.2	18.3	18.3	18.9	19.0	18.9	19.0	19.0	19.1	19.1	19.2	NF
PND07_MH45	PND07_D03	SD1045	CONDUIT	CIRCULAR	1	-	70.1	3.0256	6.2	0.2	2.0	2.8	3.5	4.3	17.0	16.0	21.1	17.0	18.3	16.1	18.5	16.4	18.6	16.5	18.7	16.6	18.8	16.6	NF
PND07_MH45	PND07_MH44	SD1043	CONDUIT	CIRCULAR	1	-	212.3	0.391	2.23	1.0	1.4	1.5	1.5	1.4	17.0	16.0	21.1	19.5	18.3	18.3	18.5	18.9	18.6	18.9	18.7	19.0	18.8	19.1	NF
PND07_MH46	PND07_MH45	SD1044	CONDUIT	CIRCULAR	1	-	89.4	0.3244	2.03	1.1	1.5	1.9	2.3	2.9	17.5	17.0	21.8	21.1	18.3	18.3	18.6	18.5	18.8	18.6	19.0	18.7	19.4	18.8	NF
PND13_MH02	PND07_MH10	SD1114	CONDUIT	CIRCULAR	2	-	215.3	1.2172	24.96	8.5	11.5	14.7	18.0	20.9	19.3	16.4	28.0	23.1	22.2	22.4	24.0	23.1	26.2	23.1	28.0	23.1	28.0	23.1	25-yr, 24-hr
PND13_MH03	PND13_MH02	SD1115	CONDUIT	CIRCULAR	2	-	74.7	3.0254	39.35	8.6	11.5	14.7	17.8	21.3	22.9	19.3	28.7	28.0	23.6	22.2	23.9	24.0	26.4	26.2	28.7	28.0	28.7	28.0	100-yr, 24-hr
PND13_MH04	PND13_MH03	SD1116	CONDUIT	CIRCULAR	2	-	228.8	1.6045	28.66	8.6	11.6	14.7	17.8	22.9	26.8	22.9	35.9	28.7	27.5	23.6	27.7	23.9	27.8	26.4	31.7	28.7	32.6	28.7	NF
PioneerCrossing	PND07_CB45	PioneerCrossing_DI-A1.2	WEIR	-	-	-	-	-	-	1.6	5.4	5.5	5.5	4.6	15.1	15.4	19.0	17.5	18.2	17.5	19.0	17.5	19.0	17.5	19.0	17.5	19.0	17.5	5-yr, 24-hr
PioneerCrossing	PND07_CB46	PioneerCrossing_DI-A1.1	WEIR	-	-	-	-	-	-	4.7	3.2	3.4	4.3	5.9	15.1	14.0	19.0	17.5	18.2	17.5	19.0	17.5	19.0	17.5	19.0	17.5	19.0	17.5	5-yr, 24-hr
SE 5th/SE High School Way (Problem Area 4)																													
DW37_CB01	DW37_CB02	SD0291	CONDUIT	CIRCULAR	1	-	214.4	4.4343	7.5	2.8	3.6	4.3	5.0	6.4	48.6	39.1	53.4	43.7	49.0	42.6	49.1	43.2	49.2	43.7	49.3	43.7	53.4	43.7	NF
DW37_CB02	DW37_MH01	SD0294	CONDUIT	CIRCULAR	1	-	18.4	1.0867	1.21	4.6	5.1	5.4	5.8	6.3	39.1	38.9	43.7	39.9	42.6	39.8	43.2	39.8	43.7	39.8	43.7	39.8	43.7	39.9	10-yr, 24-hr
DW37_CB03	DW37_CB02	SD0292	CONDUIT	CIRCULAR	1	-	68.4	0.9794	3.53	1.8	2.6	3.0	3.2	3.3	39.8	39.1	43.2	43.7	42.8	42.6	43.2	43.2	43.2	43.7	43.2	43.7	43.2	43.7	5-yr, 24-hr
DW37_CB04	DW37_CB03	SD0293	CONDUIT	CIRCULAR	1	-	126.4	0.4983	2.51	1.8	2.5	2.7	2.7	2.8	40.5	39.8	43.1	43.2	43.1	42.8	43.1	43.2	43.1	43.2	43.1	43.2	43.1	43.2	5-yr, 24-hr
PND01_CB48	PND01_D02	SD0288	CONDUIT	CIRCULAR	1	-	11.7	1.0222	3.6	1.4	1.8	2.2	2.5	3.2	25.9	25.7	26.9	26.9	26.4	26.3	26.4	26.4	26.5	26.4	26.5	26.5	26.6	26.6	NF
PND01_D02	PND01_CB47	SD0289	CONDUIT	TRAPEZOIDAL	1	6.00	483.6	1.0609	11.96	3.1	3.9	4.7	5.5	6.9	25.7	20.6	26.9	21.6	26.3	21.1	26.4	21.1	26.4	21.2	26.5	21.2	26.6	21.3	NF
PND01_N01	PND01_CB48	SD0290	CONDUIT	TRAPEZOIDAL	1	6.00	216.2	1.9196	16.09	1.4	1.8	2.2	2.5	3.2	30.0	25.9	33.5	26.9	30.3	26.4	30.4	26.4	30.4	26.5	30.4	26.5	30.5	26.6	NF
PND02_N02	PND02_N01	PND02_N02_PND02_N01	CONDUIT	TRAPEZOIDAL	1	7.00	167.7	4.0725	28.68	2.8	3.5	4.2	5.0	6.2	31.8	25.0	32.8	26.0	32.1	25.3	32.2	25.3	32.2	25.4	32.2	25.4	32.3	25.5	NF
PND02_N03	PND02_N02	PND02_N03_PND02_N02	CONDUIT	TRAPEZOIDAL	1	7.00	341.9	2.4093	22.06	2.8	3.5	4.2	5.0	6.2	40.1	31.8	41.1	32.8	40.4	32.1	40.5	32.2	40.5	32.2	40.5	32.2	40.6	32.3	NF

Notes:

** = The conduit capacity is calculated in PC SWMM using Manning's formula. The calculation is based on an assumption of steady uniform flow. Under various hydraulic circumstances (e.g. critical flow), the actual pipe capacity can exceed this reported value.

*** = HGL values for flooding nodes were set to the node rim elevation.

Attachment B: Figures



Jul 21, 2022

[BCDENFP01]: O:\PW_Exports\155252 - Scappoose_Stormwater_Master_Plan\07_GIS_Internal_BC\Pro Maps\TM#2\B-1_Subbasin_Overview.aprx tsuesser

Brown AND Caldwell

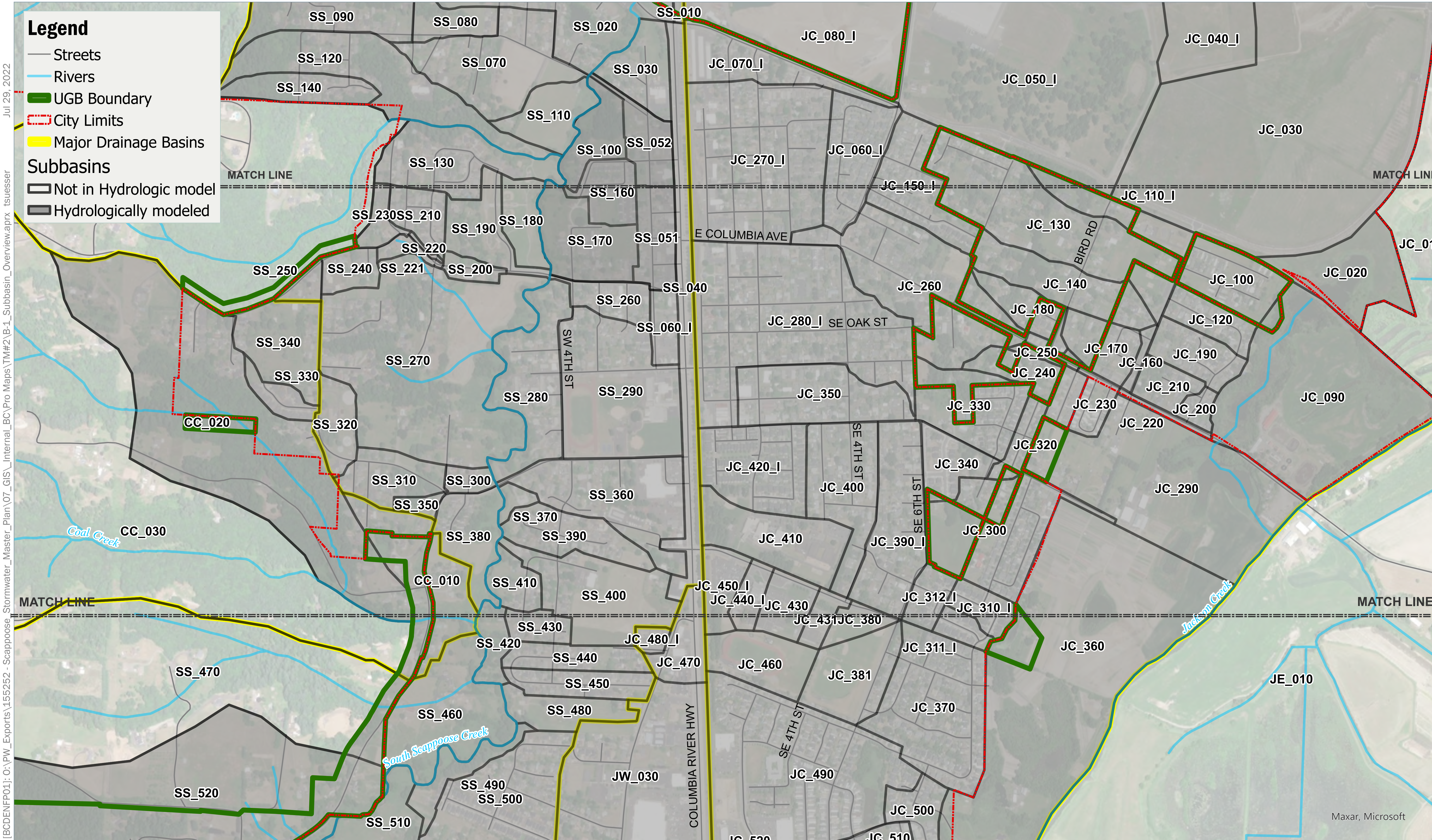
City of Scappoose
Stormwater Master Plan

September 2021
Project: 155252

Notes:
1. NAD 1983 HARN StatePlane Oregon North FIPS 3601 International Feet

Hydrology and Hydraulic Modeling Methods and Results

Figure B-1: Subbasin Overview (North)



Jul 29, 2022

[BCDENFP01]: O:\PW_Exports\155252 - Scappoose_Stormwater_Master_Plan\07_GIS_Internal_BC\Pro Maps\TM#2\B-1_Subbasin_Overview.aprx tsuesser

Brown AND Caldwell

SCAPPOOSE

City of Scappoose

Stormwater Master Plan

September 2021
Project: 155252

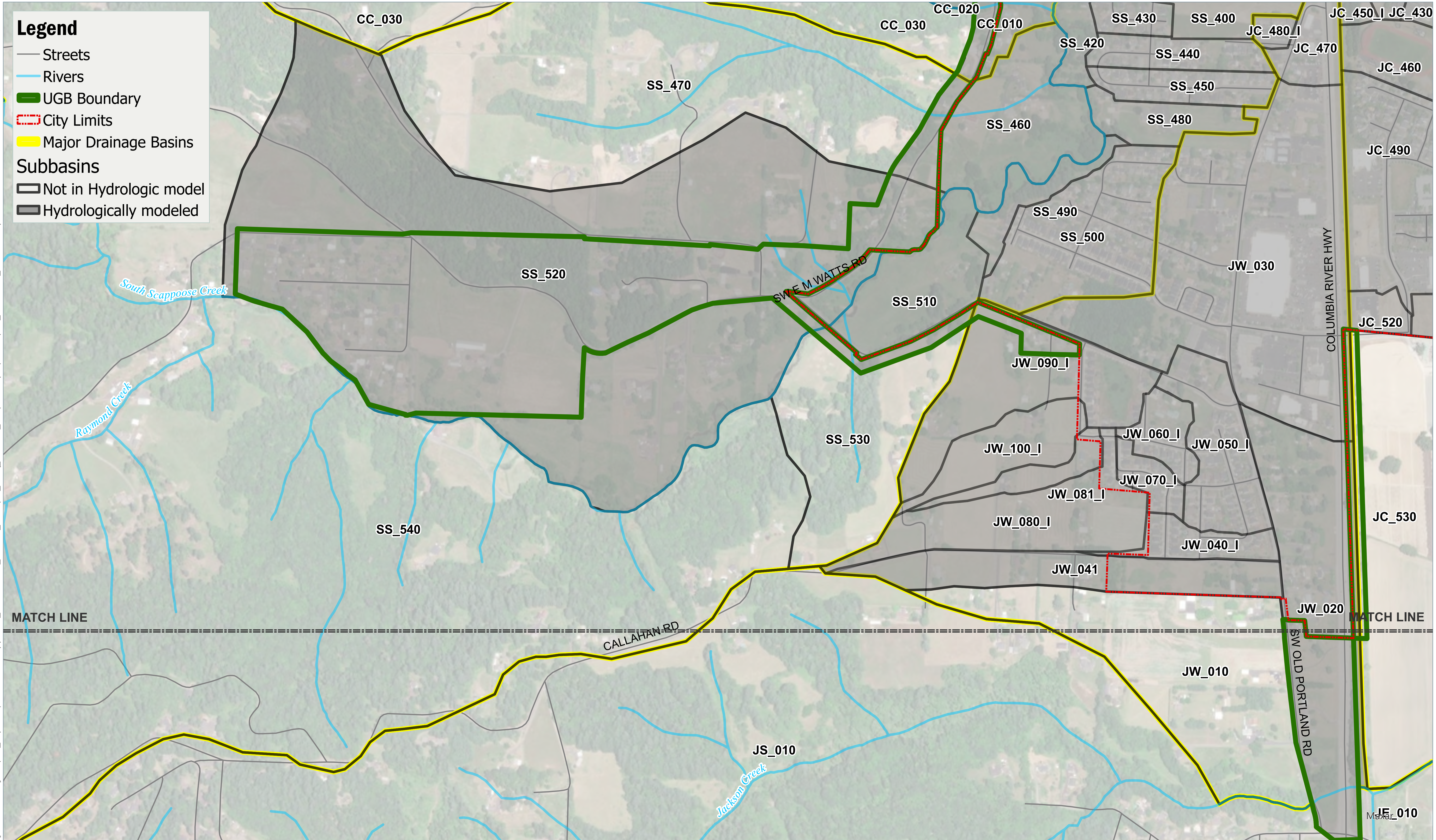
N

0 500 1,000
Feet

Notes:
1. NAD 1983 HARN StatePlane Oregon North FIPS 3601 International Feet

Hydrology and Hydraulic Modeling Methods and Results

Figure B-2: Subbasin Overview (Central)



Jul 29, 2022

tsuesser

[BCDENFP01]: O:\PW_Exports\155252 - Scappoose_Stormwater_Master_Plan\07_GIS_Internal_BC\Pro Maps\TM#2\B-1_Subbasin_Overview.aprx

Brown AND Caldwell

City of Scappoose
Stormwater Master Plan

September 2021
Project: 155252

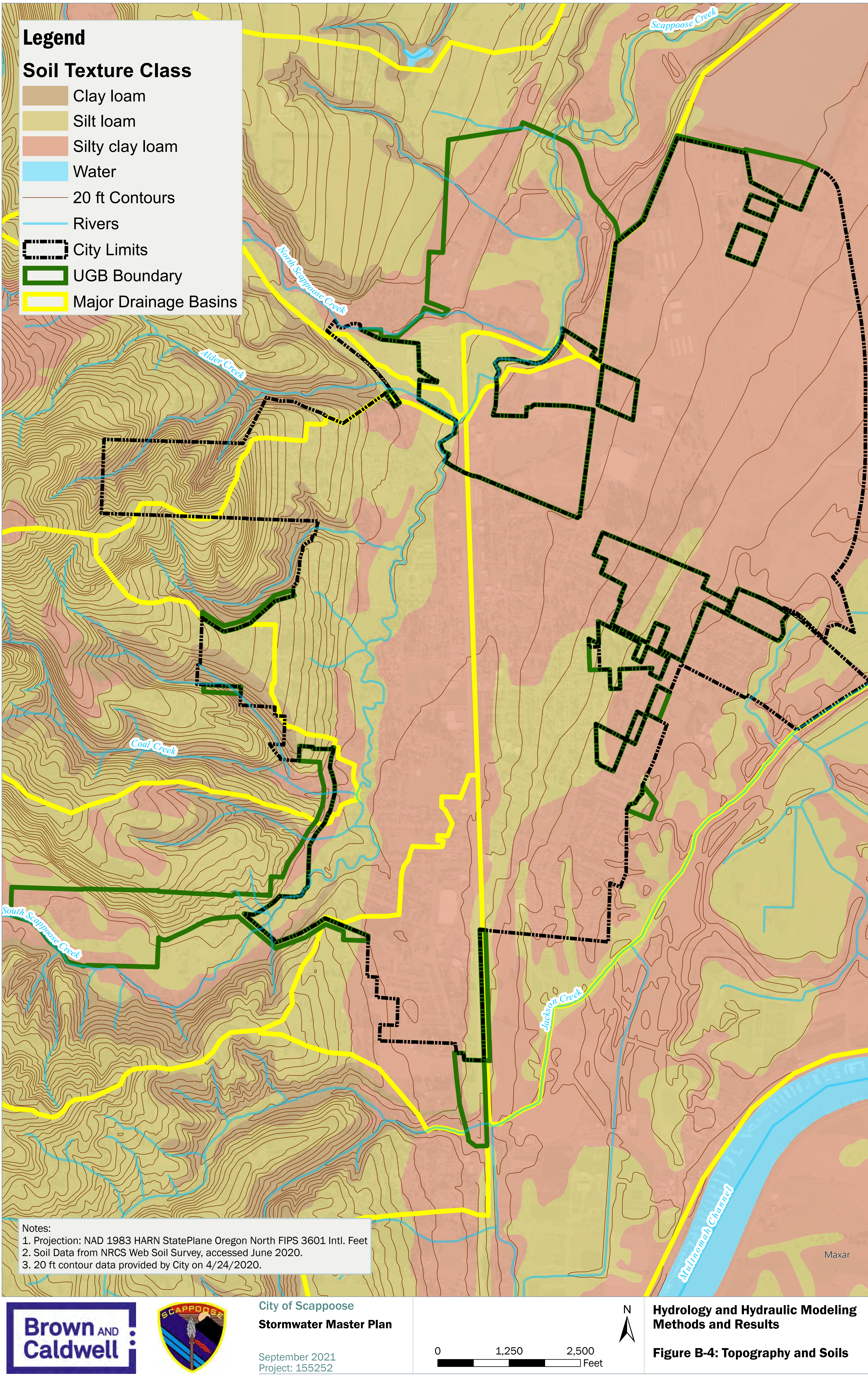
0 500 1,000 Feet

N

Notes:
1. NAD 1983 HARN StatePlane Oregon North FIPS 3601 International Feet

Hydrology and Hydraulic Modeling Methods and Results

Figure B-3: Subbasin Overview (South)



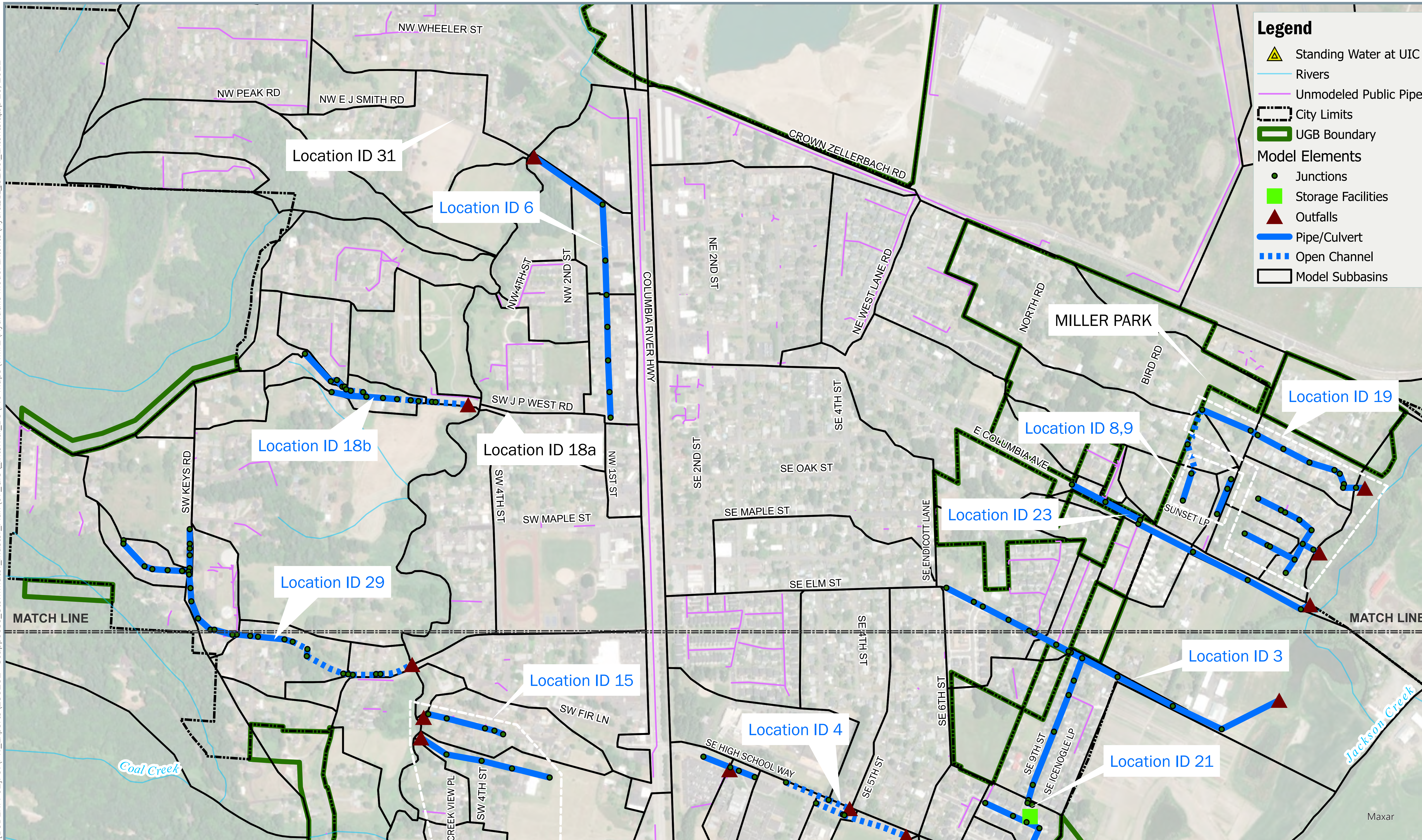
Brown AND Caldwell

City of Scappoose
Stormwater Master Plan

September 2021
Project: 155252

Hydrology and Hydraulic Modeling Methods and Results

Figure B-4: Topography and Soils



Brown AND Caldwell

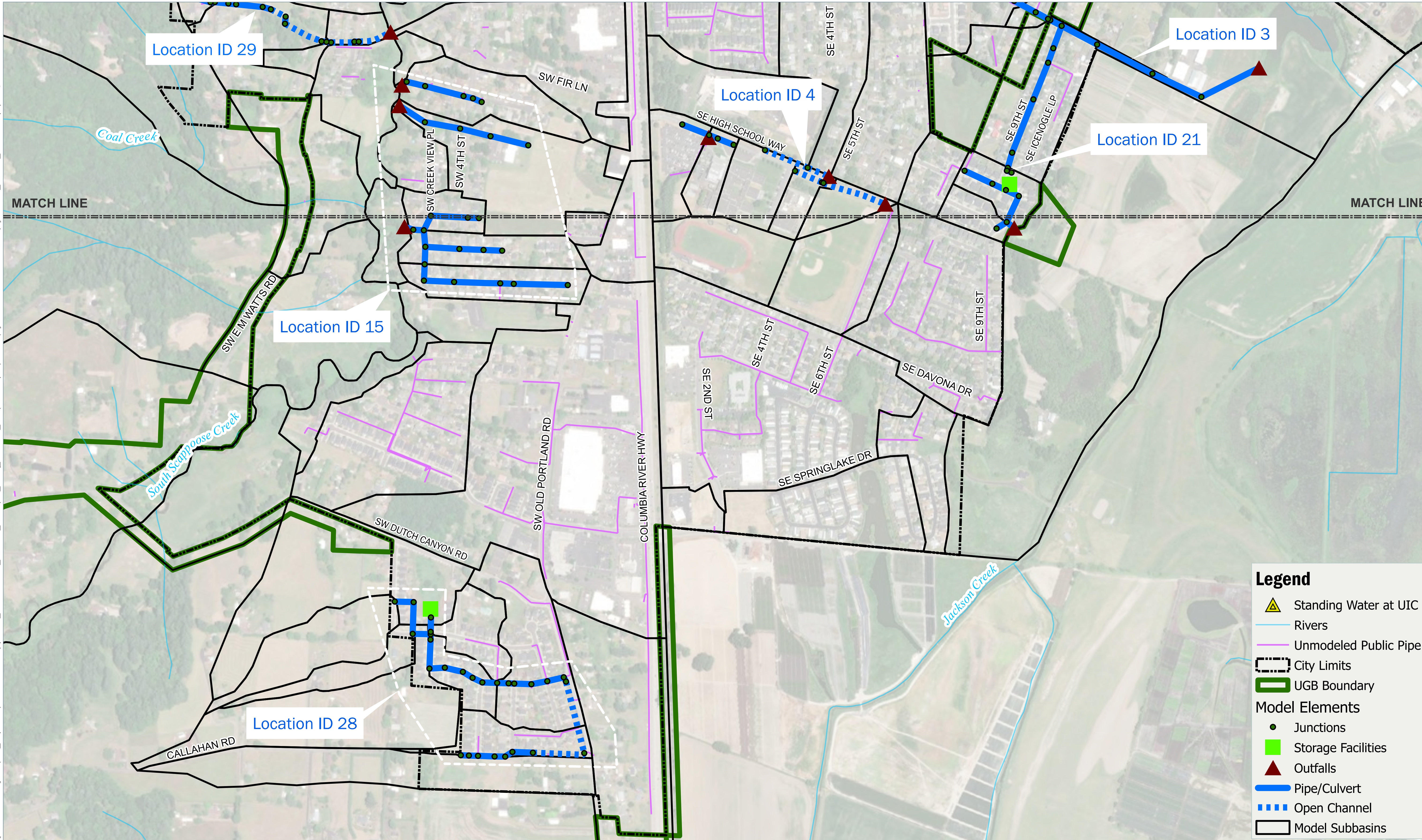
City of Scappoose

Stormwater Master Plan

October 2021
Project: 155252

Notes:
1. NAD 1983 HARN StatePlane Oregon North FIPS 3601 International Feet
2. Category 1 modeling locations shown with blue callouts.

