PLANNING COMMISSION

WEDNESDAY, FEBRUARY 14, 2024

WORK SESSION

3. Stormwater Master Plan (Rappold) (45 minutes)

PLANNING COMMISSION MEETING
STAFF REPORT

Meeting Date: February 14, 2024	**Subject:** Draft Stormwater Master Plan **Staff Member:** Kerry Rappold, Natural Resources Manager **Department:** Community Development
Action Required	**Advisory Board/Commission Recommendation**
☐ Motion	☐ Approval
☐ Public Hearing Date:	☐ Denial
☐ Ordinance 1st Reading Date:	☐ None Forwarded
☐ Ordinance 2nd Reading Date:	☒ Not Applicable
☐ Resolution	**Comments:** N/A
☒ Information or Direction	
☐ Information Only	
☐ Council Direction	
☐ Consent Agenda	

Staff Recommendation: Review and provide comment on the Draft Stormwater Master Plan.		
Recommended Language for Motion: N/A		
Project / Issue Relates To:		
☒Council Goals/Priorities: Protect and Preserve Wilsonville's Environment	☒Adopted Master Plan(s):	☐Not Applicable

ISSUE BEFORE PLANNING COMMISSION:
Staff and the consultant will present the draft Stormwater Master Plan (SMP).

EXECUTIVE SUMMARY:
In 2012, the City adopted the Stomwater Master Plan, which provided an update to the previous master plan adopted in June 2001. There have been changes in land use (e.g., Urban Growth Boundary (UGB) expansion areas) and new stormwater management requirements (i.e., National Pollutant Discharge Elimination System Municipal Separate Storm Sewer System (NPDES MS4) Permit) that need to be addressed as part of the update. The City ultimately seeks an integrated approach to stormwater and watershed management that will result in the development of management solutions and policies that maintain, restore and enhance local watersheds and meet engineering, environmental and land use needs.

In 2021, a survey was conducted to gather feedback from the community about the proposed SMP. Ninety respondents provided input on existing conditions (e.g., water quality of streams and flooding issues) related to the stormwater system and how they rate the level of service (e.g., maintenance of system and public education). Overall, the respondents felt the City was doing a good job in regards to managing the public stormwater system.

Since 2021, the consultant team has been working on data collection, problem area identification, modeling of the stormwater system, retrofit analysis, Capital Improvement Program (CIP) projects, and developing the policies that will guide the implementation of the SMP. In developing the SMP, a number of new elements were included:

1. An analysis of the City's NPDES MS4 permit (i.e., stormwater permit issued by the Oregon Department of Environmental Quality) and Total Maximum Daily Load (TMDL) Implementation Plan (i.e., a plan to address bacteria, mercury and temperature as required by Oregon DEQ) to determine the appropriate management and project objectives in the SMP.
2. Stream surveys (segments of Boeckman Creek, Meridian Creek, Arrowhead Creek, and streams in the Frog Pond Planning Area) to assess the geomorphic condition (e.g., bank erosion, and grade control, such as beaver dams) of stream channels due to hydromodification (i.e., the impact of urban stormwater runoff).
3. A staffing analysis to determine the current and future needs related to operating and maintaining the public stormwater system, including the implementation of future programmatic responsibilities and CIP projects.

The CIP addresses the variety of issues and problems associated with the City's public stormwater system and represents a critical piece in the overall management of the system. Projects were prioritized to address the capacity, condition, and maintenance of the system, and improvements associated with water quality and hydromodification. In addition to the identified CIP projects, stormwater programs, such as water quality retrofit and local drainage improvements, were developed to address regulatory drivers and support proactive system maintenance.

A total of 15 capital projects were identified to address current and future storm drainage infrastructure needs over the 20-year planning period. Due to phasing for some of the projects, these 15 capital projects represent 20 separately costed and phased projects for purposes of project prioritization and scheduling efforts. The CIP projects, which are divided into annual, high priority (2024-28), medium priority (2029-33), and low priority, have an estimated total cost of $72,065,000.

On October 11, 2023, staff presented the Executive Summary and the Capital Improvement Program at a Planning Commission work session.

Discussion Questions
The following would be helpful feedback from the Planning Commission at this work session:

- What feedback on questions does the Planning Commission have on the full Stormwater Master Plan?

EXPECTED RESULTS:
The SMP includes goals and policies, data gathering, surveying, system condition assessment, hydraulic modeling, area specific studies, retrofit analysis, Capital Improvement Program, fee in lieu of construction program, and draft and final versions of the SMP. The recommended capital improvements will provide the basis for an analysis of stormwater rates and system development charges (SDCs) that are necessary to fund the projects needed to meet permit requirements and the City's stormwater management needs.

TIMELINE:
The project team will incorporate feedback received from both the Planning Commission (February 14, 2023 work session) and the City Council (February 22, 2023 work session) into the final SMP. Adoption of the SMP by the Planning Commission is scheduled for March 13, 2023. The City Council public hearing is scheduled for April 1, 2024.

CURRENT YEAR BUDGET IMPACTS:
The amended fiscal year 2023-2024 Budget for CIP#7064 includes $77,425 in storm operations and system development charge funds.

COMMUNITY INVOLVEMENT PROCESS:
The consultant team prepared a public engagement plan for outreach to interested members of the community and businesses potentially affected by the SMP. The Public Engagement Plan incorporated the City's existing public engagement tools, including Let's Talk Wilsonville and the Boones Ferry Messenger. A survey was conducted to provide information and solicit feedback from the public related to the project scope and activities. The forthcoming Storm System Rate Study and SDC Update will also include a public engagement process with outreach to utility customers and the development community.

POTENTIAL IMPACTS or BENEFIT TO THE COMMUNITY:
The SMP will benefit the community by providing goals and policies and an updated Capital Improvement Program to serve a growing population and meet environmental regulations.

ALTERNATIVES:
The project team considered and evaluated numerous alternatives to provide the needed storm drainage improvements necessary to meet the City's system management needs and permit requirements. The recommended Capital Improvement Program implements the needed improvements in a way that is efficient and cost effective.

ATTACHMENTS:

1. Draft Stormwater Master Plan

Attachment 1

Brown AND Caldwell

Stormwater Master Plan

February 2024 // **DRAFT**

WILSONVILLE
OREGON

DRAFT

Stormwater Master Plan

Prepared for

City of Wilsonville, Oregon

February 2024

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.

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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
cfs	cubic feet per second
COM/GOV	Commercial/Government
CIP	capital improvement program
City	City of Wilsonville
CPs	capital projects
CPP	corrugated polyethylene pipe
CWA	Clean Water Act
DEQ	Oregon Department of Environmental Quality
DIP	ductile iron pipe
DS	downstream
EPA	U.S. Environmental Protection Agency
E&S	Erosion and Sediment
fps	feet per second
ft	feet/foot
GIS	geographic information system
H	horizontal
H/H	hydrologic and hydraulic
HSG	Hydrologic Soil Group
IGA	Intergovernmental Agreements
in.	inch/inches
IND	Industrial
INST	Institutional
I-5	Interstate 5
LA	Load Allocation
LF	linear foot/feet
LID	low impact development
MEP	maximum extent practicable
MH(s)	manhole(s)
MS4	municipal separate storm sewer system
NPDES	National Pollutant Discharge Elimination System
NRCS	National Resources Conservation Service
ODFW	Oregon Department of Fish and Wildlife
ODOT	Oregon Department of Transportation
OS	Open Space
PDR	Planned Development Residential
Plan	Stormwater Master Plan
PVC	polyvinyl chloride
PWS	Wilsonville Public Works Standards
RA	Rural Agricultural
RCP	reinforced concrete pipe
ROW	right-of-way
R/R	repair/replacement
SDC	System Development Charge
SF	square feet
SMP	Stormwater Master Plan
SOPs	standard operating procedures
SROZ	Significant Resource Overlay Zone
SSURGO	Soil Survey Geographic Database
TM	technical memorandum
TMDL	Total Maximum Daily Load
TSS	total suspended solids
UGB	Urban Growth Boundary
US	upstream
USCS	Unified Classification System
V	vertical
VAC	Vacant
WDC	Wilsonville Development Code
WLA	Waste Load Allocation
WQ	water quality

Acknowledgements

The Brown and Caldwell Team, including Waterways Consulting, Inc. and Consor (formerly Barney and Worth) would like to extend thanks to the following staff and stakeholders for assistance in completing this Stormwater Master Plan:

- Kerry Rappold, Natural Resources Manager and City Project Manager
- Andy Sheehan, Asset Management Coordinator
- Sean Shortes, Engineering Tech II

Wilsonville Internal Stakeholders

- Zach Weigel, City Engineer
- Andrew Barrett, Capital Projects Manager
- Amy Pepper, Development Engineering Manager
- Dan Pauly, Planning Manager
- Jim Cartan, Environmental Specialist
- Delora Kerber, Public Works Director
- Martin Montalvo, Operations Manager
- Brad Painter, Roads and Stormwater Supervisor
- Bill Evans, Communications and Marketing Manager

City Council

- Mayor Julie Fitzgerald
- Kristin Akervall, Council President
- Dr. Joann Linville, Councilor
- Caroline Berry, Councilor
- Katie Dunwell, Councilor

City Planning Commission

- Ronald Heberlein, Chair
- Jennifer Willard, Vice-Chair
- Nicole Hendrix
- Andrew Karr
- Kamran Mesbah
- Kathryn Neil

Executive Summary

In 2021, the City of Wilsonville (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 need to: 1) address changing regulatory requirements; 2) reassess the storm system based on completion of capital projects (CPs) identified in Wilsonville's previous SMP (dated March 2012), 3) accommodate new and redevelopment activities, and 4) address observed system deficiencies warranting additional study.

This 2024 SMP identifies and prioritizes projects and programs to increase system capacity, address infrastructure and maintenance needs, add or enhance water quality treatment, address natural system deficiencies, and proactively plan for future growth. The SMP development process includes the:

- Evaluation of project needs and system improvements as identified by City staff.
- Development of validated hydrologic and hydraulic (H/H) model to confirm capacity issues and to assess anticipated flooding frequency and severity.
- Assessment of stormwater system retrofit opportunities for water quality treatment and/or flow control.
- Assessment of the natural (stream) system to identify risks to infrastructure and stream stability.
- Identification of programmatic opportunities to address recurring maintenance needs and water quality issues at a citywide scale.
- Development of a comprehensive, prioritized CP list and associated costs.
- Analysis of staffing levels to meet deferred and future maintenance and regulatory requirements.

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. Project needs were initially identified through the distribution of surveys to City staff and the public, a literature-based and Geographic Information System (GIS) data review, and site visits and staff interviews. Information collected helped to create a robust inventory of the stormwater collection system features and problem areas related to capacity, maintenance, system condition, and infrastructure needs. Locations warranting additional analyses via hydraulic modeling and/or stream assessment were defined based on results of this effort.

Stormwater Retrofit Analysis. A stormwater retrofit analysis was completed to inform potential locations for water quality improvements, erosion prevention/natural resource enhancement, and/or flow mitigation in the city. Based on the site characteristics, the continued applicability of water quality projects not implemented from the 2012 SMP, and the ability to integrate water quality into other project needs, CP and program needs were identified to expand and enhance stormwater treatment throughout the city.

Stream Assessment. A stream assessment was conducted on select reaches of Boeckman, Meridian, Arrowhead, Newland, and the unnamed tributary to the Willamette River at SW Kruse Rd. (thereby referred to as Kruse Creek for this SMP) to inform locations where stream morphology may be or is currently impacted by changes to upstream land use, and in response to changes in flow, infrastructure, and sediment supply. The assessment included a desktop GIS analysis and stream walk (field observations) to inform capital project and ongoing monitoring needs.

Stormwater System Capacity Evaluation. The stormwater hydrologic and hydraulic (H/H) model developed for the 2012 SMP was updated to reflect changes in land use and impervious coverage and additional City-owned (public) storm pipe, culverts, and detention facilities constructed since 2012. CPs installed since 2012 were also incorporated into the H/H model, and the model was used to simulate rainfall and runoff characteristics and identify capacity limitations under both current and projected future development conditions.

Maintenance and Staffing Evaluation. Operational activities were assessed to identify staffing level needs and constraints. Information on current maintenance activities, regulatory needs, and anticipated engineering activities associated with implementation of this SMP, as well as compensation rates, were incorporated into staffing recommendations for both Public Works and Community Development/Engineering.

Project/Program Development and Prioritization. Project opportunities from the various technical evaluations were consolidated and developed into CPs and programs. CP development included conceptual design, facility sizing, and cost estimation. CPs were prioritized based on multiple criteria including system operations (capacity, recurring maintenance, safety); system condition; regulatory compliance (water quality, natural system condition, instream erosion); and other needs including project concurrence/scheduling, development drivers, and contributing drainage area. Project scoring and ranking helped designate high, medium, and lower priority projects for use in project scheduling and future stormwater funding evaluations.

General Recommendations

The following project, program, and policy actions are recommended to improve and enhance the performance of the storm drainage infrastructure throughout the city:

1. Implement CPs required to address system capacity, system maintenance, repair and replacement, water quality, instream erosion/sediment control, and new infrastructure needed to accommodate pending development. These CPs are intended to manage areas of reported deficiencies and accommodate development and growth.
2. Implement stormwater-related improvement programs to address recurring, maintenance-related system needs in an expedited manner, as well as address system condition issues in accordance with ongoing inspections and the City's asset management goals.
3. Implement stormwater retrofits both proactively and opportunistically to enhance water quality and improve natural system aesthetics and function.
4. Update policies and procedures to support public and private partnerships for new and redevelopment activities, specifically related to stormwater infrastructure replacement and stormwater fee-in-lieu payments in conjunction with the Town Center redevelopment.
5. Continue implementation of the City's Public Works Design Standards (PWDS) to address regulatory drivers, support private development activities, and protect stream health.
6. Add staff necessary to maintain compliance with the City's National Pollutant Discharge Elimination System (NPDES) municipal separate storm sewer (MS4) permit, as well as to implement recommendations outlined in this SMP.
7. Clearly document CP and program costs and schedule to inform future funding and rate analyses.

Capital Project Summary

Individual and city-wide CPs, as well as stormwater programs, were developed to address the following objectives:

- Increase **system capacity** to address existing and potential future deficiencies (i.e., flood control).
- Install **water quality** treatment and address instream **erosion and sediment control (E&S)** to meet regulatory drivers including the City's NPDES MS4 permit and total maximum daily load (TMDL) obligations.
- Address recurring **maintenance** and **infrastructure needs** (i.e., lack of maintenance access, add infrastructure to address localized drainage issues).
- Address system condition through **repair & replacement (R&R) needs.**

Table ES-1 summarizes the identified 15 CPs (representing 20 individually costed project phases) and 4 city-wide planning projects, including conceptual cost estimates and respective priorities. Figure ES-1 shows CP locations by primary objective.

Table ES-1. Capital Project Costs and Schedule

Project Number [a]	Project Name	Objectives Addressed [b]	Estimated Cost	% Related to Growth[c]	Implementation Schedule		
					Near-term (2024-28)	Mid-term (2029-33)	Long-term (2034-43)
Capital Projects							
BC-1	Library Pond Retrofit	• **Capacity** • Water Quality • Infrastructure Need	$1,880,000	11%	X		
BC-2	Ash Meadows Flow Mitigation	• **Capacity** • Water Quality	$2,940,000	27%	X		
BC-3-Phase 1	Wiedemann Ditch and Canyon Creek Park Retrofit, Phase 1	• **Capacity** • Water Quality	$4,860,000	19%			X
BC-3-Phase 2	Wiedemann Ditch and Canyon Creek Park Retrofit, Phase 2	• **Capacity** • Water Quality	$7,210,000	19%			X
BC-4	Boeckman Creek Stabilization at Colvin Lane	• **Erosion/Sediment Control** • Repair/Replacement • Maintenance	$410,000	19%	X		
BC-5	Memorial Park Swale Retrofit	• **Water Quality** • Erosion/Sediment Control • Maintenance	$910,000	2%			X
BC-6	Gesellschaft Water Well Channel Restoration	• **Erosion/Sediment Control** • Maintenance	$400,000	1%	X		
CLC-1-Phase 1	Day Road Stormwater Improvements, Phase 1	• **Repair/Replacement** • Capacity	$8,020,000	38%	X		
CLC-1-Phase 2	Day Road Stormwater Improvements, Phase 2	• **Capacity**	$3,930,000	38%		X	

Table ES-1. Capital Project Costs and Schedule							
Project Number [a]	Project Name	Objectives Addressed [b]	Estimated Cost	% Related to Growth[c]	Implementation Schedule		
					Near-term (2024-28)	Mid-term (2029-33)	Long-term (2034-43)
CLC-2	Arrowhead Creek Culvert Replacement at Arrowhead Creek Trail	• **Repair/Replacement** • Maintenance	$290,000	6%		X	
CLC-3	Garden Acres Pond Retrofit	• **Capacity** • Water Quality	$3,780,000	35%		X	
NC-1	Frog Pond East and South Conveyance Pipe Installation	• **Infrastructure Need**	$4,090,000	79%	X		
WR-1-Phase 1	SW Willamette Way/Morey's Landing Stormwater Improvements, Phase 1	• **Capacity** • Water Quality	$2,310,000	2%		X	
WR-1-Phase 2	SW Willamette Way/Morey's Landing Stormwater Improvements, Phase 2	• **Capacity**	$1,080,000	2%			X
WR-2-Phase 1	Miley Road Stormwater Improvements, Phase 1	• **Repair/Replacement** • Erosion/Sediment Control • Maintenance	$820,000	--		X	
WR-2-Phase 2	Miley Road Stormwater Improvements, Phase 2	• **Repair/Replacement** • Maintenance	$10,510,000	--			X
WR-3	Rose Lane Culvert Replacement	• **Capacity** • Maintenance	$200,000	10%	X		
WR-4-Phase 1	Charbonneau East Stormwater Improvements, Phase 1	• **Capacity** • Repair/Replacement	$600,000	--			X
WR-4-Phase 2	Charbonneau East Stormwater Improvements, Phase 2	• **Repair/Replacement** • Maintenance	$4,440,000	--			X
WR-5	Charbonneau West Stormwater Improvements	• **Repair/Replacement** • Maintenance	$10,370,000	--			X
City-wide Planning Projects							
City-1	Flow Monitoring and Rain Gauge Installation	• **Capacity**	$100,000	N/A	X		
City-2	Hydromodification Assessment and Stream Survey	• **Erosion/Sediment Control**	$30,000/ event	N/A	X	X	X
City-3	Porous Pavement Pilot Study	• **Water Quality**	$100,000	N/A	X		
City-4	Boeckman Creek Geotechnical Evaluation	• **Erosion/Sediment Control**	$150,000	N/A	X		
				TOTAL:	**$19.14M**	**$20.85M**	**$29.53M**

a. CP numbering reflects the following drainage basins: BC = Boeckman Creek, CLC = Coffee Lake Creek, WR = Willamette River, NC = Newland Creek. City-wide planning projects are designated as "City".

*b. Primary objectives addressed are identified in **BOLD**.*

c. % Related to Growth refers to SDC-eligible projects and the proportional cost attributable to growth.

Program Summary

In addition to the identified CPs, the following programs were identified to address regulatory drivers and support proactive stormwater system maintenance. These programs, objectives, and estimated annual cost are listed in Table ES-2 and described below:

- **Local Drainage Improvements Program (P-1).** Allocate funds to install small-scale, localized drainage improvements (i.e., new pipe, catch basins and laterals, grading to support curb-and-gutter flow).
- **Water Quality Retrofit Program (P-2).** Establish an annual funding mechanism to integrate low impact development (LID) and/or green infrastructure (GI) in conjunction with street improvements, public improvements, and other utility projects. This program supports the City's retrofit strategy and regulatory objectives by adding water quality treatment in areas that do not currently have treatment.
- **City-wide Repair/Replacement Program (P-3).** Allocate funds to conduct replacement of public pipe and outfalls (outside of the Charbonneau development area) in conjunction with inspection results and asset management efforts.
- **Charbonneau Repair/Replacement Program (P-4).** Allocate funds to conduct replacement of public pipe and structures within the Charbonneau development area in accordance with the Charbonneau Consolidated Improvement Plan (2014). Excludes portions of the system identified by CPs WR-4 and WR-5.
- **Riparian Vegetation Management Program (P-5).** Allocate funds to conduct riparian and/or in-channel vegetation restoration and maintenance including removal of invasive plant species.
- **Vegetative Facility Maintenance Program (P-6).** Allocate funds to conduct restorative maintenance for select stormwater facilities (public and private) in the City where larger-scale maintenance is needed and/or maintenance agreements are not in place or executed.

Table ES-2. Program Costs

Project Number	Project Name	Objective(s) Addressed	Estimated Annual Cost
City-Wide Programs			
P-1	Local Drainage Improvements Program	• **Infrastructure Need** • Capacity	$100,000/yr
P-2	Water Quality Retrofit Program	• **Water Quality** • Capacity	$200,000/yr
P-3	City-wide Repair/Replacement Program	• **Repair/Replacement** • Maintenance	$275,000/yr
P-4	Charbonneau Repair/Replacement Program	• **Repair/Replacement** • Maintenance	$1,920,000/yr
P-5	Riparian Vegetation Management Program	• **Maintenance** • Water Quality	$25,000/yr
P-6	Vegetative Facility Maintenance Program	• **Water Quality** • Maintenance	$25,000/yr
		Annual Total	$2,545,000/yr

*Note: Primary objectives addressed are identified in **BOLD**.*

Implementation

CPs, program needs, and policy recommendations collectively inform the City's updated Stormwater Capital Improvement Program (CIP) as described in this SMP.

To ensure effective implementation of the CIP over the 20-year planning period, City staffing levels were analyzed against project and programs developed as part of this SMP. The purpose of this analysis was to inform recommendations as needed for additional Public Works Operations and Community Development engineering staff.

An additional 2.7 FTE in Public Works Operations and 1.4 FTE in Community Development/Engineering are recommended to accommodate new projects and programs defined in this SMP as well as to address deferred maintenance activities and new regulatory requirements.

CPs are prioritized to inform the implementation schedule and respective funding needs of capital investments. The City will need to develop a financial plan to ensure funding of the scheduled capital costs, program costs, and staffing needs. Future financial planning, including level of service goals, a stormwater utility rate evaluation, and a system development charge (SDC) update, should reflect rates necessary to implement the Stormwater CIP while meeting other financial obligations.

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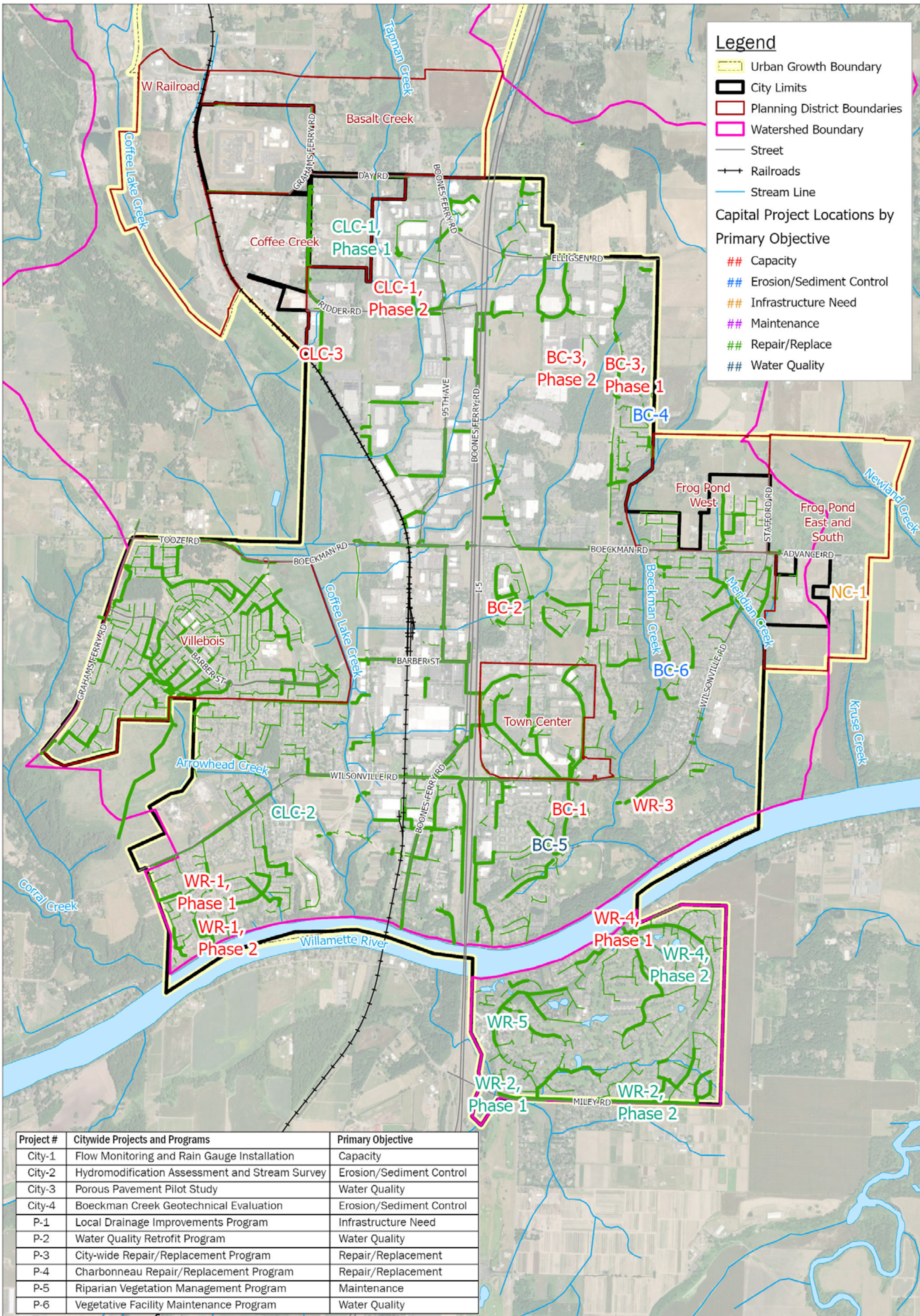

Project #	Citywide Projects and Programs	Primary Objective
City-1	Flow Monitoring and Rain Gauge Installation	Capacity
City-2	Hydromodification Assessment and Stream Survey	Erosion/Sediment Control
City-3	Porous Pavement Pilot Study	Water Quality
City-4	Boeckman Creek Geotechnical Evaluation	Erosion/Sediment Control
P-1	Local Drainage Improvements Program	Infrastructure Need
P-2	Water Quality Retrofit Program	Water Quality
P-3	City-wide Repair/Replacement Program	Repair/Replacement
P-4	Charbonneau Repair/Replacement Program	Repair/Replacement
P-5	Riparian Vegetation Management Program	Maintenance
P-6	Vegetative Facility Maintenance Program	Water Quality

Brown AND Caldwell

City of Wilsonville/
Project # 156157

Stormwater Master Plan

Note: Capital Projects City-1 to City-4 and Programs P-1 to P-6 are citywide and not specific to a single location.

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

N

0 0.25 0.5 1 Miles

Figure ES-1: City of Wilsonville Capital Improvement Program Overview

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Section 1

Introduction

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

The City's overall storm drainage system includes approximately 87 miles of piped and open channel (e.g., ditch, stream) conveyance, in addition to stormwater treatment and detention facilities for stormwater management. Most of the City's stormwater is collected and conveyed from north to south, discharging to the Willamette River via major stream corridors including Boeckman Creek (eastern portion of the City) and Coffee Lake Creek (western portion of the City). This SMP collectively considers both piped and open channel conveyances as part of the overall storm drainage system.

This Plan documents the processes and methods used to evaluate the City's storm drainage infrastructure, City stormwater programs, and maintenance activities. Results of the evaluation provide the City with projects, programs, and policies for implementation over the next 20 years and support future funding evaluations and stormwater utility rate and system development charge (SDC) calculations.

1.1 Need for a Master Plan

The City's previous SMP was completed in 2012, setting the course for stormwater management policies and CPs for the last decade. CPs and programs were proposed, prioritized, and scheduled (short term, midterm, long term, and unfunded) in the 2012 SMP, and some of the higher priority projects have been initiated or constructed. However, for some unconstructed and unfunded projects, the project needs have changed, and warrant reconsideration based on development drivers and regulatory needs.

In 2012, project prioritization focused more on project complexity and cost versus other objectives that are of increased importance (e.g., safety, recurring maintenance, water quality, erosion, and stream protection). New regulatory drivers, including the City's reissued 2021 Phase I National Pollutant Discharge Elimination System (NPDES) municipal separate storm sewer (MS4) permit 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 prompted increased consideration of water quality objectives as part of the capital project and program development effort.

Since 2012, new and re-development activities are rapidly occurring within the City's urban growth boundary (UGB). New infrastructure is continually being added, and ongoing maintenance of new infrastructure can strain City resources. The City also needs a proactive plan to address existing capacity deficiencies and aging and failing infrastructure, while considering resource limitations and development trends.

This SMP addresses water quantity, quality, and natural resource management for constructed drainage systems and stream corridors under the City's management.

1.2 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 Wilsonville.
- 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, treatment, and natural resource protection.
  - Update the City's existing hydrologic and hydraulic (H/H) model to evaluate system capacity based on current system information and updated land use and development conditions as obtained from the City's Planning Division.
  - Integrate findings and project needs stemming from stormwater planning documents completed since 2012 (i.e., 2015 Retrofit Plan, 2015 Hydromodification Assessment, development-specific master plans, etc.).
- 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 long-term staffing and funding of the City's stormwater utility.
- Support current, pending, and future regulatory requirements and drivers through CPs, programs and policy recommendations.

This Plan is intended to support regulatory directives under the City's NPDES MS4 Permit and total maximum daily load (TMDL) obligations.

1.3 Approach

The City developed this SMP using an initial, collaborative planning approach with Community Development (Engineering and Planning divisions) and Public Works to assess known storm drainage problem areas and identify areas where the addition, replacement, or retrofit of infrastructure is needed to address an issue.

Targeted system evaluations were conducted to investigate water quality or natural resource opportunities and confirm capacity limitations. Following system evaluation efforts, Project Opportunity Areas were defined and vetted with the project team to inform the development of capital project and program concepts and costs.

This overall process allowed the City to develop multi-benefit projects that target areas of the City likely to be prioritized and funded in a capital improvement program.

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

- Technical Memorandum #1 (TM1)- Stormwater Basis of Planning (February 2022), 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)-Geomorphic Reconnaissance of Boeckman, Meridian, and Arrowhead Creeks (May 2022), included in this SMP as Appendix C.
- Technical Memorandum #3 (TM3)-Hydrologic and Hydraulic Modeling Methods and Results, included in this SMP as Appendix B.

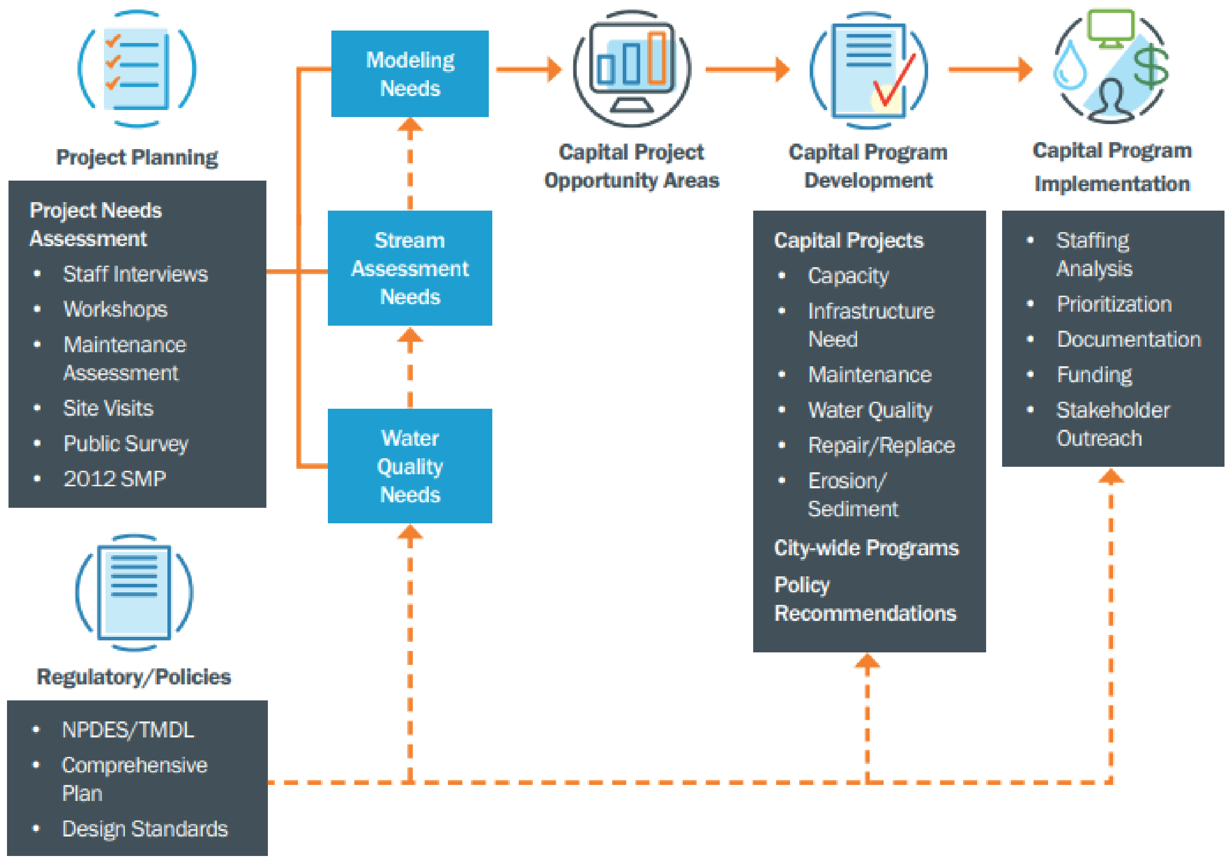


Figure 1-1: Stormwater Master Plan Approach

1.4 Supporting Documents

In addition to the 2012 SMP, several development-specific drainage reports and technical studies prepared since 2012 helped inform project development efforts. Many of these documents contain proposed infrastructure and capital improvements that have been integrated into capital projects proposed in this SMP. However, individual development master plans should still be referenced for detailed design concepts in these development areas. A summary of the reports and studies reviewed and considered for this SMP are listed in Table 1-1.

Additional detail related to regulatory drivers including the 2015 Retrofit Assessment and 2015 Hydromodification Assessment is provided in Section 2.6.

Table 1-1. Existing Stormwater Planning Documentation and Reports

Report	Date	Summary and application to the SMP
City of Wilsonville Stormwater Master Plan	2012	Recommends capital improvement projects to achieve city wide stormwater goals and objectives. Projects completed or in progress include SD4208 & SD4209, BC-4, BC-7, ST-6, ST-7, SD9030-9037, SD9013-9021, SD9060, ST-5, LID1, SD9022-9029, ST-9, and WD-3.
Villebois Village Master Plan	2013	Establishes projected land use categories/density requirements for the 2,300 residential unit development. Onsite and regional stormwater management concepts for treatment and detention are outlined.
Charbonneau Consolidated Improvement Plan	2014	Documents pipe replacement projects to address capacity deficiencies and poor condition of the existing stormwater collection system. Includes prioritization of stormwater pipe replacement in conjunction with other utilities (sanitary, water, etc.).
Stormwater Retrofit Plan	2015	Provides an updated prioritization of capital project needs stemming from the 2012 SMP, focusing on water quality criteria.
Hydromodification Assessment	2015	Provides an evaluation of hydromodification risk in stream corridors within the City, as well as recommended actions (including projects) for the City to implement.
Frog Pond Area Plan/West Master Plan	2015/2017	Provides the approximate size, location and cost of stormwater infrastructure needed to manage onsite drainage. The Frog Pond West Master Plan does not include information about proposed storm drain infrastructure, as that is detailed in the Area Plan.
Basalt Creek Concept Plan	2018	Provides preferred land use and recommends high-level concepts for transportation and infrastructure planning for the Basalt Creek Planning Area.
Town Center Plan	2019	Documents the proposed reconfiguration of existing stormwater infrastructure in conjunction with redevelopment of the Town Center area. Preliminary concepts send additional flow to the Library Detention Pond and remove an existing high flow bypass structure directing runoff west across I-5.
TMDL Implementation Plan	2019/2022	Outlines programmatic activities and best management practices (BMPs) implemented by the City to address instream temperature.
Frog Pond East/South Master Plan	2022	Provides the approximate size, location and cost of stormwater infrastructure needed to manage onsite drainage.

1.5 Master Plan 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), water quality retrofit evaluation, and additional background to support the project identification and development effort.
- Section 4 summarizes the geomorphic stream assessment.
- Section 5 describes H/H modeling methods and results of the stormwater drainage system capacity evaluation and the identification of capacity-related capital project needs.
- Section 6 summarizes the stormwater capital project development effort, including development of project opportunity areas and determination of final capital project and program needs.
- Section 7 provides an overview of the implementation elements of the capital improvement program, including results of the stormwater staffing analysis specific to Public Works and Community Development, as well as project prioritization and policy recommendations.

Section 2

Study Area Characteristics

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

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

2.1 Location and Study Area

The City of Wilsonville (City) is located primarily in Clackamas County with the northern portion of the City located in Washington County. The City is approximately 17 miles south of Portland, Oregon in the Willamette River Valley. The Willamette River runs west-east in the vicinity of the City, generally forming the southern City boundary with the majority of the City situated to the north of the river. The Charbonneau District is located south of the Willamette River (Figure 2-1). Interstate 5 (I-5) runs north to south through the center of the City and influences topography and drainage patterns.

The City covers six major basins within the city limits with topography that causes each basin to ultimately drain to the Willamette River (see Figure 2-2 at the end of this section). The waterways that define the major basins include Mill Creek (including the Corral Creek tributary), Coffee Lake Creek (including the Tapman Creek tributary), Boeckman Creek, and Meridian Creek which all flow from north to south and drain to the Willamette River. Developed areas adjacent to the Willamette River directly discharges to the Willamette River via pipe or open channel, and these areas are indicated on Figure 2-2, at the end of this section, as the Charbonneau basin and Willamette River direct basin. Together, Coffee Lake Creek/Tapman Creek and Boeckman Creek drain about 71 percent of the total city area, and their watershed boundaries extend outside the city limits and the urban growth boundary (UGB). The Coffee Lake Creek watershed is the largest, covering approximately 50 percent of the city area within the UGB.

The future Frog Pond East and South Planning District (within the UGB but partially within and outside of current City limits) will drain to Newland Creek, a tributary to the Willamette River, and the unnamed tributary to the Willamette River at SW Kruse Rd. (thereby known as Kruse Creek in this SMP).

Some drainage systems in the city have also been re-routed to accommodate new development. For example, a historical flow diversion was constructed to re-route flows from Arrowhead Creek (in the Coffee Lake Creek watershed) to Legacy Creek (outside of the city limits), and a current flow diversion is used to re-route flow from the middle tributary of Coffee Lake Creek toward upstream Boeckman Creek. While efforts have been made to redirect flows back to their historical points of discharge, impacts can still be observed.

Table 2-1 summarizes the major basins and contributing drainage areas, both within the city limits/UGB and outside of the UGB. The defined study area for this SMP reflects areas of the City where hydrologic modeling was conducted, and the study area includes all areas within the city limits and UGB, with the exception of the Frog Pond East and South Planning District, located in the Newland and Kruse Creek basins. This area is predominately outside of the current UGB and subject to basin-specific master planning for utility placement (see Section 3.5).

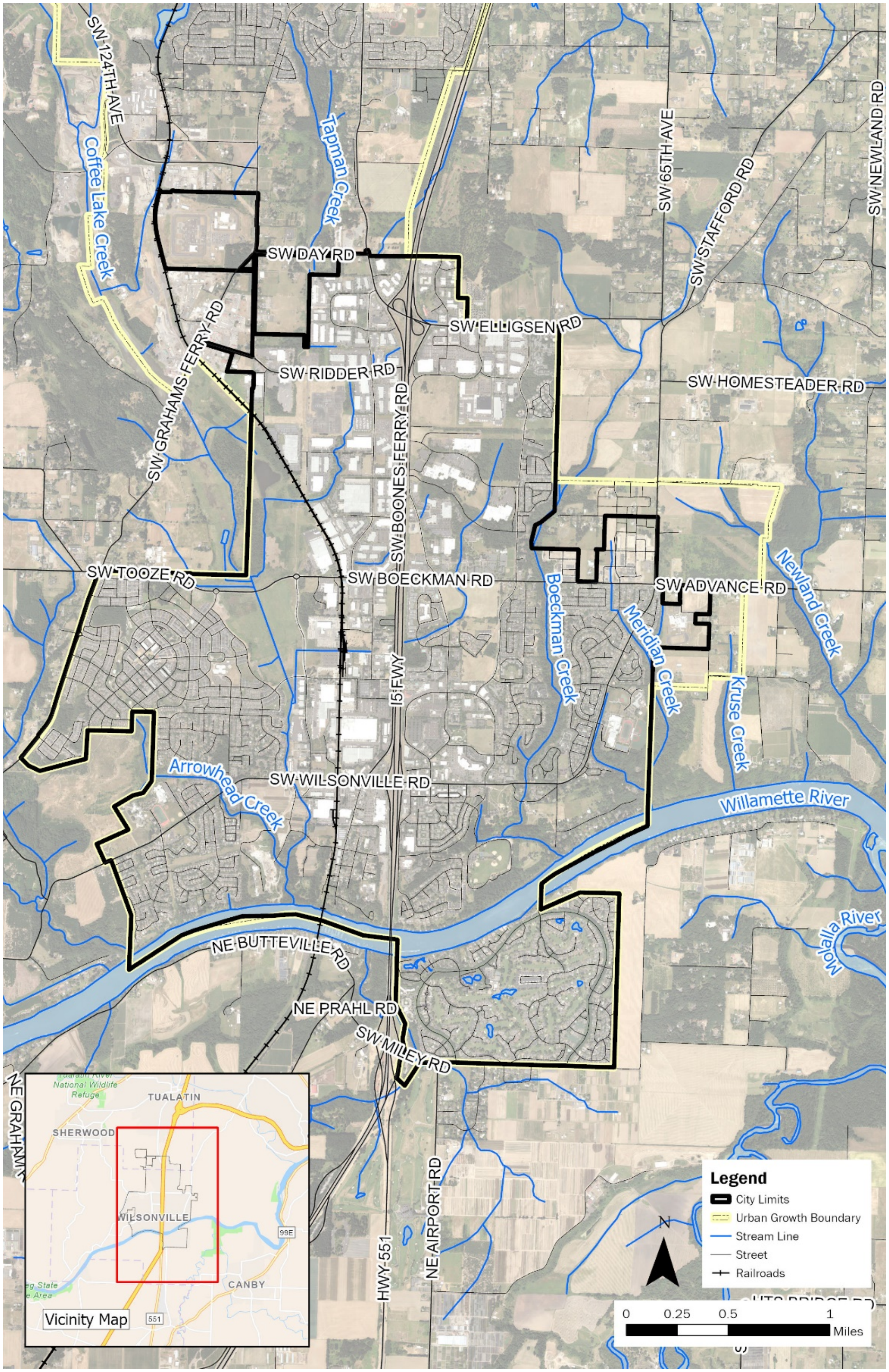


Figure 2-1: Location Overview

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	
Major Basins				
Boeckman Creek	1,096	70	806	1,972
Charbonneau	478	0	4	482
Coffee Lake Creek	2,332	1,418	1,412	5,162
Mill Creek[a]	101	0	10,424	10,525
Meridian Creek	283	100	87	470
Willamette River	505	0	0	505
Total	**4,795**	**1,588**	**12,733**	**19,116**
Related Basins				
Kruse Creek	13	55	231	299
Newland Creek	0	138	3,098	3,236

a. Area outside UGB is provided for informational purposes and does not contribute to City infrastructure.

2.2 Topography/Soils

Wilsonville's natural topography is characterized by steep hillsides on the eastern edge of the city, along the Boeckman Creek corridor, and relatively flat topography and floodplain area around Coffee Lake Creek basin and the associated Coffee Lake wetlands along the western portion of the city. Elevation within the city ranges from approximately 380 feet in the headwaters of Coffee Lake Creek to approximately 60 feet at the Willamette River.

Soil characteristics within the city vary by watershed. Soils within the city are generally limited in infiltration capability (Hydrologic Soil Group (HSG) C/D), although large areas of HSG B soils along the Willamette River and in the headwaters of Tapman Creek have higher infiltration rates. Soils are generally silty or silty loam, except along the canyon portion of Boeckman Creek, which are combination silt and sand. The downstream reach of Coffee Lake Creek also has a higher portion of gravel and cobble substrate materials than other city areas (ODFW, 2006).

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, soil texture classifications were considered 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.

Table 2-2 lists the NRCS Soil Texture Classes by percent coverage and by basin. Most of the study area (80 percent) is in the Silt Loam soil texture class. This soil class is characterized as, more than 70 percent silt, 50 percent or less sand, and less than 30 percent clay by weight.

Figure 2-3, at the end of this section, shows the soil texture classifications throughout the study area.

Table 2-2. Soil Textures within the Study Area (by % of major basin)						
Basin	Clay	Loam	Sandy Loam	Silt Loam	Silty Clay Loam	Total
Boeckman Creek	0%	1%	0%	95%	4%	100%
Charbonneau	0%	67%	2%	30%	1%	100%
Coffee Lake Creek	7%	12%	0%	76%	5%	100%
Mill Creek	0%	0%	0%	97%	3%	100%
Meridian Creek	0%	0%	0%	100%	0%	100%
Willamette River	0%	16%	6%	74%	4%	100%
Total by Combined Area	**4%**	**11%**	**1%**	**80%**	**4%**	**100%**

2.3 Land Use and Population

The City resides within the Metro UGB, and as such development in and around Wilsonville is coordinated with Metro and the surrounding jurisdictions. The City has grown from a rural farming community to a thriving city encompassing approximately 7.8 square miles (approximately 5,000 acres) and is home to over 26,500 residents. The City's population has increased by approximately 3.6 percent annually over the last decade; increasing from approximately 19,509 in 2010 to 26,597 in 2022.[1]

Land use within the City of Wilsonville includes residential, commercial, and industrial, with most of the commercial and industrial development located along the I-5 corridor. Open space areas are scattered throughout the City and include a number of parks, wetlands, and riparian areas.

2.3.1 Development Conditions

Wilsonville is primarily developed within the current city limits; however, there are areas of undeveloped and underdeveloped land that are anticipated to redevelop and densify over this SMP planning period. These areas include the Town Center Planning District and existing low-density residential in the southern portion of the City.[2]

New development is projected to occur in designated future planning areas within the UGB. These future planning areas include the Coffee Creek Planning Area (industrial development), Basalt Creek Planning Area (industrial development), Frog Pond West Planning Area (residential development), and Frog Pond East and South Planning Area (residential and institutional development). The City uses a similar master planning process for the planning areas to guide infrastructure planning and provide opportunities to mitigate natural resource impacts, including the protection and restoration of adjacent stream channels.

1 United States Census Bureau (2022), https://www.census.gov/quickfacts/fact/table/wilsonvillecityoregon#

2 House Bill (HB) 2001 was adopted by the Oregon Legislative Assembly in June 2019, and it promotes middle housing to increase housing options for Oregon citizens. As such, areas zoned as "single family residential" had to be reclassified to allow for duplexes, triplexes, and other middle housing options.

2.3.2 Land Use Coverage and Imperviousness

For this SMP, land use categories, coverages, and impervious percentages by land use category were initially prepared by the City's Planning Division and reviewed by BC to accurately reflect existing conditions and future development/densification anticipated because of House Bill (HB) 2001.[3]

Existing and future land use coverages for the study area are provided in Figure 2-4 and Figure 2-5 at the end of this section. Land use/zoning consolidation and reclassification, as well as associated impervious percentages by land use are reflected in Table 2-3. Additional description of the process for developing updated land use GIS coverages and impervious percentage estimates are reflected in Section 5.4.

Future land use coverage within the city limits or a defined concept planning area assumes that all developable (vacant) lands will develop into their underlining zoning category. In addition, specific residential areas in the City may adjust to a denser land use category (i.e., PDR2 to PDR5) per HB 2001. Aside from these situations, the existing land use coverage is generally assumed to be retained for the future development condition.

Table 2-3. Land Use Categories

Land Use Categories (2012)	Land Use Categories (Updated)	Calculated Impervious Percentage [a] (%)
Agriculture	Rural Agriculture (RA)	15 [b]
Commercial	Commercial/Government (COM/GOV)	82
Commercial-Villebois		
Industrial	Industrial (IND)	71
Residential	Planned Development Residential 1 (PDR1)	17
	Planned Development Residential 2 (PDR2)	33
Multi-Family Residential	Planned Development Residential 3 (PDR3)	43
	Planned Development Residential 4 (PDR4)	51
Residential-Villebois	Planned Development Residential 5 (PDR5)	52
Multi-Family Residential-Villebois	Planned Development Residential 6 (PDR6)	64
Open Space	Open Space (OS)	10
	Park	24
Vacant	Vacant (VAC)	3
NA	Institution (INST)	35
NA	Oregon Department of Transportation (ODOT)	48

NA: Category not used.

a. Based on aerial imagery review and digitization of impervious surfaces conducted by the City (October 2021).

b. Based on the adjusted impervious percentage value per the Boeckman Road Hydraulic Evaluation and model calibration (December 2021).

[3] Key revisions to City zoning coverage made for this SMP include the adoption of the "Planned Development Residential" (PDR) nomenclature to define residential lands, the subsequent removal of the "Villebois" designation for a subset of residential, multi-family residential, and commercial areas, and the addition of several previously uncategorized land use types.

2.4 Climate and Rainfall

Wilsonville's climate is characterized by cool wet winters and warm summers. Most rainfall occurs between October and March. On average, December is the wettest month with an average of 7.1 inches of precipitation. 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. There is currently no rain gage within the City of Wilsonville's jurisdiction, so the Aurora State Airport (UAO) rain gage (approximately 5 miles to the south) is used as a proxy. Based on the UAO data, Wilsonville averages 43 inches of rainfall a year and 2 inches of snowfall annually. Rainfall data from Clean Water Services (CWS) was also used to supplement H/H modeling and model validation efforts.

The lack of, and need for, local rainfall data has led the City to prioritize the installation of a rain gage and at least three flow meters as funded through the city-wide CP "City-1" (see Section 7 for more information). Acquisition of localized and real-time precipitation data allows the City to prepare for and support mitigation of precipitation-related impacts of climate change including increased rainfall intensities, storm surges and flooding, which are likely to affect many urban systems and services.

Current climate and rainfall projections show wide ranging uncertainty regionally and are not time scales typically used for designing storm systems. Therefore, modifications to the City's Public Works Design Standards (PWDS) and design storm events were not proposed for this SMP and associated CP sizing. However, urban planning is key to developing and implementing responses to changing precipitation patterns in urban systems. Incorporation of tools such as updated design storms reflecting local precipitation patterns are one way to adapt the SMP as necessary to address climate change. As data becomes available, the City will continue to work to identify how climate change is likely to impact the City's ability to operate its facilities and meet policy, program, and project objectives.

2.5 Drainage System

The City maintains an asset inventory of their stormwater collection system in GIS that contains various attribute fields depending on the asset class. This information is continually updated by City staff as new information becomes available, either from field investigations or as-built records.

The City manages approximately 83 miles (approximately 439,100 linear feet [LF]) of stormwater drainage pipe and culverts. Table 2-4 summarizes City-owned pipe and culvert system assets mapped (in GIS) throughout the City, as well as approximately 4 miles of mapped streams.[4]

4 Data for Tables 2-4 through 2-6 was sourced from City-provided GIS databases in 2021.

Table 2-4. System Asset Inventory-Public (City) Pipe/Culvert/Stream (mapped in GIS), City-wide							
Diameter (in)	Length (ft) by basin						Total (ft)
	Boeckman Creek	Charbonneau	Coffee Lake Creek	Mill Creek	Meridian Creek	Willamette River (direct)	
<12	11,941	11,168	21,115	532	1,104	6,514	52,375
12-18	53,046	35,189	126,356	11,591	17,799	29,216	273,196
20-27	9,469	6,104	28,636	1,205	2,772	6,125	54,311
30-36	7,326	8,358	18,855	0	1,045	4,047	39,632
42-48	1,807	823	6,054	0	0	4,381	13,064
54-60	60	0	169	0	0	0	229
72-84	424	0	250	0	0	0	674
Total Pipe [a]	84,072	61,641	201,437	13,328	22,720	50,284	433,481
Total Culvert [b]	1,412	212	3,035	322	331	284	5,596
Total Pipe & Culvert	85,484	61,853	204,472	13,650	23,051	50,568	439,077
Total Mapped Stream [c]	5,791	2,718	11,003	0	2,760	197	22,469

a. Pipe refers to active, public mainlines only, excludes laterals.

b. Ownership, maintenance responsibility, and life cycle status of culverts not identified in GIS data-all available data is included in total length.

c. Mapped stream/creek total length clipped to area within city limits and excludes Willamette River shoreline.

Tables 2-5 and 2-6 summarize major City-owned storm structures, such as clean outs, inlets, manholes, stormwater treatment facilities, and outfalls.

Table 2-5. System Asset Inventory - Storm Structures (City ownership)							
Facility	Number by basin						Total
	Boeckman Creek	Charbonneau	Coffee Lake Creek	Mill Creek	Meridian Creek	Willamette River (direct)	
Clean out	566	95	656	3	104	109	1,533
Inlets [a]	618	423	1,363	101	203	292	3,000
Manholes [b]	619	304	1,574	119	158	307	3,081
Outfalls	77	5	117	18	21	24	262

Note: Excludes identified county, ODOT and private infrastructure.

a. Inlets include all inlet types: area drains, beehive inlets, catch basins, curb inlets, and other.

b. Includes all manhole types. Ownership not identified in GIS attribute data.

Table 2-6. System Asset Inventory-Water Quality Facilities (City ownership/maintenance responsibility)														
Facility	Number / Footprint Area (SF) by basin												Total	
	Boeckman Creek		Charbonneau		Coffee Lake Creek		Mill Creek		Meridian Creek		Willamette River (direct)			
	No.	Area	No.	Area	No.	Area	No.	Area	No.	Area	No.	Area	No.	Area
Infiltration Vault [a]	1	N/A	0		2	N/A	0		0		3	N/A	6	N/A
Vegetated Facility [b]	113	37,248	0		44	213,420	2	1,432	50	46,234	3	3,443	212	301,777
Pond	6	35,758	0		4	58,518	0		0		1	992	11	95,268

a. GIS data do not include the configuration of an infiltration vault. Based on communications with City staff, an infiltration vault is likely a proprietary filtration vault (e.g., Contech StormFilter). Infiltration vaults have N/A listed in the area column as these are point locations and not dependent on facility surface size.

b. Includes swales, lined planters, and filtration rain gardens.

Figure 2-6, at the end of this section, provides an overview of the stormwater collection system throughout the City including stormwater mains, manholes, outfalls and public stormwater treatment and detention facilities as of 2021. The City's GIS data reflecting both public and private stormwater treatment and detention/retention facilities is continuously updated by City staff, the most up to date record can be found at https://www.wilsonvillemaps.com/.

2.6 Regulatory Drivers

The Oregon Department of Environmental Quality (DEQ) is responsible for implementing provisions of the federal Clean Water Act pertaining to stormwater discharges and surface water quality. DEQ issues permits related to surface water discharges, establishes water quality criteria for waterbodies based on designated beneficial 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 Phase I National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer (MS4) permit requirements and the Total Maximum Daily Load (TMDL) program and associated 303(d) listings for receiving waters.

2.6.1 NPDES Permit Requirements

The City is a co-permittee on the Clackamas County Phase 1 NPDES MS4 permit, along with 13 other jurisdictions in Clackamas County, for management of stormwater runoff. Other neighboring co-permittees include the cities of West Linn, Lake Oswego, and Oregon City.

The NPDES MS4 permit program regulates the discharges of stormwater to receiving waters from urbanized areas and requires permitted municipalities to develop and implement stormwater control measures to address water quality. As a co-permittee, the City is independently responsible for the implementation of their permit, although coordination through intergovernmental agreements (IGAs) with co-permittees is commonplace to help efficiently address programmatic needs such as public education and monitoring. The City's NPDES MS4 permit was reissued in October 2021 after being administratively extended when the previous permit expired in 2017. Most recently, the effective NPDES MS4 permit was modified in May 2023 to address a change in monitoring requirements.

Implementation of the City's NPDES MS4 permit is outlined in their 2022 Stormwater Management Program document (SWMP). Stormwater activities or best management practices (BMPs) are outlined to address the elements of the permit including:

- Public Education and Outreach
- Public Involvement and Participation
- Illicit Discharge Detection and Elimination
- Construction Site Runoff Control
- Post-Construction Stormwater Management for New Development and Redevelopment
- Pollution Prevention and Good Housekeeping for Municipal Operations
- Industrial and Commercial Facilities
- Monitoring and Reporting
- Stormwater Management Facilities Operation and Maintenance Activities

In addition to the elements above, the reissued NPDES permit requires an assessment of outcomes from the 2015 Hydromodification Assessment and 2015 Retrofit strategy, which was due to DEQ by December 1, 2023. This review required an evaluation of progress made under both plans and, as necessary, establishing new goals, priorities, and projects. This SMP incorporates goals and project identification efforts conducted for both documents (see Section 3.2 Water Quality Retrofit Analysis and Section 4 Stream Assessment), as well as identifies new projects and programs to support efforts in the future.

The continued consideration of water quality in conjunction with planning and development efforts is addressed within the City's NPDES MS4 permit, further necessitating the need for this SMP to address stormwater treatment, particularly in locations where treatment is not provided.

2.6.2 TMDL and 303(d) Listings

Wilsonville is in the Middle Willamette River watershed. All areas within the city limits and associated concept planning areas discharge either directly or indirectly to the Willamette River between river mile (RM) 37 and 40.

On September 21, 2006, DEQ finalized a TMDL for the Willamette Basin. The TMDL addressed water quality impairment of the Middle Willamette River and its tributaries and included previously approved TMDLs by reference. The Willamette Basin TMDL addressed bacteria, mercury, and temperature, and included wasteload allocations (WLAs) and load allocations (LAs) specific to Designated Management Agencies (DMAs), except for mercury, as it required additional monitoring and analysis prior to the development of allocations.

On November 22, 2019, DEQ issued the Final Revised Willamette Basin Mercury TMDL, which was in turn submitted and disapproved by the United States Environmental Protection Agency (USEPA) due to questions related to the identification of sources and associated concentrations used to define WLAs and LAs. On February 4, 2021, the Willamette Basin mercury TMDL was reissued by the USEPA, including WLAs specific to the stormwater.

Table 2-7 summarizes the TMDL pollutants and associated LAs and WLAs applicable to Wilsonville. The City's 2022 TMDL Implementation Plan specifies temperature management activities targeting effective shade as well as natural resource and stream channel restoration and riparian cover. Additionally, in conjunction with NPDES MS4 obligations, the City is required to develop pollutant load reduction benchmarks at the end of each permit cycle to quantify TMDL pollutant load reduction estimates due to stormwater management activities and facilities. This requires the continual installation of water quality treatment facilities to ensure progress is made towards TMDL pollutant load reduction goals.

Additional water quality impairments relevant to the City are reflected in the effective (2018/2020) 303(d) list for receiving waters within the City. Parameters of concern for the Middle Willamette River include aldrin, biological criteria, DDT/DDE, dieldrin, and polychlorinated biphenyls (PCBs). Such parameters represent additional targeted parameters for pollutant reduction with the City's stormwater program, as TMDLs are slated for development for these parameters in the future.

Table 2-7. TMDL Summary for Wilsonville

TMDL	Year	Subbasin(s)	TMDL Parameters	TMDL Surrogate Parameters	WLA	LA
Willamette River	2006	Middle Willamette	• Mercury • Bacteria (*E. coli*) • Temperature	Effective shade (surrogate for temperature)	• Mercury = 97% [a] • Bacteria = 75-88% reduction [b]	Temperature = 85-95% effective shade

a. Air deposition is the primary source of mercury for MS4 permittees. Through the City's reissued (2021) MS4 NPDES permit, the City was required to prepare a mercury minimization assessment and BMP effectiveness analysis to assess pollutant removal potential.

b. The WLA for bacteria varies according to season and discharge location. A 75% reduction in bacteria load is applicable for areas directly discharging to the Willamette River and a 75% reduction is applicable during the fall, winter, and spring seasons for areas discharging to tributaries. An 88% reduction during the summer season is applicable for areas that discharge to tributaries.

2.6.3 Regulatory Program Integration

Development of this SMP provides a unique opportunity to address regulatory requirements in the context of capital improvement program development, as outlined below:

- The City's 2021 NPDES MS4 permit includes expanded stormwater program and maintenance activities that will require additional stormwater resources and staffing, and such needs have been considered when developing capital project and program costs in this SMP (see Section 3.2 and Section 7.3).
- Updates to the 2015 Retrofit Plan and the 2015 Hydromodification Assessment (as required by the 2021 NPDES MS4 permit) are reflected with updated project needs identified and prioritization reflected in this SMP.
- Ongoing preservation and maintenance of stream channel vegetation and planting activities, as reflected in the 2022 TMDL Implementation Plan, are supported by capital project and program efforts (see Section 4).

Regulatory requirements have the potential to influence the City's overall stormwater capital program throughout the 20-year SMP implementation period. Figure 2-7 shows the correlation between the regulatory programs and SMP components. It reflects how requirements and activities conducted independently under individual regulatory programs help inform each other, as well as how the SMP is the primary mechanism to support capital and program funding and staffing resources that collectively benefits all programs.

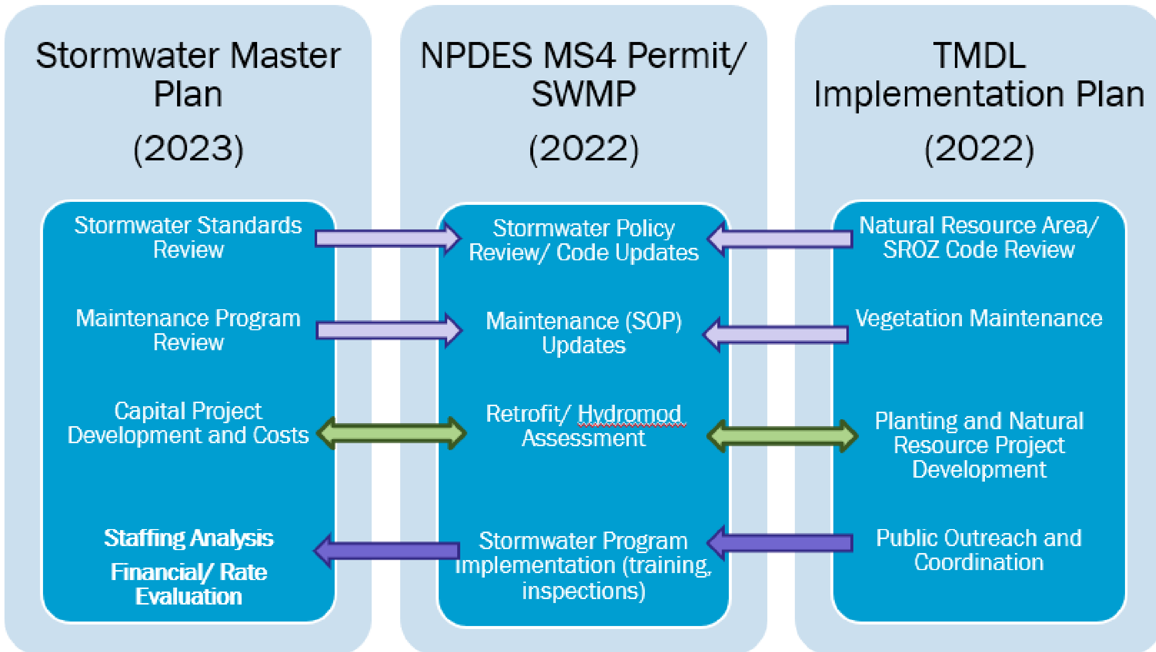


Figure 2-7: SMP and Regulatory Connectivity

2.7 Comprehensive Plan Review

All cities and counties in Oregon are required to adopt Comprehensive Plans and implement ordinances in conformance with the Statewide Planning Goals. Comprehensive Plans direct land use and development within local jurisdictions and must be legislatively adopted by the City and reviewed by the Land Conservation and Development Commission for compliance with Statewide Planning Goals. Local land use decisions must be made in conformance with the provisions and policies of the City's Comprehensive Plan.

The City of Wilsonville Comprehensive Plan (October 2018, updated June 2020) is periodically reviewed to ensure it is current and reflective of continued compliance. BC reviewed the City's Comprehensive Plan with respect to stormwater and consistency with the City's 2021 NPDES MS4 permit. Review comments are associated with the Public Facilities and Services, under the subcategory heading "Storm Drainage Plan". Comments and suggested changes are summarized below:

- Under Policy 3.1.8, page C-8 related to the Storm Drainage Plan, to be more consistent with the MS4 NPDES permit, the reference to pollutants "temperature and turbidity" should be updated to include additional pollutants of concern.
- Under Policy 3.1.8, page C-8 and throughout the plan, there are references to "detention facilities". These references imply that detention is the main or sole type of facility used for stormwater management. Given the focus of the MS4 NPDES permit on green infrastructure, low impact development, and infiltration/retention, the term "detention facilities" should be replaced with a broader term such as "stormwater management facilities" or itemized to include more recently prioritized types of facilities.
- Under Policy 3.1.7 (based on numbering, it should be Policy 3.1.9), there is reference to constructing facilities to improve stormwater quality and control the volume of runoff. To be comprehensive this should be expanded to include reference to controlling peak rates of runoff.

While not related to the MS4 permit, implementation measures related to natural resource areas and overlay zones in the Environmental Resources and Community Design Section (e.g., Implementation Management Measures 4.1.5.e, 4.1.5.m, and 4.1.5.n) were reviewed but no proposed adjustments are recommended in the context of the SMP.

2.8 Stormwater Operations

Stormwater-related maintenance activities are managed by the City of Wilsonville's Public Works Department, Roads and Stormwater Section. Stormwater-related planning, NPDES MS4 and TMDL compliance, and engineering activities are managed under the Community Development Department in the Engineering Division.

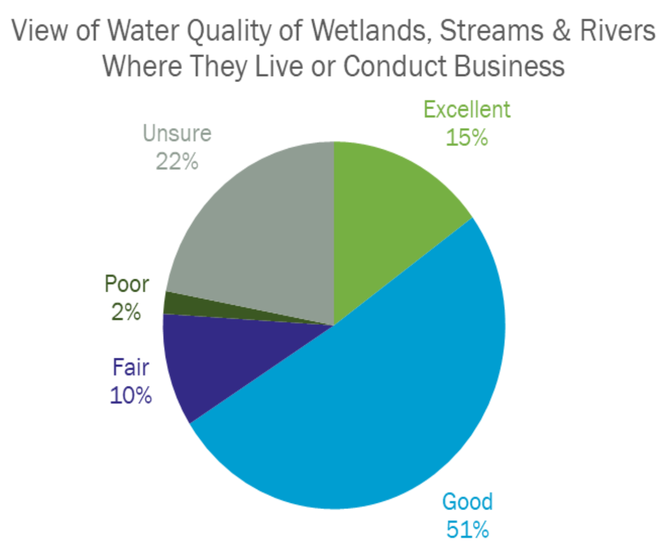
The City of Wilsonville's Public Works Roads and Stormwater Section currently has 2.74 full-time equivalent (FTE) to support ongoing stormwater maintenance efforts (0.4 FTE Stormwater Supervisor and 2.34 FTE Utility Maintenance Specialists). Of the 2.34 FTE Utility Maintenance Specialists, 2.0 FTE are dedicated to stormwater and the other 0.34 FTE reflect staff that assist with underground utility locating, but not dedicated to stormwater. Occasionally, additional coordination with Parks and Recreation is required to supplement staff to conduct routine and response-driven maintenance activities (time not reflected in the FTE summary).