Hydrology and Hydraulic Modeling Methods and Results
Figure B-5: Hydraulic Model Extents (North)



Brown AND Caldwell

City of Scappoose
Stormwater Master Plan

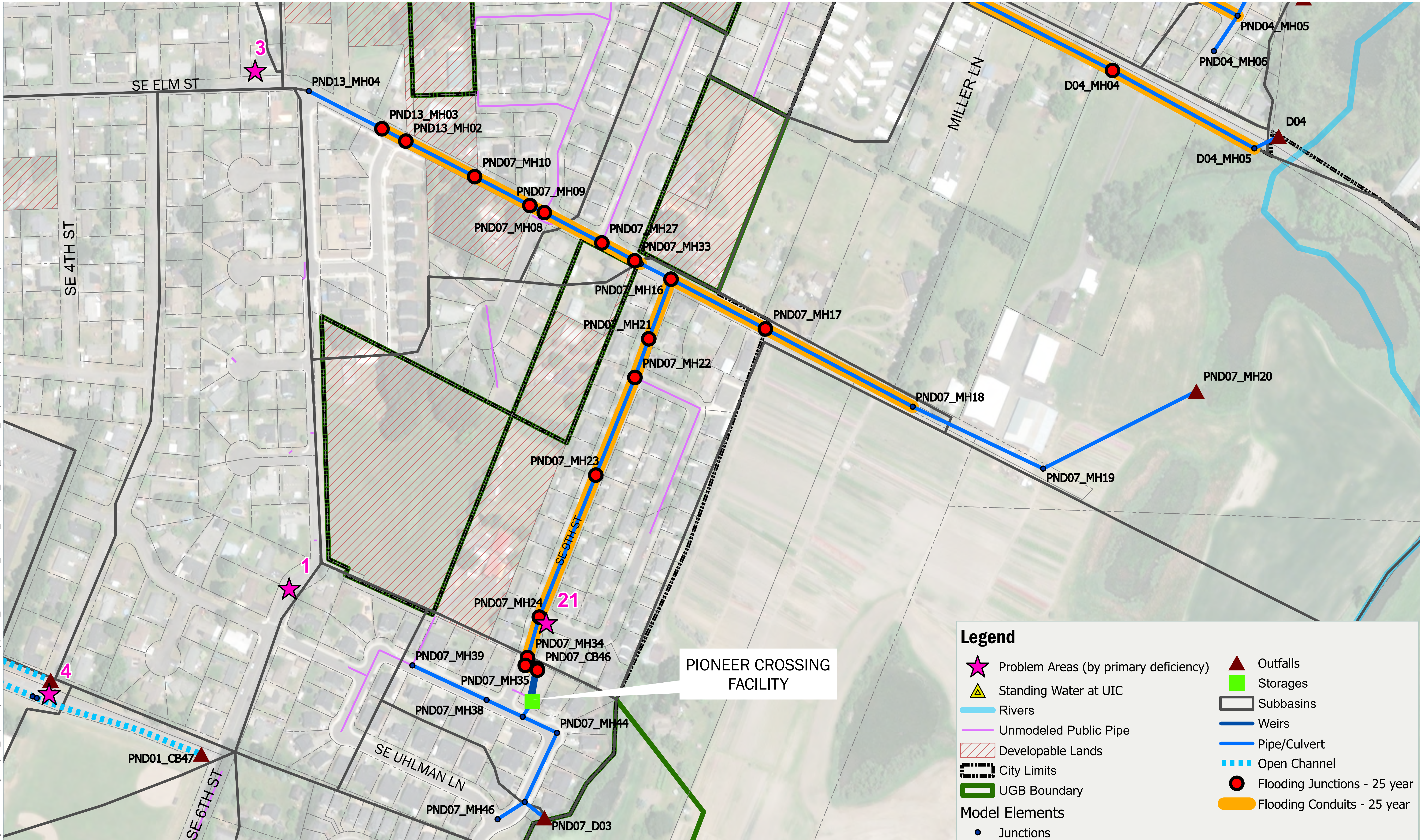
October 2021
Project: 155252

0 500 1,000 Feet

N

Notes:
1. NAD 1983 HARN StatePlane Oregon North FIPS 3601 International Feet
2. Category 1 modeling locations shown with blue callouts.

Hydrology and Hydraulic Modeling Methods and Results
Figure B-6: Hydraulic Model Extents (South)



Brown AND Caldwell

City of Scappoose

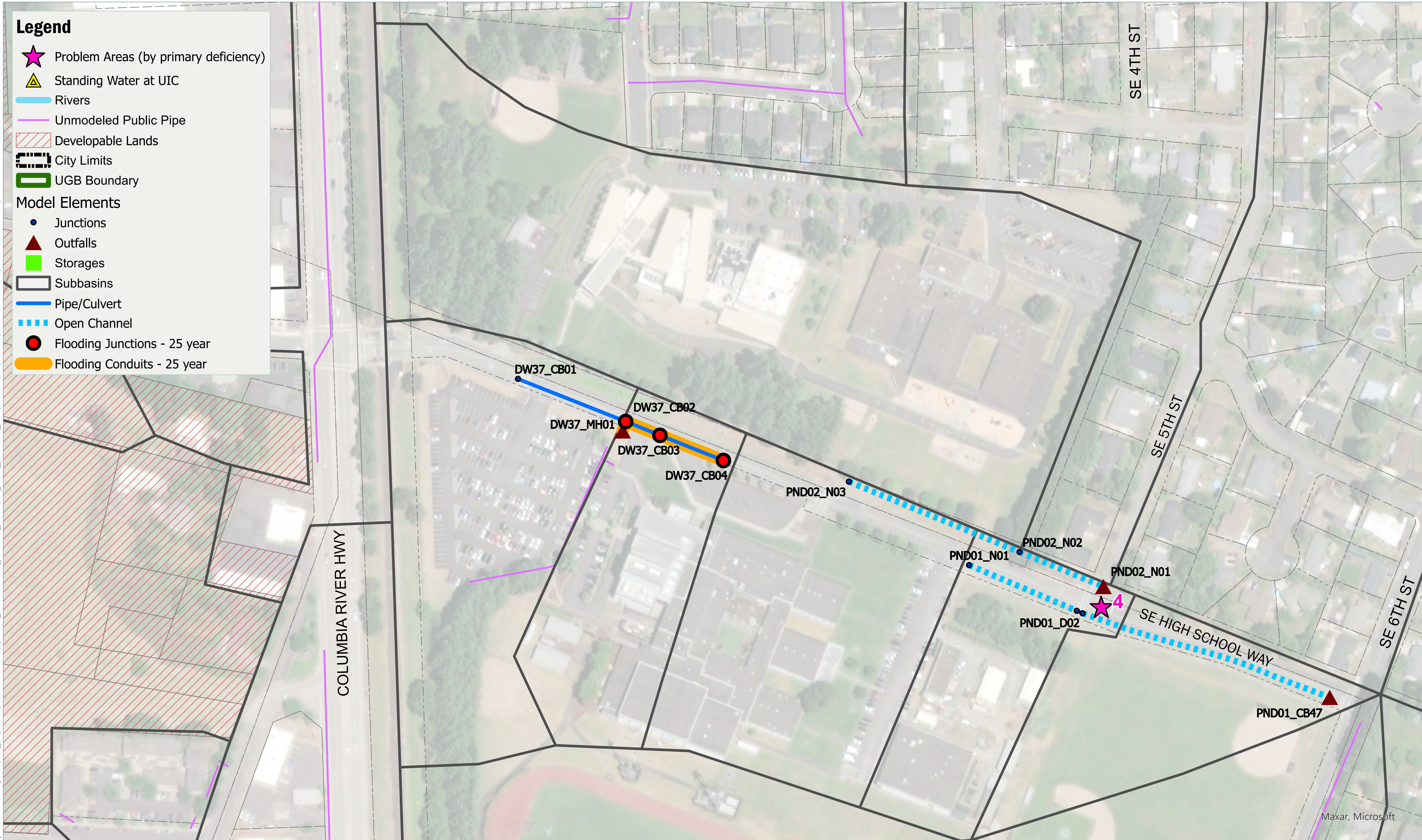
Stormwater Master Plan

October 2021
Project: 155252

Notes:
1. NAD 1983 HARN StatePlane Oregon North FIPS 3601 International Feet
2. Flooding conduits are those with upstream nodes reporting flooding for any period of time during the 25-year, 24-hour storm under existing land use conditions.

Hydrologic and Hydraulic Modeling Methods and Results

Figure B-7: Location ID 3 and 21



Brown AND Caldwell

City of Scappoose

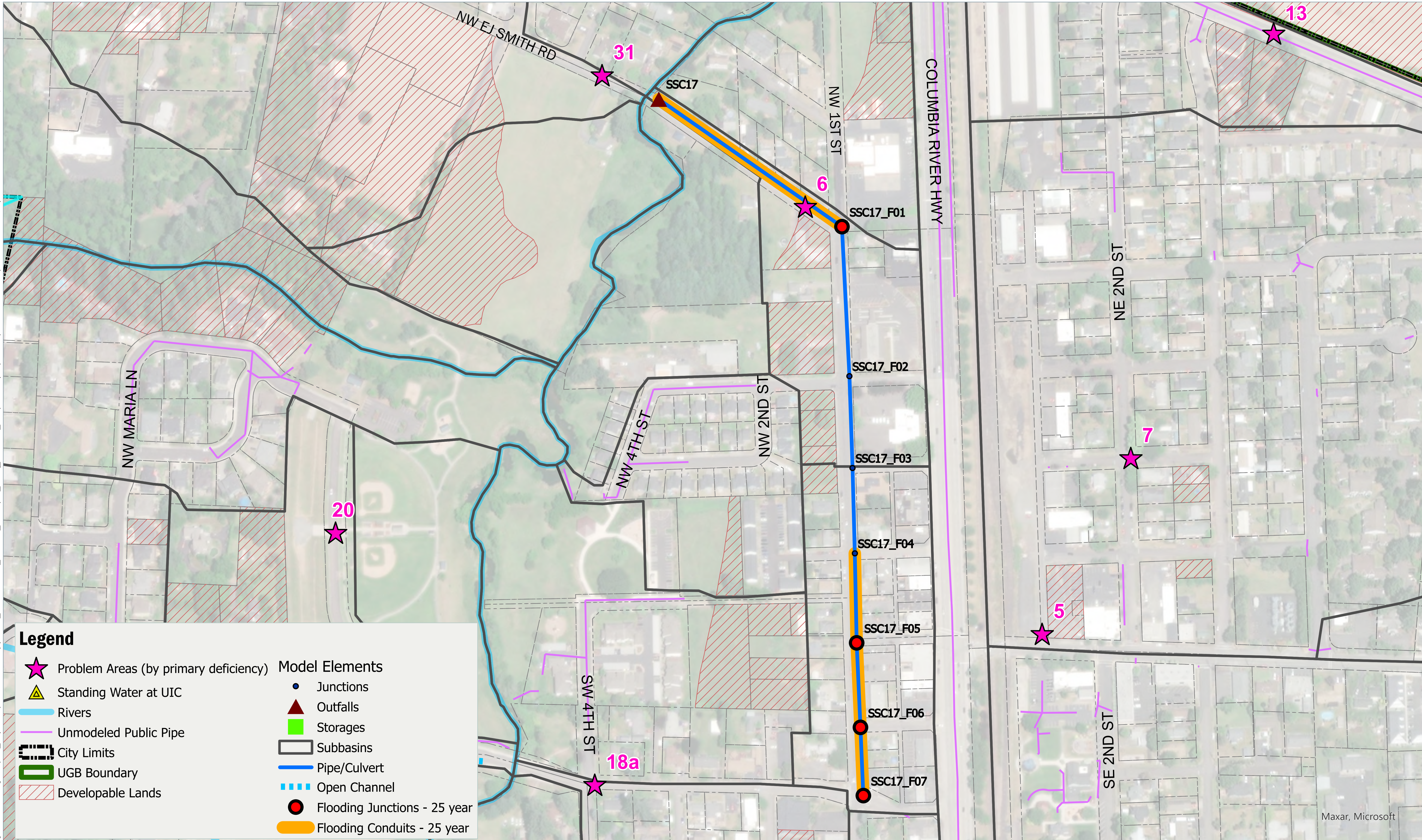
Stormwater Master Plan

October 2021
Project: 155252

Notes:
1. NAD 1983 HARN StatePlane Oregon North FIPS 3601 International Feet
2. Flooding conduits are those with upstream nodes reporting flooding for any period of time during the 25-year, 24-hour storm under existing land use conditions.

Hydrologic and Hydraulic Modeling Methods and Results

Figure B-8: Location ID 4



Brown AND Caldwell

City of Scappoose

Stormwater Master Plan

October 2021
Project: 155252

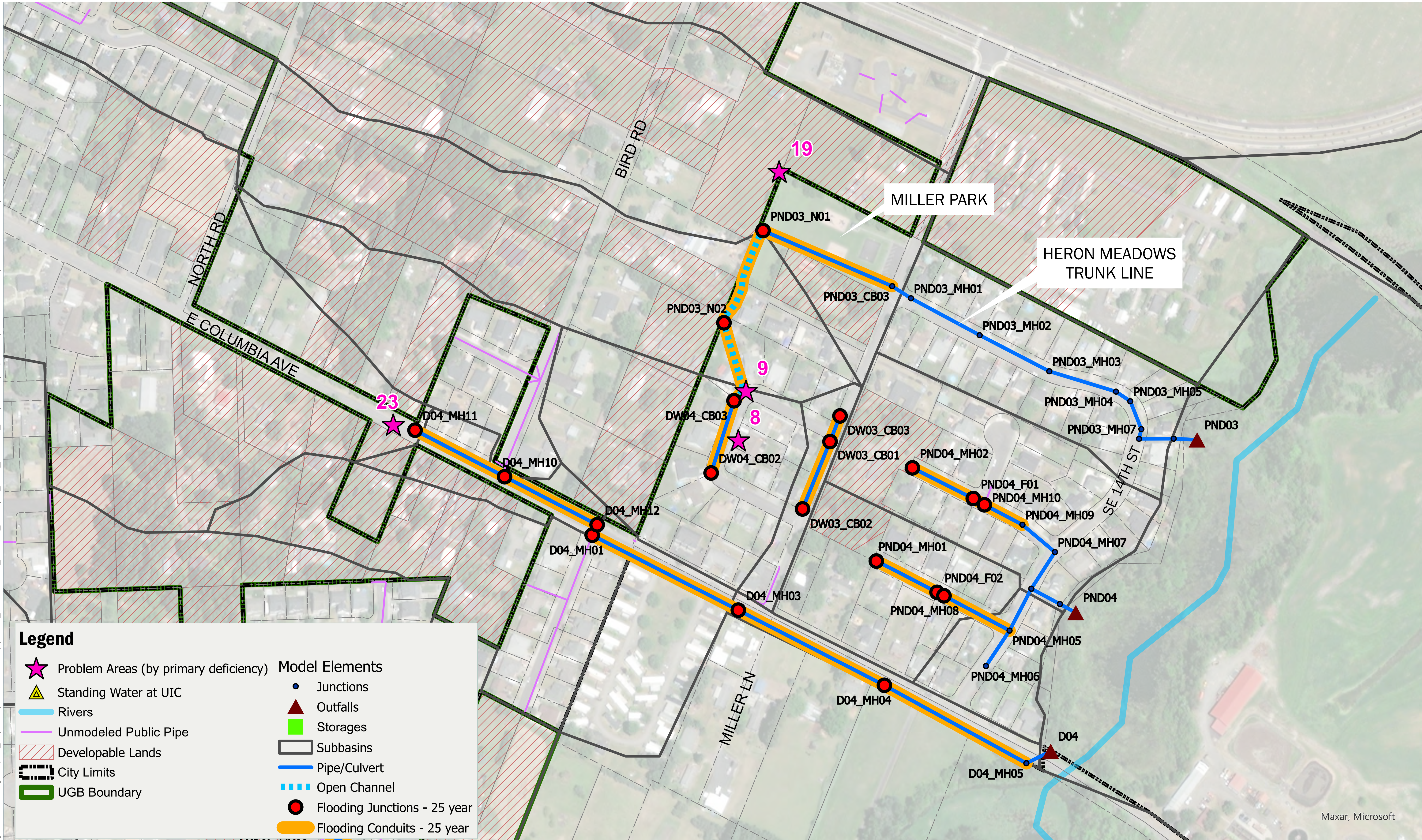
0 250 500 Feet

N

Notes:
1. NAD 1983 HARN StatePlane Oregon North FIPS 3601 International Feet
2. Flooding conduits are those with upstream nodes reporting flooding for any period of time during the 25-year, 24-hour storm under existing land use conditions.

Hydrologic and Hydraulic Modeling Methods and Results

Figure B-9: Location ID 6



[BCDENFP01]: O:\PW_Exports\155252 - Scappoose_Stormwater_Master_Plan\07_GIS_Internal_BC\Pro Maps\TM#2\Model Results\Model Results.aprx esser
Sep 16, 2022

Brown AND Caldwell

City of Scappoose

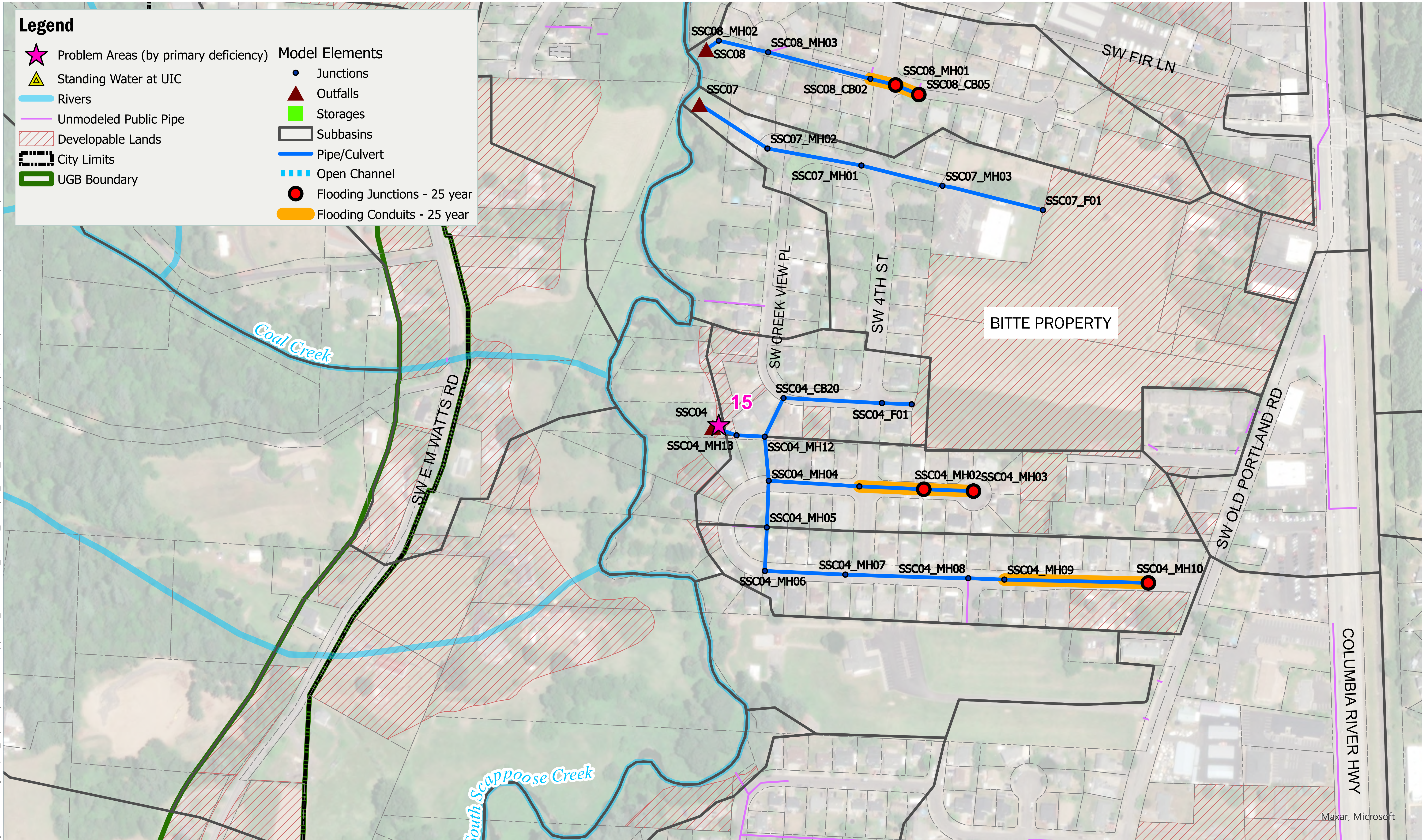
Stormwater Master Plan

October 2021
Project: 155252

Notes:
1. NAD 1983 HARN StatePlane Oregon North FIPS 3601 International Feet
2. Flooding conduits are those with upstream nodes reporting flooding for any period of time during the 25-year, 24-hour storm under existing land use conditions.

Hydrologic and Hydraulic Modeling Methods and Results

Figure B-10: Location ID 8, 9, 19 and 23



Jul 21, 2022

[BCDENFP01]: O:\PW_Exports\155252 - Scappoose_Stormwater_Master_Plan\07_GIS_Internal_BC\Pro Maps\TM#2\Model Results\Model Results.aprx

Brown AND Caldwell

City of Scappoose

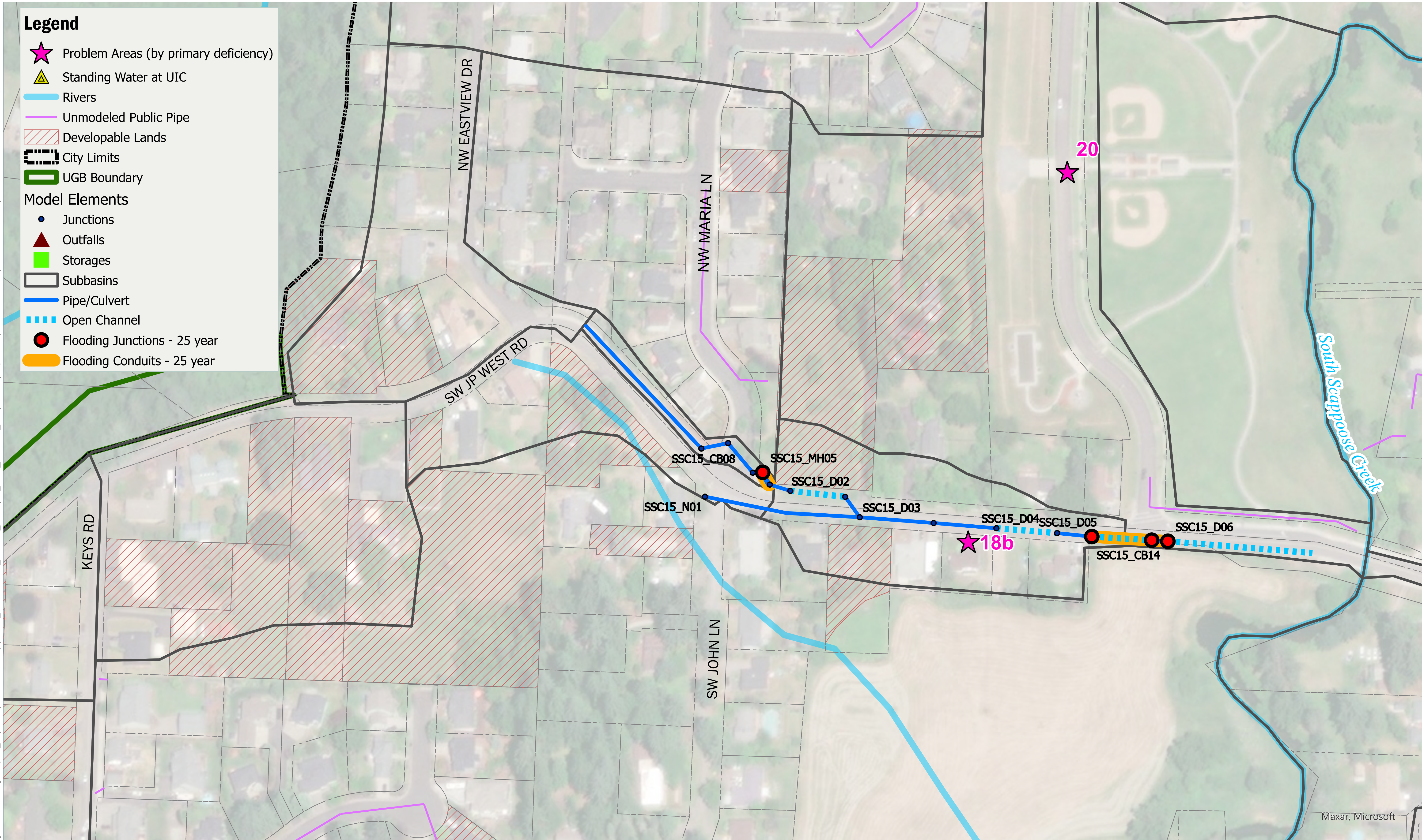
Stormwater Master Plan

October 2021
Project: 155252

Notes:
1. NAD 1983 HARN StatePlane Oregon North FIPS 3601 International Feet
2. Flooding conduits are those with upstream nodes reporting flooding for any period of time during the 25-year, 24-hour storm under existing land use conditions.

Hydrologic and Hydraulic Modeling Methods and Results

Figure B-11: Location ID 15



Brown AND Caldwell

City of Scappoose

Stormwater Master Plan

October 2021
Project: 155252

0 150 300 Feet

N

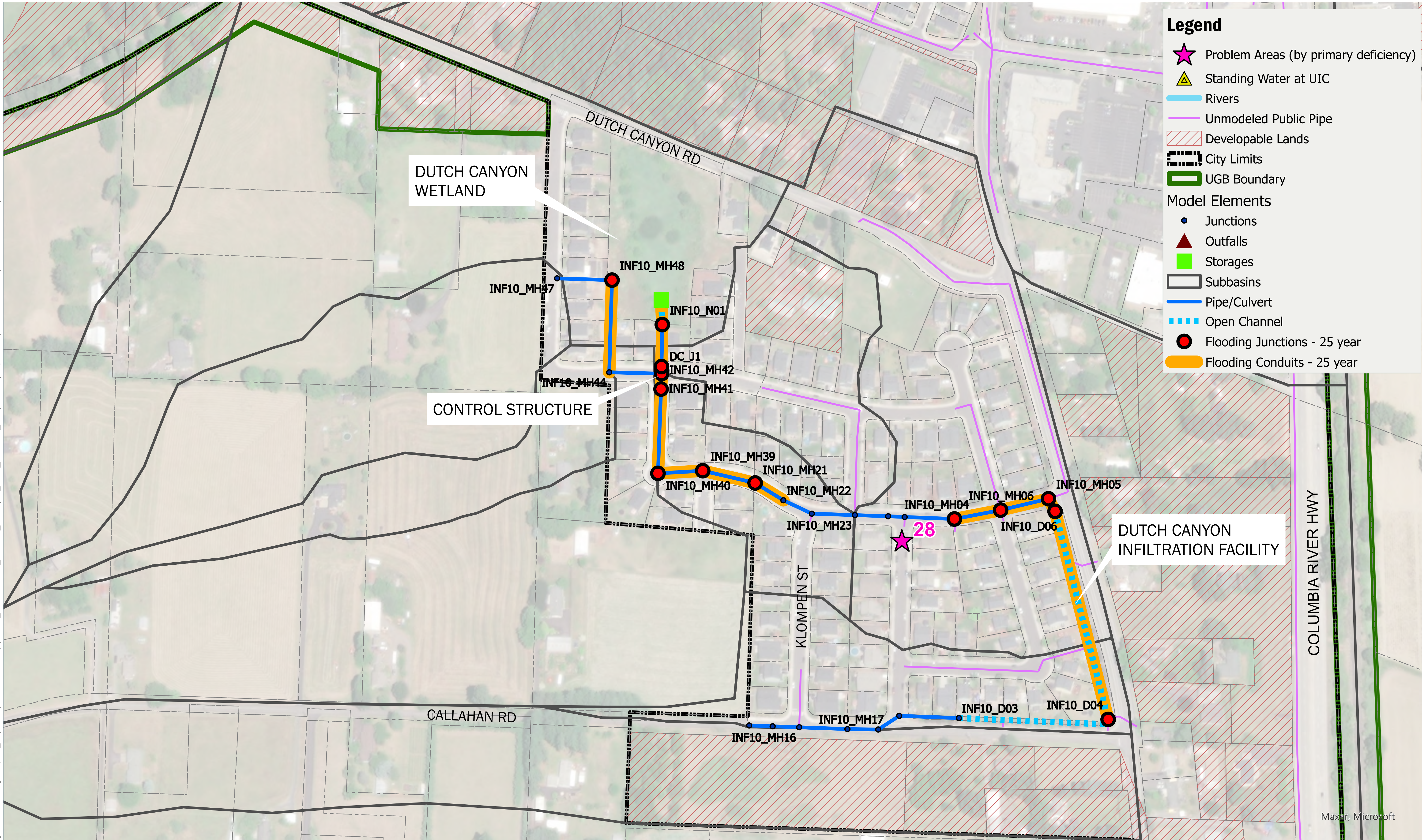
Notes:
1. NAD 1983 HARN StatePlane Oregon North FIPS 3601 International Feet
2. Flooding conduits are those with upstream nodes reporting flooding for any period of time during the 25-year, 24-hour storm under existing land use conditions.

Hydrologic and Hydraulic Modeling Methods and Results

Figure B-12: Location ID 18b

Jul 21, 2022

[BCDENFP01]: O:\PW_Exports\155252 - Scappoose_Stormwater_Master_Plan\07_GIS_Internal_BC\Pro Maps\TM#2\Model Results\Model Results.aprx esser



Brown AND Caldwell

City of Scappoose
Stormwater Master Plan

October 2021
Project: 155252

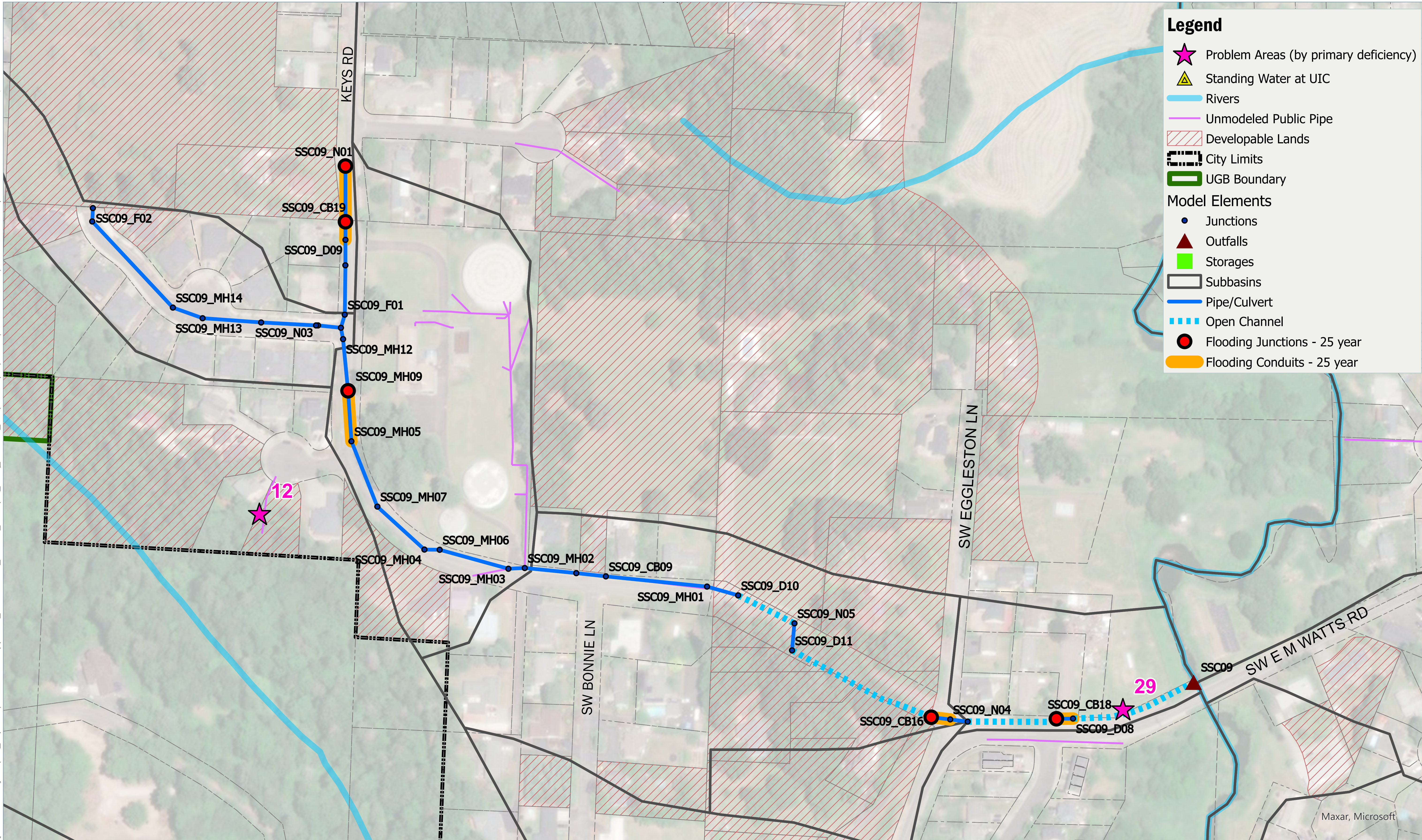
0 230 460 Feet

N

Notes:
1. NAD 1983 HARN StatePlane Oregon North FIPS 3601 International Feet
2. Flooding conduits are those with upstream nodes reporting flooding for any period of time during the 25-year, 24-hour storm under existing land use conditions.

Hydrologic and Hydraulic Modeling Methods and Results

Figure B-13: Location ID 28



Jul 21, 2022

[BCDENFP01]: O:\PW_Exports\155252 - Scappoose_Stormwater_Master_Plan\07_GIS_Internal_BC\Pro Maps\TM#2\Model Results\Model Results.aprx

Brown AND Caldwell

City of Scappoose
Stormwater Master Plan

October 2021
Project: 155252

Notes:
1. NAD 1983 HARN StatePlane Oregon North FIPS 3601 International Feet
2. Flooding conduits are those with upstream nodes reporting flooding for any period of time during the 25-year, 24-hour storm under existing land use conditions.

Hydrologic and Hydraulic Modeling Methods and Results

Figure B-14: Location ID 29

Attachment C: Photo Log

Attachment C

Photo Log Documentation

Photographs and descriptions from field assessment efforts conducted on September 2, 2020, and July 16, 2021, are provided on the following pages.

Mapped ID:	**2**
Location description:	**SW 4th Ave/ SW Maple**
Problem Description:	**Drain with poor performance**

Site location: 2

Photo number: IMG_1800

Description: Area drain looking east. This is a low spot in the area with a drain that appears to be a shallow UIC that no longer functions. There is no other outlet for stormwater so a small pond developed at this intersection during heavy rains. Potential solutions include linear infiltration facilities and/or a pipe west to Scappoose Creek.

Site location: 2

Photo number: IMG_1801

Description: Area drain looking south.

Site location: 2

Photo number: IMG_1802

Description: Area drain looking west.

Mapped ID:	**3**
Location description:	**SE Elm/Endicot**
Problem Description:	**Roadway flooding, future development flows**

Site location: 3

Photo number: IMG_0716

Description: Inlet to a French drain that has failed and low spot in roadway floods. Likely solution is to connect to an upsized Elm trunkline.

Site location: 3

Photo number: IMG_0717

Description: French drain looking west along Elm Street.

Site Location: 3
Photo number: IMG_0718
Description: French drain looking east along Elm Street.

Site Location: 3
Photo number: IMG_0719
Description: Looking west along Elm Street. Driveway on right side floods.

Site Location: 3

Photo number: IMG_0720

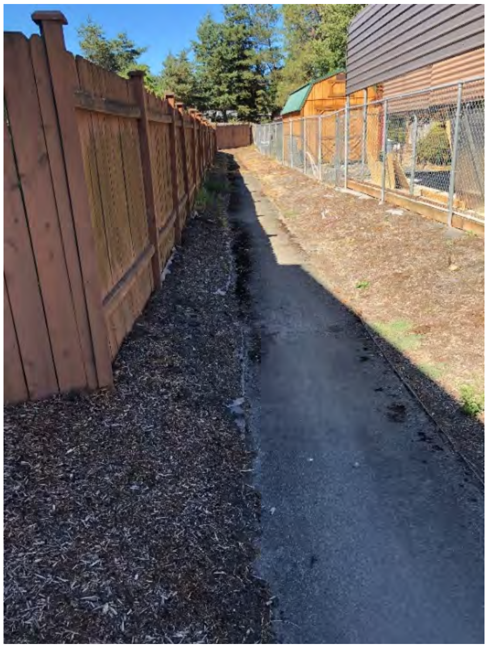
Description: Inlets along Elm Street looking south. Driveway floods during rain events.

Mapped ID:	8
Location description:	NE Sunset Loop
Problem Description:	System surcharging, open channel: shallow, no proper drainage, floods

Site location: 8
Photo number: IMG_0707
Description: Overflow path behind home looking north.

c

Site location: 8
Photo number: IMG_0708
Description: Overflow path behind home looking north.

	 **Site location:** 8 **Photo number:** IMG_0709 **Description:** Overflow path behind home looking south/south east.
	 **Site location:** 8 **Photo number:** IMG_0710 **Description:** Overflow path behind home looking north/north west between homes.

Site location:	8
Photo number:	IMG_0711
Description:	Inlet and manhole/drywell that is failing, looking south.

Site location:	8
Photo number:	IMG_0712
Description:	Inlet (near front tire of truck) and failing drywell, looking east.

Mapped ID:	**19**
Location description:	**Miller Park Playground drainage and Heron Meadows conveyance system**
Problem Description:	**Undersized pipe, roadway flooding**

Site location: C6

Photo number: IMG_0713

Description: Outfall of Heron Meadows conveyance system. Discharges to flat area that may backwater forcing the conveyance system to back up.

Mapped ID:	**20**
Location description:	**Veterans Park along Roadsides**
Problem Description:	**Swale, water backs up onto roadway**

Site location: 20
Photo number: IMG_1797
Description: Swale is elevated relative to the roadway and does not promote drainage off the street. Likely solution is regrading the swale lower. Looking south.

Site location: 20
Photo number: IMG_0715
Description: Pipe alignment through private property, looking west.

Site location:	20
Photo number:	IMG_1798
Description:	Veterans Park swale looking south.

Mapped ID:	13
Location description:	Crown Zellerbach Road
Problem Description:	Opportunity Area 8

Site location: 13
Photo number: IMG_0699
Description: Existing path adjacent to large linear channel/ditch that is known to have high infiltration rates.

Site location: 13
Photo number: IMG_0700
Description: Bottom of large channel/ditch that is known to have high infiltration rates.

Mapped ID:	28
Location description:	Callahan-Dutch Canyon Area
Problem Description:	Opportunity Area 5 and 6 – Infiltration facility may not be operating as designed.

Site location: 28
Photo number: IMG_0686
Description: Large private infiltration facility that receives runoff from multiple neighborhoods and private property as well as roads and public spaces. Looking south.

Site location: 28
Photo number: IMG_0688
Description: South end of infiltration facility looking north.

Site location: 28
Photo number: IMG_0689
Description: South end of infiltration facility looking north/northwest

Site location: 28
Photo number: IMG_0690
Description: End of SW Volendam Street looking south onto private property

Site location:	28
Photo number:	IMG_0691
Description:	End of SW Volendam Street looking south onto private property. Ditch inlets provide for future development.

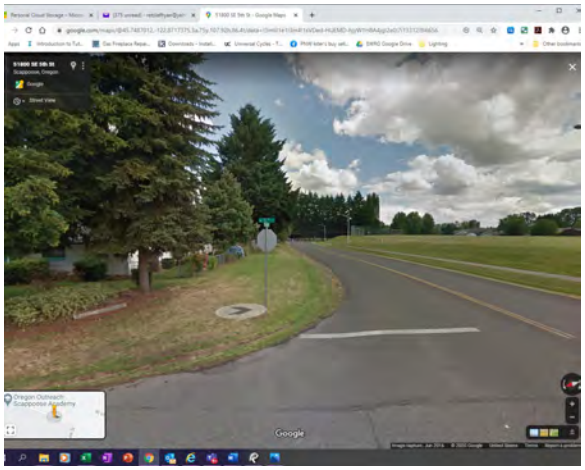
Site location:	28
Photo number:	IMG_0692
Description:	Low point in Dutch Canyon Road that drains to infiltration facility, looking NW.

Site location:	28
Photo number:	IMG_0695
Description:	Enhanced wetland along Dutch Canyon Road, looking south from the road.

Mapped ID: 4

Location description: SE 5th/SE High School Way

Problem Description: No infrastructure leads to standing water



Site location: 4

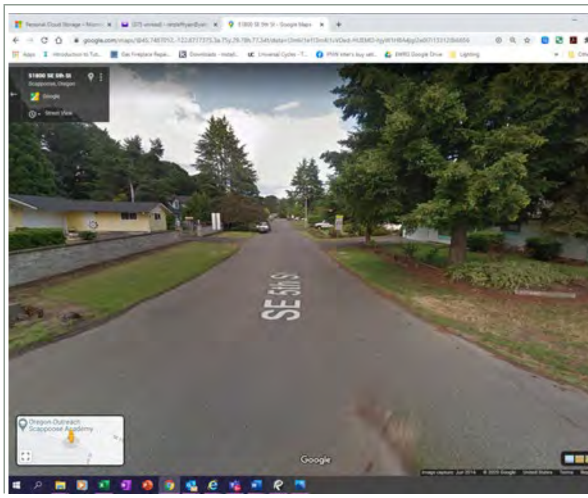
Photo number: Google screen grab

Description: Looking east at the intersection of 5th and High School Way.

Site location: 4

Photo number: Google screen grab

Description: Looking west at the intersection of 5th and High School Way. Water ponds along 5th street as it moves down High School Way.



Site location: 4

Photo number: Google screen grab

Description: Looking north along 5th street where the water ponds.

Mapped ID:	**18a**
Location description:	SW J.P. West Rd (south to SW Maple) and potential regional facility
Problem Description:	Area lacks and requires a storm drainage system – no storm structures currently present.

Site location: 18a
Photo number: IMG_0674
Description: Looking east along JP West Road where no pipe infrastructure exists.

Site location: 18a
Photo number: IMG_0675
Description: Looking east along JP West Road where no pipe infrastructure exists.

Site location: 18a
Photo number: IMG_1792
Description: Looking west along JP West Road.

Site location: 18a
Photo number: IMG_1793
Description: Looking west/south west from JP West Road where a stormwater facility may be placed.

Mapped ID:	31
Location description:	NW EJ Smith (west side of Scappoose Creek)
Problem Description:	Drainage along EJ Smith road jumps out of the current ditches and onto the road.

Site location: 31

Photo number: IMG_0670

Description: Field adjacent to EJ Smith looking east where a stormwater facility could be placed.

Site location: 31

Photo number: IMG_0671

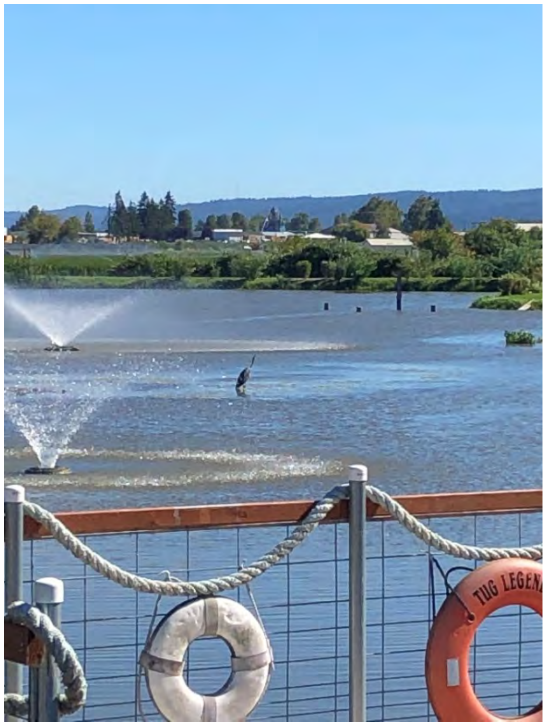
Description: Field adjacent to EJ Smith looking south where a stormwater facility could be placed.

Site location:	31
Photo number:	IMG_0672
Description:	Field adjacent to EJ Smith looking west up the hill where a stormwater facility could be placed.

Mapped ID:	30
Location description:	Spring Lake Park Basin
Problem Description:	A flow through pond that is privately owned. Built as part of the mobile home development.

Site location: 30
Photo number: IMG_0721
Description: Outfall of pond system into SDIC drainage system

Site location: 30
Photo number: IMG_0722
Description: Outfall of ponds and SDIC drainage looking east.



Site location: 30
Photo number: IMG_0724
Description: Pond system, looking south/southeast.

Site location: 30
Photo number: IMG_0728
Description: North pond looking north. Trail along pond floods during large events.

Site location:	30
Photo number:	IMG_0725
Description:	North pond looking north. Trail along pond floods during large events.

Mapped ID:	**10**
Location description:	NW View Terrace
Problem Description:	Functional/structural deficiency: catch basin/discharge at end of the road is sinking/bad pipe.

Site location:	10
Photo number:	IMG_0665
Description:	Inlet at the bottom of hill where stormwater jumps the curb and erodes the steep bank on the back side of the sidewalk.

Site location:	10
Photo number:	IMG_0666
Description:	Steep bank behind sidewalk.

Site location: 10

Photo number: IMG_0668

Looking west, up NW View Terrace Pl.

Site location: 10

Photo number: IMG_1784

Description: Inlet covered by vegetation.

Mapped ID:	16
Location description:	32952 SW Keys Crest Drive
Problem Description:	Check intake structure for damage. Storm socks in two areas, storm water is running down storm sock to ditch at bottom of hill. Outfall causing bank erosion. Clarify type of "sock" used in this location.

Site location: 16
Photo number: IMG_0679
Description: Looking down ravine

Site location: 16
Photo number: IMG_0680
Description: Storm sock at top of ravine

Site location:	16
Photo number:	IMG_0681
Description:	Storm sock at end of pipe

July 16, 2021, site visit photos.

Model ID:	**INF10_D06_INF10_D04 (Dutch Canyon Infiltration Facility)**
Location description:	Dutch Canyon Infiltration Facility (along SW Old Portland Road between SW Holland Dr and SW Callahan Rd)
Reason for Visit:	Take depth measurement for infiltration facility, inspect general condition of soils in facility, confirm inlet and outlet structures.

Model ID: INF10_D06_INF10_D04 (Dutch Canyon Infiltration Facility)

Photo number: IMG_7880

Description: Looking north at inlet structure, west wall

Model ID: INF10_D06_INF10_D04 (Dutch Canyon Infiltration Facility)

Photo number: IMG_7882

Description: Standing water present in facility near inlet structure

Model ID:	INF10_D06_INF10_D04 (Dutch Canyon Infiltration Facility)
Photo number:	IMG_7883
Description:	Looking south along length of facility

Model ID:	INF10_D06_INF10_D04 (Dutch Canyon Infiltration Facility)
Photo number:	IMG_7884
Description:	Erosion in bottom of facility

Model ID: INF10_D06_INF10_D04 (Dutch Canyon Infiltration Facility)
Photo number: IMG_7886
Description: Lateral inlet from catch basin on corner of Callahan and Old Portland that was observed flooding during Feb 2019 event

Model ID: INF10_D06_INF10_D04 (Dutch Canyon Infiltration Facility)
Photo number: IMG_7884
Description: Looking west up channel along north side of Callahan

Model ID:	**South of junction INF10_MH39**
Location description:	Inlet structure and-out connection at the end of SW Volendam St
Reason for Visit:	Verify that drain from behind houses to the west drains to this location.

Model ID: South of junction INF10_MH39
Photo number: IMG_7891
Description: Looking down at inlet structure, drain pipe entering from right side of photo (west)

Model ID: South of junction INF10_MH39
Photo number: IMG_7892
Description: Looking southeast from stub out connection. Low point potentially collects water

Model ID:	**DC_Wetland**
Location description:	Dutch Canyon Wetland
Reason for Visit:	General reconnaissance – see if assumed layout is correct, verify that “rim elevation” is approximately low point of Dutch Canyon Road

Model ID:	DC_Wetland
Photo number:	IMG_7895
Description:	Looking south into wetland from edge of Dutch Canyon Road

Model ID:	From SSC09 upstream to SSC09_CB16
Location description:	Roadside ditches and culverts on north side of EM Watts heading east to outfall at Scappoose Creek
Reason for Visit:	Measure ditches and culverts, verify layout of system and drainage patterns

Model ID: SD0591
Photo number: IMG_7896
Description: Most downstream ditch to outfall, which is covered by overgrown bushes.

Model ID: SD0591
Photo number: IMG_7899
Description: Most downstream ditch to outfall, which is covered by overgrown bushes.

Model ID:	SD0590, SD0567
Photo number:	IMG_7897
Description:	Looking west up EM Watts at ditches on north side, culvert across driveway

Model ID:	SD0590, SD0566_1, SD0566_2
Photo number:	IMG_7901
Description:	Looking east down EM watts, ditch with culvert running under the road from right side of photo to ditch

Model ID:	SSC09_CB16
Photo number:	IMG_7902
Description:	Culvert inlet at southwest corner of EM Watts and Keys road. 12" culvert

Model ID:	**From SSC09_CB16 upstream to SSC09_MH01**
Location description:	**Ditches and culverts up Keys Road from intersection with EM Watts**
Reason for Visit:	**Measure ditches and culverts, verify layout of system and drainage patterns**

Model ID:	SD0588
Photo number:	IMG_7903
Description:	Ditch on south side of Keys Road

Model ID:	SD0742 outfall into SD0740
Photo number:	IMG_7905
Description:	Culvert into ditch on north side of Keys Road

Model ID:	**SSC15_D03**
Location description:	**JP West Road system**
Reason for Visit:	**Measure ditches and culverts, verify layout of system and drainage patterns**

Model ID:	SSC15_D03
Photo number:	IMG_7907
Description:	Area-drain and junction SSC15_D03, looking west up JP West Rd

Model ID:	PND03_CB03 "upstream" to DW04_CB03
Location description:	Pathway overland drainage into Miller Park, Miller Park inlet into Pipe to Miller Road
Reason for Visit:	Verify approximate geometry of overland drainage path, verify that inlet into pipe at Miller park is at ground level.

Model ID: DW04_PND03_N02

Photo number: IMG_7927

Description: Drainage pathway that conveys upwelling from CB at sunset loop through to Miller Park

Model ID: PND03_N02_PND03_N01

Photo number: IMG_7925

Description: Drainage pathway that conveys upwelling from CB at sunset loop through to Miller Park. Inlet structure into pipe through Miller Park.

Model ID:	PND03_N01
Photo number:	IMG_7924
Description:	Inlet structure into pipe through Miller Park.

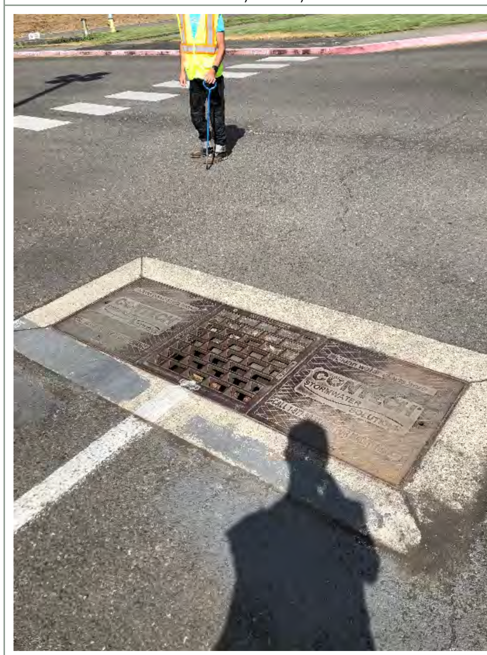
Model ID:	SD0724
Photo number:	IMG_7926
Description:	Mound conveying pipe through Miller Park.

Model ID:	**Area around DW37_CB02**
Location description:	**High School parking lots off of High School Way, down to High School Way and SE 5th St**
Reason for Visit:	**Verify that parking lots are a closed basin draining to some kind of infiltration facility, measure ditches down High School Way to 5th, confirm drainage patterns.**

Model ID: DW37_CB02

Photo number: IMG_7933

Description: Catch basin in curb at corner of parking lot, looking west. Pipes visible in basin from east, west, and south.



Model ID: N/A

Photo number: IMG_7932

Description: CONTECH device in parking lot to south of HS Way.

Model ID:	PND02_N01
Photo number:	IMG_7936
Description:	Corner of High School Way and 5th. Significant flooding reported in this area. Ditch approaches this corner from the west (bottom left corner of photo)

Facility Name:	Creekview Apartments
Location description:	52520 SW 4th St
Reason for Visit:	Potential WQ retrofit opportunity - Detention pond to PFC MH (W/5.25" & 5.5" Orifice) w/12" CMP outfall to Scappoose Creek

Facility Name Creekview Apartments
Photo number: IMG_7908
Description: Facility inside fence

Facility Name Creekview Apartments
Photo number: IMG_7909
Description: Facility inside fence – facing southwest. Scappoose creek is off to the right.

Facility Name	Creekview Apartments
Photo number:	IMG_7910
Description:	Manhole after facility outlet, before outfall to Scappoose Creek.

Facility Name	Creekview Apartments
Photo number:	IMG_7912
Description:	Facility with manhole visible to left (west) of facility

Facility Name:	**Goss Subdivision**
Location description:	**NW Manor & Scap-Vern Hwy.**
Reason for Visit:	**Will require additional WQ and detention storage if additional acreage west is developed - WQ MH to Detention Pond (ODOT seed mix over native) to DI with orifice**

Facility Name	Goss Subdivision
Photo number:	IMG_7913
Description:	Full length of facility, looking north from Manor

Facility Name	Goss Subdivision
Photo number:	IMG_7914
Description:	Inlet structure DS of WQ manhole into facility

Facility Name	Goss Subdivision
Photo number:	IMG_7916
Description:	Outlet structure, two orifices shown

Facility Name	Goss Subdivision
Photo number:	IMG_7918
Description:	Water quality manhole upstream of facility, needs cleaning/maintenance

Facility Name:	**Johnson Estates**
Location description:	**NE 2nd & Crown Zellerbach Rd.**
Reason for Visit:	**Retention Basin (4' x 4' x 50' w/3/4-1" drain rock) no overflow**

Facility Name Johnson Estates

Photo number: IMG_7919

Description: Full length of facility, looking north from corner of NE 2nd and Crown Zellerbach. Overgrown facility.

Facility Name Johnson Estates

Photo number: IMG_7921

Description: Looking south into facility.

Facility Name:	**Westview Subdivision**
Location description:	**NE Erin Dr.**
Reason for Visit:	**WQ MH to Retention Basin w/ 1" drainrock. City acquired from County after tax default.**

Facility Name	Westview Subdivision
Photo number:	IMG_7928
Description:	Looking south into facility at end of Erin Dr.

Facility Name	Westview Subdivision
Photo number:	IMG_7929
Description:	Looking northeast, facility outlet shown.

Facility Name:	**Steinfield Subdivision**
Location description:	**SE 3rd & SE Steinfeld St**
Reason for Visit:	**CB to SD MH to Retention Basin (native soils) – no WQ.**

Facility Name	Steinfield Subdivision
Photo number:	IMG_7937
Description:	Looking west into facility from on SE 3rd Ave. Facility is behind fence.

Facility Name	Steinfield Subdivision
Photo number:	IMG_7931
Description:	Looking northwest into facility, with houses along Steinfield shown in background.

Appendix D: Public Works Staffing Evaluation

Appendix D

Staffing Evaluation

City of Scappoose Storm Drainage Master Plan

Table D-1 provides a summary of the City existing and recommended maintenance activities.

Table D-1. City Proposed Maintenance Activities and Staffing Levels[1]

Activity	Existing Level of Effort (per 2020-21)				Proposed Level of Effort				Proposed Staffing Adjustment		
	Current Coverage	Frequency	Average Staff Time/Facility[2]	Total Time (Annual) (hrs)	Regulatory Driver	Coverage	Frequency	Total Time (Annual) (hrs)	Proposed Staff Increase (hrs and FTE)[3]	Rationale	Division/Staff Title
Catch basin cleaning	• 90 catchbasins (CBs). Conducted by zone (~10% of City). • Maintenance efforts include pressure washing and vactoring. • Focus on extremely leafy areas of the City (due to blockage).	1x/year	.5 hrs/CB (maintenance)	45 hours	WPCF Permit–Annual inspections and physical maintenance	~25% of public catchbasins city-wide (185 of the 739 city-owned CBs)	Annual maintenance (1x/year)	93 hrs	0.05 FTE	Regulatory compliance; addressing problem area needs	Field Services
Catch basin inspections	• 90 CBs. Conducted by zone (10% of City) in conjunction with maintenance activities.	1x/year	.25 hrs/CB (inspection)	22.5 hours	WPCF Permit–Annual inspections and physical maintenance	City-wide (739 city-owned CBs)	Annual inspections of all CBs (1x/year)	185 hrs	0.09 FTE	Regulatory compliance; addressing problem area needs	Field Services
StormFilter Cleaning	• 20 filters. • Efforts include changing media cartridges, vacuum old media cartridges and debris, disposal of material and paperwork. • City responsible for cartridge swapping.	1x/2 years (Jan & Feb)	5 hrs/facility	50 hours	WPCF Permit–Adhere to manufacturer recommendations	Increase to annual coverage.	1x/year	100 hrs	0.05 FTE	Regulatory compliance	Field Services
Street Sweeping	• City-wide (44 quadrants)	Twice a month (Jan-Mar) Once a month (Apr-Sep) Weekly (Oct-Dec) ~24 city-wide sweeps	32 hrs/city-wide sweep	768 hours	WPCF Permit–monthly (Jan-Sep) and twice monthly (Oct-Dec)	Maintain existing coverage.	Maintain existing (24 city-wide sweeps/year)	768 hrs	0.00 FTE	Regulatory compliance	Field Services
Sediment Manholes	• No activities conducted. 19 sediment manholes.	N/A	Assume 2 hrs/manhole (maintenance)	N/A	WPCF Permit–Annual inspections and physical maintenance	City-wide (19 manholes)	1x/year	40 hours	0.02 FTE	Regulatory compliance	Field Services
UIC cleaning	• No activities conducted. 55 public UICs per WPCF permit.	N/A	Assume 4 hrs/UIC (maintenance)	N/A	WPCF Permit–Annual inspections and maintenance if UICs aren't functioning	~20% of public UICs will require maintenance (12 UICs)	Annual	96 hours * assuming 2 staff	0.04 FTE	Regulatory compliance	Field Services

1 From: "Public Works Work Plan 2020-2021" provided by City. Note: January–March Street Sweeping occurs at random depending on late leaf fall/windstorms/gravel pick up from ice and snow. This could be twice a month to up to three times a month. April–September Street Sweeping–once a month sweeping usually third week of the month.