The City of Wilsonville Community Development Department in the Engineering Division includes 1.5 FTE that are responsible for NPDES MS4 and TMDL compliance and directly support the Public Works Roads and Stormwater Section with facility inspections and other activities. Additional Engineering staff oversee and manage capital projects, as well as perform stormwater development review activities.

2.9 Community Perspectives

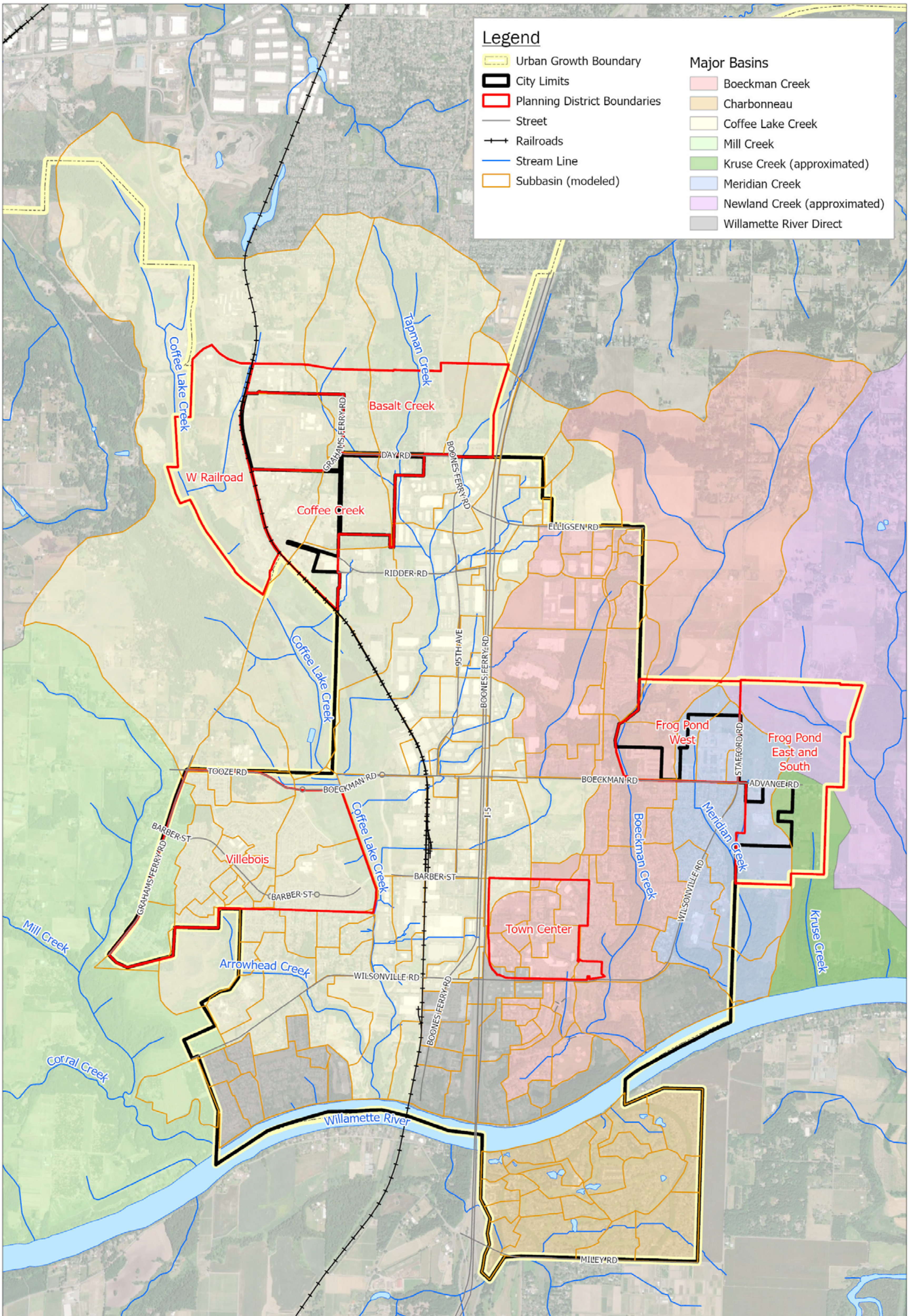
Outreach efforts were conducted at the beginning of the SMP process, in part, to obtain a better understanding of City perceptions of stormwater, as well as the perception of stormwater services provided by the City.

A public survey was advertised from April 1 to May 15, 2021, on the City's *Let's Talk Wilsonville* web platform. Interested citizens and community members were invited to participate. The survey was provided in both English and Spanish, and 90 participants completed the survey, encompassing both residential and business customers. The survey also provided a forum for participants to describe observed issues and concerns with the stormwater system operation and functionality.



Public surveys help confirm the types of capital projects most beneficial to the community

Findings from the survey indicated that more than 65 percent of the participants believe water quality in wetlands, streams, and rivers in Wilsonville are of excellent or good condition and 97 percent of participants the City had a positive impression of Wilsonville's stormwater services. For both residential and business customers, removal of pollutants before runoff enters streams; the improvement of water quality and habitat; and management of flood/flooding problems (in pipes and facilities) were identified as the most important stormwater services.



Brown AND Caldwell

City of Wilsonville/
Project # 156157

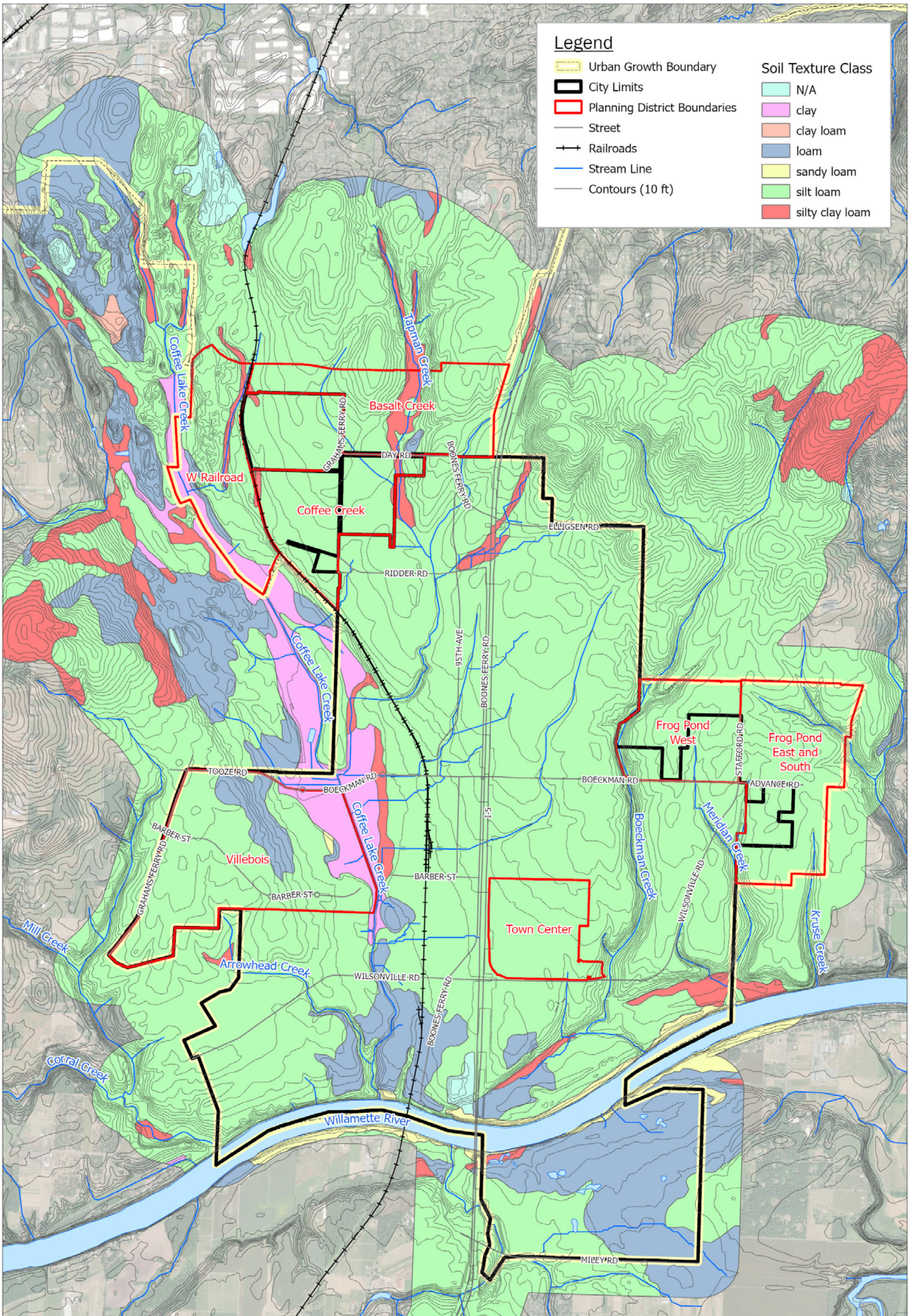
Stormwater Master Plan

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

N

0 0.25 0.5 1 Miles

Figure 2-2: Major Basins and Planning Areas



City of Wilsonville/
Project # 156157
Stormwater Master Plan

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

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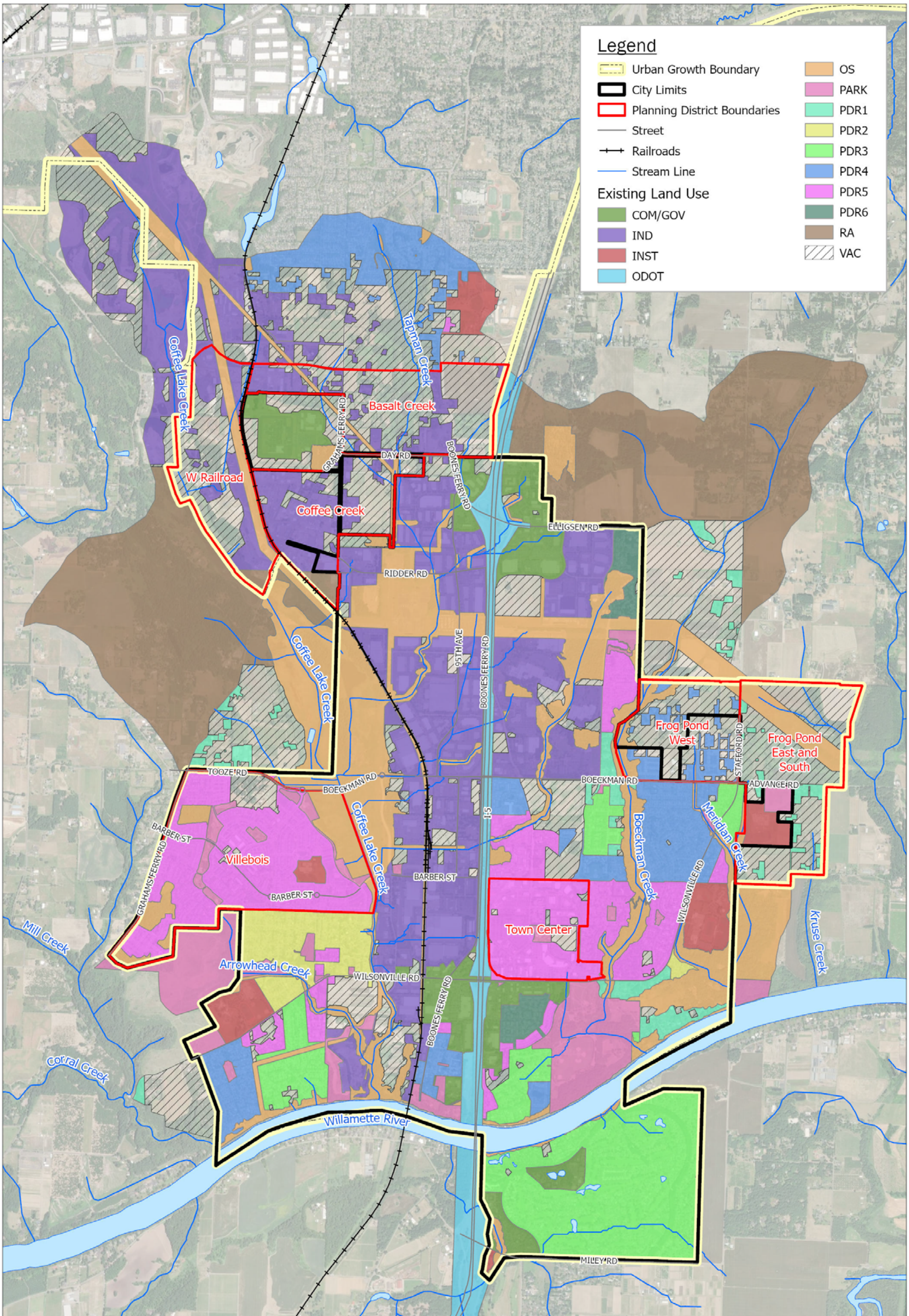
Figure 2-3: Soils and Topography



Brown AND Caldwell

City of Wilsonville/
Project # 156157
Stormwater Master Plan

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

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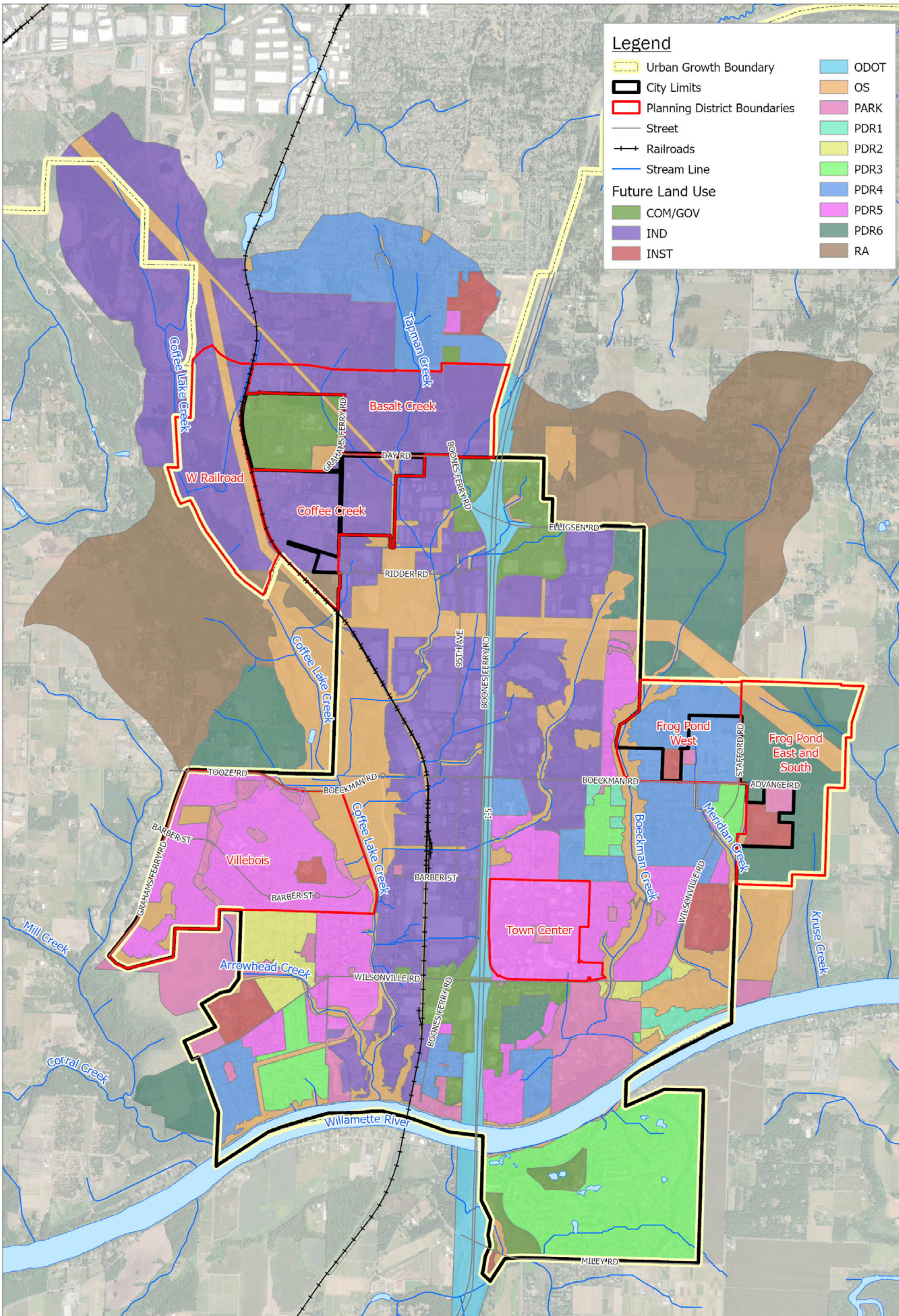
0 0.25 0.5 1 Miles

Figure 2-4: Existing Land Use Condition



Brown AND Caldwell

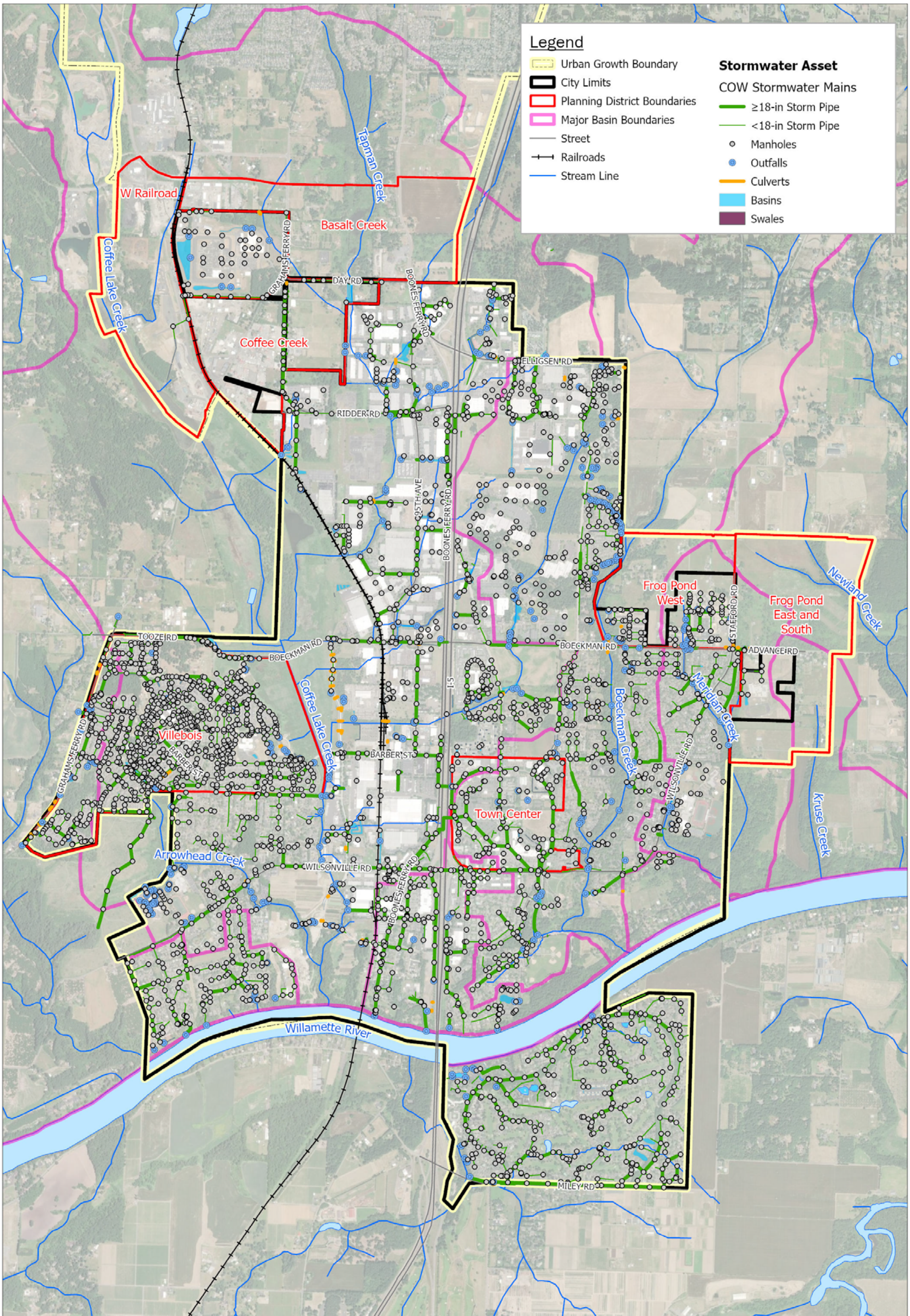
City of Wilsonville/
Project # 156157
Stormwater Master Plan

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

N

0 0.25 0.5 1 Miles

Figure 2-5: Future Land Use Condition



City of Wilsonville/
Project # 156157
Stormwater Master Plan

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

N

0 0.25 0.5 1 Miles

Figure 2-6: Stormwater System Overview

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Section 3

Basis of Planning

This section summarizes the overall project planning process and the process to identify stormwater problem areas and water quality retrofit needs, which collectively inform capital project needs identification and development efforts.

This project planning process allowed the City to develop information for areas and activities most likely to be prioritized and funded in a capital improvement program. This process qualified project and program needs in consideration of the SMP objectives, including rectifying known areas of stormwater drainage problems and flooding; enhancing and/or expanding water quality treatment and flow control; and identifying programmatic opportunities to address stormwater needs on a city-wide scale.

Appendix A includes background documentation related to the project planning activities, including a Stormwater Problem Area matrix (Appendix A, Table A-1) and a Project Opportunity Matrix (Appendix A, Table A-2). Identified project opportunities stem from the individual assessment of problem areas (Section 3.1), water quality retrofit opportunities (Section 3.2), stream assessment efforts (Section 4), and H/H modeling results (Section 5).

Referenced figures are included at the end of this section.

3.1 Problem Area Identification

A collaborative approach with Community Development and Public Works staff, as well as the public, was used to identify known stormwater problem areas where infrastructure improvement, replacement, or retrofit may be needed. Problem areas were initially identified through a combination of City staff surveys and follow-up discussions, an external survey (distributed via a virtual open house platform), review of the 2012 SMP, field investigations, and a Project Planning Workshop.

Problem areas were documented in a Stormwater Problem Area Matrix (Appendix A, Table A-1) by primary and secondary deficiency category (i.e., capacity issue, instream erosion/sediment issue, maintenance, and repair and replacement). In addition, portions of the stormwater system requiring refinement/update or expansion of the existing H/H model, as well as locations to be investigated as part of the stream assessment were identified. Problem areas are mapped by primary deficiency (see Figure 3-1 at the end of this section).

3.1.1 City Staff Surveys

In February 2021, surveys were distributed to City staff requesting input on specific locations of reported capacity deficiencies, system condition issues (i.e., pipe and open channel), frequent maintenance needs, and water quality opportunities.

On March 16, 2021, Public Works and Community Development staff collaborated and provided a summary table and accompanying map reflecting 39 problem area locations. Some locations and descriptions provided from Community Development staff overlapped with locations identified by Public Works. Specific issues included culvert misalignments, use of bubblers, standing water in roads and easements due to a lack of system capacity, flooding at open channels, crushed or improperly abandoned pipe, the buildup of sediment at catch basins, and damaged outfall structures.

3.1.2 External Stakeholder Surveys

To help facilitate external communications to the public (i.e., citizens and business community), a survey was prepared for external stakeholders to solicit information regarding drainage issues and project needs. External stakeholders included community members, businesses and community groups, developers and contractors, and neighboring jurisdictions.

The Let's Talk Wilsonville web platform was used to publish the external survey as well as provide general background information related to stormwater, the City's current stormwater system, and the purpose of the SMP. The external survey was publicized using local publications (i.e., Boones Ferry Messenger) as well as social media.[5] Website content was also translated into Spanish.

The external survey was open from April 1 to May 15, 2021, and included general demographic questions and questions intended to assess the level of understanding of the participant with respect to stormwater utilities. Additional questions related to values and level of service were also included. The survey included an opportunity for the participant to directly identify problem areas/locations and issues of concern.

The external surveys resulted in the identification of four additional problem areas that are documented in the Problem Area Matrix (Appendix A, Table A-1).

3.1.3 2012 Stormwater Master Plan

The City's 2012 SMP identified 50 stormwater CPs. Project categories included pipe replacement, planning/studies, restoration projects, and low impact development (LID) projects. Sixteen of the projects identified in the 2012 SMP were either completed or are in progress. Some of the proposed pipe replacement projects were subsequently reflected in the Charbonneau Infrastructure Plan (2014).

Outstanding (non-constructed) projects from the 2012 SMP were reviewed against identified problem areas and seven locations directly overlapped. The remainder of projects from the 2012 SMP were discussed with the City during a project coordination call to confirm the need to include the associated project area directly in the Problem Area Matrix. Because hydrologic modeling methods for this plan deviate from the 2012 SMP, and additional assessment efforts (water quality retrofit assessment, stream assessment) were conducted for this SMP, the City opted to independently evaluate project needs for this SMP update instead of relying on previous outdated work.

3.1.4 Project Planning Workshop

A Project Planning Workshop was conducted with City staff on August 24, 2021, to review data compilation efforts and the identification of the stormwater problem areas. The objective of the workshop was to solicit additional detail on the nature of each problem area, add any additional problem areas suggested by the City, and to categorize the problem areas by potential solution (whether project-based or programmatic).

A total of 46 problem areas were identified for discussion. Discussion included the size and scale of the anticipated project and whether a capital project solution or programmatic approach may be taken to address the issue. Problem area locations were also reviewed to establish 1) the need to conduct a site visit; 2) a need to expand model extents to evaluate the problem area; and 3) whether

[5] The current website is: Stormwater Master Plan Update | Let's Talk, Wilsonville! (letstalkwilsonville.com).

there is benefit in including the location as part of the stream assessment effort. From the workshop, 22 locations requiring site visits were flagged and scheduled. Seven locations were flagged for consideration as part of the stream assessment effort.

3.1.5 Field Investigation

An initial field investigation was conducted September 27, 2021, to verify stormwater problem areas and assess potential project concepts in conjunction with the Project Planning Workshop. A total of 14 problem areas were visited, clustered into seven discrete site visit locations. The site visits provided BC staff with an opportunity to discuss each of the problem areas and better understand the overall drainage patterns and system to advance discussion of modeling needs and capital project concepts.

Subsequent site visits were conducted to inform H/H model validation, water quality retrofits, and capital project development efforts, and those field investigation efforts are discussed under the respective sections.

3.1.6 Results

The Problem Area Matrix (Appendix A, Table A-1) includes the findings from the Project Planning Workshop and field investigation efforts, and documents whether the problem area and potential project solution required additional evaluation as part of the stream assessment and/or hydraulic modeling (via expansion of the existing modeling extents). Problem area locations, including those where a site visit was conducted are reflected in Figure 3-1 at the end of this section.

Of the comprehensive list of 46 identified problem area locations, 11 locations were not anticipated to warrant a project or program solution but were maintained in Table A-1 for reference. Seven locations were identified for further evaluation as part of the stream assessment effort, and eight locations were identified for evaluation as part of the capacity analysis.

Following field investigations and additional evaluation efforts, vetted problem areas were carried forward as Project Opportunity Areas (see additional discussion in Section 6.1) and CP needs. Project Opportunity Areas are documented in Appendix A, Table A-2.

3.2 Maintenance Evaluation

Per Section 3.1, some problem areas were identified as the result of deferred maintenance or due to a relatively minor drainage issue that may not warrant capital project funding. These issues can be more efficiently addressed by expansion of the City's maintenance program (with increased staffing) and/or by defining a programmatic need that can be annually funded.

Maintenance activities and staffing allocations were discussed during a series of two interviews with Public Works staff in late 2021. Staff labor estimates by department and maintenance activity were compiled for use during interviews. The interviews were used to verify the current (as of 2021) maintenance activities, maintenance frequencies and internal processes to issue work orders. The City's Public Works Department uses Cartegraph for asset management, and Cartegraph refers to features (assets) in the City's GIS system to specify where maintenance is required.

Table 3-1 summarizes the primary stormwater maintenance activities conducted by the City of Wilsonville's Public Works Roads and Stormwater Section, along with a summary of the frequency and ability of the stormwater staff to meet maintenance targets (whether they are NPDES MS4 Permit-related or individual Public Works goals). Table 3-1 does not reflect an extensive list of activities but rather reflects the primary activities with a regulatory driver.

Table 3-1. City Maintenance Activities and Potential Implementation Gaps								
Activity	NPDES MS4 SWMP Requirement	Frequency Required [a]	Annual Target [a]	Regularly Meeting Target? (Y/N) [b]	Required Crew Size	Stormwater Staff Time (per person)	Department	Increased Staffing Need (Y/N)
TV inspection	Not explicitly stated	Annual	15% (60,000 LF) of public conveyance system >6"	N	2	200 ft/hr	Public Works (see Cartegraph Work Flow Process 8.0)	Y
Pipeline cleaning	Y	Annual	As required based on inspections	Y	2	250 ft/hr	Public Works	N
Priority CB inspection and cleaning	Y	Annual	All	Y	2	0.5 hr/facility	Public Works	N
Other CB inspection and cleaning (public)	Y	Every 4 years	25% of total	N	2	0.5 hr/facility	Public Works	Y
Culvert inspections and cleaning	Y	Annual	20%	Uncertain	2	2 hr/facility	Public Works	Potential
WQ MH inspection/cleaning	Y	Annual	150	N	2	1 hr/facility	Public Works	Y
Street sweeping [c]	Y	Monthly	All curbed	Y	NA	165 hours total annually	Contractor	N
System repair and maintenance	Y	As needed	-	Y	2	Varies	Public Works	N (Programmatic approach recommended)
Public water quality facility inspections	Y	Annual	All	N	2	1 hr/facility	Community Development/ Public Works	N
Public water quality facility maintenance [c]	Y	Annual	Public works performs maintenance independent of inspection results	Y (magnitude varies)	2	1-16+ hrs/facility	Public Works	Potential
Public water quality facility maintenance (landscaping)	Y	Annual	All	Y (magnitude varies	NA	291 hours	Public Works	Potential
Private WQ facility inspections [d]	Y	Annual	Varies	Y	1	4 hr/facility	Community Development	N

a. Based on the documentation in the 2022 SWMP Document and/or as documented in the City's Stormwater Maintenance Schedule.

b. Based on the available documentation in the NPDES MS4 annual reports or as provided by Public Works. This column reflects the ability of the Roads and Stormwater Section to conduct this work independently (not requiring staff supplementation from other Sections or Divisions).

c. Activity requirements vary based on inspection results.

d. Current GIS data does not differentiate types of facilities in the "basins" GIS layer. Basins includes ponds, swales, planters, and raingardens.

3.2.1 Staffing Estimates to Support Maintenance Activities

In accordance with Table 3-1, additional staffing is required to conduct routine maintenance activities in conjunction with NPDES MS4 permit requirements. Estimated staffing needs were initially calculated based on required staff time and length/number of assets (see Section 2.5) and discussed with the Public Works Operations Manager to better incorporate the following staffing considerations:

- Approximately 35 percent of time reserved for stormwater maintenance ultimately supports other departments and emergency response needs. Because many maintenance activities require a crew of two people, the Public Works Roads and Stormwater Section (with 2.74 FTE) is unable to consistently conduct routine maintenance activities and be available to respond to emergencies.
- Based on detailed staff labor estimates compiled by the City, approximately 15 percent of work orders issued by the Stormwater Division are cancelled, which means staffing limitations are preventing the work orders from being completed.

Additional staffing estimates assume that one FTE equals approximately 1,650 hours of work after deducting estimated annual leaves, training, and other non-task related hours (Personal communication with Martin Montalvo, Public Works Department Operations Manager, November 17, 2021). The following maintenance activities were evaluated and additional staff support needs estimated.

- **CCTV Inspections:** Closed-circuit television (CCTV) inspections for stormwater and sanitary were historically contracted out by the City, but in 2021, the City took over delivery of the work. Stormwater CCTV efforts do not routinely occur. The City maintains a Public Works goal of inspecting 15 percent of their public collection system (>6 inches in diameter) annually, which is approximately 60,000 LF of pipe. Stormwater Division staff are needed to operate the CCTV equipment and review of the CCTV reports.

  Recommendation = 0.5 FTE

- **Non-priority Catch Basin/Pollution Control Manhole Cleaning:** The City regularly maintains identified priority catch basins, but routine cleaning of all catch basins is more challenging with current Roads and Stormwater section staffing levels (i.e., clean all catch basins on a 4-year cycle).

  Recommendation = 0.25 FTE

- **Vegetated System Maintenance:** LID facilities (swales/planters) and stormwater basins (ponds) require more extensive maintenance than traditional gray infrastructure (e.g., filter vaults, underground detention facilities, etc.). Maintenance activities include debris removal, vegetation removal and replacement, regrading, replacement of amended soil media, inlet and outlet cleaning, and repair of structural components. Some activities may occur during each maintenance effort (e.g., annually), whereas some may be conducted once every few years.

  Current staffing levels and maintenance efforts do not account for/include vegetation/soil replacement or the large-scale reconstruction/replanting of facilities that are not operating property. Additional staffing needs will help ensure a more proactive program for inspection and maintenance, as well as development of a standard operating procedure (SOP) to guide vegetated system maintenance (both shorter term and larger scale).

  Recommendation = 1.25 FTE (assuming annual maintenance of 4 hours for vegetated facilities; 16 hours for ponds).

A total of two additional FTE are estimated to address recurring and deferred maintenance activities exclusive to the Public Works Roads and Stormwater Section. Final maintenance-related staffing recommendations in conjunction with the 2022 SWMP Document and identified CPs per this SMP are referenced in Section 7.3.

3.2.2 Programmatic Needs

The Project Planning Workshop and subsequent interviews with Public Works staff also identified the following ongoing programmatic activities that, if routinely conducted, could offset individual CP needs. These programmatic concepts were refined and are detailed in conjunction with CP development activities in Section 6.

- **Repair and Replacement (R/R) Program.** Dedicated funding is needed to repair/replace all public pipe 12-inches and greater within the City limits over a defined timeframe to address lifecycle costs.
- **Localized Drainage Improvements.** Dedicated funding is needed to assist with minor system configuration or installation needs or to respond to recurring maintenance needs.
- **Inlet Replacement Program.** Dedicated funding is needed to relocate and/or install curb inlets instead of catch basins in high traffic roads with significant leaf debris to help address localized drainage issues.
- **Green Street Retrofit Program.** A dedicated program is needed to retrofit local streets, which may include, depending on the feasibility, porous pavement overlays and/or green street facilities to promote additional infiltration and water quality treatment.

3.3 Water Quality Retrofit Analysis

Opportunities to incorporate water quality treatment are necessitated by the regulatory drivers in place for the City and supported by the community and public goals to protect water quality. These water quality retrofits can be accommodated through the addition of new water quality and/or detention facilities or the reconfiguration of existing facilities.

The problem area identification effort was focused on capacity and maintenance issues (Section 3.1) and did not focus on water quality objectives. Therefore, a separate analysis was conducted to identify locations where water quality could be integrated into the developed landscape or where pending development and future transportation projects could be leveraged to initiate construction of new facilities. To support the analysis, a GIS desktop evaluation was conducted to map public property (classified as vacant, parks, open space, or City-owned), ponds (public and private), water quality projects from the 2012 SMP, existing stormwater facility contributing drainage areas, and future transportation corridors.

Based on a review of the mapping and City staff preferences, the following objectives (strategies) were developed to guide the water quality retrofit analysis for this SMP:

1. Revisit priority (higher scoring) retrofit projects previously identified in the 2015 Retrofit Assessment to confirm continued relevance. These projects reflect water quality-related projects per the 2012 SMP. Review and integration of findings from the 2015 Retrofit Assessment was conducted to support compliance with requirements of the 2021 NPDES MS4 permit.
2. Retrofit underutilized facilities such as ponds or swales to enhance water quality and/or provide downstream flow mitigation to address erosion/hydromodification issues.
3. Integrate water quality and/or flow control into existing project opportunity areas (where possible).

Identification of new facilities to support future development and growth is not a preferred retrofit strategy, given the fact that private development will already be required to adhere to the City's prescriptive stormwater design standards.

Figure 3-2, at the end of this section, reflects source information used for the water quality retrofit analysis, as well as the resulting project needs.

3.3.1 2015 Retrofit Assessment Update

The City's 2015 Stormwater Retrofit Plan documents the City's stormwater policies, projects, and programs intended to improve water quality in areas of the City that are currently underserved or lacking stormwater quality controls. The 2015 Retrofit Plan included a review of twenty, non-constructed capital projects (CPs) per the City's 2012 SMP and 2014 Capital Improvement Program that had a water-quality element. Updated scoring criteria that focused on water quality objectives were applied to each project. Criteria included:

- Progress toward meeting TMDL Wasteload Allocations (i.e., bacteria and mercury)
- Priority areas for treatment (focusing on areas with no structural stormwater treatment facility and high pollutant generating areas [commercial/industrial land uses])
- Temperature control (meet the shade targets identified in the TMDL)
- Erosion prevention and control (i.e., retrofit of outfalls or stream channel restoration where active erosion results in the transport of excess sediment, increased turbidity and reduced instream water quality).
- Additional objectives (including project integration, maintenance, livability/sustainability, safety, and land acquisition).

For this SMP, the prioritized projects per the City's 2015 Retrofit Plan were reviewed to confirm: 1) projects completed and/or where a project need may have changed, and 2) projects that should be carried forward as part of this SMP.

Results of this review are detailed in Table 3-2. Identified project needs are carried forward as a Project Opportunity Area.

Table 3-2. 2015 Retrofit Assessment Review and Project Opportunity Status								
2015 Retrofit Assessment Project ID	Project Name	Constructed?	Overlaps with 2023 SMP Problem Area Location ID	Overall Score [a]	Retrofit Assessment Findings			
					Feedback	2024 SMP Result		
						Project Opportunity	Program Opportunity	N/A
LID3	SW Camelot Green Street Mid-block Curb Extension	No	Yes, 46	16	Viable project, but could be reflected in program (Section 6.5)		X	
LID7	SW Wilsonville Road Stormwater Planters	No	No	16	Viable project, but could be reflected in program (Section 6.5)		X	
CLC-10B	Coffee Creek Storm Projects	No	Yes	16	Not Applicable-reflects 2012 SMP CLC-1. Project number is unique to the Retrofit Assessment source document.			X
BC-5	Boeckman Creek Outfall Realignment	No	No	13	• Project involves realignment of an existing outfall into Boeckman Creek (330' N of Wilsonville Rd) that is causing erosion. • Erosion issues not identified/confirmed in 2022 stream assessment effort. • Project location overlaps potential Boeckman Road mitigation site (Creekside Apartments). See Project Opportunity Area #23.	X		
CLC-6	Coffee Lake Creek South Tributary Wetland Enlargement	No	No	13	• Referenced as a long-term project need from source document of retrofit assessment. • Project location overlaps with a portion of the Boeckman Road mitigation area (Siemens/Ash Meadows). Current METRO project may also negate the project need.			X
BC-4	Gesellschaft Water Well Channel Restoration	No	No	13	Project still viable and construction may occur in conjunction with other infrastructure projects (Interceptor Trail).	X		
LID2	SW Hillman Green Street Stormwater Curb Extension	No	No	13	Viable project, but could be reflected in program (Section 6.5)		X	
BC-8	Canyon Creeks Estate Pipe Removal	No	Yes, 37	12	• Short term/High priority CIP need per source document from retrofit assessment. • Project locations may overlap potential Boeckman Road mitigation site (Canyon Creek Park). See Project Opportunity Area #24.	X		
CLC-3	Commerce Circle Channel Restoration	No	Yes, 15/32	12	• Mid-term project need from source document of retrofit assessment. • See Project Opportunity Area #9.	X		
WD-4A	Willamette Way West Outfall Replacement	No	No	11	Project location is being monitored. No immediate project needs.			X
WD-4B	Belknap Ct Outfall Protection	Yes	No	11	Complete. Remove from list.			X

Table 3-2. 2015 Retrofit Assessment Review and Project Opportunity Status

2015 Retrofit Assessment Project ID	Project Name	Constructed?	Overlaps with 2023 SMP Problem Area Location ID	Overall Score [a]	Retrofit Assessment Findings: Feedback	2024 SMP Result: Project Opportunity	2024 SMP Result: Program Opportunity	2024 SMP Result: N/A
WD-4C	Morey Ct West Outfall Protection	Yes	No	11	Complete. Remove from list.			X
BC-2	Boeckman Creek Outfall Rehabilitation	No	No	9	• Project involves rehab of five existing outfalls between Wilsonville Rd and Boeckman Rd that have erosion issues. • Erosion issues not identified/confirmed in the 2022 stream assessment. • Targeted retrofit of culverts has already occurred.			X
BC-10	Memorial Park Stream and Wetland Enhancement	No	No	9	• Project was intended to enhance the existing stream channel that flows into Boeckman Creek to the N of Memorial Park baseball field (near sanitary lift station). This stream receives flow from the Memorial Drive Swales which are just upstream. Mid-term project need from source document of retrofit assessment. • Project location overlaps with potential Boeckman Road flow mitigation site. See Project Opportunity Area #23.	X		
CLC-1	Detention/Wetland Facility Near Tributary to Basalt Creek	No	Yes, 15/32	8	• Referenced as a long-term project need from source document of retrofit assessment but aligns with problem area. • See Project Opportunity Area #9.	X		
CLC-2	SW Parkway Avenue Stream Restoration	No	No	8	• Project is no longer needed, given onsite improvements for capacity (La Quinta). Remove from retrofit assessment.			X
CLC-7	Coffee Lake Creek South Tributary Stream Restoration	No	No	8	• Project is no longer needed as this location conflicts with proposed new Public Works building. Current METRO project may also negate the project need.			X
CLC-8	Coffee Lake Creek Restoration	No	No	8	• Project is no longer needed. This location is associated with 5th and Kinsman Project-Road isn't going to come out so project no longer applicable. Also at the driveway for Wilsonville Concrete.			X
CLC-5	Coffee Lake Creek Stream and Riparian Enhancement	No	No	7	• Referenced as a long-term project need from source document of retrofit assessment. • Limited access onto private property.			X
CLC-4	Ridder Road Wetland Restoration	No	No	7	• Referenced as a long-term project need from source document of retrofit assessment. • Not a high priority need for future restoration, but maintain as a future Project Opportunity Area.	X		

a. The overall score is per the 2015 Retrofit Assessment and considered for this 2024 SMP as an indication of the preferred water quality projects per the 2012 SMP.

3.3.2 New Retrofit Opportunities

In addition to project needs maintained from the 2015 Retrofit Assessment, several opportunities to integrate water quality and/or flow control into existing, underutilized facilities or another Project Opportunity Area were identified. These opportunities and their preliminary retrofit concepts are summarized in Table 3-3.

Table 3-3. New Retrofit Opportunities

Location	Retrofit Strategy	Retrofit Concept
Library Pond	Underutilized Facility	Install outlet structure to existing pond to provide flow control benefits. Drainage from Town Center is conveyed through this facility. Opportunity to implement a fee-in-lieu system for upstream redevelopment.
Tivoli and Oulanka Parks	Underutilized Facility	Combination of public and private swales at these locations. Swales have not been properly maintained and need retrofit.
Oregon Glass Pond	Underutilized Facility	Ponds near the outfall of the Ridder Rd./Peters Rd. Piped stormwater system may be reconfigured to provide a flow control benefit. Opportunity to help mitigate the pipe capacity issues at this location.
Memorial Park Dr. Swales	Underutilized Facility and Existing Project Opportunity	Existing swale is not draining properly. Swale needs retrofit and potential relocation.
Canyon Creek Park	Existing Project Opportunity	Existing Park property has potential for construction of a regional facility. This facility could treat upstream runoff from Argyle Square, Sysco, and other future developments. Due to location within BPA easement, additional coordination would be required.

3.4 Boeckman Road Hydraulic Evaluation and Mitigation Opportunities

Concurrent with development of this SMP, Wilsonville is constructing improvements to Boeckman Road from SW Canyon Creek Road to SW Stafford Road, as part of a Progressive Design-Build project. The Boeckman Road Corridor Project (BRCP), initiated in 2021, involves widening and reconstruction of the road, including removal of an existing culvert and instream flow control structure (FCS) on Boeckman Creek immediately north of Boeckman Road. The removal of the culvert and FCS prompted earlier planning efforts and a technical evaluation of Boeckman Creek. Opportunities for water quality and flow control mitigation within the Boeckman Creek watershed were identified and considered with project planning efforts for this SMP.

In 2021, a hydraulic evaluation of Boeckman Creek was conducted to evaluate potential changes to flows and water surface elevations (WSE) in Boeckman Creek due to removal of the FCS and the existing culvert crossing (Boeckman Road Hydraulic Evaluation, January 2022). The City's existing H/H InfoSWMM model (also used for this SMP) was refined and calibrated to reflect existing hydraulic performance. Efforts to identify potential off-site flow mitigation were initiated in 2022 with significant participation from City staff and the Progressive Design-Build consultant team. Both upland and instream mitigation locations were evaluated based on specific criteria including contributing drainage area and available storage capacity.

Four potential mitigation locations were ultimately identified as preferred locations. Preferred mitigation locations are referenced in the Project Opportunity Matrix for this SMP (see Appendix A, Table A-2).

3.5 Growth-Related Considerations

A particular focus for this SMP is future development/growth areas, as these areas are expected to develop in the near term and require new stormwater infrastructure including pipe and stormwater management facilities. Such future development may result in increased impervious area and additional stormwater runoff.

Specific growth areas of interest for this SMP include those areas documented in the Basalt Creek Concept Plan (2018), the Town Center Plan (2019), and the Frog Pond East/South Concept Plan (2022). These growth areas represent Project Opportunity locations because new public infrastructure is required and may be funded (in part) by the City. Therefore, cost estimates for new infrastructure are required for inclusion in the overall stormwater CIP.

3.5.1 Basalt Creek Concept Planning Area

With the adoption of the Basalt Creek Concept Plan by the cities of Tualatin and Wilsonville in August 2018, efforts are underway to amend the City's Comprehensive Plan and Transportation System Plan to promote industrial development in the area. Downstream capacity deficiencies on Tapman Creek require further study and planning to address increases in impervious surface due to anticipated development. Development in the Tapman Creek basin will be subject to differing onsite stormwater management standards for new and redevelopment activities. The City of Tualatin, in the upstream portion of the basin, implements Clean Water Services (CWS) standards, whereas the City of Wilsonville regulates stormwater locally. Despite differing standards and requirements, all drainage from the Basalt Creek concept planning area will ultimately drain through City infrastructure before entering Coffee Lake Creek.

The Day Road area, including Commerce Circle, is identified as a problem area (Appendix A, Table A-1) and Project Opportunity Area (Appendix A, Table A-2) and receives flow directly from new development in the Basalt Creek Concept Planning area. Policies related to onsite stormwater management in the upstream portions of the basin may be considered to help mitigate existing, downstream capacity constraints.

3.5.2 Town Center Planning Area

The Town Center Plan (2019) addresses a key redevelopment area in the city, located north of Wilsonville Road in the Boeckman Creek basin. Redevelopment of the Town Center area is anticipated to require major reconfiguration of the existing stormwater collection system. The Town Center Plan proposes the demolition of several segments of existing stormwater trunkline and the installation of new piping alignments in conjunction with City ROW. As a result of these improvements, additional flow is anticipated to be conveyed to the downstream Library Detention Pond, south of Wilsonville Road in Memorial Park.

Inclusion of new infrastructure associated with the Town Center redevelopment area is reflected as a Project Opportunity in Appendix A, Table A-2 (Figure 3-3). In addition, the Library Pond is identified as a current problem area, as well as a Project Opportunity. Policies related to the use of the Library Pond as a fee-in-lieu strategy/facility for treatment and/or flow control for upstream redevelopment are described in Section 6.3.4.

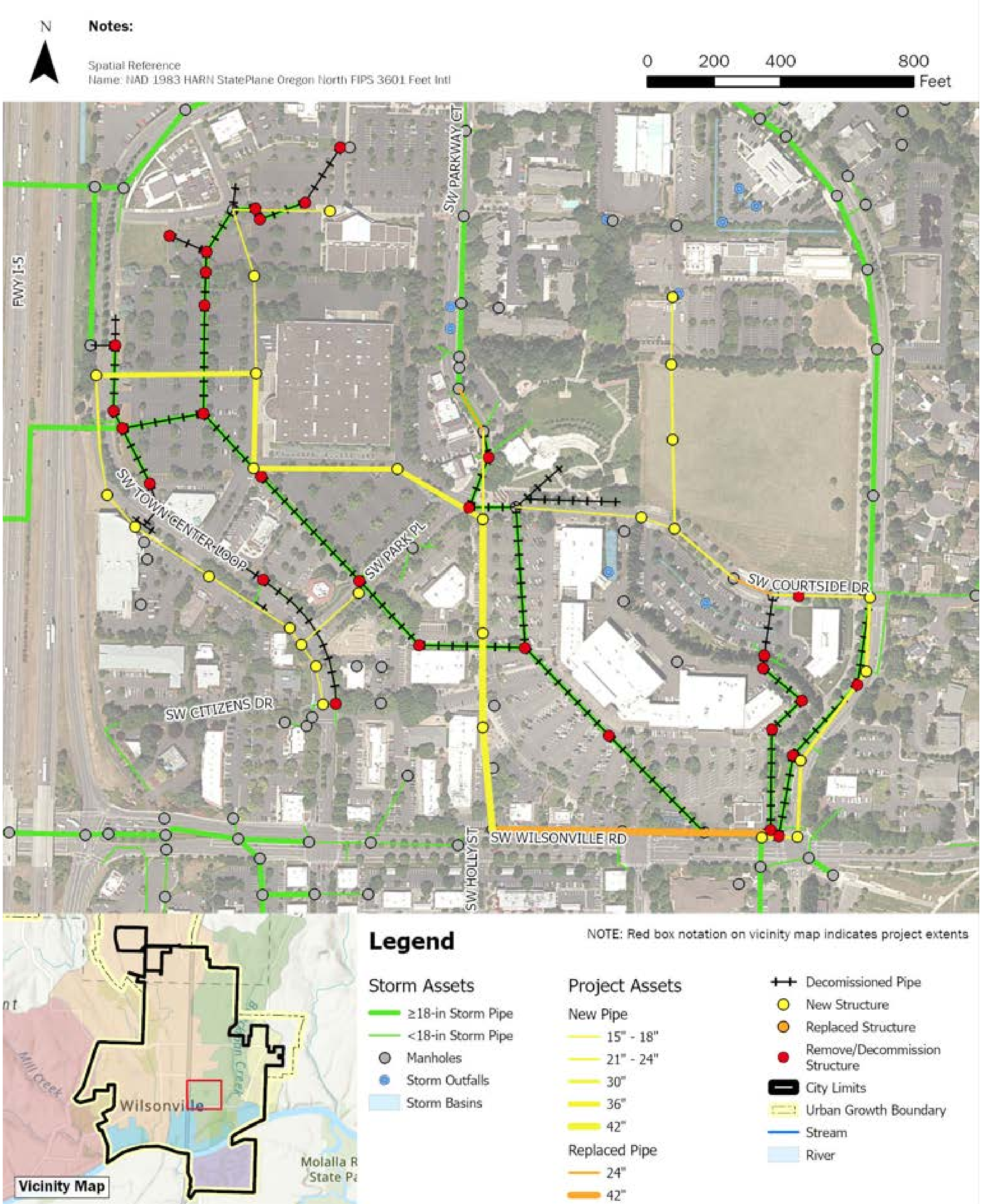

Figure 3-3: Town Center Stormwater Infrastructure Proposal

3.5.3 Frog Pond East and South Planning Area

The Frog Pond East and South Planning Area is located east of the existing Frog Pond development, adjacent to Advance Road in the Newland Creek basin. New development warrants the installation of new stormwater trunklines and outfalls in dedicated City ROW. Inclusion of new infrastructure associated with the Frog Pond East and South Planning Area is reflected as a Project Opportunity Area (Appendix C, Table C-2).

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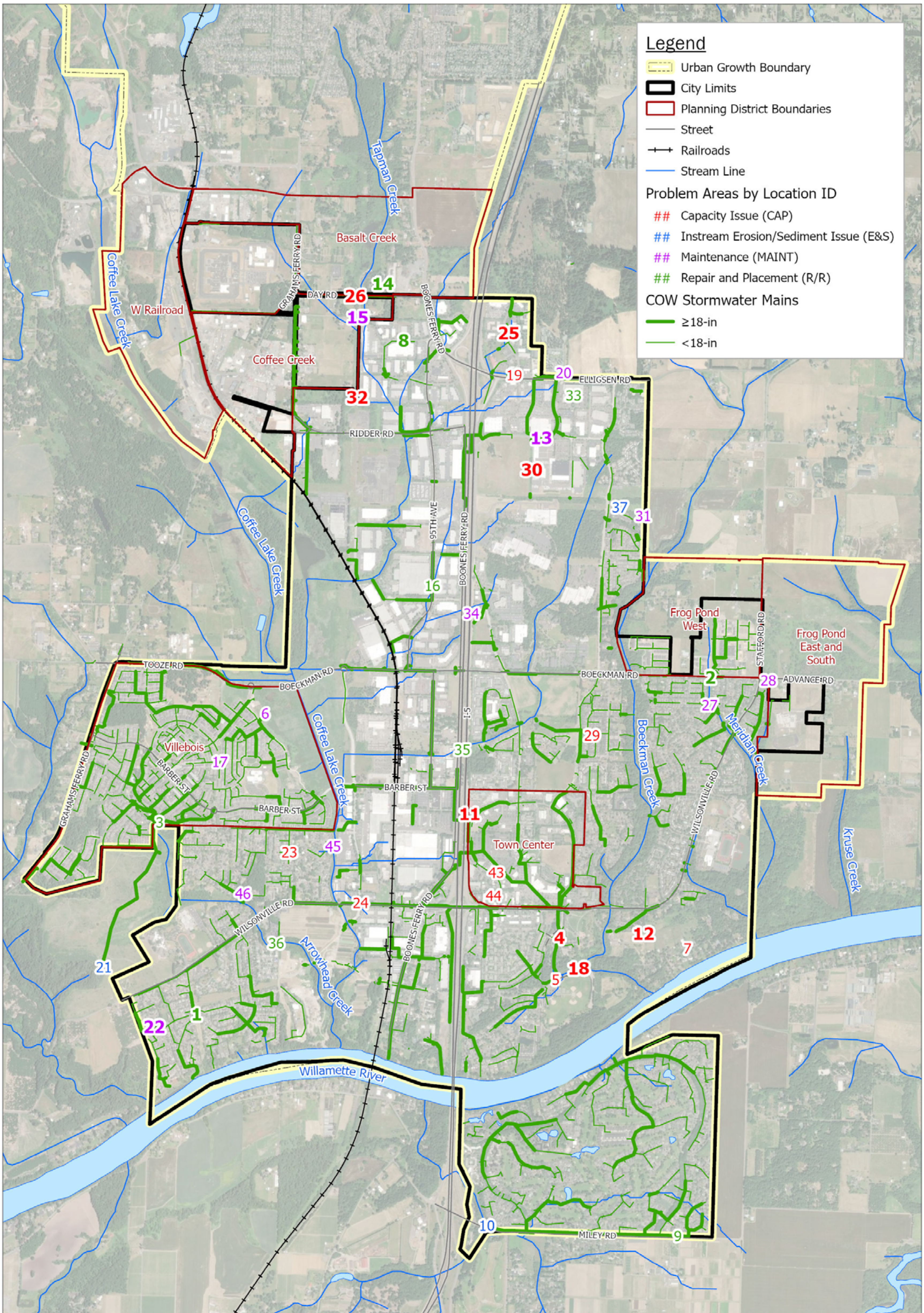

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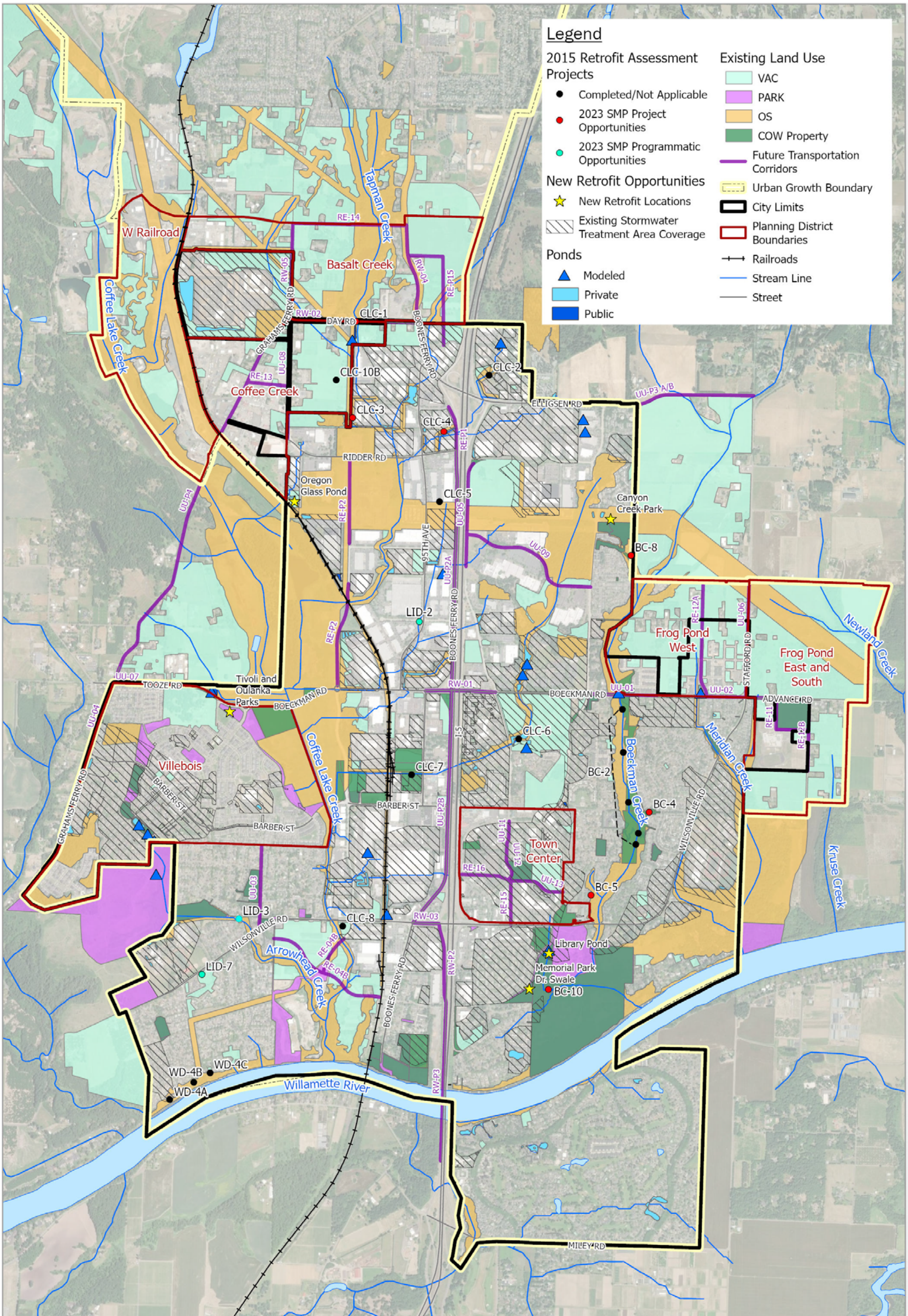
Note: Bold location IDs represent locations where a site visit occurred.

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

N

0 0.25 0.5 1 Miles

Figure 3-1: Problem Area Location



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Stormwater Master Plan

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

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Figure 3-2: Water Quality Retrofit Analysis

Section 4

Stream Assessment

Tributary stream channels to the Willamette River are an important element of the overall stormwater collection and conveyance system in the city. Stream channels provide conveyance and storage of water and sediment and provide habitat for aquatic and terrestrial species.

This section outlines results of the stream assessment conducted for this SMP to inform project, program, and policy recommendations. The stream assessment effort helps improve the understanding of hydraulic processes in the selected reaches, as well as identify infrastructure risks associated with changes in stream hydraulics. The stream assessment is described in additional detail in Appendix C. Project Opportunities stemming from the results of the Stream Assessment are detailed below and referenced in the Project Opportunity Matrix (Appendix A, Table A-2).

4.1 Regulatory Background

The City of Wilsonville prepared a 2015 Hydromodification Assessment in accordance with requirements of the City's 2012 NPDES MS4 permit. The 2015 Hydromodification Assessment focused on aspects of hydromodification[6] that are addressed in NPDES MS4 permits, specifically erosion, sedimentation, and alteration of stormwater flow, volume, and duration that may cause or contribute to water quality degradation. Efforts included a GIS desktop assessment, targeted field assessment, and review of existing planning documents and policies to inform the development of strategies and approaches to address hydromodification. Findings from the 2015 Hydromodification Assessment reflect the following:

- Observed stream channels indicate historical hydromodification impacts; minor impacts are observed in locations of concentrated flow or development encroachment.
- Current City programs and policies appear to be effective at addressing hydromodification indicators.
- Current land use and future development patterns show there is a potential for future flow increases; however, the City's current land use policies and updated stormwater design standards are in line with best practices to address hydromodification; and
- The City has identified, and is implementing projects to address hydromodification (per their 2012 SMP).

Recommendations from the 2015 Hydromodification Assessment included the following:

- Implement key capital projects to address instream hydromodification problems including erosion at stormwater outfalls and sites with historic channel modifications.
- Continue to monitor known problem areas.
- Continue to develop and implement master plans for new development areas that address natural resource and channel restoration needs.

[6] The U.S. Environmental Protection Agency (EPA) broadly defines hydromodification as the alternation of the hydrologic characteristics of coastal and non-coastal waters, which in turn could cause degradation of water resources."

This SMP update includes a focus on instream channel conditions and erosion prevention in conjunction with capital project development. To inform capital project and program needs, as well as directly address the recommendations per the 2015 Hydromodification Assessment, a geomorphic stream assessment was conducted for select reaches of Boeckman, Meridian, Arrowhead, Newland, and Kruse creeks to better understand the stream processes and identify infrastructure at risk due to changes in stream hydraulics.

Channel incision and aggradation can inform locations of active erosion and hydromodification risk

4.2 Objectives and Methods

The stream assessment included stream walks along priority reaches as well as desktop mapping and analysis. The objectives of the stream assessment were to:

- Provide a baseline assessment of existing physical stream conditions.
- Identify existing problem areas, such as locations of channel instability or excessive erosion that may impact private or public infrastructure.
- Assess the potential for changes and impacts to the stream channel.
- Recommend capital, operational, maintenance or other solutions or stream restoration actions that would address the identified risks to infrastructure or improve the resiliency of the stream corridor to impacts associated with hydromodification.

The stream assessment was conducted by Waterways Consulting, Inc. (Waterways) to reflect the continued evaluation of stream channel conditions as recommended by the 2015 Hydromodification Assessment. Information collected as part of this assessment should be referenced and used during future inspection efforts to help assess improvements and degradation.

In accordance with the Problem Area Identification effort (Section 3.1), City staff identified priority and secondary assessment locations in the city based on the observed hydromodification impacts, land accessibility, future development potential (and the ability to establish a baseline condition of the stream), and history of staff or citizen complaints/concerns.

Figure 4-1 identifies specific stream reaches investigated for the Stream Assessment, as well as the secondary assessment locations not investigated as part of this effort that may be considered in the future.

4.2.1 Stream Walks

Stream walks were conducted over four days, in November 2021 and January 2022 in the Meridian, Boeckman, and Arrowhead Creek basins. Additional stream walks were conducted in October 2023 in the Newland Creek and Kruse Creek basins. Stream walk locations are identified generally in Figure 4-1 at the end of this section. Specific reach numbering associated with stream walk locations can be referenced in Appendix C.

Stream walk activities included a review of key geomorphic features, stream and bank conditions, and infrastructure. During the stream walks, photographs were taken to document stream characteristics and conditions. Physical and biological stream conditions were noted and mapped and included:

- General vegetation condition.
- In-stream and hillslope erosion processes (incision, aggradation, and hillslope failures).
- Location of stormwater outfalls, exposed pipes, bridges, culverts, affected roads and trails.
- Wildlife activity (presence of beaver dams).
- Heavily eroded banks, headcuts, and bedrock outcrops.

Photo logs and stream reach summary sheets were developed to identify cross section and physical condition characteristics for each reach at the time of the stream walk (see Appendix A).

4.2.2 Desktop Analysis

The desktop assessment included compilation and analysis of geospatial data, including infrastructure, topographic, and geologic information. Waterways used the 2014 LiDAR data to create "Relative Elevation Models" (REMs) for Boeckman, Meridian, Arrowhead, Newland, Kruse and Tapman[7] creeks. A REM shows the height of the ground surface relative to the adjacent streambed, which is helpful for identifying and interpreting geomorphic surfaces relative to the stream.

Waterways also created and analyzed topographic and geologic cross sections and stream longitudinal profiles to develop a set of field maps identifying streams and stormwater infrastructure identified during the field component.

4.3 Findings and Results

Observations made during the stream walks were used to qualitatively identify current stream channel deficiencies and potential strategies for improvement.

Table 4-1 summarizes the general findings by stream reach. Locations where ongoing vegetation management/invasive removal is needed are identified, as well as locations where future monitoring for impacts is recommended. Locations considered a Project Opportunity (see Appendix A, Table A-2) are also identified, and these locations were discussed with the City for consideration as a capital project (see Section 6). Additional detail on these locations is provided in Appendix C.

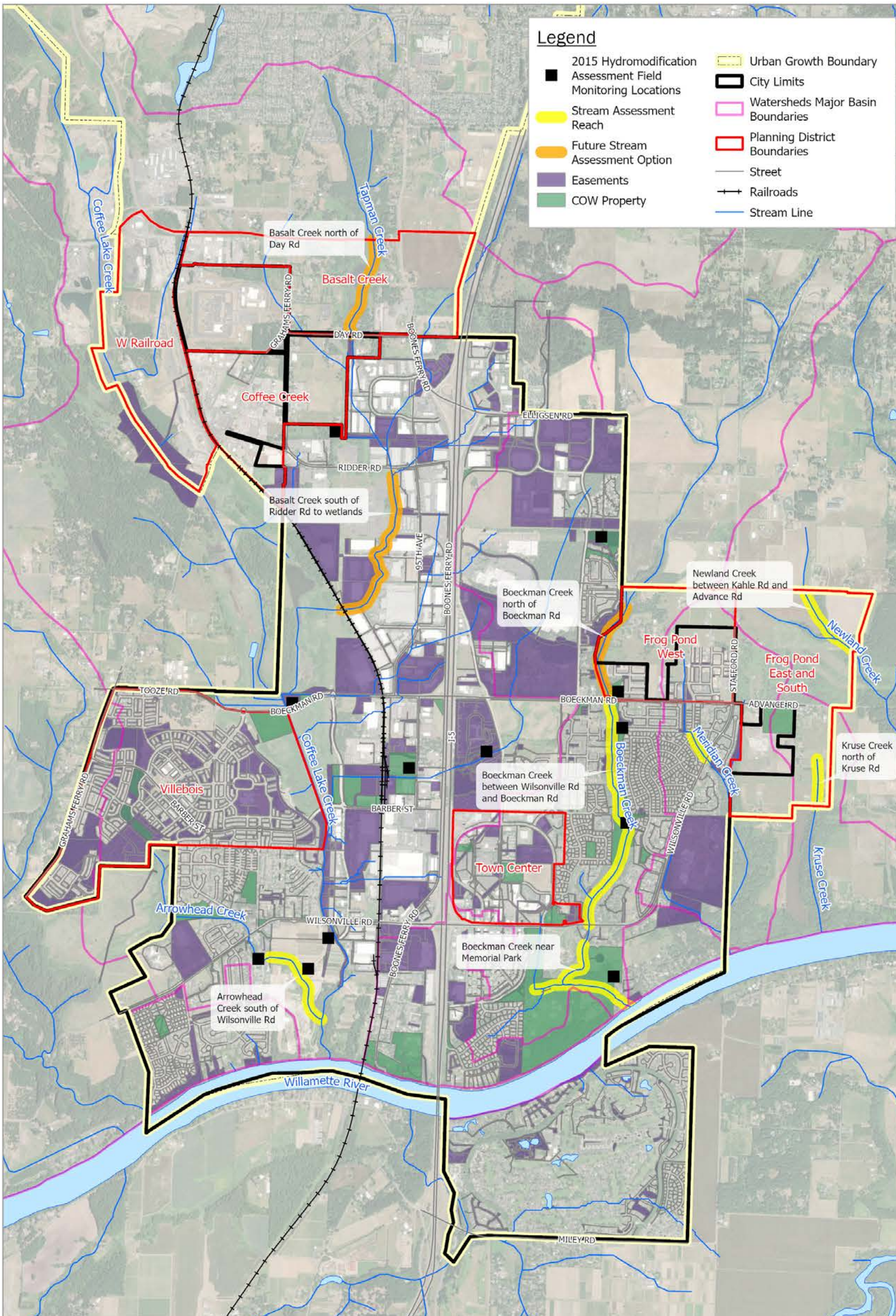
Of note, the downstream portion of Kruse Creek (Reach 4) was unable to be accessed due to bank stability issues. Future annexation and development activity along Kruse Creek should incorporate a geotechnical evaluation and consider setbacks from the top of canyon, given ongoing landslide risk.