2 Source: Doug Nassimbene's email from 3/29/21.

3 Assume 1 FTE = 2,000 hrs

Table D-1. City Proposed Maintenance Activities and Staffing Levels[1]

Activity	Existing Level of Effort (per 2020-21)				Proposed Level of Effort				Proposed Staffing Adjustment		
	Current Coverage	Frequency	Average Staff Time/Facility[2]	Total Time (Annual) (hrs)	Regulatory Driver	Coverage	Frequency	Total Time (Annual) (hrs)	Proposed Staff Increase (hrs and FTE)[3]	Rationale	Division/Staff Title
UIC inspections	• No activities conducted. 55 public UICs per WPCF permit.	N/A	Assume 4 hr/UIC (inspection)	N/A	WPCF Permit–Annual inspections and maintenance if UICs aren't functioning	Inspection of all UICs	Annual	220 hours	0.12 FTE	Regulatory compliance	Field Services
Public Stormwater Facilities (swales)[4]	• 2 (public) swales. • Mowing.	2x/month May-Sep	4 hrs/swale	80 hours	Willamette Basin Mercury TMDL–Operate and maintenance facilities and conduct record keeping	Expand frequency to all months of the year.	2x/ month Annually	200 hours	0.06 FTE	Regulatory compliance	Field Services
Public Stormwater Facilities (ponds, other) cleaning[5]	• No activities conducted. 14 public detention/infiltration facilities	As needed	10 hrs/facility (maintenance)	N/A	Willamette Basin Mercury TMDL–Operate and maintenance facilities and conduct record keeping	Maintenance of all facilities	Annual	280 hours *assuming 2 staff	0.28 FTE	Regulatory compliance; addressing problem area	Field Services
Public Stormwater Facilities (ponds, other) inspection	• No activities conducted. 14 public detention/infiltration facilities	As needed	4 hrs/facility (inspection)	N/A	Willamette Basin Mercury TMDL–Operate and maintenance facilities and conduct record keeping	Inspection of all facilities.	Annual	56 hours	0.06 FTE	Regulatory compliance; addressing problem area	Field Services
Private Stormwater Facilities[6]	• No activities conducted. 15 private facilities	N/A	4 hrs/facility (inspection)	N/A	Willamette Basin Mercury TMDL–Ensure long-term O&M for facilities under private ownership	Inspection of all facilities.	Annual	100 hours	0.10 FTE	Regulatory compliance	Field Services
Pipeline Cleaning	• No activities conducted.	N/A	100-200 ft/hr	N/A	N/A	Varies based on CCTV needs (see Section 5.3 for basis of estimate)	Annual	100 hours	0.10 FTE	Condition assessment	Field Services
								TOTAL	0.92 FTE		

[4] City GIS inventory indicates 38 public swales. Current City inventory indicates 2 swales (Springlake Meadows facilities).

[5] City GIS inventory indicates 45 public facilities. Current City inventory indicates 14 public facilities including detention pipe, retention basins, and detention ponds.

[6] City GIS inventory indicates 31 private facilities. Current City inventory indicates 15 private facilities including swales, retention basins, and detention ponds.

Appendix E: Capital Project Detailed Cost Estimates

Unit Cost Table			
Costs based on RS Means, collected bid tabs, and recent master planning efforts. *Unit costs escalated to 2021 dollars via ENR Consumer Cost Index.*			
Item	**Unit**	**Unit Cost (2021)**	**Revised Unit Cost Source**
General			
Construction Access	LS	10,000	BC
Earthwork			
General Earthwork/Excavation	CY	26	BC
Embankment	CY	10	BC
Clear and Grub brush including stumps	AC	8,900	BC
Clearing and Grubbing	AC	15,000	BC
Amended Soils and Mulch	CY	65	BC
Jute Matting, Biodegradeable	SY	4	BC
Tree removal	EA	340	BC
Geomembrane	SY	33	BC
Geotextile	SY	3	BC
Energy dissapation pad - Rip-Rap, Class 50	CY	92	BC
Energy dissapation pad - Rip-Rap, Class 100	CY	88	BC
Energy dissapation pad - Rip-Rap, Class 200	CY	106	BC
Dewatering	LS	5,000 - 50,000	BC
Drain Rock	CY	102	BC
Water Quality Facility Installation			
Outflow Control Structure	EA	6,700	BC
Facility Inlet Structure	EA	5,000	BC
Water Quality Facility Plantings with Trees	SF	6	BC
Rain Garden (Swale type)	SF	43	BC
Stormwater Planter	SF	79	BC
Gravel Access Road	SF	5	BC
Beehive Overflow	EA	1,700	BC
Structure Installation			
Field Ditch Inlet	EA	4,400	BC
Precast Concrete Manhole (48", 0-8' deep)	EA	4,900	BC
Precast Concrete Manhole (48", 9-12' deep)	EA	7,200	BC
Precast Concrete Manhole (48", 13-20' deep)	EA	11,200	BC
Precast Concrete Manhole (60", 0-8' deep)	EA	5,900	BC
Precast Concrete Manhole (60", 9-12' deep)	EA	6,100	BC
Precast Concrete Manhole (72", 0-8' deep)	EA	9,100	BC
Precast Concrete Manhole (72", 9-12' deep)	EA	12,900	BC
Precast Concrete Manhole (72", >12' deep)	EA	13,400	BC
Flow Splitter/WQ Manhole (72", all depths)	EA	43,100	BC
Drywell (48", 20-25' deep)	EA	13,300	BC
Curb Inlet	EA	3,000	BC
Catch Basin, all types	EA	3,500	BC
Concrete Fill - UIC Decomissioning	EA	11,200	BC
Connection to Existing Lateral	EA	1,292	BC
Connection to Existing Structure, standard	EA	1,400	BC
Abandon Existing Pipe, no excavation (12")	FT	11	BC
Abandon Existing Pipe, no excavation (15"-18")	FT	22	BC
Abandon Existing Pipe, no excavation (21"-24")	FT	27	BC
Abandon Existing Pipe, no excavation (27"-36")	FT	39	BC
Abandon Existing Structure	EA	1,100	BC
Demo pipe	LF	78	BC
Remove existing pavement	SY	11	BC
Remove structure	EA	1,100	BC
Plug Existing Pipe	EA	800	BC
Check dams	EA	550	BC
Stem wall check dam	LF	110	BC
Headwall with wingwalls, larger than 48" pipe	EA	15,400	BC
Headwall with wingwalls, up to 48" pipe	EA	8,700	BC
Ecology Block Structural Wall	EA	760	BC
Outfall Improvements	EA	3,000-10,000	BC

Unit Cost Table			
Costs based on RS Means, collected bid tabs, and recent master planning efforts. *Unit costs escalated to 2021 dollars via ENR Consumer Cost Index.*			
Item	**Unit**	**Unit Cost (2021)**	**Revised Unit Cost Source**
Restoration/Resurfacing			
Non-Water Quality Facility Landscaping	AC	16,800	BC
Riparian/Wetland Planting (Non-irrigated)	AC	22,300	BC
Riparian/Wetland Planting (w/temporary irrigation)	AC	35,700	BC
Planting and Bioengineered Restoration	SY	44	BC
4-foot Chain Link Fence	LF	24	BC
Split Rail Fence	LF	27	BC
Hydroseed, large quantities	AC	2,600	BC
Seeding, small quantities (< 5,000 sf)	SF	3	BC
Sidewalk Installation	SF	16	BC
Trench resurfacing, Permanent ACP, 6-Inch Depth	SY	92	BC
Permeable Paver Installation	SF	13	BC
Porous Asphalt Paving	SF	2	BC
Concrete Curbs	FT	44	BC
Pipe Unit Cost			
Underdrain Pipe, 4"	LF	32	BC
Underdrain, 6" perforated HDPE	LF	61	BC
HDPE Inlet Lead (12", 2-5' deep)	FT	100	BC
HDPE Pipeline w/asphalt resurfacing (12", 5-10' deep)	FT	150	BC
HDPE Pipeline (12", 5-10' deep)	FT	140	BC
HDPE Pipeline w/asphalt resurfacing (12", 10-15' deep)	FT	170	BC
HDPE Pipeline w/asphalt resurfacing (18", 5-10' deep)	FT	210	BC
HDPE Pipeline w/asphalt resurfacing (22", 5-10' deep)	FT	260	BC
HDPE Pipeline w/asphalt resurfacing (24", 5-10' deep)	FT	300	BC
HDPE Pipeline (24", 5-10' deep)	FT	290	BC
HDPE Pipeline w/asphalt resurfacing (30", 5-10' deep)	FT	360	BC
HDPE Pipeline (30", 5-10' deep)	FT	250	BC
HDPE Pipeline w/asphalt resurfacing (36", 5-10' deep)	FT	440	BC
HDPE Pipeline (36", 5-10' deep)	FT	290	BC
HDPE Pipeline (36", 10-15' deep)	FT	340	BC
HDPE Pipeline w/asphalt resurfacing (36", 10-15' deep)	FT	530	BC
HDPE Pipeline w/asphalt resurfacing (42", 5-10' deep)	FT	560	BC
HDPE Pipeline (42", 5-10' deep)	FT	380	BC
HDPE Pipeline w/ asphalt resurfacing (42", >10' deep)	FT	400	BC
HDPE Pipeline w/asphalt resurfacing (48", 5-10' deep)	FT	620	BC
HDPE Pipeline (48", 5-10' deep)	FT	480	BC
HDPE Pipeline w/ asphalt resurfacing (48", >10' deep)	FT	580	BC
HDPE Pipeline w/ asphalt resurfacing (54", >10' deep)	FT	620	BC
HDPE Pipeline w/ asphalt resurfacing (54", 5-10' deep)	FT	750	BC
HDPE Pipeline w/asphalt resurfacing (60", 5-10' deep)	FT	890	BC
HDPE Pipeline (60", 5-10' deep)	FT	740	BC
HDPE Pipeline (84", 5-10' deep)	FT	1,500	BC
CMP Pipeline w/asphalt resurfacing (84", 5-10' deep)	FT	1,300	BC
CMP Pipeline (84", 5-10' deep)	FT	1,030	BC
CMP Pipeline w/ no asphalt resurfacing (72", 5-10' Deep)	FT	940	BC
CMP Pipeline w/ no asphalt (75"x115" arch, 5-10' Deep)	FT	1,500	BC
Extra depth pipe	FT	56	BC
PVC Pipeline w/no asphalt resurfacing (6", 0-5' deep)	FT	86	BC
PVC Pipeline w/ asphalt resurfacing (12", 5-10' deep)	FT	170	BC
PVC Pipeline w/ asphalt resurfacing (18", 5-10' deep)	FT	220	BC
PVC Pipeline w/ asphalt resurfacing (24", 5-10' deep)	FT	280	BC
PVC Pipeline (24", 5-10' deep)	FT	250	BC
PVC Pipeline w/ asphalt resurfacing (30", 5-10' deep)	FT	350	BC
PVC Pipeline w/ asphalt resurfacing (36", 5-10' deep)	FT	390	BC
RCP Pipeline w/ asphalt resurfacing (48", 5'-10' deep)	FT	490	BC
RCP Pipeline (48", 5'-10' deep)	FT	420	BC
RCP Pipeline (54", 5'-10' deep)	FT	520	BC
RCP Pipeline w/ asphalt resurfacing (54", 5'-10' deep)	FT	600	BC
RCP Pipeline w/ asphalt resurfacing (60", 5'-10' deep)	FT	710	BC
RCP Pipeline w/ asphalt resurfacing (72",5'-10' deep)	FT	820	BC
RCP Pipeline w/ asphalt resurfacing (84", 5'-10' deep)	FT	900	BC

Unit Cost Table			
Costs based on RS Means, collected bid tabs, and recent master planning efforts. Unit costs escalated to 2021 dollars via ENR Consumer Cost Index.			
Item	**Unit**	**Unit Cost (2021)**	**Revised Unit Cost Source**
Box Culvert (160 LF, 4' x 9')	LS	1,040	BC
Box Culvert Installation	FT	1,200	BC
Box Culvert (8' x 3')	FT	870	BC
Box Culvert (10' x 3')	FT	970	BC
Box Culvert (12' x 3')	FT	1,800	BC
Contingencies and Multipliers			
Mobilization	LS	10%	BC
Erosion and Sediment Control	LS	3%	BC
Contingency	LS	30%	BC
Traffic Control/Utility Relocation	LS	5-10%	BC
Capital Expense Total (including contingency)			
Design/Construction Administration (%)	LS	5%	BC
Engineering and Permitting (%)	LS	20-30%	BC

JC-1 – Elm Street Storm Improvements

Key Project Elements

Upsize existing infrastructure to increase system capacity:

- Remove and replace approx. 400 LF of existing 24" pipe with 30" HDPE pipe
- Remove and replace approx. 1,860 LF of existing 24" pipe with 42" HDPE pipe
- Remove and replace 10 manholes
- Remove and replace outfall

Design Assumptions

- 3 upstream manholes and 3 pipes to remain unchanged – model shows current configuration to have adequate capacity for upstream area.
- CP developed assumes new pipe will be installed in roadway right-of-way and repaved upon completion.
- Easement and property acquisition not included in cost estimate.
- Dewatering not included in cost estimate.
- A detailed survey of existing infrastructure, other utilities, and roadway elevations should be completed prior to final design.

Item	Unit	Unit Cost (2021)	Quantity	Total Cost
General				
Construction Access	LS	10,000	1	$10,000
Structure Installation				
Precast Concrete Manhole (48", 0-8' deep)	EA	4,900	3	$14,700
Precast Concrete Manhole (60", 0-8' deep)	EA	5,900	7	$41,300
Connection to Existing Structure, standard	EA	1,400	2	$2,800
Outfall Improvements	EA	10,000	1	$10,000
Demo pipe	LF	78	2260	$175,233
Pipe Unit Cost				
HDPE Pipeline w/asphalt resurfacing (30", 5-10' deep)	FT	360	400	$144,000
HDPE Pipeline (42", 5-10' deep)	FT	380	480	$182,400
HDPE Pipeline w/asphalt resurfacing (42", 5-10' deep)	FT	560	1380	$772,800
Project Sub-Total				$1,353,000
Contingencies and Multipliers				
Mobilization	LS	10%		$135,300
Erosion and Sediment Control	LS	3%		$40,590
Contingency	LS	30%		$405,900
Traffic Control/Utility Relocation	LS	5%		$67,650
Capital Expense Total (including contingency)				$2,002,000
Design/Construction Administration (%)	LS	5%		$100,100
Engineering and Permitting (%)	LS	30%		$600,600
			TOTAL	$2,703,000

JC-2 – High School Way Storm Improvements

Key Project Elements

- Remove and replace unregistered UIC and install pretreatment
- Install approx. 50 LF of 24” HDPE

Design Assumptions

- CP assumes alignments will be installed in roadway right-of-way and repaved upon completion.
- A detailed survey of existing utilities and roadway elevations should be completed prior to final design.
- Dewatering not included in cost estimate.

Item	Unit	Unit Cost (2021)	Quantity	Total Cost
General				
Construction Access	LS	10,000	1	$10,000
Structure Installation				
Catch Basin, all types	EA	3,500	2	$7,000
Drywell (48", 20-25' deep)	EA	13,300	1	$13,300
Pipe Unit Cost				
HDPE Inlet Lead (12", 2-5' deep)	FT	100	35	$3,505
HDPE Pipeline w/asphalt resurfacing (24", 5-10' deep)	FT	300	50	$15,000
Project Sub-Total				$49,000
Contingencies and Multipliers				
Mobilization	LS	10%		$4,900
Erosion and Sediment Control	LS	3%		$1,470
Contingency	LS	30%		$14,700
Traffic Control/Utility Relocation	LS	5%		$2,450
Capital Expense Total (including contingency)				$73,000
Design/Construction Administration (%)	LS	5%		$3,650
Engineering and Permitting (%)	LS	20%		$14,600
			TOTAL	$91,000

JC-3 Phase 1 - E Columbia Ave Storm Improvements

Key Project Elements

- Remove and replace approx. 980 total LF of existing 24" HDPE pipe with 54" HDPE pipe
- Remove and replace 3 manholes
- Replace existing outfall
- Conduct geotechnical investigation and infiltration testing

Design Assumptions

- CP assumes alignments will be installed in roadway right-of-way and repaved upon completion.
- A detailed survey of existing culverts, other utilities, and roadway elevations should be completed prior to final design.
- Dewatering not included in cost estimates.

Item	Unit	Unit Cost (2021)	Quantity	Total Cost
General				
Construction Access	LS	10,000	1	$10,000
Geotechnical Investigation/Infiltration Testing	LS	10,000	1	$10,000
Structure Installation				
Precast Concrete Manhole (72", 0-8' deep)	EA	9,100	3	$27,300
Outfall Improvements	EA	10,000	1	$10,000
Demo pipe	LF	78	980	$75,986
Pipe Unit Cost				
HDPE Pipeline w/ asphalt resurfacing (54", 5-10' deep)	FT	750	980	$735,000
Project Sub-Total				$868,000
Contingencies and Multipliers				
Mobilization	LS	10%		$86,800
Erosion and Sediment Control	LS	3%		$26,040
Contingency	LS	30%		$260,400
Traffic Control/Utility Relocation	LS	10%		$86,800
Capital Expense Total (including contingency)				$1,328,000
Design/Construction Administration (%)	LS	5%		$66,400
Engineering and Permitting (%)	LS	30%		$398,400
			TOTAL	$1,793,000

JC-3 Phase 2 – E Columbia Ave Storm Improvements

Key Project Elements

- Remove and replace approx. 1,060 total LF of existing 24" HDPE and CPP pipe with 54" HDPE pipe
- Remove and replace 7 manholes
- Remove and replace approx. 530 LF of existing 15" HDPE pipe with 30" HDPE pipe
- Install approx. 210 LF of 30" HDPE pipe
- Install approx. 600 LF of 24" HDPE pipe
- Install 3 manholes
- Install 6 CBs and associated inlet leads

Design Assumptions

- CP assumes alignments will be installed in roadway right-of-way and repaved upon completion.
- A detailed survey of existing culverts, other utilities, and roadway elevations should be completed prior to final design.
- Dewatering not included in cost estimates.

Item	Unit	Unit Cost (2021)	Quantity	Total Cost
General				
Construction Access	LS	10,000	1	$10,000
Structure Installation				
Precast Concrete Manhole (72", 0-8' deep)	EA	9,100	4	$36,400
Precast Concrete Manhole (48", 0-8' deep)	EA	4,900	6	$29,400
Curb Inlet	EA	3,000	6	$18,000
Demo pipe	LF	78	1590	$123,283
Pipe Unit Cost				
HDPE Pipeline w/ asphalt resurfacing (54", 5-10' deep)	FT	750	1060	$795,000
HDPE Pipeline w/asphalt resurfacing (30", 5-10' deep)	FT	360	740	$266,400
HDPE Pipeline w/asphalt resurfacing (24", 5-10' deep)	FT	300	600	$180,000
HDPE Inlet Lead (12", 2-5' deep)	FT	100	105	$10,516
Project Sub-Total				$1,469,000
Contingencies and Multipliers				
Mobilization	LS	10%		$146,900
Erosion and Sediment Control	LS	3%		$44,070
Contingency	LS	30%		$440,700
Traffic Control/Utility Relocation	LS	10%		$146,900
Capital Expense Total (including contingency)				$2,248,000
Design/Construction Administration (%)	LS	5%		$112,400
Engineering and Permitting (%)	LS	20%		$449,600
			TOTAL	$2,810,000

JC-3 Phase 3 – E Columbia Ave Storm Improvements

Key Project Elements

- Install approx. 1,000 LF of 24" HDPE pipe
- Install approx. 780 LF of 30" HDPE pipe
- Install approx. 310 LF of 36" HDPE pipe
- Install 6 new manholes
- Install 12 new CBs and associated inlet pipe.

Design Assumptions

- CP assumes alignments will be installed in roadway right-of-way and repaved upon completion.
- A detailed survey of existing culverts, other utilities, and roadway elevations should be completed prior to final design.
- Dewatering not included in cost estimates.

Item	Unit	Unit Cost (2021)	Quantity	Total Cost
General				
Construction Access	LS	10,000	1	$10,000
Structure Installation				
Precast Concrete Manhole (48", 0-8' deep)	EA	4,900	6	$29,400
Curb Inlet	EA	3,000	12	$36,000
Pipe Unit Cost				
HDPE Pipeline w/asphalt resurfacing (24", 5-10' deep)	FT	300	1000	$300,000
HDPE Pipeline w/asphalt resurfacing (30", 5-10' deep)	FT	360	780	$280,800
HDPE Pipeline w/asphalt resurfacing (36", 5-10' deep)	FT	440	310	$136,400
HDPE Inlet Lead (12", 2-5' deep)	FT	100	210	$21,032
Project Sub-Total				$814,000
Contingencies and Multipliers				
Mobilization	LS	10%		$81,400
Erosion and Sediment Control	LS	3%		$24,420
Contingency	LS	30%		$244,200
Traffic Control/Utility Relocation	LS	10%		$81,400
Capital Expense Total (including contingency)				$1,245,000
Design/Construction Administration (%)	LS	5%		$62,250
Engineering and Permitting (%)	LS	20%		$249,000
			TOTAL	$1,556,000

JC-3 Phase 4 – E Columbia Ave Storm Improvements

Key Project Elements

- Install approx. 800 LF of 12" HDPE pipe
- Install approx. 365 LF of 18" HDPE pipe
- Install 3 new manholes
- Install 6 new CBs and associated inlet pipe

Design Assumptions

- CP assumes alignments will be installed in roadway right-of-way and repaved upon completion.
- A detailed survey of existing culverts, other utilities, and roadway elevations should be completed prior to final design.
- Dewatering not included in cost estimates.

Item	Unit	Unit Cost (2021)	Quantity	Total Cost
General				
Construction Access	LS	10,000	1	$10,000
Structure Installation				
Precast Concrete Manhole (48", 0-8' deep)	EA	4,900	3	$14,700
Curb Inlet	EA	3,000	6	$18,000
Pipe Unit Cost				
HDPE Pipeline w/asphalt resurfacing (12", 5-10' deep)	FT	150	800	$120,000
HDPE Pipeline w/asphalt resurfacing (18", 5-10' deep)	FT	210	365	$76,650
HDPE Inlet Lead (12", 2-5' deep)	FT	100	102	$10,215
Project Sub-Total				$250,000
Contingencies and Multipliers				
Mobilization	LS	10%		$25,000
Erosion and Sediment Control	LS	3%		$7,500
Contingency	LS	30%		$75,000
Traffic Control/Utility Relocation	LS	10%		$25,000
Capital Expense Total (including contingency)				$383,000
Design/Construction Administration (%)	LS	5%		$19,150
Engineering and Permitting (%)	LS	20%		$76,600
			TOTAL	$479,000

JC-4 Alt 1 - Sunset Loop Storm Improvements Alternative #1

Key Project Elements

- Remove approx. 37,440 SF of existing impervious pavement and existing subgrade
- Excavate approx. 2,080 CY of material
- Install 2 2-inch lifts covering 37,440 SF of porous pavement ODOT F-mix over a 24-inch deep open-graded base rock layer (approx. 2,775 CY)
- Remove 2 existing CBs
- Remove approx. 210 LF of existing 6” PVC

Design Assumptions

- Use of porous pavement on public streets must be approved by the City Engineer and Public Works Director.
- Cost estimation and quantities of excavation assume that the pavement removal will include 6” excavation depth. All excavation in the cost estimate is assumed in addition to this 6” depth.
- Standards currently only allow for intercepting rainfall directly and not receiving stormwater runoff from other areas – CP includes surrounding rooftops, sidewalks, and driveways - will require approval by the City.
- Impervious surface replacement with porous pavement 1:1 ratio.
- CP developed with drain rock capable of holding full runoff volume of 25-year storm from roadway, surrounding sidewalks, rooftops, and driveways.
- A detailed survey of existing culverts, other utilities, and roadway elevations should be completed prior to final design.
- Dewatering not included in cost estimates.

Item	Unit	Unit Cost (2021)	Quantity	Total Cost
General				
Construction Access	LS	10,000	1	$10,000
General Earthwork/Excavation	CY	26	2080	$55,057
Earthwork				
Drain Rock	CY	102	2775	$283,898
Structure Installation				
Remove existing pavement	SY	11	4160	$44,799
Demo pipe	LF	78	210	$16,283
Remove structure	EA	1,100	2	$2,200
Restoration/Resurfacing				
Porous Asphalt Paving	SF	2	37440	$72,817
Project Sub-Total				$485,000
Contingencies and Multipliers				
Mobilization	LS	10%		$48,500
Erosion and Sediment Control	LS	3%		$14,550
Contingency	LS	30%		$145,500
Traffic Control/Utility Relocation	LS	5%		$24,250
Capital Expense Total (including contingency)				$718,000
Design/Construction Administration (%)	LS	5%		$35,900
Engineering and Permitting (%)	LS	20%		$143,600
			TOTAL	$898,000

JC-4 Alt 2 - Sunset Loop Storm Improvements Alternative #2

Key Project Elements

- Install approx. 1,265 LF of 24" HDPE pipe
- Install approx. 270 LF of 22" HDPE pipe
- Install approx. 290 LF of 18" HDPE pipe
- Remove and replace pipe approx. 200 LF of existing 6" PVC pipe with 22" HDPE pipe.
- Remove and replace 4 failing open-bottom catch basin structures with standard CBs.
- Install 3 new manholes.
- Install outfall

Design Assumptions

- CP assumes alignments will be installed in roadway right-of-way and repaved upon completion.
- Proposed pipes in Sunset Loop do not meet slope or cover requirements – as to accommodate ground level limitations in the area. Concrete pipes proposed to account for cover requirement exception. Pipe materials and constructability should be considered prior to final design.
- If selected, it is assumed that construction of this alternative would take place concurrently with Phase 1 of Location 23 – E. Columbia Ave. storm improvements.
- A detailed survey of existing culverts, other utilities, and roadway elevations should be completed prior to final design.
- Dewatering not included in cost estimates.

Item	Unit	Unit Cost (2021)	Quantity	Total Cost
General				
Construction Access	LS	10,000	1	$10,000
Structure Installation				
Demo pipe	LF	78	200	$15,507
Curb Inlet	EA	3,000	4	$12,000
Precast Concrete Manhole (48", 0-8' deep)	EA	4,900	3	$14,700
Outfall Improvements	EA	10,000	1	$10,000
Pipe Unit Cost				
HDPE Pipeline w/asphalt resurfacing (24", 5-10' deep)	FT	300	1265	$379,500
HDPE Pipeline w/asphalt resurfacing (22", 5-10' deep)	FT	260	470	$122,200
HDPE Pipeline w/asphalt resurfacing (18", 5-10' deep)	FT	210	290	$60,900
Project Sub-Total				$625,000
Contingencies and Multipliers				
Mobilization	LS	10%		$62,500
Erosion and Sediment Control	LS	3%		$18,750
Contingency	LS	30%		$187,500
Traffic Control/Utility Relocation	LS	5%		$31,250
Capital Expense Total (including contingency)				$925,000
Design/Construction Administration (%)	LS	5%		$46,250
Engineering and Permitting (%)	LS	30%		$277,500
			TOTAL	$1,249,000

JC-5 – 6th and Vine UIC Replacement

Key Project Elements

- Install 2 sumped CBs
- Install traditional UIC at intersection

Design Assumptions

- Project is not SDC eligible as it is an existing regulatory issue.
- A detailed survey of existing culverts, other utilities, and roadway elevations should be completed prior to final design.
- Dewatering not included in cost estimates.

Item	Unit	Unit Cost (2021)	Quantity	Total Cost
General				
Construction Access	LS	10,000	1	$10,000
Structure Installation				
Drywell (48", 20-25' deep)	EA	13,300	1	$13,300
Catch Basin, all types	EA	3,500	2	$7,000
Pipe Unit Cost				
HDPE Inlet Lead (12", 2-5' deep)	FT	100	40	$4,006
Project Sub-Total				$34,000
Contingencies and Multipliers				
Mobilization	LS	10%		$3,400
Erosion and Sediment Control	LS	3%		$1,020
Contingency	LS	30%		$10,200
Traffic Control/Utility Relocation	LS	10%		$3,400
Capital Expense Total (including contingency)				$52,000
Design/Construction Administration (%)	LS	5%		$2,600
Engineering and Permitting (%)	LS	20%		$10,400
			TOTAL	$65,000

JW-1 Phase 1 - Dutch Canyon System Improvements

Key Project Elements

- Install a new overflow control structure
- Install approx. 1700 LF of 36" HDPE pipe
- Install 4 new manholes
- Install 8 new CBs and associated inlet pipe.
- Install new outfall

Design Assumptions

- Investigation into UIC feasibility in the area west of North Road is suggested (lump sum cost for infiltration testing assumed). If feasible, Phase 4 may not be necessary, with UICs installed to capture flow. Installation of UICs may also reduce flows to the pipes installed in Phases 1-3. Pipe sizing and cost estimation assumes that no reduction in flows from UICs is achieved.
- CP assumes alignments will be installed in roadway right-of-way and repaved upon completion.
- City GIS showed that Sanitary mains along E Columbia Ave are at lower elevations than proposed storm. Therefore, potential conflicts with the sanitary system are assumed to be limited to sanitary laterals. Any cost implications of potential conflicts are assumed covered by contingency.
- A detailed survey of existing culverts, other utilities, and roadway elevations should be completed prior to final design.
- Dewatering not included in cost estimates.

Item	Unit	Unit Cost (2021)	Quantity	Total Cost
General				
Construction Access	LS	10,000	1	$10,000
Infiltration Testing - UIC Feasibility Study	#N/A	10,000	1	$10,000
Structure Installation				
Outflow Control Structure	EA	6,700	1	$6,700
Precast Concrete Manhole (48", 0-8' deep)	EA	4,900	4	$19,600
Catch Basin, all types	EA	3,500	8	$28,000
Outfall Improvements	EA	10,000	1	$10,000
Pipe Unit Cost				
HDPE Pipeline w/asphalt resurfacing (36", 5-10' deep)	FT	440	1400	$616,000
HDPE Pipeline w/asphalt resurfacing (36", 10-15' deep)	FT	530	300	$159,000
HDPE Inlet Lead (12", 2-5' deep)	FT	100	140	$14,021
Project Sub-Total				$873,000
Contingencies and Multipliers				
Mobilization	LS	10%		$87,300
Erosion and Sediment Control	LS	3%		$26,190
Contingency	LS	30%		$261,900
Traffic Control/Utility Relocation	LS	5%		$43,650
Capital Expense Total (including contingency)				$1,292,000
Design/Construction Administration (%)	LS	5%		$64,600
Engineering and Permitting (%)	LS	20%		$258,400
			TOTAL	$1,615,000

JW-1 Phase 2 - Dutch Canyon System Improvements

Key Project Elements

Install approx. 75 LF of 24" HDPE
Install new overflow structure

Design Assumptions

- A detailed survey of existing culverts, other utilities, and roadway elevations should be completed prior to final design.
- Dewatering not included in cost estimates.
- Land-use condition assumed Low-Density Residential (40% impervious) for all future development in the Callahan-Dutch Canyon area and along SW Old Portland Road.

Item	Unit	Unit Cost (2021)	Quantity	Total Cost
General				
Construction Access	LS	10,000	1	$10,000
Structure Installation				
Outflow Control Structure	EA	10,000	1	$10,000
Outfall Improvements	EA	10,000	1	$10,000
Pipe Unit Cost				
HDPE Pipeline w/asphalt resurfacing (24", 5-10' deep)	FT	300	75	$22,500
Project Sub-Total				$53,000
Contingencies and Multipliers				
Mobilization	LS	10%		$5,300
Erosion and Sediment Control	LS	3%		$1,590
Contingency	LS	30%		$15,900
Traffic Control/Utility Relocation	LS	5%		$2,650
Capital Expense Total (including contingency)				$78,000
Design/Construction Administration (%)	LS	5%		$3,900
Engineering and Permitting (%)	LS	30%		$23,400
			TOTAL	$105,000

SC-1 – NW 1st Street Storm Improvements				

Key Project Elements

- Remove and replace approx. 190 LF of existing 12” pipe with 18" HDPE pipe.
- Remove and replace approx. 980 LF of existing 15” pipe with 18" HDPE pipe.
- Remove and replace approx.1,040 LF of existing 15” pipe with 24" HDPE pipe.
- Remove and replace 7 manholes
- Remove and replace outfall structure

Design Assumptions

- Surface facilities/green streets are not recommended due to traffic.
- Urban Renewal may result in updates to the roadway that should be considered with design.
- CP assumes alignments will be installed in roadway right-of-way and repaved upon completion.
- Manholes adjacent to replaced pipe will also require replacement.
- Easement and property acquisition not evaluated in cost estimate.
- A detailed survey of existing culverts, other utilities, and roadway elevations should be completed prior to final design.
- Dewatering not included in cost estimates.

Item	Unit	Unit Cost (2021)	Quantity	Total Cost
General				
Construction Access	LS	10,000	1	$10,000
Structure Installation				
Precast Concrete Manhole (48", 0-8' deep)	EA	4,900	7	$34,300
Outfall Improvements	EA	10,000	1	$10,000
Demo pipe	LF	78	2210	$171,356
Pipe Unit Cost				
HDPE Pipeline w/asphalt resurfacing (18", 5-10' deep)	FT	210	1170	$245,700
HDPE Pipeline w/asphalt resurfacing (24", 5-10' deep)	FT	300	1040	$312,000
Project Sub-Total				$783,000
Contingencies and Multipliers				
Mobilization	LS	10%		$78,300
Erosion and Sediment Control	LS	3%		$23,490
Contingency	LS	30%		$234,900
Traffic Control/Utility Relocation	LS	10%		$78,300
Capital Expense Total (including contingency)				$1,198,000
Design/Construction Administration (%)	LS	5%		$59,900
Engineering and Permitting (%)	LS	30%		$359,400
			TOTAL	$1,617,000

SC-2 – JP West Rd Storm Improvements - East

Key Project Elements

- Install 4 new manholes and
- Install 8 CBs with inlet leads
- Install a new outfall
- Install approx. 845 LF of 18" HDPE pipe

Design Assumptions

- CP assumes alignments will be installed in roadway right-of-way and repaved upon completion
- CP developed with proposed manhole locations within the structure location spacing requirement of 500 LF
- A detailed survey of existing culverts, other utilities, and roadway elevations should be completed prior to final design.
- Dewatering not included in cost estimates.

Item	Unit	Unit Cost (2021)	Quantity	Total Cost
General				
Construction Access	LS	10,000	1	$10,000
Structure Installation				
Precast Concrete Manhole (48", 0-8' deep)	EA	4,900	4	$19,600
Catch Basin, all types	EA	3,500	8	$28,000
Outfall Improvements	EA	10,000	1	$10,000
Pipe Unit Cost				
HDPE Pipeline w/asphalt resurfacing (18", 5-10' deep)	FT	210	845	$177,450
HDPE Inlet Lead (12", 2-5' deep)	FT	100	140	$14,021
Project Sub-Total				$259,000
Contingencies and Multipliers				
Mobilization	LS	10%		$25,900
Erosion and Sediment Control	LS	3%		$7,770
Contingency	LS	30%		$77,700
Traffic Control/Utility Relocation	LS	5%		$12,950
Capital Expense Total (including contingency)				$383,000
Design/Construction Administration (%)	LS	5%		$19,150
Engineering and Permitting (%)	LS	30%		$114,900
			TOTAL	$517,000

SC-3 – JP West Rd Storm Improvements – West

Key Project Elements

- Install new outfall
- Install approx. 890 LF of 12” HDPE pipe
- Remove and replace approx. 50 LF of existing 8" and 12” CMP pipe with 12” HDPE pipe
- Install approx. 90 LF of 18” HDPE pipe
- Install approx. 610 LF of 24” HDPE pipe
- Remove and replace approx. 40 LF of existing 12” pipe with 18” HDPE pipe
- Replace or install 8 new manholes
- Replace existing outfall with a new manhole
- Install 6 new manholes
- Install 12 new catch basins with associated inlet lead lines

Design Assumptions

- CIP developed assuming alignments will be installed in roadway right-of-way and repaved upon completion.
- CIP developed with proposed manhole locations within the structure location spacing requirement of 500 LF.
- A detailed survey of existing culverts, other utilities, and roadway elevations should be completed prior to final design.
- Dewatering not included in cost estimates.

Item	Unit	Unit Cost (2021)	Quantity	Total Cost
General				
Construction Access	LS	10,000	1	$10,000
Earthwork				
Dewatering	LS	10,000	1	$10,000
Structure Installation				
Precast Concrete Manhole (48", 0-8' deep)	EA	4,900	15	$73,500
Catch Basin, all types	EA	3,500	12	$42,000
Outfall Improvements	EA	10,000	1	$10,000
Demo pipe	LF	78	200	$15,507
Pipe Unit Cost				
HDPE Pipeline w/asphalt resurfacing (12", 10-15' deep)	FT	170	940	$159,800
HDPE Pipeline w/asphalt resurfacing (18", 5-10' deep)	FT	210	130	$27,300
HDPE Pipeline w/asphalt resurfacing (24", 5-10' deep)	FT	300	610	$183,000
HDPE Inlet Lead (12", 2-5' deep)	FT	100	210	$21,032
Project Sub-Total				$552,000
Contingencies and Multipliers				
Mobilization	LS	10%		$55,200
Erosion and Sediment Control	LS	3%		$16,560
Contingency	LS	30%		$165,600
Traffic Control/Utility Relocation	LS	5%		$27,600
Capital Expense Total (including contingency)				$817,000
Design/Construction Administration (%)	LS	5%		$40,850
Engineering and Permitting (%)	LS	30%		$245,100
			TOTAL	$1,103,000

SC-4 – Keys Road Storm Improvements				

Key Project Elements

- Install new outfall
- Install 5 new manholes
- Install approx. 280 LF of 24" HDPE pipe
- Install approx. 700 LF of 18" HDPE pipe
- Install 8 new catch basins with associated inlet lead lines
- Abandon 3 culverts

Design Assumptions

- CP assumes alignments will be installed in roadway right-of-way and repaved upon completion.
- A detailed survey of existing culverts, other utilities, and roadway elevations should be completed prior to final design.
- Dewatering not included in cost estimates.

Item	Unit	Unit Cost (2021)	Quantity	Total Cost
General				
Construction Access	LS	10,000	1	$10,000
Structure Installation				
Precast Concrete Manhole (48", 0-8' deep)	EA	4,900	5	$24,500
Catch Basin, all types	EA	3,500	8	$28,000
Outfall Improvements	EA	10,000	1	$10,000
Pipe Unit Cost				
HDPE Pipeline w/asphalt resurfacing (18", 5-10' deep)	FT	210	700	$147,000
HDPE Pipeline w/asphalt resurfacing (24", 5-10' deep)	FT	300	280	$84,000
HDPE Inlet Lead (12", 2-5' deep)	FT	100	140	$14,021
Project Sub-Total				$318,000
Contingencies and Multipliers				
Mobilization	LS	10%		$31,800
Erosion and Sediment Control	LS	3%		$9,540
Contingency	LS	30%		$95,400
Traffic Control/Utility Relocation	LS	10%		$31,800
Capital Expense Total (including contingency)				$487,000
Design/Construction Administration (%)	LS	5%		$24,350
Engineering and Permitting (%)	LS	30%		$146,100
			TOTAL	$657,000

SC-5 Phase 1 – EJ Smith Storm Improvements

Key Project Elements

- Install 5 new manholes
- Install 10 new catch basins and associated pipe for inlets
- Install a new outfall to the west side of S. Scappoose Creek
- Install approx. 790 LF of 18” HDPE pipe
- Install approx. 270 LF of 24” HDPE pipe
- Install approx. 660 LF of 30” HDPE pipe

Design Assumptions

- CP developed assuming alignments will be installed in roadway right-of-way and repaved upon completion.
- Easement and property acquisition not evaluated in cost estimate.
- A detailed survey of existing culverts, other utilities, and roadway elevations should be completed prior to final design.
- Dewatering not included in cost estimates.

Item	Unit	Unit Cost (2021)	Quantity	Total Cost
General				
Construction Access	LS	10,000	1	$10,000
Structure Installation				
Precast Concrete Manhole (48", 0-8' deep)	EA	4,900	5	$24,500
Outfall Improvements	EA	10,000	1	$10,000
Catch Basin, all types	EA	3,500	10	$35,000
Pipe Unit Cost				
HDPE Pipeline w/asphalt resurfacing (18", 5-10' deep)	FT	210	790	$165,900
HDPE Pipeline w/asphalt resurfacing (24", 5-10' deep)	FT	300	270	$81,000
HDPE Pipeline w/asphalt resurfacing (36", 5-10' deep)	FT	440	660	$290,400
HDPE Inlet Lead (12", 2-5' deep)	FT	100	175	$17,527
Project Sub-Total				$634,000
Contingencies and Multipliers				
Mobilization	LS	10%		$63,400
Erosion and Sediment Control	LS	3%		$19,020
Contingency	LS	30%		$190,200
Traffic Control/Utility Relocation	LS	5%		$31,700
Capital Expense Total (including contingency)				$938,000
Design/Construction Administration (%)	LS	5%		$46,900
Engineering and Permitting (%)	LS	30%		$281,400
			TOTAL	$1,266,000

SC-5 Phase 2 – EJ Smith Storm Regional Facility

Key Project Elements

• Construct a regional water quality south of EJ Smith just upstream of outfall to S. Scappoose Creek [tax lot 3N2W12BD 600] or other available land (approx. footprint area of 71,000 sf).

Design Assumptions

- Easement and property acquisition not evaluated in cost estimate.
- A detailed survey of existing culverts, other utilities, and roadway elevations should be completed prior to final design.
- Dewatering not included in cost estimates.

Item	Unit	Unit Cost (2021)	Quantity	Total Cost
General				
Construction Access	LS	10,000	1	$10,000
Earthwork				
General Earthwork/Excavation	CY	26	7890	$208,845
Clear and Grub brush including stumps	AC	8,900	0.5	$4,450
Amended Soils and Mulch	CY	65	5260	$339,869
Energy dissapation pad - Rip-Rap, Class 50	CY	92	5	$458
Drain Rock	CY	102	876	$89,620
Water Quality Facility Installation				
Outflow Control Structure	EA	6,700	1	$6,700
Facility Inlet Structure	EA	5,000	1	$5,000
Water Quality Facility Plantings with Trees	SF	6	69400	$448,421
Restoration/Resurfacing				
Non-Water Quality Facility Landscaping	AC	16,800	1	$16,800
4-foot Chain Link Fence	LF	24	1100	$26,061
Project Sub-Total				$1,156,000
Contingencies and Multipliers				
Mobilization	LS	10%		$115,600
Erosion and Sediment Control	LS	3%		$34,680
Contingency	LS	30%		$346,800
Traffic Control/Utility Relocation	LS	5%		$57,800
Capital Expense Total (including contingency)				$1,711,000
Design/Construction Administration (%)	LS	5%		$85,550
Engineering and Permitting (%)	LS	30%		$513,300
			TOTAL	$2,310,000

Appendix F: Capital Project Narrative Summaries

Project ID/ Name	JC-1 – Elm Street Storm Improvements
Project Opportunity Area Location ID	3
Objective Addressed	System Capacity
Contributing Drainage Area	70.4 acres
Statement of Need	• City staff observe roadway flooding and catch basins that do not drain. • Future development flows are anticipated to exacerbate flooding, and limited detention is provided upstream. • Capacity deficiencies confirmed by hydraulic model. • Identified as a project need per the 1998 SMP.
Project Description	• Upsize existing infrastructure to increase system capacity: • Remove and replace SD0048, SD0047, and SD0049; approx. 400 LF of existing 24" pipe with 30" HDPE pipe. • Remove and replace SD0808, SD0809, SD0104, SD0105, SD0106, SD0107, and SD0108; approx. 1,860 LF of existing 24" pipe with 42" HDPE pipe. • Outfall replacement • Remove and replace ten (10) manholes: PND07_MH10, PND07_MH09, PND07_MH08, PND07_MH27, PND07_MH33, PND07_MH11, PND07_MH16, PND07_MH17, PND07_MH18 and PND07_MH19.
Estimated Total Project Cost	$2.703M
Design Consideration	• Capital Project (CP) sized for 25-year, 24-hour storm, future land use conditions. • CP sizing assumes HDPE with roughness coefficient of 0.013 (per Design Standards). • Outfall location and invert elevation remains unchanged. • Junction invert depths for CP were modeled to meet minimum cover requirements (30" of cover for paved areas). • CP assumes alignments will be installed in roadway right-of-way and repaved upon completion. • Minimum cover requirements prioritized over minimum slope requirements. • A detailed survey of existing infrastructure, other utilities, and roadway elevations should be completed prior to design. • Dewatering not included in cost estimate. • Easement and property acquisition not included in cost estimate. • 2016 Scappoose Transportation System Plan: Volume 1 identified several Projects in the area: I12, W16, B18, and D14. Proposed new sidewalk along Elm from 3rd street to east UGB (medium), roadway improvements along Elm from 6th street to UGB ("aspirational"). Potential opportunity for overlap with CP.

Project ID/ Name	JC-2 – High School Way Storm Improvements
Project Opportunity Area Location ID	4
Objective Addressed	System Capacity, Water Quality
Contributing Drainage Area	24.2 acres
Statement of Need	• City staff observe roadway flooding at SE High School Way and 5th due to existing roadside ditch with no clear outlet. • Deficient, unregistered UIC upstream of problem area at SE 5th Street and SE Vine Street contributes to flooding. • Limited collection, disposal and conveyance infrastructure results in standing water.
Project Description	• Remove and replace unregistered UIC at northwest corner of SE 5th Street and SE Vine Street. Install two (2) sumped catch basins to serve as pretreatment upstream of the UIC. Install lateral lines to connect pretreatment catch basins to UIC. • Install approx. 50 LF of 24” HDPE culvert crossing SE 5th Street on the north side of SE High School way to connect roadside ditches.
Estimated Total Project Cost	$91,000
Design Considerations	• Capital Project (CP) sized for 25-year, 24-hour storm, future land use conditions. • CP sizing assumes HDPE with roughness coefficient of 0.013 (per Design Standards). • Junction invert depths for CP were modeled to meet minimum cover requirements (30” of cover for paved areas). • CP assumes alignments will be installed in roadway right-of-way and repaved upon completion. • A detailed survey of existing utilities and roadway elevations should be completed prior to design. • Dewatering not included in cost estimate. • Easement and property acquisition not included in cost estimate.2016 Scappoose Transportation System Plan: Volume 1 identifies multiple projects in the area between SE High School Way and SE Vine Street along SE 5th Street. Potential opportunity for overlap with CP.

Project ID/ Name	JC-3 – E Columbia Ave Storm Improvements
Project Opportunity Area Location ID	23
Objective Addressed	System Capacity, Infrastructure Need
Contributing Drainage Area	99.2 acres
Statement of Need	• City staff observes that the existing pipe along E Columbia to be undersized. The area north of Columbia and west of Bird Road lacks storm drainage infrastructure. • Capacity deficiency confirmed by hydraulic model. • Significant future development in the area is anticipated potentially resulting in higher flows. • High groundwater prevents use of UICs in the eastern portion of the pipe alignment.

Project Description	**Phase 1**
	• Upsize Existing Pipes in E Columbia Ave from outfall to Miller Road:
	    • Remove and replace pipes SD0182, SD0181, and SD0180; approx. 980 total LF of existing 24" HDPE pipe with 54" HDPE pipe.
	    • Remove and replace three (3) manholes; D04_MH05, D04_MH04, and D04_MH03.
	    • Replace existing outfall.
	• Conduct geotechnical investigation and infiltration testing to determine feasibility of UIC installation in north-western portion of catchment area, west of North Road.
	Phase 2
	• Upsize Existing Pipes in E Columbia Ave:
	    • Remove and replace pipes SD0179, SD0857, SD0858, and SD0849; approx. 1,060 LF of existing 24" HDPE and CPP pipe with 54" HDPE pipe.
	    • Remove and replace four (4) manholes; D04_MH01, D04_MH10, D04_MH11, and D04_MH12.
	• Add/replace pipes along Bird Road:
	    • Remove and replace SD0850, SD0859, and SD0861; approx. 530 LF of existing 15" HDPE pipe with 30" HDPE pipe.
	    • Install approx. 210 LF of 30" HDPE pipe from structure D04_MH07 northeast along Bird Rd.
	    • Install approx. 600 LF of 24" HDPE pipe along Bird Rd.
	    • Remove and replace three (3) manholes; D04_MH09, D04_MH06, and D04_MH07.
	    • Install three (3) new manholes.
	    • Install six (6) new catch basins (CBs) and associated inlet leads.
	Phase 3
	• Install new pipe up E Columbia Ave to North Road:
	    • Install approx. 310 LF of 36" HDPE pipe and approx. 420 LF of 30" HDPE along E Columbia Ave to extend from current upstream end of pipeline to the intersection with North Road.
	    • Install two (2) new manholes.
	    • Install four (4) new CBs and associated inlet pipe.
	• Install new pipe along North Road:
	    • Install approx. 360 LF of 30” HDPE pipe and approx. 1,000 LF of 24” HDPE pipe along North Road from intersection with Columbia.
	    • Install four (4) new manholes.
	    • Install eight (8) new CBs and associated inlet pipe.
	Phase 4
	• Install new pipe up Columbia from North Road to 4th Street:
	    • Install approx. 365 LF of 18" HDPE pipe and approx. 800 LF of 12" HDPE pipe along E Columbia Ave to extend from North Road to end at 4th Street.
	    • Install three (3) new manholes.
	    • Install six (6) new CBs and associated inlet pipe.

Project ID/ Name	JC-3 – E Columbia Ave Storm Improvements
Estimated Total Project Cost	Phase 1: $1.793M Phase 2: $2.810M Phase 3: $1.556M Phase 4: $479,000 **Total Combined Project Cost: $6.64M**
Design Considerations	• Investigation into UIC feasibility in the area west of North Road is suggested during Phase 1 (lump sum cost for infiltration testing assumed). If UICs are feasible in this area, Phase 4 may not be necessary, with UICs installed to capture flow. Installation of UICs may also reduce flows to the pipes installed in Phases 1-3. Pipe sizing and cost estimation assumes that no reduction in flows from UICs is achieved. • CP sized for 25-year, 24-hour storm, future land use conditions. • CP sizing assumes HDPE with roughness coefficient of 0.013 (per Design Standards). • Junction invert depths for CP were modeled to meet minimum cover requirements (30" of cover for paved areas). • CP assumes alignments will be installed in roadway right-of-way and repaved upon completion. • CP developed with proposed manhole spacing meeting the requirement of 500 LF. • CP replacement pipes match existing pipe slopes, and as such do not meet minimum slope design requirement of 1%. • City GIS shows that sanitary mains along E Columbia Ave are at lower elevations than the proposed storm system. Potential conflicts with the sanitary system are assumed to be limited to sanitary laterals. Any cost implications of potential conflicts are assumed covered by contingency. • A detailed survey of existing culverts, other utilities, and roadway elevations should be completed prior to design. • Dewatering not included in cost estimate. • Easement and property acquisition not included in cost estimate. • 2016 Scappoose Transportation System Plan: Volume 1 identifies a proposed sidewalk along Columbia Ave from 4th Street to the eastern UGB, and a new intersection at 4th Street. (Project #W33). Improvement package classified as "Aspirational". Potential opportunity for overlap with CP.

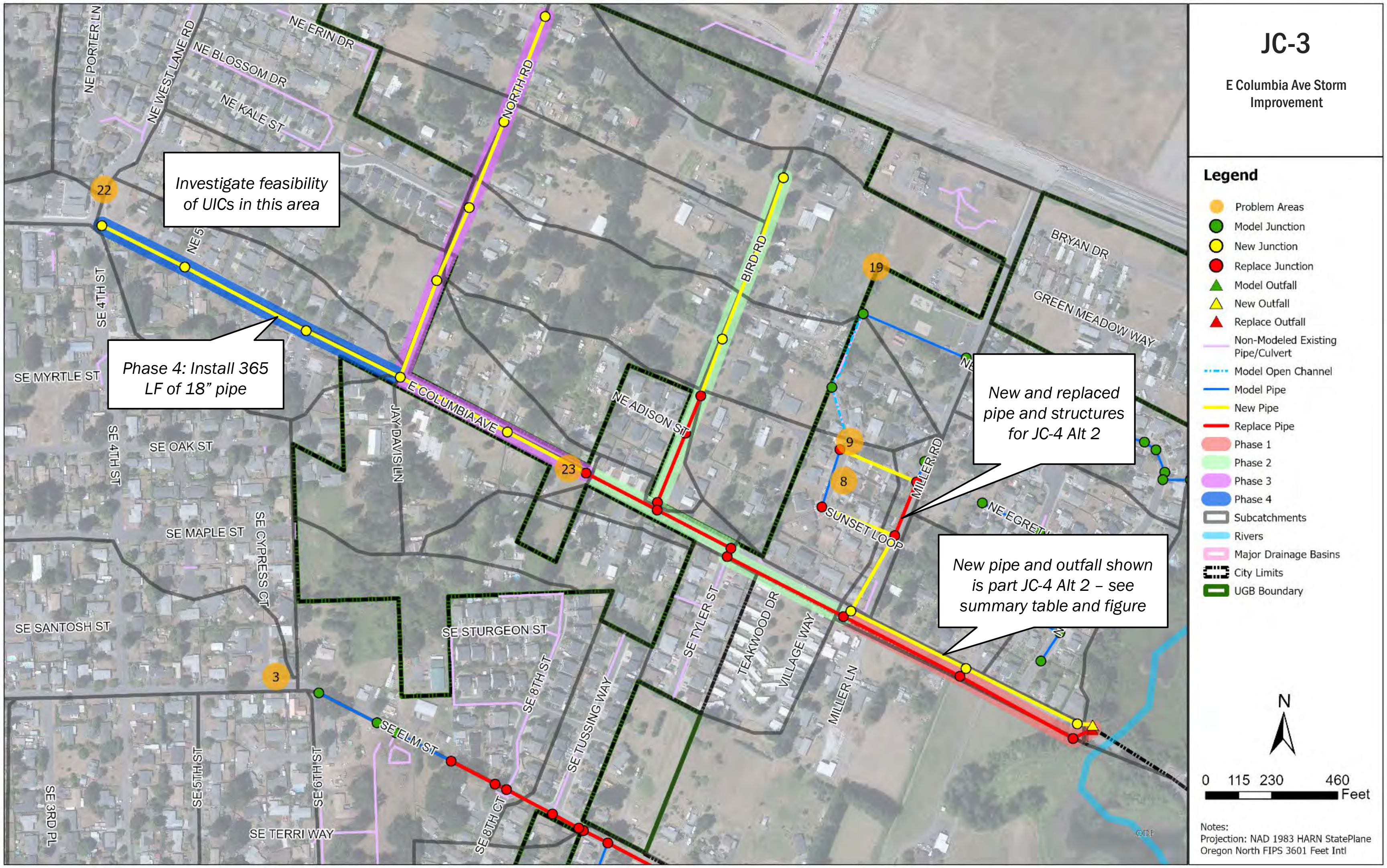


Figure 1. JC-3: E Columbia Ave Storm Improvements

Project ID/ Name	JC-4 Alt 1 – Sunset Loop Storm Improvements Alternative #1
Project Opportunity Area Location ID	8 and 9
Objective Addressed	System Capacity, Maintenance, Water Quality
Contributing Drainage Area	8.9 acres
Statement of Need	• City staff observe localized flooding of NE Sunset Loop, private property, walking paths and driveways that extends to Miller Park. • Deficient/failing UICs that may be contribute to flooding (UIC numbers 3 and 4 report standing water, UIC 50 is reported to have standing water).
Project Description	CP developed to infiltrate runoff from the NE Sunset Loop roadway, sidewalk, residential driveways, and the roofs of surrounding homes that drain onto the road via weephole connections to minimize flooding. • Remove 37,440 SF of existing impervious pavement on NE Sunset Loop and existing subgrade. • Excavate approx. 2,080 CY of additional material for new additional base drain rock. • Install 37,440 SF of porous pavement ODOT F-mix over a 24-inch deep open-graded base rock layer (approx. 2,775 CY). • Remove two (2) existing catch basins: DW04_CB02 and DW04_CB03. • Remove SD0485, approx. 210 LF of existing 6" PVC.
Estimated Total Project Cost	$898,000
Design Considerations	• Capital Project (CP) sized for 25-year, 24-hour storm, future land use conditions. • Use of porous pavement on public streets must be approved by the City Engineer and Public Works Director. • Impervious surface replacement with porous pavement 1:1 ratio. • Depth of base rock layer meets the minimum depth requirement of 12 inches. • Cost estimation and quantities of excavation assume that the pavement removal will include 6" excavation depth. All excavation in the cost estimate is assumed in addition to this 6" depth. • Standards currently only allows for intercepting rainfall directly and not receiving stormwater runoff from other areas – inclusion of the surrounding rooftops and driveways will require approval by the City. Design of CP assumes infiltrating surrounding rooftops runoff via weephole connections. • Slopes in surrounding area are <5% with Type B soils – underdrain system not needed. • Model confirmed that CP is not within the 100-year floodplain. • CP designed with a gravel void ratio of 0.4 (standard soil without high amounts of silt or clay). • Historical service life of F-mix porous asphalt is 11-14 year, with an estimated design life is 16 years (data from 2011 ODOT Report Number FHWA-OR-RD-17). • CP designed with drain rock capable of holding full runoff volume of 25-year storm from roadway, surrounding sidewalks, rooftops, and driveways. • CP assumes that street sweeping will be conducted on Sunset Loop with regularity. Street Sweeping is an important O&M practice for porous pavement. • A detailed survey of existing infrastructure, other utilities, and roadway elevations should be completed prior to design. • Dewatering not included in cost estimate. • Easement and property acquisition not included in cost estimate. • 2016 Scappoose Transportation System Plan: Volume 1 identified Project W22 on Miller Rd to complete sidewalk system between E. Columbia Ave. and Crown Zellerbach Rd. Improvement package classified as "Aspirational". Potential opportunity for overlap with CP.