[7] Tapman Creek is referred to as Basalt Creek in TM2.

Table 4-1. Summary of Stream Assessment Findings

Stream	Assessment Date(s)	Reach No.[a]	Beaver Dam Presence (Y/N)	Infrastructure at Risk? (Y/N)	Invasive Vegetation Present? (Y/N)	Field Observations	Vegetation Management Need? (Y/N)	Ongoing Monitoring Need? (Y/N)	Project Opportunity? (Y/N)
Boeckman Creek	Nov. 19 and 24, 2021	2-9	Y	N	Y	Stream reaches appear laterally confined and vertically stable.	Y	Y	N
Boeckman Creek	Jan. 25, 2022	1	N	Y	N	Risk of channel incision and lateral erosion due to lack of stable beaver dams and seasonal variability in the backwater conditions on the Willamette River.	N	Y	Y
Meridian Creek	Nov. 26, 2021	1	N	Y	Y	Stable stream reaches due to bedrock base level control and lateral confinement. Obstructed culvert at Wilsonville Road (30”) results in backwater conditions.	Y	Y	Y
Meridian Creek	Nov. 26, 2021	2	N	Y	Y	Historic channel incision and head cuts, but active head cuts not readily observed. Obstructed culvert at Willow Creek Drive and downstream stabilization measures in place.	Y	Y	Y
Arrowhead Creek	Jan. 25, 2022	2-3	Y	N	Y	General stream stability due to shallow hardpan and abundant beaver dams. Riparian vegetation management needed to ensure beaver activity.	Y	Y	N
Arrowhead Creek	Jan. 25, 2022	4	Y	Y	Y	Culvert at pedestrian crossing is failing. Upstream portion of culvert not evaluated due to access issues.	Y	Y	Y
Kruse Creek	Oct. 26, 2023	1-2	N	N	Y	Moderately incised channel but appears relatively stable. Riparian corridor in relatively good condition, but non-native (ivy and English holly) was noted in Reach 1.	Y	Y	N
Kruse Creek	Oct. 26, 2023	3-4	Unknown	Unknown	Unknown	Reach 4 was inaccessible due to deep channel incision and unstable banks. High groundwater table and seeps and springs contributing to natural stability issues.	Unknown	Y	N
Newland Creek	Oct. 26, 2023	1-3	N	N	N	Reaches are highly incised and likely to incise further. Culvert at SW Kahle Road is acting as grade control and likely preventing additional headcut. Riparian corridor is in good condition, but narrower in reaches 2 and 3.	N	Y	N
Newland Creek	Oct. 26, 2023	4	Y	N	N	Gradient is flatter with in-channel wood and debris dams. Reach 4 is at risk of bank stability, but only one head cut observed. Riparian corridor is in good condition.	N	Y	N

a. Reach numbering can be referenced in Appendix C.



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

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0 0.25 0.5 1 Miles

Figure 4-1: Stream Assessment

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Section 5

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 to verify and identify conveyance capacity limitations.

H/H modeling conducted for this SMP used the City's existing InfoSWMM model, which was originally developed as part of the 2012 SMP effort. The model includes major hydraulic components of the City's stormwater drainage system including public stormwater pipe (15-inch-diameter and greater) and open channel conveyances defined by a simplified trapezoidal geometry. Capacity deficiencies within the study area were identified and/or problem areas validated using the H/H model.

This section summarizes the updates to the City's 2012 InfoSWMM model for this SMP effort, as well as the H/H modeling approach and results.

H/H modeling assumptions, methods and results are described in additional detail in Technical Memorandum #3 (TM3), included in this SMP as Appendix B. Referenced figures are included at the end of this section.

5.1 Objectives and Approach

The City's existing InfoSWMM 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.

Targeted updates to the City's existing model were conducted where updated development activities, CP installations or identified problem areas were identified and there was a need to quantify system capacity to help develop project solutions.

For this SMP, the following modeling approach was generally used to update the H/H model and evaluate conveyance capacity:

1. Review available data (via GIS, as-builts, etc.) to compare mapped infrastructure (i.e., pipe size, slope, etc.) and existing model profiles. Update the existing hydraulic model accordingly.
2. Compile a list of known and suspected problem areas and identify areas where modeling is needed to inform corrective measures. Expand the hydraulic model extents accordingly.
3. Refine the existing subbasin delineation based on the updated hydraulic model coverage.
4. Develop an updated city-wide hydrologic model to estimate stormwater runoff generated for existing and future development conditions.
5. Validate modeled flooding using historical rainfall records, and anecdotal flooding information (photographs, City records),
6. Verify capacity constraints and identify potential sources or causes of flooding with City staff (preliminary flooding results); and
7. Use the validated hydraulic model to document existing capacity deficiencies for inclusion as Problem Opportunity Areas.
8. Use the validated hydraulic model to develop potential solutions to capacity problems (see Section 6).

5.2 Stormwater Design Standards and Performance Criteria

Design standards and criteria related to the sizing and evaluation of stormwater infrastructure are described in the City of Wilsonville's Public Works Standards (PWS), Section 3 Stormwater & Surface Water Design and Construction Standards, as revised in December 2015.

Additional planning guidelines are described in the City of Wilsonville Code (WC), Chapter 4 Wilsonville Development Code (WDC). The WDC defines assumptions related to the concept planning district designations, overlays and open space designations, and general development regulations that inform land use coverage and hydrologic modeling assumptions for this project.

5.2.1 Planning and Sizing Criteria

Stormwater sizing/design criteria will ultimately be used to both assess the existing stormwater system for deficiencies and guide the design of capital projects in the context of the SMP. Planning and sizing design criteria for select infrastructure components are outlined in Table 5-1. Design storms referenced in the design criteria are outlined in Table 5-2.

Table 5-1. Wilsonville Drainage Standards and Design Criteria

Criteria	Source	Value
Water Quality Facility Design	• PWS 301.4.04.c	• Provide water quality treatment for a design storm of 1 inch in 24 hours. • Design water quality facilities to capture and treat 80% of the average annual runoff volume to the MEP with the goal of 70% TSS removal. • See BMP Sizing Tool.
Water Quantity Facility Design	• PWS 301.4.09.d • PWS 301.4.09.e • PWS 301.4.09.f	• Properties or development draining directly to and within 300 ft of the Willamette River or the Coffee Lake wetlands are exempt from the flow control standards. • Maximum water storage depth for the 100-year storm should not exceed 4 ft deep. • Side slopes should not exceed 4H:1V up to the maximum design water surface elevation; maximum exterior side slopes = 2H:1V. • At least 25% of the pond perimeter should be vegetated with maximum slide slopes of 3H:1V. • See BMP Sizing Tool.
Conveyance Piping Design	• PWS 301.1.10.e • PWS 301.1.13 • PWS 301.8.02 • PWS 301.8.02.c • PWS 301.9.03.b	• Mainline pipes shall be 12 inches in diameter. • Design pipes for conveyance of the 25-year undetained storm (emergency overflow structures should be designed for the 100-year storm). • A minimum of 1 ft of freeboard should be provided between the hydraulic grade line and the top of the structure or finished grade. • Mainline pipes should be reinforced concrete pipe (RCP), ductile iron pipe (CIP), polyvinyl chloride pipe (PVC), or corrugated polyethylene pipe (CPP). Pipe and fittings shall consist of one type of material throughout.
Culvert Design	• PWS 301.1.14 • PWS 301.7.02	• Culverts shall be designed for the 100-year storm. • All culverts shall be designed for fish passage in accordance with ODFW's "Fish Passage Criteria," or latest edition, unless exempt by ODFW or the City. • The headwater elevation must be at least 1 foot lower than road or parking lot subgrade. • New culverts ≤18 inches in diameter: the maximum headwater elevation (measured from the inlet invert) should not exceed 2x the pipe diameter. • New culverts >1 8 inches in diameter: the maximum headwater elevation should not exceed 1.5x the pipe diameter.

Table 5-1. Wilsonville Drainage Standards and Design Criteria		
Criteria	Source	Value
Open Channel Design	• PWS 301.1.13.f • PWS 301.6.02	• Open channels shall be designed for the 25-year undetained storm with a minimum of 1 ft of freeboard. • Channel lining material is site specific. • The minimum slope for the flow line is 1% where practicable, but flow shall not be less than 2 fps (unless approved by City).
Pipe Cover	• PWS 301.8.02m Table 3.8 Minimum Pipe Cover	• 36" of cover: Nonreinforced, RCP Class III, Other Pipe Materials • 24" of cover: RCP Class IV • 12" of cover: RCP Class V, AWWA C-900, AWWA C-905, DIP
Structure Spacing	• PWS 301.8.06	• The maximum distance between structures (manholes, area drains, and catch basins-excluding clean outs) is 400 ft.
Outfalls to Open Channel Waterways	• PWS 301.6.04	• Design bank stabilization for the 25-year storm. • Flows from outfall structures should be directed downstream, typically no less than 30 degrees from perpendicular to waterway flow. • Outfalls must be located at higher elevations than the downstream mean low water. • Plantings (willows or other approved plantings) every 2 ft.
Manhole Design	• PWS 301.8.01 • PWS 301.9.01 • PWS 301.4.11	• Manholes are required at least every 400 ft (unless approved by the City). Required placement includes at every grade change, change in pipe size, change in alignment, pipe connection greater than 6 inches, and at the end of the main lines. • Manhole sizing: • 48-inch-diameter manhole for pipe ≤24 inches in diameter • 60-inch-diameter manhole for pipe 27 to 36 inches in diameter and pretreatment manholes • 72-inch-diameter manhole for pipe ≥42 inches in diameter • Maximum of four pipes entering/exiting a manhole. • Minimum free drop of 0.20 ft, maximum free drop of 1.5 ft.
Catch Basins/Curb Inlets	• PWS 301.8.04 • PWS 301.8.05 • PWS 301.8.05.b	• Must be designed for the 10-year storm. • All catch basins must have a sump (unless approved by the City). • Maximum of three catch basins may be connected in a series before connecting to the mainline. • Curb inlets should be constructed with an 18"minimum sump and 6 ft deep from the top of grate to the lowest pipe invert. • Between the inlet and the mainline or mainline structure, the maximum length of pipeline shall be 60 ft for 12" pipe, unless additional length is required to cross the street ROW.

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-, 10-, 25-, and 100-year recurrence interval 24-hour events as well as water quality events. Design storms are listed in the City's PWS and listed in Table 5-2. The rainfall distribution for these design storms is based on a Unified Soil Classification System (USCS) Type IA distribution.

Table 5-2. Design Storm Depths	
Design storm event	Rainfall depth, inches
2-yr, 24-hr	2.50
10-yr, 24-hr	3.45
25-yr, 24-hr	3.90
100-yr, 24-hr	4.50
Water Quality Event , 24-hr	1.00

5.2.2 BMP Sizing Tool

The cities of Wilsonville and Oregon City, together with Clackamas Water Environment Services (WES) developed a custom tool, referred to as the BMP Sizing Tool, to help size stormwater treatment and flow control facilities in consideration of instream hydromodification impacts. The BMP Sizing Tool (updated 2017) is intended to be used in conjunction with the City's PWS to automate some of the required calculations to support sizing and design for a specific set of stormwater management facility types based on long-term rainfall records, soils, and land use cover data. The BMP sizing tool can be used to calculate facility sizes for the following BMP types:

- Rain Garden-Filtration and Infiltration
- Stormwater Planter-Filtration and Infiltration
- Vegetated Swale-Filtration and Infiltration
- Infiltrator
- Detention Pond

The BMP Sizing Tools offers two design options: (1) treatment and flow control, or (2) treatment only. The BMP types that are available for each design option depend on the native soil infiltration rate at the location of the BMP facility. The BMP Sizing Tool was developed and calibrated based on local conditions (rainfall, soil characteristics, etc.) for Clackamas County, Oregon. The distinction between infiltration and filtration-based facilities is based on the facility soil subgroup. Infiltration rates greater than 0.5 in/hr are considered acceptable for use with infiltration facilities and can be used to meet treatment and flow control standards directly. Infiltration rates less than 0.5 in/hr require use of filtration facilities that include piped underdrain systems and orifice controls to meet flow control requirements.

Use of the BMP Sizing Tool represents a shift away from traditional stormwater detention design practices to match pre- and post- development peak flows for standard (i.e., 24-hour) synthetic design storms. Instead, the tool sizes facilities to match the duration of post development peak flows to pre-development levels for the range of flows anticipated to be the most erosive. The BMP Sizing tool was used to size several CPs in this SMP as well as to evaluate policy recommendations associated with use of the Library Pond to support treatment and flow control requirements associated with the Town Center redevelopment. Additional information related to the Library Pond evaluation is discussed in Section 6.3.4 and Appendix F.

5.3 Model Evaluation Criteria

Stormwater infrastructure was evaluated using the H/H model for capacity per the design criteria defined in Table 5-1. Key hydraulic design requirements for modeled elements are listed below:

- **Pipes and Open channels:** Sized to convey and contain the peak runoff from the 25-year design storm while also maintaining a minimum of 1 foot of freeboard between the hydraulic grade line (HGL) and the top of structure or ground surface.
- **Culverts:** Designed to safely pass the 100-year design storm flow and provide a minimum of 1 foot of freeboard between the HGL and the ground surface.

Specific to the identification and evaluation of conveyance capacity issues with existing City infrastructure, the model evaluation identified capacity deficiencies up to the 25-year design storm event. Capacity deficiencies were defined based on predicted flooding where the hydraulic grade line (HGL) exceeds the ground surface elevation. This approach allowed for deficiencies to be quickly identified throughout the system at a city-wide level.

For capacity deficient locations where a CP was recommended and developed (see Section 6), the goal was to adhere to the PWS and accommodate the minimum of 1 foot of freeboard between the HGL and the ground surface.

5.4 Model Refinement

Wilsonville developed a city-wide H/H model using the Innovyze InfoSWMM model platform for the 2012 SMP. Localized model updates were incorporated in 2019.

For this SMP, updates to the model datum, hydrologic input parameters, hydraulic model extents and select hydraulic infrastructure were completed. Additional detail related to datum corrections and hydrologic model refinements are included in TM1, which are independent from this SMP. Specific locations of hydraulic model refinement, as well as more detailed explanation of the model validation effort are outlined in Appendix B.

5.4.1 Datum Conversion

As part of the GIS data review process, initiated in 2021, BC reviewed rim and invert elevation data stored in the City's GIS with LiDAR data to identify consistency regarding the vertical datum. Results of this GIS-based spatial analysis indicated inconsistency between recorded datums within the City's GIS dataset, which prompted a similar comparison effort on the City's 2012 InfoSWMM model.

Based on the model comparison results, the original (2012) hydraulic model appeared to rely on inconsistent vertical datums for select model elements. Through discussions with the City, this inconsistency was due to the City switching standards from the National Geodetic Vertical Datum of 1929 (NGVD29) to the North American Vertical Datum of 1988 (NAVD88) sometime between 2006 and 2008.

To rectify this discrepancy, BC reviewed and adjusted hydraulic model elevations to be consistent with the City's current standard of NAVD88. Successful conversion of the existing model to NAVD88 was completed in June 2021.

5.4.2 Hydrologic Model Refinement

Hydrologic model refinements included updated subbasin delineations, existing and future land use coverage, and land-use based impervious percentages. With the adjusted subbasin delineation, updated area-weighted average values for infiltration parameters and impervious areas were assigned for each subbasin. In addition, updated subbasin areas, slopes and widths were calculated.

The City's 2012 SMP reflected an initial subbasin delineation within each major basin for purposes of characterizing hydrology. BC reviewed this existing watershed and subbasin delineation and made updates based on:

- Topographic Light Detection and Ranging (LiDAR) and contour data (2019)
- Stormwater infrastructure geographic information system (GIS) data (2021)
- Aerial Imagery (2021)

Where necessary, major basin boundaries were adjusted to accurately reflect that the entire drainage area was captured. However, most adjustments occurred on the subbasin level and typically involved the refinement of existing subbasin boundaries to better reflect newly developed areas or the subdivision of subbasins to depict drainage patterns more accurately.

A summary of the updated subbasin delineation by major basin is presented in Table 5-3. Please note Newland Creek (and its associated drainage area) is outside the designated study area for the H/H model and not included in Table 5-3.

Table 5-3. Subbasin Summary

Major Basin	Subbasins			Contributing Drainage Area (acres)
	Number	Average Area (acres)	Median Area (acres)	
Boeckman Creek	46	42.2	14.5	1,941
Charbonneau	20	23.9	16.8	478
Coffee Creek/Tapman Creek	77	67.4	28.5	5,192
Mill Creek	3	47.0	49.0	141
Meridian Creek	7	67.2	40.8	470
Willamette River (direct)	25	20.2	14.6	505
Total	**178**	**49.0**	**23.9**	**8,728**

As introduced in Section 2.3, City staff developed an updated existing and future (full build-out) land use coverage using City zoning and comprehensive plan designations plus specific overlays where development is restricted (e.g., Significant Resource Overlay Zone (SROZ), METRO vacant/developable lands, City maintained vacant lands, Bonneville Power Administration (BPA) easements, significant wetlands, public parks/natural areas etc.). Impervious coverage by land use designation was based on digitization of impervious area (from aerial imagery) for representative tax lots within each existing land use category and calculated by the City as an area-weighted impervious percentage.

Land use categories reflecting reclassification due to HB 2001, as well as calculated impervious percentages are provided in Table 2-3.

5.4.3 Hydraulic Model Refinement and Model Validation

Updates to the City's 2012 InfoSWMM hydraulic model were completed from May 2021 to May 2022. Hydraulic model updates included areas of model expansion, primarily in new growth areas since the 2012 SMP was completed or identified problem areas, and updates to reflect revised pipe sizing/alignment in conjunction with completed capital projects.

The updated H/H model went through a validation process from May to August 2022 with the objective to increase confidence in the updated model's accuracy and results. The model validation effort included the following key components:

- Citywide integration of the model calibration adjustments recommended as part of the Boeckman Road Hydraulic Evaluation (January 2022).
- Simulation of a validation storm event from January 2022 and comparison of model results with photographs and field measurements collected near Ridder Rd.
- Discussion of preliminary model flooding results with City staff to confirm validity of modeled flooding locations and the need for additional refinement of hydraulic model elements using newly provided as-built data.

Discussion of preliminary model flooding results with City staff focused on newly identified 25-year flooding locations where the 2012 SMP did not define a CP to address flooding under existing land use conditions. In general, City staff agreed with the preliminary flooding results presented by the model. However, based on results of the validation exercise, additional hydraulic model updates were warranted in select locations based on updated information provided by the City.

These locations included:

- **Charbonneau SW French Prairie Rd. Outfall.** Model revised based on as-built information to incorporate the outfall pipe lining completed as part of the emergency repair project in 2019.
- **Library Pond.** Model revised to more accurately represent the pond's storage capacity based on a review of LiDAR and as-built information. The outlet pipe configuration was also modified to better reflect the ditch inlet and 18-inch outlet pipe per the as-built information.
- **Penske Truck Rental Property.** Model revised to reflect updated culvert information underneath the parking lot based on as-built drawings.
- **Wilsonville Distribution Center Pond.** Model revised to reflect the pond outlet structure based on as-built drawings.

Figure 5-1, at the end of this section, summarizes the hydraulic modeling extents as well as locations where the hydraulic model was expanded or updated, including updates based on model validation efforts.

5.5 Model Results and Project Opportunity Area Identification

Upon completion of the model validation effort, detailed H/H model results were simulated for the 2-yr, 10-yr, 25-yr, and 100-yr design storm.

H/H model inputs and results are summarized for the hydrologic and hydraulic models in Appendix B, Attachment B, Tables B-2 and B-3, respectively.

5.5.1 Hydrologic Model Results

The hydrologic model results for all design storms show that future land use conditions (and associated increased imperviousness) result in increased peak flows compared to existing land use conditions. The increase in peak flows is most significant during the 2-year storm and gradually becomes less pronounced with larger storm events.

In general, most locations within the city limits are nearly fully developed; therefore, the increase in peak flow from these areas is expected to be relatively small. This is most evident in urbanized locations such as Charbonneau, Villebois, and along the I-5 corridor. The largest anticipated increases in peak flow are primarily in the subbasins located outside of city limits, specifically within the upper reaches of the Coffee Lake Creek and Boeckman Creek watersheds. These locations are primarily undeveloped, but new development is pending and will increase the amount of impervious surface (runoff flow).

Although flow attenuation with new development is anticipated through implementation of the City's stormwater design standards, for purposes of this SMP, CP sizing is based on unmitigated flows. In addition, policy recommendations may be considered to ensure that for capacity limited infrastructure, additional efforts are made to retain and mitigate stormwater flows onsite.

5.5.2 Hydraulic Model Results and Project Opportunity Areas

Hydraulic model results identify locations with the potential for flooding and the need to develop CPs to increase conveyance capacity. As described in Section 5.2, flooding within the model is defined as locations where the hydraulic grade line exceeded the structure's rim elevation. Flooding is a direct output from the model that can be used to efficiently identify capacity issues throughout the hydraulic system. Since the City's conveyance standard is the 25-yr design storm, this storm event was used as the benchmark to identify potential issues.

To assist in prioritizing locations by flooding severity, the 2-yr and 10-yr design storms were also simulated to identify the minimum flooding frequency. Table 5-4 and Figure 5-2, at the end of this Section, summarize the 18 locations that are anticipated to experience flooding under the existing conditions. Generally, all modeled flooding locations are designated as Project Opportunity Areas unless indicated otherwise, and the "priority need" column in Table 5-4 indicates whether a flooding location is confirmed by City staff as necessitating a CP or program to address.

Table 5-4. Modeled Capacity Deficiencies						
Flooding Location ID (Figure 5-2)	Basin	Location Description	Minimum Flooding Frequency	Flooding Predicted in 2012 SMP? (Y/N)	Project Opportunity Area (Y/N)	Priority Need
1	Charbonneau	Miley Road	10-yr	Y	Y	Y
2	Charbonneau	French Prairie Rd and Old Farm Rd	2-yr	Y	Y	Y
3	Willamette	Parkway Ave/Metolius Ln	10-yr	Y	Y	N
4	Willamette	SW Miami	25-yr	N	Y	N
5	Boeckman	Memorial Dr	2-yr	Y	Y	Y
6	Boeckman	Canyon Creek Rd	10-yr	Y	Y	N
7	Boeckman	Sysco Ditch	10-yr	N	Y	N
8 [a]	Boeckman	Elligsen Rd	10-yr	Y	N	N
9	Coffee	Shrine Center Pond	2-yr	Y	Y	Y
10	Coffee	Commerce Circle Ditch	2-yr	Y	Y	Y
11	Coffee	Garden Acres	2-yr	N (not modeled)	Y	Y
12 [b]	Coffee	Coffee Creek Wetlands	2-yr	Y	N	N
13	Coffee	Boberg Rd and RR crossing	10-yr	N	Y	N
14	Coffee	I-5 Culverts	25-yr	N	Y	N
15	Coffee	Barber Street	25-yr	Y	Y	N
16	Willamette	River Fox Park	2-yr	N	Y	Y
17	Willamette	Lower Boones Ferry	2-yr	Y	Y	N
18 [c]	Coffee Lake	Boeckman Corp. Center Pond	10-yr	Y	N	N

a. *Flooding likely due to modeled routing (large subbasin at the upstream end of model). City indicated no Project Opportunity Area designation needed.*

b. *Generalized modeled cross sections are underrepresenting the actual storage. City indicated no Project Opportunity Area designation needed.*

c. *Model configuration questions exist in regard to an existing flow control structure in this area. City staff report no flooding and so this area was not included as a Project Opportunity at this time.*

Three locations were identified as key flooding locations based on discussions with the City. These locations are considered high priority for purposes of CP development and required alternatives analysis to ensure that City objectives and preferences will be achieved. These locations are discussed further in Section 6.3 and include:

- Flooding Location ID 2: Charbonneau (French Prairie and Old Farm Road)
- Flooding Location ID 10: Commerce Circle Ditch (Day Road)
- Flooding Location ID 11: Garden Acres

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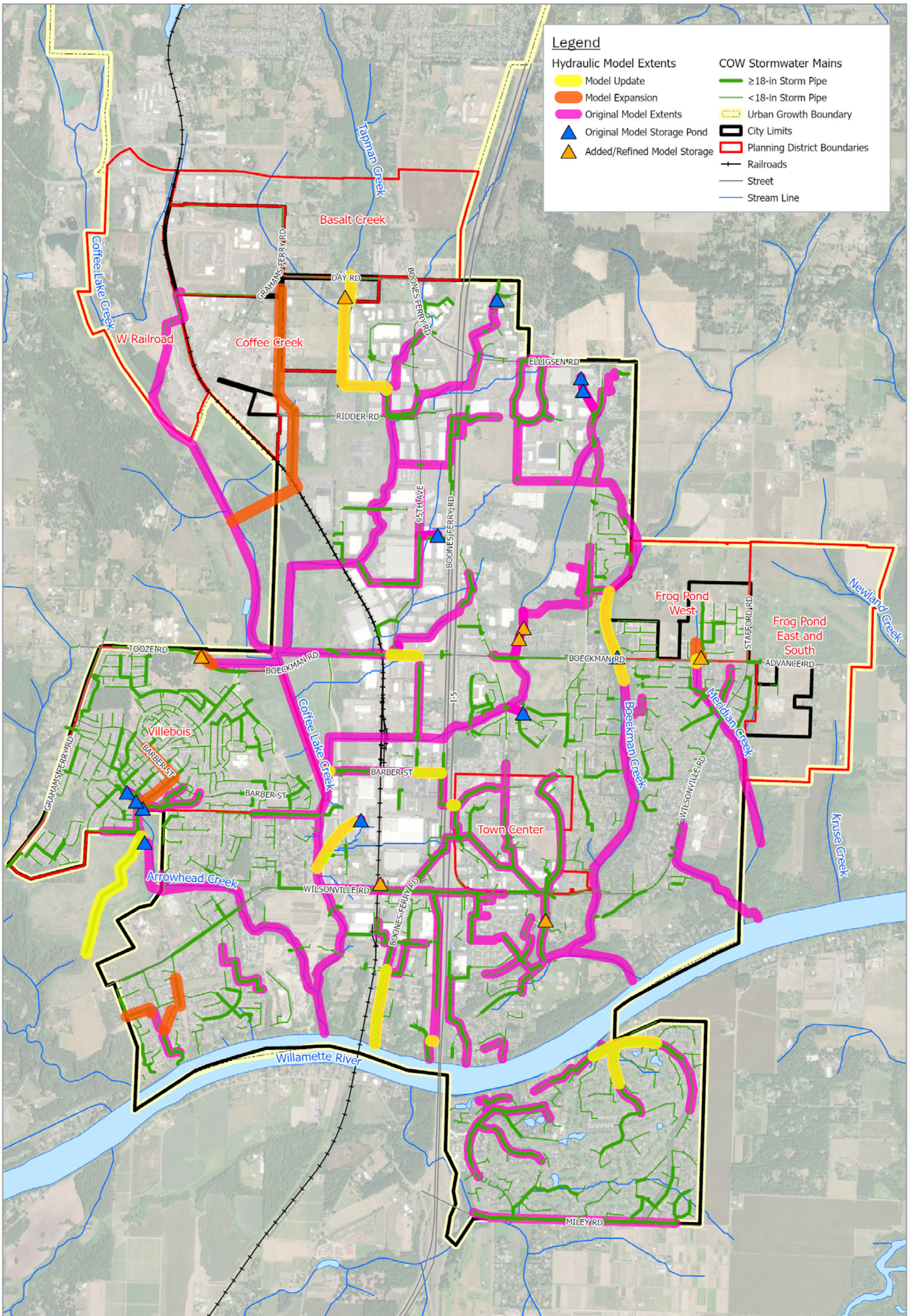
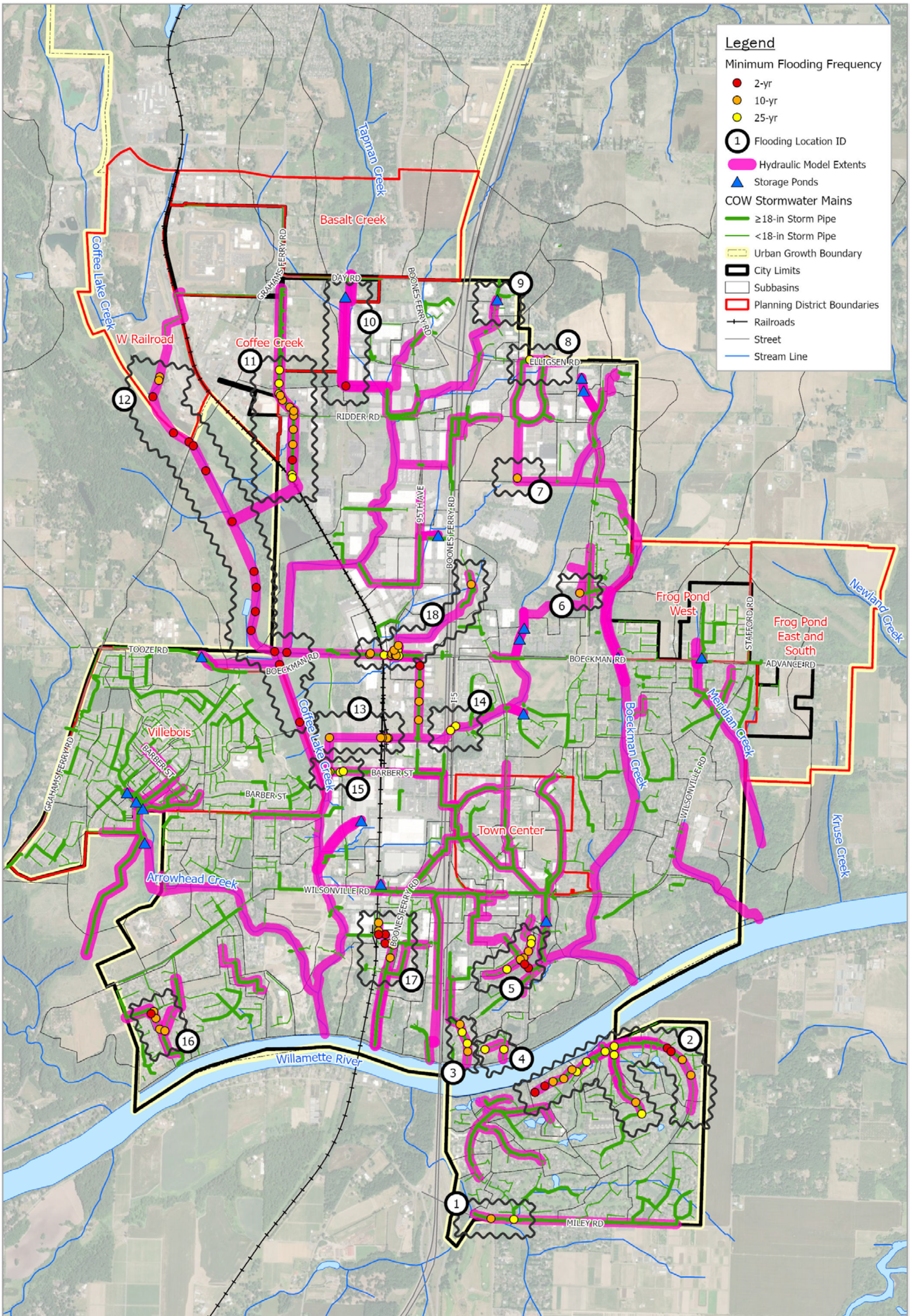


Brown AND Caldwell	City of Wilsonville/ Project # 156157 **Stormwater Master Plan**	Spatial Reference: Name: NAD 1983 HARN StatePlane Oregon North FIPS 3601 Feet Intl N 0 0.25 0.5 1 Miles	Figure 5-1: Hydraulic Model Overview



Brown AND Caldwell City of Wilsonville/ Project # 156157 **Stormwater Master Plan**	Spatial Reference: Name: NAD 1983 HARN StatePlane Oregon North FIPS 3601 Feet Intl N 0 0.25 0.5 1 Miles	Figure 5-2: Capacity Deficiencies (Existing Land Use)

Section 6

Capital Program Development

Project planning and technical analyses as outlined in Sections 3, 4, and 5 of this SMP resulted in the identification of 47 Project Opportunities, which represent locations with a potential need for a Capital Project (CP) or program as part of the overall stormwater Capital Improvement Program (CIP).

Input from City staff helped focus the projects and programs selected for inclusion in the CIP on addressing the most immediate needs. Project Opportunities not developed into recommended CPs are documented in this SMP as future project needs, although full project descriptions and costs are not developed as part of this SMP.

This section describes the process to develop CPs from Project Opportunities. A detailed list of Project Opportunities is provided in Appendix A, Table A-2. Resulting fact sheets for identified CPs are provided in Appendix D and detailed cost estimates for identified CPs are provided in Appendix E.

6.1 Capital Project Needs Identification

Project Opportunities stemming from the Problem Area identification effort (Section 3.1); Water Quality Retrofit Assessment (Section 3.3); Stream Assessment (Section 4) and Model Evaluation (Section 5) were compiled into a matrix to facilitate discussion amongst Public Works and Community Development/Engineering staff. Areas with overlapping project needs were consolidated into a single Project Opportunity area to facilitate development of multi-objective project concepts.

6.1.1 Project Opportunity Matrix

The Project Opportunity matrix (Appendix A, Table A-2) details the source of the Project Opportunity; the relative deficiency or objective the project would address; and how the system evaluation activities support the project need. If applicable, the Problem Area Location (Appendix A, Table A-1) is also identified. Figure 6-1, at the end of this section, identifies all Project Opportunity Locations by primary deficiency category.

6.1.2 Capital Project Workshops

Two capital project planning workshops were held in the spring of 2023 with members of Public Works and Community Development/Engineering to discuss which Project Opportunities should be prioritized for project development. Staff considered the feasibility of construction during a 20-year Capital Improvement Plan (CIP) implementation period in the selection of locations warranting a capital project, as well as recurring maintenance activities, known/reported capacity deficiencies, and pending development drivers. These identified priority locations (i.e., Project Opportunities identified as “costed capital project needs” per Table A-2) include a conceptual project design and cost estimate that will ultimately factor into future financial evaluations and rate studies.

In some cases, an immediate project need was not identified, and instead a program to address activities at a city-wide scale was the preferred approach. These programmatic needs are identified with an annual funding mechanism (see Section 6.5). In other cases, the Opportunity Area does not warrant a more immediate project, but a project may become more necessary in the future. Those areas are identified as “unfunded capital project need” per Table A-2. These Project Opportunities are typically associated with a modeled capacity deficiency that was not confirmed or substantiated by city staff.

Of the Project Opportunity Areas, 22 locations resulted in a capital project conceptually designed and costed in this SMP. Notes from the respective workshops are detailed in Table A-2.

6.2 Capital Project Sizing and Design Assumptions

CP sizing generally follow the City's PWS and design criteria summarized in Table 5-1 as detailed below.

- **Capacity Projects.** Projects to replace stormwater infrastructure, including pipes and culverts, are sized in accordance with the City's PWS unless noted. Pipelines are sized for the 25-year, 24-hour design event under future land use conditions and culverts for the 100-year, 24-hour design event under future land use conditions. Where possible, replaced infrastructure was sized to adhere to the minimum one-foot freeboard between the HGL and top of structure.
- **Water Quality Facility.** For purposes of conceptual sizing and cost estimation, the BMP Sizing Tool was used to size treatment or treatment and flow control facilities in accordance with the specified facility type.
- **New Infrastructure.** Several capital projects require new infrastructure in locations where no storm system currently exists. In the case of the Frog Pond East and South Planning Area, infrastructure sizing per the concept plan was maintained for CP development and costing. For other areas, new infrastructure was sized in accordance with the City's PWS. New infrastructure alignments are in the public right-of-way (ROW). 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.

For certain CPs, the project description and costs are developed with a phased approach, splitting the overall project into multiple phases that may be funded and constructed on different timelines. This approach was applied to specific, higher-cost projects for this SMP. These selected projects are generally associated with the same Project Opportunity area but have separate, independent components. In some cases, additional flow monitoring and model calibration may influence the scope or size of the proposed improvements and as such, portions of the project may be delayed, warranting scheduling as a different phase.

For phased projects, Phase 1 project elements should be constructed first, and Phase 2 project elements may be conducted later or following additional evaluation efforts.

6.3 Project Alternative Analysis

In developing CP concepts, a more in-depth evaluation of alternatives was warranted for select locations. These locations include Day Road, Charbonneau, and Garden Acres Road. These areas have complicated drainage patterns and reflect Project Opportunities where a single project solution may not resolve all deficiencies.

A description of the alternatives analysis and H/H model development is provided below for these locations, identified by their Project Opportunity ID. Additional background and description of the preferred design concept is provided in the respective fact sheets (Appendix D).

6.3.1 Day Road/Commerce Circle (Project Opportunity ID#9)

Tapman Creek, between Day Road and Ridder Road, is conveyed through a series of culverts and open channels before it enters a piped section just north of Ridder Road. The open channels include reaches of negative slope and limited capacity and storage potential. Flooding has been observed at adjacent industrial properties, and the catchment area upstream includes the Basalt Creek Planning Area (see Section 3.5.1). Pending, and future, development from the Coffee Creek Industrial Area and Basalt Creek Planning Area may increase the frequency and severity of flooding.

In 2019, AKS prepared a facility siting alternatives report, which included design concepts expected to alleviate flooding during the existing land use condition. The report did not include analysis of alternatives' performance under future land use conditions.

For this SMP, the preferred AKS concept as well as other system configurations were analyzed for both existing and future development conditions using the updated H/H model. Model results validated the AKS report's conclusion that the preferred concept would alleviate flooding under existing land use conditions, but flooding under future land use conditions is still predicted.

Therefore, to augment the preferred AKS alternative, additional system configuration alternatives were evaluated, including use of a surface detention facility, pipe/culvert upsizing at Day Road, and piped conveyance system upsizing north of Ridder Road. The 25-year storm was used to evaluate flooding, and water surface elevations (WSE) predicted during the 100-year storm were also compared to the elevation of adjacent structures. Results of the additional alternatives evaluation are shown in Table 6-1.

Table 6-1. Day Road Evaluation Summary

Alternative	25-Year Flooding Result		100-Year Flooding Result	
	Existing Land Use	Future Land Use (unmitigated)	Existing Land Use	Future Land Use (unmitigated)
Existing Conveyance	Flooding at multiple points in system	Extensive system flooding	WSE at or above structures at multiple locations	WSE at or above structures at multiple locations
AKS Preferred Concept (AKS)	None	Extensive system flooding	Approx. 2 ft freeboard to structures	WSE at or above structures
AKS + Detention Pond	None	Flooding at multiple points in system	Not analyzed[a]	WSE at or above structures
AKS + Upsizing pipes upstream of Ridder Rd	None	Flooding at multiple points in system	Not analyzed[a]	Approx. 1 ft freeboard to structures
AKS + Detention Pond + Upsizing pipes upstream of Ridder Rd	None	Minimal flooding	Not analyzed[a]	Approx. 1 ft freeboard to structures

a. Alternative not analyzed because it was assumed to have good or better performance than the AKS Preferred Concept.

Evaluation of alternatives considered the relative costs and benefits associated with the alternatives. For example, the addition of a detention pond involves significant costs and logistical challenges, while model results still predict flooding, albeit reduced, for this alternative. Ultimately, the City selected the alternative that included both the preferred AKS concept and upsizing of pipes upstream of Ridder Road. See Appendix F, CP CLC-1, Phases 1 and 2.

In accordance with the City's PWS, the City requires new and redevelopment to implement flow control standards that match pre-development site hydrology. Application of the City's design standards are anticipated to mitigate some of the increased flow associated with future land use.

However, the larger drainage area to this conveyance system includes area outside of city limits, creating further uncertainty about flow mitigation. In conjunction with this CP, a policy defining and directing the implementation of design standards in the Coffee Creek Industrial Area (as well as other new development areas currently outside of the UGB but draining towards capacity-limited infrastructure and stream corridors) is recommended. In addition, a capital planning project is proposed to conduct flow monitoring to inform additional H/H model calibration with hopes of refining/confirming system upsizing needs affiliated with Phase 2.

6.3.2 Charbonneau East (Project Opportunity ID#30)

The Charbonneau East Project Opportunity reflects the continuation of identified pipe replacement and system upsizing along SW French Prairie Rd and SW Old Farm Road. The 2012 SMP identified both capacity and condition limitations throughout the Charbonneau basin. The 2014 Charbonneau Consolidated Improvement Plan categorizes the stormwater infrastructure in this neighborhood as Storm Priority 1 and 2, and efforts to replace deficient infrastructure are ongoing (Figure 6-2). Specific to the SW French Prairie Rd and SW Old Farm Road systems, some pipe upsizing and replacement has already occurred in the downstream portions of the system.

Figure 6-2: Charbonneau Consolidated Improvement Plan (2014), Charbonneau East

In accordance with this SMP, H/H modeling confirmed continued flooding along the extents of SW French Prairie Rd and SW Old Farm Road due, in part, to an undersized outfall pipe discharging to the Willamette River. Reported condition deficiencies also exist.

Various alternatives were evaluated to reduce the extent and coverage of flooding predicted under existing (25-year) and future development scenarios, while considering the portions of the piped collection system that have already been replaced. Due to space limitations, above ground detention was ruled out as a method of flow control to minimize the need for widespread pipe upsizing. Alternatives evaluated included inline detention along SW French Prairie Rd and/or SW Old Farm Rd, both at the upstream end and downstream end, as well as the upsizing and replacement of the outfall.

Alternatives were presented to the City in a workshop, and ultimately inline detention alternatives were not selected due to existing sanitary utility conflicts, space (limited ROW) constraints, maintenance concerns, as well as cost implications of replacing recently constructed infrastructure. The selected alternative includes a phased approach reflecting upsizing of the outfall to the Willamette River under Phase 1, and selective upsizing/replacing the remaining condition-limited pipes along SW French Prairie Rd and SW Old Farm Rd under Phase 2. See Appendix F, CP WR-4, Phases 1 and 2.

Like with the Day Road CP, a capital planning project is proposed to conduct flow monitoring to inform additional H/H model calibration with hopes of refining/confirming system upsizing needs affiliated with Phase 2.

6.3.3 Garden Acres (Project Opportunity ID#32)

The stormwater collection system along Peters Road is undersized with several pipe constrictions and a downstream pipe constriction at the P&W railroad crossing on the south end of Peters Road. The larger catchment area upstream includes portions of the Coffee Creek Industrial Area and West Railroad Planning Area. Pending development may increase the frequency and severity of flooding.

Options to upsize the collection system at the railroad crossing are limited due to required coordination with the railroad and METRO. Stormwater is currently diverted towards a public stormwater pond on the 10450 SW Riddler Road parcel west of Peters Road to reduce flow through undersized storm piping (Figure 6-3). The existing pond does not have an outlet control structure and based on aerial imagery and site visits, appears to overflow to an existing stormwater ditch west of the pond along the railroad ROW.

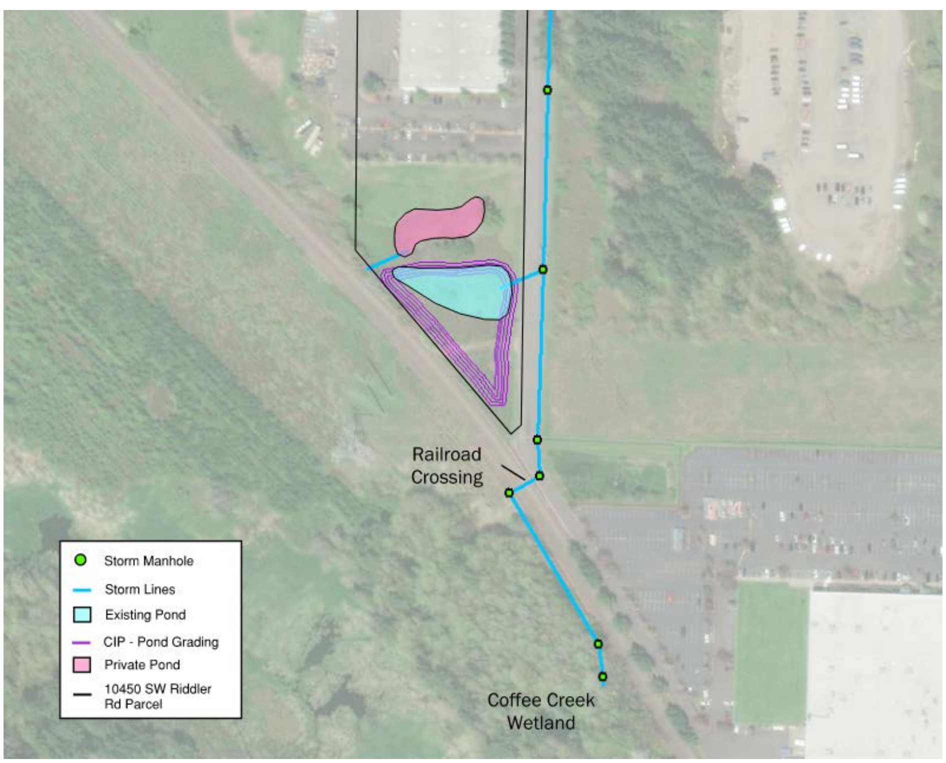


Figure 6-3: Garden Acres Pond (within Coffee Lake Wetlands)

Several alternatives were evaluated to retrofit the existing public pond to provide additional treatment and storage (detention) of stormwater during high flow events. In addition, reconfiguration of the pond to establish a discharge route from the pond to the stormwater collection system in Peters Road would also reduce the amount of overflow to the railroad ROW. Design alternatives include expansion of the public pond footprint and available storage capacity, including one scenario to utilize additional storage capacity in a private detention pond (currently serving private development).

H/H model scenarios to optimize the storage capacity needed and relieve reported flooding in Peters Road during the 25-year storm event were developed and presented to City staff in a workshop setting. The City opted to increase the existing pond storage capacity to 39,000 cubic feet, fully utilizing the existing parcel while maintaining separation from the private pond located to the north. See Appendix F, CP CLC-3.

In accordance with the City's PWS, the City requires new and redevelopment to implement flow control standards that match pre-development site hydrology. As with the Day Road CP, application of the City's design standards is anticipated to mitigate and offset some of the increased flow associated with future land use. The Garden Acres system reflects another area of the City where adherence to current stormwater design standards requiring retention/mitigation of flows to pre-development conditions is needed, as the CP does not completely alleviate all modeled flooding in the system.

6.3.4 Library Pond Analysis (Project Opportunity ID#4)

The Library Detention Pond (Library Pond), located in Memorial Park, was originally constructed in the 1980s and receives drainage from approximately 180 acres of commercial property in the southeastern portion of Wilsonville, predominately associated with the Town Center Planning Area. Although operating as a regional detention facility, the current pond configuration has structural and sizing limitations preventing it from adhering to the City's current PWS as a water quality and flow control facility.

Dense, overgrown vegetation and accumulated sediment, combined with a lack of an outlet control structure, limits Library Pond's capacity and water quality function.

The city anticipates using the Library Pond as a regional stormwater facility to mitigate stormwater treatment and flow control requirements associated with redevelopment of the Town Center Planning Area. Therefore, as part of this SMP, a sizing evaluation was conducted to confirm capital project needs (specific to retrofit of the pond to meet current operations), as well as policy recommendations applicable to the Town Center Planning Area to allow the Library Pond to offset onsite stormwater treatment and flow control needs associated with redevelopment.

The BMP Sizing Tool was used to evaluate sizing of the Library Pond in conjunction with 1) varying pre-development conditions (to facilitate adherence to the City's flow control standard), 2) varying coverage of onsite stormwater management facilities applied to redevelopment areas, and 3) varying site and depth constraints associated with retrofit of the Library Pond (while maintaining the same pond footprint). Detailed findings and results of the sizing evaluation are contained in Appendix F.

Results of the evaluation conclude that there are limited redevelopment options to retrofit the Library Pond to current design standards under future development conditions. Scenarios are described in Appendix F, Table 5, with Scenario 2B and Scenario 3 being the sole options that meet pond design criteria under future development conditions.

Scenario 2B requires onsite mitigation (treatment and flow control) of approximately 50 percent of all redeveloped impervious surface, which requires redevelopment to adhere to the stormwater standards as outlined in the PWS including definition of pre-developed land cover condition and pond design criteria. Scenario 3 requires the City to approve of a policy change, allowing the definition of pre-development for the Town Center Planning Area to conform with existing development conditions (as opposed to pre-developed land cover).

For purposes of capital project development, Scenario 2B was assumed for costing and reflected in the CP fact sheet. See Appendix F, CP BC-1. In conjunction with this CP, a policy defining and directing redevelopment in the Town Center Planning Area is required. The policy needs to define a fee-in-lieu program and onsite stormwater mitigation tracking system to ensure adequate capacity in Library Pond is available while adhering to the City's current design standards and definition of predevelopment.

6.4 Cost Estimate Assumptions

CP costs are based on the total capital investment necessary to complete a project (i.e., engineering through construction). Unit costs for project (construction) elements are generally based on recent bid tabs and stormwater master planning efforts and (as necessary) adjusted for 2023 based on a historical cost index. City staff validated unit costs used in this SMP. 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 generally apply a 40 percent construction contingency and multipliers to account for traffic control/utility relocation (5-10 percent), erosion control (3 percent), surveying (5 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 (13.5 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. Variations from these assumptions are noted on the project fact sheets in Appendix D.

Due to the resulting construction cost of select projects, the cost applicable to engineering and permitting and construction administration was capped in certain cases. For planning purposes, costs were rounded to the nearest $1,000 for engineering and permitting and construction administration; total project cost was rounded to the nearest $10,000 for budgeted purposes.

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 6.5.

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).

6.5 Programmatic Recommendations

During the problem area identification (Section 3.1) and project planning efforts (Section 6.1), select maintenance-related, regulatory-driven, and condition-related project needs were consolidated into program recommendations, to address issues at a city-wide scale instead of as multiple, stand-alone individual projects.

The following programs defined below support the successful management of a municipal stormwater system. Implementation will result in cost savings by providing for proactive maintenance, replacement, and repair, as well as contracting efficiencies for smaller, localized project needs.

Costs proposed for the programs are estimated based on current City spending and vetted with City staff. Funding may accumulate over multiple years to be used on a larger cost effort.

6.5.1 Localized Drainage Improvements (P-1)

This program would dedicate funding to assist with minor system configuration/reconfiguration or installation needs or in response to a recurring maintenance need. Improvements funded under this program are not anticipated to require extensive engineering services and would help address localized issues that do not warrant a standalone capital project. These improvements may include relocation and/or installation of curb inlets instead of catch basins in high traffic roads with significant leaf debris to help address localized drainage issues, as well as the installation of additional inlets and laterals (to address localized flooding or lack of infrastructure) and the minor regrading and replanting of conveyance ditches and swales.

An annual cost of $100,000 is estimated for this program. Project Opportunity Areas potentially benefitting from this program include the following:

- SW Parkway Avenue (south of Costco) (Project Opportunity ID #8),
- Wilsonville Road and Kinsman Road (Project Opportunity ID #10),
- SW Salish Lane and Parkway Ave (Project Opportunity ID #11),
- Commerce Circle (Project Opportunity ID #36),
- Serenity Way (Project Opportunity ID #37),
- SW Camelot Street (Project Opportunity ID #38), and
- SW Del Monte Ct (regular maintenance need reported during staff interviews).

6.5.2 Water Quality Retrofit Program (P-2)

This program stems from the project planning efforts and the stormwater retrofit analysis. This program involves the opportunistic incorporation of LID features (planters, curb bump outs, bioretention basins, porous pavement overlays, etc.) to address water quality in conjunction with other transportation, public improvement, or utility planning projects. These types of retrofit activities promote additional infiltration and water quality treatment, which are core values reflected in results from the public survey and external stakeholder outreach efforts. Efforts will help address NPDES MS4 retrofit requirements and TMDL compliance. Targeted locations may include collector roadways, park properties, and residential neighborhoods with limited or no existing water quality treatment.

An annual cost of $200,000 is estimated for this program. Project Opportunity Areas potentially benefitting from this program include the following:

- SW Parkway Avenue (south of Costco) (Project Opportunity ID #8),
- SW Salish Lane and Parkway Ave (Project Opportunity ID #11),
- Green Streets/LID Facilities (Project Opportunity ID #39),

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

CCTV is one of the least expensive and most robust methods to document, assess, and identify condition-related issues in the piped stormwater network. The City's Public Works Road and Storm Section is implementing their CCTV program in accordance with staffing recommendations.

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.

This program includes dedicated funding to repair/replace all public pipe 12-inches to 48-inches in diameter in-kind within the city limits over a 100-year timeframe. This fund would utilize results of the CCTV inspections to proactively schedule necessary replacement projects and exclude Charbonneau infrastructure, as replacement of a significant portion of the system is underway via a separate program effort in accordance with the Charbonneau Consolidated Improvement Plan (2014) (see Section 6.5.4).

Based on the City's asset inventory, this requires the replacement of approximately 3,700 LF of public stormwater pipe and associated manholes annually, reflecting a present-day construction cost (excluding contingencies and multipliers) of approximately $2.66M/year. However, this estimate does not consider ongoing pipe replacement efforts in CIP implementation 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 an additional $275,000 per year (approximately 10 percent of the annually calculated amount for this program.

6.5.4 Charbonneau R/R Program (P-4)

Since 2014, the City has implemented stormwater R/R efforts in the Charbonneau basin as part of the Charbonneau Consolidated Improvement Plan. The Charbonneau Consolidated Improvement Plan identified improvements across four utilities and consolidated utility improvements based on priority and location over a 20+ year period. To date, approximately 12,900 linear feet of pipe has been replaced. Project identification and H/H modeling efforts as part of this SMP identified two CP needs (WR-4, Phases 1 and 2 and WR-5) that incorporate pipe upsizing and direct pipe replacement in the Charbonneau basin.

This R/R program reflects direct replacement of remaining public pipe identified in the Charbonneau Consolidated Improvement Plan that has not been replaced or costed as a CP in this SMP (see Figure 6-4). This program includes in-kind replacement of approximately 30,000 linear feet of public pipe and 150 manhole structures. Pipe replacement will use PVC; pipe diameters less than 12 inches are assumed to be replaced with 12-inch pipe in accordance with the PWDS. A program duration of 20 years is maintained in conjunction with the Charbonneau Consolidated Improvement Plan.

Program costs were calculated directly and incorporate contingency, and multipliers as outlined in Section 6.4 (see Appendix E for a detailed cost estimate). The present-day construction cost (including contingencies and multipliers) is approximately $38.36M, resulting in an annualized program cost of approximately $1.92M per year.

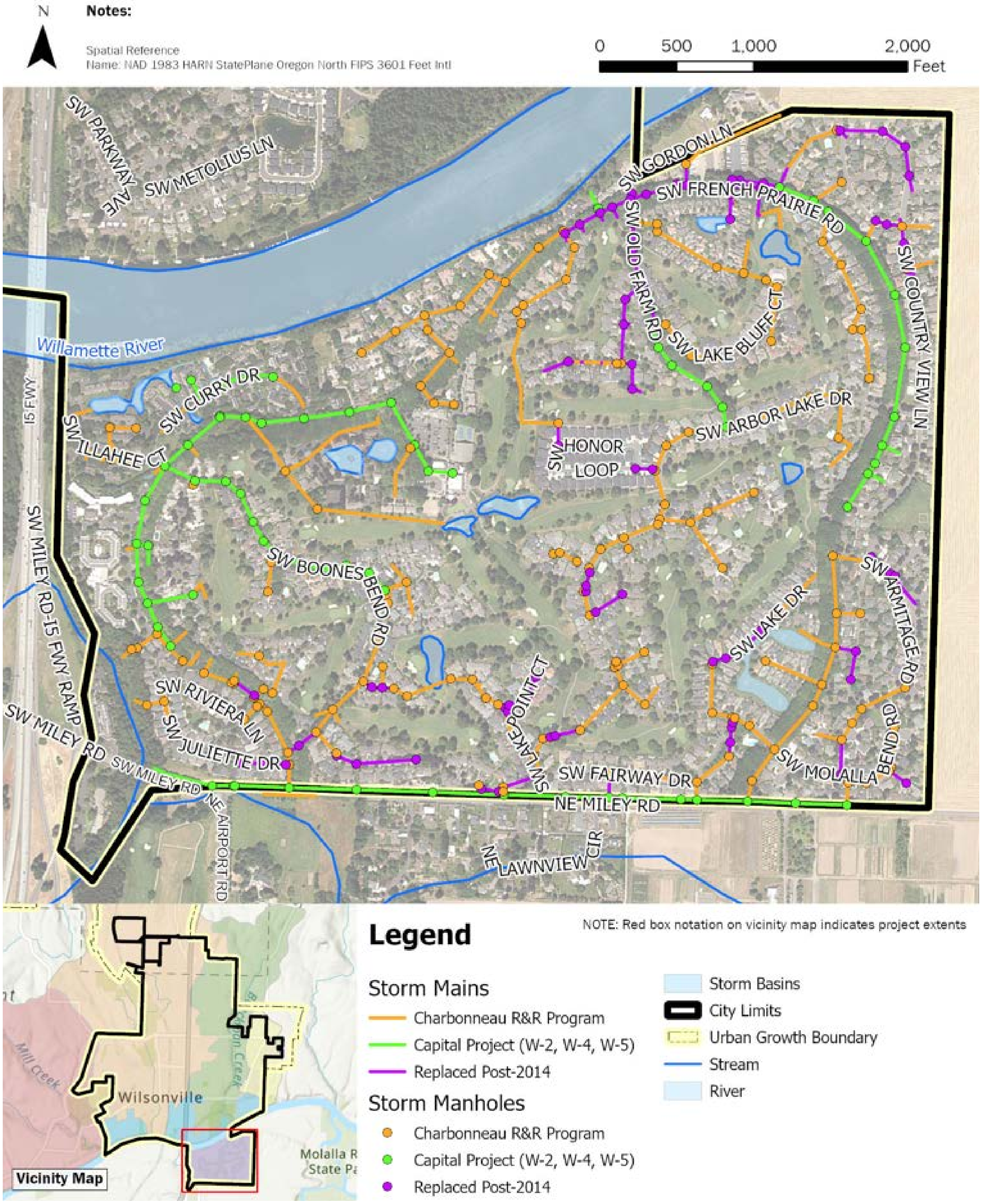


Figure 6-4: Charbonneau R/R Program Coverage

6.5.5 Riparian Vegetation Management Program (P-5)

This program includes dedicated funding to conduct riparian vegetation management and maintenance activities along stream corridors including removal of invasive species. This need was identified in the Stream Assessment (Section 4 and Appendix C), as there was dense coverage of invasive species including Himalayan blackberry, reed canary grass, and English ivy. In some cases, extensive vegetation prevented data collection efforts. These efforts support NPDES MS4 and TMDL (temperature management) initiatives.

An annual cost of $25,000 is allocated for this program. Project Opportunity Areas and specific locations noted in the Stream Assessment (Appendix C) that would potentially benefit from this program include:

- Boeckman Creek Reaches 2-9 (Stream Assessment identified vegetation management need)
- Kruse Creek Reaches 1-2 (Stream Assessment identified vegetation management need)
- Meridian Creek in Landover Park (Reaches 1 and 2) (Project Opportunity ID #18 and #19)
- Arrowhead Creek Reach 4 (Project Opportunity ID #20)
- Boeckman Creek Instream Flow Mitigation and Restoration (Project Opportunity ID #27)

6.5.6 Stormwater Facility Enhanced Maintenance Program (P-6)

This program establishes a dedicated funding mechanism supporting Public Works staff efforts to conduct more reactive and extensive maintenance of public and private vegetated stormwater facilities. Although routine maintenance of public facilities is addressed in conjunction with existing maintenance activities and staffing levels, occasionally additional support is needed to conduct a more robust, restorative maintenance effort on a larger, regional facility or address widespread replacement of amended soils and vegetation on LID/GI facilities.

Private facilities subject to this program would include those where private facility maintenance agreements are not in place and/or not being implemented after enforcement efforts are conducted. Maintenance on private facilities where a maintenance agreement is on file may be subject to reimbursement.

An annual cost of $25,000 is allocated for this program. Project Opportunity Areas potentially benefitting from this program include the following:

- Pond F and other ponds in Villebois (Project Opportunity ID #5),
- SW Daybreak Street and SW Morningside Avenue (Project Opportunity ID #12),
- Oulanka and Tivoli Parks (Project Opportunity ID #22)

6.6 Project and Program Numbering and Naming

CP numbering is applied to all location-specific capital projects, based on major basin. The project numbering convention maintains consistency with the 2012 SMP and includes a major basin abbreviation and number to indicate the individual project location. Phasing is defined within the project numbering. Project naming incorporates the location and primary objective of the project in the title.

Major basin abbreviations used for project numbering are listed below:

- Boeckman Creek (BC)
- Coffee Lake Creek (CC), includes projects associated with Tapman Creek drainage area
- Willamette River (WR), includes projects associated with the Charbonneau planning area
- Newland Creek (NC)

Four planning-related capital projects are identified and numbered with a “City” prefix.

Programmatic activities are numbered P-1 through P-6 and reflect city-wide implementation and an annual funding need.

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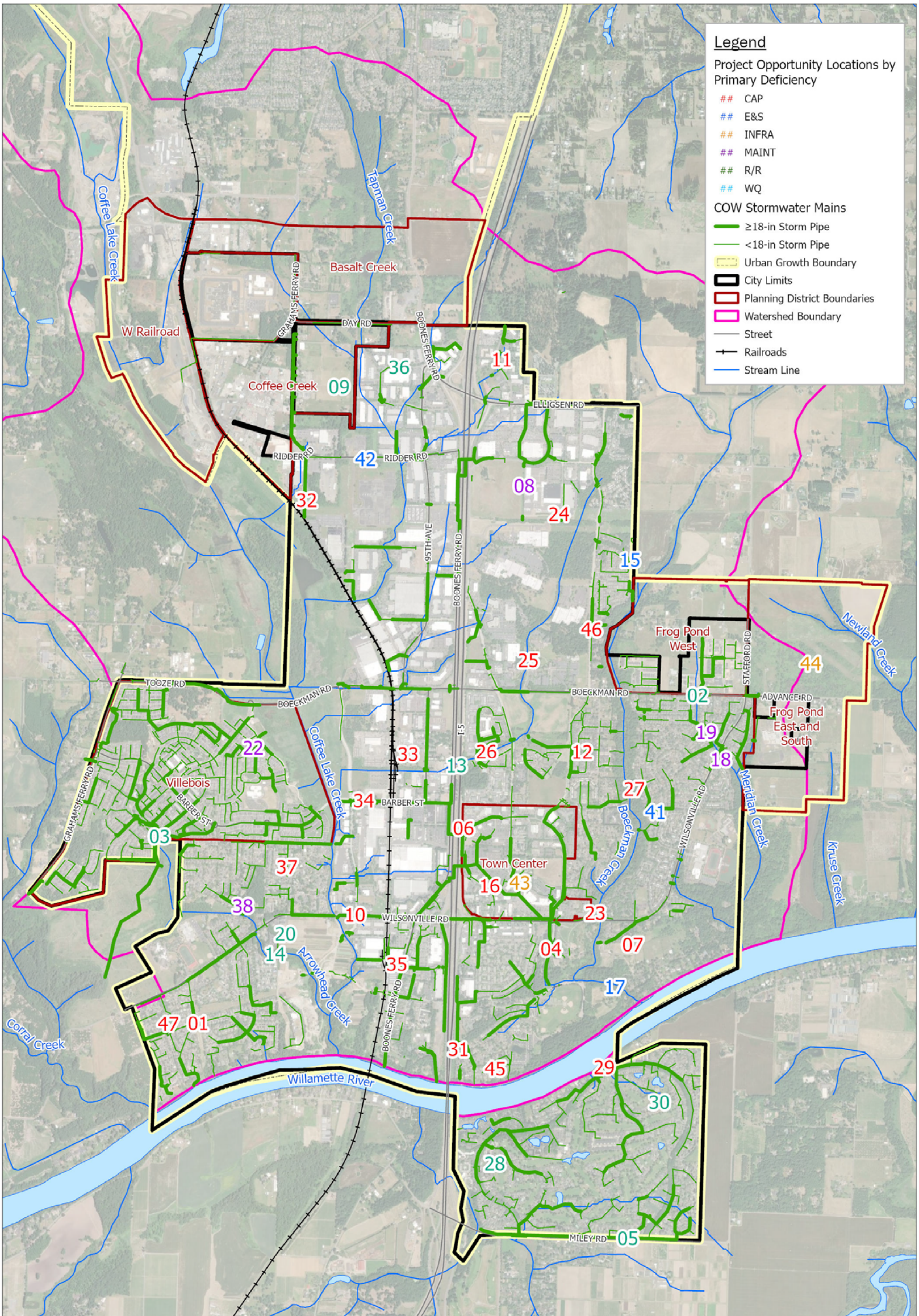

Brown AND Caldwell

City of Wilsonville/
Project # 156157

Stormwater Master Plan

Note: Locations 39 & 40 are citywide programs and not specific to an area.

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

N

0 0.25 0.5 1 Miles

Figure 6-1: Project Opportunity Locations

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Section 7

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 15 capital projects (CPs) are identified to address current and future storm drainage infrastructure needs related to system capacity, repair and replacement (R/R), a lack of infrastructure, recurring maintenance, instream erosion and sediment accumulation, and water quality. Considering multiples phases for some projects, these 15 CPs represent 20 separately costed and phased projects for purposes of project prioritization and scheduling efforts.

CP recommendations are considered a one-time cost and are shown in Figure 7-1, located at the end of this section.

In addition to the 15 CPs, there are four, city-wide planning projects that are also considered a one-time cost. These planning projects are described in Section 7.2.

Six programmatic recommendations are identified, including addressing ongoing support for localized drainage improvements, city-wide system repair and replacement (R/R) needs, water quality retrofits and expanded stormwater facility maintenance needs, and riparian vegetation management. Program recommendations are considered an annual cost, as described in Section 6.5, and intended to support ongoing asset management efforts.

Section 7.1 summarizes the recommended actions costed for this SMP. Section 7.2 summarizes the overall CIP, and Section 7.3 outlines the staffing analysis to assess Public Works and Engineering staffing needs in support of this SMP and regulatory obligations.

7.1 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 CPs required to address system capacity, system maintenance, repair and replacement, water quality, instream erosion/sediment control, and new infrastructure needed to accommodate pending development. These CPs are intended to manage areas of reported deficiencies and accommodate development and growth.
- Implement stormwater-related improvement programs to address recurring, maintenance-related system needs in an expedited manner, as well as address system condition issues in accordance with ongoing inspections and the City's asset management goals.
- Implement stormwater retrofits both proactively and opportunistically to enhance water quality and improve natural system aesthetics and function.
- Update policies and procedures to support public and private partnerships for new and redevelopment activities, specifically related to stormwater infrastructure replacement and stormwater fee-in-lieu payments in conjunction with the Town Center redevelopment.
- Continue implementation of the City's Public Works Design Standards (PWDS) to address regulatory drivers, support private development activities, and protect stream health.