Figure 2. JC-4-Alt 1: Sunset Loop Storm Improvements Alternative #1

Project ID/ Name	JC-4 Alt 2 – Sunset Loop Storm Improvements Alternative #2
Project Opportunity Area Location ID	8 and 9
Objective Addressed	System Capacity, Maintenance
Contributing Drainage Area	8.9 acres
Statement of Need	• City staff observe localized flooding of NE Sunset Loop, private property, walking paths and driveways that extends to Miller Park. • Deficient/failing UICs that may be contribute to flooding (UIC numbers 3 and 4 report standing water, UIC 50 is reported to have standing water).
Project Description	Reconfigure Sunset Loop conveyance infrastructure and add parallel pipe down Columbia: • Install approx. 935 LF of 24" HDPE pipe along E Columbia Ave., parallel to existing/replaced storm pipe. • Install approx. 330 LF of 24" HDPE pipe along Miller Rd from new parallel Columbia pipe to existing structure DW03_CB02. • Install approx. 270 LF of 22" HDPE pipe on Sunset Loop between structures DW04_CB02 and DW03_CB02. • Install approx. 290 LF of 18" HDPE pipe on Sunset Loop between structures DW04_CB03 and DW03_CB01. • Remove and replace pipe SD0484; approx. 200 LF of existing 6" PVC pipe with 22" HDPE pipe. • Remove and replace four (4) failing open-bottom catch basin structures DW03_CB01, DW03_CB012, DW04_CB02, and DW04_CB03 with standard catch basins. • Install three (3) new manholes. • Install outfall parallel to existing outfall on north side of E. Columbia Ave.
Estimated Total Project Cost	$1.249M
Design Considerations	• Capital Project (CP) sized for 25-year, 24-hour storm, future land use conditions. • CP sizing assumes HDPE with roughness coefficient of 0.013 (per Design Standards). • CP assumes alignments will be installed in roadway right-of-way and repaved upon completion. • CP developed with proposed manhole spacing meeting the requirement of 500 LF. • CP design prioritizes pipe cover and invert elevation constraints over minimum slope requirements. • City GIS shows that sanitary mains along E Columbia Ave are at lower elevations than the proposed storm system. Potential conflicts with the sanitary system are assumed to be limited to sanitary laterals. Any cost implications of potential conflicts are assumed covered by contingency. • Construction of this CP to occur concurrently with JC-3 Phase 1 – E. Columbia Ave. Storm Improvements. Estimated costs do not account for potential cost savings resulting from concurrent construction. • A detailed survey of existing culverts, other utilities, and roadway elevations should be completed prior to design. • Dewatering not included in cost estimate. • Easement and property acquisition not included in cost estimate. • 2016 Scappoose Transportation System Plan: Volume 1 identifies a proposed sidewalk along Columbia Ave from 4th Street to the eastern UGB, and a new intersection at 4th Street. (Project #W33). Improvement package classified as “Aspirational”. Potential opportunity for overlap with CP. • 2016 Scappoose Transportation System Plan: Volume 1 identified Project W22 on Miller Rd to complete sidewalk system between E. Columbia Ave. and Crown Zellerbach Rd. Improvement package classified as “Aspirational”. Potential opportunity for overlap with CP.

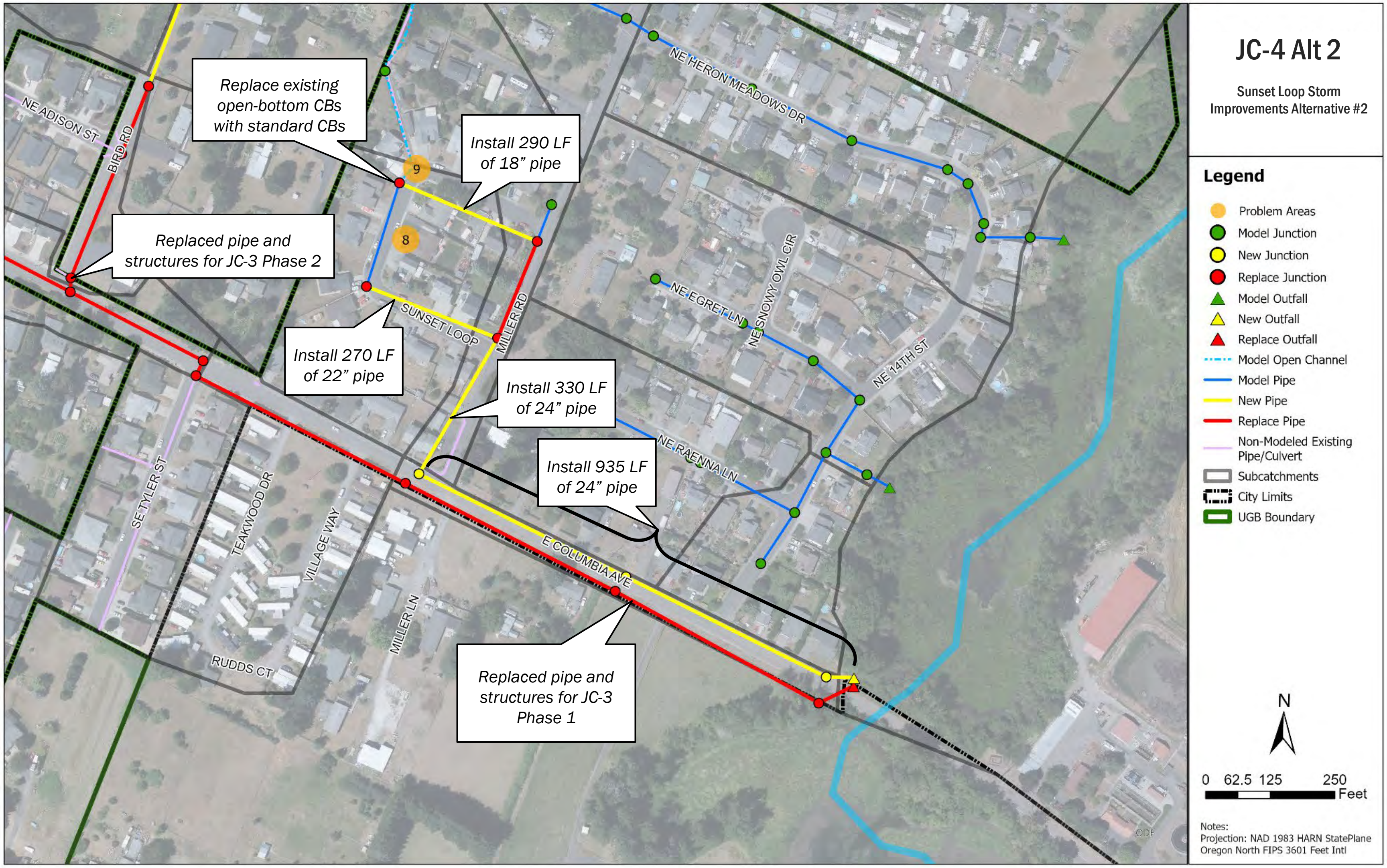


Figure 3. JC-4 Alt 2: Sunset Loop Storm Improvements Alternative #2

Project ID/ Name	JC-5 – 6th and Vine UIC Replacement
Project Opportunity Area Location ID	1
Objective Addressed	Water Quality
Contributing Drainage Area	19.3 acres
Statement of Need	• City staff observe poor drywell performance - failing UICs, and roadway flooding. • UICs need to be retrofitted or replaced. • UICs are non-standard open bottom catch basins requiring significant maintenance or replacement to operate properly. • UICs do not have pretreatment.
Project Description	• Retrofit one (1) existing bottomless CB at southwest corner of intersection. Replace the CB with a sumped CB as a pretreatment structure. • Install one (1) sumped CB as a pretreatment structure at northeast corner of intersection. • Install one (1) new UIC at center of intersection.
Estimated Total Project Cost	$65,000
Design Considerations	• Project is not SDC eligible as it is an existing regulatory issue. • A detailed survey of existing utilities and roadway elevations should be completed prior to design. • Dewatering not included in cost estimate. • Easement and property acquisition not included in cost estimate. • 2016 Scappoose Transportation System Plan: Volume 1 identifies proposed roadway and sidewalk improvements for SE Vine Street from SE Grant Watts Street to SE 6th St and along SE 6th Street between SE Vine Street and SE Elm Street (Project #s W14, W17). Potential opportunity for project overlap with CP.

Project ID/ Name	JW-1 - Dutch Canyon System Improvements
Project Opportunity Area Location ID	28
Objective Addressed	System Capacity, Infrastructure Need
Contributing Drainage Area	142.4 acres
Statement of Need	• Development has put capacity pressures on existing linear infiltration facility (currently serving all phases of development). Facility is to be rebuilt as condition of Phase IV development, to meet original design performance. • Unknown drainage patterns contribute to roadway flooding on Dutch Canyon Road. • Additional development is anticipated for Phase IV of the Callahan-Dutch Canyon area and between Highway 30 and SW Old Portland Road. • Lack of storm infrastructure along SW Old Portland Road south of SW Callahan Road.
Project Description	**Phase 1** – Install new storm pipe along SW Old Portland Road. • Install a new overflow structure in the existing infiltration facility leading to the proposed 36" pipe in Old Portland Road. • Install approx. 1700 LF of 36" HDPE pipe along SW Old Portland Road. • Install four (4) new manholes • Install eight (8) new CBs and associated inlet pipe. • Install new outfall to the north bank of Jackson Creek, west of Highway 30. **Phase 2 –** Install new culvert crossing Dutch Canyon Road. • Install approx. 75 LF of 24" HDPE culvert across Dutch Canyon Road at low point adjacent to existing wetland. • Install a new overflow structure in the existing wetland leading to the proposed 24" culvert across Dutch Canyon Road.
Estimated Total Project Cost	Phase 1 = $1.614M Phase 2 = $105,000
Design Considerations	• Capital Project (CP) sized for 25-year, 24-hour storm, future land use conditions. • CP sizing assumes HDPE with roughness coefficient of 0.013 (per Design Standards). • Junction invert depths for CP were modeled to meet minimum cover requirements (30" of cover for paved areas). • CP developed assuming alignments will be installed in roadway right-of-way and repaved upon completion. • For Phase 2, 24" culvert size assumed based on preliminary assessment. Detailed modeling should be conducted prior to design. • Subcatchments to be developed for Phase IV assumed to be routed south, via existing conveyance infrastructure, to the infiltration facility. • Land-use condition assumed Low-Density Residential (40% impervious) for all future development in the Callahan-Dutch Canyon area and along SW Old Portland Road. • A detailed survey of existing utilities and roadway elevations should be completed prior to design. • Dewatering not included in cost estimate. • Easement and property acquisition not included in cost estimate. • 2016 Scappoose Transportation System Plan: Volume 1 identifies proposed roadway and sidewalk improvements for SW Old Portland Road between Jenny Lane and Highway 30 (Project #s D23, W1). Potential opportunity for overlap with CP.

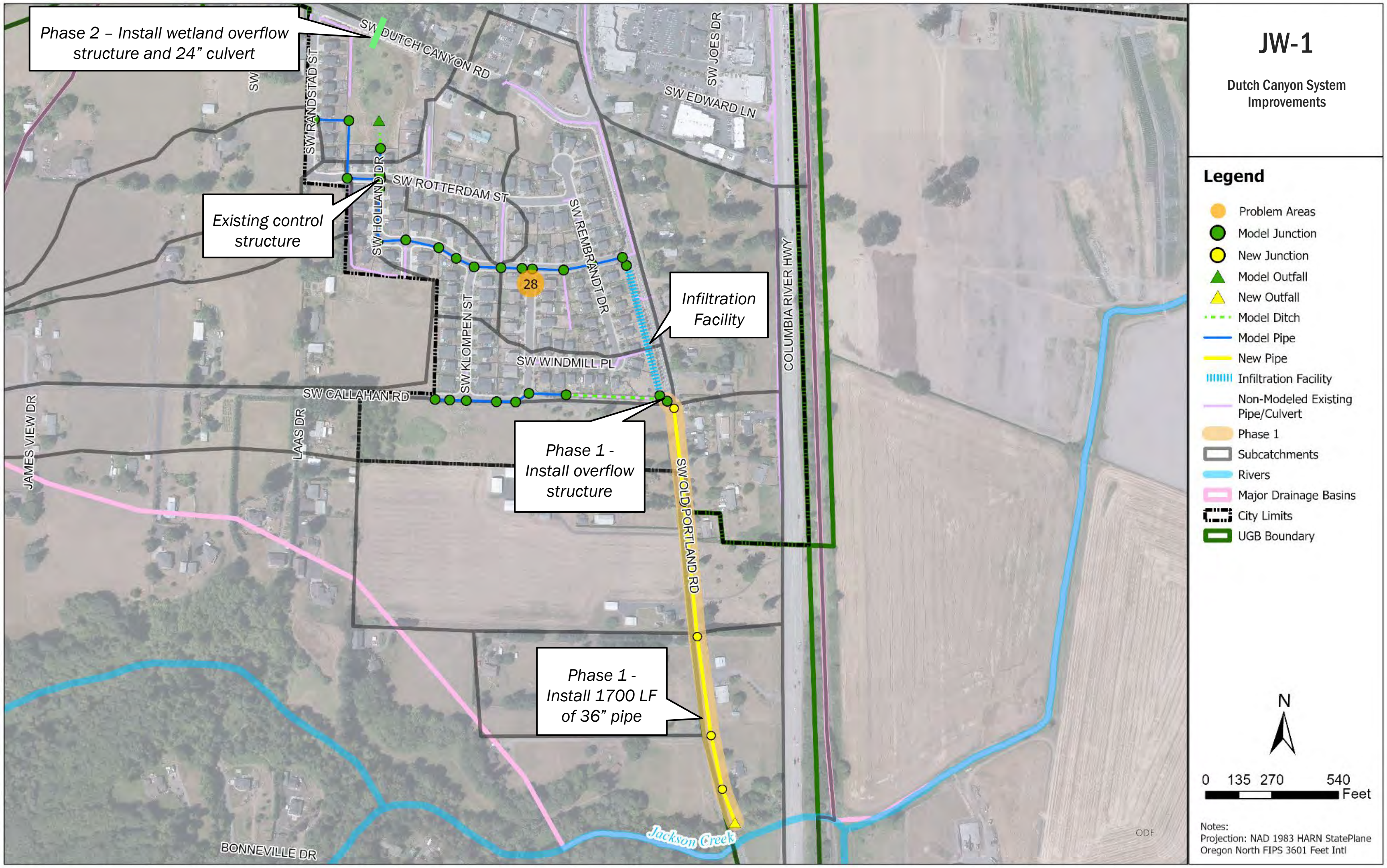


Figure 1. JW-1: Dutch Canyon System Improvements

Project ID/ Name	SC-1 – NW 1st Street Storm Improvements
Project Opportunity Area Location ID	6
Objective Addressed	System Capacity
Contributing Drainage Area	14.8 acres
Statement of Need	• City staff report that the existing 12” and 15” pipe on NW 1st Street and NW EJ Smith Road to the outfall into S. Scappoose Creek is undersized. • Capacity deficiencies were confirmed by model results. • Future development flows are anticipated to exacerbate flooding.

Project Description	• Upsize existing infrastructure to increase system capacity to meet design standards:
	  • Remove and replace SD0460; approx. 190 LF of existing 12” pipe with 18" HDPE pipe.
	  • Remove and replace SD0461, SD0462, SD0463, and SD0464; approx. 980 LF of existing 15” pipe with 18" HDPE pipe.
	  • Remove and replace SD0465 and SD0466; approx. 1,040 LF of existing 15” pipe with 24" HDPE pipe.
	• Remove and replace seven (7) manholes: SSC17_F07, SSC17_F06, SSC17_F05, SSC17_F04, SSC17_F03, SSC17_F02, and SSC17_F01.

Estimated Total Project Cost	$1.617M
Design Considerations	• Surface facilities/green streets are not recommended due to heavy traffic. • Urban Renewal plan may result in updates to the roadway that should be considered with design. • Assumed ground surface and rim elevations would remain unchanged. • Capital project (CP) sized for 25-year, 24-hour storm, future land use conditions. • CP sizing assumes HDPE with roughness coefficient of 0.013 (per Design Standards). • Outfall location and invert elevation remains unchanged. • Junction invert depths for CP were modeled to meet minimum cover requirements (30” of cover for paved areas). • CP assumes alignments will be installed in roadway right-of-way and repaved upon completion. • Minimum cover requirements prioritized over minimum slope requirements. • A detailed survey of existing culverts, other utilities, and roadway elevations should be completed prior to design. • Dewatering not included in cost estimate. • Easement and property acquisition not included in cost estimate. • 2016 Scappoose Transportation System Plan: Volume 1 identified several Projects # I11 - Proposed new curb alignment at corner of 1st and JP West (high). Potential opportunity for CP overlap.

Project ID/ Name	SC-2 – JP West Rd Storm Improvements - East
Project Opportunity Area Location ID	18a
Objective Addressed	Infrastructure Need
Contributing Drainage Area	8.3 acres
Statement of Need	• Lack of storm drainage infrastructure along SW JP West Road between Hwy 30 and South Scappoose Creek. • Future development of the area anticipated and will increase existing flows. • Identified as a project need per the 1998 SMP.
Project Description	• Install approx. 845 LF of 18" HDPE pipe. • Install four (4) new manholes. • Install a new outfall on the east bank of S. Scappoose Creek. • Install eight (8) new catch basins and associated inlet pipes.
Estimated Total Project Cost	$517,000
Design Considerations	• Capital project (CP) sized for 25-year, 24-hour storm, future land use conditions. • CP sizing assumes HDPE with roughness coefficient of 0.013 (per Design Standards). • Junction invert depths for CP were modeled to meet minimum cover requirements (30" of cover for paved areas). • CP assumes alignments will be installed in roadway right-of-way and repaved upon completion. • CP developed with proposed manhole spacing meeting the requirement of 500 LF. Proposed pipes are within velocity and slope requirements per draft Design Standards. • A detailed survey of existing culverts, other utilities, and roadway elevations should be completed prior to design. • Dewatering not included in cost estimate. • Easement and property acquisition not included in cost estimate. • 2016 Scappoose Transportation System Plan: Volume 1 identifies a proposed sidewalk along JP West Road from NW 2nd Street to NW 4th Street (Project # W9). Potential opportunity for overlap with CP.

Project ID/ Name	SC-3 – JP West Rd Storm Improvements – West
Project Opportunity Area Location ID	18b
Objective Addressed	Infrastructure Need, System Capacity
Contributing Drainage Area	20.0 acres
Statement of Need	• Lack of storm drainage infrastructure between Keys Road and South Scappoose Creek. • Future development along Keys Rd anticipated resulting in potential increased flows. • Capacity deficiencies identified by hydraulic model.

Project Description	• Improve storm drain conveyance along JP West Road through piping of roadside ditches, construction of a new outfall, and replacement of existing pipe.
	  • Install new outfall on the west bank of South Scappoose Creek.
	  • Replace existing outfall SSC15 with a new manhole in the ROW.
	  • Install approx. 80 LF of 24" HDPE pipe from structure SSC15 to new outfall.
	  • Install approx. 530 LF of 24" HDPE pipe from existing structure SSC15_D04 to replaced structure SSC15 to redirect flow from existing roadside ditches SD0717, SD0697 and SD0699 and culverts SD0718 and SD0698.
	  • Abandon culverts SD0718 and SD0698.
	  • Remove and replace SD0702; approx. 40 LF of existing 12" pipe with 18" HDPE pipe.
	  • Install approx. 90 LF of 18" HDPE pipe between structures SSC15_D02 and SSC15_CB11 to redirect flow from existing unnamed roadside ditch.
	  • Remove and replace SD0187/SD0188; approx. 30 LF of existing double-barreled 8" CMP pipe with a single 12" HDPE pipe.
	  • Remove and replace SD0189; approx. 20 LF of existing 12" CMP pipe with 12" HDPE pipe.
	  • Replace or install eight (8) additional new manholes for above improvements (see figure below for placement).
	  • Install six (6) new catch basins, two per manhole and associated inlet leads adjacent to manholes (see figure below for placement)
	• Construct additional storm drain conveyance to extend piped conveyance to Keys Road in anticipation of future development.
	  • Install approx. 890 LF of 12" HDPE pipe along JP West Road from structure SSC15_CB10 to intersection with Keys Road.
	  • Install six (6) new manholes for new storm line to Keys Road.
	  • Install six (6) new catch basins (one catch basin for each manhole) along downhill side of road. Install associated inlet lead lines.

Estimated Total Project Cost	$1.103M
Design Considerations	• Capital Project (CP) sized for 25-year, 24-hour storm, future land use conditions. • CP sized assuming HDPE with roughness coefficient of 0.013 (per Design Standards). • Junction invert depths for CP were modeled to meet minimum cover requirements (30" of cover for paved areas). • CP assumes alignments will be installed in roadway right-of-way and repaved upon completion. • CP developed with proposed manhole spacing meeting the requirement of 500 LF. Proposed pipes are within velocity and slope requirements per draft Design Standards. • A detailed survey of existing culverts, other utilities, and roadway elevations should be completed prior to design. • Dewatering not included in cost estimate. • Easement and property acquisition not included in cost estimate. • 2016 Scappoose Transportation System Plan: Volume 1 identifies a proposed sidewalk along JP West Road from NW 4th Street to Keys Road (Project # W8). Potential opportunity for overlap with CP.

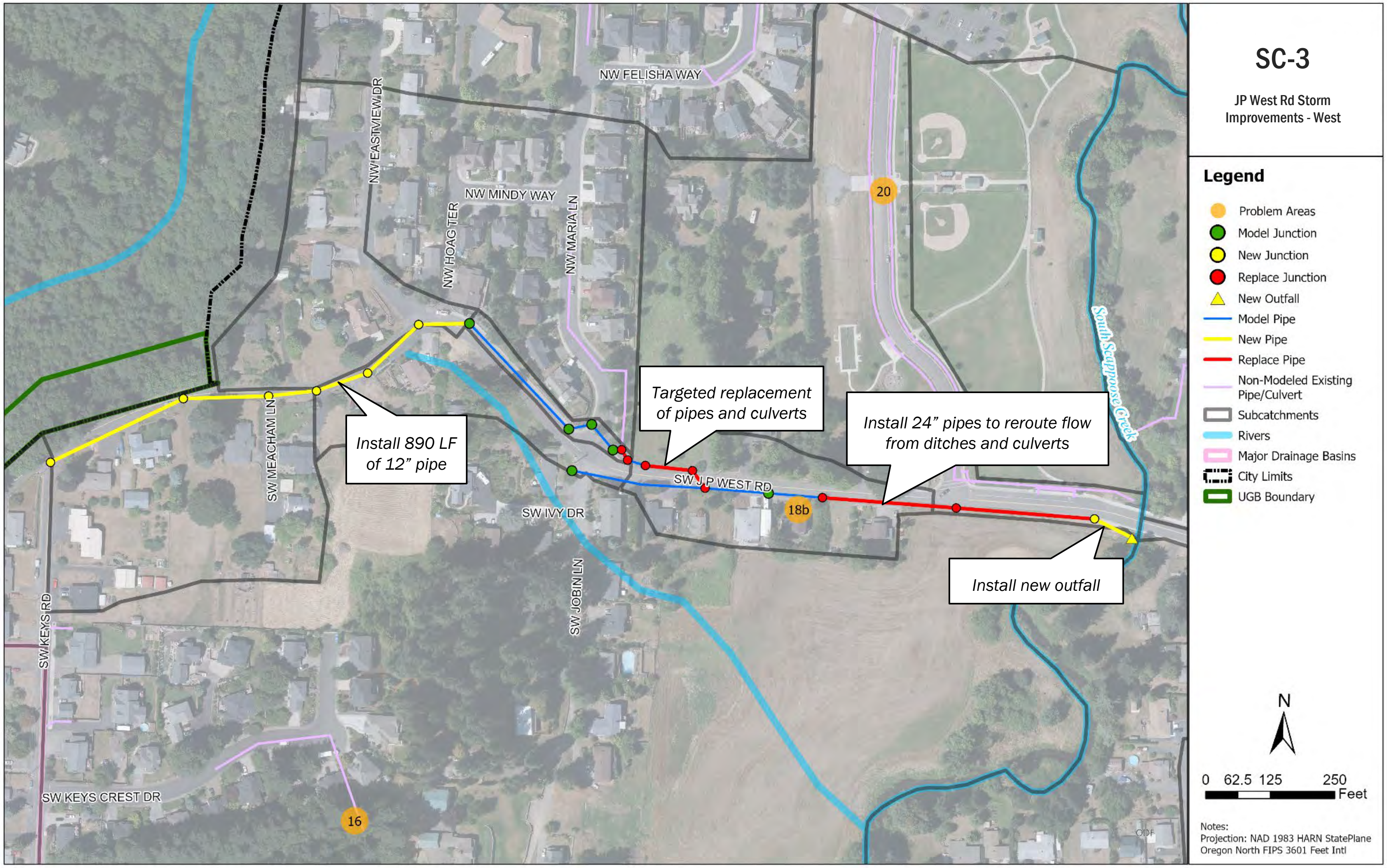


Figure 5. SC-3: JP West Rd Storm Improvements – West

Project ID/ Name	SC-4 – Keys Road Storm Improvements
Project Opportunity Area Location ID	29
Objective Addressed	System Capacity, Infrastructure Need
Contributing Drainage Area	36.7 acres
Statement of Need	• Lack of storm drainage infrastructure (primarily ditch conveyance down Keys Road, Huser Lane, and SW EM Watts Road). • Future development anticipated likely resulting in increased flows. • Capacity deficiencies identified by hydraulic model.
Project Description	• Improve storm drain conveyance along SW Keys Road and SW EM Watts Road West Road through piping of roadside ditches, construction of a new outfall, and replacement of existing pipes. • Install new outfall on the west bank of S. Scappoose Creek. • Install two (2) new manholes in SW EM Watts ROW – one each at intersections with SW Eggleston Lane and Boom Lane. • Install approx. 280 LF of 24” HDPE pipe from new manhole at Boom Lane to new outfall, to redirect flow from existing 18” CMP culvert SD0567and existing roadside ditch SD0591. • Install approx. 250 LF of 18” HDPE pipe from new manhole at SW Eggleston Lane to new manhole at Boom Lane, to redirect flow from existing 12” concrete culvert SD0566 and existing roadside ditches SD0588 and SD0590. • Install one (1) new manhole at existing structure SSC09_D10. • Install approx. 450 LF of 18” HDPE pipe from new manhole at SSC09_D10 to new manhole at SW Eggleston Lane, to redirect flow from existing roadside ditches SD0740and SD0588and existing culvert SD0743. • Install two (2) new manholes in SW Keys Road ROW. • Install eight (8) new catch basins (two adjacent to each new manhole). Install associated inlet lead lines. • Abandon culverts SD0567, SD0566, and SD0743.
Estimated Total Project Cost	$657,000
Design Considerations	• CP sized for 25-year, 24-hour storm, future land use conditions. • CP sized assuming HDPE with roughness coefficient of 0.013 (per Design Standards). • Junction invert depths for CP were modeled to meet minimum cover requirements (30” of cover for paved areas). • CP assumes alignments will be installed in roadway right-of-way and repaved upon completion. • CP developed with proposed manhole spacing meeting the requirement of 500 LF. Proposed pipes are within velocity and slope requirements per draft Design Standards. • A detailed survey of existing culverts, other utilities, and roadway elevations should be completed prior to design. • Dewatering not included in cost estimate. • Easement and property acquisition not included in cost estimate. • 2016 Scappoose Transportation System Plan: Volume 1 identifies a proposed sidewalk along EM Watts from SW 4th Street to Keys Road (Project #W6). Potential opportunity for overlap with CP.

Figure 6. SC-4: Keys Road Storm Improvements

Project ID/ Name	SC-5 – EJ Smith Storm Improvements and Regional Facility
Project Opportunity Area Location ID	31
Objective Addressed	Infrastructure Need, Water Quality
Contributing Drainage Area	53.4 acres
Statement of Need	• Lack of storm drainage infrastructure along EJ Smith Road and tie-ins for 5th, 6th, and 7th Street drainage results in localized flooding. • Future development of the area anticipated and will increase existing flows. • Potential regional water quality facility opportunity along EJ Smith Road.