- Add staff necessary to maintain compliance with the City's National Pollutant Discharge Elimination System (NPDES) municipal separate storm sewer (MS4) permit, as well as to implement recommendations outlined in this SMP.
- Clearly document capital project and program costs and schedule to inform future funding and rate analyses.

7.2 Capital Improvement Program Recommendations

CP locations are mapped in Figure 7-1, at the end of this section, based on the following objectives (identified in **BOLD**):

- Increase **system capacity** to address existing and potential future deficiencies (i.e., flood control).
- Install **water quality** treatment and address instream **erosion and sediment control (E&S)** to meet regulatory drivers including the City's NPDES MS4 permit and total maximum daily load (TMDL) obligations.
- Address recurring **maintenance** and **infrastructure needs** (i.e., lack of maintenance access, add infrastructure to address localized drainage issues).
- Address system condition through **repair & replacement (R&R) needs.**

Table 7-1 lists all CP and program recommendations and references the associated Project Opportunity Area as defined in Section 6. A brief description of the project and summary of project objectives are also included. Most projects address multiple objectives. Table 7-1 also reflects the anticipated implementation schedule for the CP, based on prioritization efforts. Corresponding CP fact sheets with more detailed project information are provided in Appendix D.

The portion of total project cost considered eligible for funding via system development charges (SDCs) is also provided in Table 7-1. Projects solely related to planning, repair & replacement, and maintenance were determined not eligible for SDCs, as they do not address required improvements associated with new or redevelopment. The portion of the total project cost considered SDC eligible is calculated based on the increase in flow associated with anticipated development, using percent increase in impervious coverage as a surrogate.

Description of the four planning-related projects (City-1, City-2, City-3, and City-4) are provided below. Planning projects require specific, scheduled budget allocations and so were added to the overall stormwater CIP.

7.2.1 Flow Monitoring and Rain Gauge Installation (City-1)

This planning project includes the installation of three flow monitors, installed in the piped stormwater collection system, as well as the installation of one rain gauge to assess stormwater flow and aid in the more refined calibration of the City's InfoSWMM model. Additional flow monitoring and model calibration will help confirm the need for and sizing of select CPs, particularly where City staff have not yet observed flooding issues, but the model is predicting flooding.

Recommended locations for installation of flow monitoring include locations with a phased, capacity-related CP and pending new development. They include locations in each of the three major basins: Coffee Lake Creek, Boeckman Creek, and the Willamette basin (e.g., Charbonneau). CPs potentially informed by this effort include Day Road Stormwater Improvements (Project ID CLC-1), Garden Acres Pond Retrofit (Project ID CLC-3), Morey's Landing (Project ID WR-1), Charbonneau East (WR-4), and Charbonneau West (WR-5).

The project duration (for costing purposes) is estimated at 12 months, and the cost estimate of $100,000 for this effort is based on recent bids for similar levels of service. This estimate has not been validated or based on a detailed scope.

7.2.2 Hydromodification Assessment and Stream Survey (City-2)

This planning project includes follow up monitoring efforts related to the 2022 geomorphic assessment of select high priority reaches as conducted for this SMP (see Appendix C). Although the focus of the assessment was to identify existing and potential future risks associated with hydromodification, the assessment also provided a baseline within the study areas to assess changes in channel, floodplain, and riparian condition over time. This was done by documenting locations of noticeable bank erosion, headcuts, neglected or compromised riparian corridor, grade control locations, and other points of interest.

Data collection efforts will use similar protocols and data sheets developed during the 2022 assessment along these high priority reaches to provide continuous monitoring of stream impacts associated with upstream development activities or hydromodification mitigation strategies. The assessment will be both field-based, consisting of stream walks along the select reaches, and qualitative, including descriptions of geomorphic setting, geomorphic trends (i.e., aggrading, incising or stable), presence of base level controls, and the primary risk to infrastructure. Reaches recommended for ongoing evaluation per the 2022 assessment include Boeckman Creek (reaches 2, and 9), Meridian Creek (reaches 1 and 2), Arrowhead Creek (reaches 2 and 3), Newland Creek (reaches 1-4), and Kruse Creek (reaches 1-3).

Additionally, the City may want to establish baseline conditions associated with identified “secondary” locations that were not included in the 2022 geomorphic assessment effort. This new evaluation may be conducted in addition to or in lieu of ongoing monitoring at select reaches.

The complete assessment will be documented in a technical memorandum summarizing the results for inclusion in TMDL and/or NPDES MS4 reporting.

This project is estimated to be completed every three years and/or following a high flow event that exceeds the 10-yr discharge. A project cost of $30,000 per monitoring event is reflected in Table 7-1 and is assumed to occur once during initial 5-year CIP implementation period; once during the second 5-year CIP implementation period; and twice during the third, 10-year CIP implementation period.

7.2.3 Porous Pavement Pilot Study (City-3)

This planning project stems from the City’s NPDES MS4 Retrofit Strategy, water quality project objectives, TMDL drivers, and the need to expand water quality treatment to areas lacking in treatment. To date, use of pervious pavement, porous asphalt or other permeable road and drive surfaces has not been used in the public right-of-way (ROW). This pilot study would include the installation of a porous pavement overlay in conjunction with pavement resurfacing efforts in the City. Water quality monitoring may be conducted to confirm/inform stormwater pollutant reduction, as local research efforts have indicated water quality benefits (i.e., reduction of sediment, bacteria, heavy metals, and organic compounds) can be observed, even with an overlay versus full pavement replacement with pervious pavement.

Recommended locations for implementation of the pilot project have not yet been identified but are anticipated to coordinate with scheduled pavement maintenance. A project duration (for costing purposes) is estimated at 24 months and scheduled during the first 5-year CIP implementation period, and the cost estimate of $100,000 for this effort is based on recent efforts in the City of Milwaukie. This estimate has not been validated or based on a detailed scope.

7.2.4 Boeckman Creek Geomorphic and Geotechnical Evaluation (City-4)

This planning project is to conduct a geomorphic and geotechnical evaluation on Reach 1 of Boeckman Creek, where continued risk of channel incision and bank erosion exists. This project stems from a recommendation in the 2022 geomorphic assessment, which was unable to confirm source, rate, or extent of bank failure in the reach (see Appendix C). A holistic evaluation of backwater conditions, geomorphic conditions and a geotechnical assessment of slope stability and potential bank stabilization techniques is recommended.

The project duration (for costing purposes) is estimated at 12 months, and a cost estimate of $150,000 for this effort is based on recent bids for similar levels of service. This estimate has not been validated or based on a detailed scope.

Table 7-1. City of Wilsonville Stormwater Capital Project and Program Summary

Project No.[a]	Project Opportunity Area Location ID	Basin/ Waterbody	Project/Program Name	Objectives [b]	Location	Contributing Drainage Area, acres	Project/Program Summary	Estimated Cost [c]	SDC Eligible Cost [c]	Recommended Project/Program Timing			
										Annual	High Priority (2024-28)	Medium Priority (2029-33)	Low Priority (2034-43)
BC-1	4	Boeckman Creek	Library Pond Retrofit	• **Capacity** • Water Quality • Infrastructure Need	Existing Library Pond facility, east of SW Memorial Drive in Memorial Park	132.0	• Clear, regrade, and replant 0.7 acre detention pond, including adding 3 ft required rocks and media to pond bottom. • Install a new outlet structure. • Replace 70 LF of 18-inch CSP pipe. • Install 70 LF of 6-inch perforated HDPE underdrain. • Install 15-foot-wide, 25-foot-long road for maintenance access.	$1,880,000	$213,000		X		
BC-2	25, 26	Boeckman Creek	Ash Meadows Flow Mitigation	• **Capacity** • Water Quality	East of SW Ash Meadows Rd, West of SW Parkway Ave, and north of SW Greenway Dr	295.0	• Plug the flow diversion structure at Siemens Pond B. • Upsize 95 LF of 30-inch culvert at Boeckman Road to 48-inch diameter PVC. • Update 80 LF of 36-inch culvert at SW Parkway Ave to 48-inch diameter PVC. • Install a 3-foot x 3-foot grated inlet to serve as a flow control structure at Ash Meadows Cir. • Clear, regrade, and replant 1.3 acres of drainage way and embankment to ensure a low-flow drainage path and healthy vegetation.	$2,940,000	$798,000		X		
BC-3-Phase 1	24	Boeckman Creek	Wiedemann Ditch and Canyon Creek Park Retrofit, Phase 1	• **Capacity** • Water Quality	Canyon Creek Park, north of SW Carriage Oaks Ln	295.0	• Clear, regrade, and replant approximately the 1.6-acre proposed vegetated storage facility. • Install a flow control/outlet structure with emergency overflow at the storage facility. • Install 350 LF of 36-inch diameter PVC to discharge from the southeast corner of the site towards Boeckman Creek. • Install one new manhole at bend in new 36-inch pipe.	$4,860,000	$920,000				X
BC-3-Phase 2	24	Boeckman Creek	Wiedemann Ditch and Canyon Creek Park Retrofit, Phase 2	• **Capacity** • Water Quality	Existing Wiedemann Ditch alignment, south of Sysco property	295.0	• Clear, regrade, and replant approximately 2.1 acres along the existing ditch alignment to install five, tiered wetland complexes. • Install a 12-foot-wide, 1,500-foot-long access road west of Canyon Creek Road.	$7,210,000	$1,365,000				X
BC-4	15	Boeckman Creek	Boeckman Creek Stabilization at Colvin Lane	• **Erosion/Sediment Control** • Repair/Replacement • Maintenance	Boeckman Creek corridor adjacent to Canyon Creek Estates and bounded on the west by SW Roanoke Dr	358.0	• Removal of approx. 30 LF of existing outfall pipe. • Installation of approx.70 LF of 12-inch-diameter PVC to serve as a new outfall. • Install planting and bioengineered restoration/stabilization measures along approx. 600 LF of stream corridor. • Reconstruction of 150 LF of vegetated swale in accordance with the City's PWS.	$410,000	$78,000		X		
BC-5	21	Boeckman Creek	Memorial Park Swale Retrofit	• **Water Quality** • Erosion/Sediment Control • Maintenance	Within Memorial Park, north of the parking lot by the baseball fields and south of SW Memorial Dr	33.0	• Remove 90 LF of 10-inch CSP (SD5041 and SD5042). • Remove 120 LF of 12-inch CSP (SD5044). • Remove: manhole (ST5098), swale inlet structure (CARTE ID 568), and outlet structure (CARTE ID 19). • Fill existing 1,500 SF swale and revegetate area. • Replace two 48-inch manholes (ST5200 and ST5208). • Replace 60 LF of 12-inch CSP with 18-inch PVC pipe (SD5046). • Replace 50 LF of 18-inch CSP with 18-inch PVC pipe (SD5206). • Replace manhole ST5208 with a 72-inch flow splitting/WQ manhole. • Install 2,400 SF vegetated water quality swale with 1 foot of drain rock and 1.5 feet of amended soil. • Install 140 LF of 6-inch perforated HDPE underdrain pipe. • Install 50 LF of 12-inch PVC pipe. • Install structures for the new swale: swale inflow spreader with rip-rad pad, beehive overflow structure, and outfall to the creek.	$910,000	$22,000				X

Table 7-1. City of Wilsonville Stormwater Capital Project and Program Summary													
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										Annual	High Priority (2024-28)	Medium Priority (2029-33)	Low Priority (2034-43)
BC-6	41	Boeckman Creek	Gesellschaft Water Well Channel Restoration	• **Erosion/Sediment Control** • Maintenance	Boeckman Creek riparian area near Wilsonville High School, at the Gesellschaft well site (29001 SW Meadows Pkwy)	25.0	• Install approx. 480 LF of 12" PVC pipe to convey discharge flows from the well maintenance. • Install two new 48-inch manholes. • Install outfall with 8 CY of Class 200 rip-rap to the creek. • Restore approx. 310 LF of the existing channel with coir log check dams and matting, and re-vegetating with native trees and shrubs.	$400,000	$2,000		X		
CLC-1 - Phase 1	9	Coffee Lake Creek	Day Road Stormwater Improvements, Phase 1	• **Repair/Replacement** • Capacity	Open channel alignment south of Day Rd	944.0	• Regrade and reconstruct approx. 4,500 feet of open channel to eliminate negative slope. The resulting channel shall be approximately 5-foot wide (bottom width) ranging from 1-foot to 6-feet deep. The channel widens at elevation 223.0 to create a floodplain. Side slopes are designed at 2H:1V. • Construct a structural earth wall at bends in the channel and along the east-west portion of the alignment, as specified in the AKS report. • Install 200 LF of open-bottom or box culverts (4 culverts total) to provide access to the existing BPA utility poles while also maximizing conveyance. • Remove the unmapped, 50-foot existing culvert at the northwest corner of the northernmost industrial property south of Day Road. • Install approx. 180 LF of two barrel, 36-inch diameter PVC culverts at Day Road.	$8,020,000	$3,054,000		X		
CLC-1 - Phase 2	9	Coffee Lake Creek	Day Road Stormwater Improvements, Phase 2	• **Capacity**	North of Ridder Rd through Tax Lot 500	944.0	• Remove 1.200 LF of existing pipe. • Upsize 1,800 LF of existing 36-inch parallel storm pipes to 48-inch. • Replace seven 72-inch manholes. • Install 3 trash racks.	$3,930,000	$1,497,000			X	
CLC-2	20	Coffee Lake Creek	Arrowhead Creek Culvert Replacement at Arrowhead Creek Trail	• **Repair/Replacement** • Maintenance	Arrowhead Creek culvert crossings under pedestrian path at the south end of SW Morey Ln	421.0	• Remove and replace approx. 70 LF existing double 5 ft x 5 ft concrete box culverts with a 10 ft x 3 ft concrete box culvert. • Install planting and bioengineered restoration/stabilization measures after replacement of the culvert to stabilize an area approximately 20 feet along the pedestrian path length and approximately 50 feet upstream and downstream of the crossing. • Repave approx. 30 LF of the approx. 20-foot-wide pedestrian path after culvert replacement.	$290,000	$16,000			X	
CLC-3	32	Coffee Lake Creek	Garden Acres Pond Retrofit	• **Capacity** • Water Quality	Existing public pond in an industrial area along Peters Rd between SW Graham's Ferry Rd to the west, SW Day Rd to the north, SW 95th Ave to the east, and the Coffee Lake Wetlands to the south.	231.0	• Install a flow diversion structure at Peters Road (ST2101A). • Install 95 LF of 24-inch PVC pipe from Peters Road to the inlet of the detention pond. • Increase existing detention pond capacity by 25,600 cubic feet and lower pond bottom invert to 196-ft. • Clear, regrade, and replant 0.9-acres of pond footprint area. • Install an outlet control structure within the detention pond. • Install 155 LF of 24-inch diameter PVC pipe from the detention pond to the stormwater conveyance system on Peters Road (ST2431). • Install pond underdrain in accordance with the 2015 PSW Section 3, Appendix A landscape and soil media requirements. Including 15" of drain rock, a 3" separation layer, and 18" of growing media.	$3,780,000	$1,339,000			X	
NC-1	44	Newland Creek	Frog Pond East and South Conveyance Pipe Installation	• **Infrastructure Need**	East of SW Stafford Road and the Frog Pond West development area in Wilsonville, outside of the current city limits and UGB. Only K1 Basin of Frog Pond East and South.	61.0	• Install 2,050 LF of 24-inch PVC pipe. • Install 310 LF of 30-inch PVC pipe. • Install seven 60-inch manholes. • Install 1 outfall.	$4,090,000	$3,222,000		X		

Table 7-1. City of Wilsonville Stormwater Capital Project and Program Summary

Project No.[a]	Project Opportunity Area Location ID	Basin/ Waterbody	Project/Program Name	Objectives [b]	Location	Contributing Drainage Area, acres	Project/Program Summary	Estimated Cost [c]	SDC Eligible Cost [c]	Recommended Project/Program Timing			
										Annual	High Priority (2024-28)	Medium Priority (2029-33)	Low Priority (2034-43)
WR-1 - Phase 1	1	Willamette River	SW Willamette Way/Morey's Landing Stormwater Improvements, Phase 1	• **System Capacity** • Water Quality	Along Willamette Wy East from SW Pkwy Dr to the Belknap Ct Outfall, including greenfield along BPA easement	46.0	• Remove existing Morey's Landing Bubbler (STD6604). • Clear, grade, and replant 0.12-acres to create two infiltration raingardens within the BPA easement. • Install a flow control diversion structure and 25 LF of 8-inch PVC to route water quality events (low flow) to new raingardens and high flow events to the Belknap Court outfall. • Install 120 LF of 12-inch PVC for flow exceeding the water quality event. • Upsize 575 LF of 10-inch CPS to 12-inch PVC (SD6629, SD6630, SD6632). • Upsize 145 LF of 10-inch CSP to 18-inch PVC (SD6638). • Install one 48-inch manhole and replace four 48-inch manholes (ST6618, ST6619, ST6606, and ST6605).	$2,310,000	$45,000			X	
WR-1 - Phase 2	1	Willamette River	SW Willamette Way/Morey's Landing Stormwater Improvements, Phase 2	• **System Capacity**	SW Champoeg Dr	46.0	• Upsize 610 LF of 12-inch CSP to 18-inch PVC on SW Champoeg Dr E (SD6634 - SD6637). • Replace three 48-inch manholes (ST6607, ST6608, and ST6609) and field inlet (6647).	$1,080,000	$21,000				X
WR-2 - Phase 1	5	Willamette River	Miley Road Stormwater Improvements, Phase 1	• **Repair/Replacement** • Erosion/Sediment Control • Maintenance	Miley Rd outfall	138.0	• Replace and upsize 80 LF outfall pipe (from area drain with ENG ID 9341 to outfall) from 36-inch CMP to 42-inch PVC. • Replace area drain (ENG ID 9341). • Replace 320 LF of existing storm pipe between area drain (9341) and MH (ST9002) with same diameter 42-inch PVC. • Replace and lower invert of MH (ST9002) to ensure 3 ft cover requirement is met for incoming pipe. Maintain 0.2 ft drop within MH. • Install planting and bioengineered restoration/stabilization measures after replacement of the culvert to stabilize an area approximately 25 feet along the channel upstream and downstream of the outfall.	$820,000	$0		X		
WR-2 - Phase 2	5	Willamette River	Miley Road Stormwater Improvements, Phase 2	• **Repair/Replacement** • Maintenance	Miley Rd from NE Airport Rd to eastern intersection with SW French Prairie Rd	138.0	• Install approx. 530 LF of new 42-inch pipe from replaced MH ST9002 to new manhole at the near intersection with SW French Prairie Road. • Install three 72-inch diameter manholes for the above 42-inch line, the most upstream of which is at the SW French Prairie Road. • Install 10 new 60-inch diameter manholes and approx. 3015 LF of new 36-inch storm pipe along NE Miley Road from SW French Prairie Road to new manhole adjacent to MH ST9011. • Install 2 new 48-inch diameter manholes and approx. 650 LF of new 24-inch storm pipe from the new manhole adjacent to MH ST9011 to new manhole at upstream most lateral. • Extend six total existing main connections to the new pipe alignment (approx. 40 LF each, varying diameters). Note that these points of connection run under the existing brick wall. • Reconnect all existing curb inlets along new NE Miley Road alignment - approximately 13.	$10,510,000	$0			X	
WR-3	7	Willamette River	Rose Lane Culvert Replacement	• **Capacity** • Maintenance	SW Rose Ln between SW Wilsonville Rd and SW Montgomery Wy	14.0	• Remove the existing 25 LF of 12-inch culvert (CARTE ID: 24370). • Install approx. 40 LF of parallel 12-inch RCP culverts. Realign the culverts at a diagonal across the road with the same outlet location. • Reinforce stormwater conveyance around property near culvert to move water into ditch.	$200,000	$19,000		X		
WR-4 - Phase 1	30	Willamette River	Charbonneau East Stormwater Improvements, Phase 1	• **Capacity** • Repair/Replacement	SW French Prairie outfall	159.0	• Remove and replace existing Charbonneau East Outfall (ENG ID: STD9005). • Upsize 115 LF of 30-inch pipe to 36-inch PVC discharging to Willamette River (ENG ID: STD9005 to ST9014). • Replace one 72-inch manhole (ST9014).	$600,000	$0				X

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										Annual	High Priority (2024-28)	Medium Priority (2029-33)	Low Priority (2034-43)
WR-4 - Phase 2	30	Willamette River	Charbonneau East Stormwater Improvements, Phase 2	• **Repair/Replacement** • Maintenance	SW French Prairie Rd and SW Old Farm Rd	159.0	• Replace 230 LF of 10-inch pipe with 12-inch PVC on SW French Prairie Rd (ST9087 to end, and ST9088 to end). • Replace 680 LF of 12-inch pipe with 12-inch PVC on SW French Prairie Rd (ST9023 to ST9242). • Replace 1,200 LF of 15-inch pipe with 15-inch PVC on SW French Prairie Rd (ST9023 to ST9020). • Replace 310 LF of 18-inch pipe with 18-inch PVC on SW French Prairie Rd (ST9020 to ST9019). • Upsize 360 LF of 21-inch pipe to 30-inch PVC on SW French Prairie Rd (ST9019 to ST9017). • Replace 570 LF of 24-inch pipe with 24-inch PVC on Old Farm Rd (ST9030 to ST9027). • Replace 300 LF of 30-inch pipe with 30-inch PVC on Old Farm Rd (ST9031 to ST9030). • Replace eight 48-inch manholes. • Replace nine 60-inch manholes.	$4,440,000	$0				X
WR-5	28	Willamette River	Charbonneau West Stormwater Improvements	• **Repair/Replacement** • Maintenance	SW Curry Dr, SW French Prairie Rd, and SW Boones Bend Rd	54.0	• Pipe replacement along SW Curry Drive: • Replace 110 LF of 15-in pipe with PVC (PST9012 to new manhole). • Replace 520 LF of 18-in pipe with PVC (new manhole to PRIVATE manhole CARTE ID: 1892). • Replace 140 LF of 18-in private pipe with PVC (private manhole CARTE ID: 1892 to private outfall CARTE ID: 15). • Replace private outfall (CARTE ID: 15). • Replace two private 48-in manholes (CARTE ID 1892 and 1383). • Install three 48-in manholes. • Pipe replacement along SW French Prairie Road: • Replace 200 LF of 12-in pipe with PVC (ST9331 to ST9044) • Replace 1,280 LF of 15-in pipe with PVC (ST9048 to ST9046; ST9269 to ST9046; and ST9281 to ST9043). • Replace 1,370 LF of 18-in pipe with PVC (ST9046 to ST9044 and ST9043 to CARTE ID: 1859 - ENG ID unknown) • Replace 550 LF of 24-in pipe with PVC (ST9044 to ST9040). • Replace 640 LF of 30-in pipe with PVC (ST9040 to ST9067, ST9041 to ST9067, and unknown to ST9041). • Replace 20 LF of 36-in pipe with PVC (unknown to ST9067). • Replace 150 LF of private 36-in PVC pipe (ST9041 to private outfall - ID unknown). • Replace private outfall; install one 48-in manholes and replace 14 48-in manholes; replace four 60-in manholes; and replace two 72-in manholes. • Pipe replacement along SW Boones Bend Road: • Replace 150 LF of 15-in pipe with PVC (ST9059 to ST9058). • Replace 420 LF of 18-in pipe with PVC (ST9058 to ST9055). • Replace 680 LF of 21-in pipe with PVC (ST9055 to ST9051). • Replace 120 LF of 24-in pipe with PVC (ST9051 to ST9050). • Replace 420 LF of 27-in pipe with PVC (ST9050 to ST9040). • Replace eight 48-in manholes; and replace three 60-in manholes.	$10,370,000	$0				X
City-1	N/A	City-wide	Flow Monitoring and Rain Gauge Installation	• **Capacity**	City-wide	N/A	• Location of one rain gauge and installation of a minimum of three flow meters over a 12-month duration to aid in Info-SWMM model calibration and validation of project needs/phasing.	$100,000	N/A		X		

Table 7-1. City of Wilsonville Stormwater Capital Project and Program Summary

Project No.[a]	Project Opportunity Area Location ID	Basin/ Waterbody	Project/Program Name	Objectives[b]	Location	Contributing Drainage Area, acres	Project/Program Summary	Estimated Cost[c]	SDC Eligible Cost[c]	Recommended Project/Program Timing			
										Annual	High Priority (2024-28)	Medium Priority (2029-33)	Low Priority (2034-43)
City-2	18, 19, 27	Boeckman, Meridian, and Newland	Hydromodification Assessment and Stream Survey	• **Erosion/Sediment Control**	Stream corridors associated with developing portions of the Boeckman Creek, Meridian Creek and Newland Creek basins	N/A	• Follow-up monitoring related to the 2022 geomorphic assessment, targeting select stream reaches.	$30,000/event	N/A		X	X	X
City-3	40	City-wide	Porous Pavement Pilot Study	• **Water Quality**	City-wide	N/A	• Implementation of a porous pavement overlay and associated water quality monitoring to inform more widespread applications.	$100,000	N/A		X		
City-4	17	Boeckman Creek	Boeckman Creek Geotechnical Evaluation	• **Erosion/Sediment Control**	Downstream 750' of the Boeckman Creek stream corridor	N/A	• Geomorphic and geotechnical evaluation of the downstream 750' of Boeckman Creek at the confluence with the Willamette River.	$150,000	N/A		X		
P-1	5, 7, 10, 17	City-wide	Local Drainage Improvements Program	• **Infrastructure Need** • 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). • Relocate/install curb inlets instead of catch basins in high traffic roads to address local drainage issues	$100,000/yr	N/A	X			
P-2	8, 11, 39, 40	City-wide	Water Quality Retrofit Program	• **Water Quality** • Capacity	City-wide	N/A	• Design and install opportunistic LID or green infrastructure (porous pavement overlays, regional facilities, stormwater planters/curb bump outs) along streets, within public property, and/or within available ROW to provide water quality treatment.	$200,000/yr	N/A	X			
P-3	N/A	City-wide	City-wide Repair/Replacement Program	• **Repair/Replacement** • Maintenance	City-wide	N/A	• Conduct prescriptive replacement of public pipe and structures s over a 100-year period. Use results of CCTV analysis to inform locations.	$275,000/yr	N/A	X			
P-4	29	Willamette River	Charbonneau Repair/Replacement Program	• **Repair/Replacement** • Maintenance	Charbonneau Basin	478.0	• In-kind repair and replacement of public pipe and manholes within the Charbonneau basin, in accordance with the Charbonneau Consolidated Improvement Plan. Excludes pipes replaced within the last 10-years (since 2014) and CP WR-4, Phases 1 and 2 and WR-5.	$1,920,000/yr	N/A	X			
P-5	18, 19, 20, 27	City-wide	Riparian Vegetation Management Program	• **Maintenance** • Water Quality	City-wide	N/A	• Conduct riparian and/or in-channel vegetation maintenance including removal of invasives.	$25,000/yr	N/A	X			
P-6	5, 12, 22	City-wide	Stormwater Facility Enhanced Maintenance Program	• **Water Quality** • Maintenance	City-wide	N/A	• Conduct restorative maintenance on select public and private stormwater facilities.	$25,000/yr	N/A	X			
									TOTAL	$2.545M	$19,140,000	$20,850,000	$29,530,000

N/A: Not Applicable

a. CP numbering reflects the following drainage basins: BC = Boeckman Creek, CLC = Coffee Lake Creek, WR = Willamette River, NC = Newland Creek. Citywide planning projects are designated as "City". Programs (to be funded annually) are prefaced with a P designation.

*b. Primary objective (for mapping purposes) is identified in **BOLD**.*

c. Estimated costs and SDC eligible costs are described in Section 7 of the SMP and detailed cost summaries provided in Appendix E. City-wide planning projects and solely related to Repair/Replacement or Maintenance are not eligible for SDCs and the SDC eligible cost is indicated as N/A. For projects with no developable lands in the upstream contributing drainage area, the portion of project cost associated with SDCs is $0.

7.3 Future/Unfunded Capital Project Opportunities

Table 7-2 summarizes potential, additional CP needs as identified during project planning efforts and documented in the Project Opportunity Matrix (Appendix A, Table A-2). However, these are considered unfunded capital projects for purposes of this SMP, as needs are more undefined and/or staff have not observed specific deficiencies in these areas. In some cases, a standalone CP may not be necessary if the project opportunity can be addressed as part of a program activity (i.e., Localized Drainage Improvement [P-1]).

Specific cost estimates have not been developed and schedule for implementation not established for these projects.

Table 7-2. Unfunded/Future Capital Project Concepts										
Project Opportunity Location ID	Location/ Asset Description	Basin	Source	Problem Description	Deficiency Category [a]		Project Background			
					Primary	Secondary	Modeled Capacity Deficiency (Y/N)	Stream Assessment ID Need (Y/N)	Water Quality Retrofit Opportunity (Y/N)	Project Concept
8	SW Parkway Ave south of Costco	Boeckman Creek	Staff Surveys H&H Model	Modeled results indicate flooding at US node of 30" culvert at N-S end of ditch. Downstream N-S drainage swale has flat grades and is routinely filled with sediment, surcharging the roadway drainage system, and resulting in an ongoing maintenance concern.	MAINT	CAP	Y	N	Y	• Install WQ manhole(s) or other facilities to remove sediments from public runoff.
11	SW Salish Ln at intersection with Parkway Ave	Coffee Lake Creek	Staff Surveys H&H Model	A city-owned pond receives a small amount of drainage and requires frequent maintenance (due to undersized catch basins). Model predicts flooding within the pond and outlet.	CAP		Y	N	N	• Improve maintenance access from the Shrine Center parking lot. • Expand/retrofit pond to improve water quality function and outlet configuration.
17	Boeckman Creek - Reach 1 (US of Willamette R.)	Boeckman Creek	Stream Assessment	Continued channel incision and lateral erosion along the lowest reach of Boeckman Creek prior to confluence of the Willamette River.	E&S		N	Y	N	• Planning project (City-4) proposed to evaluate source and potential, structural repairs first. • Channel stabilization and grade control (retaining/crib wall or soldier pile) pending planning study feedback.
22	Oulanka and Tivoli Parks	Coffee Lake Creek	Retrofit Analysis	Four private swales—have not been maintained consistently	MAINT	WQ	N/A	N	Y	• Acquire private swales and conduct restorative maintenance.
23	Creekside Apartments (Boeckman Creek at Wilsonville Rd.)	Boeckman Creek	Boeckman Road Mitigation Study Retrofit Analysis	Underutilized irrigation pond adjacent to Boeckman Creek. Upstream of this location there is an existing outfall to Boeckman Creek that has known erosion issues per the 2012 SMP (BC-5).	CAP	WQ	N/A	N	Y	• Expand water quality treatment through retrofit of existing facility. • Will require private property partnership.

Table 7-2. Unfunded/Future Capital Project Concepts

Project Opportunity Location ID	Location/ Asset Description	Basin	Source	Problem Description	Deficiency Category [a]		Project Background			
					Primary	Secondary	Modeled Capacity Deficiency (Y/N)	Stream Assessment ID Need (Y/N)	Water Quality Retrofit Opportunity (Y/N)	Project Concept
31	Parkway Ave./Metolius Ln.	Willamette River	H/H Model 2012 SMP	Model predicts flooding along N-S run of pipe starting at the 10-yr design storm. Capacity is limited by the small diameter (21") pipes near the outfall which is causing a constriction. Flooding at this location could threaten the adjacent properties along SW Parkway Ave.	CAP		Y	N	N	• Invert elevation in MH prior to outfall are misaligned, causing constriction. • Pipe upsizing and realignment as necessary.
34	Barber St.	Coffee Lake Creek	H/H Model 2012 SMP	Model predicts flooding at several DS nodes prior to Coffee Creek outfall and at node near RR tracks starting at the 25-yr design storm. Backwater conditions from Coffee Creek may be contributing to downstream flooding.	CAP		Y	N	N	• Pipe upsizing and realignment as necessary. No immediate need.
35	Lower Boones Ferry Rd.	Willamette River	H/H Model	Model predicts flooding along private drainage (former Albertsons property) to Boones Ferry Rd starting at the 2-yr design storm. Flooding at this location could impact the commercial properties along SW Boones Ferry Rd.	CAP		Y	N	Y	• Pipe upsizing and realignment as necessary. No immediate need.
42	Ridder Road Wetland Restoration	Coffee Lake Creek	2012 SMP Retrofit Analysis	Current drainage channel is underutilized with invasive vegetation. Referenced as CLC-4 per 2012 SMP.	E&S	MAINT	--	N	Y	• Future restoration/retrofit opportunity.
43	Town Center Conveyance Piping	Boeckman Creek	Community Development Town Center Concept Plan	Public stormwater collection pipe (>15" diameter) per Town Center Concept Plan.	INFRA		--	N	Y	• Additional assets/re-piping is development driven. • New/decommissioned infrastructure pending development activities.

Table 7-2. Unfunded/Future Capital Project Concepts

Project Opportunity Location ID	Location/ Asset Description	Basin	Source	Problem Description	Deficiency Category [a]		Project Background			
					Primary	Secondary	Modeled Capacity Deficiency (Y/N)	Stream Assessment ID Need (Y/N)	Water Quality Retrofit Opportunity (Y/N)	Project Concept
45	SW Miami	Willamette River	H/H Model	Model predicts flooding along 15" piping starting at the 25-yr design storm.	CAP		Y	--	N	• Pipe upsizing and realignment as necessary. No immediate need.
46	Canyon Creek Rd (near Xerox)	Boeckman Creek	H/H Model	Model predicts flooding at node that conveys private stormwater from Xerox to the E across Canyon Creek Rd. starting at the 10-yr design storm.	CAP		Y	--	N	• Pipe upsizing and realignment as necessary. No immediate need.
47	River Fox Park	Willamette River	H/H Model	Model predicted flooding in 12" pipe	CAP		Y	--	N	• Pipe upsizing and realignment as necessary. No immediate need.

N/A = not applicable.

a. Categories include: MAINT=Maintenance; R/R=Repair and Replacement; CAP=Capacity Issue; E&S=Instream Erosion/Sediment Issue; INFRA=New infrastructure need per growth and development; WQ= Water Quality.

7.4 Staffing Evaluation

A supplemental staffing analysis was conducted to support the earlier, maintenance-related staffing evaluation described in Section 3.2. This analysis included both Public Works and Engineering staffing needs in conjunction with 1) new regulatory obligations associated with the City's 2021 NPDES MS4 permit and 2022 Stormwater Management Program (SWMP) Document, and 2) implementation of this SMP.

Specific to implementation of this SMP, additional Engineering staff are required to execute and manage the CPs over the 20-year CIP (see the construction administration cost by CP included in Appendix E). Additional Public Works staff support will be needed to maintain additional assets resulting from CP implementation. Figure 7-2 summarizes the departments and associated activities resulting in the need for additional staff. Summary tables and documentation related to this evaluation are included in Appendix G.

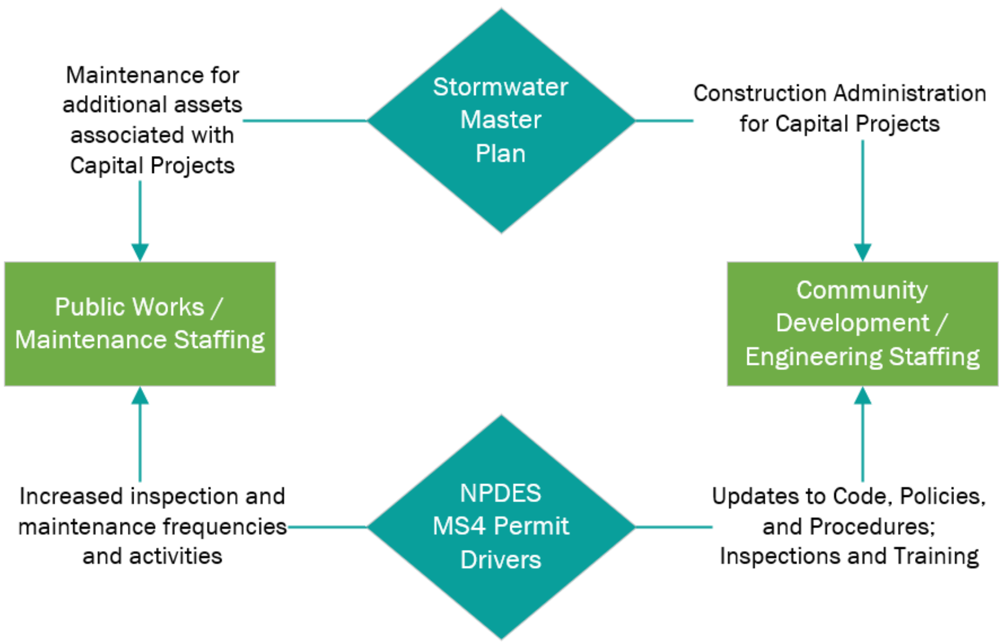


Figure 7-2: Staffing Evaluation Considerations

7.4.1 Assumptions

The following general assumptions were used to develop the staffing evaluation for both Public Works Stormwater staff and Engineering staff. Detailed assumptions specific to staffing estimates by activity are outlined in Appendix G.

- Except for the additional Public Works staffing needs identified in Section 3.2 for deferred maintenance, it is assumed that existing Public Works and Engineering staffing levels were adequate to implement the City's stormwater program and CP implementation prior to reissuance of the City's NPDES MS4 permit or implementation of this SMP. Thus, only additional activities are used to inform additional staff resource needs.
- One FTE represents 1,650 hrs (after deducting estimated annual leaves, training, and other non-task replaced hours); 0.02 FTE represents 40 hrs. For purposes of calculating an equivalent FTE cost estimate, an annual FTE labor cost was assumed at $200,000/year (as confirmed by City staff).

- The NPDES program costs are based on an implementation schedule covering a 5-year permit term (Oct. 1, 2021-Sept. 30, 2026) - reported in tables as Fiscal Years (FY) 2023-2027, with an anticipated administrative extension after FY 2027.
- CPs are assumed implemented on an annual basis, and the CIP is assumed to be implemented over a 20-year implementation schedule, ranging from 2024-2043. Given uncertainty with schedule, CP costs are averaged across the 20-year implementation schedule equally. In practice there will be cycles of more and less staff time demands based on which projects are in construction/constructed.
- For the CPs listed in this SMP, 100 percent of engineering and permitting costs will be used for consultant support, and 100 percent of design/construction administration costs will be required for City Engineering staff.

7.4.2 Results

Table 7-3 provides a summary of the combined Public Works/Stormwater and Community Development/Engineering staffing needs for both the NPDES MS4 Permit driven activities and CP implementation activities. Detailed staffing projections, as reported in Appendix G, reflect FY 2023-2027 in alignment with the NPDES MS4 Permit timeline. However, staffing projections are relatively consistent when annualized and reflect the ongoing implementation of regulatory requirements over the 5-year permit period, as well as an annual average over a 20-year CIP implementation period. Thus, the annual average staffing is reflected below, and rounded to the nearest 0.1 FTE.

Table 7-3. Combined Staffing Assessment Summary

		Increased Staffing (FTE)
		Annual Average
Public Works/Stormwater Staff Cost Schedule	NPDES MS4 Permit Driven Activities	2.1
	Staffing contingency for NPDES MS4 Driven Activities [a]	0.4
	CP Implementation	0.2
	Public Works Staffing Total	2.7
Community Development/Engineering Staff Cost Schedule	NPDES MS4 Permit Driven Activities	0.2
	CP Implementation	1.2
	Community Development Staffing Total	1.4

a. Staffing contingency estimated at 20% to account unscheduled maintenance and response.

For Public Works (Roads and Stormwater Section), an increase of approximately 2.5 FTE is recommended to address both deferred and additional maintenance activities as defined with the reissued NPDES MS4 permit. This increase reflects a 20 percent contingency to account for additional, unscheduled activities as well as prescriptive maintenance efforts. An additional 0.2 FTE increase is anticipated for maintenance of new infrastructure (assets) associated with CIP implementation. However, timing of this 0.2 FTE may vary in accordance with construction of CPs and could be delayed over the 20-year implementation period.

For Community Development (Engineering Division), an increase of approximately 0.2 FTE is recommended to address additional tracking and inspection needs as defined with the reissued NPDES MS4 permit. This may be accommodated through reallocation of existing staffing or contracted support. An additional 1.2 FTE is anticipated to manage and execute contracts for CP design and construction services. This increase accounts for the 1.0 FTE of engineering staff currently dedicated to overseeing stormwater CP implementation, and reflects the additional staffing need. As with Public Works staffing, timing of this 1.2 FTE may vary in accordance with design and construction schedules and could be delayed over the 20-year implementation period. It should be noted that cost estimates for programmatic activities (i.e., Projects P-1 through P-5) have not been included in the staffing projections.

7.5 Project Prioritization

Project prioritization is an important component of the stormwater master planning process and can provide direction in sequencing projects in accordance with City objectives. This section summarizes the prioritization of CPs for implementation.

For this SMP, a CP prioritization tool was developed to assist with project prioritization. This Multi-Criteria Decision Analysis (MCDA) tool was developed using Microsoft Excel and includes prioritization criteria, scoring mechanism, and weighting factor schemes to present graphical and numeric rankings of CPs. The MCDA tool normalizes City-assigned scores for each criterion and project, which allows better differentiation of relative project performance (difference between best and worst options) and balances variability in scoring. Normalized scores were multiplied by their associated weights and summed to represent the overall project priority. The MCDA tool is intended to be updated on a continual basis; as projects are constructed, they can be removed from the ranking tool and new projects can be included as master plans are updated.

It should be noted that the overall stormwater CIP includes several new programs established to facilitate improvements without dedicated, individual CP consideration. Programs are not prioritized as part of this effort.

7.5.1 Prioritization Criteria

Proposed CPs are developed to address a variety of objectives including increased capacity, new infrastructure needs, maintenance, repair & replacement, water quality, and instream erosion/sediment control.

In consideration of the varied scope of proposed CPs and overlapping project objectives, the following scoring categories were used as the basis for developing project prioritization criteria.

- **System Operations**: System operations is a collective category representing capacity deficiencies, regular or recurring maintenance needs, and safety and accessibility as related to the location of a proposed issue or deficiency.
- **System Condition:** System condition reflects known problem areas where repair or replacement of an asset addresses a known or immediate issue.
- **Compliance:** Compliance reflects a CPs ability to address regulatory drivers including NPDES MS4 permit needs (water quality retrofits needs), TMDL and shade management drivers, and hydromodification risk.
- **Other:** Other criteria including contributing drainage area, project sequencing and phasing, construction constraints and funding source.

Table 7-4 summarizes the evaluation criteria and scoring guide. The scoring guide helps score projects consistently and advises others that may need to apply the tool in the future. A range of scores, from 0 to 3, is applied to each criterion for every project to yield an unweighted total score. As the City implements projects over time, and as priorities change and evolve, these criteria and the scoring guide can be revised in the CP prioritization tool.

Table 7-4. Project Prioritization Criteria

Criteria	Scoring Definition (3 = High; 2 = Medium; 1 = Lower; 0=Does not address)			
	High (H)	Medium (M)	Lower (L)	Does not address
System Operation-Capacity	• Addresses a reported capacity deficiency (problem area) per Wilsonville Public Works or Engineering, and • Addresses an existing capacity deficiency per hydraulic modeling efforts.	• Addresses a reported capacity deficiency (problem area) per Wilsonville Public Works or Engineering, and • Addresses a lack of infrastructure (infrastructure need)	• Addresses a future capacity/infrastructure need.	• May provide some capacity benefit, but the location has not been identified as an existing or future capacity deficiency.
System Operation-Maintenance	• Addresses a location that has frequent citizen complaints and onsite response requirements.	• Addresses a location that has frequent citizen complaints and will reduce existing maintenance needs.	• Addresses a location that has less frequent citizen complaints and will reduce existing maintenance needs.	• Project does not address existing maintenance deficiency or lack of infrastructure
System Operation-Safety and Accessibility	• Reduces risk near a transit line, school, or backbone utility	• Mitigates risk, including system relocation into the public ROW to avoid collateral damage, safety concerns on private property.	• Reduces risk to non-essential property/minor roadways/structures.	• The identified problem is not anticipated to address safety concerns.
System Condition	• Addresses an immediate system condition need (problem area) where delay may result in immediate property damage or safety concerns.	• Addresses a system condition need (problem area) where delay may result in additional infrastructure deterioration or property damage.	• Replaces an existing City asset.	• The project does not include replacement of an existing asset.
Compliance-Water Quality	• Provides new or enhanced water quality treatment to address pollutants of concern, qualifying as a retrofit project with potential for fee-in-lieu	• Restores or enhances water quality function or coverage, qualifying as a retrofit project only.	• Provides some water quality benefit through sedimentation.	• The project does not include water quality treatment.
Compliance-Vegetation Management	• Restores shade protection (within 100' of stream bank) to address temperature TMDL	• Enhances riparian corridor vegetation coverage; removes invasive species	• Enhances upland vegetation conditions/characteristics.	• No plantings or vegetation enhancement associated with project construction
Compliance-Hydromodification	• Addresses area of known or observed instream erosion that could result in property damage or infrastructure failure.	• Addresses area of known or observed instream erosion that could result in bank stability issues.	N/A	• Project does not address area of known hydromodification impacts
Other-Contributing Area	• Project has regional impacts (drainage area is > 100 acres)	• Project has subbasin impacts (drainage area is > 10 acres)	• Project has local impacts (drainage area is < 10 acres)	
Other-Sequencing	• Project is required as a pre-requisite or preliminary project before another prioritized project need.	N/A	N/A	• Project construction scheduling would not be impacted by other project scheduling needs.
Other-Traffic and Accessibility	• Project construction is not expected to impact traffic or private property	• Construction may impact residential streets.	• Construction may impact collector streets.	• Construction will impact arterial streets or structures on private property are expected
Other-Development Drivers	• Project is a prerequisite to a current construction project.	• Project is required to support future growth and development or a planning area.	N/A	N/A
Other-Funding Source	• Project is eligible for funding via SDCs (50% or greater)	• Project is eligible for funding via SDCs (25%-50%)	• Project is eligible for funding via SDCs (up to 25%)	• Project is not eligible for SDC funding.

7.5.2 Scoring and Weighting Factors

Every CP was reviewed by the City Engineer, Natural Resource Manager, and Public Works Operations Supervisor and scored by assigning a “0” through “3” score to each criterion in accordance with the scoring definitions (Table 7-4).

The MCDA tool includes the ability to incorporate weighting factors schemes that vary based on the importance of various scoring categories and individual criteria. Weighting factor schemes were established in collaboration with City staff including 1) an initial weighting with emphasis on system condition and balanced weights within the system operation and compliance categories, 2) adjusted weighting to emphasize on project sequencing (part of the other category), and 3) emphasis on criteria prioritized by Public Works.

Results of the various weighting schemes were compared, and outcomes discussed internally by the City. These schemes resulted in relatively consistent prioritization of projects, with some projects moving slightly up or down in ranking depending on the scheme. Ultimately, the city selected the initial weighting scheme and opted to make some related project scheduling adjustments in accordance with Public Works feedback. Resulting weighting factors are provided in Table 7-5.

The final, average score for each criterion were multiplied by the weighting factors associated with the select weighting factor scheme and summed for a final project score creating a project ranking.

Table 7-5. Selected Weighting Schema

Scoring Category	Category Weight (%)	Criteria	Criteria Weight (%)
System Operation	30	System Operation - Capacity	10
		System Operation - Maintenance	10
		System Operation - Safety and Accessibility	10
System Condition	25	System Condition	25
Compliance	25	Compliance - Water Quality	8.33
		Compliance - Vegetation Management	8.33
		Compliance - Hydromodification	8.33
Other	20	Other - Contributing Area	5
		Other - Sequencing	5
		Other - Traffic and Accessibility	5
		Other - Development Drivers	2.5
		Other - Funding Source	2.5

7.5.3 Prioritization Results

The CP prioritization tool provides a bar graph that illustrates scoring results (see Figure 7-3). Each bar represents the total score, and each colored segment of the bar represents a specific evaluation criterion so the user can see which criterion played the most prominent role in the scoring results for each project.

The prioritization and ranking of the CPs were reviewed and used to inform the ultimate project scheduling (see Figure 7-1). In general, the highest scoring priority projects are scheduled in the next 5 years (2024-2028); the next level of priority projects are scheduled in the following 5 years (2029-2033); and the remaining priority projects are scheduled 10 years from now (2034-2043). Based on the total number and cost of projects within any one timeframe, some project schedules were adjusted per City feedback (see Table 7-1).

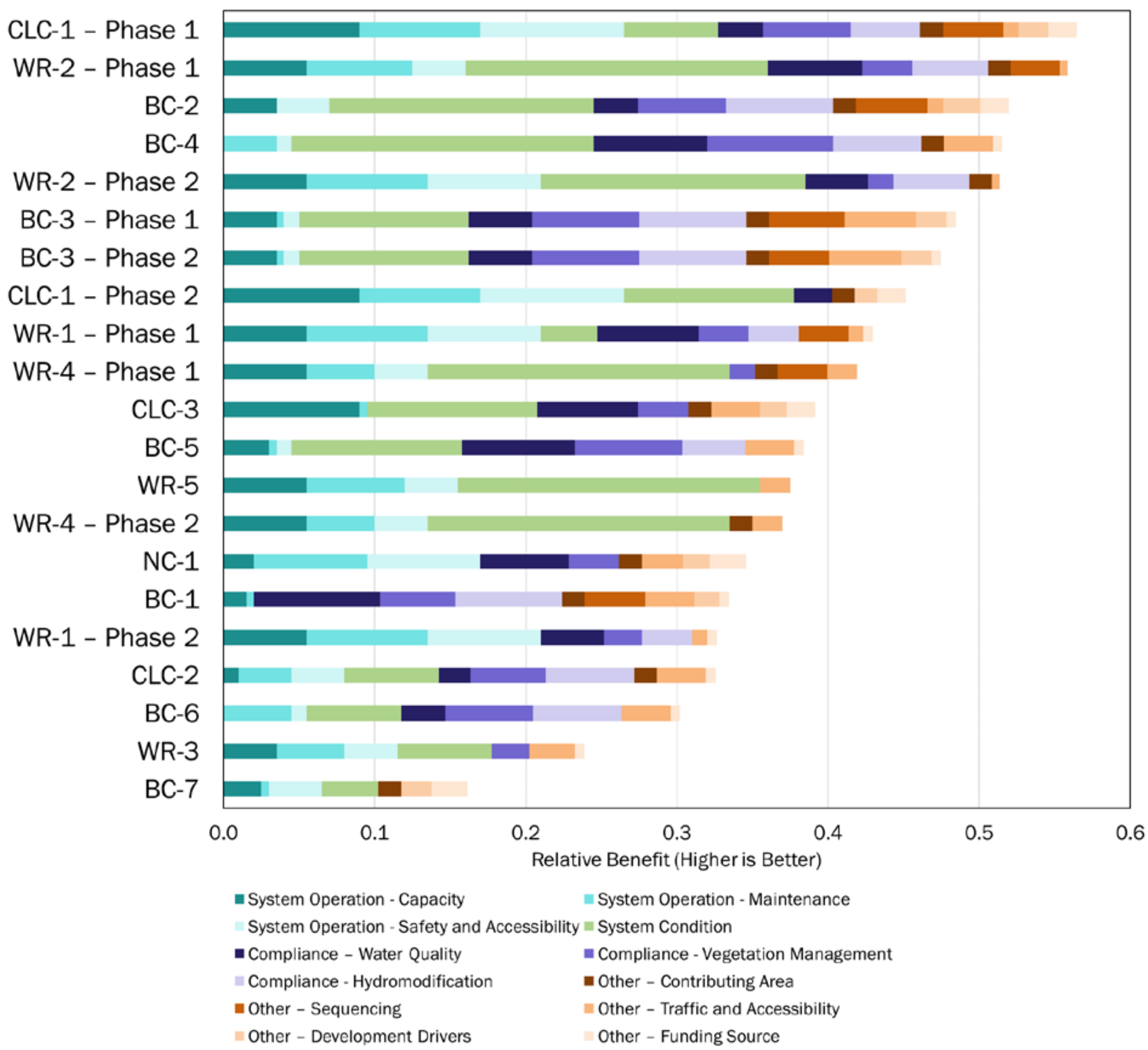


Figure 7-3: Prioritization Results

7.6 Policy Recommendations

The following policy recommendations pertaining to the implementation of this SMP and associated CIP have been referenced in this SMP and are summarized for City consideration:

7.6.1 Stormwater Design Standards Applicable to Town Center

As described in Section 6.3.4, utilization of the Library Pond to mitigate stormwater treatment and flow control for Town Center redevelopment requires a site-specific stormwater design standard applicable to the Town Center property.

The City will need to define a fee-in-lieu program and onsite stormwater mitigation tracking system to ensure adequate capacity in Library Pond is available while adhering to the City's current design standards and definition of predevelopment. Onsite treatment and flow control will need to be provided for 50% of the redeveloped property (both private and public ROW).

7.6.2 Comprehensive Plan Updates

As summarized in Section 2.7, the City of Wilsonville Comprehensive Plan was reviewed with respect to stormwater and consistency with the City's 2021 NPDES MS4 permit to ensure it is current and reflective of continued compliance.

A detailed summary of proposed modifications to the Comprehensive Plan are provided in Appendix H.

7.6.3 Design Standards for New Development and Growth Areas

Capacity-related CPs are sized in accordance with future growth and development, both within the city limits and outside city limits to the extent future zoning is established. Most area subject to new development will be within the City's jurisdiction and subject to the city's stormwater design standards that mimic pre-development flow conditions and require the use of infiltration-based facilities to the maximum extent feasible.

Site constraints occasionally prevented CP design to adhere to the City's design criteria, and in a few cases, flooding or system surcharge is still anticipated with implementation of CPs. Implementation of the City's stormwater design standards help ensure maximum capacity in the downstream stormwater collection system.

There are a few key locations in the City where future development outside of the city limits will be subject to another jurisdictions stormwater design standards (i.e., CP CLC-1: Day Road Stormwater Improvements). Establishing consistent stormwater design standards and design metrics for key Planning Areas (Coffee Creek Industrial Planning Area, Basalt Creek Planning Area) that encompass neighboring jurisdictions including Clean Water Services and the City of Tualatin is recommended to ensure that onsite retention and flow mitigation are applied to these new development areas. This mitigation should mimic pre-development site conditions to reduce the risk of downstream capacity and hydromodification impacts, as well as preserve water quality.

7.6.4 Stormwater Facility Tracking and Maintenance for Private Facilities

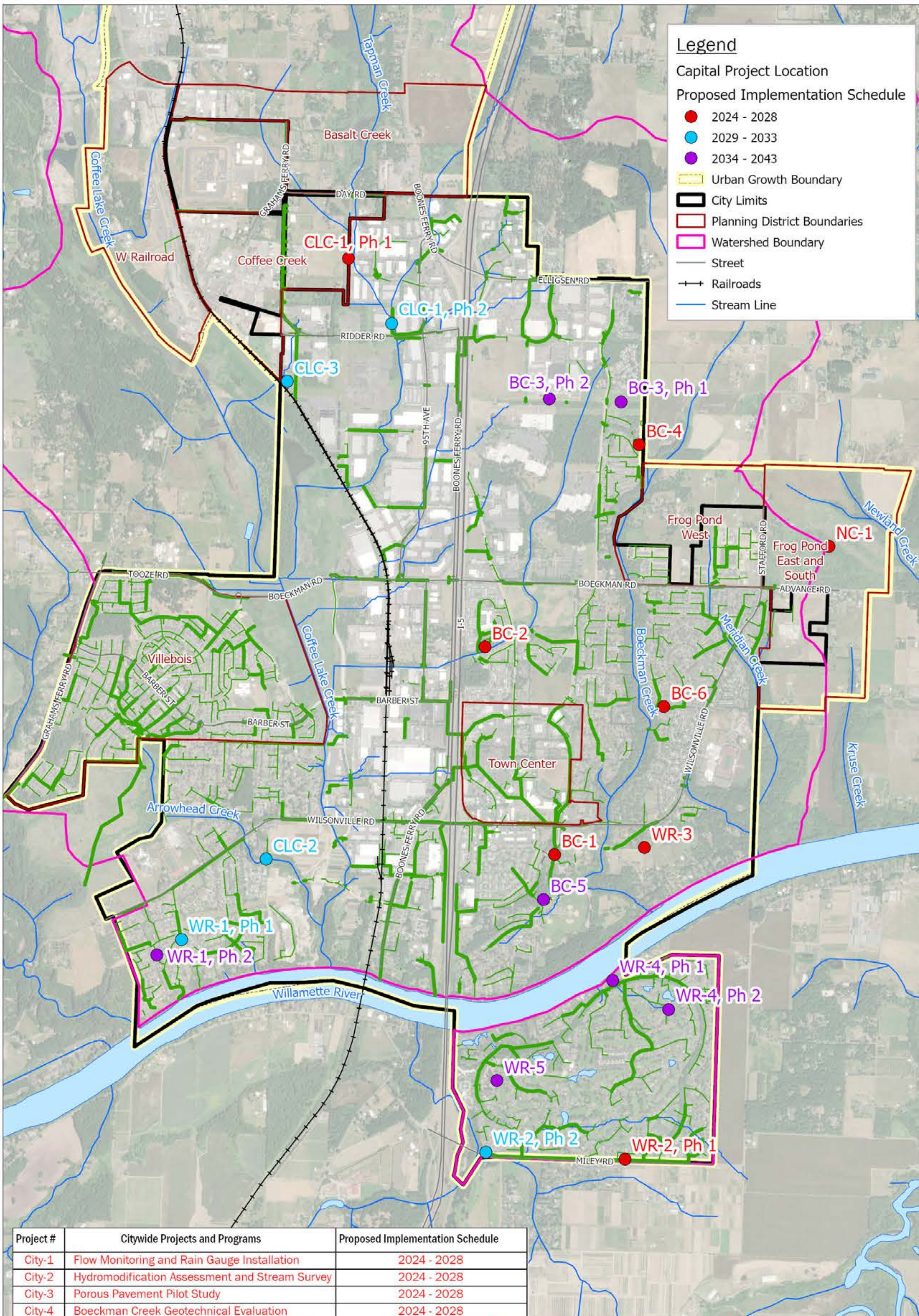
The City's GIS inventory of stormwater treatment and detention facilities is currently being updated to include consistent facility naming conventions (i.e., swales, raingardens, detention ponds) and inclusion of ownership information (specific to private facilities). Such updates will allow better integration between mapping and asset management, as well as allow geographic tracking of maintenance activities and responsibilities.

The City's Stormwater Operations and Maintenance Plan is required for newly installed private facilities to ensure that the owners recognize responsibility for inspections and maintenance of their private stormwater facilities. The Stormwater Operations and Maintenance Plan requirements went into effect in 2012 and require submittal of an Annual Inspection and Maintenance Report by May 1 each year. The City conducts private facility inspections annually, targeting facilities that did not return an Annual Inspection and Maintenance Report.

In conjunction with the identification of problem areas and Project Opportunity Areas, private facilities are routinely observed to have deficient system maintenance, due to inconsistent and infrequent maintenance. In cases where the private facility is not being maintained and functionality is compromised, the City may consider a policy to reassign maintenance responsibility for existing private stormwater facilities and conduct maintenance in accordance with public facility maintenance protocols and schedules, subject to reimbursement by the private facility owner. Implementation of this proposed policy is supported through P-5: Stormwater Facility Enhanced Maintenance Program.

7.7 Next Steps

Following adoption of this Plan, a financial analysis will be required to evaluate the City's current stormwater utility rate and SDCs to ensure adequate funding is available for implementation of CPs and programs outlined in this SMP. The resulting financial plan will provide a funding structure in accordance with the defined LOS that allows the City to implement the CPs and programs as costed and scheduled in this SMP while meeting other financial obligations and policy objectives.



Project #	Citywide Projects and Programs	Proposed Implementation Schedule
City-1	Flow Monitoring and Rain Gauge Installation	2024 - 2028
City-2	Hydromodification Assessment and Stream Survey	2024 - 2028
City-3	Porous Pavement Pilot Study	2024 - 2028
City-4	Boeckman Creek Geotechnical Evaluation	2024 - 2028

Brown AND Caldwell

City of Wilsonville/
Project # 156157

Stormwater Master Plan

Note: Planning Projects City-1 to City-4 and Programs P-1 to P-6 are all city-wide and not specific to a location. Programs P-1 to P-6 assume annualized funding.