Project Description	• **Phase 1** – CP developed for a storm drain system along EJ Smith Road to address lack of storm infrastructure and accommodate future development.
	  • Install five (5) new manholes.
	  • Install ten (10) new catch basins and associated inlet lead lines.
	  • Install a new outfall on the west bank of S. Scappoose Creek.
	  • Install approx. 790 LF of 18" HDPE pipe.
	  • Install approx. 270 LF of 24" HDPE pipe.
	  • Install approx. 660 LF of 30" HDPE pipe.
	• **Phase 2** – Construct a regional water quality south of EJ Smith just upstream of outfall to S. Scappoose Creek [tax lot 3N2W12BD 600] or other available land (approx. footprint area of 71,000 sf).

Estimated Total Project Cost	Phase 1 = $1.266M Phase 2 = $2.310M
Design Considerations	• Capital project (CP) sized for 25-year, 24-hour storm, future land use conditions. • CP sizing assumes HDPE with roughness coefficient of 0.013 (per Design Standards). • Junction invert depths for CP were modeled to meet minimum cover requirements (30" of cover for paved areas). • CP assumes alignments will be installed in roadway right-of-way and repaved upon completion. • CP developed with proposed manhole spacing meeting the requirement of 500 LF. Proposed pipes are within velocity and slope requirements per draft Design Standards. • Regional facility sized using 8% sizing factor per draft stormwater standards (assuming biofiltration with sideslope). Assumes 1' of storage depth. • A detailed survey of existing culverts, other utilities, regional facility, and roadway elevations should be completed prior to design. • Dewatering not included in cost estimate. • SDC eligible cost calculated with equal eligibility percentage for each phase. • Easement and property acquisition not included in cost estimate. • 2016 Scappoose Transportation System Plan: Volume 1 identifies a proposed sidewalk along EJ Smith Road from NW 1st Street to Bella Vista Drive (Project # W23) - noted as financially constrained. Potential opportunity for overlap with CP.

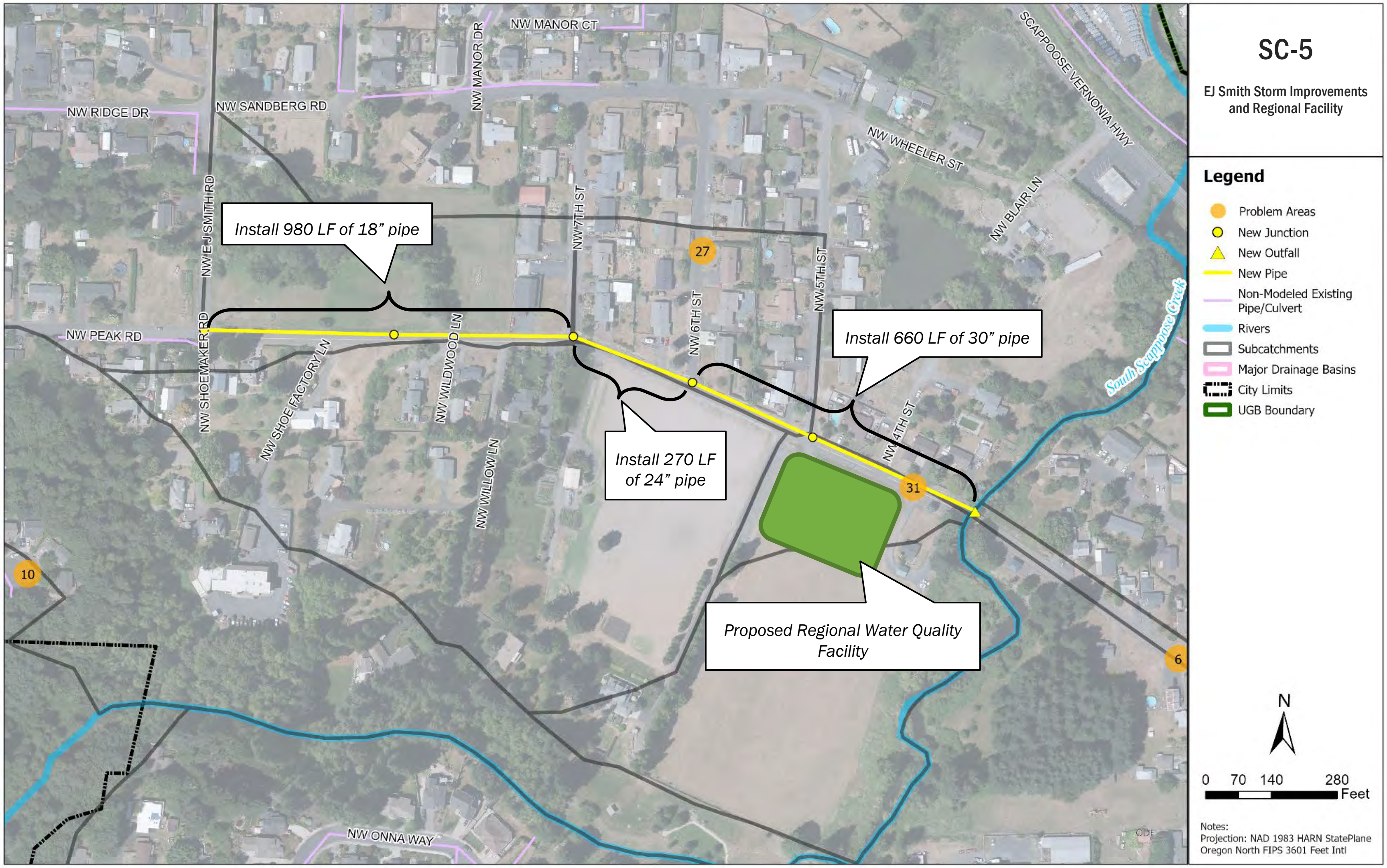


Figure 7. SC-5 – EJ Smith Storm Improvements and Regional Facility

Project ID/ Name	SC-6 – SW 4th Street Storm Improvements
Project Opportunity Area Location ID	2
Objective Addressed	System Capacity, System Condition
Contributing Drainage Area	30.4 acres
Statement of Need	• Localized flooding along 4th Avenue and Maple due to a non-functional area drain. • System is piped from middle school field up 4th to Day St, then west along Day St to outfall at the creek, but piping has no manholes, is currently plugged or failing. • Existing pipe is galvanized.
Project Description	• Remove and replace existing, failing storm pipe with approximately 980 LF of 30" HDPE pipe. • Install five (5) new manholes. • Install eight (8) new CBs and associated lateral pipe. It is assumed that CBs will be located at locations shown in the figure below at low areas adjacent to the roadway, as appropriate. • Remove and replace outfall to east side of S. Scappoose Creek.
Estimated Total Project Cost	$1.037M
Design Considerations	• Capital Project (CP) developed for 25-year, 24-hour storm, future land use conditions. • CP sized assuming HDPE with roughness coefficient of 0.013 (per Design Standards). • Junction invert depths for CP were modeled to meet minimum cover requirements (30" of cover for paved areas). • CP assumes alignments will be installed in roadway right-of-way and repaved upon completion. • CP developed with proposed manhole spacing meeting the requirement of 500 LF. Proposed pipes are within velocity and slope requirements per draft Design Standards. • A detailed survey of existing culverts, other utilities, and roadway elevations should be completed prior to design. • Dewatering not included in cost estimate. • Easement and property acquisition not included in cost estimate. • 2016 Scappoose Transportation System Plan: Volume 1 identifies a proposed sidewalk along SW Maple Street between Highway 30 and SW 4th Street (Project # W11). Potential opportunity for overlap with CP at west end of sidewalk project.

Appendix G: Project Scoring

Project No. [a]	Project/Program Name	Basin/ Waterbody	Location	Objectives	Estimated Cost [b]	SDC Eligible Cost [b]	Scoring Criteria									Final Project Priority		
							Addresses an Identified Capacity Problem	Provides Water Quality Benefits	Provides Maintenance Benefits	Requires Acquisition	SDC Funding Source	Permitting Complexity	Enhances Safety/Prevents Liability	Project Sequencing	Relative Cost per Drainage Area	High Priority	Medium Priority	Low Priority (Unfunded)
JC-1	Elm Street Storm Improvements	Jackson Creek	SE Elm St (SE Endicott Ln to Outfall)	• System capacity	$2,703,000	$574,000	1	1	1	2	2	3	2	1	3			X
JC-2	High School Way Storm Improvements	Jackson Creek	SE 5th/SE High School Wy	• System capacity • Water quality	$91,000	$ -	3	2	2	3	1	3	3	1	3	X		
JC-3–Phase 1	E. Columbia Ave Storm Improvements	Jackson Creek	E Columbia Ave (outfall to Miller Rd)	• System capacity • Infrastructure need	$1,793,000	$482,000	2	1	1	3	2	3	2	3	3	X		
JC-3–Phase 2			E Columbia Ave (Miller Road to Bird Road) and Bird Rd		$2,810,000	$763,000	2	1	1	3	2	3	2	2	3		X	
JC-3–Phase 3			E Columbia Ave (Bird Road to North Rd) and North Rd		$1,556,000	$347,000	2	1	1	3	2	3	2	2	3		X	
JC-3–Phase 4			E Columbia Ave (North Rd to 4th St)		$479,000	$128,000	2	1	1	3	2	3	2	1	3			X
JC-4–Alt1	Sunset Loop Storm Improvements Alternative #1	Jackson Creek	NE Sunset Lp	• System capacity • Maintenance • Water quality	$898,000	$ -	2	3	2	3	1	3	2	1	1		X	
JC-4–Alt2	Sunset Loop Storm Improvements Alternative #2	Jackson Creek	NE Sunset Lp	• System capacity • Maintenance	$1,249,000	$243,000	2	1	1	3	2	3	2	1	1	Not applicable–Alternative 1 is preferred.		
JC-5	6th and Vine UIC Replacement	Jackson Creek	SE 6th St/SE Vine St	• Water quality	$65,000	$ -	3	2	3	3	1	3	3	1	3	X		
JW-1–Phase 1	Dutch Canyon System Improvements	Jackson Creek West	Callahan-Dutch Canyon Area	• System capacity • Infrastructure need	$1,615,000	$1,615,000	2	1	2	2	3	1	2	1	3			X
JW-1–Phase 2					$105,000	$66,000	3	1	1	2	3	3	3	1	3	X		
SC-1	NW 1st Street Storm Improvements	S. Scappoose Creek	NW EJ Smith and NW 1st St	• System capacity	$1,617,000	$199,000	2	2	2	3	2	1	2	1	1			X
SC-2	JP West Rd Storm Improvements - East	S. Scappoose Creek	SW JP West Rd (S. Scappoose Creek east to SW 1st St)	• Infrastructure need	$517,000	$26,000	3	3	3	2	1	1	3	1	2	X		
SC-3[c]	JP West Rd Storm Improvements–West	S. Scappoose Creek	SW J.P. West Rd (S. Scappoose Creek to Keys Rd)	• Infrastructure need	$1,103,000	$258,000	2	3	1	3	2	1	3	1	2	X		
SC-4[c]	Keys Road Storm Improvements	S. Scappoose Creek	SW Keys Rd, SW Huser Lane, and EM Watts Rd	• System capacity • Infrastructure need	$657,000	$286,000	2	1	2	3	3	1	2	1	3		X	
SC-5–Phase 1	EJ Smith Storm Improvements and Regional Facility	S. Scappoose Creek	NW EJ Smith Rd (S. Scappoose Creek to NW Shoemaker Rd)	• Infrastructure need • Water quality	$1,266,000	$135,000	2	1	2	3	2	1	3	1	3		X	
SC-5–Phase 2					$2,310,000	$247,000	1	3	1	3	2	1	3	1	3			X
SC-6	SW 4th Street Storm Improvements	S. Scappoose Creek	SW 4thSt/SW Maple St	• System capacity • System condition	$1,037,000	$10,000	3	2	3	3	1	1	3	1	3	X		
															Total	$4,711,000	$6,289,000	$9,622,000

Table G-1. City of Scappoose Capital Project Scoring Summary

a. Numbering reflects the following drainage basins: JC = Jackson Creek or Santosh Channel, JW = Jackson Creek West (west of Highway 30), SC = South Scappoose Creek

b. Estimated costs and SDC eligible costs are based on the detailed cost summaries provided in Appendix E.

c. Final project priority adjusted from final project scoring, based on City feedback.

Appendix H: Financial Evaluation TM

City of Scappoose, OR

Storm Drainage Utility Rate & SDC Study

DRAFT REPORT

April 2022

Washington
7525 166th Avenue NE, Ste. D215
Redmond, WA 98052
425.867.1802

Oregon
5335 Meadows Road, Ste. 330
Lake Oswego, OR 97035
503.841.6543

Colorado
1320 Pearl St, Ste 120
Boulder, CO 80302
719.284.9168

www.fcsgroup.com

FCS GROUP
Solutions-Oriented Consulting

TABLE OF CONTENTS

Section I. INTRODUCTION

UTILITY BACKGROUND

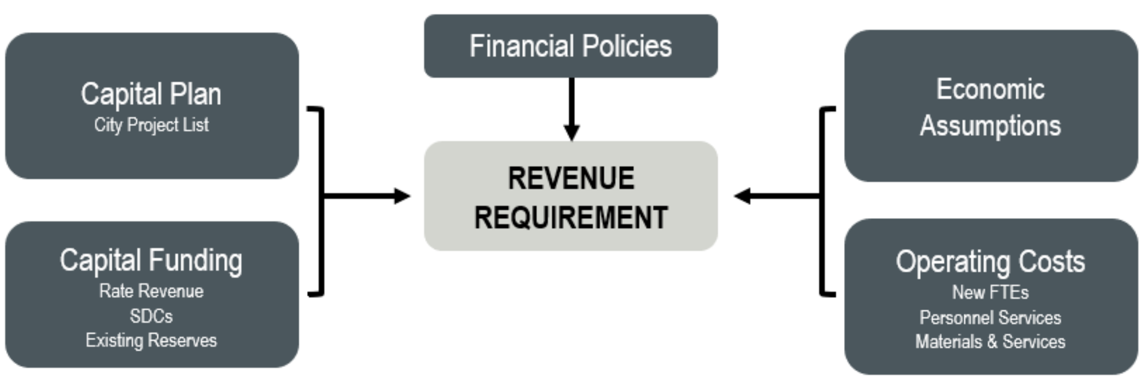
The City of Scappoose ("City"), located in Columbia County, Oregon, owns and operates a storm drainage utility. In November of 2021, the City contracted with the engineering consulting firm Brown and Caldwell to update the storm drainage system plan and for FCS GROUP to complete a financial analysis in support of that plan.

The rate increases described in this report support three distinct capital plans – referred to in this report as levels of service (LOS). Each financial plan supports the operational costs of the system, as well as the capital improvement program (CIP) associated with that level of service. The City bills and collects rates from customers within its service area to provide resources needed to plan, manage, design, construct, maintain, revise, and upgrade its storm drainage system and the forecasted rate increases are necessary to support these functions.

RATE STUDY

The main purpose of this rate study is to develop a funding plan ("revenue requirement") for the FY 2025-44 study period, which aligns with the capital planning period. The revenue requirement typically identifies the total revenue needed to fully fund the utility on a standalone basis considering operating and maintenance expenditures, fiscal policy achievement, the capital project needs of the utility, and in this case, three distinct levels of service. Project costs, priorities, and level of service options were provided to FCS GROUP by Brown and Caldwell.

Exhibit 1: Revenue Requirement Overview



Basic LOS

The basic level of service includes high priority projects within a 20-year planning period (FY 2025-44). Both low and medium priority projects remain unfunded. Programmatic activities are scaled down from the recommended and aspirational LOS; specifically, reduced funding is provided for closed-circuit television (CCTV) inspections, repair and replacement, and localized drainage improvements, and no green street pilot program is funded. This level of service includes staff increases to address maintenance and regulatory needs; in fact, all levels of service provide the same amount of assumed staff funding.

Recommended LOS

The recommended level of service includes high priority projects within a 10-year planning period (FY 2025-34), and medium priority projects within the subsequent 10-year planning period (FY 2035-44). Low priority projects remain unfunded. There is an increase to the repair and replacement costs, local drainage improvement costs, and the addition of a green street pilot program. This level of service includes staff increases as described in the Basic LOS.

Aspirational LOS

The aspirational level of service includes high priority projects within a 10-year planning period (FY 2025-34), and medium and low priority projects within the subsequent 10-year planning period (FY 2035-44). All program costs in this level of service are funded. The repair and replacement costs, local drainage improvement costs as well as the green street pilot program remain at the same funding level as the Recommended LOS. This level of service includes staff increases as described in the Basic LOS.

Section II. Fiscal Policies

The basic framework for evaluating utility revenue needs includes sound fiscal policies. Several policy topics are important to consider as part of managing the finances of the utilities, including operating reserves, capital reserves, and rate funded capital. The City has two funds for this utility – the Storm Water Drainage Fund and the Storm Water Drainage SDC Fund.

OPERATING RESERVE

An operating reserve is designed to provide a liquidity cushion; it protects the utility from the risk of short-term variation in the timing of revenue collection or payment of expenses. A reasonable operating reserve balance target for storm drainage utilities is 45 days of operating expenses.

> Recommended Policy: Given the existing fund balances and forecasted needs, achieve a year-end minimum balance target of at least 120 days of total annual operating expenses. This equates to roughly $101,400 in FY 2023 assuming $308,400 of expenses.

CAPITAL RESERVE

This reserve provides a source of emergency funding for unexpected asset failures or other unanticipated capital needs. This capital reserve policy is not intended to guard against catastrophic system failure or extreme acts of nature. Minimum balances for capital reserves are often based on a percentage (commonly 1% to 2%) of the original cost of utility fixed assets or an amount determined sufficient to fund an emergency capital project or equipment failure.

> Recommended Policy: Achieve a minimum balance target of $100,000. This target represents the cost to address a system emergency or equipment failure.

RATE FUNDED CAPITAL

Rate funded capital is the funding of long-term infrastructure replacement needs through a regular (annual) and predictable rate provision. Most commonly, utilities that have addressed replacement funding needs have used historical (original cost) depreciation expense as the basis for a reasonable level of reinvestment in the system. This strategy can help minimize (or eliminate) a utility's reliance on debt.

> Recommended Policy: The City desires to continue to cash-fund its capital program at this time. Therefore, all cash above the 120-day operating reserve target is used as cash for capital.

DEBT SERVICE

The utility currently has no existing debt and does not plan to use debt to fund the Storm Drainage capital plan. However, if the City were to consider debt in the future there are a few policies to consider.

Debt Reserve

A debt reserve is most often required as a condition of bond issuance, though some state loan programs also require a reserve. The reserve intends to protect bondholders (or the agency issuing loans) from the risk of the borrower defaulting on their payments and is most often linked to either average annual debt service or maximum annual debt service. The City policy for a debt reserve should be dictated in the future by terms outlined in covenants for future debt obligations, if applicable.

Debt Service Coverage

Debt service coverage is a requirement typically associated with revenue bonds and some state loans, and it is a financial measure assessing the ability to repay debt. Coverage is most easily understood as a factor applied to annual debt service. If the City issues debt (generally revenue bonds) the City agrees to set rates to meet operating expenses and not only pay debt service but to collect an additional 25% above bonded debt service (commonly referred to as 1.25x). The extra revenue is a "cushion" that assures bondholders that the utility has the financial resources to meet its debt service obligations. If the City take on new debt, it is prudent to maintain a debt service coverage of 1.25x.

Exhibit 2 provides a summary of the recommended fiscal policies for the City.

Exhibit 2: Summary of Fiscal Policies

Policy	Recommended Target
Operating Reserve	Target: 120 days of operating expenses Result: Target $101,400 based on FY 2023 budget of $308,400.
Capital Reserve	Target: Cash to address a system emergency Result: Target $100,000
Operating + Capital	$201,400 (or 238 days of operating expenses)
Rate Funded Capital	Set rates to allow the utility to cash fund its capital program.

Section III. REVENUE REQUIREMENT

The main purpose of the revenue requirement is to develop a funding plan ("revenue requirement") for the FY 2024-44 study period. The revenue requirement identifies the total revenue needed to fully fund the utility on a standalone basis considering current financial obligations including operating expenditures, policy-driven commitments, and future capital expenditures. Rate increases are applied "across-the-board" for the utility; there were no rate structure changes incorporated in this plan.

Although each level of service strives to fund a different amount of capital, the fiscal policies, economic and inflation factors, fund balances, and existing debt obligations are consistent among levels of service.

ECONOMIC & INFLATION FACTORS

The operating and maintenance expenditure forecast largely relies on the City's FY 2023 adopted budget. The line items in the budget are then adjusted each year by utilizing one of the following applicable factors:

- General Cost Inflation – assumed to be 3.0 percent per year through FY 2031 and 2.50 percent thereafter based on the recent historical performance of the Consumer Price Index: West, and discussions with City staff.
- Construction Cost Inflation – assumed to be 6.0 percent per year from FY 2023-24, and 3.0 per year thereafter based on the Engineering News-Record's Construction Cost Index (20-City Average), discussions with City staff, and current trends within the industry.
- Personnel Cost Inflation – based on Employment Cost Indices (U.S. Bureau of Labor Statistics) as well as discussions with City staff.
  - Labor Cost Inflation: assumed to be 3.50 percent per year.
  - Benefits Cost Inflation: assumed to be 5.0 percent per year.
- Fund Earnings – assumed to be 0.50 percent per year based on input from City staff as well as recent earnings reports from the State's Local Government Investment Pool (LGIP).
- Customer Account Growth – assumed to be 0.75 percent through FY 2032 and 1.0 percent a year thereafter, based on discussions with City staff at the time of analysis. This equates to an average of 50 additional customers in from FY 2022 to FY 2044.

FUND BALANCES

The City began FY 2022 with roughly $930,000 in cash or cash equivalents. For forecasting purposes, operating resources and uses are tracked separately from capital resources and uses. **Exhibit 3** shows that of the $930,000 in beginning cash, $42,000 was allocated to the operating reserve (120 days of operating expenses) and the remainder was allocated to the capital reserve. As a note, in the following year (FY 2023) the operating budget increases by roughly 2.5x and therefore increases the 120-day operating target.

Exhibit 3: Cash or Cash Equivalent Balances

Reserve	FY 2022 Beginning Balance
Operating Reserve	$42,000
Capital Reserve	$888,000
Total	$930,000

EXISTING DEBT OBLIGATIONS

The Storm Drainage utility does not currently have any outstanding debt. Based on discussions with City staff, it is their preference that the utility continue to cash-fund capital projects during the study period. However, if the City were to ever issue debt, it may be prudent to consider the following:

- While cash funding might be cheaper in the long run because there is no interest cost, debt funding may be practical in some situations since it allows for the payment of costs over an extended period. Utilizing debt might also allow the City to complete projects more quickly, thereby avoiding some inflation costs.
- Using debt to spread the cost over time also promotes "generational equity," ensuring that future customers pay for their fair share of system costs.
- The City's ability to meet debt service coverage and other debt-related requirements may limit the amount of debt that it can issue.
- Excessive amounts of outstanding debt can affect a utility's credit rating (and its ability to secure low-interest debt).

CAPITAL PROGRAM

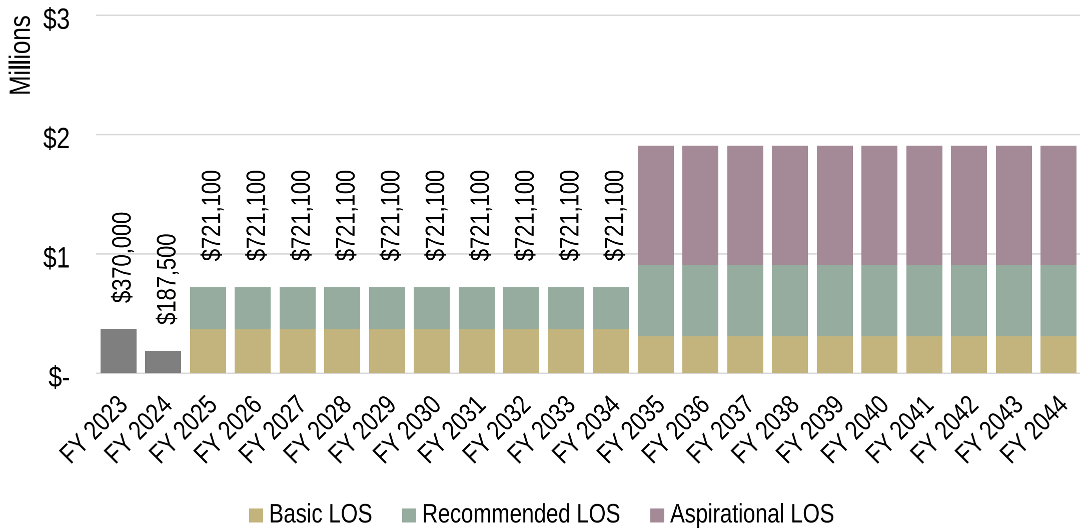
The engineering consultant Brown and Caldwell supplied FCS GROUP with FY 2023-44 CIPs for three distinct levels of service (LOS): Basic, Recommended and Aspirational. Project costs and timing for each were allocated in part based on a low, medium, and high priority schedule. Projects designated as low are not funded except under the aspirational LOS, medium projects are funded under the recommended and aspirational LOS from FY 2035-44, and high projects are funded (schedule varies based on LOS). If specific years were not provided for certain projects, the total cost of the project was split evenly within its priority schedule.

The total Aspirational LOS capital from FY 2023-44 totals $26.8 million in 2021 dollars or $46.5 million with anticipated cost escalation due to inflation. A few summary notes related to the capital plan are provided below:

- In escalated costs, the spending plan averages $2.1 million per year.
- The FY 2023-34 plan is approximately $10.8 million in escalated dollars.
- The FY 2035-44 plan is approximately $35.7 million in escalated dollars.

Exhibit 4 shows the total CIP by level of service in 2021 dollars. These costs are cumulative, meaning the Aspirational LOS costs are in addition to the Basic and Recommended LOS costs.

Exhibit 4: Capital Improvement Program (2021 dollars)



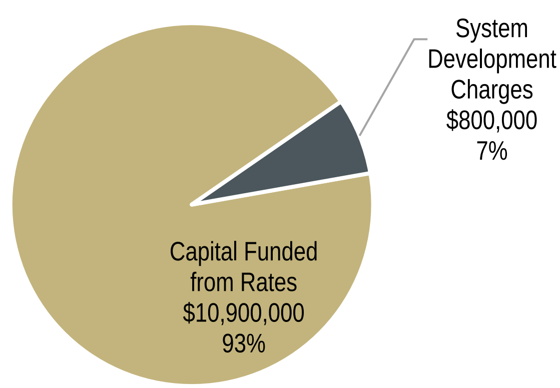
REVENUE REQUIREMENT FOR BASIC LOS

Capital Funding Strategy (Basic LOS)

The total FY 2023-44 capital plan for all levels of service totals $46.5 million with cost escalation. As noted earlier, the Basic LOS only funds those projects in yellow as shown in **Exhibit 4** (high priority projects). This is $11.7 million with cost escalation. This LOS eases pressure on rates but requires the City to defer on most capital projects and reduce funding for select program activities.

The resulting plan funds roughly $11.7 million of capital, of which $10.9 million is expected to be funded with rate revenues set aside for capital, and $800,000 is expected to be funded by system development charges. The capital funding strategy is shown in **Exhibit 5**. Note that the capital funding strategy does not assume any grant funding or debt.

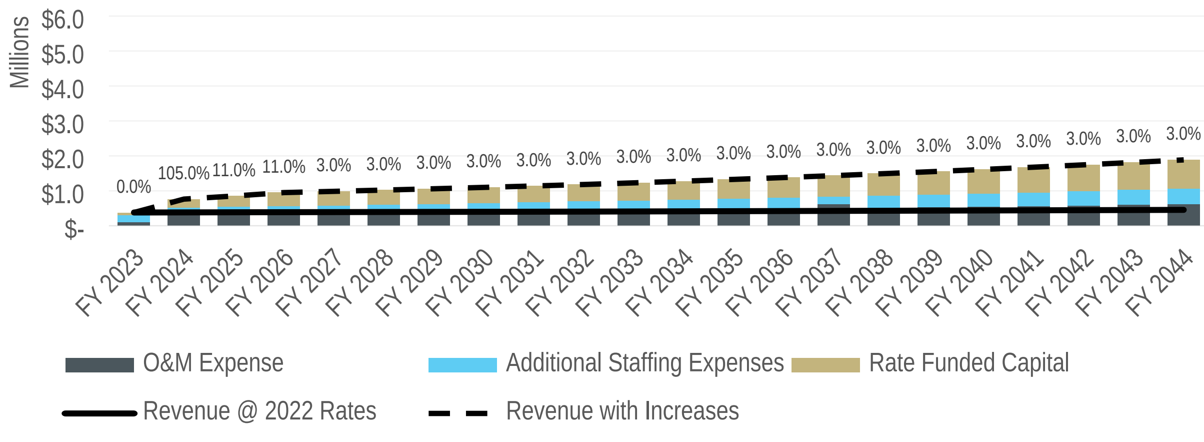
Exhibit 5: Basic LOS: Capital Funding Strategy FY 2023-44 ($11.7 million in capital)



Revenue Requirement (Basic LOS)

Exhibit 6 graphically represents the revenue requirement forecast through FY 2044. The stacked columns represent costs of the utility such as operating expenses, increased staffing costs, and annual capital spending. The solid black line represents revenue at existing rates and the dashed line shows forecasted revenue with rate increases.

Exhibit 6: Basic LOS: Annual Revenue Requirement Forecast FY 2023-44

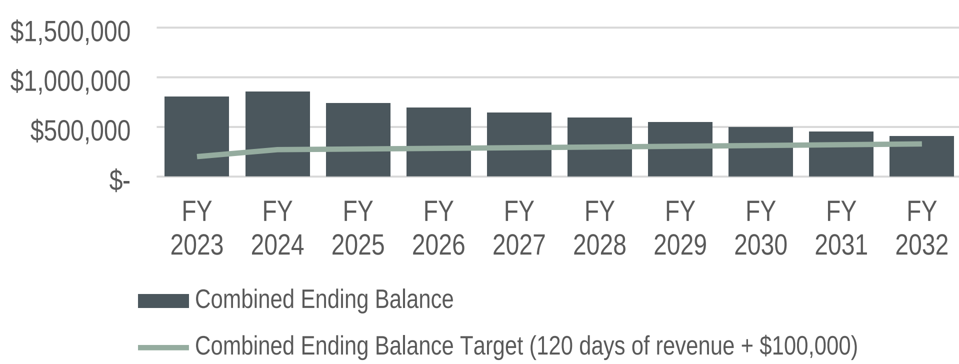


As demonstrated in **Exhibit 6**, the utility requires a 105.0 percent rate increase in FY 2024, 11.0 percent from FY 2025-26, and 3.0 percent thereafter to cover the utility operational and capital needs in the Basic LOS.

Forecasted Reserves (Basic LOS)

The target operating reserve is equal to 120 days of operating revenues. The target capital reserve is $100,000 of emergency funds. **Exhibit 7** shows that the ending fund balance is generally keeping pace with these targets over the next 10 years.

Exhibit 7: Basic LOS: Operating and Capital Reserve Forecast



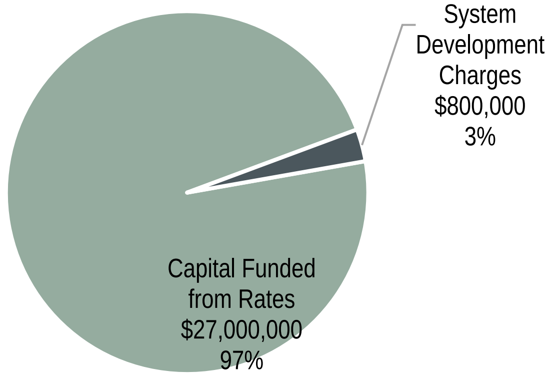
REVENUE REQUIREMENT FOR RECOMMENDED LOS

Capital Funding Strategy (Recommended LOS)

The total FY 2023-44 capital plan for all levels of service totals $46.5 million with cost escalation. As noted earlier, the Recommended LOS funds those projects in yellow and green as shown in **Exhibit 4** (high and medium priority projects). This is $27.8 million with cost escalation. This LOS eases pressure on rates but requires the City to defer the lower priority capital projects.

The resulting plan funds roughly $27.8 million of capital, of which $27.0 million is expected to be funded with rate revenues set aside for capital, and $800,000 is expected to be funded by system development charges. The capital funding strategy is shown in **Exhibit 8**. Note that the capital funding strategy does not assume any grant funding or debt.

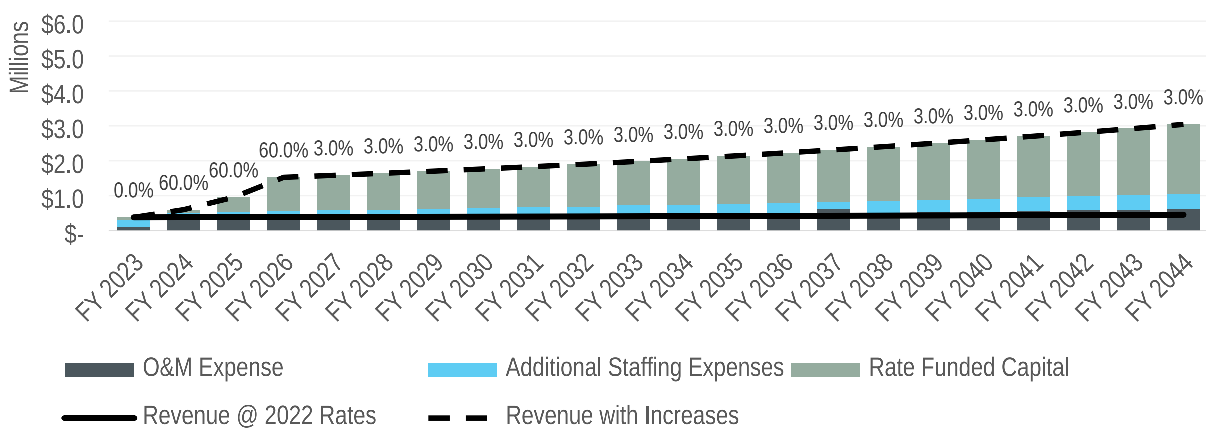
Exhibit 8: Recommended LOS: Capital Funding Strategy FY 2023-44 ($27.8 million in capital)



Revenue Requirement (Recommended LOS)

Exhibit 9 graphically represents the revenue requirement forecast through FY 2044. The stacked columns represent costs of the utility such as operating expenses, increased staffing costs, and annual capital spending. The solid black line represents revenue at existing rates and the dashed line shows forecasted revenue with rate increases.

Exhibit 9: Recommended LOS: Annual Revenue Requirement Forecast FY 2023-44

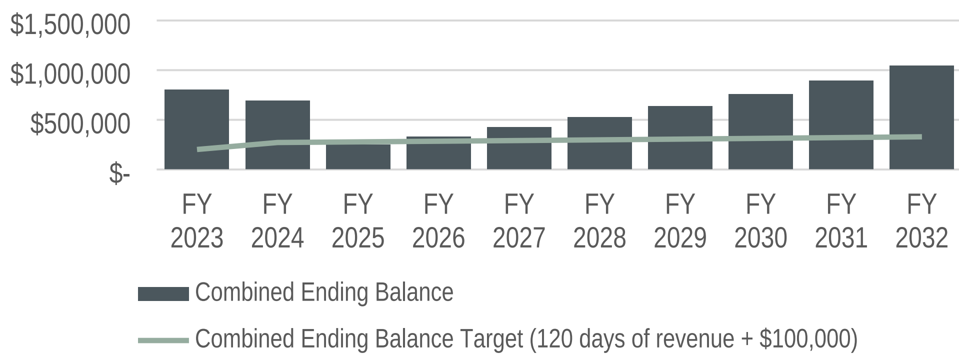


As demonstrated in the **Exhibit 9**, the utility requires 60.0 percent rate increases each year from FY 2024-26, and 3.0 percent thereafter to cover the utility operational and capital needs in the Recommended LOS.

Forecasted Reserves (Recommended LOS)

The target operating reserve is equal to 120 days of operating revenues. The target capital reserve is $100,000 of emergency funds. **Exhibit 10** shows that the ending fund balance is generally keeping pace with these targets over the next 10 years.

Exhibit 10: Recommended LOS: Operating and Capital Reserve Forecast



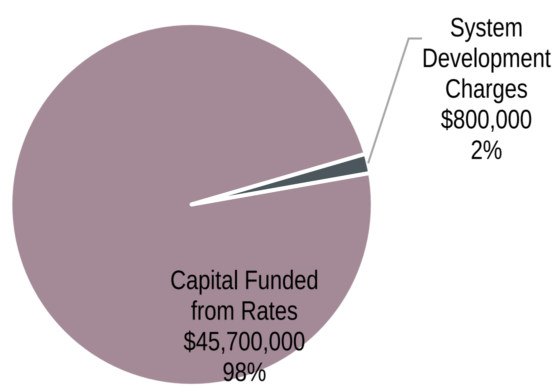
REVENUE REQUIREMENT FOR APSIRATIONAL LOS

Capital Funding Strategy (Aspirational LOS)

The total FY 2023-44 capital plan totals $46.5 million with cost escalation. As noted earlier, the Aspirational LOS funds all City storm drainage projects (yellow, green, and pink) as shown in **Exhibit 4** (high, medium, and low priority projects).

The resulting plan funds roughly $46.5 million of capital, of which $45.7 million is expected to be funded with rate revenues set aside for capital, and $800,000 is expected to be funded by system development charges. The capital funding strategy is shown in **Exhibit 11**. Note that the capital funding strategy does not assume any grant funding or debt.

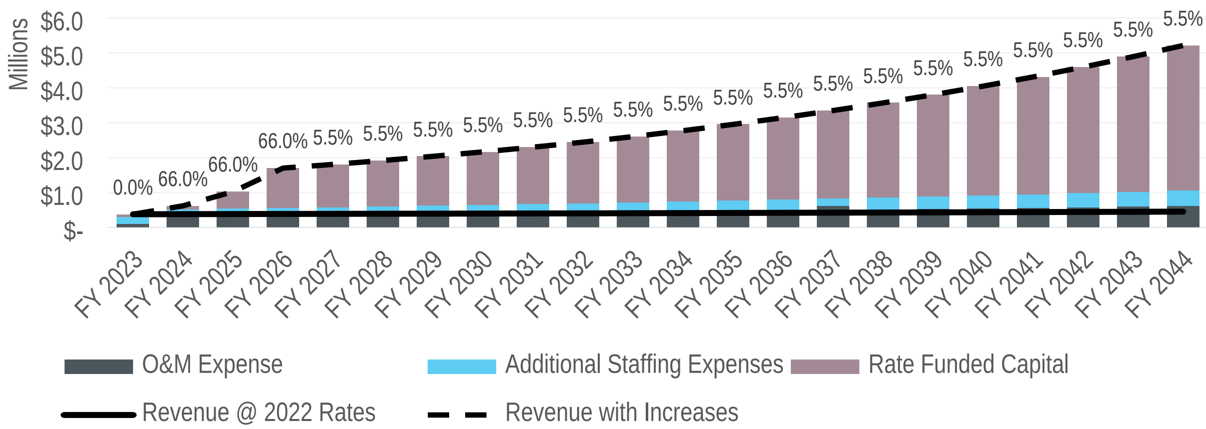
Exhibit 11: Aspirational LOS: Capital Funding Strategy FY 2023-44 ($46.5 million in capital)



Revenue Requirement (Recommended LOS)

Exhibit 12 graphically represents the revenue requirement forecast through FY 2044. The stacked columns represent costs of the utility such as operating expenses, increased staffing costs, and annual capital spending. The solid black line represents revenue at existing rates and the dashed line shows forecasted revenue with rate increases.

Exhibit 12: Aspirational LOS: Annual Revenue Requirement Forecast FY 2023-44

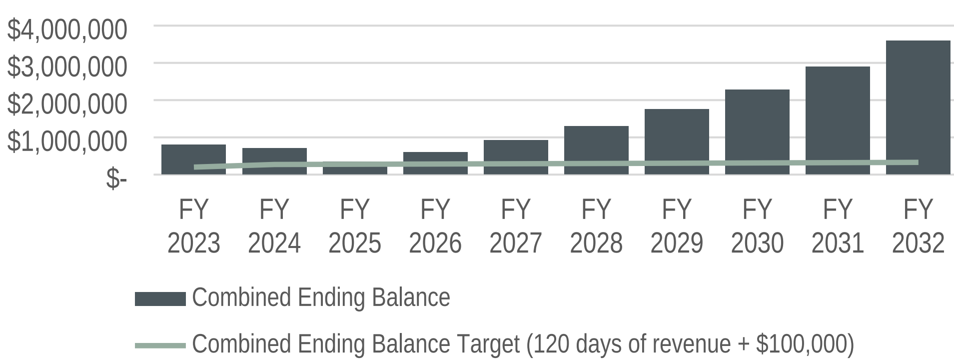


As demonstrated in the **Exhibit 12**, the utility requires 66.0 percent rate increases each year from FY 2024-26, and 5.5 percent thereafter to cover the utility operational and capital needs in the Aspirational LOS.

Forecasted Reserves (Recommended LOS)

The target operating reserve is equal to 120 days of operating revenues. The target capital reserve is $100,000 of emergency funds. **Exhibit 10** shows that the ending fund balance is generally keeping pace with these targets over the next 10 years.

Exhibit 13: Aspirational LOS: Operating and Capital Reserve Forecast



Section IV. Rate Study Conclusion

REVENUE REQUIREMENT & RATE SCHEDULE

Based on the City's preference for cash funding capital (no debt), FCS GROUP recommends the annual rate plans shown in **Exhibit 14** by level of service. These increases allow the utility to accomplish the following for the City's desired level of service:

- Continue to fund existing operating expenses, plus cost escalation;
- Allow the utility to pay for increased staffing costs;
- Allow the utility to cash fund their capital plan (from $11.7 million to $46.5 million); and
- Maintain utility reserves at a healthy level throughout the forecast.

Exhibit 14: Rate Increases & Monthly Rates by LOS

Basic LOS									
	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029	FY 2030	FY 2031
Annual Increase	5.80%	105.13%	11.00%	11.00%	3.00%	3.00%	3.00%	3.00%	3.00%
Monthly Rate	$5.85	$12.00	$13.32	$14.79	$15.23	$15.69	$16.16	$16.64	$17.14

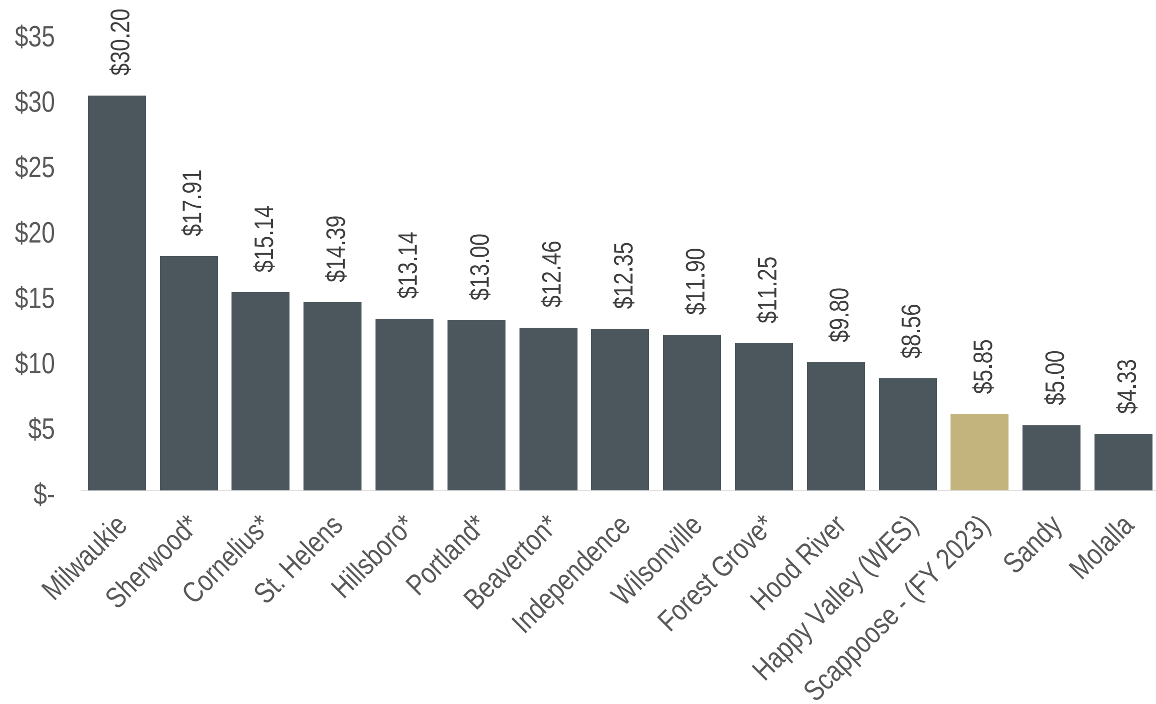
Recommended LOS									
	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029	FY 2030	FY 2031
Annual Increase	5.80%	60.00%	60.00%	60.00%	3.00%	3.00%	3.00%	3.00%	3.00%
Monthly Rate	$5.85	$9.36	$14.98	$23.96	$24.68	$25.42	$26.18	$26.97	$27.78

Aspirational LOS									
	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029	FY 2030	FY 2031
Annual Increase	5.80%	66.00%	66.00%	66.00%	5.50%	5.50%	5.50%	5.50%	5.50%
Monthly Rate	$5.85	$9.71	$16.12	$26.76	$28.23	$29.78	$31.42	$33.15	$34.97

SINGLE-FAMILY RESIDENTIAL RATE COMPARISON

As a resource to the City and its customers, a rate survey of comparable utilities was performed in 2023. **Exhibit 15** shows each jurisdiction's monthly single-family residential rate. Note that each jurisdiction has a unique set of geographic traits, customers, and system characteristics that can have a significant impact on rates. Additionally, some of these jurisdictions may have rate increases planned. Jurisdictions marked with an asterisk include a regional Clean Water Services charge of $10.14. At $12.00, the Basic LOS proposed rates would put the City in the middle of the jurisdictions documented below.

Exhibit 15: Jurisdictional Survey – Monthly Single Family Storm Drainage Rates



Updating This Study's Findings

It is recommended that the City revisit the study findings during the forecast period to check that the assumptions used are still appropriate and that no significant changes have occurred that would alter the results of the study. The City should use the study findings as a living document, routinely comparing the study outcomes to actual revenues and expenses. Any significant or unexpected changes may require adjustments to the rate strategy recommended in this report.

Section V. SYSTEM DEVELOPMENT CHARGES

STORM DRAINAGE SDC

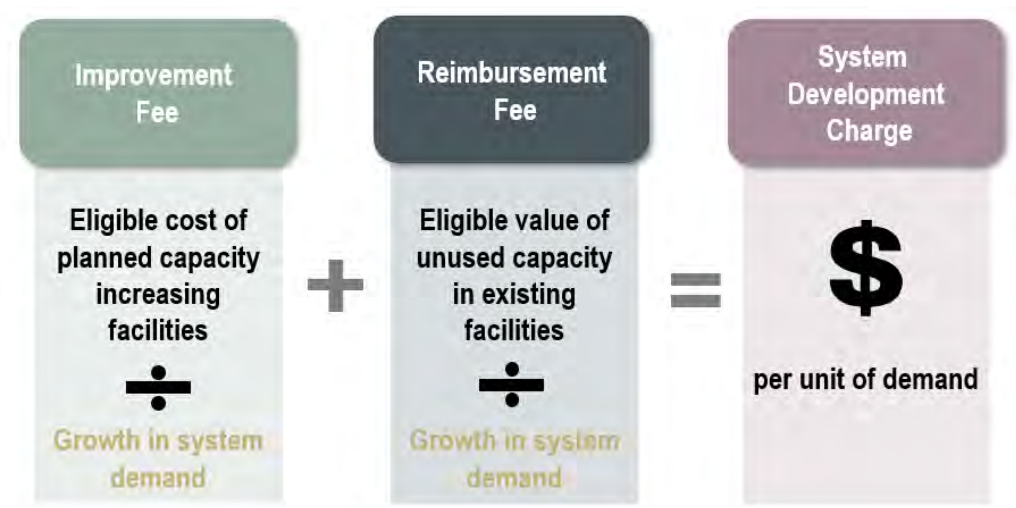
System development charges (SDCs) are one-time fees (rather than ongoing rates) imposed on new and increased development to recover the cost of system facilities needed to serve that growth. These charges are available for water, wastewater, storm drainage, transportation, and park utilities.

This section provides the rationale and calculation for a storm drainage SDC update that the City could impose, collect, and spend on capital related projects.

Method of Calculation

In general, SDCs are calculated by adding a reimbursement fee component (if applicable) and an improvement fee component – both with potential adjustments. Each component is calculated by dividing the eligible cost by growth in units of demand. The unit of demand becomes the basis of the charge. Below in **Exhibit 16** is an illustration of this calculation.

Exhibit 16: System Development Charge Calculation



Unit of Measurement: System Demand

The storm drainage SDC basis is reflected in equivalent service unit (ESUs). In the City of Scappoose, 1 ESU is equivalent to 2,750 square feet. This square footage is meant to represent the impervious area on an average sized residential lot. This way a commercial customer's charge can be scaled up based on their impervious area - the fee for commercial and retail development equals the total impervious area divided by one ESU (2,750 square feet).

Growth in System Demand

In a storm drainage master plan, growth is often reflected as an increase in impervious surface area due to new development (including redevelopment) activities. The increase in impervious surface causes an increase in storm drainage runoff volume. The City's consulting engineer Brown and Caldwell estimates that the amount of impervious area (minus roads) discharging to the City's storm drainage infrastructure will increase by approximately 493 acres. This increase translates to 21.5 million square feet, or 7,809 additional ESUs.

Improvement Fee Cost Basis

Of the City's storm drainage capital improvement plan, only a portion of selected projects will create any system capacity for future storm drainage customers. Based on data provided by the City's consulting engineer Brown and Caldwell, this portion amounts to $5.4 million. As a note, the SDC analysis uses the full CIP (Aspirational LOS), as these projects represent the full capacity of the master plan. **Exhibit 17** shows the SDC eligible projects.

Exhibit 17: Total SDC Eligible Project Costs

Project	Total Cost	Eligible Cost
Elm Street Storm Improvements	$2,703,000	$574,000
E Columbia Ave Storm Improvements Phase I	$1,793,000	$482,000
E Columbia Ave Storm Improvements Phase II	$2,810,000	$763,000
E Columbia Ave Storm Improvements Phase III	$1,556,000	$347,000
E Columbia Ave Storm Improvements Phase IV	$479,000	$128,000
Sunset Loop Storm Improvements Alternative #2	$1,249,000	$243,000
Dutch Canyon System Improvements Phase I	$1,615,000	$1,615,000
Dutch Canyon System Improvements Phase II	$105,000	$66,000
NW 1st Street Storm Improvements	$1,617,000	$199,000
JP West Rd Storm Improvements – East	$517,000	$26,000
JP West Rd Storm Improvements – West	$1,103,000	$258,000
Keys Road Storm Improvements	$657,000	$286,000
EJ Smith Storm Improvements and Regional Facility Phase I	$1,266,000	$135,000
EJ Smith Storm Improvements and Regional Facility Phase II	$2,310,000	$247,000
SW 4th Street Storm Improvements	$1,037,000	$10,000
Total	$20,817,000	$5,379,000

A typical adjustment to an SDC is the deduction of available fund balance from the improvement fee cost basis. The storm drainage SDC fund ended FY 2021 with $518,497 in fund balances. The total improvement cost basis is reduced by this amount in order to prevent over-charging new customers. **Exhibit 18** shows the improvement fee calculation.

Exhibit 18: Improvement Fee Cost Basis

Adjustment to Cost Basis	Cost
Unadjusted Improvement Fee Cost Basis	$5,379,000
Improvement Fee Fund Balance	-$518,497
Improvement Fee Cost Basis	$4,860,503

Reimbursement Fee Cost Basis

It is assumed that there is no available capacity in the City's existing storm drainage infrastructure, a conclusion supported by the fact that the capital plan is targeted at correcting existing deficiencies. We have therefore not calculated a reimbursement fee.

Adjustments

Oregon Revised Statutes (ORS) 223.307(5) authorizes the expenditure of SDCs on "the costs of complying with the provisions of ORS 223.297 to 223.314, including the costs of developing system development charge methodologies and providing an annual accounting of system development charge expenditures." To avoid spending monies for compliance that might otherwise have been spent on growth-related projects, this report includes an estimate of compliance costs in the SDC cost basis. After consultation with the City, we estimate the City will spend $243,025 over the planning period on the compliance costs allowed by statute. This amount represents 5.0 percent of the unadjusted cost basis.

Calculated SDC

The total SDC ($654 per ESU) is show below in **Exhibit 19**. This includes the improvement fee per ESU, and the compliance cost per ESU.

Exhibit 19: SDC Calculation

SDC Calculations	Cost
Unadjusted Improvement Fee Cost Basis	$5,379,000
Improvement Fee Fund Balance	-$518,497
Improvement Fee Cost Basis	$4,860,503
Compliance Costs	+$243,025
Total Cost Basis	$5,103,528
Growth in ESUs	7,809
	$5,103,528 ÷ 7,809
SDC per ESU	$654

Indexing

ORS 223.304 allows for the periodic indexing of SDCs for inflation, as long as the index used is:

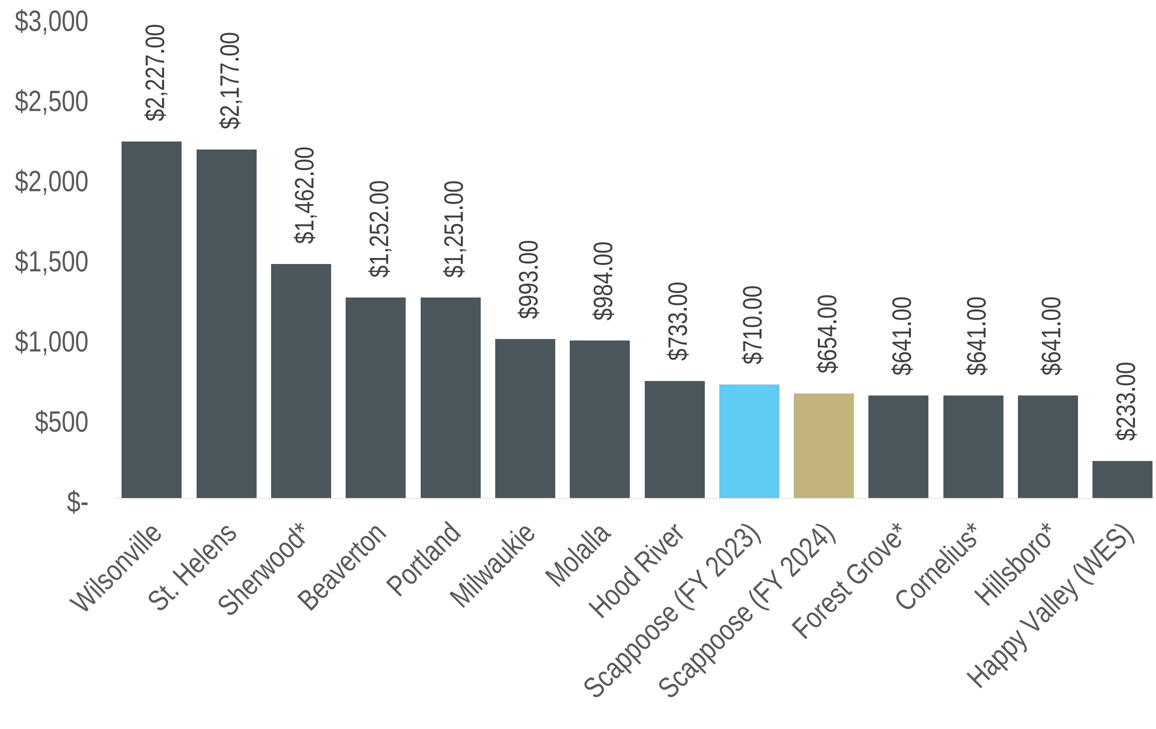
> (A) A relevant measurement of the average change in prices or costs over an identified time period for materials, labor, real property or a combination of the three;
> (B) Published by a recognized organization or agency that produces the index or data source for reasons that are independent of the system development charge methodology; and
> (C) Incorporated as part of the established methodology or identified and adopted in a separate ordinance, resolution or order.

We recommend that the City index its storm drainage SDC to the *Engineering News Record* Construction Cost Index (20-City Average) and adjust charges annually. There is no comparable Oregon-specific index.

SINGLE-FAMILY RESIDENTIAL RATE COMPARISON

As a resource to the City and its customers, a survey of comparable utilities was performed in 2023. **Exhibit 20** shows each jurisdiction's single-family SDC. Note that each jurisdiction has a unique set of geographic traits, customers, and system characteristics that can have a significant impact on rates. Additionally, some of these jurisdictions may have an increase planned. Jurisdictions marked with an asterisk have a charge set by Clean Water Services.

Exhibit 20: Jurisdictional Survey – Single-Family Storm Drainage SDC



Brown AND Caldwell

Portland Office

6500 S Macadam Avenue
Suite 200
Portland, OR 97239-3552

T 503.244.7005