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

N

0 0.25 0.5 1 Miles

Figure 7-1: Capital Improvement Projects Prioritization

Section 8

Limitations

This document was prepared solely for City of Wilsonville in accordance with professional standards at the time the services were performed and in accordance with the contract between City of Wilsonville and Brown and Caldwell dated January 11, 2021. This document is governed by the specific scope of work authorized by City of Wilsonville; 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 Wilsonville and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

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Section 9

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Appendices

Appendix A: Project Planning Matrices

Table A-1: Problem Area Matrix

Table A-2: Project Opportunity Matrix

Appendix B: TM #3: Stormwater Modeling Methods, Assumptions, and Results

Appendix C: TM #2: Stream Assessment

Technical Memorandum: Geomorphic Reconnaissance of Parts of Boeckman, Meridian, Arrowhead, Newland and Kruse Creeks

Appendix D: Capital Project Fact Sheets

BC-1: Library Pond Retrofit
BC-2: Ash Meadows Flow Mitigation
BC-3: Wiedemann Ditch and Canyon Creek Park Retrofit, Phase 1 & 2
BC-4: Boeckman Creek Stabilization at Colvin Lane
BC-5: Memorial Park Swale Retrofit
BC-6: Gesellschaft Water Well Channel Restoration
CLC-1: Day Road Stormwater Improvements, Phase 1 & 2
CLC-2: Arrowhead Creek Culvert Replacement at Jobsey Lane
CLC-3: Garden Acres Pond Retrofit
NC-1: Frog Pond East and South Conveyance Pipe Installation
WR-1: Willamette Way East/Morey's Landing Stormwater Improvements, Phase 1 & 2
WR-2: Miley Road Stormwater Improvements, Phase 1 & 2
WR-3: Rose Lane Culvert Replacement
WR-4: Charbonneau East Stormwater Improvements, Phase 1 & 2
WR-5: Charbonneau West - SW French Prairie Road and SW Boones Bend Road

Appendix E: Capital Project Cost Estimates

Appendix F: Library Pond Analysis

Appendix G: Staffing Evaluation

Appendix H: Comprehensive Plan Review

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Appendix A: Project Planning Matrices

Table A-1: Problem Area Matrix

Table A-2: Project Opportunity Matrix

Table A-1 . Wilsonville Problem Area Matrix

Problem Area Location ID	Location/Asset Description	Source	Problem Description	Deficiency Category[1]		Site Visit Conducted?	Workshop/Coordination Call Feedback (8-24-21 and 9-1-21)	Site Visit Outcome (9-27-21) (Green font reflects action items)	Project Planning[1]			
				Primary	Secondary				Hydraulic Model Expansion/ Update Need (Y/N)	Stream Assessment Location (Y/N)[2]	Project Need? (Y/N)[3]	Program Need?
1	Morey's Landing bubbler (AKA Willamette Way East bubbler)	Public Works Community Development	Localized flooding during high intense storm events. Existing bubbler meant to collect runoff from the streets and divert to grass easement area under the power line and to the river. The design (location) is flawed and the water flows into the yard of the homes that back up against the easement, requiring sandbags to redirect flow.	R/R		Y	Recent outfall projects on Belknap and Morey Lane. AKS study (2017) indicated current pipe size is not sufficient to redirect flow into pipe to SW Belnap Ct outfall. AKS study identified alternatives. Meetings have occurred with BPA related to locating a pond.	Any pond option on the BPA easement would require coordination and adequate BPA utility access. There is a high-pressured fuel line running N-S on the E edge of the easement that would need to be avoided. Infiltration rates anticipated to be high. Project development considerations: Need to understand infiltration rates for pond/gsi feasibility. Current sandbag system 'works' (UV resistant sandbags needed). Location of bubbler not ideal. Both pond/GSI and pipe upsizing in one project unlikely System modeling would be needed to assess flows and size detention.	Y	N	Y*	N
2	Frog Pond ditch and culvert under Boeckman Rd.	Public Works	Ongoing flooding issue at 6920 SW Boeckman Rd. House - foundation is only 2-3 in. higher than W Fork Meridian Creek. Possible culvert misalignment and minimal slope downstream of property.	R/R		Y	Area has presented an ongoing issue. Model extension is needed.	Existing culvert along Boeckman Road is directed toward the homeowner's garage, where peak flows come very close to the foundation. Project development considerations: Project needed to right size the culvert underneath Boeckman Rd (currently not in the model). A box culvert may be easier to maintain. Pipe the drainage along Boeckman Road beyond the property owner's house where the channel has additional vertical drop. Projects may be implemented as part of the Boeckman Road improvements	Y	Secondary	Y*	N
3	Pond F	Public Works	Possible design flaw and blockages impeding flow; potential maintenance issue.	R/R	MAINT	N		Not visited but discussed with PW staff. Pond is already included in model but scheduled for reconfiguration.	N	N	TBD	TBD
4	Library Pond	Public Works Community Development	Library Pond does not have flow control/orifice structure or emergency overflow type structure. Pond currently floods into Library parking lot and Memorial Dr near park entrance.	CAP		Y	City wants to include Library Pond expansion in fee in lieu program for Town Center redevelopment. Current configuration/ contributing drainage area in model overestimates flow contribution. Model updates needed to more accurately reflect existing drainage area to pond.	Flow from the pond is a ditch inlet that requires maintenance to keep clear from vegetation and debris (currently there is a temporary fence installed for this purpose). Project development considerations: Phase 1: retrofit the pond outlet structure to include an emergency overflow for consistency with current standard pond details. Clear vegetation and debris. Phase 2: construct flow control structure per standard details and pond outlet structure to accommodate per future growth. Include a dedicated maintenance access path. No as-builts/drainage report available to confirm existing stage-storage. Model updates required to refine the current contributing drainage area (hydrology) and evaluate capacity.	N	Primary	Y*	N

[1] Project planning outcome results are identified. TBD means that additional discussion may be warranted following modeling evaluation. Location IDs that are shaded in gray are not anticipated to require a project or program.
[2] Stream assessment locations identified as priority or secondary.
[3] Priority project location identified with a *

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				Primary	Secondary				Hydraulic Model Expansion/ Update Need (Y/N)	Stream Assessment Location (Y/N)[2]	Project Need? (Y/N)[3]	Program Need?
5	Memorial Lift Station - current location	Public Works	Ditch behind lift station occasionally overflows during heavy precipitation.	CAP		N	Lift station is being relocated to the east and should mitigate this issue.	Not visited.	N	N	N	N
6	Regional Parks 7 & 8; SW Coffee Lake Dr. Level Spreader	Public Works	Level spreader does not drain properly causing erosion issues	MAINT	E&S	N	Appears to be an operational issue only.	Not visited.	N	N	N	N
7	SW Montgomery Way	Public Works Community Development 2012 SMP	Channel and culvert issues are causing flooding. Future development (PDR1) is anticipated upstream of problem area.	CAP		N	City staff have not reported recent flooding issues here and don't consider it a project need any longer. 2012 MP identified a CIP (WD-1) for this location. Limited GIS information available to conduct modeling. City staff have not reported recent flooding issues here and don't consider it a project need any longer.	Not visited.	N	N	N	N
8	Commerce Circle near Delta Logics parking lot	Public Works Community Development	Improperly abandoned storm line on private property is causing flooding and a sink hole (safety concern).	R/R		Y	Contributing drainage area to pipeline is unclear.	Improperly abandoned storm line is not shown in the GIS. Pipe is on private property north of the street. Project/ program development considerations: Public Works would like a contracting mechanism to contract the investigation and proper abandonment of this pipe independent of the PW maintenance budget. Current sink hole is causing a safety concern. Additional as-built research is needed to identify lateral connections to the abandoned pipe.	N	N	N	Y
9	Miley Rd sinkhole	Public Works 2012 SMP	Collapsed mainline due to age and pipe corrosion has caused a sinkhole. Remaining pipe is failing and needs replacement.	R/R		Still Needed	Project location is in an extremely steep area. 2012 MP identified a CIP (SD9000 to SD9069) for this location. Location is already included in hydraulic model extents.	Not visited.	N	N	Y	TBD
10	Miley Rd outfall	Public Works 2012 SMP	Significant scouring into jurisdictional wetland.	E&S		Still Needed	Project location is in an extremely steep area. 2012 MP identified a CIP (SD9000 to SD9069) for this location. Location is already included in hydraulic model extents. Erosion issues are entering a jurisdictional wetland and thus replacement is beyond scope for maintenance.	Not visited.	N	N	Y*	N

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				Primary	Secondary				Hydraulic Model Expansion/ Update Need (Y/N)	Stream Assessment Location (Y/N)[2]	Project Need? (Y/N)[3]	Program Need?
11	Town Center Loop near Les Schwab Tire Shop	Public Works Community Development	Observed flooding along Town Center Loop W via the CBs that tie into current high flow bypass. Town Center redevelopment will impact high flow bypass for flows towards Library Pond.	CAP		Y	In 2015, ODOT installed a reducer on the 18" pipe that outfalls west before entering ODOT culvert under I-5.	ODOT reducer (12" as verified by PW 10-11-21) limits the existing 18" pipe that outfalls west to the ODOT culvert underneath I-5. Town Center redevelopment will remove the high flow bypass that currently sends flow south towards Library Pond. PW has observed flooding along Town Center Loop W via the CBs that tie into this current high flow bypass line. Project development considerations: Model development needed to determine when it floods, and project need for existing conditions. Future conditions will be driven by adherence to Town Center plan.	Y	N	Y	N
12	Rose Ln culvert	Public Works Community Development 2012 SMP	Culvert under Rose Lane floods road and neighboring yard/garage on downstream side. Drainage is very flat with several hard turns. Future development (PDR1) is anticipated upstream of problem area.	CAP	MAINT	Y	City has implemented programmatic activities to resolve the issues but is still a problem. 2012 MP identified a CIP (WD-2) for this location. Limited GIS information available to conduct modeling. Boeckman Road project may inform need.	Culvert underneath Rose Lane floods as vegetation on the upstream side blocks flow and drainage overtops the road and floods the neighbor's yard/garage on the downstream side. Drainage patterns here take several hard turns and is very flat. Project development considerations: Realign the existing culvert (at a diagonal) and/or install a secondary culvert south across Rose Lane to alleviate the US ponding that occurs in the adjacent field.	N	N	Y	N
13	SW Parkway Ave south of Costco	Public Works	N-S drainage swale south of Parkway has filled with sediment, surcharging the roadway drainage system, and resulting in ongoing maintenance. Ditch is owned and maintained by Sysco) but receives flows from both public and private sources. Upstream drainage from Costco includes a large underground detention system that does not function properly and holds water year-round. Related to Problem Area #30.	MAINT	CAP	Y	Ongoing maintenance issue. Grade of swale and channel is a concern. Ditch was recently dredged. Location is already included in hydraulic model extents.	Sysco ditch experiences high sedimentation rates due to minimal grade for the first section of the ditch. Sysco has plans to develop the lot to the west of the ditch, but timeline for this is unknown. Project development considerations: Since this is a complicated issue (Sysco owns ditch but receives drainage from others both public/private), City may install WQ manhole (s) to remove sediments from public runoff. This would isolate any additional sediment accumulated in Sysco ditch to private sources. Hydraulic model review is needed to confirm long stream profile for potential improvement opportunities. Public works confirmed 36" pipe from Costco to 40" pipe to Sysco ditch (may attribute to Costco backwater).	N	N	TBD	TBD
14	Culvert south of Day Rd.	Public Works	Culvert needs replacement. Conveyance and storage limitations exist south of Day Rd (limited areas, BPA towers, narrow channel, etc.). Related to Problem Area #15/26.	R/R		Y	Location is already included in hydraulic model extents. AKS Coffee Creek system evaluation included additional survey that needs to be incorporated into model. Need to evaluate area from larger perspective and investigate US/DS opportunities for improvement.	See Problem #15.	Y	Secondary	Y*	N

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				Primary	Secondary				Hydraulic Model Expansion/ Update Need (Y/N)	Stream Assessment Location (Y/N)[2]	Project Need? (Y/N)[3]	Program Need?
15	South of Day Road ponds near power lines behind businesses	Public Works 2012 SMP	Without brush clearing, the ponds south of Day Road back up and flow onto the road. Conveyance and storage limitations S of Day Rd (limited areas, BPA towers, narrow channel, etc.). Related to Problem Area #14/26.	MAINT		Y	Location is already included in hydraulic model extents. 2012 MP identified a CIP (CLC-1) for this location. AKS Coffee Creek system evaluation included additional survey that needs to be incorporated into model. Need to evaluate area from larger perspective and investigate US/DS opportunities for improvement.	Area studied as part of AKS Coffee Creek Facility Study. Effort worked to identify infrastructure needs and alternatives). The 2012 MP also included several capital projects to address these issues. Project development considerations: AKS study did not directly incorporate survey into existing condition model (extra effort required to incorporate survey independently into the hydraulic model). AKS study does not alleviate flooding.	Y	Secondary	TBD	TBD
16	95th Ave north of Hillman Rd.	Public Works	Crushed storm pipe found during CCTV inspection.	R/R		N	Location is already included in hydraulic model extents. Per City (10-1-21), replacement being completed as CIP #7062 95th Avenue Storm Line Repair. North repair is replacement of 120 LF of existing 24" CMP with 24" PVC (Carte ID 2335). South Repair is replacement of 44 LF of 15" CMP with 15" PVC (Carte ID 2337).	Not visited.	N	N	N	N
17	Mont Blanc in Villebois	Public Works	Tree planted in front of inlet blocking drainage into swale	MAINT		N	Appears to be an operational issue.	Not visited.	N	N	N	N
18	Memorial Park drainage area behind the barn	Public Works	Same drainage ditch that causes issues with Memorial lift station (see Location ID5).	CAP		N	Lift station is being relocated to the east and should mitigate this issue.	Not visited.	N	N	N	N
19	NW intersection of Elligsen Road and SW Parkway Ave near 76 gas station	Public Works External Survey	During heavy precipitation the CB backs up and floods the road at the corner	CAP		N	Additional CBs were installed with roadway improvements at low points and has alleviated flooding issue.	Visited surrounding property area and confirmed no issue.	N	N	N	N
20	NE corner of Elligsen Road and SW Parkway Center	Public Works	Sediment from the agriculture area north of Elligsen Road impacts Pheasant Ridge RV Park detention pond.	MAINT		N	Appears to be an operational issue.	Not visited.	N	N	N	N
21	NW corner of Graham Oaks parking lot	Public Works	Erosion around outfall sends debris into creek.	E&S		N	Outfall included in model for capacity only, does not evaluate erosion. Public Works filled with CDF and is continuing to monitor for erosion.	Not visited.	N	N	N	N

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				Primary	Secondary				Hydraulic Model Expansion/ Update Need (Y/N)	Stream Assessment Location (Y/N)[2]	Project Need? (Y/N)[3]	Program Need?
22	Converted bubbler River Fox Park & SW Preakness	Parks Department (via) Public Works	Piped collection system is outside of the ROW and pipe diameter is reduced. Leaf debris affects the manhole in front of 11591 SW Preakness limits flow to mainline to Willamette Way East causing flooding. "Bubbler" manhole at fenceline acts like a sump.	MAINT	CAP	Y	Manhole (Cartograph # 57) surcharges and water exits the system, overflowing to inlet Cart #1240. Issue is capacity and whether the manhole should be redesigned to actually be a bubbler and not a surcharged manhole.	Complicated SW configuration. Pipe size changes from 24" to 18" to 12". Based on conversations with the property owner at 11242 SW Champoeg Dr (adjacent to inlet grate in SW corner of park) no flooding occurs here. Project development considerations: May consider installation of a pipe to directly tie runoff that is coming from Preakness Dr. into the MH at the end of Champoeg Dr. Following site visit, PW confirmed with Parks that this is nonissue. Clearing grates of any leaf debris addresses the issue. Future CCTV at this location may be warranted to confirm configuration.	N	N	N	N
23	Cul-de-sacs west of Serenity Way	Public Works	Inlets at Pleasant (Cartograph #1750) and Serenity Ln. (Cartograph #1748) become covered with leaf debris causing cul-de-sacs to flood.	CAP		N	Installation of additional inlets near the intersection of Serenity Ln. may prevent ponding at the bottom of the cul-de-sac.	Not visited but confirmed that additional inlets can be included in a programmatic effort.	N	N	N	Y
24	Catch basins corner of Wilsonville Rd & Kinsman Rd	Public Works	Recurring flooding at catchbasins occurs after cleaning.	CAP	MAINT	Still Needed	Location is already included in hydraulic model extents.	Not visited.	N	N	TBD	TBD
25	SW Salish Ln at intersection with Parkway Ave	Public Works	Undersized catch basins cause flooding (ponding in SE corner by pond).	CAP		Y	Location is already included in hydraulic model extents, but with limited detail. As-builts provided from City reflect drainage ditches but no cross sections for ditches.	City pond at the Shrine Center receives a small amount of drainage and requires frequent maintenance. Project development considerations: Need improved access (for a vactor truck) to the WQ MH and pond maintenance (like Library Pond). Access should be from the Shrine Center parking lot. Refinement of the model extents not needed.	N	N	Y	TBD
26	Day Rd culvert at Tapman Creek near PGE substation	Public Works	Undersized culvert over capacity causing flooding. Conveyance and storage limitations S of Day Rd (limited areas, BPA towers, narrow channel, etc.). Related to Problem Areas #14/15.	CAP		Y	Location is already included in hydraulic model extents. Need to evaluate area from larger perspective and investigate US/DS opportunities for improvement.	See Problem #15.	N	Secondary	Y*	N
27	Storm basin SW Iron Horse St & SW Willow Creek Dr	Public Works	Reoccurring maintenance issues causing flooding; mix of private and City maintained structures	MAINT		N	Appears to be an operational issue.	Not visited.	N	N	N	N
28	SW Advance Rd btwn Stafford Rd & SW 63rd Ave	Public Works	Outfall blockage issues caused by vegetation. City cannot access to fix	MAINT		N	Appears to be an operational issue.	Not visited.	N	N	N	N

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				Primary	Secondary				Hydraulic Model Expansion/ Update Need (Y/N)	Stream Assessment Location (Y/N)[2]	Project Need? (Y/N)[3]	Program Need?
29	SW Daybreak St & SW Morningside Ave	Public Works	Capacity issues with Renaissance detention pond. Possible elevation or directional issue with flow out of detention pond	CAP		N	Renaissance Pond is included in existing hydraulic model. City confirmed configuration and pond outlet to west.	Not visited.	N	N	TBD	N
30	Sysco drainage ditch south of Parkway Ave	Public Works Community Development	Historical flooding issues; can no longer be accessed due to newly constructed fence. Ditch is owned and maintained by Sysco) but receives flows from both public and private sources. Upstream drainage from Costco includes a large underground detention system that does not function properly and holds water year-round. Related to Problem Area #30.	CAP	MAINT	Y	Ongoing maintenance issue. Grade of swale and channel is a concern. Ditch was recently dredged. Location is already included in hydraulic model extents.	See Problem #13. Same issue.	N	N	Y	TBD
31	Off Canyon Creek Road; catch basin in a residential backyard	Public Works	When farmer plows the field east of area debris enters catch basin and causes backups.	MAINT		N	Appears to be an operational issue.	Not visited.	N	N	N	N
32	Drainage ditch west & south of Delta Logistics	Public Works 2012 SMP	Overflow floods parking lot/channel conveyance issues. Related to Problem Area#15.	CAP		Y	Location is already included in hydraulic model extents. 2012 MP identified a CIP (CLC-3) for this location. AKS Coffee Creek system evaluation included additional survey that needs to be incorporated into model. Need to evaluate area from larger perspective and investigate US/DS opportunities for improvement.	See Problem #15. Same issue.	Y	Secondary	Y*	N
33	Elligsen Rd and Parkway Center Dr near Jeep Dealership	Public Works	Bubbler does not operate as designed; runoff goes over road.	R/R		N	Bubbler location is mapped incorrectly (located on SW Canyon Creek Rd near Burns Way). Issue deemed to be not significant by COW staff.	Not visited.	N	N	N	N
34	95th Ave at Grace Chapel	Public Works Community Development	Outfall blockage in ODOT right of way.	MAINT		N	Appears to be an operational issue requiring coordination with ODOT.	Not visited.	N	N	N	N
35	Culverts under I-5	Public Works	End of design life and need to be replaced (already modeled). Various locations along Parkway Ave & Boones Ferry Rd.	R/R		Still Needed	Locations already included in hydraulic model extents. Requires coordination with ODOT.	Not visited.	N	N	TBD	TBD

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				Primary	Secondary				Hydraulic Model Expansion/ Update Need (Y/N)	Stream Assessment Location (Y/N)[2]	Project Need? (Y/N)[3]	Program Need?
36	Culverts under Jobsey Ln. and Arrowhead Creek	Public Works 2012 SMP	Damaged and old culverts (already modeled), need to be replaced	R/R		Y	Locations already included in hydraulic model extents. 2012 MP identified a CIP (CLC-9) for this location.	Not visited.	N	N	Y	TBD
37	Boeckman Creek N of Colvin Ln.	Public Works	Erosion of streambank and migrating channel.	E&S		N	Potential stream survey evaluation area	Not visited.	N	Primary	Y	N
38	Villebois neighborhoods	Public Works	Ponding issues in front of mailboxes.	R/R		N	Staff is unaware of any ponding in this area. Existing modeling extents are adequate.	Not visited.	N	N	N	N
39	Villebois neighborhood	Public Works	Concerns about the various detention ponds and whether they are being maintained appropriately. Maintenance issues include Grahams Ferry Pond – potential design issues for the WQ manhole and adjacent outlets. Palermo (Pond F) - a large concrete pond off Grahams Ferry Road requires routine maintenance to prevent upstream tailwater issues.	MAINT		Still Needed	HOA is responsible for maintenance of ponds (currently overgrown with vegetation) and the City maintains the inlets and outlets. Grahams Ferry Pond has some design issues associated with the WQ manhole and adjacent inlets. Tooze Pond needs to be added to the hydraulic model (need stage-storage curve).	Not visited but discussed with PW. Pond maintenance is an ongoing issue. Recommend dedicated program to address and review of SOPs.	Y	N	TBD	Y
40	Citywide	Public Works	1996 flooding event	CAP		N	No additional information provided for specific areas/structures of concern.	Not visited.	N	N	N	N
41	Citywide	Public Works	2006 flooding event	CAP		N	No additional information provided for specific areas/structures of concern.	Not visited.	N	N	N	N
42	Citywide	Public Works	2015 flooding event	CAP		N	No additional information provided for specific areas/structures of concern.	Not visited.	N	N	N	N
43	Town Center Loop W - Shari's	External Survey	Drainage issues -Shari's parking lot.	CAP		N	Issue to be resolved with SW infrastructure proposed in Town Center Plan (2019).	Not visited.	N	N	Y	N
44	Town Center Loop W - Starbucks	External Survey	Drainage issues -Starbucks parking lot.	CAP		N	Issue to be resolved with SW infrastructure proposed in Town Center Plan (2019).	Not visited.	N	N	Y	N
45	Coffee Creek	External Survey	Lots of trash within creek at various locations (especially at choke points).	MAINT		N	Locations already included in hydraulic model extents, but need to verify configuration.	Not visited but location discussed with PW. Modeling refinements to incorporate the 30" and 36" lines from the Coca Cola Pond, starting at Seely Road to Coffee Creek.	Y	N	N	N
46	29851/29840 SW Camelot St	External Survey	Flooding from storm drain street grate. Grate clogs with debris .	MAINT		N	Appears to be an operational issue.		N	N	N	Y

Table A-2. Project Opportunity Matrix

Project Opportunity Location ID[5]	Previous Problem Area Location ID	Location/ Asset Description	Basin	Source	Problem Description	Deficiency Category[1]		Site Visit Conducted (Y/N)	Project Planning[2]					Project/Program Development			
						Primary	Secondary		Hydraulic Model Developed? (Y/N)	Modeled Capacity Deficiency (Y/N)	Stream Assessment IDd Need (Y/N)[3]	Water Quality Retrofit Opportunity (Y/N)	Project Development Considerations (per Workshop and City Discussions)	Costed Capital Project Need? (Y/N)[4]	Unfunded or Future Capital Project Need? (Y/N)[4]	Program Need? (Y/N)	Policy Need?
1	1	Morey's Landing bubbler (AKA Willamette Way East bubbler)	Willamette River	Staff Surveys	Localized flooding during high intense storm events. Existing bubbler meant to collect runoff from the streets and divert to grass area within the BPA power line easement and to the river. 2012 AKS study identified deficient pipe capacity, preventing flow from reaching SWM Belknap Court outfall. Water flows into yards adjacent to the easement, requiring sandbags to redirect flow.	R/R	WQ	Y	Y	Y	N	Y	• Project area is adjacent to high pressure fuel line. • Project will require continued coordination with BPA to locate water quality facility and maintain utility access. • Need to understand infiltration rates for retention/GSI feasibility. • Current sandbag system 'works' (UV resistant sandbags needed). Location of bubbler not ideal. • GSI and pipe upsizing in one project unlikely	Y- WR-1, Phase 1 and 2	--	--	--
2	2	Frog Pond ditch and culvert under Boeckman Rd.	Meridian Creek	Staff Surveys H&H Model	Ongoing flooding issue at 6920 SW Boeckman Rd. Culvert along Boeckman Road directs flows toward an existing garage. The foundation is only 2-3 inches higher than W Fork Meridian Creek. Possible culvert misalignment and minimal slope downstream of property.	R/R	CAP	Y	Y	Y	Y	N	• Project Fact Sheet and Cost Estimate prepared March 2022. • Project currently in design as part of the Boeckman Road improvements • Piped drainage system extended along Boeckman Road beyond the existing house, where the channel has additional vertical drop.	N	N	N	N
3	3, 39	Pond F and other ponds in Villebois	Coffee Lake Creek	Staff Surveys	Concerns whether various private detention ponds are being maintained appropriately. HOA is responsible for maintenance of ponds (currently overgrown with vegetation) and the city maintains the inlets and outlets. Maintenance issues include Grahams Ferry Pond – potential design issues for the WQ manhole and adjacent outlets. Palermo (Pond F) - a large concrete pond off Grahams Ferry Road requires routine maintenance to prevent upstream tailwater issue.	R/R	MAINT	Y	Y, except for Grahams Ferry Pond	N	N	Y	• H/H model updated to include relevant facilities. • Active maintenance implemented by HOA. • Workshop recommendation – Need program for restorative maintenance of ponds (especially private). Current PW staffing doesn't support private pond maintenance. • Policy recommendation – Implement an escalating, more robust enforcement protocol with provisions for City-initiated maintenance subject to private property reimbursement. • Per City (6/9/23) – Pond F swales above the level spreader have been cleaned out and are no longer causing issues.	N	N	Y- P-6	Y
4*	4	Library Pond	Boeckman Creek	Staff Surveys Retrofit Analysis H&H Model	Library Pond does not have flow control/orifice structure or emergency overflow type structure. Pond currently floods into Library parking lot and Memorial Dr near park entrance.	CAP	WQ	Y	Y	Y	N	Y	• Primary objective is to accommodate redevelopment of the Town Center; secondary is to accommodate Boeckman mitigation needs. • As-builts (stage-storage) incorporated into H&H evaluation.	Y – BC-1	--	--	Y

N/A = Not Applicable
Project Opportunities in gray have been removed from consideration for further project development.
[1] Categories include: MAINT=Maintenance; R/R=Repair and Replacement; CAP=Capacity Issue; E&S=Instream Erosion/Sediment Issue; INFRA=New infrastructure need per growth and development; WQ= Water Quality.
[2] Project planning outcome results are identified. TBD means that additional discussion may be warranted following modeling evaluation. Location IDs that are shaded in gray are not anticipated to require a project or program.
[3] Stream assessment locations identified as priority or secondary.
[4] Costed Project needs = Y were confirmed with City during on 3-15-23 and require a conceptual design, fact sheet and cost estimate. Unfunded Project needs will be documented in the SMP but will not have a conceptual design or cost associated. The resulting Project ID is listed for reference.
[5] Project Opportunity Locations affiliated with the Boeckman Road mitigation efforts are indicated with a *.

Table A-2. Project Opportunity Matrix																	
Project Opportunity Location ID[5]	Previous Problem Area Location ID	Location/ Asset Description	Basin	Source	Problem Description	Deficiency Category[1]		Site Visit Conducted (Y/N)	Project Planning[2]					Project/Program Development			
						Primary	Secondary		Hydraulic Model Developed? (Y/N)	Modeled Capacity Deficiency (Y/N)	Stream Assessment IDd Need (Y/N)[3]	Water Quality Retrofit Opportunity (Y/N)	Project Development Considerations (per Workshop and City Discussions)	Costed Capital Project Need? (Y/N)[4]	Unfunded or Future Capital Project Need? (Y/N)[4]	Program Need? (Y/N)	Policy Need?
					Ongoing challenges with debris removal at existing ditch inlet (which serves as outlet from pond). City has considered expanding the pond as part of the fee in lieu program for Town Center redevelopment.								• BC to document findings specific to future policy requirements and cost improvements to the pond to adhere to current design criteria. • Policy recommendation –Require portions of redevelopment to install onsite treatment and flow control to ensure capacity in Library Pond as a fee-in-lieu opportunity.				
5	9, 10	Miley Rd sinkhole and outfall	Charbonneau	Staff Surveys 2012 SMP H&H Model	2012 MP CIP SD9000 to SD9069. Collapsed mainline due to age and pipe corrosion has caused a sinkhole at eastern edge of pipe alignment. Challenge is exacerbated by steep slopes. Remaining pipe along Miley Rd. is failing and needs replacement. Significant scouring into jurisdictional wetland. Upstream capacity deficiencies indicated by H/H modeling (preliminary flooding location #1).	R/R	CAP	Y	Y	Y	N	N	• Steep slopes will require geotechnical evaluation. • Erosion issues are entering the jurisdictional wetland, and beyond the scope of maintenance actions, such as adding riprap to dissipate energy at the outfall. • Upstream end is collapsed (replacement in kind) and upsizing with outfall. Alignment is under private retaining wall. • Modeled capacity deficiencies at the upstream portion of the alignment (due to hydrologic inputs)	Y – WR-2, Phase 1 and 2	--	--	--
6	11	Town Center Loop near Les Schwab Tire Shop	Boeckman Creek	Staff Surveys	Observed flooding along Town Center Loop W via the CBs that tie into current high flow bypass. Existing reducer (12” control on 18” pipe) was installed in 2015 to limit flow toward ODOT culvert under I-5. Restriction contributes to upstream problems through Town Center Loop. Town Center redevelopment will remove the high flow bypass for flows towards Library Pond.	CAP		Y	Y	N	N	N	• Model does not reflect flooding in this location. • Future conditions will be driven by adherence to Town Center Plan. • Discussion during 3-15 Wksp confirmed not an immediate need. • Policy recommendation – As a best practice, establish public/private partnerships in conjunction with road overlay efforts to replace damaged private stormwater pipe.	N	N	N	Y
7	12	Rose Ln culvert	Willamette River	Staff Surveys 2012 SMP	2012 MP identified a CIP WD-2 for this location. Culvert under Rose Lane floods road and neighboring yard/garage on downstream side. Drainage pattern is very flat with several hard turns. Future development (PDR1) is anticipated upstream of problem area.	CAP	MAINT	Y	N	N/A	N	N	• Realign the existing culvert (at a diagonal) and/or install a secondary culvert south across Rose Lane to alleviate the US ponding that occurs in the adjacent field. • Consider opportunity to construct project in conjunction with future upstream development (PDR1). • Discussion during 3-15 Wksp confirmed historic project need requiring cost estimate.	Y – WR-3	--	--	--
8	13, 30	SW Parkway Ave south of Costco	Boeckman Creek	Staff Surveys H&H Model	N-S drainage swale south of Parkway has flat grades and is routinely filled with sediment, surcharging the roadway drainage system, and resulting in an ongoing maintenance concern.	MAINT	CAP	Y	Y	Y	N	Y	• Public works confirmed 36” pipe from Costco to 40” pipe to Sysco ditch (may attribute to Costco backwater). • Sysco intends to expand its footprint at this location, so private development may alleviate immediate open channel issue.	N	Y	Y- P-1	--

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					Ditch is owned and maintained by private owner (Sysco) but receives flows from both public and private sources. Upstream drainage from Costco includes a large underground detention system that does not function properly and holds water year-round. Modeled results indicate flooding at US node of 30" culvert at N-S end of ditch.								• Future Project/ Program Recommendation - City may install WQ manhole(s) or other facilities to remove sediments from public runoff (Localized Drainage Improvements Program or Green Street/LID Retrofit). This would isolate any additional sediment accumulated in the ditch to private sources (could be done as part of a program activity).				
9	14, 15, 26, 32	Open channel system from Day Rd. to Ridder Rd	Coffee Lake Creek	Staff Surveys 2012 SMP H&H Model	Culvert needs replacement. Conveyance and storage limitations exist south of Day Rd (limited areas, BPA towers, narrow channel, etc.). Existing AKS design does not fully alleviate modeled flooding.	R/R		Y	Y	Y	N	Y	• AKS Coffee Creek system evaluation included additional survey that was incorporated into model as part of validation efforts. AKS evaluation did not include impoundment (incorporated into BC model) or updated hydrology. • Need to evaluate area from larger perspective and investigate US/DS opportunities for improvement. • Discussion during 3-15 Wksp indicated purchasing the adjacent (to the west) parcel for installation of the detention pond (AKS concept) is complicated by access road issues. • BC to confirm feasibility of improvements and 100-year WSE with respect to adjacent structures. City to confirm what level of future flooding is acceptable. • Policy recommendation – May be required to limit/ confirm adherence to City stormwater standards upstream (north) of Day Rd and establish similar standards for Tualatin discharge. • Planning Project – Conduct flow monitoring prior to Phase 2 initiation to confirm sizing needs.	Y – CLC-1, Phase 1 and 2 and City-1	--	Y- P-5	Y
10	24	Catch basins corner of Wilsonville Rd & Kinsman Rd	Coffee Lake Creek	Staff Surveys	Recurring flooding at catch basins occurs even after cleaning.	CAP	MAINT	N	Y	N	N	Y	• Reconstruction is occurring so this may not be a pressing issue; future deficiencies to be addressed as part of a program (Localized Drainage Improvements Program)	N	N	Y- P-1	N
11	25	SW Salish Ln at intersection with Parkway Ave	Coffee Lake Creek	Staff Surveys H&H Model	Undersized catch basins cause flooding (ponding in SE corner by pond). A city-owned pond at the Shrine Center receives a small amount of drainage and requires frequent maintenance. Model predicts flooding within the pond and outlet. Pond configuration is based on original model build from 2012 SMP (preliminary flooding location #10).	CAP		Y	Y	Y	N	N	• Need improved access for a vactor truck to access the WQ MH and pond for maintenance. Access should be from the Shrine Center parking lot. • Refinement of the model extents or pond configuration determined to not be needed. • Program Recommendation - Localized Drainage Improvements Program or Green Street/LID Retrofit.	N	Y	Y- P-1	N

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													• Other option would be documentation of an unfunded project for maintenance enhancement.				
12*	29	SW Daybreak St & SW Morningside Ave	Coffee Lake Creek	Staff Surveys	Capacity issues with Renaissance detention pond. Possible elevation or directional issue with flow out of detention pond. Opportunity to improve water quality treatment through retrofit and reconfiguration of existing pond property.	CAP		Y	N	N	N	Y	• Possible pond retrofit to increase storage capacity and improve water quality treatment. • Location is also affiliated with Boeckman Road mitigation alternative locations and Ash Meadows (Project Opportunity Location #26), but not a prioritized location. • Workshop recommendation – Need program for restorative maintenance of ponds (especially private). Current PW staffing doesn't support private pond maintenance. • Policy recommendation – Implement an escalating, more robust enforcement protocol with provisions for City-initiated maintenance subject to private property reimbursement.	N	N	Y- P-6	Y
13	35	Culverts under I-5	Coffee Lake Creek	Staff Surveys H/H Model	End of design life and need to be replaced. Various locations along Parkway Ave & Boones Ferry Rd (crossings from E-W).	R/R		N	Y	Y	N	N	• Project may be referred to ODOT; not one that the City would initiate. • Locations already included in hyd. model.	N	N	N	N
14	36	Culverts under Jobsey Ln. and Arrowhead Creek	Coffee Lake Creek	2012 SMP Stream Assessment	2012 MP identified CIP CLC-9 for this location. Damaged and old culverts (already modeled), need to be replaced	R/R	E&S	Y	Y	N	Y	N	• Locations already included in hydraulic model. • Combine with Project Opportunity #20.	Y – CLC-2	--	N	N
15	37	Boeckman Creek N of Colvin Ln.	Boeckman Creek	Staff Surveys 2012 SMP	2012 MP identified BC-8 (Canyon Creeks Estate Pipe Removal) for this location. Erosion of streambank and migrating channel reported in downstream portion of the project site.	E&S	WQ	Y	Y	N	N	N	• Consider more detailed stream survey evaluation to understand channel constraints and extents of potential planting. • Per meeting on 3-8, City confirmed ongoing issue. Refer to 2012 SMP.	Y – BC-4	--	N	N
16	43, 44	Town Center Loop W - Shari's and Starbucks	Boeckman Creek	External Survey	Drainage issues - Shari's and Starbucks parking lot (down the road from each other).	CAP		N	Y	N	N	TBD	• May be localized ponding addressed with addition of inlets (programmatic). • This issue was identified to be addressed through the Town Center Plan (2019). • Discussion during 3-15 Wksp confirmed not an immediate need. • Policy recommendation – As a best practice, establish public/private partnerships in conjunction with road overlay efforts to replace damaged private stormwater pipe.	N	N	N	Y
17		Boeckman Creek - Reach 1 (US of Willamette R.)	Boeckman Creek	Stream Assessment	Significant risk of continued channel incision and lateral erosion along the lowest reach of Boeckman Creek prior to confluence of the Willamette River. Several properties have experienced bank failures and loss of land, and an active	E&S		Y	Y	N	Y	Y	• Consider upstream opportunities to reconnect floodplain, allow high flows to expand laterally, and dissipate channel energy. • Boeckman Road mitigation efforts (in progress) include evaluation of the tributary channel to the	Y- City-4	Possible	N	N

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					landslide is impacting the backyard and deck of one of the properties.								main reach of Boeckman and potential modification to increase upstream retention. • Per 3-15 Wksp, efforts may include stabilizing the channel and apply grade control; geotechnical investigation; retaining/ crib wall or soldier pile. • June 2023 – Per City - location to part of ongoing monitoring project (planning project need)				
18		Meridian Creek in Landover Park - Reach 1 (US of Wilsonville Rd.)	Meridian Creek	Stream Assessment	Sediment-clogged culvert (30-inch) at the Meridian Creek Crossing at Wilsonville Road. Culvert is mostly obstructed and appears to cause ponding during storm runoff.	MAINT	E&S	Y	Y	N	Y	N	• Consider location of ponding and whether infrastructure is being impacted. • If ponding is isolated to park and not overtopping any roadways or impacting private property, then maybe this isn't a problem that needs to be fixed. It's effectively a detention pond. • Per Wksp 3-15, planning project need to monitor location and confirm worsening.	Y- City-2	N	Y- P-5	N
19		Meridian Creek in Landover Park - Reach 2 (DS of Willow Creek Dr.)	Meridian Creek	Stream Assessment	Culvert outlet at upstream end of reach is clogged and backs up water underneath Willow Creek Dr. PVC SW outfall along reach is undermined (STA 1,100) and 6-foot section has washed out and moved downstream.	MAINT	E&S	Y	Y	N	Y	N	• Need in-water work permits to replace culvert. • Traffic impacts to Willow Creek Drive during culvert replacement. • Per Wksp 3-15, planning project need to monitor location and confirm worsening.	Y- City-2	N	Y- P-5	N
20		Arrowhead Creek at Pedestrian Bridge (Reach 4)	Coffee Lake Creek	Stream Assessment	Culvert at upstream end of reach (at pedestrian crossing) is failing and should be considered for replacement.	R/R		Y	Y	N	Y	N	• Need in-water work permits to replace culvert. • See Project Opportunity #14.	Y – CLC-2	N	N	N
21*		Memorial Park (Swale Retrofit, Pipe Upsizing, and Mitigation)	Boeckman Creek	Retrofit Analysis H/H Model	Swale at Memorial Dr. is not draining properly. Potential concept is to extend swale all the way along the road or relocate to the base of hill. Modeling evaluation indicates that the pipe system after convergence point at Memorial Drive has a constriction resulting in backwater and upstream system flooding (preliminary flooding location #5).	MAINT	CAP	Y	Y	Y	N	Y	• Opportunity to expand water quality treatment through retrofit of existing facility. • Location is also affiliated with Boeckman Road mitigation alternative location (raising of pedestrian trail to detain flow from entering Boeckman Creek). • Relocation of swale allows for offline facility construction. •	Y – BC-5	--	N	N
22		Oulanka and Tivoli Parks	Coffee Lake Creek	Retrofit Analysis	6 swales haven't been maintained properly - 2 are City owned and 4 need to be retrofitted and taken over by City	MAINT	WQ	Y	N	N/A	N	Y	• Level spreaders aren't working well. • Opportunity to expand water quality treatment through retrofit of existing facility. • June 2023 – Per City – PW already fixed the swales. Instead, recommend unfunded project or program for restorative maintenance of facilities (especially private). Current PW staffing doesn't support private facility maintenance. • Policy recommendation – Implement an escalating, more robust enforcement protocol with provisions for City-initiated maintenance subject to private property reimbursement.	N	Y	Y- P-6	Y

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23*		Creekside Apartments (Boeckman Creek at Wilsonville Rd.)	Boeckman Creek	Boeckman Road Mitigation Study Retrofit Analysis	City staff have identified a former irrigation pond near this apartment complex adjacent to Boeckman Creek. This location may have potential to provide additional storage or provide mitigation measures. Upstream of this location there is an existing outfall to Boeckman Creek that has known erosion issues per the 2012 SMP (BC-5).	CAP	WQ	Y	N	N/A	N	Y	• Opportunity to expand water quality treatment through retrofit of existing facility. • Boeckman Road mitigation efforts originally identified as a potential flow mitigation site but was not prioritized for alternative evaluation. • Will require private property partnership. • Policy recommendation – Implement an escalating, more robust enforcement protocol with provisions for City-initiated maintenance subject to private property reimbursement.	N	Y	N	Y
24*		Wiedeman Ditch/ Canyon Creek Park/BPA Easement	Boeckman Creek	Boeckman Road Mitigation Study 2012 SMP Retrofit Analysis	City staff identified potential project opportunity to construct a regional wetland or drainage facility at this location (would require BPA coordination). Facility would be able to manage runoff from Argyle Square, Sysco, and other future developments to help offset Boeckman Creek flows. This location is adjacent to previously identified erosion issues within Canyon Creek Estates (BC-8).	CAP	WQ	Y	N	N	N	Y	• Opportunity to expand water quality treatment and increase detention/retention through retrofit of existing facility. • Boeckman Road mitigation efforts evaluated storage capabilities in Wiedeman Ditch and Canyon Creek. This location is one of the preferred alternatives. • Will require coordination with BPA. • Potential mitigation opportunity for Sysco redevelopment (discussions in progress).	Y – BC-3, Phase 1 and 2	--	N	N
25*		Mentor Graphics/Siemens Ponds	Coffee Lake Creek	Boeckman Road Mitigation Study	Existing series of ponds located on Siemens property (8005 Boeckman Rd) currently only provide flow through storage. Ponds have potential to be modified to provide detention or reconfigured to divert less flow to Boeckman Creek during large storm events.	CAP		Y	Y	N	N	Y	• Opportunity to expand water quality treatment and increase detention/retention capacity through retrofit of existing facility. • Boeckman Road mitigation efforts included evaluation of potential bypass for low flow conditions and reroute from Boeckman to Coffee Creek watershed (in line with historic drainage patterns). See Project Opportunity #26. This location is one of the preferred alternatives.	Y – BC-2	--	N	N
26*		Mentor Graphics/Siemens Flow diversion structure and Ash Meadows Detention	Coffee Lake Creek	Boeckman Hydraulic Eval TM	Eliminate flow diversion structure on private property that diverts flows to Boeckman Creek during high flows (Project Opportunity Area 25). To account for additional flow returning to the Coffee Lake Creek drainage basin, utilize the Ash Meadows area to detain flows prior to entering the ODOT culvert underneath I-5. Utilize the volume of the natural depression near Ash Meadows to detain flows during large storm events.	CAP	WQ	Y	Y	N	N	N	• Boeckman Road mitigation efforts evaluated flow control potential at this location. This location is one of the preferred alternatives. • May require additional capital improvement projects downstream of Ash Meadows to ensure adequate conveyance capacity is available. • Will require coordination with ODOT.	Y – BC-2	--	N	N
27*		Boeckman Creek Instream flow mitigation and restoration	Boeckman Creek	Boeckman Hydraulic Eval TM	Within Boeckman Creek, several concepts have been identified to provide flow mitigation for projected increases in flow.	CAP	E&S	Y	Y	N	Y	Y	• Boeckman Road mitigation efforts indicated that instream improvements wouldn't provide the level of flow protection required.	Y- City-2	N	Y- P-5	N

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				Retrofit Analysis	Specific locations within Boeckman Creek have not been identified at this stage: • Beaver Analogs: Increase the depth and size of natural ponding within the creek. This would supplement the existing population of beavers and dams currently within Boeckman Creek. • Channel Improvements: Protect, harden, or slow flow in areas potentially impacted by the change in creek flows. May include the addition of large woody debris, large root wads, grade control structures or other appropriate measures to protect threatened stream banks."								• Program need - Instream restoration or vegetation enhancement. Project needs may stem from monitoring efforts.				
28		Charbonneau West - SW French Prairie Rd and SW Boones Bend Rd.	Charbonneau	2012 SMP	Stormwater system within the western portion of Charbonneau was identified in the 2012 SMP as a location that requires replacement	R/R	CAP	N	Y	Y	N	N	• Model indicates limited capacity deficiency at this location. • The 2012 SMP and subsequent Charbonneau Plan identified the piped infrastructure at this location in need of repair and replacement. • Per 3-15 Wksp, City confirmed need to cost out capital project for this area per the R/R Chabonneau Infrastructure Master Plan.	Y – WR-5	--	N	N
29		Charbonneau East- SW French Prairie Rd Outfall and SW Edgewater	Charbonneau	H/H Model 2012 SMP	Model predicts flooding at this outfall and along the SW Edgewater piped system. Predicted flooding along this system generally starts at the 10-yr design storm, while the most upstream pipe segments along SW Edgewater are predicted to start at the 2-yr design storm. Restriction is caused by undersized outfall (30") in comparison to upstream pipe segments (36"). This outfall pipe was replaced in 2018 during an emergency repair but was not upsized to 36" per the recommendation from the 2012 SMP.	CAP	R/R	N	Y	Y	N	N	• Model indicates limited capacity deficiency at this location. • Wallis Engineering is currently designing the portion of the system on Edgewater that contributes to this outfall. Per City (11-2-22), no capital project needed for Edgewater component.	N	N	Y- P-4	N
30		Charbonneau East- SW French Prairie Rd and SW Old Farm Rd piped system	Charbonneau	2012 SMP	Model predicts flooding throughout these piped systems starting at the 2-yr design storm due to insufficient capacity at the outfall pipe (Project Opportunity #29). Flooding at this location could impact the residential properties within Charbonneau.	R/R	CAP	Y	Y	Y	N	N	• Model indicates limited capacity deficiency at this location. • Alternatives evaluated include inline detention upstream along SW French Prairie Rd and/or SW Old Farm Rd and replacement of outfall. Due to space limitations a detention pipe within the roadway cannot provide adequate flow control. • Planning Project – Conduct flow monitoring prior to Phase 2 initiation to confirm sizing needs. • City to confirm how much modeled flooding is acceptable.	Y – WR-4, Phase 1 and 2 and City-1	--	N	N

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31		Parkway Ave./Metolius Ln.	Willamette River	H/H Model 2012 SMP	Model predicts flooding at several nodes along N-S run of pipe starting at the 10-yr design storm. Capacity is limited by the small diameter (21") pipes near the outfall which is causing a constriction. Flooding at this location could threaten the adjacent properties along SW Parkway Ave.	CAP		N	Y	Y	N	N	• Invert elevation in MH prior to outfall are misaligned, causing constriction. • Per 3-15 Wksp, PW Ops confirmed no immediate project need.	N	Y	N	N
32		Garden Acres Rd./Peters Rd.	Coffee Lake Creek	H/H Model Retrofit Analysis	Model predicts flooding along N-S piped system along Garden Acres that crosses the RR tracks and outfalls to Coffee Creek wetlands. Model flooding starts at the 2-yr design storm. City concern with obtaining easement/ coordinating with railroad to upsize pipe. Flooding at this location during the 2-yr design storm is concerning as in the future the contributing drainage area will further develop which will exacerbate this issue.	CAP		Y	Y	Y	N	TBD	• Prior to outfall, there are several smaller size pipe constraints constricting flow and causing surcharge. • As-builts were received for the existing ponds (two private, one public) located near the outfall (at the location of several small diameter pipes) of the Garden Acres Rd./Peters Rd. piped system. • Potential pipe rerouting and new outfall was evaluated to divert flow away from the undersized storm piping along Peters Rd. and towards a separate outfall to Coffee Creek. Per meeting 3-29, not a preferred option because would require new outfall. • Expanded pond to help mitigate flow downstream.	Y – CLC-3	--	N	N
33		Boberg Rd. and RR crossing	Coffee Lake Creek	H/H Model 2012 SMP	Model predicts flooding along N-S pipe prior to discharging into open channel starting at the 2-yr design storm. Predicted flooding also at two large diameter culverts flowing E-W underneath RR tracks. Flooding at this location could impact the industrial properties along Boberg Rd.	CAP		N	Y	Y	N	N	• May be addressed in conjunction with Opp Area #32.	---	N	N	N
34		Barber St.	Coffee Lake Creek	H/H Model 2012 SMP	Model predicts flooding at several DS nodes prior to Coffee Creek outfall and at node near RR tracks starting at the 25-yr design storm. Backwater conditions from Coffee Creek may be contributing to downstream flooding.	CAP		N	Y	Y	N	N	• Per H/H results, immediate project need is unlikely.	N	Y	N	N
35		Lower Boones Ferry Rd.	Willamette River	H/H Model	Model predicts flooding along piping that conveys private drainage (former Albertsons property) to Boones Ferry Rd starting at the 2-yr design storm. Flooding at this location could impact the commercial properties along SW Boones Ferry Rd.	CAP		N	Y	Y	N	Y	• Modeled flooding may be due in part to hydrology node placement. • Large parking lots in adjacent areas could be potential for retrofit with pervious pavements or stormwater planters for stormwater collection. • Will require coordination with private property owners. • Per Wksp 3-15, City is unaware of existing issue here.	N	Y	N	N

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36	8	Commerce Circle near Delta Logics parking lot	Coffee Lake Creek	Staff Survey	Improperly abandoned storm line on private property is causing flooding and a sink hole (safety concern).	R/R		Y	N	--	N	N	• Discussion during Public Works during site visit concludes no project need. • Public Works would like a contracting mechanism to contract the investigation and proper abandonment of this pipe independent of the PW maintenance budget. • Additional as-built research is needed to identify lateral connections and drainage area to the abandoned pipe. • Program Recommendation - Localized Drainage Improvements Program or Repair and Replacement.	N	N	Y- P-1	N
37	23	Cul-de-sacs west of Serenity Way	Coffee Lake Creek	Staff Survey	Inlets at Pleasant (Cartograph #1750) and Serenity Ln. (Cartograph #1748) become covered with leaf debris causing cul-de-sacs to flood.	CAP		N	N	--	N	N	• Program Recommendation - Localized Drainage Improvements Program. Installation of additional inlets near the intersection of Serenity Ln. may prevent ponding at the bottom of the cul de sac.	N	N	Y- P-1	N
38	46	29851/29840 SW Camelot St	Coffee Lake Creek	External Survey	Flooding from storm drain street grate. Grate clogs with debris.	MAINT	WQ	N	N	--	N	N	• Appears to be an operational issue. • Program Recommendation - Localized Drainage Improvements Program.	N	N	Y- P-1	N
39		Green Streets/LID Facilities	N/A	Retrofit Analysis	Develop a program to install LID facilities in conjunction with planned roadway improvements. Potential locations as listed in the Retrofit Assessment include SW Camelot, SW Wilsonville Road, and SW Hillman.	R/R			N	--	N	Y	• Program Recommendation – Water Quality Retrofit Program.	N	N	Y- P-2	N
40		Porous Pavement Pilot Study	N/A	Retrofit Analysis	Evaluate feasibility of porous pavement for future paving projects.	R/R			N	--	N	Y	• Consider applicability as a planning project to do porous pavement overlays for water quality in conjunction with pavement restoration/ improvement needs.	Y- City-3	N	N	N
41		Gesellschaft Water Well Channel Restoration	Boeckman Creek	2012 SMP Retrofit Analysis	Erosion is occurring within the drainage channel that enters Boeckman Creek.	E&S		N	N	--	N	Y	• Determined to be a higher priority retrofit location per 2015 Retrofit Assessment. • Per Wksp 3-15, project per 2012 SMP needed for funding.	Y – BC-6	N	N	N
42		Ridder Road Wetland Restoration	Coffee Lake Creek	2012 SMP Retrofit Analysis	Current drainage channel is underutilized with invasive vegetation. Referenced as CLC-4 per 2012 SMP.	E&S	MAINT	N	N	--	N	Y	• Determined to be a low priority retrofit location per 2015 Retrofit Assessment. • Discussion needed during planning workshop to confirm that funded project is not warranted.	N	Y	N	N
43		Town Center Conveyance Piping	Boeckman Creek	Community Development Town Center Concept Plan	Public stormwater collection pipe (>15" diameter) per Town Center Concept Plan.	INFRA		Y	N	--	N	Y	• Conveyance sizing is based on no onsite controls. • Library Pond analysis will be used to support onsite (private) collection system requirements. • Additional assets/ re-piping is development driven. No defined project need, pending redevelopment.	N	Y	N	Y

Table A-2. Project Opportunity Matrix																		
Project Opportunity Location ID[5]	Previous Problem Area Location ID	Location/ Asset Description	Basin	Source	Problem Description	Deficiency Category[1]		Site Visit Conducted (Y/N)	Project Planning[2]					Project/Program Development			
						Primary	Secondary		Hydraulic Model Developed? (Y/N)	Modeled Capacity Deficiency (Y/N)	Stream Assessment IDd Need (Y/N)[3]	Water Quality Retrofit Opportunity (Y/N)	Project Development Considerations (per Workshop and City Discussions)	Costed Capital Project Need? (Y/N)[4]	Unfunded or Future Capital Project Need? (Y/N)[4]	Program Need? (Y/N)	Policy Need?
44		Frog Pond E and S Conveyance Piping	Newland Creek	Community Development Frog Pond East and South Master Plan	Public stormwater collection pipe and outfall along SW 60th Ave. (>15" diameter) per Frog Pond Master Plan.	INFRA		N	N	--	Y	Y	• Frog Pond E and S Master Plan complete in December 2022. • Additional stream assessment conducted in October 2023 baselined receiving water characteristics. • SMP incorporates trunk line and outfall associated with proposed system along SW 60th.	Y – NC-1	--	N	N
45		SW Miami	Willamette River	H/H Model	Model predicts flooding along 15" piping starting at the 25-yr design storm.	CAP		N	Y	Y	--	N	• City doesn't recall location as being an issue. Per City with validation exercise, no immediate project need.	N	Y	N	N
46		Canyon Creek Rd (near Xerox)	Boeckman Creek	H/H Model	Model predicts flooding at node that conveys private stormwater from Xerox to the E across Canyon Creek Rd. starting at the 10-yr design storm.	CAP		N	Y	Y	--	N	• City doesn't recall location as being an issue. Per City with validation exercise, no immediate project need.	N	Y	N	N
47		River Fox Park	Willamette River	H/H Model	Model predicted flooding in 12" pipe	CAP		Y	Y	Y	--	N	• City doesn't recall location as being an issue. Per City with validation exercise, no immediate project need.	N	Y	N	N

Appendix B: TM#3: Stormwater Modeling Methods, Assumptions, and Results

Technical Memorandum: Hydrologic and Hydraulic Modeling Methodology and Results

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Technical Memorandum

FINAL

Prepared for: City of Wilsonville

Project Title: Stormwater Master Plan

Project No.: 156157

Technical Memorandum #3

Subject: Hydrologic and Hydraulic Modeling Methodology and Results

Date: March 7, 2023 (Final)

To: Kerry Rappold, City of Wilsonville

From: Michael Glass, P.E.
Angela Wieland, P.E.

Prepared by: ____________________
Michael Glass, P.E., Oregon PE#94214, Exp. 6/30/2023

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Limitations:

This document was prepared solely for Wilsonville in accordance with professional standards at the time the services were performed and in accordance with the contract between Wilsonville and Brown and Caldwell dated January 11, 2021. This document is governed by the specific scope of work authorized by Wilsonville; 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 Wilsonville and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

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List of Abbreviations

BC	Brown and Caldwell
BRCP	Boeckman Road Corridor Project
CIP	capital improvement program
City	City of Wilsonville
CMP	corrugated metal pipe
COM	Commercial
CPs	capital projects
CWS	Clean Water Services
GIS	geographic information system
GOV	Government
HB	House Bill
H/H	hydrological and hydraulic
HGL	hydraulic grade line
IND	Industrial
INST	Institution
LID	low impact development
LIDAR	Light Detection and Ranging
NAVD88	North American Vertical Datum of 1988
NGVD29	National Geodetic Vertical Datum of 1929
NRCS	National Resource Conservation Service
ODOT	Oregon Department of Transportation
OS	Open Space
PDR	Planned Development Residential
PVC	polyvinyl chloride
PWS	Public Works Stadards
RA	Rural Agriculture
RCP	reinforced concrete pipe
SMP	Stormwater Master Plan
TM	Technical Memorandum
TMDL	total maximum daily load
TSS	total suspended solids
UGB	urban growth boundary
VAC	Vacant

Section 1: Introduction

The City of Wilsonville (City) is developing an updated Stormwater Master Plan (SMP) to improve the understanding of stormwater system characteristics and infrastructure in the city. The SMP will include a capital improvement program (CIP) reflecting prioritized capital projects (CPs) and programmatic activities to address conveyance, capacity, water quality, and natural resource enhancement for existing and future development.

To document efforts completed as part of the SMP update, a series of Technical Memorandums (TM) have been developed. Technical Memorandum #1 (TM#1): Stormwater Basis of Planning (2/18/22) documented data collection and compilation efforts, presents applicable regulatory and design criteria, identifies stormwater problem areas (informing hydrologic and hydraulic [H/H] model updates), as well as preliminary project and programmatic concepts. Technical Memorandum #2 (TM#2): Geomorphic Analysis (5/25/22) documented field stream assessments for select stream channels within the City and identifies areas for additional consideration as a capital project.

This Technical Memorandum #3 (TM#3) builds upon the previously completed TMs to document the methodology and results of the H/H model activities. Topics covered in TM#3 include:

- H/H model evaluation criteria.
- Hydrologic model updates, including development of revised input parameters.
- Hydraulic model updates and expansion efforts, including refinement of existing modeled elements and the inclusion of additional stormwater infrastructure.
- Model validation approach, objectives, and adjustments.
- H/H model results under applicable design storm events, including identification of capacity limitations to inform development of capital projects.
- Next steps, including the comprehensive summary of project opportunities to inform CP development.

Section 2: Design Storm and Model Evaluation Criteria

The City's 2012 SMP developed a city-wide H/H model using the Innovyze InfoSWMM model platform. BC reviewed the City's existing H/H model and initiated updates as described in Sections 2.2 and 5.4 of TM#1. In addition, Brown and Caldwell (BC) reviewed Section 3 of the City's Public Works Standards (PWS) to outline planning criteria and sizing/design criteria to assess the existing stormwater system for deficiencies. This review is detailed in Section 4 of TM#1.

Section 2.1 identifies design storms that will be simulated for the H/H model and how model results will be used to assess compliance with the Surface Water Design and Construction Standards outlined in Section 3 of the City's PWS, revised December 2015.

2.1 Design Storms

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 used for this study include the 2-, 10-, 25-, and 100-year, 24-hour recurrence interval events. The rainfall distribution for these design storms is based on the standard National Resource Conservation Service (NRCS) Type IA storm, which is applicable to western Oregon, Washington, and northwestern California. Table 1 lists the design storm rainfall depths used in the hydrology model, as listed in the City's PWS.

Table 1. Design Storm Depths	
Design Storm Event	Rainfall Depth (inches)
2-year, 24-hour	2.5
10-year, 24-hour	3.45
25-year, 24-hour	3.9
100-year, 24-hour	4.5

2.2 Model Evaluation Criteria

Stormwater infrastructure within the H/H model will be evaluated for capacity per the design criteria established in the PWS. The PWS reflects design criteria for new infrastructure and will also be the basis for design of future CPs developed as part of this SMP. Key hydraulic design requirements for modeled elements are listed below:

- **Pipes and Open channels:** Sized to convey and contain the peak runoff from the 25-year design storm while also maintaining a minimum of 1 foot of freeboard between the hydraulic grade line (HGL) and the top of structure or ground surface.
- **Culverts:** Designed to safely pass the 100-year design storm flow and provide a minimum of 1 foot of freeboard between the HGL and the ground surface.
  - For new culverts 18 inches in diameter or less, the maximum allowable design storm event headwater elevation (measured from the inlet invert) shall not exceed two times the pipe diameter or three times the pipe diameter with a seepage collar, unless an exception is approved by the City.
  - For new culverts larger than 18 inches in diameter, the maximum allowable design storm event headwater elevation (measured from the inlet invert) shall not exceed 1.5 times the pipe diameter, unless an exception is approved by the City Engineer.

Specific to the identification and evaluation of conveyance capacity issues with existing City infrastructure, the model evaluation conducted in Section 7 identified capacity deficiencies up to the 25-year design storm event. Capacity deficiencies were defined based on predicted flooding which consisted of locations where the HGL exceeded the ground surface elevation. This approach allowed for deficiencies to be quickly identified throughout the system at a city-wide level. For capacity deficient locations where a CP is developed, recommended projects will follow the PWS to allow for the minimum of 1 foot of freeboard between the HGL and ground surface. For additional information on PWS design standards and criteria as it relates to this SMP, refer to TM#1 Section 4.

Section 3: Hydrologic Model Development

The hydrologic model developed for this SMP update utilizes InfoSWMM version 15.0 and the RUNOFF method, which is consistent with the original modeling approach for the 2012 SMP. The RUNOFF method is a simple yet well-established method for simulating subbasin hydrology that utilizes the Green-Ampt method for calculating infiltration.

The necessary parameters for the RUNOFF method when utilizing the Green-Ampt method for infiltration includes subbasin area, slope, width, impervious percentage, hydraulic conductivity, initial moisture deficit, and suction head. The hydrologic module in InfoSWMM 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 to update the original model.

3.1 Subbasin Delineation

The total contributing drainage area to City owned stormwater infrastructure is approximately 8,728 acres and extends beyond both the City limits and the urban growth boundary (UGB) in some locations. This total contributing drainage area represents the study area for the SMP and is organized by watershed or major basin. The study area is further subdivided into subbasins as shown on Figure A-1 of Attachment A. The receiving water body for all watersheds is the Willamette River.

The City's 2012 SMP developed subbasin delineations within each major basin for purposes of characterizing hydrology. BC reviewed this existing watershed and subbasin delineation and updated based on the following City provided information:

- Topographic Light Detection and Ranging (LiDAR) and contour data (2019)
- Stormwater infrastructure geographic information system (GIS) data (2021)
- Aerial Imagery (2021)

Where necessary, major basin boundaries were adjusted to accurately reflect that the entire drainage area was captured. However, most adjustments occurred on the subbasin level and typically involved the refinement of existing subbasin boundaries to better reflect newly developed areas or the subdivision of subbasins to depict drainage patterns more accurately.

From this revised subbasin delineation, ArcGIS Pro was used to calculate individual subbasin areas for use as a hydrologic input into the model. A summary of the subbasins by major basin is presented in Table 2. Please note Newland Creek (and its associated drainage area) is outside the designated study area and not included in Table 2.

Table 2. Subbasin Summary

Major Basin	Subbasins			Contributing Drainage Area (acres)
	Number	Average Area (acres)	Median Area (acres)	
Boeckman Creek	46	42.2	14.5	1,941
Charbonneau [a]	20	23.9	16.8	478
Coffee Creek/Tapman Creek	77	67.4	28.5	5,192
Mill Creek	3	47.0	49.0	141
Meridian Creek	7	67.2	40.8	470
Willamette River (direct)	25	20.2	14.6	505
Total	**178**	**49.0**	**23.9**	**8,728**

a. The Charbonneau basin discharges to the Willamette River (direct) but was classified as a separate major based due to its location south of the Willamette River versus north.

The largest basins within the study area are the Boeckman Creek and Coffee Creek/Tapman Creek watersheds. These watersheds represent over 80 percent of the contributing drainage area from which the City manages stormwater runoff.

Subbasin names throughout the watershed are consistent with those developed for the 2012 SMP. This naming convention includes a unique four-digit ID (e.g., 1100, etc.) to classify each individual subbasin. Per the 2012 SMP, deviations from this convention include several subbasins that are instead named in accordance with the detention facility they drain to (e.g., CANYON_N etc.).

Modification to subbasin naming for this SMP update only occurred when the original subbasin delineations were subdivided to provide a greater level of hydrologic detail. Split basins use “A” or “B” in the suffix to the original subbasin ID for identification purposes.

3.2 Subbasin Slope and Width

The RUNOFF method requires both subbasins slope and width parameters which are a function of the revised subbasin delineation discussed in Section 3.1. To approximate these two physical parameters for modeling purposes, the subbasin slope was first calculated based on the longest flow path line within each individual subbasin. Flow path lines were generated for each subbasin in ArcGIS Pro using automated spatial processing tools. These tools approximate the flow path line as the straight-line distance between the highest and lowest elevation points (based on LIDAR) in the subbasin. The auto generated flow path lines for each subbasin were then reviewed, and manually adjusted as necessary to correct instances where the flow path lines did not appear to represent reality. Examples of this includes flow path lines that did not follow the existing topography or followed a path outside of the subbasin due to an oddly shaped catchment or other nonstandard configuration. Subbasin slope was then calculated based on the flow path line length and upstream and downstream elevations. Subbasin width was then calculated for each subbasin by dividing the subbasin area by the flow path line length.

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 NRCS Soil Survey. Soil information is based upon 2020 soil survey data in Clackamas and Washington County, Oregon. Soil texture class information for the study area is presented on Figure A-2 of Attachment A.

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 which is consistent with the 2012 SMP approach. The Green Ampt method was used due to its ability to be applied City-wide and for its use of parameters that can be sourced from available soil data without the need for field work.

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 were based on the reference values in Table 6-1 of the City’s 2012 SMP and confirmed against published literature values. These values have been reproduced as Table 3.

Table 3. Soil Infiltration Parameters (Green Ampt Method)				
Soil Texture Class	Saturated Hydraulic Conductivity (inches/hour)	Initial Moisture Deficit (fraction)	Suction Head (inches)	Percent of Contributing Drainage Area (%)
Sand	4.74	0.41	1.93	0
Loamy Sand	1.18	0.39	2.40	0
Sandy Loam	0.43	0.37	4.33	1
Loam	0.13	0.35	3.50	12
Silt Loam	0.26	0.37	6.69	79
Sandy Clay Loam	0.06	0.26	8.66	0
Clay Loam	0.04	0.28	8.27	0
Silty Clay Loam	0.04	0.26	10.63	4
Sandy Clay Loam	0.02	0.21	9.45	0
Silty Clay Loam	0.02	0.23	11.42	0
Clay	0.01	0.21	12.60	4

An area-weighted average value was assigned to each subbasin for each input parameter based on the distribution of soil texture class within the subbasin. The average input parameters for each subbasin are listed in Attachment B, Table B-2.

3.4 Land-Use and Impervious Percentage

Area-weighted impervious percentages were assigned to each subbasin based on an associated percent imperviousness for each land-use coverage in the City. Land use coverage and percent imperviousness by land use were adjusted from values used in the 2012 SMP due to refined zoning categories (i.e., impacts of House bill [HB] 2001) and improved methodology for calculating impervious coverage.

Land-use categories and coverages (reflecting existing development conditions and future, full-build out development conductions) were developed with the City in October 2021 using City zoning, comprehensive plan designations, developable lands/open space coverage, floodplain and wetland area designations, and impervious area coverages. The methodology of developing representative, current percent impervious percentages for each land-use coverage for this study is summarized in Section 2.3.2 of TM#1. A summary of the updated land use categories and associated impervious percentages are shown in Table 4 below.

Table 4. Land-Use Categories		
SMP 2012 Categories	**SMP Category**	**Representative Impervious Percentage [a] (%)**
Agriculture	Rural Agriculture (RA)	15[b]
Commercial	Commercial/Government (COM/GOV)	82
Commercial-Villebois		
Industrial	Industrial (IND)	71
Residential	Planned Development Residential 1 (PDR1)	17
	Planned Development Residential 2 (PDR2)	33
Multi-Family Residential	Planned Development Residential 3 (PDR3)	43
	Planned Development Residential 4 (PDR4)	51
Residential–Villebois	Planned Development Residential 5 (PDR5)	52
Multi-Family Residential-Villebois	Planned Development Residential 6 (PDR6)	64
Open Space	Open Space (OS)	10
	Park	24
Vacant	Vacant (VAC)	3
NA	Institution (INST)	35
NA	Oregon Department of Transportation (ODOT)	48

NA: Category not used

a. Based on aerial imagery review and digitization of impervious surfaces conducted by the City.

b. Adjusted as part of the calibration process for the Boeckman Creek Hydraulic Evaluation TM (1/31/22). See Section 5.1 of the TM.

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 land-use based impervious percentages. The future land use coverage assumes conversion of vacant lands that are developable to their underlying zoning or comprehensive plan designation. The existing and future impervious percentage for each subbasin is listed in Attachment B, Table B-2 and shown in Attachment A, Figures A-3, and A-4.

The revised hydrologic input parameters discussed in this section inform the amount of runoff generated and ultimately routed through the hydraulic model as discussed in Section 4.

Section 4: Hydraulic Model Development

The City's existing InfoSWMM H/H model was initially developed as part of the 2012 SMP effort with minor, localized revisions for the Elligsen Pump-to-Waste evaluation completed in 2019. This most recent version of the H/H model was provided to BC in March 2021 and additional hydraulic updates were made as necessary for this SMP effort. The following subsections provide a description of the key hydraulic inputs required for the model and a summary of the hydraulic updates completed for this SMP.

4.1 Hydraulic Input Parameters

The InfoSWMM hydraulic model includes a network of nodes connected by conduits to represent the City's stormwater system in the model environment. Hydraulic information required by the model is stored within each node or conduit dataset. Within each node or conduit element, various hydraulic information is stored to govern the calculations and flow routing performed by the model.

4.1.1 Node Data

Model nodes include structures such as manholes, outfalls, storage facilities and junctions. These elements are informed by the City's GIS. Model nodes also include other relevant connection points in the system not defined in the GIS such as connection points between continuous open channel segments. Key model node attributes are listed in Table 5.

Table 5. Model Node Attributes

Attribute	Value
ID	The ID is maintained from the original 2012 SMP model. New nodes were assigned an ID based on the City's GIS attribute information.
Invert elevation	Invert elevation of the junction in feet (vertical datum NAVD88)[a]
Rim elevation	Elevation at the ground level in feet (vertical datum NAVD88)[a]
Storage Volume (if applicable)	Stage storage relationship (Depth vs. surface area)

a. Vertical datum of GIS data discussed in Section 4.2.1.

Storage nodes within the model allow for the simulation of ponds, underground detention, and other flow control facilities within the City's stormwater network. Each storage node is assigned a stage storage relationship (depth. vs. surface area) to represent the available volume of storage at a given water elevation. Table 6 lists the storage facilities included within the H/H model, including both those reflected in the 2012 SMP and those newly added or modified as part of this SMP update.

Table 6. Model Storage Nodes

Storage Node ID	Description	SMP update status
POND_LIBRARY	Library Pond (Memorial Dr.)	Updated
POND_E1	Villebois–Palermo Park dry pond	No adjustment
POND_E2	Villebois–Palermo Park dry pond	No adjustment
POND_F	Villebois–Palermo Park dry pond	No adjustment
COCA-COLA_POND	Coca Cola Facility Pond (SW Kinsman Rd.)	No adjustment
RENAISSANCE_POND	Renaissance Development Pond (SW Canyon Creek Rd.)	No adjustment
STAFFORD_POND	Al Kader Shrine Center pond (SW Parkway Ave.)	No adjustment
WILSONVILLE_DIST_CTR_POND	Wilsonville Distribution Center pond (Boones Ferry Rd.)	No adjustment
TONKIN_NISSAN_POND	Tonkin Wilsonville Nissan Pond (SW 95th Ave.)	No adjustment
CANYON_CR_PH2_DET	Canyon Creek Business Park underground detention facility	No adjustment
CANYON_CR_ARCH_PIPE	Canyon Creek Business Park underground detention facility	No adjustment
POND_BOECKMAN	Area upstream of Boeckman Rd. flow control structure	Updated
SIEMENS_POND_B	Private pond on Mentor Graphics/Siemens property (Boeckman Rd.)	Added
SIEMENS_POND_C&D	Private ponds on Mentor Graphics/Siemens property (Boeckman Rd.)	Added
STAFFORD_MEADOWS_1_BASIN	Frog Pond West–Stafford Meadows pond (Boeckman Rd.)	Added
DAY_RD_IMPOUNDMENT	Impoundment south of Day Rd.	Added
TOOZE_POND	Villebois–Calais East (Tooze Rd.)	Added

4.1.2 Conduit Data

Key attributes for conduits (i.e., pipes, culverts, and open channels) include ID, length, invert elevations, slope, shape (i.e., circular, or open channel cross-section), inlet and outlet losses, and Manning's roughness coefficient. The existing model conduit ID and naming convention was maintained for this SMP update. In locations where new conduits were integrated into the model, an ID was assigned based on the City's GIS attribute information.

Manning's roughness coefficient "n" is dependent on the material of the conduit. Table 7 provides a list of the roughness values applied, which are consistent with the documentation for the 2012 H/H model.

Table 7. Model Conduit Roughness

	Manning's *"n"* Roughness Coefficient
Pipe Material and Open Channel	Polyvinyl chloride (PVC) Pipe: 0.011
	Reinforced Concrete Pipe (RCP): 0.013
	Concrete Pipe: 0.013
	Corrugated Metal Pipe (CMP): 0.024
	Open channels: 0.035

4.2 Hydraulic Updates

Hydraulic model updates completed for this SMP update include model expansion, primarily in new growth areas since the previous 2012 SMP was completed or in identified problem areas (see TM#1), and model updates to reflect revised pipe sizing/alignment in conjunction with completed capital projects. These areas were discussed in a System Status and Modeling Extents workshop with City Staff in August 2021 to identify/confirm the specific locations for hydraulic model updates and documented in TM#1. Hydraulic updates used the City's GIS data (provided June 2021) as the primary source information and supplemented by City provided as-built drawings and field verification where necessary. Additional hydraulic model refinement described outside of this section was completed as part of the model validation adjustments discussed in Section 5.3.

4.2.1 Vertical Datum Resolution

The original hydraulic model used inconsistent vertical datums to reflect elevations of hydraulic model elements. Based on discussions with the City, this inconsistency was determined to be due to the City switching standards from the National Geodetic Vertical Datum of 1929 (NGVD29) to the North American Vertical Datum of 1988 (NAVD88) sometime between 2006 and 2008.

To rectify this discrepancy, BC reviewed and adjusted all existing hydraulic model elevations to be consistent with the City's current standard of NAVD88. Details and assumptions related to the identification and correction of datums is included in TM#1, Section 2.1.2. With this effort complete, future hydraulic updates (Section 4.2.2) were able to be integrated into the model under a consistent datum.

4.2.2 Model Update and Area Expansion Locations

Hydraulic model updates were completed from May 2021 through May 2022 as additional data were received and concurrently with the problem area identification process (see TM#1 Section 5.1). This process supported the initial identification of stormwater problem areas for the City, as locations requiring modeling to validate an observed problem. Additionally, expanded modeling helps to identify new problem areas or predict future problem capacity deficiencies.

Table 8 summarizes the specific locations of hydraulic model updates that were integrated into the City's InfoSWMM model for this SMP update. Comprehensive locations of hydraulic model updates are shown in Attachment A, Figure A-5.

Table 8. Hydraulic Model Update Summary

Date Completed	Type of Revision	Rationale for Update	Location	Description
May 2021	Update	Topographic survey	Boeckman Creek	Integrated open channel cross-sections surveyed in the vicinity of Boeckman Rd. crossing. Revised stage storage relationship of Boeckman Pond based on survey information.
June 2021	Update	Constructed capital project	Charbonneau	Revised model to incorporate Charbonneau pipe upsizing associated with CP SD9022-9025 (Old Farm Rd. Phase I) and CP SD9014-9016, & SD9030 (French Prairie Drive Phase II).
June 2021	Update	Constructed capital project	Barber Street	Revised model to incorporate pipe upsizing along Barber St. associated with CP SD4208 and SD4209.
August 2021	Update	GIS discrepancy	ODOT yard west of I-5	Updated diameter of modeled culvert from 40-in to 42-in to match GIS data.
August 2021	Update	GIS discrepancy	Boones Ferry Rd.	No model adjustment needed north of 5th St. for existing 24-in pipe segment. City rectified GIS data to match the 24-in pipe shown in model. Model adjusted south of 5th St. to reflect pipe upsizing to 30-in shown in GIS.
August 2021	Update	GIS discrepancy	Wilsonville Rd.	No model adjustment needed. City rectified GIS data to match 30-in pipe shown in model.
August 2021	Update	GIS discrepancy	Graham Oaks Nature Park	Adjusted model to follow correct piping alignment shown in GIS.
August 2021	Update	GIS discrepancy	Boeckman Rd. (west of I-5)	Adjusted pipe diameter to 24-in to reflect latest GIS data.
August 2021	Update	GIS discrepancy	Hillman Ct.	No model adjustment needed. City rectified GIS data to match 24-in pipe shown in model.
October 2021	Update	Problem area and site visit	Kinsman Rd.	Model adjusted to incorporate field measurements (rim and measure-down elevations) collected by Public Works.
October 2021	Update	Problem area and site visit	Town Center Loop	Model adjusted to incorporate field measurement of ODOT reducer (12-in) collected by Public Works.
November 2021	Expansion	Problem area and site visit	Tooze Pond	Model expanded to include Tooze Pond detention facility. Stage-storage relationship estimated form City provided as-built drawings.
November 2021	Update	Problem area and site visit	Day Rd. to Ridder Rd.	Model updated with culvert information (diameter, length, inverts) surveyed in 2019 as part of the Coffee Creek Stormwater Facility Study. Surveyed open channel information not incorporated.
November 2021	Update	Boeckman Creek Hydraulic TM	Boeckman Road flow control structure	Integrated as-built information to update flow control structure elevations and the storage capacity of the pond upstream of the flow control structure.
November 2021	Update	Boeckman Creek Hydraulic TM	Mentor Graphics/Siemens	Model updated based on survey information collected as part of the Boeckman Road Improvement Hydraulic Evaluation. Survey information included geometry and elevations of the Boeckman Creek diversion structure and weirs. Onsite Siemens ponds added to the model based on as-built drawings.

Table 8. Hydraulic Model Update Summary				
Date Completed	Type of Revision	Rationale for Update	Location	Description
December 2021	Expansion	New growth	Garden Acres Rd.	Expand model to include piped stormwater infrastructure along Garden Acres Rd. to Coffee Creek outfall.
December 2021	Expansion	New growth	Villebois	Expand model to include additional large diameter (>18-in) pipe within the Villebois planning district.
December 2021	Expansion	Problem area and site visit	Willamette Way E	Expand model to include additional infrastructure associated with Belnap Court outfall and Bonneville Power Administration (BPA) easement outfall.
February 2022	Update/Expansion	Problem area and site visit	Meridian Creek at Boeckman Rd. (Frog Pond)	Revised Meridian Creek culvert information based on City provided as-built drawings. Expanded model to include the open channel and “Stafford Meadows 1 Basin” detention pond upstream of the culverts.
May 2022	Expansion	Problem area and site visit	Day Rd. impoundment	Impoundment south of Day Rd. added to model based on as-built information provided by the City.

Section 5: Model Validation

The updated H/H model went through a validation process from May to August 2022 with the objective to increase confidence in the updated model’s accuracy and results. Flow monitoring and model calibration was not specifically conducted as part of this SMP update. The validation process involved several successive steps, as described below, leading to refinement of model input data to ultimately support the use of the H/H model to identify and develop CPs under this SMP update. The validation process included discussion of intermediate modeling results with the City during regular project check in meetings, which informed additional hydraulic modeling updates where the incorporation of as-built information was necessary.

The model validation effort included the following key components:

- Citywide integration of the model calibration adjustments determined as part of the Boeckman Road Hydraulic Evaluation (1/31/22).
- Simulation of a validation storm event from January 2022 and comparison of model results with photographs and field measurements collected near Ridder Rd.
- Discussion of preliminary model flooding results with City staff to confirm validity of modeled flooding locations and the need for additional refinement of hydraulic model elements using newly provided as-built data.

5.1 Boeckman Road System Calibration

The Boeckman Road Hydraulic Evaluation (1/31/22) is a separate but concurrent study conducted as a precursor to the Boeckman Road Corridor Project (BRCP). This study utilizes the same, updated, citywide InfoSWMM H/H model as being updated for this SMP. The study calibrated the H/H model for the Boeckman Creek basin based on flow monitoring data collected at the Boeckman Road flow control structure from March to June 2021. This flow data represents drainage from approximately 1,400 acres of the study area, specifically the upper Boeckman Creek watershed that drains to the Boeckman Road flow control structure.

Calibration adjustments integrated into the H/H model are summarized in Table 9 below.

Table 9. Boeckman Rd. Hydraulic Evaluation Calibration Adjustment Summary	
Adjustment	**Description**
1. Baseflow addition	Added constant 0.4 cubic feet per second of inflow to the Boeckman Creek system and simulated the three preceding months of rainfall to replicate antecedent conditions.
2. Residential Agriculture (RA) Land Use Impervious Percentage	Revised the initial RA impervious percentage from 6 to 15 percent. This adjustment affected hydrology citywide.
3. Mentor Graphics/Siemens survey results (2022)	Updated model to better represent existing conditions of private stormwater infrastructure, which included the Boeckman Creek diversion structure and weirs.

These calibration adjustments result in model results that match (within 3 percent) the peak instream flow for the selected calibration storm (June 11-15, 2021). Since conveyance infrastructure is sized based on peak flows, matching peak flow was the primary objective for this calibration effort. Detailed results of this calibration process including assumptions and rationale are described in the Boeckman Creek Hydraulic Evaluation TM, dated 1/31/22.

The calibration adjustments were applied to the citywide H/H model as the initial validation step for this SMP update. The anticipated impact from these calibration adjustments is not expected to be substantial; however only adjustment #2 from Table 9 directly impacts basins outside of Boeckman Creek watershed. Residential agriculture (RA) land use only comprises a small portion of the study area (approximately 14 percent), and most of this area is outside of the city limits. As such, additional validation efforts beyond the Boeckman Road Hydraulic Evaluation calibration adjustments alone were needed to sufficiently validate the citywide model.

5.2 Model Validation

To further validate the City-wide model, a validation storm event from January 4 to 7, 2022, was selected by City staff for simulation in the H/H model. This event was identified based on reported flooding observed by Public Works staff near Day Road and Commerce Circle (NW portion of City limits). Available information for this storm event included anecdotal accounts of flooding, photographs, and water surface measurements. The 15-minute rainfall data was collected from a nearby rain gauge.

Public Works staff provided several photographs from January 6 (time unknown) to document the reported ponded water south of Day Road as shown in Figure 1.

Figure 1. Validation observations (south of Day Road)

To correlate observed standing water conditions with measured data, BC staff collected a water depth measurement downstream of the observed flooding per Figure 2 (left) on January 7, 2022 at 11 a.m.. This measurement was collected at one of the 48-inch culverts underneath Ridder Road. While this measurement was collected after the peak of the storm event, water levels within the culvert remained high, as the culvert was approximately 67 percent full as shown in Figure 2 (right) below.

Figure 2. Validation measurement location (48-in. culvert underneath Ridder Road)

Left: Location of culvert. Right: Depth of water in culvert.

Rainfall data for this validation storm event was obtained from a rain gauge owned and operated by Clean Water Services (CWS) located along 99W Pacific Hwy between King City and Sherwood near the Tualatin National Wildlife Refuge. The gauge is identified by CWS as “LTR” and is approximately 5.75 miles from the Boeckman Road and Boeckman Creek crossing. This rain gauge was also used for the model calibration effort conducted for the 2012 SMP. The validation storm event rainfall is plotted (15-minute increments) on Figure 3, and storm characteristics are summarized in Table 10.

Table 10. Validation Storm Event

Statistic	Storm 1
Start Date/Time	1/4/22, 12:00
End Date/Time	1/7/22, 12:00
Duration, hours	72
Total Rainfall, inches	1.76
Peak Intensity, inches/hour	0.28

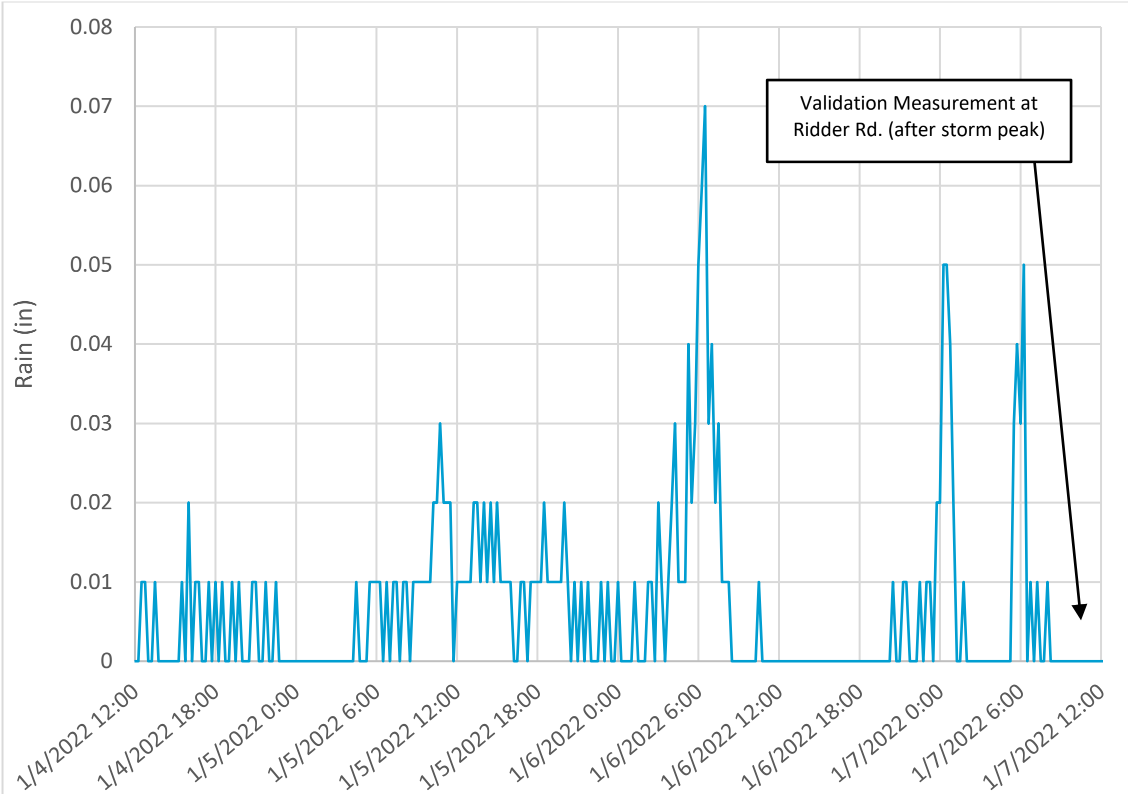


Figure 3. January 2022 validation storm event

5.2.1 Model Simulation

The validation storm was simulated in the H/H model to attempt to replicate the observed water surface elevations within the culverts at Ridder Road. The validation model simulation was unable to replicate observed conditions (i.e., standing water), indicating a discrepancy between the model results, City staff observations and BC measurements. The validation model results underpredicted the water depth measurements collected at the culverts underneath Ridder Road (Figure 2). While field measurements indicate that the culverts were approximately 67 percent full, the validation model predicted that the culverts would only be 11 percent full during that same period of the storm.

The discrepancy between the measured and simulated water surface elevation was attributed to the model not fully representing actual upstream hydraulic conditions from the culverts at Ridder Road. The modeled hydraulic reach between Day Road and Ridder Road includes simplified geometry to represent the open channel conveyance (trapezoidal cross-sections) and does not include the large wetland area north of Day Road nor the impoundment directly south of Day Road. In addition, it is suspected that during the storm event, the buildup of vegetation and sediment along this reach significantly contributed to backwater conditions and elevated water surface levels throughout the system.

5.2.2 Hydraulic Model Updates (Commerce Circle)

Adjustments to the system hydrology and hydrologic input parameters were briefly discussed with City staff but ultimately not made to resolve the large discrepancy in water surface elevations at the Ridder Road culverts. Rainfall patterns and storm volumes can vary significantly, and the rainfall gauge used to obtain the rainfall data is a relatively far distance from the validation location. Also, any adjustment to the hydrologic input parameters to increase flows at this location may have unintended consequences (i.e., impact CP sizing in other locations). The drainage area to the Ridder Road culverts is relatively small compared to the overall City's contributing drainage area. Therefore, it was decided that hydrologic adjustments associated with the model validation effort are not preferred and hydraulic model refinements should be made.

The hydraulic model between Day Road and Ridder Road was reviewed and updated based on available survey data within the general system area. Representative channel cross-sections were developed using the preliminary design information for AKS' 2019 Coffee Creek Stormwater Facility Study including the topographic data for the area collected by the survey team. This provided a more accurate representation of channel geometry in comparison to the conceptual trapezoidal channels included in the 2012 SMP model, although the change in the model results for the validation storm was marginal.

5.3 Preliminary Flooding Results and Additional Model Adjustments

With the large disparity in validation model results in the Day Road and Commerce Circle system (Section 5.2), it was decided jointly with the City to use a more comprehensive approach to qualify other flooding locations throughout the City.

Preliminary model results (reflecting validation adjustments described above) were discussed with the City in May 2022. This review focused on newly identified flooding locations (i.e., the 2012 SMP did not define a CP to address flooding in a specific location) throughout the City based on the 25-yr design storm (City's conveyance standard) under existing conditions. The preliminary flooding results were reviewed to identify and confirm deficiencies within the City's drainage network.

Locations with predicted flooding were cataloged in a summary table (Attachment B, Table B-2) and mapped (Attachment A, Figure A-6). City staff provided input on the preliminary modeled flooding locations as well as provided additional information (as-builts) to help refine the model prior to producing finalized results. City staff confirmed known flooding locations and locations where model flooding may not be indicative of a real-world issue.

In general, City staff agreed with the preliminary flooding results presented by the model. Preliminary flooding locations where City staff were not aware of issues were reviewed in detail to confirm their hydraulic configuration and whether the contributing drainage area and subbasin delineation was representative. For several locations where flooding had not been previously known by City staff, modeled flooding was resolved by further subdividing subbasins to simulate runoff entering the piped hydraulic system more accurately. It was decided jointly with the City that these adjustments were reasonable to resolve the issues and further effort should focus on the higher priority locations.

Additional locations (per Attachment A, Figure A-6) warranted hydraulic updates based on updated information provided by the City. These locations include:

- Location #2 Charbonneau SW French Prairie Rd. Outfall. Model revised based on as-built information to incorporate the outfall pipe lining completed as part of the emergency repair project in 2019.
- Location #6 Library Pond. Model revised to more accurately represent the pond's storage capacity based on a review of LiDAR and as-built information. The outlet pipe configuration was also modified to better reflect the ditch inlet and 18-inch outlet pipe per the as-built information.
- Location #11: Penske Truck Rental Property. Model revised to reflect updated culvert information underneath parking lot based on as-built drawings.
- Location #15: Wilsonville Distribution Center Pond: Model revised to reflect pond outlet structure based on as-built drawings.

Following hydraulic model adjustments, several locations are still predicted to flood despite City staff not being aware of any issues. These locations are outlined in Attachment B, Table B-1 as location IDs without narrative in the "City Validation Notes" column. Completion of the City-driven validation adjustments to the hydraulic model concluded the validation effort for the model. As previously discussed, traditional validation efforts for this H/H model were not feasible due to limited data. BC relied on feedback from City staff as part of this validation effort as it provided the most realistic path forward to continue with the capacity evaluation (Section 7) and advance CP development without requiring additional extensive data collection or flow monitoring.

Section 6: Future Flow Condition Modeling Analysis

During the model development process (Sections 3 and 4), BC evaluated different future flow assumption methodologies to determine impacts on runoff rates and ultimately CP sizing.

This analysis was initiated based on efforts to expedite design of a culvert replacement project at Meridian Creek at Boeckman Road (Problem Area #2) in February 2022. In this location, upstream development complies with current City stormwater design standards and incorporates various low impact development (LID) and flow control facilities and practices. As the sizing of CPs is typically independent of the presence of onsite facilities, the impact of onsite treatment and flow control on CP sizing was considered. While the immediate applicability of this effort was intended to inform this specific design effort (implemented and funded as part of the Boeckman Road Corridor Project), it was acknowledged that the future flow assumptions established here should apply to CPs developed as part of this SMP. This section documents the analysis for application to the SMP.

6.1 Background

The 2012 SMP developed CPs with a future flow condition that assumed each contributing subbasin would be fully built out to its zoning coverage. Future condition hydrology was developed from this future land use condition to size applicable stormwater infrastructure (i.e., pipes, culverts, ponds, etc.).

Since adoption of the 2012 SMP, the City revised their Stormwater and Surface Water Design and Construction Standards (2015). As part of this revision, developers are required to maintain pre-development runoff characteristics to minimize the effects of sediment transport and erosion, as described in Section 301.1.05 below:

> Stormwater management facilities shall be designed to maximize groundwater recharge through the process of infiltration of runoff into vegetated facilities and the use of what is referred to as Low Impact Development (LID) facilities and/or flow controls to address hydromodification.
>
> *Section 301.1.05, Wilsonville Stormwater and Surface Water Design and Construction Standards, 2015*

Compliance with this requirement provides a level of flow control for new development that was not accounted for in the 2012 SMP methodology for estimating future flows. If the same methodology is used, there is a potential to oversize CPs, as any upstream flow mitigation provided by LID facilities may reduce the peak flow to be managed by the constructed CP. The objective of this analysis was to evaluate whether implementation of onsite LID facilities should adjust the future flow methodology for CP development.

6.2 LID Facilities Modeling Approach

Evaluating the direct impact of future LID facilities associated with future development using the InfoSWMM H/H model is inherently difficult as the configuration and location of these facilities is unknown. InfoSWMM is capable of modeling specific LID facilities through its hydraulic module, but requires several known inputs such as invert elevations, depth/storage curves, outlet structure geometry, and specific locations within the drainage system to accurately retain and route flow.

Due to the absence of this information, the impact of future LID facilities was estimated through InfoSWMM's hydrologic module, specifically by adjusting the Sub-Area routing feature. The Sub-Area routing default within InfoSWMM routes all impervious and pervious area associated with a subbasin directly to the outlet (outlet routing). An optional configuration called percent routing, allows for a percentage of the impervious area within a subbasin to be routed over the pervious area within a subbasin prior to reaching the outlet. This is illustrated in Figure 4, originally published in the EPA Storm Water Management Model Reference Manual Volume I, Hydrology.

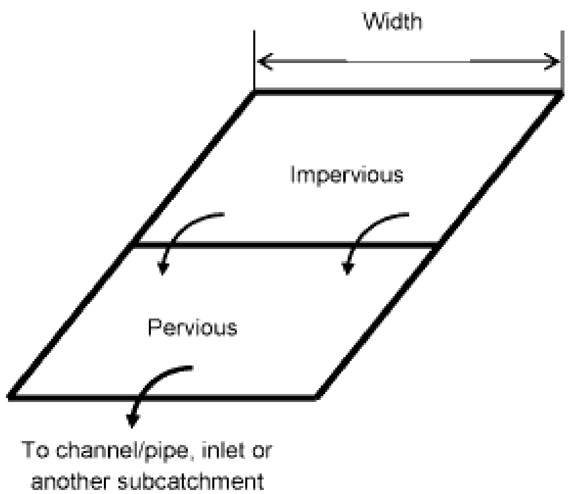


Figure 4. Percent routing diagram

Use of this percent routing feature within InfoSWMM is a simple routing mechanism. Available literature on this routing feature reflects its usage to approximate impacts of LID facilities within a subbasin, as it slows the timing of peak flow and allows for flow attenuation and additional infiltration.

The percent routed can range from 0 percent (direct outlet routing) to 100 percent (all runoff from impervious area routed to pervious area). To assess the sensitivity of the percent routing option on peak flows within the model, three different future alternative scenarios were simulated in addition to the traditional outlet routing model:

- PERV=75 percent
  - Routes 75 percent of impervious area over pervious area (less conservative)
- PERV=50 percent
  - Routes 50 percent of impervious area over pervious area
- PERV=25 percent
  - Routes 25 percent of impervious area over pervious area (more conservative)
- Outlet Routing
  - Impervious area and pervious area are routed directly to outlet (most conservative)

6.3 Results

The different future alternative scenarios were simulated for several design storms to assess relative impact on peak flows specific to the location of the Meridian Creek culvert replacement project. Results for the 10-yr design storm and the 100-yr design storm (culvert design standard) are shown below on Figures 5 and 6, respectively.

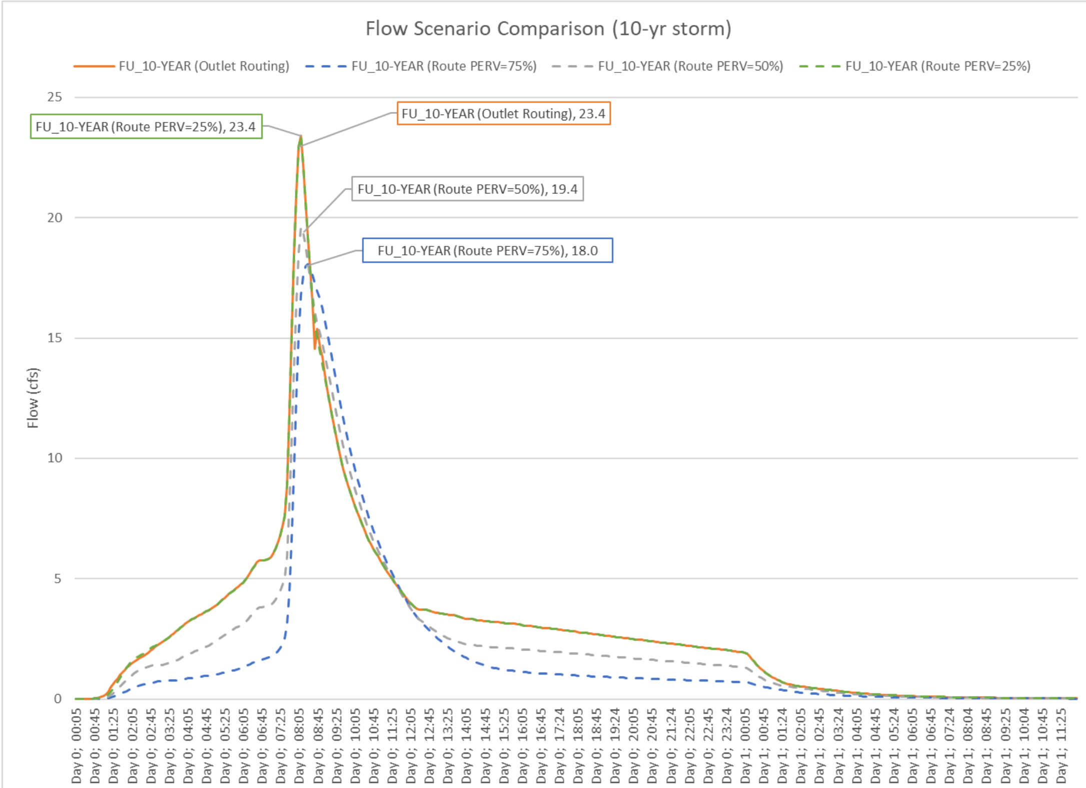


Figure 5. Meridian creek culvert–10-yr design storm

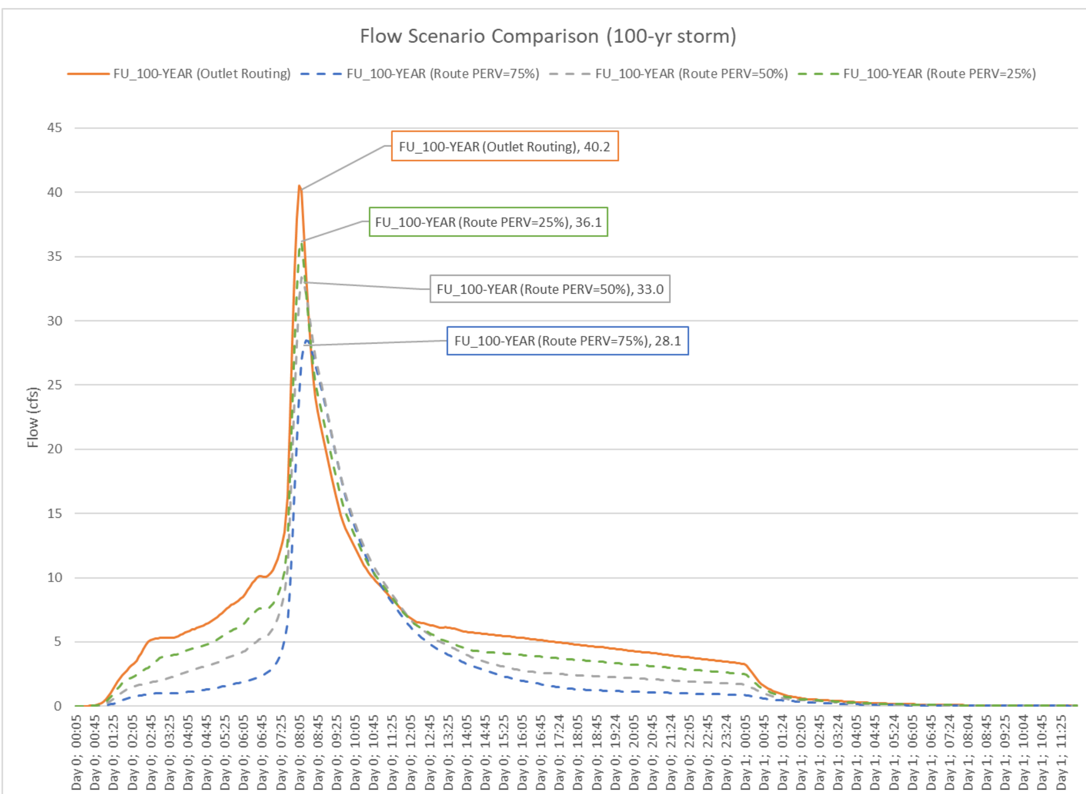


Figure 6. Meridian creek culvert–100-yr design storm

Based on these sensitivity model runs, the following conclusions regarding peak flow percent routing were reached:

- Increasing percent routing for a subbasin reduces anticipated peak flows.
- Percent routing has a greater impact on anticipated peak flows for larger design storms (i.e., 100-yr design storm)
- Percent routing has a greater impact on subbasins with lower impervious percentages (undeveloped/vacant lands).
- For smaller design storms (i.e., 10-yr design storm) the anticipated peak flow difference between outlet routing and PERV=25 percent is insignificant.

Based on these conclusions, and the desire to build some conservatism into the sizing for future CPs, it was decided jointly with the City to proceed with future condition modeling without subbasin percent routing. It was acknowledged that this approach may lead to the oversizing of some stormwater infrastructure; however, this would only be where the contributing drainage area is primarily undeveloped.

Section 7: H/H Model Evaluation and Results

Upon completion of the model validation effort (Section 5), detailed H/H model results were simulated for the 2-yr, 10-yr, 25-yr, and 100-yr design storm. H/H model inputs and results are summarized for the hydrologic and hydraulic models in Tables B-2 and B-3, of Attachment B, respectively. The following sections present the findings resulting from the model and how the model will inform CP development efforts.

7.1 Hydrologic Results

The hydrologic model results for all design storms show that future land use conditions (and associated increased imperviousness) result in increased peak flows compared to existing land use conditions. The increase in peak flows is most significant during the 2-year storm and gradually becomes less pronounced with larger storm events. Future land use conditions represent the development of developable (vacant) lands per their associated zoning category or adjusted zoning coverage for select, developed lands based on anticipated zoning in accordance with House Bill (HB) 2001.[1]

In general, most locations within the city limits are nearly fully developed; therefore, the increase in peak flow from these areas is expected to be relatively small. This is most evident in urbanized locations such as Charbonneau, Villebois, and along the I-5 corridor. Attachment A, Figure A-7 presents subbasins within the study area and their anticipated increase in peak flows (based on percentage) from existing to future land use conditions.

The largest anticipated increases in peak flow are primarily in the subbasins located outside of city limits, specifically within the upper reaches of the Coffee Lake Creek and Boeckman Creek watersheds. These locations are primarily undeveloped, but new development is pending and will increase the amount of impervious surface (runoff flow). As noted in Section 6, flow attenuation during new development is anticipated through implementation of the City's stormwater design standards, but for purposes of this SMP, CP sizing will be based on unmitigated flows.

Detailed hydrologic inputs and peak flow results for all subbasins and design storms are included in Attachment B, Table B-2.

[1] HB 2001 was passed by the 2019 Oregon State Legislature and requires Cities to allow for middle housing (e.g., duplexes) for properties zoned as single family residential.

7.2 Hydraulic Results

Hydraulic model results identify flooding locations with the intent to develop CPs to increase conveyance capacity and resolve flooding. For purposes of this evaluation, and as referenced in Section 2.2, flooding within the model was defined as locations where the hydraulic grade line exceeded the node rim elevation. Node flooding is a direct output from the model that can be used to efficiently identify capacity issues throughout the hydraulic system. Since the City's conveyance standard is the 25-yr design storm, this storm event was used as the benchmark to identify potential issues.

To assist in prioritizing locations by flooding severity, the 2-yr and 10-yr design storm flooding locations were also identified as shown in Attachment A, Figures A-8 and A-9. Using results from the three design storms, flooding locations were discussed with the City and cross-referenced with the Problem Area Matrix (Table A-1 of TM#1) to confirm the need to develop a CP for inclusion in the SMP.

As described in Attachment B, Table B-1, there are a total of 17 locations that continue to experience flooding in the existing condition. Of these, three locations were identified as key flooding locations based on discussions with the City. These locations are considered high priority for purposes of CP development and may require alternatives analysis to ensure that City objectives and preferences will be achieved. Description of these key flooding locations is provided below.

7.2.1 Charbonneau

Flooding is predicted within the SW French Prairie Rd. area of the Charbonneau District during rainfall events starting at the 2-yr design storm. Deficiencies (capacity and condition) in stormwater infrastructure within Charbonneau were previously identified in the 2012 SMP and subsequent Charbonneau Consolidated Improvement Plan (2014). Since the completion of those studies, some of the recommended pipe improvements have been completed and as-builts or revised GIS is integrated into the updated hydraulic model (see Table 8).

As part of the model validation exercise (Section 6), this area was reviewed in detail to investigate predicted flooding in the model since model results should incorporate completed pipe upsizing projects. Discussions with City staff led to an in-depth review of the as-builts for an emergency outfall repair project adjacent to 31233 SW Edgewater Pl. completed in 2019. Review of the as-builts indicated that the damaged section of the 30-inch corrugated metal pipe (CMP) was removed and replaced with a lined 30-inch CMP. The outfall pipe was not upsized to 36-inches as recommended by the 2012 SMP due to limitations associated with the emergency repair. While the lining of the pipe increases flow (reduces pipe roughness), the H/H model still indicates this section of pipe is a bottleneck in the system resulting in an elevated hydraulic grade line upstream of the outfall as shown on Figure 7 below.

To address predicted flooding, CP development at this location will evaluate options to incorporate detention into the upstream (non-replaced) portions of the collection system, to reduce peak flows downstream. Since available space is limited within the area, concepts that utilize a limited footprint such as detention pipes will be explored.

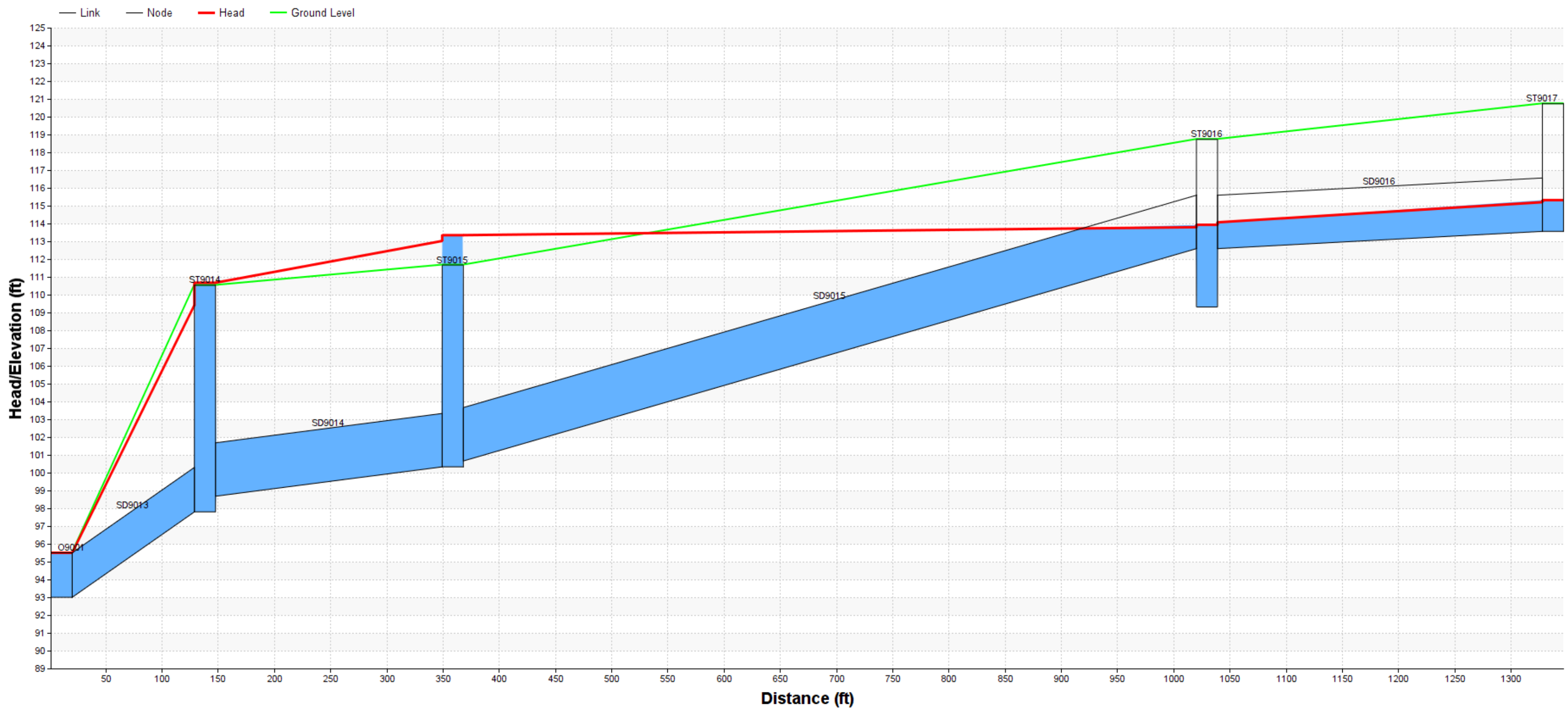


Figure 7. Charbonneau outfall–hydraulic grade line 25-yr design storm

7.2.2 SW Garden Acres Rd./Peters Rd.

Starting at the 2-yr design storm, flooding is anticipated along the stormwater collection system running north to south along SW Garden Acres Rd. and Peters Rd. The modeled capacity issue at this location is caused by a constriction due to undersized pipes (24-inch/27-inch) prior to the system discharging to the Coffee Lake Creek wetlands as shown on Figure 8 below. The upstream drainage area to this piped system is expected to develop into a high impervious land use type (industrial) and as such currently contains large diameter conveyance pipes (42-inch/48-inch). Future development will further exacerbate the predicted flooding at this location. This location is a known issue for the City, and a CP will be developed at this location to address the capacity issues.

Early discussions with the City have identified potential issues to upsize the undersized pipe, due to the fact the alignment transects the railroad right-of-way and discharges to a greenspace property owned by Metro. To avoid railway and Metro conflicts, the City has suggested retrofit of existing (private and public) ponds along the pipe alignment near the terminus of Peters Road to provide additional flow mitigation (discussed further in Section 8.1). In addition, alternative alignments may also be considered to divert runoff from the identified pipe constriction near the existing outfall. One possibility that could avoid the railroad right-of-way and Metro property would be to install new piping along SW Clutter Rd. to the west and along Grahams Ferry Rd. to the south to outfall into Coffee Lake Creek wetlands. This concept is preliminary and will need to be investigated and tested further with the City once CPs start to be developed.

7.2.3 Commerce Circle and Day Road

Starting at the 2-year design storm, model results indicate that the open channel to the west of Commerce Circle continues to be a flooding problem area. Banks of the open channel and the existing impoundment adjacent to Day Road are expected to overtop during larger storm events. These model results are consistent with the modeling/CP development for the 2012 SMP, and the follow up study “Coffee Creek Stormwater Facility Study” completed by AKS in 2019.

This location has several deficiencies within the waterway such as undersized culverts, heavy buildup of vegetation/debris, and segments with negative grade. Historically, this location has been particularly difficult to address due to space constraints, limited available grade, and the original drainage design allowing for the adjacent parking lots to flood to provide detention. This SMP update will build upon previous preliminary design concepts to develop a refined option for implementation.

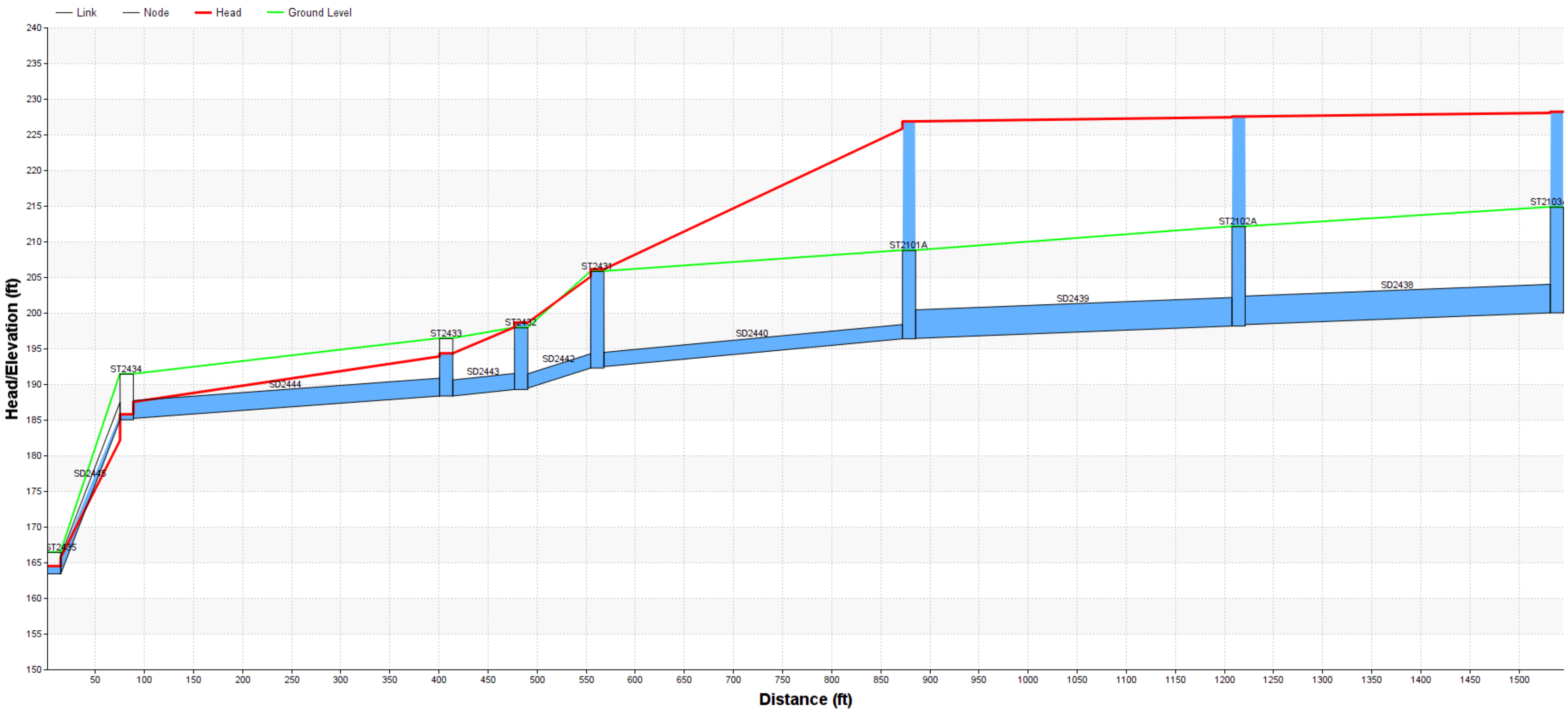


Figure 8. Peters Road–hydraulic grade line 25-yr design storm

Section 8: Retrofit Analysis

In conjunction with the H/H modeling evaluation of the City's stormwater system, BC initiated efforts to investigate additional project opportunity locations where the addition of new water quality and/or detention facilities or the reconfiguration of such facilities can provide regulatory or development benefit within the City.

To assist in this analysis, a working map was developed to facilitate the identification of potential retrofit locations. Key elements displayed on this figure included potential property (classified as vacant, parks, open space, or City owned), ponds (public and private), water quality projects from the 2012 SMP, best management practice drainage areas, and future transportation corridors. This retrofit figure is included in Attachment A, Figure A-10.

Based on review of the retrofit analysis figure and City staff preferences, the following objectives (strategies) were developed to guide the retrofit analysis:

1. Revisit priority (higher scoring) retrofit projects previously identified in the 2015 Retrofit Assessment to confirm continued relevance. These projects generally align with water quality-related projects per the 2012 SMP. This effort supports requirements of the 2021 National Pollutant Discharge Elimination System municipal separate storm sewer permit, which requires permittees to revisit the 2015 Retrofit Assessment and provide a status update.
2. Integrate water quality and/or flow control into existing project opportunity areas (where possible).
3. Retrofit underutilized facilities such as ponds or swales to enhance water quality and/or provide downstream flow mitigation.

Identification of new facilities to support anticipated development and growth was not considered a preferred retrofit strategy, given the fact that private development already has to adhere to the City's prescriptive stormwater design standards. These strategies helped to inform the retrofit projects and program discussed below.

8.1 Potential Retrofit Project Locations

Retrofit project locations were organized into two primary categories: previously identified locations and new opportunity locations. Applicable and relevant project opportunities are discussed in the following subsections to document potential locations for future CP development.

8.1.1 Previously Identified Opportunities

The 2012 SMP originally identified 14 restoration and 7 LID projects. These projects were reassessed and prioritized as part of the 2015 Retrofit Assessment.

For this SMP update, these projects were revisited to confirm implementation status and continued applicability in conjunction with current retrofit objectives. To track these projects and document discussions with City staff, Table 11 below was produced.

In this table, eight projects were removed (see gray shading) from consideration either due to them already being completed or no longer being feasible. Most projects were deemed still applicable and thus have been retained for inclusion in the overall project opportunity list.

Table 11. 2015 Retrofit Assessment Review and Status Confirmation

Project ID[a]	Project Name	Constructed?	Overlaps with Existing Problem Area	Overall Score [a]	Scoring criteria (per 2015 Retrofit Assessment)							Implementation Timeframe	Notes
					Progress Toward TMDL WLA	Location	Temperature Control	Erosion Control	Integration	Impact Area	Funding Source		
					0–4	0–3	0–3	0–3	0–3	1–3	0/1	1–3	
LID3	SW Camelot Green Street Mid-block Curb Extension	No	Yes, 46	**16**	4	2	2	2	3	1	0	2	Reflect in Program
LID7	SW Wilsonville Road Stormwater Planters	No	No	**16**	4	2	2	2	3	1	0	2	Reflect in Program
CLC-10B	Coffee Creek Storm Projects	No	Yes	**16**	4	2	2	2	2	1	1	2	Not Applicable–reflects CLC-1. Project number is unique to the Retrofit Assessment source document.
BC-5	Boeckman Creek Outfall Realignment	No	No	**13**	2	0	0	3	3	2	1	2	Project involves realignment of an existing outfall into Boeckman Creek (330' N of Wilsonville Rd) that is causing erosion. Erosion issues not identified in 2021 stream assessment. Mid-term project need from source document of retrofit assessment. Project location may overlap with a Boeckman Road mitigation need (Creekside Woods Pond). Not considered a retrofit but keep as a Project Opportunity Area.
CLC-6	Coffee Lake Creek South Tributary Wetland Enlargement	No	No	**13**	2	2	3	2	0	3	0	1	Referenced as a long-term project need from source document of retrofit assessment. Project location overlaps with Siemens/Ash Meadows. Current METRO project may also negate the project need. Remove from Project Opportunity List.
BC-4	Gesellschaft Water Well Channel Restoration	No	No	**13**	2	0	1	3	2	1	1	3	Project may be constructed in conjunction with other infrastructure projects (Interceptor Trail). Not considered a retrofit but keep as a Project Opportunity Area.
LID2	SW Hillman Green Street Stormwater Curb Extension	No	No	**13**	4	3	2	2	0	1	0	1	Reflect in Program
BC-8	Canyon Creeks Estate Pipe Removal	No	Yes, 37	**12**	2	0	1	3	0	2	1	3	Short term/High priority CIP need per source document from retrofit assessment. Maintain as a retrofit project and keep as a Project Opportunity Area (combined with problem area).
CLC-3	Commerce Circle Channel Restoration	No	Yes, 15/32	**12**	0	0	3	1	3	2	1	2	Mid-term project need from source document of retrofit assessment. Maintain as a retrofit project and Project Opportunity Area (combined with problem area).
WD-4A	Willamette Way West Outfall Replacement	No	No	**11**	2	0	0	3	0	2	1	3	Project location is being monitored. No immediate project need. Remove as a Retrofit project and Project Opportunity Area.
WD-4B	Belknap Ct Outfall Protection	**Yes**	No	**11**	2	0	0	3	0	2	1	3	Complete. Remove from list.
WD-4C	Morey Ct West Outfall Protection	**Yes**	No	**11**	2	0	0	3	0	2	1	3	Complete. Remove from list.
BC-2	Boeckman Creek Outfall Rehabilitation	No	No	**9**	0	0	0	1	3	2	1	2	Project involves rehab of 5 existing outfalls between Wilsonville Rd and Boeckman Rd that have erosion issues. Erosion issues not identified in 2021 stream assessment. Mid-term project need from source document of retrofit assessment. Project location may overlap with other infrastructure projects. Not considered a retrofit but keep as a Project Opportunity Area.
BC-10	Memorial Park Stream and Wetland Enhancement	No	No	**9**	0	0	3	0	2	2	0	2	BC-10 enhances the existing stream channel that flows into Boeckman Creek to the N of Memorial Park baseball field (near sanitary lift station). This stream receives flow from the Memorial Drive Swales which are just upstream (Problem Area #52 & BC-9). Mid-term project need from source document of retrofit assessment. Project location overlaps with potential Boeckman Road flow mitigation site. Keep as a retrofit project and Project Opportunity Area.

Table 11. 2015 Retrofit Assessment Review and Status Confirmation

Project ID[a]	Project Name	Constructed?	Overlaps with Existing Problem Area	Overall Score [a]	Scoring criteria (per 2015 Retrofit Assessment)							Implementation Timeframe	Notes
					Progress Toward TMDL WLA	Location	Temperature Control	Erosion Control	Integration	Impact Area	Funding Source		
					0–4	0–3	0–3	0–3	0–3	1–3	0/1	1–3	
CLC-1	Detention/Wetland Facility Near Tributary to Basalt Creek	No	Yes, 15/32	**8**	2	1	0	2	0	1	1	1	Referenced as a long-term project need from source document of retrofit assessment but aligns with problem area. Maintain as a retrofit project and Project Opportunity Area (combined with problem area).
CLC-2	SW Parkway Avenue Stream Restoration	No	No	**8**	0	0	3	1	0	2	0	2	Project is no longer needed, given onsite improvements for capacity (La Quinta). Remove from retrofit assessment.
CLC-7	Coffee Lake Creek South Tributary Stream Restoration	No	No	**8**	0	0	3	1	0	3	0	1	Project is no longer needed as this location conflicts with proposed new Public Works building. Current METRO project may also negate the project need.
CLC-8	Coffee Lake Creek Restoration	No	No	**8**	0	0	3	1	0	3	0	1	Project is no longer needed. This location is associated with 5th and Kinsman Project–Road isn't going to come out so project no longer applicable. Also at the driveway for Wilsonville Concrete.
CLC-5	Coffee Lake Creek Stream and Riparian Enhancement	No	No	**7**	0	0	3	1	0	2	0	1	Referenced as a long-term project need from source document of retrofit assessment. Maintain as a retrofit project and Project Opportunity Area (combined with problem area).
CLC-4	Ridder Road Wetland Restoration	No	No	**7**	0	0	3	1	0	2	0	1	Referenced as a long-term project need from source document of retrofit assessment. Maintain as a retrofit project and Project Opportunity Area (combined with problem area).

a. Overall score is based on a maximum 23 points possible.

TMDL = total maximum daily load

WLA = waste load allocation

8.1.2 New Opportunities

In addition to the projects previously identified in the 2015 Retrofit Assessment, this SMP update identified several opportunities to integrate water quality and/or flow control into an existing project opportunity or retrofit an existing, underutilized facility. These opportunities and their preliminary retrofit concept are summarized in Table 12.

Table 12. New Retrofit Opportunities

Location	Retrofit Strategy	Retrofit Concept
Library Pond	Existing Project Opportunity	Install outlet structure to existing pond to provide flow control benefits. Drainage from Town Center is conveyed through this facility. Opportunity to implement a fee-and-lieu system for upstream redevelopment.
Tivoli and Oulanka Parks	Underutilized Facility	Combination of public and private swales at these locations. Swales have not been properly maintained and need retrofit.
Oregon Glass Pond	Underutilized Facility	Ponds near the outfall of the Ridder Rd./Peters Rd. piped stormwater system may be able to be reconfigured to provide a flow control benefit. Opportunity to help to mitigate the pipe capacity issues at this location.
Memorial Park Dr. Swales	Existing Project Opportunity and Underutilized Facility	Existing swale is not draining properly. Swale needs retrofit.
Canyon Creek Park	Existing Project Opportunity	Existing park property has potential to construct a regional facility. This facility could treat upstream runoff from Argyle Square, Sysco, and other future developments. Due to location within BPA easement, additional coordination would be required.

While these are the opportunities identified to date, additional opportunities may be identified in the future especially with the current design efforts associated with the BRCP. As part of the BRCP, mitigation opportunities associated with Boeckman Creek are currently being identified and evaluated for future project development. Any projects that result from the BRCP will be coordinated with projects developed as part of the SMP update. At this time, preferred mitigation opportunity locations have also been integrated into the larger project opportunity list for this SMP.

8.2 Potential Programs

To allow for the opportunistic integration of water quality in conjunction with transportation or other utility replacement projects, this retrofit assessment identified two potential programs that would provide a general funding mechanism to support retrofit strategies. These programs include the following:

- Green Street/LID Facilities–Allocate approximately $250,000/year to support green street and LID facility installations of facilities in conjunction with already planned utility work for select roadway improvements. This would allow for continued expansion of water quality treatment areas in areas without any existing treatment.
- Porous Pavement Pilot Study–Allocate approximately $25,000/year to install porous pavement overlays in conjunction with scheduled pavement replacement or restoration efforts. This would allow the City to begin to evaluate feasibility of adopting porous pavement for future paving projects in the City.

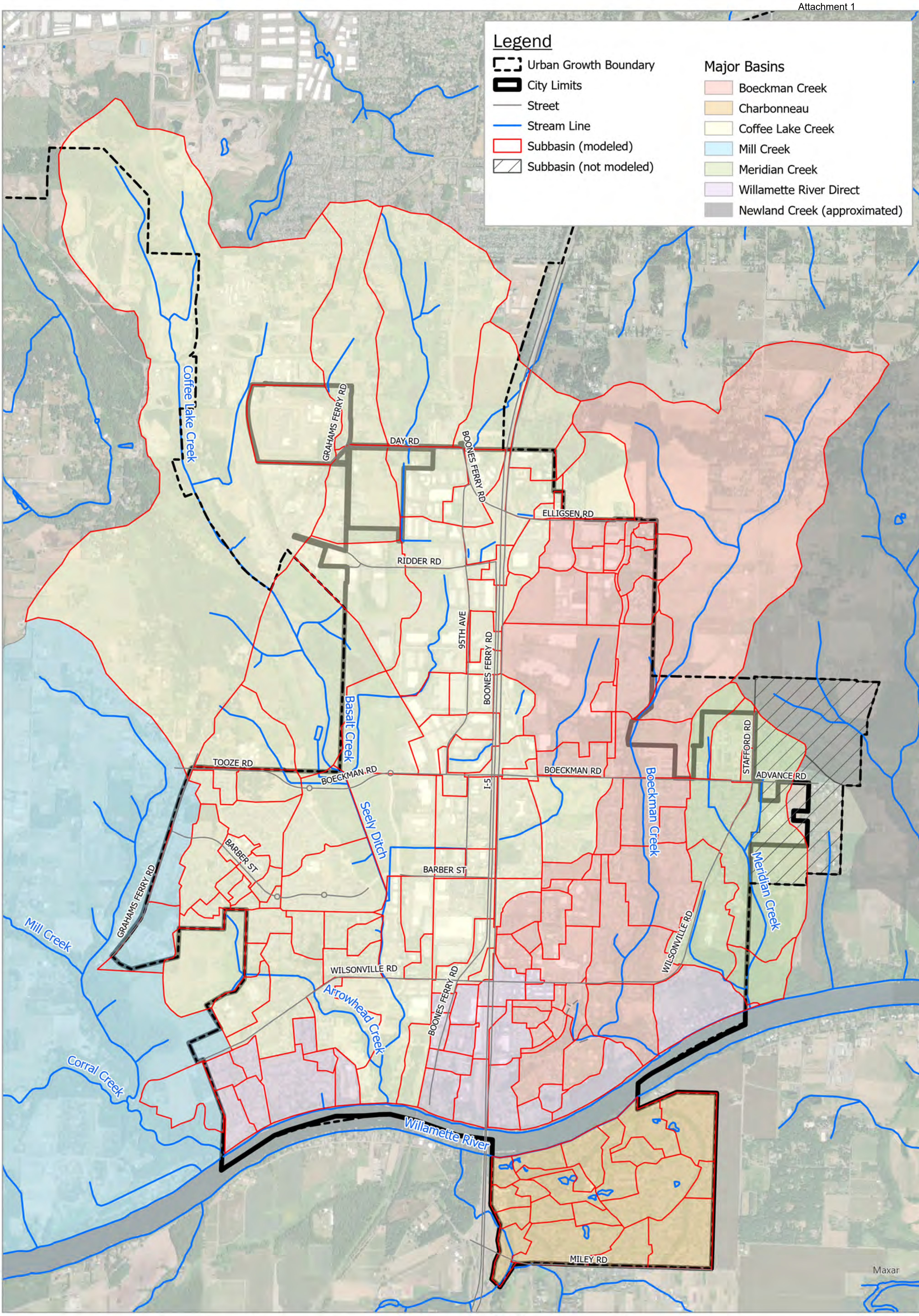
These programs will be considered in conjunction with other CP planning. Additional program opportunities have previously been identified as outlined in TM#1.

Section 9: Conclusions and Next Steps

Project identification and preliminary project concepts stemming from the H/H modeling (Section 7) and retrofit assessment (Section 8), as documented in this TM, have been integrated into a Project Opportunity Matrix (Attachment B, Table B-4). The Project Opportunity Matrix expands the Problem Area Matrix that was originally included as Table A-1 in TM#1. The Project Opportunity Matrix provides a comprehensive summary of project needs in the City and will be used to facilitate City discussions and identify preferred locations to develop CPs for the SMP update.

Following City review of this TM, BC will start evaluating priority flooding locations (see Attachment B, Table B-4) to assess alternatives and feasibility of preferred project concepts. Subsequent evaluation efforts will focus on other priority locations, as confirmed through the Capital Project Workshop (scheduled for February/March 2023). Refined project concepts and cost estimates will be developed for select (approximately 15) project opportunity locations, and results documented in the SMP in graphical and tabular format.

Attachment A: Figures



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City of Wilsonville/
Project # 156157

Stormwater Master Plan

Date: 3/3/2023

Notes:

Drawn By: SWG
Checked By:

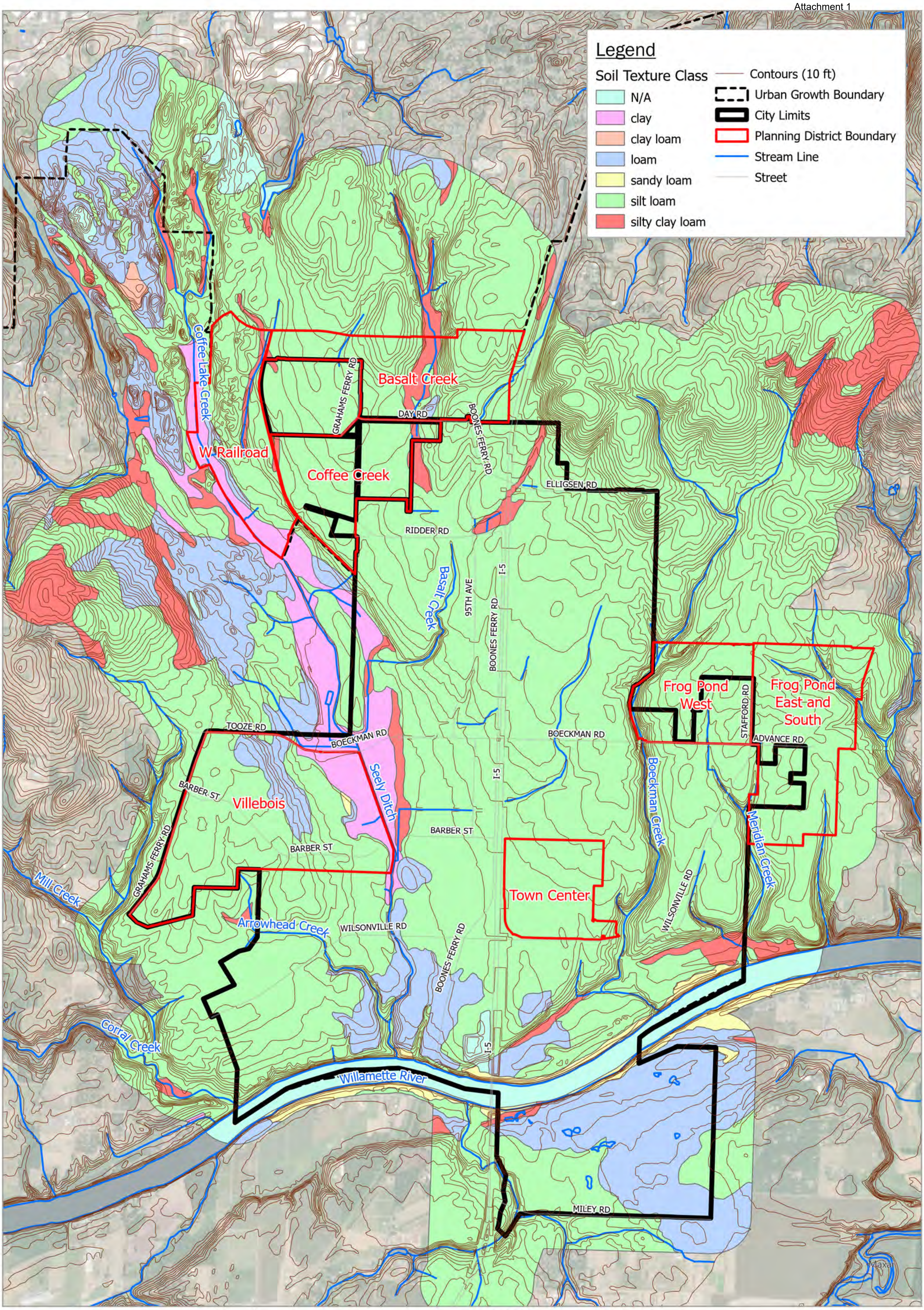
Spatial Reference:
Name: NAD 1983 HARN StatePlane Oregon North FIPS 3601 Feet Intl

N

0 1,250 2,500 5,000 Feet

Figure A-1: Subbasin Delineation

Attachment 1



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Notes:

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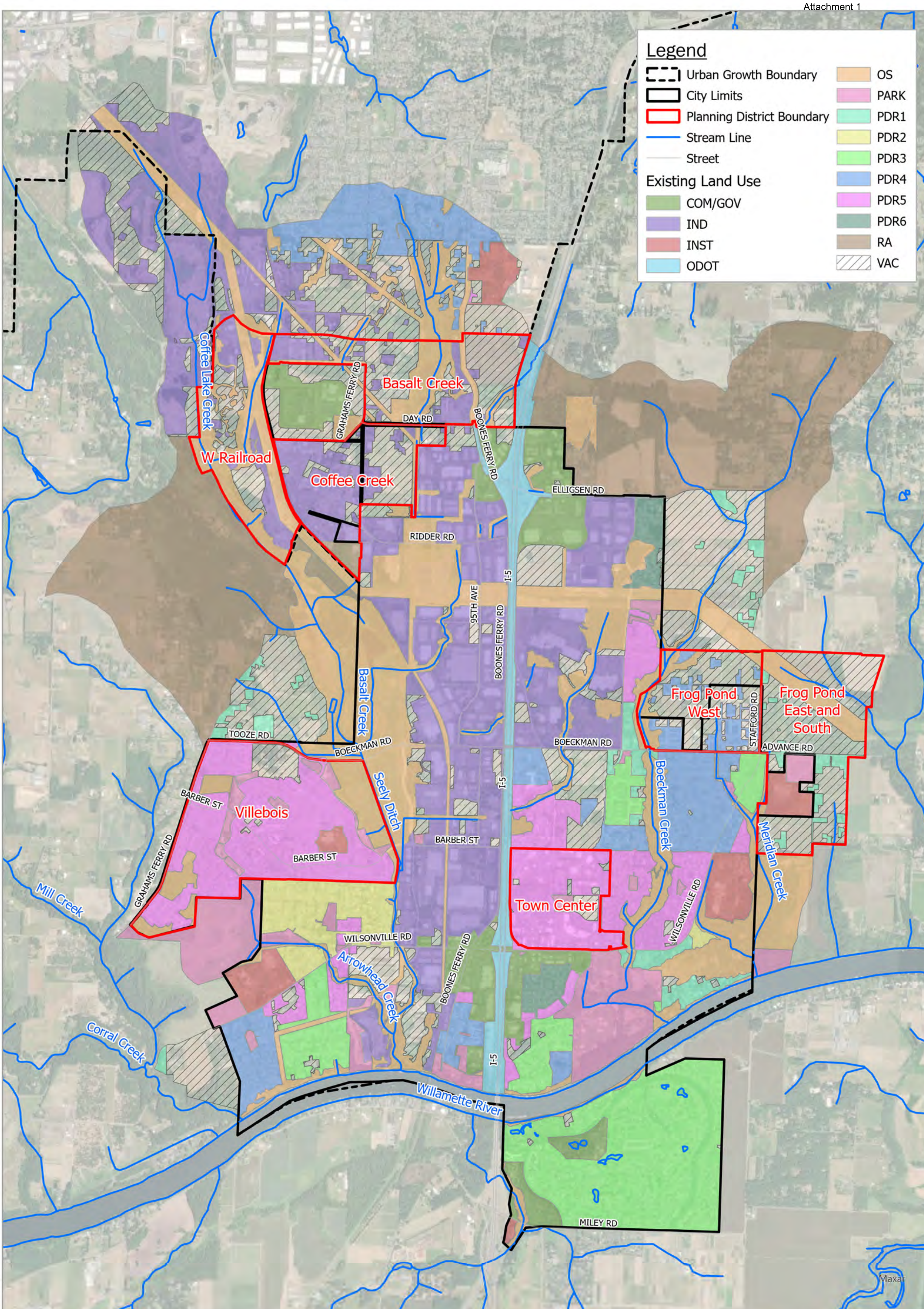
Spatial Reference:
Name: NAD 1983 HARN StatePlane Oregon North FIPS 3601 Feet Intl

N

0 1,250 2,500 5,000 Feet

Figure A-2: Soils and Topography

Attachment 1



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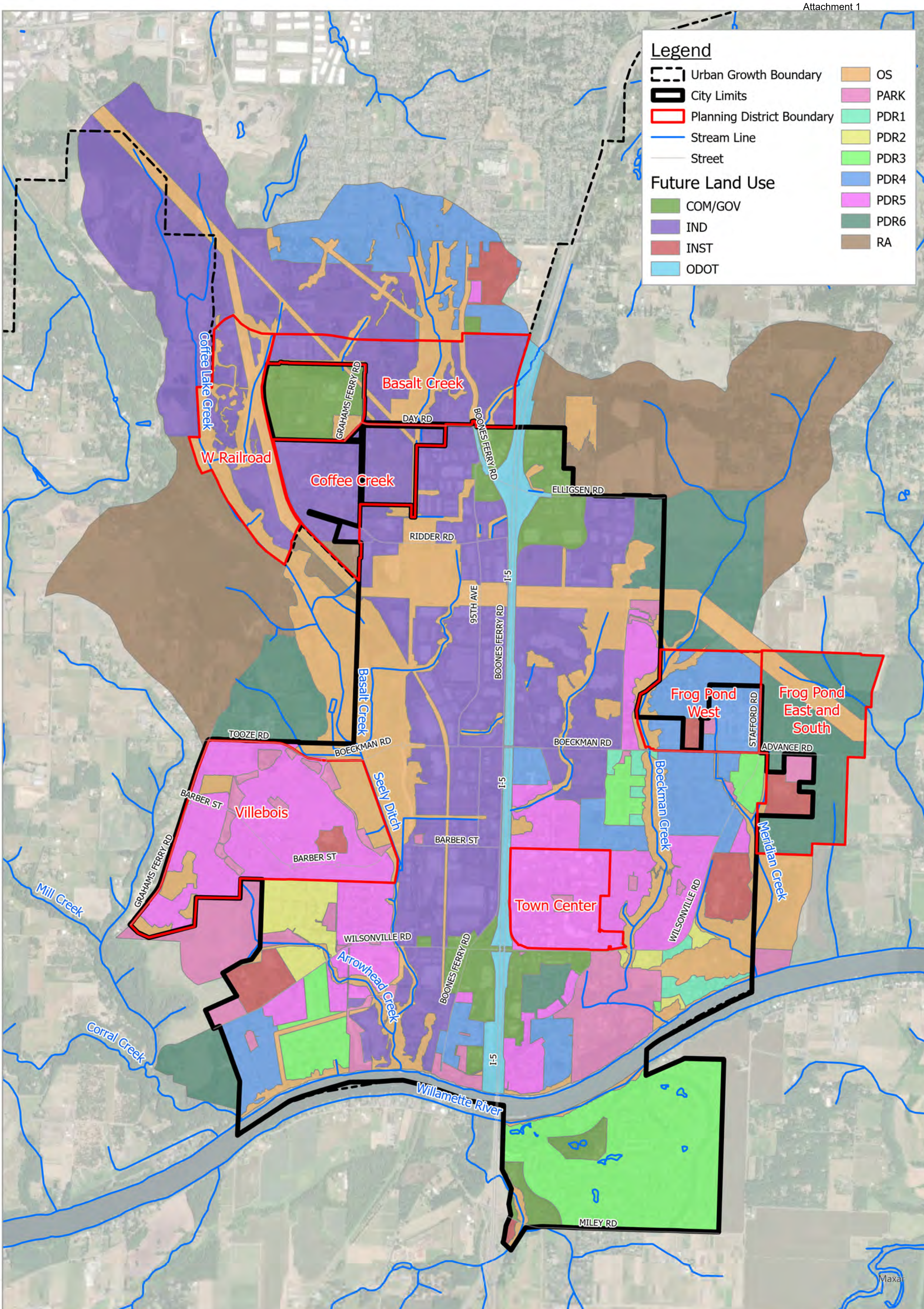
Checked By:

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

N

0 1,250 2,500 5,000 Feet

Figure A-3: Existing Land Use Condition



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Checked By:

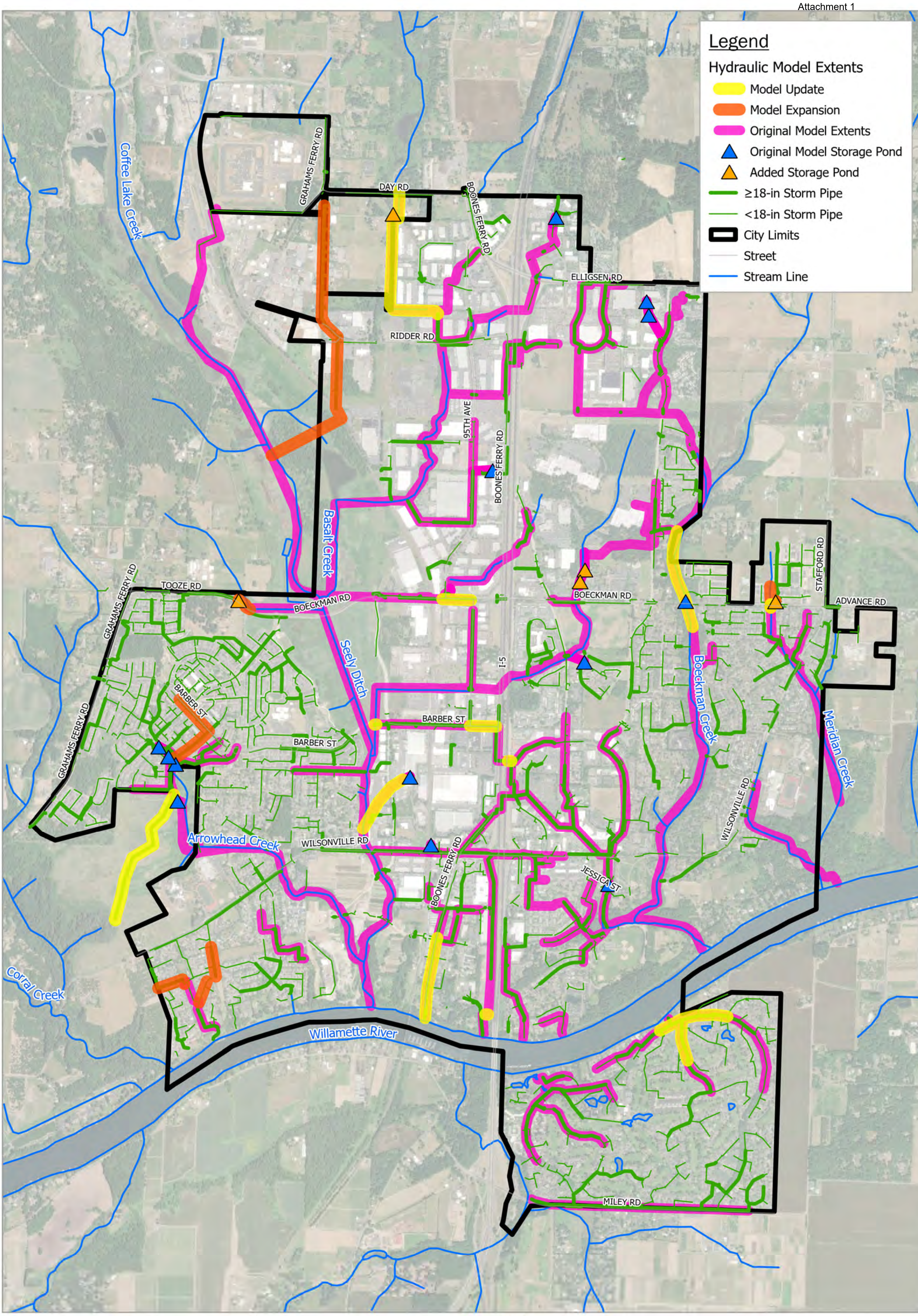
Spatial Reference:
Name: NAD 1983 HARN StatePlane Oregon North FIPS 3601 Feet Intl

N

0 1,250 2,500 5,000 Feet

Figure A-4: Future Land Use Condition

Attachment 1



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Drawn By: MRG
Checked By:

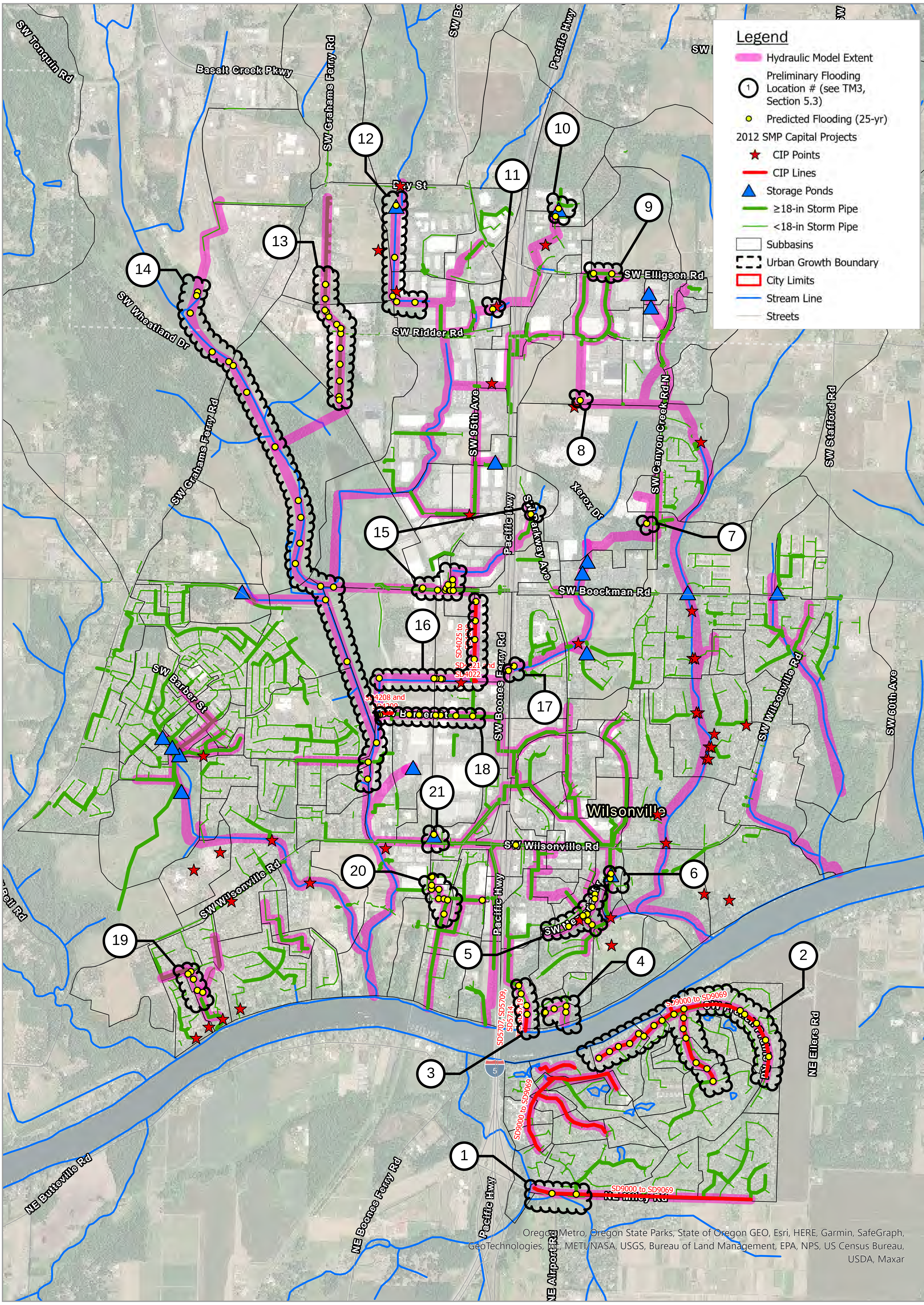
Spatial Reference:
Name: NAD 1983 HARN StatePlane Oregon North FIPS 3601 Feet Intl

N

0 1,000 2,000 4,000 Feet

Figure A-5. Hydraulic Model Overview

Attachment 1



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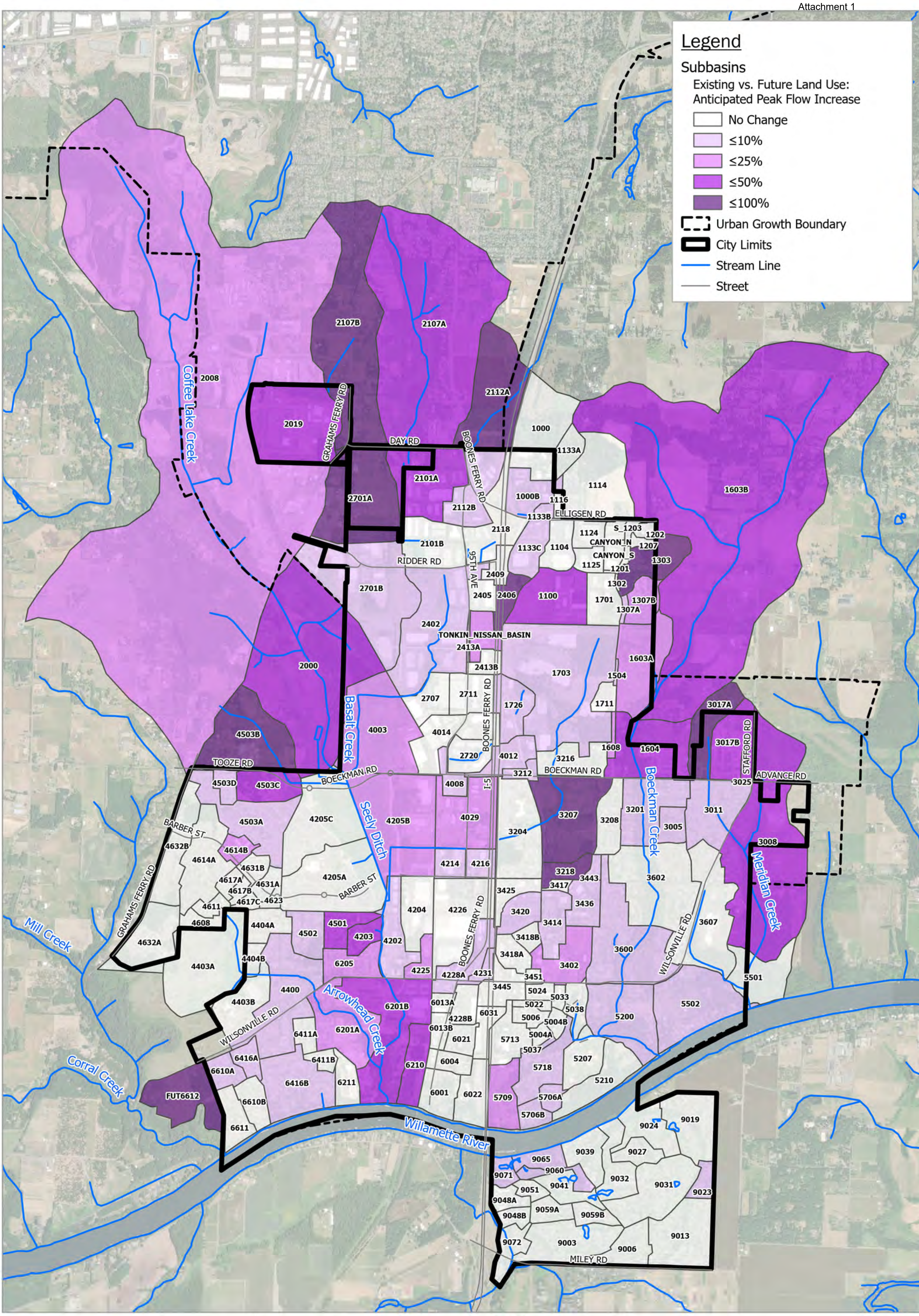
Checked By:

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

N

0 1,000 2,000 4,000 Feet

Figure A-6: Preliminary Flooding Results (25-yr design storm)



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Notes:

Drawn By: SWG
Checked By:

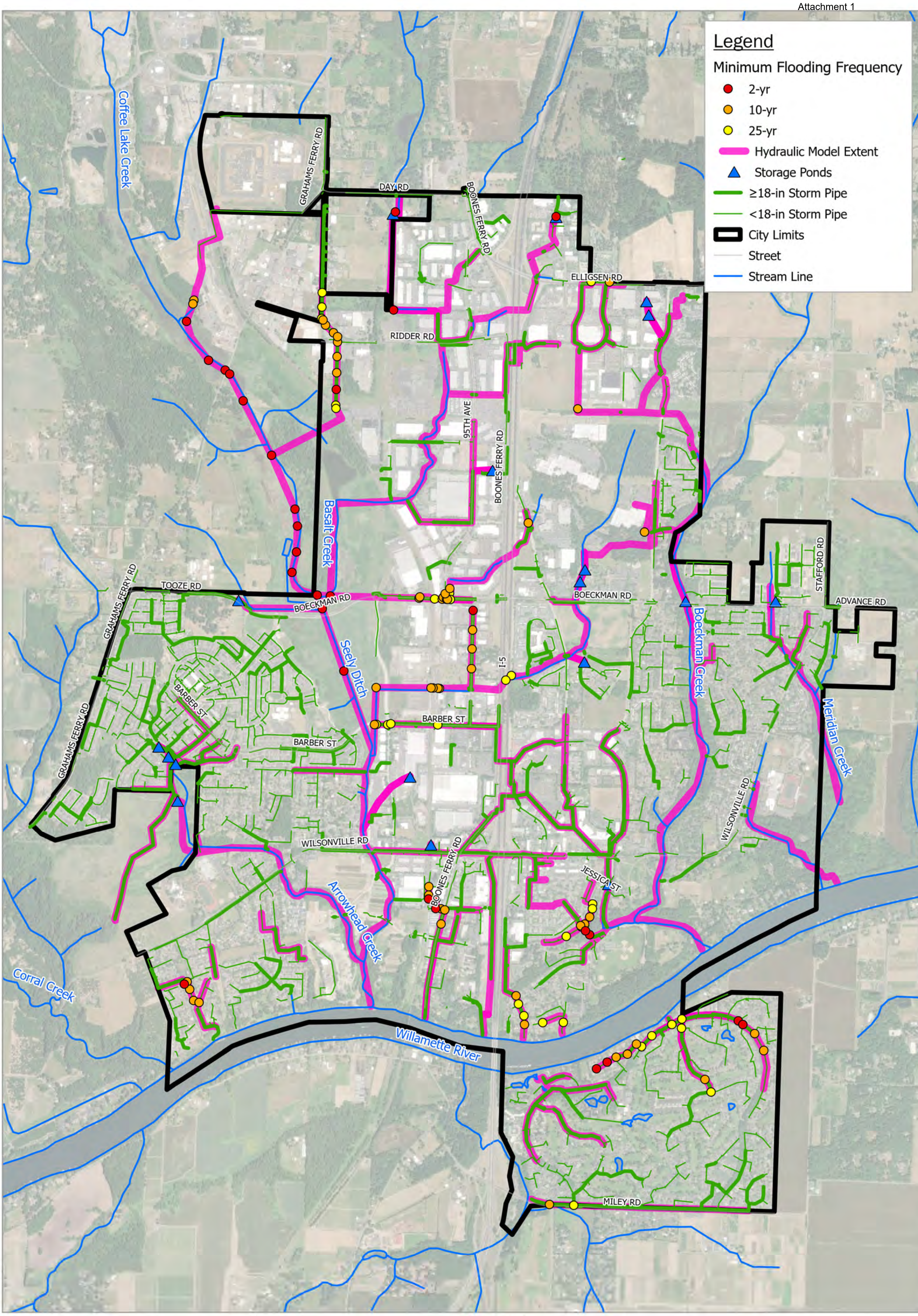
Spatial Reference:
Name: NAD 1983 HARN StatePlane Oregon North FIPS 3601 Feet Intl

N

0 1,250 2,500 5,000 Feet

Figure A-7: Hydrologic Results: Subbasin Peak Flow Increase %

Date: 3/7/2023



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Notes:

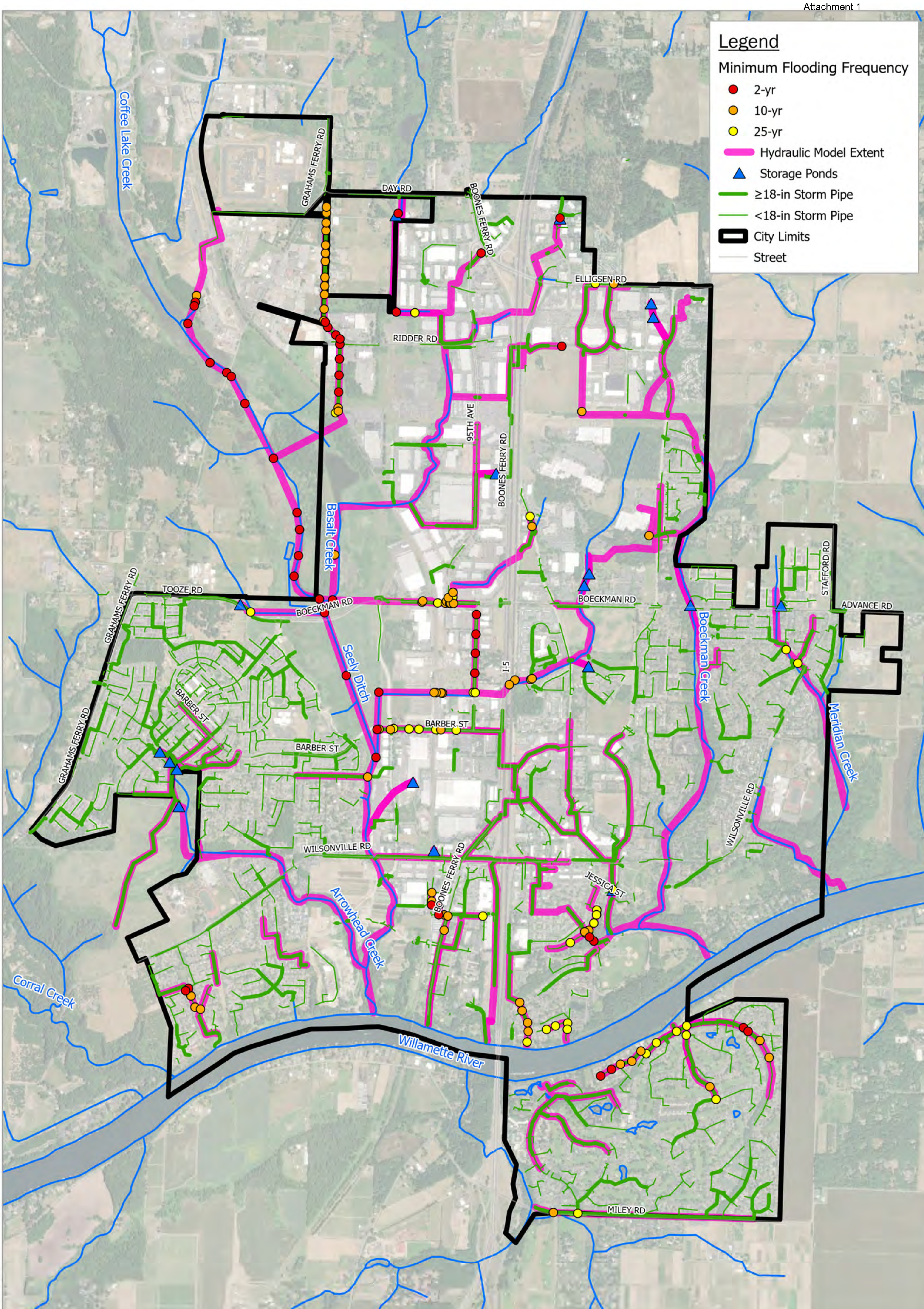
Drawn By: MRG
Checked By:

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

N

0 1,000 2,000 4,000
Feet

Figure A-8. Hydraulic Results: Existing Condition Flooding Locations



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Accessed By: SGILMARTIN at 03/07/2023

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Date: 3/7/2023

Notes:

Drawn By: MRG
Checked By:

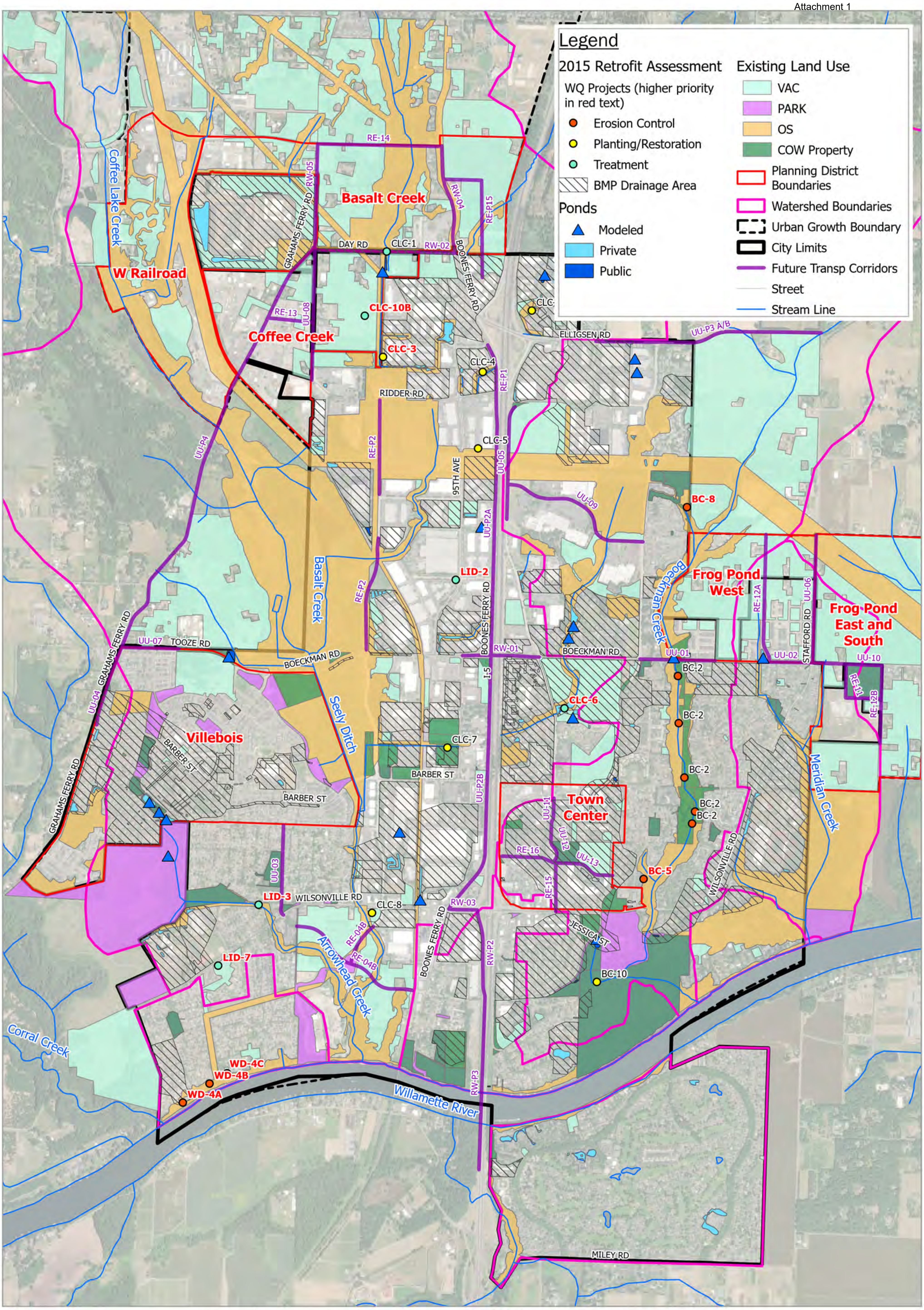
Spatial Reference:
Name: NAD 1983 HARN StatePlane Oregon North FIPS 3601 Feet Intl

N

0 1,000 2,000 4,000 Feet

Figure A-9. Hydraulic Results: Future Condition Flooding Locations

Attachment 1



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Stormwater Master Plan

Date: 3/7/2023

Notes:

Drawn By: SWG
Checked By:

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

N

0 1,000 2,000 4,000 Feet

Figure A-10. Retrofit Analysis

Attachment B: Tables

Table B-1. Modeled Capacity Deficiencies												
Flooding Location ID	Watershed	Location	Model Description/ Preliminary Flooding Results	Minimum Flooding Frequency (up to 25-yr design storm)	Modeling Notes	Model Adjustments per Validation	Associated Problem Area from TM#1 (2022)	Flooding predicted in 2012 SMP?	Associated CIP from 2012 SMP?	CIP from 2012 SMP Constructed? (Y/N)	Flooding Predicted following Model Validation?	Project Need per 2022 SMP	Notes
1	Charbonneau	Miley Rd.	Predicted flooding at 42" pipe segment upstream of Miley Rd. outfall.	10-yr	Rim elevations and inverts along pipe profile appears reasonable and match GIS data. No apparent issues.	None	10 (E&S)	Y	SD9000 to SD9069 (Charbonneau Pipe Replacement)	N	Y	Y	City confirmed project need at this location for inclusion in the SMP.
2	Charbonneau	French Prairie Rd. & Old Farm Rd.	Flooding indicated throughout these piped systems. Model contains some pipe replacement projects completed as CIPs from the Charbonneau Consolidated Improvement Plan (2014). Small portion of all improvements recommended per the plan.	2-yr	Issues previously identified/documented in 2012 SMP and Charbonneau Consolidated Improvement Plan. Capacity issue appears to be the outfall piping (30") acting as a constriction to the upstream piping that was upsized (36") as part of the CIP.	Model previously was updated to reflect the completed CIPs. Asbuilts of the emergency outfall repair were provided and reviewed by BC. Confirmed model assumption of 30" diameter of outfall. Updated model to include revised pipe slope and Manning's roughness for installation of CMP liner based on provided asbuilt information.	None	Y	SD9000 to SD9069 (Charbonneau Pipe Replacement)	Y (select phases completed)	Y	Y	Wallis Engineering is currently working on the design of pipe upsizing along SW French Prairie and SW Edgewater. City coordinated meeting between BC and Wallis with the goal to have the capacity deficiency identified by the SMP modeling effort (outfall pipe constriction) inform current design project. based on the capacity deficiency identified by the SMP modeling effort. This work is in progress and strategies are being discussed to provide flow detention to mitigate the model predicted flooding.
3	Willamette River	Parkway Ave./Metolius Ln.	Flooding at several nodes along N-S run of pipe. Constriction appears to be the small diameter pipe at the outfall and one conduit US.	10-yr	Invert elevations in MH prior to outfall are misaligned. Pipe sequence is 48">42">21">15" causing constriction. No GIS data available to verify the existing model data. Issue previously identified in previous MP.	None. Inverts and diameters appear odd but better information is not available in GIS to resolve. City would need to provide measurements or asbuilts to potentially update and fix model here.	None	Y	SD5707, SD5709, SD5714, and SD5719 (SW Parkway Pipes Replacement)	N	Y	?	
4	Willamette River	SW Miami	15" conveyance pipe with US node preliminary flooding results.	25-yr	Subbasin hydrology is inserted at most US node of each pipe segment to generate flow w/in all pipes. May not be fully representative of runoff received by US nodes in reality. There also is a pond that is not currently being modeled which may alleviate flooding to the system.	Original subbasin subdivided to try and address the suspected hydrology input issue. However flooding still predicted at this location.	None	N. However the drainage area to this location was revised from the original model.	None	N	Y	N	City does not recall issues at this location. Maintain this location as a flooding location however development of a project is not warranted.
5	Boeckman	Memorial Dr.	Piped system near Memorial Dr. swale predicts flooding.	2-yr	After convergence point at Memorial Dr. (ST5002) pipe sizes are 24">15">12">18">24" prior to outfall to Boeckman Creek causing the constriction and US flooding.	Asbuilts of the swale and piped system were provided and reviewed by BC. Asbuilts confirmed the model configuration, no adjustments required.	52 (swale issues)	Y	BC-9 (Memorial Drive Pathway and Storm Drain Repair)	Y	Y	Y	Based on confirmed pipe configuration and known issues at this location, project at this location is needed.
6	Boeckman	Library Pond	Preliminary Library Pond flooding, Depth >9' (pond max depth). and node DS of Library Pond outlet shows flooding	N/A	Unknown how previous model build accounted for amount of library pond storage or developed the outlet curve for flow leaving the pond. From site visit, outlet should just be a pipe w grate. Seems unlikely that pond would flood based on configuration.	Model updated per asbuilts to reflect pond outlet configuration	4 (CAP)	Y	None	N	N	Y	Project to be developed at this location to provide a flow control benefit for pond storage. Project need is primarily based on providing flow control for Town Center redevelopment and not for capacity (no issues observed by City).
7	Boeckman	Canyon Creek Rd (near Xerox)	Flooding at node that convey private SW (Xerox) to the S and then E across Canyon Creek Rd.	10-yr	Pipe sequence is 15">18">15">12">12" causing constriction at Canyon Creek Rd. Final 12" pipe is at 5%.	None. GIS information is the same as model. City would need to provide measurements or asbuilts to potentially update and fix model here.	None	Y	None		Y	N	City confirmed pipe configuration per as-built drawings. City does not recall this location as an issue and unlikely to be a project need.
8	Boeckman	Sysco Ditch	Flooding at US node of 30" culvert at end of N-S section of Sysco Ditch	10-yr	Issue (constriction) is at 30" culvert. Very steep slope @ 8.6%.	None. GIS information is the same as model. City would need to provide measurements or asbuilts to potentially update and fix model here.	30 (CAP and MAINT)	N	BC-1 (Wiedeman Road Regional SW Detention/Stream Enhancement)		Y	N	Very limited grade. Flooding shown at upstream end of culvert and impacts downstream Costco property. Sysco owns property to west of ditch. Ditch can be removed (manmade) and they are proposing. Does not warrant a City project need - up to Sysco to resolve.
9	Boeckman	Elligsen Rd	Flooding along US nodes of 18" SW piping	10-yr	Model set up seems reasonable. Large subbasins is inserted at US end which may be causing the flooding. Trailer Park pond on N side of Elligsen is not currently in the model	None. Flooding likely can be disregarded here, otherwise additional routing likely needed for model (pond and open channel for routing purposes)	20 (MAINT)	Y	None		Y	N	

Flooding Location ID	Watershed	Location	Model Description/ Preliminary Flooding Results	Minimum Flooding Frequency (up to 25-yr design storm)	Modeling Notes	Model Adjustments per Validation	Associated Problem Area from TM#1 (2022)	Flooding predicted in 2012 SMP?	Associated CIP from 2012 SMP?	CIP from 2012 SMP Constructed? (Y/N)	Flooding Predicted following Model Validation?	Project Need per 2022 SMP	Notes
10	Coffee Creek	Shrine Center Pond	Pond flooding (HGL>4.7' max pond depth) and DS node from pond outlet	2-yr	Unknown how previous model build accounted for amount of pond storage or developed the outlet curve for flow leaving the pond.	None. To fix, would need to throughly investigate asbuilts for this pond.	25 (MAINT Access)	Y	None		Y	Y (specfic to maintenance access only)	
11	Coffee Creek	NW of 95th Ave. and Ridder Rd. intersection	Preliminary flooding at US end of culvert that conveys flow E to W under a private parking lot (Penske Truck)	N/A	Rim elevation at US end of culvert appears low. GIS does not show culvert, so unable to verify inherited model data.	None. City would need to provide measurements or asbuilts to verify culvert data if desired.	None	N	CLC-4 (Ridder Rd Wetland Restoration). Proj is immediately US of culvert that floods		N	N	Culvert under parking lot - private (Penske property) and not in GIS. City not aware of issues at this location but provided as-built information. -BC incorporated revised culvert information into model from provided asbuilts. US end of culvert flooding resolved.
12	Coffee Creek	Commerce Circle Ditch	Flooding throughout N-S run of ditch and culverts to the W of Commerce Circle	2-yr	See old MP and AKS study for issues that have been well documented. Current model has updated culvert inverts from survey	None	14/15/26 (R/R, MAINT, CAP)	Y	CLC-1 (Detention/Wetland Facility near Tributary to Basalt Creek) and CLC-3 (Commerce Circle Channel Restoration)		Y	Y	Known important project area. Beaver dam, other unknowns may not be reflected in model and factor into current discrepancy in peak flow and WSE. Redevelopment application looking to build parking area west of channel and would have to span existing channel to other development area - no access from Day Road. -BC developed 4 representative cross-sections along the Commerce Circle Ditch based on AKS survey points. Model link geometry within this reach then revised accordingly. Note that survey data was unavailable for 1 model link and thus a revised cross-section was not developed for this section.
13	Coffee Creek	Garden Acres	N-S piped system along Garden Acres Rd. and Peters Rd. Outfalls to Coffee Creek wetlands.	2-yr	Prior to outfall there is several small diameter pipes (24") that cause constriction and elevated HGL that backs up system. Most other pipes in profile are large diameter (42"/36")	None. Model matches GIS info. City (Sean S.) provided as-builts of this outfall (1994) which showed this small diameter pipe near the outlet of piping run.	None	Not modeled	None		Y	Y	City not surprised by flooding here. This is a priority need in conjunction with build out of Coffee Creek area. Private development is currently having to overdetain. Higher priority need. Railroad and METRO coordination needed (outfalls to METRO property).
14	Coffee Creek	Coffee Creek Wetlands	Flooding throughout wetlands predicted	2-yr	Main issue is the generalization of cross-sections in the model(under represents the actual amount of storage in locations)	None	None	Y	None		Y	N	
15	Coffee Creek	Boeckman Corp. Center Pond	Flooding DS of flow control structure in model and at node near the US end. Flow control structure configuration rationale is unknown but appears to be the restriction	N/A	At very US end of this pipe segment there is a 30">12">24" which seems incorrect. GIS has same info	None. Would need to thouroughly look through asbuilts to modify how this flow control structure is modeled from scratch	None	Y	None		Y	N	US portion - on Parkway. No known issue DS portion - Car dealership - existing pond is mitigation for wetland. Flooding reported downstream of pond. City not aware of any flooding in area (may be an after effect of how pond was integrated into the model. - Based on asbuilt review, control structure configuration adjusted. Pond no longer floods during 25-yr storm event.
16	Coffee Creek	Boberg Rd. and RR crossing	Flooding along N-S pipe prior to discharging into ope channel. This was an area identified in original MP. Flooding also at two large diameter culverts (59" and 51"?!) flowing E-W underneath RR tracks	10-yr	Pipe profile looks reasonable. Previous CIP location. Culverts in model (in series) do not match configuration in GIS (parallel). GIS does not have diameters or inverts	None. Need more info about culverts to make updates	None	Y	SD4025-SD4029 (Boberg Rd Pipe Replacement)		Y	?	
17	Coffee Creek	I-5 Culverts	Flooding at culverts crossing I-5 from E to W	25-yr	Profile looks reasonable. Culvert size (36") can not be verified as that info is not in the GIS data.	None. City would need to provide measurements or asbuilts to verify culvert data if desired.	35 (R&R)	N	None		Y	N	City thinks that flooding at this location is accurate. Maintain as a flooding location, however a project that upsizes ODOT culverts is unlikely.
18	Coffee Creek	Barber St	Flooding indicated at several DS nodes prior to outfall and at node near RR tracks	25-yr	DS flooding along this segment appears to be from backwatering of Coffee Creek (see location #14). Profile appears reasonable and matches the GIS data.	None	None	Y	SD4208 and SD4209 (Barber Street Pipe Replacement). -	N	Y	Unlikely	
19	Willamette River	River Fox Park (site visit	Flooding predicted within 12" pipes	2-yr	Profile looks reasonable and matches the GIS data.	None	22 (MAINT and CAP)	N	None	N/A	Y	Y	

Flooding Location ID	Watershed	Location	Model Description/ Preliminary Flooding Results	Minimum Flooding Frequency (up to 25-yr design storm)	Modeling Notes	Model Adjustments per Validation	Associated Problem Area from TM#1 (2022)	Flooding predicted in 2012 SMP?	Associated CIP from 2012 SMP?	CIP from 2012 SMP Constructed? (Y/N)	Flooding Predicted following Model Validation?	Project Need per 2022 SMP	Notes
20	Willamette River	Lower Boones Ferry	Flooding along 18" Piped segment on private property.	2-yr	Hydrology is input at most US node to generate flow through all pipes, not reflective of reality for US node flooding.	Split subbasin at this location with assumption that they have the same hydrology characteristics. Model still indicates flooding during the 25-yr event.	None	Y	None	N/A	Y	?	
21	Coffee Creek	Wilsonville Distr Center Pond	Model predicts pond flooding	N/A	Unknown how previous model build accounted for amount of pond storage or developed the outlet curve for flow leaving the pond.	None. To fix, would need to throughly investigate asbuilts for this pond.	None	N. However the original model is configured incorrectly such that flow is not actually routed through the pond.	None	N/A	N	?	

Table B-2. Hydrologic Model Inputs and Results																	
Subbasin Name	Inlet Node	Area (Ac)	Impervious Area (%)		Average Subbasin Slope (ft/ft)	Subbasin Width (ft)	Green-Ampt Infiltration Parameters			Maximum Flow (cfs) for Design Storm							
			Existing Land Use	Future Land Use			Average Capillary Suction (in)	Initial Moisture Deficit (frac.)	Saturated Hydraulic Conductivity (in/hr)	2-yr storm event		10-yr storm event		25-yr storm event		100yr storm event	
										Existing Land Use	Future Land Use	Existing Land Use	Future Land Use	Existing Land Use	Future Land Use	Existing Land Use	Future Land Use
1000	STAFFORD_POND	69.13	33.7	33.7	11.2	1616	6.85	0.36	0.25	14.3	14.3	23.9	23.9	29.8	29.8	38.7	38.7
1000B	ST1000	28.49	59.7	62.4	3.8	673	7.26	0.35	0.23	9.9	10.3	15.0	15.6	17.8	18.4	21.7	22.3
1100	ST1100	55.81	29.9	52.1	1.5	1516	6.69	0.37	0.26	9.8	16.6	15.2	24.7	18.2	29.1	22.8	35.2
1104	ST1104	21.55	82.2	82.2	1.7	625	6.69	0.37	0.26	9.8	9.8	14.3	14.3	16.6	16.6	19.6	19.6
1114	ST1114	74.81	15.3	15.3	7.8	1303	6.69	0.37	0.26	7.1	7.1	12.8	12.8	16.5	16.5	22.5	22.5
1116	ST1116	3.25	82.2	82.2	4.6	209	6.69	0.37	0.26	1.6	1.6	2.4	2.4	2.8	2.8	3.3	3.3
1124	ST1124	14.02	70.8	70.8	4.9	601	6.69	0.37	0.26	5.9	5.9	8.9	8.9	10.5	10.5	12.6	12.6
1125	ST1125	10.91	71.6	71.6	4.5	649	6.69	0.37	0.26	4.7	4.7	7.1	7.1	8.4	8.4	10.1	10.1
1133A	ST1002	14.12	10.0	10.0	11.9	412	6.69	0.37	0.26	1.0	1.0	2.5	2.5	3.5	3.5	5.1	5.1
1133B	ST1000	4.26	74.4	79.8	3.6	370	6.69	0.37	0.26	1.9	2.1	2.9	3.1	3.4	3.6	4.1	4.3
1133C	ST1132	25.05	74.2	80.6	2.1	766	6.69	0.37	0.26	10.5	11.3	15.5	16.7	18.1	19.4	21.6	22.9
1201	ST1201	2.75	66.1	66.1	5.6	151	6.69	0.37	0.26	1.1	1.1	1.7	1.7	2.0	2.0	2.4	2.4
1202	PST1202	4.78	64.1	64.1	11.9	588	6.69	0.37	0.26	2.0	2.0	3.2	3.2	3.8	3.8	4.6	4.6
1207	PST1207	4.10	64.1	64.1	14.5	392	6.69	0.37	0.26	1.7	1.7	2.7	2.7	3.2	3.2	3.9	3.9
1302	ST1302	0.70	39.5	39.5	1.8	68	6.69	0.37	0.26	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.5
1303	ST1303	35.38	19.2	51.4	5.6	841	6.69	0.37	0.26	4.2	10.7	7.4	16.3	9.4	19.5	12.6	23.9
1307A	ST1307	2.27	36.0	47.3	5.4	733	6.69	0.37	0.26	0.7	0.8	1.3	1.4	1.6	1.7	2.0	2.1
1307B	ST1402	20.17	36.0	47.3	5.4	733	6.69	0.37	0.26	4.4	5.8	7.3	9.1	9.1	11.0	11.7	13.8
1504	ST1504	1.09	37.0	43.6	2.8	82	6.69	0.37	0.26	0.3	0.3	0.4	0.5	0.6	0.6	0.7	0.8
1603A	ST1404A	63.03	30.0	37.1	3.8	1121	6.69	0.37	0.26	11.2	13.7	17.2	20.8	20.8	24.8	26.0	30.6
1603B	ST1603	809.84	12.6	26.7	3.5	3376	7.01	0.36	0.24	58.3	112.1	87.9	166.3	104.4	194.8	129.7	235.6
1604	POND_BOECKMAN	69.37	19.4	40.0	5.6	1559	6.69	0.37	0.26	8.3	16.5	14.3	25.7	18.2	31.0	24.4	38.7
1608	ST1608	3.82	49.3	62.5	4.1	209	6.69	0.37	0.26	1.1	1.4	1.9	2.2	2.3	2.7	2.8	3.2
1701	ST1701	25.65	40.7	40.7	2.2	907	6.69	0.37	0.26	6.2	6.2	9.6	9.6	11.6	11.6	14.4	14.4
1703	ST1703	171.87	41.3	46.8	1.5	2258	6.69	0.37	0.26	38.3	42.6	56.6	62.9	66.3	73.5	79.7	88.2
1711	ST1711	9.40	69.5	69.5	3.6	531	6.69	0.37	0.26	3.9	3.9	5.9	5.9	7.0	7.0	8.4	8.4
1726	ST1726	29.64	54.6	60.0	1.1	721	6.69	0.37	0.26	8.9	9.7	13.2	14.4	15.5	16.8	18.6	20.1
2000	ST2000	250.97	9.7	21.1	1.3	2548	8.82	0.30	0.14	16.6	32.0	30.9	52.7	30.4	55.3	30.9	59.8
2008	ST2008	1550.87	31.4	42.1	0.9	4917	6.57	0.34	0.19	194.4	238.8	292.4	358.6	343.9	421.2	415.2	507.8
2019	ST2019	102.09	48.4	76.9	3.6	2343	6.75	0.36	0.26	28.8	44.3	43.6	65.1	51.8	75.9	63.4	90.1
2101A	ST2120	69.86	43.0	62.5	2.9	1499	7.45	0.35	0.22	17.8	25.0	27.4	37.5	33.2	44.5	41.3	54.0
2101B	ST2101	44.71	50.7	50.7	1.4	1656	6.74	0.36	0.26	13.2	13.2	19.9	19.9	23.6	23.6	28.8	28.8
2107A	ST2123	359.21	24.0	41.2	1.2	2353	7.15	0.35	0.23	44.8	68.9	66.6	102.5	78.3	120.0	95.0	144.3
2107B	ST2123	178.65	22.1	55.4	1.9	1285	6.69	0.37	0.26	21.8	46.4	32.3	68.6	37.9	80.0	45.9	95.5
2112A	ST2112	88.70	15.9	56.5	2.9	1214	6.69	0.37	0.26	8.4	27.3	13.4	40.3	16.4	47.1	21.1	56.5
2112B	ST2112	43.89	62.6	71.3	2.9	854	6.69	0.37	0.26	15.4	17.3	22.7	25.4	26.6	29.7	31.9	35.4
2118	ST2118	42.69	52.3	52.3	2.0	571	7.85	0.34	0.19	12.1	12.1	18.4	18.4	21.8	21.8	26.6	26.6
2402	ST2402	112.36	39.2	41.2	1.6	1188	6.69	0.37	0.26	23.3	24.3	34.4	35.9	40.3	42.0	48.4	50.4

Table B-2. Hydrologic Model Inputs and Results																		
Subbasin Name	Inlet Node	Area (Ac)	Impervious Area (%)		Average Subbasin Slope (ft/ft)	Subbasin Width (ft)	Green-Ampt Infiltration Parameters			Maximum Flow (cfs) for Design Storm								
			Existing Land Use	Future Land Use			Average Capillary Suction (in)	Initial Moisture Deficit (frac.)	Saturated Hydraulic Conductivity (in/hr)	2-yr storm event		10-yr storm event		25-yr storm event		100yr storm event		
										Existing Land Use	Future Land Use	Existing Land Use	Future Land Use	Existing Land Use	Future Land Use	Existing Land Use	Future Land Use
2405	ST2405	13.00	63.9	63.9	1.4	785	6.69	0.37	0.26	4.9	4.9	7.4	7.4	8.8	8.8	10.6	10.6
2406	ST2406	15.27	22.0	56.6	2.0	463	6.69	0.37	0.26	2.0	5.0	3.3	7.5	4.2	8.8	5.4	10.7
2409	ST2409	11.04	57.3	57.4	1.2	422	7.23	0.35	0.23	3.7	3.7	5.6	5.6	6.6	6.6	8.1	8.1
2413A	ST2413	2.04	46.8	50.2	1.1	73	6.69	0.37	0.26	0.6	0.6	0.8	0.9	1.0	1.0	1.2	1.3
2413B	ST2410	10.32	66.1	66.4	1.6	444	6.69	0.37	0.26	4.0	4.0	5.9	5.9	6.9	7.0	8.3	8.4
2701A	ST2119A	102.46	28.7	67.3	1.6	2586	6.69	0.37	0.26	17.4	38.2	26.8	56.4	32.3	65.9	40.4	78.7
2701B	ST2105A	128.40	39.2	41.1	1.8	2063	6.69	0.37	0.26	28.3	29.6	42.1	43.9	49.5	51.6	60.1	62.5
2707	ST2707	23.67	64.1	64.1	2.3	650	6.69	0.37	0.26	8.7	8.7	12.9	12.9	15.1	15.1	18.1	18.1
2711	ST2711	26.66	70.9	70.9	2.2	755	6.69	0.37	0.26	10.7	10.7	15.8	15.8	18.5	18.5	22.1	22.1
2720	ST2720	24.22	57.1	57.1	2.2	484	6.69	0.37	0.26	7.7	7.7	11.4	11.4	13.4	13.4	16.1	16.1
3005	ST3005	14.54	50.8	51.3	2.8	598	6.69	0.37	0.26	4.4	4.4	6.8	6.9	8.2	8.2	10.1	10.1
3008	ST3008	213.73	16.8	38.0	2.4	1453	6.69	0.37	0.26	20.4	41.6	30.5	61.4	36.1	71.7	44.2	85.9
3011	ST3011	51.74	45.7	46.3	2.8	2046	6.69	0.37	0.26	14.1	14.3	22.0	22.3	26.6	26.8	33.0	33.3
3017A	9067	36.66	10.9	46.6	1.5	600	6.69	0.37	0.26	2.4	9.3	4.0	13.8	4.9	16.2	6.5	19.4
3017B	STAFFORD_MEADOWS_1_BASIN	38.68	27.2	51.3	1.4	774	6.69	0.37	0.26	6.1	10.9	9.3	16.2	11.1	19.0	13.7	22.8
3025	ST3024	5.99	31.7	51.0	2.5	378	6.69	0.37	0.26	1.2	1.9	2.0	2.9	2.6	3.6	3.4	4.4
3201	ST3201	51.42	29.7	30.3	4.5	918	6.69	0.37	0.26	9.1	9.2	14.1	14.4	17.1	17.4	21.5	21.8
3204	ST3204	64.53	46.3	46.3	2.0	1078	6.69	0.37	0.26	16.7	16.7	24.7	24.7	29.1	29.1	35.1	35.1
3207	ST3207	78.25	17.7	56.7	2.1	1728	6.69	0.37	0.26	8.4	25.0	13.6	37.1	16.9	43.6	22.0	52.5
3208	RENAISSANCE_POND	25.07	41.1	41.2	0.9	587	6.69	0.37	0.26	5.8	5.8	8.6	8.6	10.1	10.1	12.2	12.2
3212	ST3212	7.21	62.2	66.8	2.1	366	6.69	0.37	0.26	2.7	2.8	4.0	4.3	4.8	5.0	5.8	6.1
3216	ST3208	30.40	62.0	62.0	2.0	881	6.69	0.37	0.26	10.8	10.8	16.0	16.0	18.8	18.8	22.6	22.6
3218	ST3218	14.44	19.6	51.8	1.8	415	6.69	0.37	0.26	1.7	4.3	2.8	6.5	3.5	7.6	4.6	9.3
3402	ST3402	34.92	41.4	52.6	1.4	1087	6.69	0.37	0.26	8.4	10.5	12.8	15.7	15.2	18.6	18.7	22.5
3414	ST3414	25.72	43.5	46.7	1.6	652	6.69	0.37	0.26	6.4	6.9	9.7	10.3	11.4	12.1	13.9	14.8
3417	ST3417	3.75	52.0	52.2	2.4	230	6.69	0.37	0.26	1.2	1.2	1.9	1.9	2.2	2.3	2.8	2.8
3418A	ST3421	14.99	51.6	52.0	0.6	631	6.69	0.37	0.26	5.6	5.7	8.9	8.9	10.4	10.4	12.2	12.3
3418B	ST3418	8.22	52.2	52.2	0.5	456	6.69	0.37	0.26	2.5	2.5	3.7	3.7	4.4	4.4	5.3	5.3
3420	ST3420	20.12	51.0	52.2	3.2	1215	6.69	0.37	0.26	6.2	6.4	10.0	10.2	12.1	12.3	15.0	15.2
3425	ST3425	15.60	51.2	51.3	1.2	378	6.69	0.37	0.26	4.5	4.5	6.6	6.6	7.8	7.8	9.4	9.4
3436	ST3436	22.08	48.4	52.2	1.8	734	6.69	0.37	0.26	6.2	6.7	9.4	10.1	11.2	11.9	13.7	14.5
3443	ST3443	4.70	49.2	51.3	2.3	314	6.69	0.37	0.26	1.4	1.5	2.2	2.3	2.7	2.8	3.4	3.5
3445	ST3445	23.46	63.5	63.5	2.6	930	6.69	0.37	0.26	8.7	8.7	13.2	13.2	15.5	15.5	18.8	18.8
3451	ST3451	3.55	56.1	56.1	0.9	289	6.69	0.37	0.26	1.2	1.2	1.8	1.8	2.2	2.2	2.7	2.7
3600	ST3600	91.20	41.5	43.1	3.7	1193	6.69	0.37	0.26	21.5	22.2	32.0	33.1	37.7	38.9	45.8	47.2
3602	ST3602	90.57	39.7	39.9	5.8	1918	6.69	0.37	0.26	21.4	21.5	33.1	33.3	40.0	40.1	49.9	50.0
3607	ST3606	82.77	36.5	36.5	2.9	916	6.70	0.37	0.26	16.9	16.9	25.0	25.1	29.4	29.5	35.6	35.7
4003	ST4003	95.74	18.9	22.1	1.7	1565	8.66	0.31	0.17	11.5	13.2	19.6	21.9	24.8	27.5	32.5	35.6

Table B-2. Hydrologic Model Inputs and Results																	
Subbasin Name	Inlet Node	Area (Ac)	Impervious Area (%)		Average Subbasin Slope (ft/ft)	Subbasin Width (ft)	Green-Ampt Infiltration Parameters			Maximum Flow (cfs) for Design Storm							
			Existing Land Use	Future Land Use			Average Capillary Suction (in)	Initial Moisture Deficit (frac.)	Saturated Hydraulic Conductivity (in/hr)	2-yr storm event		10-yr storm event		25-yr storm event		100yr storm event	
										Existing Land Use	Future Land Use	Existing Land Use	Future Land Use	Existing Land Use	Future Land Use	Existing Land Use	Future Land Use
4008	ST4008	12.06	67.5	70.9	3.3	714	6.69	0.37	0.26	4.9	5.1	7.4	7.7	8.8	9.1	10.6	10.9
4012	ST4012	22.39	59.4	66.3	2.0	626	6.69	0.37	0.26	7.6	8.4	11.3	12.4	13.3	14.6	16.0	17.5
4014	ST4014	41.33	66.2	66.2	2.7	710	6.69	0.37	0.26	14.9	14.9	22.0	22.0	25.7	25.7	30.8	30.8
4029	ST4029	59.74	51.7	64.5	2.7	1218	6.69	0.37	0.26	17.6	21.5	26.2	31.8	30.9	37.2	37.4	44.6
4202	ST4202	34.53	63.0	64.3	1.0	936	6.59	0.33	0.16	12.3	12.5	19.0	19.3	22.6	22.9	25.2	25.6
4203	ST4203	13.49	31.3	48.5	1.5	630	7.57	0.34	0.22	2.6	4.0	4.4	6.2	5.5	7.5	7.2	9.4
4204	COCA-COLA_POND	32.66	68.5	68.5	0.5	726	5.91	0.36	0.23	11.1	11.1	16.5	16.5	19.3	19.3	23.1	23.1
4205A	ST4205	89.30	40.5	40.5	3.2	1666	7.97	0.33	0.20	21.6	21.6	33.6	33.6	40.9	40.9	51.3	51.3
4205B	ST4205	113.36	28.3	34.3	1.3	2147	9.25	0.30	0.14	20.3	23.9	34.4	39.4	35.4	41.2	37.5	44.3
4205C	ST4000	79.50	29.0	29.0	3.2	1548	9.46	0.28	0.11	17.5	17.5	20.2	20.2	24.4	24.4	30.6	30.6
4214	ST4214	13.80	61.0	68.2	1.9	778	6.69	0.37	0.26	5.0	5.6	7.6	8.4	9.1	9.9	11.0	11.8
4216	ST4216	13.42	61.5	66.8	2.5	563	6.69	0.37	0.26	4.9	5.3	7.4	7.9	8.7	9.3	10.6	11.2
4225	ST4225	11.73	54.8	66.6	0.8	449	6.69	0.37	0.26	3.7	4.4	5.4	6.4	6.4	7.5	7.7	9.0
4226	WILSONVILLE_DIST_CTR_POND	65.84	68.0	68.0	1.0	1069	6.69	0.37	0.26	22.3	22.3	32.9	32.9	38.3	38.3	45.7	45.7
4228A	ST4228	28.98	72.6	74.3	1.4	623	6.69	0.37	0.26	11.2	11.4	16.4	16.8	19.2	19.5	22.8	23.2
4228B	ST6007	14.64	82.2	82.2	1.1	522	6.27	0.36	0.24	6.6	6.6	9.8	9.8	11.3	11.3	13.4	13.4
4231	ST4231	6.30	56.3	57.4	3.9	511	6.69	0.37	0.26	2.2	2.2	3.5	3.6	4.3	4.3	5.2	5.3
4400	ST4400	84.63	33.9	37.5	2.9	1896	6.69	0.37	0.26	16.9	18.6	26.1	28.5	31.4	34.1	39.2	42.2
4403A	ST4403	93.84	23.5	23.5	2.0	1987	6.88	0.36	0.25	13.2	13.2	20.7	20.7	25.2	25.2	32.1	32.1
4403B	ST4402	34.38	31.5	31.5	0.7	841	6.69	0.37	0.26	6.2	6.2	9.3	9.3	11.0	11.0	13.4	13.4
4404A	ST4639	19.90	32.9	32.9	2.6	672	6.69	0.37	0.26	3.9	3.9	6.3	6.3	7.7	7.7	9.8	9.8
4404B	ST4404	8.40	32.9	32.9	2.6	672	6.69	0.37	0.26	1.7	1.7	3.1	3.1	4.0	4.0	5.2	5.2
4501	ST4501	18.45	34.0	52.1	1.8	420	6.78	0.36	0.26	3.7	5.4	5.6	8.1	6.6	9.5	8.2	11.5
4502	ST4502	22.56	31.8	32.3	4.2	1035	6.69	0.37	0.26	4.4	4.5	7.6	7.7	9.6	9.7	12.5	12.6
4503A	ST4503	58.83	46.4	49.1	2.6	745	5.59	0.36	0.21	15.2	15.9	22.8	23.9	27.1	28.4	33.1	34.6
4503B	ST4503	81.06	6.2	64.1	3.9	1499	5.80	0.36	0.22	3.7	29.6	8.2	44.3	11.7	52.4	17.7	63.4
4503C	ST4503	30.20	13.8	39.1	5.7	899	5.86	0.33	0.14	4.2	8.5	9.9	15.3	8.3	15.0	8.8	16.5
4503D	TOOZE_POND	12.16	49.2	51.8	3.2	450	4.99	0.36	0.19	3.7	3.9	6.1	6.3	7.5	7.7	9.3	9.5
4608	ST4608	10.25	51.9	51.9	1.6	280	6.69	0.37	0.26	3.0	3.0	4.5	4.5	5.3	5.3	6.5	6.5
4611	POND_E2	7.97	47.5	47.5	2.7	475	6.69	0.37	0.26	2.3	2.3	3.7	3.7	4.5	4.5	5.6	5.6
4614A	POND_E1	53.36	42.8	42.9	1.6	1058	6.69	0.37	0.26	12.9	12.9	19.2	19.2	22.6	22.6	27.4	27.4
4614B	ST4829	11.09	45.2	52.2	2.2	662	6.69	0.37	0.26	3.0	3.5	4.9	5.5	5.9	6.6	7.4	8.1
4617A	ST4610	6.68	52.1	52.1	1.6	378	6.69	0.37	0.26	2.1	2.1	3.2	3.2	3.8	3.8	4.7	4.7
4617B	ST4803	5.35	52.2	52.2	2.1	268	6.69	0.37	0.26	1.7	1.7	2.6	2.6	3.1	3.1	3.8	3.8
4617C	ST4617	4.89	52.2	52.2	2.2	310	6.69	0.37	0.26	1.5	1.5	2.4	2.4	2.9	2.9	3.6	3.6
4623	ST4623	4.26	52.2	52.2	1.2	453	6.69	0.37	0.26	1.4	1.4	2.2	2.2	2.6	2.6	3.3	3.3
4631A	ST4631	9.68	52.2	52.2	0.8	535	6.66	0.37	0.26	3.0	3.0	4.5	4.5	5.3	5.3	6.5	6.5
4631B	ST4806	10.14	52.2	52.2	2.4	615	6.66	0.37	0.26	3.2	3.2	5.0	5.0	6.1	6.1	7.5	7.5

Table B-2. Hydrologic Model Inputs and Results																	
Subbasin Name	Inlet Node	Area (Ac)	Impervious Area (%)		Average Subbasin Slope (ft/ft)	Subbasin Width (ft)	Green-Ampt Infiltration Parameters			Maximum Flow (cfs) for Design Storm							
			Existing Land Use	Future Land Use			Average Capillary Suction (in)	Initial Moisture Deficit (frac.)	Saturated Hydraulic Conductivity (in/hr)	2-yr storm event		10-yr storm event		25-yr storm event		100yr storm event	
										Existing Land Use	Future Land Use	Existing Land Use	Future Land Use	Existing Land Use	Future Land Use	Existing Land Use	Future Land Use
4632A	O4632A	49.06	31.8	31.8	1.7	814	6.69	0.37	0.26	8.9	8.9	13.4	13.4	15.8	15.8	19.4	19.4
4632B	O4632B	41.58	43.7	43.7	1.2	674	6.69	0.37	0.26	9.9	9.9	14.6	14.6	17.1	17.1	20.5	20.5
5004A	ST5004	5.30	59.7	59.7	3.1	360	5.50	0.36	0.21	2.0	2.0	3.2	3.2	3.9	3.9	4.7	4.7
5004B	ST5028	6.65	54.3	54.3	4.2	380	6.69	0.37	0.26	2.2	2.2	3.5	3.5	4.2	4.2	5.2	5.2
5006	ST5006	9.00	64.1	64.1	1.1	589	6.69	0.37	0.26	3.4	3.4	5.1	5.1	6.0	6.0	7.3	7.3
5022	ST5022	4.80	70.7	70.7	0.9	304	6.69	0.37	0.26	2.0	2.0	2.9	2.9	3.4	3.4	4.1	4.1
5024	ST5024	7.31	78.8	78.8	1.2	645	6.69	0.37	0.26	3.4	3.4	5.1	5.1	5.9	5.9	7.0	7.0
5033	ST5033	4.32	71.8	71.8	3.3	476	6.69	0.37	0.26	1.9	1.9	2.9	2.9	3.4	3.4	4.2	4.2
5037	ST5037	2.66	49.2	50.3	3.5	135	4.36	0.35	0.16	0.9	0.9	1.5	1.5	1.8	1.9	2.0	2.0
5038	ST5038	15.24	43.6	43.6	7.1	553	6.69	0.37	0.26	4.0	4.0	6.6	6.6	8.1	8.1	10.2	10.2
5200	ST5200	64.84	21.6	23.9	4.8	1222	6.75	0.36	0.26	8.5	9.3	13.9	15.1	17.2	18.6	22.4	23.9
5207	ST5207	26.98	23.7	23.7	2.5	1176	6.91	0.36	0.24	4.0	4.0	7.2	7.2	9.1	9.1	12.4	12.4
5210	O5210	37.10	23.5	23.5	10.3	3038	6.21	0.37	0.29	5.3	5.3	12.9	12.9	17.2	17.2	23.0	23.0
5501	ST5501	40.80	14.3	14.3	8.6	1077	7.94	0.33	0.19	4.6	4.6	10.2	10.2	14.2	14.2	19.9	19.9
5502	O5502	75.65	12.7	13.9	7.8	1936	7.24	0.34	0.24	6.5	7.0	13.7	14.4	18.5	19.3	27.1	27.9
5706A	ST5703	8.78	43.6	47.1	3.6	607	5.51	0.36	0.24	2.4	2.6	4.1	4.3	5.1	5.3	6.5	6.7
5706B	ST5706	11.41	43.6	47.1	3.6	607	5.51	0.36	0.24	3.1	3.3	5.1	5.4	6.3	6.6	8.0	8.3
5709	ST5709	29.34	43.9	53.0	6.1	642	5.20	0.36	0.22	7.8	9.3	12.3	14.4	15.1	17.3	18.9	21.4
5713	ST5713	25.39	71.0	71.0	2.9	985	6.30	0.36	0.24	10.6	10.6	15.9	15.9	18.7	18.7	22.4	22.4
5718	ST5718	34.38	39.0	46.2	7.6	1251	6.12	0.34	0.16	9.6	11.0	17.7	19.3	21.9	23.6	23.1	25.2
6001	ST6001	24.29	39.6	39.6	10.7	1121	5.08	0.36	0.19	6.8	6.8	12.5	12.5	15.8	15.8	19.6	19.6
6004	ST6003	13.42	53.7	53.7	1.6	528	5.03	0.36	0.19	4.4	4.4	6.9	6.9	8.3	8.3	10.2	10.2
6013A	ST6013	6.55	73.9	73.9	1.3	1183	4.91	0.36	0.19	3.1	3.1	4.9	4.9	5.7	5.7	6.7	6.7
6013B	ST6007	9.69	73.9	73.9	1.3	1183	4.91	0.36	0.19	4.5	4.5	7.0	7.0	8.2	8.2	9.7	9.7
6021	ST6021	12.43	68.8	68.8	1.0	513	3.99	0.35	0.15	4.9	4.9	7.8	7.8	8.9	8.9	10.4	10.4
6022	ST6022	27.99	51.1	51.1	6.8	687	5.56	0.37	0.30	8.4	8.4	12.6	12.6	15.1	15.1	18.3	18.3
6031	ST6031	14.40	65.2	65.2	1.9	429	6.61	0.37	0.26	5.3	5.3	7.9	7.9	9.3	9.3	11.1	11.1
6201A	ST6412	56.66	34.1	42.4	1.9	885	5.81	0.36	0.22	11.1	13.5	16.9	20.3	20.2	24.2	25.1	29.6
6201B	ST6201	97.87	25.0	49.0	3.0	1101	4.90	0.36	0.19	14.6	26.4	23.2	40.1	28.4	47.8	36.2	58.4
6205	ST6205	25.21	37.1	49.6	2.3	757	6.71	0.36	0.25	5.6	7.3	8.7	11.1	10.5	13.3	13.2	16.3
6210	O6210	26.56	23.8	51.5	4.4	551	4.29	0.35	0.17	4.2	8.4	7.8	13.4	10.1	16.2	12.0	19.0
6211	O6211	16.53	37.7	37.7	10.1	587	4.46	0.35	0.17	4.5	4.5	8.3	8.3	10.4	10.4	12.2	12.2
6411A	ST6411	10.69	40.1	40.1	2.4	565	6.37	0.36	0.25	2.6	2.6	4.3	4.3	5.3	5.3	6.7	6.7
6411B	ST6405	7.47	40.1	40.1	2.4	565	6.37	0.36	0.25	1.9	1.9	3.2	3.2	4.0	4.0	5.1	5.1
6416A	ST6653	11.82	48.7	49.7	1.7	435	6.68	0.37	0.26	3.4	3.4	5.1	5.2	6.1	6.2	7.5	7.6
6416B	O6416	59.26	34.8	36.5	5.6	1204	6.68	0.37	0.26	12.3	12.9	19.3	20.0	23.3	24.2	29.4	30.4
6610A	ST6610	15.48	44.9	46.9	2.6	789	6.69	0.37	0.26	4.2	4.4	6.7	6.9	8.1	8.4	10.2	10.5
6610B	ST6605	18.06	43.6	43.6	7.3	525	6.69	0.37	0.26	4.8	4.8	7.6	7.6	9.2	9.2	11.6	11.6

Table B-2. Hydrologic Model Inputs and Results																			
Subbasin Name	Inlet Node	Area (Ac)	Impervious Area (%)		Average Subbasin Slope (ft/ft)	Subbasin Width (ft)	Green-Ampt Infiltration Parameters			Maximum Flow (cfs) for Design Storm							
			Existing Land Use	Future Land Use			Average Capillary Suction (in)	Initial Moisture Deficit (frac.)	Saturated Hydraulic Conductivity (in/hr)	2-yr storm event		10-yr storm event		25-yr storm event		100yr storm event	
										Existing Land Use	Future Land Use	Existing Land Use	Future Land Use	Existing Land Use	Future Land Use	Existing Land Use	Future Land Use
6611	O6611	20.49	44.0	44.1	6.3	530	6.69	0.37	0.26	5.4	5.4	8.4	8.5	10.2	10.2	12.7	12.7
9003	ST9003	52.84	50.4	50.4	1.6	900	6.35	0.36	0.25	14.6	14.6	21.6	21.6	25.3	25.3	30.5	30.5
9006	ST9006	26.30	43.4	43.4	1.8	752	4.66	0.35	0.18	7.0	7.0	11.2	11.2	13.7	13.7	17.0	17.0
9013	ST9013	58.92	43.4	43.4	0.7	1462	4.40	0.35	0.17	14.7	14.7	22.9	22.9	27.6	27.6	32.4	32.4
9019	ST9019	46.34	43.4	43.4	2.0	995	3.51	0.35	0.13	12.2	12.2	18.9	18.9	20.6	20.6	25.2	25.2
9023	ST9023	11.00	42.7	43.4	1.5	481	4.61	0.35	0.18	3.0	3.0	4.9	5.0	6.1	6.1	7.6	7.7
9024	ST9024	30.75	41.9	41.9	4.5	727	3.57	0.35	0.16	8.3	8.3	13.8	13.8	17.3	17.3	19.0	19.0
9027	ST9027	14.17	43.4	43.4	3.2	799	3.50	0.35	0.13	4.3	4.3	7.3	7.3	7.7	7.7	9.7	9.7
9031	ST9031	56.63	43.4	43.4	1.3	1438	3.51	0.35	0.13	14.8	14.8	22.9	22.9	25.0	25.0	30.5	30.5
9032	ST9032	29.13	42.7	42.7	3.9	608	3.72	0.35	0.16	7.8	7.8	12.7	12.7	15.9	15.9	17.4	17.4
9039	ST9039	24.37	51.0	51.0	5.4	777	3.58	0.35	0.16	8.1	8.1	13.4	13.4	16.6	16.6	18.3	18.3
9041	ST9066	19.00	64.7	64.7	1.2	395	4.18	0.35	0.16	6.7	6.7	10.2	10.2	12.2	12.2	13.8	13.8
9048A	ST9044	11.52	53.9	53.9	2.6	1140	6.62	0.37	0.26	3.8	3.8	6.3	6.3	7.6	7.6	9.4	9.4
9048B	ST9048	8.86	53.9	53.9	2.6	1140	6.62	0.37	0.26	3.0	3.0	5.0	5.0	6.1	6.1	7.4	7.4
9051	ST9051	7.62	43.3	43.4	1.8	365	3.82	0.35	0.14	2.2	2.2	3.6	3.6	4.0	4.0	4.6	4.6
9059A	ST9053	13.59	43.4	43.4	1.4	582	6.15	0.36	0.24	3.5	3.5	5.5	5.5	6.6	6.6	8.3	8.3
9059B	ST9059	11.82	43.4	43.4	1.4	582	6.15	0.36	0.24	3.1	3.1	4.9	4.9	5.9	5.9	7.4	7.4
9060	ST9060	11.18	63.9	64.7	1.8	230	3.50	0.35	0.13	4.0	4.1	6.1	6.2	6.8	6.9	8.1	8.2
9065	ST9065	14.62	35.3	39.3	10.5	997	4.96	0.33	0.12	4.2	4.5	7.6	7.9	8.2	8.6	10.6	11.0
9071	O9071	10.19	39.8	40.4	8.5	743	5.61	0.33	0.14	3.6	3.7	6.5	6.6	6.6	6.6	7.2	7.2
9072	O9072	19.38	43.9	43.9	4.1	1126	6.69	0.37	0.26	5.2	5.2	8.7	8.7	10.7	10.7	13.5	13.5
CANYON_N	CANYON_CR_PH2_DET	7.24	70.4	70.4	9.3	367	6.69	0.37	0.26	3.1	3.1	4.8	4.8	5.6	5.6	6.8	6.8
CANYON_S	CANYON_CR_ARCH_PIPE	7.74	70.9	70.9	3.9	469	6.69	0.37	0.26	3.3	3.3	5.0	5.0	5.9	5.9	7.1	7.1
FUT6612	O6612	50.30	3.7	64.1	5.1	1383	6.69	0.37	0.26	1.5	18.9	4.7	28.4	7.1	33.5	11.4	40.4
S_1203	1203	3.59	64.8	64.8	5.5	126	6.69	0.37	0.26	1.4	1.4	2.1	2.1	2.5	2.5	3.0	3.0
TONKIN_NISSAN_BASIN	TONKIN_NISSAN_POND	17.83	37.3	43.5	0.9	638	6.69	0.37	0.26	3.9	4.5	5.9	6.7	7.0	8.0	8.7	9.8

Table B-3. Hydaulic Model Inputs and Results																				
Conduit			Conduit Atributes								Existing Land Use Conditions					Future Land Use Conditions				
			Shape	Diameter (ft)/ Max Width (ft)	Depth (ft)	Length (ft)	Invert Elevation (ft)		Slope (%)	Manning's Roughness	Peak Flow (cfs)				When Hydraulically Deficient	Peak Flow (cfs)				When Hydraulically Deficient
ID	US Node	DS Node					US	DS			2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr		2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr	
ST1202	1203	ST1202	CIRCULAR	1.5	-	262	276.62	265.7	3.87	0.013	5.0	8.0	9.5	11.5	NF	5.0	8.0	9.5	11.5	NF
17559	3316	ST3017	CIRCULAR	1.5	-	77	212.75	211.2	2.08	0.024	3.2	5.0	6.0	6.8	NF	6.9	8.1	8.6	9.5	100-yr, 24-hr
17558	3316	ST3017	CIRCULAR	1.5	-	77	212.75	211.2	2.08	0.024	3.2	5.0	6.0	6.8	NF	6.9	8.1	8.6	9.5	100-yr, 24-hr
SD6629	6652	ST6618	CIRCULAR	0.83	-	106.2	161.33	160.0	1.04	0.013	0.0	0.0	0.0	0.3	NF	0.0	0.0	0.0	1.8	NF
STAFFORD_MEADOWS_CHANNEL	9067	3316	STAFFORD_CHANNEL	88	3	410	214.8	212.8	0.50	0.035	2.4	3.8	4.8	6.3	NF	9.2	13.6	15.8	19.1	NF
SD2151	DAY_RD_IMPOUNDMENT	ST2107	CIRCULAR	2	-	192.4	227.55	227.5	0.07	0.01	17.4	16.7	16.4	16.4	2-yr, 24-hr	16.8	16.7	16.7	16.9	2-yr, 24-hr
SD5218	POND_LIBRARY	ST5215	CIRCULAR	1.5	-	69	140.76	136.0	4.08	0.013	19.3	22.2	22.2	22.2	100-yr, 24-hr	21.9	22.2	22.2	22.1	25-yr, 24-hr
PST1204	PST1202	PST1204	CIRCULAR	1	-	84.3	331.58	329.2	2.59	0.011	2.0	3.2	3.8	4.6	NF	2.0	3.2	3.8	4.6	NF
PST1205	PST1204	PST1205	CIRCULAR	1	-	129.3	329.2	314.6	11.16	0.011	2.0	3.2	3.8	4.6	NF	2.0	3.2	3.8	4.6	NF
PST1206	PST1205	PST1206	CIRCULAR	1	-	189.2	314.58	309.5	2.59	0.011	2.0	3.2	3.8	4.6	NF	2.0	3.2	3.8	4.6	NF
PST1207	PST1206	PST1207	CIRCULAR	1	-	121.8	309.49	307.0	1.91	0.011	2.0	3.2	3.8	4.6	NF	2.0	3.2	3.8	4.6	NF
PST1208	PST1207	PST1208	CIRCULAR	1	-	61.1	306.97	292.8	8.21	0.011	3.6	5.9	7.0	8.5	NF	3.6	5.9	7.0	8.7	NF
PST1209	PST1208	PST1209	CIRCULAR	1	-	116.5	292.77	278.1	14.30	0.011	3.6	5.9	7.0	8.5	NF	3.6	5.9	7.0	8.5	NF
1203	PST1209	1203	CIRCULAR	1	-	23.3	278.08	276.6	1.50	0.011	3.6	5.9	7.0	8.5	NF	3.6	5.9	7.0	8.5	NF
SD1740	SIEMENS_POND_C&D	ST3208	CIRCULAR	2.5	-	77	208.45	207.0	1.95	0.013	2.8	6.1	8.3	11.8	NF	3.5	7.5	10.1	14.3	NF
SD1000	ST1000	ST1129	CIRCULAR	2.5	-	142.7	257.9	253.5	3.12	0.013	18.9	25.5	28.9	33.7	NF	19.5	26.2	29.7	34.6	NF
SD1001	ST1001	ST1000	CIRCULAR	1.5	-	900	270.05	257.9	1.24	0.013	7.2	8.3	7.9	8.1	NF	7.2	7.8	7.8	8.1	NF
SD1002	ST1002	ST1001	CIRCULAR	1.25	-	540	277.75	270.1	1.38	0.013	7.2	8.4	8.7	8.3	25-yr, 24-hr	7.2	8.1	8.1	8.2	25-yr, 24-hr
SD1100	ST1100	ST1700	CIRCULAR	2.5	-	72	241.73	239.2	3.59	0.013	36.2	49.6	57.9	72.9	10-yr, 24-hr	39.6	57.3	68.1	80.4	10-yr, 24-hr
SD1101	ST1101	ST1100	SYSCO	21	3.8	1170	244.65	241.7	0.25	0.035	28.5	43.6	48.3	52.6	NF	28.5	40.9	43.8	51.9	100-yr, 24-hr
SD1102	ST1102	ST1101	CIRCULAR	3.5	-	58	244.82	244.7	0.29	0.011	28.9	44.2	52.2	63.0	NF	28.9	44.1	52.0	63.0	NF
SD1103	ST1103	ST1102	CIRCULAR	3.5	-	77	245.25	244.8	0.30	0.011	28.9	44.2	52.2	63.0	NF	28.9	44.1	52.0	63.0	NF
SD1104	ST1104	ST1103	CIRCULAR	3	-	31	245.61	245.3	0.52	0.011	18.4	28.5	34.0	41.4	NF	18.4	28.5	34.0	41.5	NF
SD1105	ST1105	ST1104	CIRCULAR	2.5	-	150	250.61	245.6	3.20	0.011	8.7	14.6	18.1	22.8	NF	8.7	14.6	18.1	22.8	NF
SD1106	ST1106	ST1105	CIRCULAR	2.5	-	332.6	253.77	250.6	0.89	0.011	8.7	14.6	18.1	22.8	NF	8.7	14.6	18.1	22.8	NF
SD1107	ST1107	ST1106	CIRCULAR	2.5	-	170.5	255.79	253.8	1.07	0.011	8.7	14.6	18.2	22.8	NF	8.7	14.6	18.2	22.8	NF
SD1108	ST1108	ST1107	CIRCULAR	2.5	-	180	257.5	255.8	0.89	0.011	8.7	14.6	18.1	22.8	NF	8.7	14.6	18.1	22.8	NF
SD1109	ST1109	ST1108	CIRCULAR	2.5	-	273.1	261.49	257.5	1.39	0.011	8.7	14.6	18.2	22.9	NF	8.7	14.6	18.2	22.9	NF
SD1110	ST1110	ST1109	CIRCULAR	2.5	-	218.1	266.69	261.5	2.29	0.011	8.7	14.6	18.1	22.8	NF	8.7	14.6	18.1	22.8	NF
SD1111	ST1111	ST1110	CIRCULAR	2	-	112.9	267.03	266.7	0.30	0.013	7.1	12.4	15.7	20.4	NF	7.1	12.4	15.7	20.4	NF
SD1112	ST1112	ST1111	CIRCULAR	1.5	-	100	271.56	267.0	4.53	0.013	7.1	12.4	15.7	20.4	NF	7.1	12.4	15.7	20.4	NF
SD1113	ST1113	ST1112	CIRCULAR	1.5	-	67.4	272.22	271.6	0.68	0.013	7.1	12.4	15.7	20.4	25-yr, 24-hr	7.1	12.4	15.7	20.4	25-yr, 24-hr
SD1114	ST1114	ST1113	CIRCULAR	1.5	-	379.5	276.02	272.2	0.92	0.013	7.1	12.4	15.7	20.8	10-yr, 24-hr	7.1	12.4	15.7	20.8	10-yr, 24-hr
SD1115	ST1115	ST1110	CIRCULAR	2.5	-	47	268.44	266.7	2.32	0.012	1.6	2.4	2.8	3.3	NF	1.6	2.4	2.8	3.3	NF
SD1116	ST1116	ST1115	CIRCULAR	2.25	-	79	270.48	268.4	2.58	0.013	1.6	2.4	2.8	3.3	NF	1.6	2.4	2.8	3.3	NF
SD1117	ST1117	ST1103	CIRCULAR	2.75	-	238.4	246.52	245.3	0.31	0.013	10.6	15.9	18.4	22.0	NF	10.6	15.8	18.2	21.9	NF
SD1118	ST1118	ST1117	CIRCULAR	2.75	-	350.9	247.64	246.5	0.32	0.013	10.6	15.9	18.5	22.0	NF	10.6	15.9	18.3	21.9	NF
SD1119	ST1119	ST1118	CIRCULAR	2.75	-	293.1	262.81	247.6	5.18	0.013	5.9	8.9	10.5	11.8	NF	5.9	8.9	10.5	11.9	NF
SD1120	ST1120	ST1119	CIRCULAR	1.5	-	309	267.58	262.8	1.48	0.013	5.9	8.9	10.5	11.8	NF	5.9	8.9	10.5	11.9	NF
SD1121	ST1121	ST1120	CIRCULAR	1.5	-	277.3	271.88	267.6	1.44	0.013	5.9	8.9	10.5	12.4	NF	5.9	8.9	10.5	12.4	NF
SD1122	ST1122	ST1121	CIRCULAR	1.5	-	277.7	273.75	271.9	0.67	0.013	5.9	8.9	10.5	12.2	NF	5.9	8.9	10.5	12.2	NF
SD1123	ST1123	ST1122	CIRCULAR	1.25	-	105.6	276.24	273.8	2.12	0.013	5.9	8.9	10.5	12.2	100-yr, 24-hr	5.9	8.9	10.5	12.2	100-yr, 24-hr
SD1124	ST1124	ST1123	CIRCULAR	1.25	-	257.5	284.48	276.2	3.20	0.013	5.9	8.9	10.5	12.3	100-yr, 24-hr	5.9	8.9	10.5	12.3	100-yr, 24-hr
SD1125	ST1125	ST1118	CIRCULAR	1.75	-	193.8	251.13	247.6	1.28	0.013	4.7	7.1	8.4	10.1	NF	4.7	7.1	8.5	10.2	NF
SD1127	ST1126	ST1701	CANYON_CR	22	4	1500	246.95	237.5	0.63	0.035	12.5	19.9	24.0	31.1	NF	19.0	28.9	34.1	42.3	NF
SD1128	ST1128	ST2118	CIRCULAR	2.5	-	307.2	244.51	241.5	0.86	0.013	18.8	28.7	28.9	33.3	NF	19.3	28.8	29.4	34.1	NF
SD1129	ST1129	ST1128	BASALT_CR9	11	2	530	253.45	244.5	0.75	0.035	18.8	33.6	33.6	33.7	NF	19.3	38.5	38.5	34.3	NF
SD2411	ST1130	ST2407	CIRCULAR	2	-	727	240.02	236.7	0.43	0.024	8.7	9.4	9.8	10.4	NF	8.8	9.5	9.8	10.5	NF
SD2410	ST1130	ST2409	CIRCULAR	2	-	263.6	240.02	240.3	0.59	0.024	1.6	5.8	8.0	10.6	NF	2.1	6.2	8.2	10.8	NF
SD1130	ST1131	ST1130	CIRCULAR	2.75	-	105.9	242.76	240.0	0.32	0.024	10.5	15.4	18.0	21.5	NF	11.0	15.9	18.3	22.0	NF
SD1131	ST1132	ST1131	CIRCULAR	2.75	-	399.7	244.2	242.8	0.31	0.024	10.5	15.5	18.0	21.5	NF	11.0	15.9	18.3	22.0	NF

Table B-3. Hydaulic Model Inputs and Results																				
Conduit			Conduit Atributes								Existing Land Use Conditions					Future Land Use Conditions				
			Shape	Diameter (ft)/ Max Width (ft)	Depth (ft)	Length (ft)	Invert Elevation (ft)		Slope (%)	Manning's Roughness	Peak Flow (cfs)				When Hydraulically Deficient	Peak Flow (cfs)				When Hydraulically Deficient
ID	US Node	DS Node					US	DS			2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr		2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr	
SD1132	ST1133	ST1132	CIRCULAR	1.25	-	282.4	247.5	244.2	0.64	0.013	0.0	0.0	0.0	0.1	NF	11.0	15.9	18.3	22.0	2-yr, 24-hr
SD1302	ST1200	ST1302	CIRCULAR	2.25	-	75	257.59	256.1	1.64	0.013	8.4	12.8	14.9	19.1	NF	8.4	12.8	14.9	19.1	NF
SD1200	ST1201	ST1200	CIRCULAR	2.25	-	180	260.31	257.6	1.46	0.013	8.5	12.8	14.9	19.1	NF	8.5	12.8	14.9	19.1	NF
SD1201	ST1202	ST1201	CIRCULAR	2	-	251.1	265.7	260.3	2.05	0.013	5.0	8.0	9.5	11.5	NF	5.0	8.0	9.5	11.5	NF
SD1126	ST1300	ST1126	CIRCULAR	3	-	68	247.22	247.0	0.40	0.013	8.6	13.1	15.3	19.5	NF	8.6	13.1	15.3	19.5	NF
SD1300	ST1301	ST1300	CIRCULAR	3	-	121	248.45	247.2	0.55	0.013	8.6	13.1	15.3	19.5	NF	8.6	13.1	15.3	19.5	NF
SD1301	ST1302	ST1301	CIRCULAR	2.5	-	323	256.11	248.5	2.18	0.013	8.6	13.1	15.3	19.5	NF	8.6	13.1	15.3	19.5	NF
SD1303	ST1303	ST1126	CIRCULAR	1	-	90	250.55	247.0	1.33	0.011	1.4	2.8	3.6	4.3	NF	3.9	5.6	6.6	8.0	100-yr, 24-hr
SD1304	ST1303	ST1126	CIRCULAR	1	-	90	250.55	247.0	1.44	0.011	0.1	1.3	2.2	4.0	NF	3.1	5.4	6.4	7.9	100-yr, 24-hr
SD1305	ST1303	ST1126	CIRCULAR	1	-	90	250.55	247.0	0.44	0.011	2.7	3.2	3.5	4.3	NF	3.8	5.4	6.4	7.9	100-yr, 24-hr
SD1401	ST1304	ST1400	CIRCULAR	1.5	-	93.8	240.49	238.7	1.03	0.013	0.6	1.3	1.6	2.0	NF	0.8	1.4	1.7	2.1	NF
SD1306	ST1305	ST1304	CIRCULAR	1	-	310.8	242.46	240.5	0.60	0.013	0.6	1.3	1.6	2.0	NF	0.8	1.4	1.7	2.1	NF
SD1307	ST1306	ST1305	CIRCULAR	1.25	-	159	244.66	242.5	0.82	0.013	0.6	1.3	1.6	2.0	NF	0.8	1.4	1.7	2.1	NF
SD1308	ST1307	ST1306	CIRCULAR	1.25	-	147.8	246.73	244.7	1.33	0.013	0.7	1.3	1.6	2.0	NF	0.8	1.4	1.7	2.1	NF
SD1400	ST1400	ST1401	CIRCULAR	1.5	-	10	238.7	235.4	0.80	0.013	0.6	1.3	1.6	2.0	NF	0.8	1.4	1.7	2.1	NF
SD1402	ST1401	ST1402	CIRCULAR	4	-	68	235.43	235.4	0.49	0.013	43.7	58.1	65.6	73.7	NF	50.9	65.0	71.1	79.1	NF
SD1403	ST1402	ST1403	BOECKMAN_CR	37	9	970	235.43	197.5	3.92	0.035	45.9	61.7	69.6	78.5	NF	53.5	68.8	75.5	83.9	NF
SD1404	ST1403	ST1404A	CIRCULAR	4	-	45	197.45	195.5	4.45	0.013	45.4	61.6	69.3	78.1	NF	53.1	68.6	75.2	83.6	NF
SD1405A	ST1404A	ST1404B	BOECKMAN_CR	37	9	1285	195.45	160.9	2.69	0.035	50.8	70.3	79.8	91.8	NF	59.7	78.6	88.7	102.5	NF
SD1405B	ST1404B	ST1603	BOECKMAN_CR	37	9	500	160.9	147.5	2.69	0.035	50.8	70.3	79.7	91.8	NF	59.7	78.6	88.4	102.2	NF
SD1602	ST1500	ST1600	CIRCULAR	2.5	-	221.5	203.36	194.6	2.06	0.011	0.3	0.4	1.5	3.1	NF	0.3	0.5	1.6	3.2	NF
SD1500	ST1501	ST1500	CIRCULAR	1.5	-	153	212.81	203.4	5.47	0.013	0.3	0.4	0.5	0.7	NF	0.3	0.5	0.6	0.8	NF
SD1502	ST1502	ST1501	CIRCULAR	1.5	-	300.9	220.39	212.8	2.49	0.013	0.3	0.4	0.5	0.7	NF	0.3	0.5	0.6	0.8	NF
SD1503	ST1503	ST1502	CIRCULAR	1.25	-	276	227.5	220.4	2.49	0.013	0.3	0.4	0.5	0.7	NF	0.3	0.5	0.6	0.8	NF
SD1504	ST1504	ST1503	CIRCULAR	1.25	-	54	228.96	227.5	2.52	0.013	0.3	0.4	0.6	0.7	NF	0.3	0.5	0.6	0.8	NF
SD1603	ST1600	ST1601	CIRCULAR	4	-	157.6	194.55	180.0	9.11	0.013	29.8	37.4	42.0	50.0	NF	31.3	39.9	44.8	56.1	NF
SD1604	ST1601	ST1602	CIRCULAR	4	-	169	180.04	156.6	14.03	0.013	29.8	37.4	42.0	50.2	NF	31.3	39.9	44.8	56.5	NF
SD1605	ST1602	ST1603	MENTOR_GRAPHICS	13	1	350	156.56	147.5	2.60	0.035	29.8	37.4	41.9	49.2	NF	31.3	39.9	44.8	54.5	NF
SD1607	ST1603	POND_BOECKMAN	BOECKMAN_CR_B	141.6	15.3	100	147.45	131.5	16.21	0.035	130.5	186.1	216.4	529.5	NF	196.0	278.7	707.7	651.9	NF
SD3200	ST1605	ST3200	CIRCULAR	5	-	300	131.45	127.6	1.29	0.024	124.0	161.8	210.5	289.9	25-yr, 24-hr	166.9	247.4	304.8	303.6	10-yr, 24-hr
SD1600	ST1608	ST1600	CIRCULAR	1.25	-	251	212.8	194.6	5.11	0.013	1.1	1.9	2.3	2.8	NF	1.4	2.2	2.7	3.2	NF
16687	ST1640	3316	CIRCULAR	1.5	-	125	214.82	212.8	1.54	0.011	3.7	4.9	5.3	5.9	NF	5.3	6.4	6.9	7.5	NF
SD1700	ST1700	ST1701	SYSCO-2	70	3	900	239.15	237.5	0.19	0.035	35.7	49.0	52.8	62.3	NF	39.3	52.2	59.7	70.3	NF
SD1701	ST1701	ST1702	SYSCO-3	24	5	350	237.45	236.2	0.35	0.035	43.5	57.9	65.4	73.8	NF	50.7	64.7	70.7	79.3	NF
SD1702	ST1702	ST1401	CIRCULAR	4	-	95	236.23	235.4	0.49	0.013	43.4	57.7	65.2	73.4	100-yr, 24-hr	50.6	64.6	70.7	78.7	100-yr, 24-hr
SD1703	ST1703	ST1704	CIRCULAR	4	-	56	208.45	210.4	0.18	0.013	24.9	30.8	34.7	40.2	NF	26.1	34.0	37.8	44.4	NF
SD1704	ST1704	ST1705	CIRCULAR	4	-	312	210.35	209.4	0.32	0.013	24.8	30.8	34.6	40.1	NF	26.1	33.5	37.7	43.7	NF
SD1705	ST1705	ST1706	CIRCULAR	4	-	276.9	209.35	208.3	0.40	0.013	24.8	30.8	34.6	40.1	NF	26.1	33.5	37.7	43.7	NF
SD1706	ST1706	ST1707	CIRCULAR	4	-	263.6	208.25	207.7	0.20	0.013	24.8	30.8	34.6	40.1	NF	26.0	33.4	37.6	43.7	NF
SD1707	ST1707	ST1708	CIRCULAR	4	-	142.8	207.72	207.4	0.23	0.013	24.8	30.8	34.6	40.1	NF	26.0	33.4	37.6	43.7	NF
SD1708	ST1708	ST1709	CIRCULAR	4	-	434.9	207.39	206.0	0.32	0.013	24.7	30.8	34.5	40.4	NF	26.0	33.4	37.6	44.4	NF
SD1709	ST1709	ST1710	CIRCULAR	4	-	277	205.99	200.6	1.93	0.013	24.8	30.8	34.6	42.4	NF	26.0	33.4	37.7	48.2	NF
SD1716	ST1710	ST1600	CIRCULAR	4	-	75	200.64	194.6	8.15	0.013	28.6	35.7	39.8	48.2	NF	29.8	38.1	42.9	54.5	NF
SD1710	ST1711	ST1712	CIRCULAR	1.25	-	310	217.25	215.0	0.71	0.013	3.9	5.9	7.1	8.4	100-yr, 24-hr	3.9	5.9	7.2	8.5	100-yr, 24-hr
SD1711	ST1712	ST1713	CIRCULAR	1.5	-	270	215.04	208.6	2.14	0.013	3.9	5.8	7.1	8.4	NF	3.9	5.8	7.2	8.4	NF
SD1715	ST1713	ST1500	CIRCULAR	1.5	-	128	208.58	203.4	9.93	0.013	0.0	0.0	1.0	2.5	NF	0.0	0.0	1.0	2.5	NF
SD1712	ST1713	ST1714	CIRCULAR	1.25	-	250.1	208.58	208.6	-0.28	0.013	3.9	5.3	6.2	6.5	NF	3.9	5.3	6.2	6.5	NF
SD1713	ST1714	ST1715	CIRCULAR	1	-	135	208.58	205.7	2.17	0.013	3.8	5.2	5.9	5.9	10-yr, 24-hr	3.8	5.3	5.9	5.9	10-yr, 24-hr
SD1714	ST1715	ST1710	CIRCULAR	1	-	20	205.65	200.6	25.88	0.013	3.8	5.2	5.9	5.9	NF	3.8	5.3	5.9	5.9	NF
SD2722	ST1717	ST2720	CIRCULAR	2	-	500	209.05	205.5	0.72	0.013	8.6	12.6	13.8	16.9	100-yr, 24-hr	9.3	13.0	14.5	17.2	100-yr, 24-hr
SD1717	ST1718	ST1717	TRAPEZOIDAL	30	2	50	209.45	209.1	0.80	0.035	8.7	12.9	13.8	17.4	100-yr, 24-hr	9.4	13.4	14.5	18.3	100-yr, 24-hr

Table B-3. Hydaulic Model Inputs and Results																				
Conduit			Conduit Atributes								Existing Land Use Conditions					Future Land Use Conditions				
			Shape	Diameter (ft)/ Max Width (ft)	Depth (ft)	Length (ft)	Invert Elevation (ft)		Slope (%)	Manning's Roughness	Peak Flow (cfs)				When Hydraulically Deficient	Peak Flow (cfs)				When Hydraulically Deficient
ID	US Node	DS Node					US	DS			2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr		2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr	
SD1718	ST1719	ST1718	CIRCULAR	3.5	-	107	210.45	209.5	0.93	0.024	8.8	13.1	15.0	17.7	NF	9.5	14.2	15.9	18.9	NF
SD1719	ST1720	ST1719	ARCH	2.92	2	100	211.35	210.5	0.90	0.024	8.8	13.1	15.3	18.1	NF	9.5	14.2	16.1	18.9	NF
SD1720	ST1721	ST1720	CIRCULAR	2	-	282.2	216.15	211.4	1.70	0.013	8.8	13.1	15.3	18.1	NF	9.5	14.2	16.5	18.9	NF
SD1721	ST1722	ST1721	CIRCULAR	1.5	-	38.9	216.83	216.2	0.98	0.013	8.8	13.1	15.3	18.1	NF	9.5	14.2	16.5	19.3	NF
SD1722	ST1723	ST1722	CIRCULAR	2	-	90	217.26	216.8	0.32	0.013	8.8	13.1	15.4	18.1	NF	9.5	14.2	16.5	19.3	100-yr, 24-hr
SD1723	ST1724	ST1723	CIRCULAR	1	-	40.9	217.39	217.3	0.05	0.011	8.8	13.1	15.3	18.1	25-yr, 24-hr	9.6	14.2	16.5	19.4	10-yr, 24-hr
SD1724	ST1725	ST1724	CIRCULAR	2.5	-	208	218.26	217.4	0.36	0.013	8.8	13.2	15.5	18.3	100-yr, 24-hr	9.6	14.4	16.6	19.7	100-yr, 24-hr
SD1725	ST1726	ST1725	CIRCULAR	2.5	-	34	218.56	218.3	0.56	0.013	8.9	13.2	15.5	18.6	NF	9.7	14.4	16.8	20.0	100-yr, 24-hr
SD2000	ST2000	ST4002	PRISON_OFFSITE6	33	3.5	820	139.95	139.5	0.06	0.035	127.8	162.0	174.8	191.0	2-yr, 24-hr	160.7	199.6	206.0	225.9	2-yr, 24-hr
SD2001	ST2001	ST2000	PRISON_OFFSITE6	33	3.5	331.9	140.15	140.0	0.06	0.035	157.8	187.7	190.6	190.8	2-yr, 24-hr	150.7	191.5	196.6	216.5	2-yr, 24-hr
SD2002	ST2002	ST2001	PRISON_OFFSITE5	40	3.5	630.6	140.45	140.2	0.05	0.035	143.6	179.7	178.7	184.3	2-yr, 24-hr	172.0	182.4	191.0	215.3	2-yr, 24-hr
SD2003	ST2003	ST2002	PRISON_OFFSITE4	19	3.5	359.2	140.95	140.5	0.14	0.035	166.1	167.6	177.3	181.0	2-yr, 24-hr	174.5	177.2	189.9	214.5	2-yr, 24-hr
SD2004	ST2004	ST2003	PRISON_OFFSITE4	19	3.5	1208.4	142.45	141.0	0.12	0.035	135.7	141.5	156.5	179.6	2-yr, 24-hr	145.3	175.5	189.3	214.1	2-yr, 24-hr
SD2005	ST2005	ST2004	PRISON_OFFSITE3	48	3	1322.9	142.95	142.5	0.04	0.035	121.1	143.8	156.6	177.1	2-yr, 24-hr	138.2	171.1	186.8	207.0	2-yr, 24-hr
SD2006	ST2006	ST2005	PRISON_OFFSITE2	23.4	2.3	705.4	143.85	143.0	0.13	0.035	132.5	173.0	192.3	219.2	2-yr, 24-hr	159.1	208.4	231.2	260.1	2-yr, 24-hr
SD2007	ST2007	ST2006	PRISON_OFFSITE2	23.4	2.3	46.3	143.95	143.9	0.22	0.035	137.8	182.4	203.7	232.9	2-yr, 24-hr	166.8	220.2	245.4	280.0	2-yr, 24-hr
SD2008	ST2008	ST2007	PRISON_OFFSITE2	23.4	2.3	195.6	144.15	144.0	0.10	0.035	140.3	187.1	209.8	241.4	2-yr, 24-hr	170.1	226.5	253.7	290.8	2-yr, 24-hr
SD2009	ST2009	ST2008	PRISON_OFFSITE2	23.4	2.3	1744.5	145.45	144.2	0.10	0.035	17.3	34.6	42.9	55.8	2-yr, 24-hr	19.8	39.8	54.8	73.7	2-yr, 24-hr
SD2010	ST2010	ST2009	PRISON_OFFSITE	20	4	108	150.46	145.5	4.18	0.035	29.5	78.9	115.0	90.8	10-yr, 24-hr	101.0	72.6	64.2	81.2	2-yr, 24-hr
SD2011	ST2011	ST2010	RECT_CLOSED	6	3	32	153.13	150.5	8.37	0.013	45.5	112.8	114.3	109.3	10-yr, 24-hr	110.2	115.1	81.6	86.6	2-yr, 24-hr
SD2012	ST2012	ST2011	PRISON_OFFSITE	20	4	89	160.54	153.1	8.35	0.035	28.7	54.1	57.9	62.4	100-yr, 24-hr	51.8	64.2	75.1	93.3	10-yr, 24-hr
SD2013	ST2013	ST2012	PRISON_OFFSITE	20	4	361	170.14	160.5	2.66	0.035	28.8	43.2	51.0	62.4	NF	43.8	64.2	77.1	89.5	100-yr, 24-hr
SD2014	ST2014	ST2013	RECT_CLOSED	6	3	32	170.46	170.1	1.00	0.013	28.8	43.1	51.0	62.5	NF	43.8	64.2	75.2	89.5	100-yr, 24-hr
SD2015	ST2015	ST2014	PRISON_OFFSITE	20	4	587	178.35	170.5	1.34	0.035	28.8	43.2	51.2	62.7	NF	43.9	64.5	75.6	89.8	NF
SD2016	ST2016	ST2015	CIRCULAR	3.5	-	279	187.75	178.4	3.37	0.013	28.8	43.3	51.4	62.9	NF	44.0	64.6	75.8	90.0	NF
SD2017	ST2017	ST2016	CIRCULAR	3.5	-	401	199.05	187.8	2.79	0.013	28.8	43.3	51.4	62.8	NF	44.0	64.6	75.8	90.0	NF
SD2018	ST2018	ST2017	CIRCULAR	3.5	-	551	201.95	199.1	0.50	0.013	28.8	43.4	51.4	62.9	NF	44.0	64.7	75.9	90.1	NF
SD2019	ST2019	ST2018	CIRCULAR	3.5	-	69	202.45	202.0	0.49	0.013	28.8	43.6	51.8	63.4	NF	44.2	65.1	75.9	90.1	NF
SD2403B	ST2100	ST2403	CIRCULAR	4	-	79.9	222.7	222.1	1.29	0.013	50.8	63.0	67.7	73.4	NF	58.7	69.1	72.9	77.5	NF
SD2403	ST2100	ST2403	CIRCULAR	4	-	80.8	222.7	222.1	0.84	0.013	46.1	59.5	64.6	70.1	NF	55.0	66.1	69.7	75.5	NF
SD2100	ST2101	ST2100	CIRCULAR	3	-	602.1	224.96	222.7	0.31	0.013	34.0	41.9	44.3	46.6	NF	42.8	48.0	49.3	51.2	NF
SD2101	ST2101	ST2100	CIRCULAR	3	-	603.7	224.96	222.7	0.28	0.013	33.9	41.8	44.2	46.5	NF	43.2	47.9	49.2	51.2	NF
SD2440	ST2101A	ST2431	CIRCULAR	2	-	327.1	196.41	192.3	1.19	0.013	37.9	47.3	51.3	56.2	2-yr, 24-hr	47.3	55.7	59.5	65.2	2-yr, 24-hr
SD2102	ST2102	ST2101	COMMERCE_CIR_DITCI	140.2	7.4	493.4	226.88	225.0	0.37	0.035	37.9	44.8	46.6	48.6	NF	45.0	48.8	49.9	50.3	NF
SD2439	ST2102A	ST2101A	CIRCULAR	4	-	346.6	198.2	196.4	0.50	0.013	38.8	54.5	55.8	70.9	10-yr, 24-hr	54.2	65.0	60.2	65.8	2-yr, 24-hr
SD2103	ST2103	ST2102	CIRCULAR	4	-	30	226.56	226.9	-1.07	0.024	37.9	42.6	44.4	46.1	NF	42.8	46.0	46.9	47.2	25-yr, 24-hr
SD2438	ST2103A	ST2102A	CIRCULAR	4	-	334.3	200.05	198.2	0.49	0.013	39.4	57.1	61.3	71.7	10-yr, 24-hr	57.6	62.7	63.5	69.7	2-yr, 24-hr
SD2104	ST2104	ST2103	BASALT_CR5_UPDATE	91.5	4	367.5	225.75	226.6	-0.22	0.035	38.1	43.3	44.2	45.0	2-yr, 24-hr	43.1	44.5	44.9	45.1	2-yr, 24-hr
SD2437	ST2104A	ST2103A	CIRCULAR	4	-	302.8	203.63	200.1	1.12	0.013	43.4	57.9	66.1	73.3	10-yr, 24-hr	59.9	69.9	71.2	75.6	2-yr, 24-hr
SD2105	ST2105	ST2104	CIRCULAR	4	-	96.7	226.41	225.8	0.68	0.024	39.7	44.1	45.9	47.4	NF	43.4	46.6	47.6	48.5	NF
SD2167	ST2105A	ST2104A	CIRCULAR	4	-	109.2	204.37	203.6	0.49	0.013	45.1	60.2	70.5	79.7	10-yr, 24-hr	63.2	76.4	77.6	80.1	2-yr, 24-hr
SD2106	ST2106	ST2105	COMMERCE_CIR_DITCI	42.1	9.8	754	226.75	226.4	0.05	0.035	41.0	44.6	46.7	48.8	NF	43.7	48.0	49.4	50.9	NF
SD2164	ST2106A	ST2105A	CIRCULAR	3.5	-	117.7	205.46	204.4	0.50	0.013	18.3	22.6	23.5	26.7	10-yr, 24-hr	35.8	43.4	44.2	43.4	2-yr, 24-hr
SD2107	ST2107	ST2120	COMMERCE_CIR_DITCI	26.4	7.4	965	227.47	226.7	0.08	0.035	28.8	28.8	29.1	29.5	NF	29.7	29.7	29.7	29.9	NF
SD2163	ST2107A	ST2106A	CIRCULAR	3.5	-	227.5	206.8	205.5	0.50	0.013	18.0	24.5	27.2	32.0	10-yr, 24-hr	42.2	48.6	48.5	50.6	2-yr, 24-hr
SD2108	ST2108	ST2101	BASALT_CR	24	5	300	228.84	225.0	1.27	0.035	22.8	34.0	40.2	50.4	NF	41.8	63.5	73.7	81.8	NF
17184	ST2108A	ST2107A	CIRCULAR	3.5	-	119.8	207.59	206.8	0.49	0.013	18.1	24.9	31.6	40.8	25-yr, 24-hr	41.9	48.0	48.4	48.5	2-yr, 24-hr
SD2109	ST2109	ST2108	BASALT_CR7	48	4	500	229.63	228.8	0.16	0.035	23.0	34.2	40.4	51.2	NF	42.1	63.9	74.2	85.8	NF
17195	ST2109A	ST2186	CIRCULAR	3.5	-	236.9	209.13	208.0	0.48	0.013	18.2	24.5	34.7	40.4	25-yr, 24-hr	40.5	47.4	47.7	47.6	10-yr, 24-hr
SD2110	ST2110	ST2109	CIRCULAR	3	-	70	230.56	229.6	1.33	0.013	23.0	34.4	40.6	52.0	NF	42.2	64.1	74.4	86.0	NF
17194	ST2110A	ST2109A	CIRCULAR	3.5	-	299.2	212.26	209.1	0.98	0.013	18.4	25.8	34.7	40.4	25-yr, 24-hr	40.3	47.4	47.6	47.9	10-yr, 24-hr

Table B-3. Hydaulic Model Inputs and Results

Conduit			Conduit Atributes								Existing Land Use Conditions					Future Land Use Conditions				
			Shape	Diameter (ft)/ Max Width (ft)	Depth (ft)	Length (ft)	Invert Elevation (ft)		Slope (%)	Manning's Roughness	Peak Flow (cfs)				When Hydraulically Deficient	Peak Flow (cfs)				When Hydraulically Deficient
ID	US Node	DS Node					US	DS			2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr		2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr	
SD2111	ST2111	ST2110	BASALT_CR6	48	2	330	236.05	230.6	1.66	0.035	23.7	35.9	42.8	51.9	NF	44.3	64.1	74.4	86.0	NF
17203	ST2111A	ST2110A	CIRCULAR	3	-	177.8	214.19	212.3	0.80	0.013	17.4	26.8	34.5	40.4	100-yr, 24-hr	40.1	47.3	47.6	47.9	10-yr, 24-hr
SD2112	ST2112	ST2111	CIRCULAR	2	-	279.3	240.69	236.1	1.45	0.013	23.7	36.1	43.0	52.0	100-yr, 24-hr	44.4	64.2	74.5	88.8	10-yr, 24-hr
17201	ST2112A	ST2111A	CIRCULAR	3	-	178.4	215.82	214.2	0.80	0.013	17.4	28.7	34.3	40.5	100-yr, 24-hr	39.9	47.3	47.5	49.2	10-yr, 24-hr
SD2113	ST2113	ST2100	CIRCULAR	4	-	235.4	224.98	222.7	0.65	0.013	29.8	40.8	44.7	51.1	NF	30.2	41.0	45.2	51.6	NF
17269	ST2113A	ST2112A	CIRCULAR	3	-	329.5	218.27	215.8	0.68	0.013	17.4	27.5	34.2	40.5	100-yr, 24-hr	39.7	47.3	47.5	52.9	10-yr, 24-hr
SD2114	ST2114	ST2113	CIRCULAR	4	-	282.9	227.4	225.0	0.82	0.013	29.8	40.8	44.7	51.2	NF	30.3	41.1	45.2	51.8	NF
17271	ST2114A	ST2113A	CIRCULAR	3	-	166	219.51	218.3	0.63	0.013	17.4	27.0	34.0	40.4	100-yr, 24-hr	39.5	47.2	50.3	57.1	10-yr, 24-hr
SD2115	ST2115	ST2114	CIRCULAR	4	-	242	229.45	227.4	0.82	0.013	29.8	40.8	44.7	51.2	NF	30.3	41.0	45.2	51.7	NF
17280	ST2115A	ST2114A	CIRCULAR	3	-	166.1	220.95	219.5	0.75	0.013	17.4	27.6	33.7	40.4	100-yr, 24-hr	39.2	48.0	52.8	60.2	10-yr, 24-hr
SD2116	ST2116	ST2115	BASALT_CR11	16	4	150	233.95	229.5	3.00	0.035	29.8	40.8	44.7	51.2	NF	30.3	41.1	45.2	51.8	NF
17282	ST2116A	ST2115A	CIRCULAR	2.5	-	300.4	224.4	221.0	0.98	0.013	17.4	28.8	33.5	40.2	100-yr, 24-hr	39.0	50.1	55.9	64.5	10-yr, 24-hr
SD2117	ST2117	ST2116	CIRCULAR	3	-	288	235.45	234.0	0.69	0.013	29.8	40.8	44.7	51.2	100-yr, 24-hr	30.3	41.1	45.2	51.8	100-yr, 24-hr
17285	ST2117A	ST2116A	CIRCULAR	2.5	-	159.9	226.55	224.4	1.22	0.013	17.4	26.7	33.2	40.2	NF	38.8	52.1	59.0	68.8	10-yr, 24-hr
SD2118	ST2118	ST2117	BASALT_CR10	44	4	380	241.45	235.5	1.45	0.035	30.8	45.2	50.3	59.7	NF	31.3	44.7	51.0	60.3	NF
17290	ST2118A	ST2117A	CIRCULAR	2.5	-	202.4	229.21	226.6	1.22	0.013	17.4	26.7	34.1	40.2	NF	38.5	53.8	61.8	72.8	10-yr, 24-hr
17291	ST2119A	ST2118A	CIRCULAR	2.5	-	120	230.56	229.2	0.96	0.013	17.4	26.7	32.4	40.2	100-yr, 24-hr	38.2	55.5	64.5	76.8	10-yr, 24-hr
SD2120	ST2120	ST2106	CIRCULAR	4	-	62	226.67	226.8	-0.13	0.024	41.8	45.3	47.2	49.5	NF	44.2	48.7	50.5	52.2	NF
SD2121	ST2121	ST2107	ARCH	3	1.67	53.8	228.59	227.5	2.10	0.024	14.1	13.5	13.2	13.3	NF	13.6	13.5	13.5	13.6	NF
DAY_RD_BYPASS_CHANNEL	ST2122	DAY_RD_IMPOUNDMENT	TRAPEZOIDAL	17	3	20	226.18	227.6	0.01	0.035	54.6	89.7	108.5	135.0	NF	105.6	163.5	193.1	233.5	NF
SD2122	ST2122	ST2121	COMMERCE_CIR_DITCH	20.9	3.7	583	226.18	228.6	-0.41	0.035	19.2	15.8	14.1	14.1	NF	14.4	14.1	14.1	14.4	NF
SD2123	ST2123	ST2122	CIRCULAR	3	-	43	226.37	226.2	0.44	0.024	66.6	98.9	116.2	140.8	NF	115.3	171.1	200.0	239.7	100-yr, 24-hr
17196	ST2186	ST2108A	CIRCULAR	3.5	-	42.6	207.99	207.6	0.47	0.013	17.6	24.7	34.8	40.4	25-yr, 24-hr	41.0	47.5	48.0	47.8	10-yr, 24-hr
SD2706	ST2400	ST2706	BASALT_CR3	42	5	1130	214.45	175.5	3.45	0.035	133.9	178.5	197.6	223.3	NF	155.1	196.9	214.7	238.8	NF
SD2400	ST2401	ST2400	BASALT_CR3	42	5	90	214.9	214.5	0.50	0.035	134.0	178.5	197.7	223.4	NF	155.1	197.0	214.8	238.9	NF
SD2401	ST2402	ST2401	BASALT_CR3	42	5	1110	220.95	214.9	0.55	0.035	134.3	178.7	197.9	223.6	NF	155.3	197.2	215.0	239.1	NF
SD2402	ST2403	ST2402	BASALT_CR8	38	5	1000	222.09	221.0	0.10	0.035	96.3	121.7	131.5	142.6	NF	113.1	134.4	141.9	152.3	NF
SD2404	ST2404	ST2402	BASALT_CR2	30	5	400	228.12	221.0	1.67	0.035	19.9	29.9	35.2	42.8	NF	23.1	33.6	39.0	47.1	NF
SD2405	ST2405	ST2404	CIRCULAR	4.5	-	250	228.12	228.1	0.00	0.013	19.9	29.9	35.2	42.9	NF	23.1	33.6	39.1	47.1	NF
SD2406	ST2406	ST2405	BASALT_CR	24	5	450	229.5	228.1	0.31	0.035	15.5	23.4	27.6	33.5	NF	18.7	27.2	31.5	38.0	NF
SD2407	ST2407	ST2406	CIRCULAR	3.5	-	677	236.7	229.5	1.06	0.011	13.8	20.6	24.1	28.9	NF	14.1	20.6	23.8	28.6	NF
SD2408	ST2408	ST2407	CIRCULAR	3	-	131	238.66	236.7	1.18	0.011	5.1	11.2	14.3	18.6	NF	5.4	11.2	14.1	18.3	NF
SD2409	ST2409	ST2408	CIRCULAR	3	-	242.8	240.25	238.7	0.54	0.013	5.1	11.2	14.3	18.6	NF	5.4	11.2	14.1	18.3	NF
SD2716	ST2410	ST2715	CIRCULAR	1.5	-	253	214.7	210.3	1.42	0.013	5.0	7.6	9.1	11.4	NF	5.1	8.1	9.7	11.9	NF
SD2412	ST2411	ST2410	CIRCULAR	1.25	-	284	217.44	214.7	0.84	0.013	0.6	0.8	1.0	1.2	NF	0.6	0.9	1.0	1.3	NF
SD2413	ST2412	ST2411	CIRCULAR	1.25	-	415.1	221.01	217.4	0.85	0.013	0.6	0.8	1.0	1.2	NF	0.6	0.9	1.0	1.3	NF
SD2414	ST2413	ST2412	CIRCULAR	1.25	-	318.4	223.72	221.0	0.82	0.013	0.6	0.8	1.0	1.2	NF	0.6	0.9	1.0	1.3	NF
SD2442	ST2431	ST2432	CIRCULAR	2	-	69	192.31	189.3	4.08	0.013	37.9	47.3	51.3	56.2	100-yr, 24-hr	47.3	55.7	59.5	65.2	10-yr, 24-hr
SD2443	ST2432	ST2433	CIRCULAR	2.25	-	67.6	189.3	188.4	1.35	0.013	37.9	47.3	51.3	56.2	100-yr, 24-hr	47.3	55.7	59.5	65.2	10-yr, 24-hr
SD2444	ST2433	ST2434	CIRCULAR	2.5	-	335.6	188.39	185.1	0.94	0.013	37.9	47.3	51.3	56.2	NF	47.3	55.7	59.5	65.2	25-yr, 24-hr
SD2445	ST2434	ST2435	CIRCULAR	2.5	-	65	185.05	163.5	35.23	0.013	37.9	47.3	51.3	56.2	NF	47.3	55.7	59.5	65.2	NF
SD2446	ST2435	ST2004	PRISON_OFFSITE3	48	3	2000	163.45	142.5	1.05	0.035	37.4	47.1	51.2	56.2	NF	47.1	55.7	59.5	65.2	NF
SD2700	ST2700	ST4003	COFFEE_CR2	80	3.5	900	143.45	140.0	0.39	0.035	147.8	203.5	204.0	224.2	NF	170.4	192.2	226.7	298.4	10-yr, 24-hr
SD2701	ST2701	ST2700	COFFEE_CR2	80	3.5	1000	147.95	143.5	0.45	0.035	149.7	205.8	230.9	261.4	NF	172.0	223.8	248.1	278.0	NF
SD2702	ST2702	ST2701	COFFEE_CR2	80	3.5	1100	169.45	148.0	1.95	0.035	151.0	207.1	232.5	263.4	NF	173.3	225.7	250.1	280.6	NF
SD2703	ST2703	ST2702	COFFEE_CR	40	5	50	173.45	169.5	8.03	0.035	151.3	207.3	232.7	263.6	NF	173.5	225.9	250.4	281.0	NF
SD2704	ST2705	ST2703	BASALT_CR4	44	4	350	173.95	173.5	0.14	0.035	151.3	207.3	232.7	263.6	NF	173.5	225.9	250.4	281.0	NF
SD2705	ST2706	ST2705	BASALT_CR3	42	5	170	175.45	174.0	0.88	0.035	133.6	178.3	197.4	223.1	NF	154.9	196.7	214.5	238.6	NF
SD2707	ST2707	ST2705	CIRCULAR	2.5	-	48	178.69	174.0	6.79	0.013	24.2	35.8	40.7	47.6	NF	24.4	36.2	41.3	48.2	NF
SD2708	ST2708	ST2707	CIRCULAR	2.5	-	452	182.05	178.7	0.70	0.013	15.6	22.9	26.0	29.3	NF	15.7	23.3	26.6	30.1	NF
SD2709	ST2709	ST2708	CIRCULAR	2	-	274	188.85	182.1	2.30	0.013	15.6	23.1	26.3	29.5	NF	15.7	23.5	27.0	33.6	NF

Table B-3. Hydaulic Model Inputs and Results																				
Conduit			Conduit Atributes								Existing Land Use Conditions					Future Land Use Conditions				
			Shape	Diameter (ft)/ Max Width (ft)	Depth (ft)	Length (ft)	Invert Elevation (ft)		Slope (%)	Manning's Roughness	Peak Flow (cfs)				When Hydraulically Deficient	Peak Flow (cfs)				When Hydraulically Deficient
ID	US Node	DS Node					US	DS			2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr		2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr	
SD2710	ST2710	ST2709	CIRCULAR	2	-	400	195.05	188.9	1.50	0.013	15.6	23.1	27.4	32.1	100-yr, 24-hr	15.7	23.5	30.2	32.2	100-yr, 24-hr
SD2711	ST2711	ST2710	CIRCULAR	2	-	400	200.45	195.1	1.30	0.013	15.6	23.1	27.3	32.7	100-yr, 24-hr	15.7	23.5	28.4	32.9	100-yr, 24-hr
SD2712	ST2712	ST2711	CIRCULAR	3	-	106.1	203.05	200.5	2.45	0.013	5.0	7.6	11.8	30.3	100-yr, 24-hr	5.1	8.0	13.4	29.9	100-yr, 24-hr
SD2713	ST2713	ST2712	CIRCULAR	2	-	247.2	205.72	203.1	0.76	0.013	5.0	7.6	9.1	14.3	NF	5.1	8.0	9.8	15.7	100-yr, 24-hr
SD2714	ST2714	ST2713	CIRCULAR	2	-	174.8	206.95	205.7	0.70	0.013	5.0	7.6	9.1	13.8	NF	5.1	8.0	9.7	16.9	100-yr, 24-hr
SD2715	ST2715	ST2714	CIRCULAR	1.75	-	293	210.3	207.0	1.04	0.013	5.0	7.6	9.1	11.7	NF	5.1	8.0	9.7	13.8	NF
SD2717	ST2716	ST4015	CIRCULAR	2.5	-	84.3	171.46	169.9	1.74	0.024	12.5	23.4	25.0	26.7	25-yr, 24-hr	13.7	24.1	25.5	26.9	25-yr, 24-hr
SD2718	ST2717B	ST2716	CIRCULAR	2.5	-	75	172.13	171.5	0.89	0.024	12.5	23.4	25.0	26.6	25-yr, 24-hr	13.8	24.1	25.5	26.8	25-yr, 24-hr
SD2719	ST2718	ST2717	COFFEE_CR	40	5	680	186.45	172.1	2.11	0.035	15.3	22.5	25.5	30.3	NF	15.9	23.0	26.1	31.0	NF
SD2720	ST2719	ST2718	ARCH	4.5	2.25	76	188.2	186.5	2.30	0.024	15.3	22.6	25.6	30.3	NF	16.0	23.1	26.2	31.0	NF
SD2721	ST2720	ST2719	COFFEE_CR	40	5	640	205.45	188.2	2.70	0.035	15.9	23.7	26.6	31.5	NF	16.6	24.0	27.3	32.8	NF
SD3000	ST3001	ST3201	CIRCULAR	1.25	-	111.7	171.92	113.5	25.67	0.011	4.4	6.8	8.1	10.0	NF	4.4	6.9	8.2	10.1	NF
SD3001	ST3002	ST3001	CIRCULAR	1.25	-	71.5	180.31	171.9	11.82	0.011	4.4	6.8	8.1	10.0	NF	4.4	6.9	8.2	10.1	NF
SD3002	ST3003	ST3002	CIRCULAR	1.25	-	116.4	188.52	180.3	7.07	0.011	4.4	6.8	8.1	10.2	NF	4.4	6.9	8.2	10.2	NF
SD3003	ST3004	ST3003	CIRCULAR	1.25	-	35	190.86	188.5	4.58	0.011	4.4	6.8	8.1	11.4	NF	4.4	6.9	8.2	10.6	NF
SD3004	ST3005	ST3004	CIRCULAR	1.25	-	293	195.52	190.9	1.53	0.011	4.4	6.8	8.1	10.7	NF	4.5	6.9	8.2	10.6	NF
SD3006	ST3007	O3000	N_FORK_MERIDIAN_CF	22	4	5350	153.45	58.5	1.78	0.035	36.1	52.3	59.8	71.2	NF	61.6	85.8	98.4	120.8	NF
SD3007	ST3008	ST3007	N_FORK_MERIDIAN_CF	22	4	500	169.45	153.5	2.20	0.035	38.0	54.6	62.6	73.6	NF	63.6	88.7	101.6	123.8	NF
SD3008	ST3009	ST3008	N_FORK_MERIDIAN_CF	22	4	750	185.82	169.5	2.18	0.035	18.4	26.6	29.2	35.4	NF	24.5	30.8	34.9	46.1	NF
SD3009	ST3010	ST3009	CIRCULAR	2	-	63.8	190	185.8	6.57	0.011	18.4	26.6	29.2	40.5	NF	24.5	30.9	34.9	54.0	100-yr, 24-hr
SD3010	ST3011	ST3010	CIRCULAR	2	-	198	191.45	190.0	0.73	0.011	18.4	26.6	29.2	36.8	NF	24.5	30.9	34.9	49.3	100-yr, 24-hr
SD3011	ST3012	ST3011	N_FORK_MERIDIAN_CF	22	4	260	192.03	191.5	0.22	0.035	6.9	11.2	13.6	25.3	NF	14.6	18.0	19.5	37.2	100-yr, 24-hr
SD3012	ST3013	ST3012	CIRCULAR	3	-	101.9	198.56	192.0	6.42	0.013	6.4	9.9	11.9	25.2	NF	13.7	16.1	17.2	36.7	NF
SD3013	ST3014	ST3013	CIRCULAR	3	-	27.7	200.02	198.6	4.55	0.011	6.4	9.9	11.9	29.3	NF	13.7	16.1	17.2	36.7	NF
SD3014	ST3015	ST3014	CIRCULAR	3	-	116.1	204.42	200.0	3.79	0.013	6.4	9.9	11.9	17.3	NF	13.7	16.1	17.2	36.7	NF
SD3015	ST3016	ST3015	CIRCULAR	3	-	31.7	206.09	204.4	4.32	0.013	6.4	9.9	11.9	13.6	NF	13.7	16.1	17.2	53.3	NF
SD3016	ST3017	ST3016	N_FORK_MERIDIAN_CF	22	4	600	211.15	206.1	0.84	0.035	6.5	10.1	12.0	13.7	NF	13.7	16.1	17.2	18.9	NF
SD3017	ST3018	ST3011	CIRCULAR	2	-	158.4	203.41	191.5	3.18	0.011	1.2	2.0	2.5	3.3	NF	1.8	2.9	3.5	15.6	NF
SD3018	ST3019	ST3018	CIRCULAR	2	-	61.4	204.08	203.4	1.01	0.011	1.2	2.0	2.5	3.3	NF	1.8	2.9	3.5	7.0	NF
SD3019	ST3020	ST3019	CIRCULAR	2	-	266.8	205.51	204.1	0.50	0.011	1.2	2.0	2.5	3.3	NF	1.8	2.9	3.5	5.0	NF
SD3020	ST3021	ST3020	CIRCULAR	1.5	-	56.5	209.33	205.5	4.48	0.011	1.2	2.0	2.5	3.3	NF	1.8	2.9	3.5	4.4	NF
SD3021	ST3022	ST3021	CIRCULAR	1.5	-	203.2	210.35	209.3	0.40	0.011	1.2	2.0	2.5	3.3	NF	1.8	2.9	3.5	4.4	NF
SD3022	ST3023	ST3022	CIRCULAR	1.25	-	38.7	211.86	210.4	0.41	0.011	1.2	2.0	2.6	3.4	NF	1.9	2.9	3.5	4.4	NF
SD3023	ST3024	ST3023	CIRCULAR	1.25	-	220.6	212.84	211.9	0.40	0.011	1.2	2.0	2.6	3.4	NF	1.9	2.9	3.5	4.4	NF
SD3201	ST3200	ST3201	BOECKMAN_CR_D	123.6	15.8	1100	127.59	113.5	1.29	0.035	124.0	161.8	188.4	281.1	NF	166.9	227.1	280.9	280.9	NF
SD3202	ST3201	ST3202	BOECKMAN_CR2	40	10	1100	113.45	111.5	0.18	0.035	132.6	172.7	195.5	285.6	NF	173.4	232.9	284.6	284.8	NF
SD3603	ST3202	ST3603	BOECKMAN_CR2	40	10	900	111.45	105.5	0.67	0.035	132.4	172.6	195.3	285.4	NF	173.3	232.1	284.5	284.8	NF
SD3203	ST3203	ST4025	CIRCULAR	3	-	100	177.45	177.0	0.50	0.013	39.1	51.4	56.3	70.1	25-yr, 24-hr	50.1	61.4	76.5	95.2	10-yr, 24-hr
SD3204	ST3204	ST3203	S_COFFEE_CR3	29	2	250	181.45	177.5	1.60	0.035	39.1	51.4	57.6	102.9	NF	50.1	94.4	109.5	118.2	25-yr, 24-hr
SD3220	ST3205	ST3204	CIRCULAR	3	-	100	183.45	181.5	2.00	0.024	15.6	23.8	27.0	24.4	100-yr, 24-hr	26.4	25.2	53.8	28.2	10-yr, 24-hr
SD3225	ST3205	ST3204	CIRCULAR	3	-	100	183.45	181.5	2.00	0.024	7.8	11.9	13.5	48.8	100-yr, 24-hr	13.2	50.4	26.9	56.4	10-yr, 24-hr
SD3221	ST3206	ST3205	S_COFFEE_CR2	30	2	750	190.73	183.5	0.97	0.035	23.6	36.1	43.2	54.5	NF	39.7	58.5	68.6	77.4	NF
SD3205	ST3207	ST3206	CIRCULAR	3	-	90.5	192.45	190.7	1.90	0.013	15.1	13.0	15.4	18.5	NF	25.6	19.7	22.4	58.5	NF
SD3206	ST3207	ST3206	CIRCULAR	2	-	90.6	192.45	190.7	0.79	0.013	8.6	23.2	28.0	36.1	NF	14.2	39.0	46.4	29.8	NF
SD3207	ST3208	ST3207	S_COFFEE_CR	16	2	1400	206.95	192.5	1.04	0.035	14.5	21.7	25.9	32.4	NF	14.8	22.4	27.0	34.7	NF
SD3208	ST3209	ST3208	CIRCULAR	1.5	-	204.1	210.24	207.0	1.20	0.013	2.7	4.0	4.8	5.8	NF	2.8	4.3	5.0	6.1	NF
SD3209	ST3210	ST3209	CIRCULAR	1.5	-	218.1	212.35	210.2	0.88	0.013	2.7	4.0	4.8	5.8	NF	2.8	4.3	5.0	6.1	NF
SD3210	ST3211	ST3210	CIRCULAR	1.5	-	50	213.1	212.4	1.30	0.013	2.7	4.0	4.8	5.8	NF	2.8	4.3	5.0	6.1	NF
SD3211	ST3212	ST3211	CIRCULAR	1.5	-	38	213.53	213.1	0.66	0.013	2.7	4.0	4.8	5.8	NF	2.8	4.3	5.0	6.1	NF
SD3418	ST3217	ST3417	CIRCULAR	1.25	-	279.3	188.65	186.5	0.70	0.013	1.7	2.8	3.5	4.5	NF	4.3	6.5	7.6	9.3	NF
SD3216	ST3218	ST3217	CIRCULAR	1.25	-	242.9	192.02	188.7	1.37	0.013	1.7	2.8	3.5	4.6	NF	4.3	6.5	7.6	9.3	NF

Table B-3. Hydaulic Model Inputs and Results

Conduit			Conduit Atributes								Existing Land Use Conditions					Future Land Use Conditions				
			Shape	Diameter (ft)/ Max Width (ft)	Depth (ft)	Length (ft)	Invert Elevation (ft)		Slope (%)	Manning's Roughness	Peak Flow (cfs)				When Hydraulically Deficient	Peak Flow (cfs)				When Hydraulically Deficient
ID	US Node	DS Node					US	DS			2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr		2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr	
SD3400	ST3400	ST5039	CIRCULAR	4	-	88	158.96	155.2	0.48	0.013	35.1	54.3	64.4	79.2	NF	39.7	60.7	71.5	87.7	NF
SD3401	ST3401	ST3400	CIRCULAR	3.5	-	17.3	159.33	159.0	2.14	0.013	27.6	42.8	50.7	62.4	NF	31.6	48.5	56.9	73.2	NF
SD3402	ST3402	ST3401	CIRCULAR	3.5	-	187.4	160.35	159.3	0.54	0.013	27.6	42.9	50.7	62.4	NF	31.6	48.5	56.9	70.5	NF
SD3403	ST3403	ST3402	CIRCULAR	3.5	-	400	162.32	160.4	0.44	0.013	19.3	30.7	36.5	45.3	NF	21.4	33.6	40.0	49.5	NF
SD3404	ST3404	ST3403	CIRCULAR	3	-	365	165.43	162.3	0.81	0.011	19.4	30.8	36.5	45.2	NF	21.5	33.6	39.8	50.7	NF
SD3405	ST3405	ST3404	CIRCULAR	2	-	410	170.29	165.4	0.89	0.011	7.6	11.4	13.5	16.4	NF	8.9	13.2	15.5	19.1	NF
SD3406	ST3406	ST3405	CIRCULAR	2	-	11.7	171.08	170.3	6.34	0.013	7.6	11.4	13.5	16.5	NF	8.9	13.2	15.5	18.7	NF
SD3407	ST3407	ST3406	CIRCULAR	2	-	143	171.45	171.1	0.12	0.013	7.6	11.4	13.5	16.5	NF	8.9	13.2	15.5	18.7	NF
SD3408	ST3408	ST3407	CIRCULAR	2	-	163	171.85	171.5	0.12	0.013	7.6	11.4	13.5	16.5	NF	8.9	13.2	15.5	18.7	NF
SD3409	ST3409	ST3408	CIRCULAR	2	-	77	172.15	171.9	0.13	0.013	7.6	11.4	13.5	16.5	NF	8.9	13.2	15.5	18.7	NF
SD3410	ST3410	ST3409	CIRCULAR	2	-	145	174.88	172.2	1.75	0.011	7.6	11.4	13.5	16.5	NF	9.0	13.2	15.5	18.7	NF
SD3411	ST3411	ST3410	CIRCULAR	2	-	60	175.55	174.9	0.78	0.011	7.6	11.4	13.5	16.5	NF	9.0	13.2	15.6	18.7	NF
SD3412	ST3412	ST3411	CIRCULAR	2	-	27.1	175.43	175.6	-0.81	0.011	7.6	11.4	13.5	16.5	NF	9.0	13.2	15.6	18.7	NF
SD3413	ST3413	ST3412	CIRCULAR	2.5	-	145	176.1	175.4	0.46	0.013	7.6	11.4	13.5	16.5	NF	9.0	13.2	15.6	18.8	NF
SD3414	ST3414	ST3413	CIRCULAR	2.5	-	20	176.25	176.1	0.75	0.013	7.6	11.4	13.5	16.5	NF	9.0	13.3	15.6	18.8	NF
SD3415	ST3415	ST3414	CIRCULAR	1.5	-	268	178.63	176.3	0.73	0.013	1.2	1.8	2.2	2.8	NF	2.1	3.0	3.5	4.4	NF
SD3416	ST3416	ST3415	CIRCULAR	1.25	-	254	182.49	178.6	1.41	0.013	1.2	1.8	2.2	2.7	NF	2.1	3.0	3.5	4.1	NF
SD3417	ST3417	ST3416	CIRCULAR	1	-	230.5	186.51	182.5	1.61	0.013	1.2	1.8	2.2	2.7	NF	2.1	3.0	3.5	4.1	NF
SD3433	ST3417	ST3430	CIRCULAR	1.25	-	216.6	186.51	180.4	2.76	0.013	1.7	2.8	3.5	4.6	NF	3.4	5.3	6.4	8.0	NF
SD3419	ST3418	ST3404	CIRCULAR	3	-	591	168.26	165.4	0.47	0.013	11.8	19.5	22.9	29.8	NF	12.6	20.3	24.3	31.5	NF
SD3420	ST3419	ST3418	CIRCULAR	3	-	429.1	169.25	168.3	0.23	0.013	9.4	15.9	18.8	24.1	NF	10.2	16.8	20.2	26.0	NF
SD3421	ST3420	ST3419	CIRCULAR	3	-	258	169.73	169.3	0.15	0.013	9.4	15.9	18.8	24.2	NF	10.2	16.8	20.3	26.0	NF
SD3422	ST3421	ST3420	CIRCULAR	1.75	-	247.8	170.98	169.7	0.50	0.013	3.2	6.2	7.0	9.3	NF	3.9	6.9	8.4	10.8	NF
SD3423	ST3421	ST4236	CIRCULAR	1.5	-	638	170.98	166.9	0.65	0.013	2.7	5.5	7.5	8.1	NF	3.2	6.6	7.8	8.5	NF
SD3424	ST3422	ST3421	CIRCULAR	1.75	-	59	170.81	171.0	-0.29	0.013	0.4	2.9	4.4	5.5	NF	1.6	4.8	5.9	7.6	NF
SD3425	ST3423	ST3422	CIRCULAR	1.75	-	195	171.05	170.8	0.19	0.013	0.4	2.9	4.3	5.5	NF	1.6	4.8	5.9	7.6	NF
SD3426	ST3424	ST3423	CIRCULAR	1.75	-	74.2	171.12	171.1	0.09	0.013	0.4	2.9	4.3	5.5	NF	1.6	4.8	5.8	7.6	NF
SD3427	ST3425	ST3424	CIRCULAR	1.75	-	479.2	169.61	171.1	0.18	0.013	0.4	2.9	4.4	5.5	NF	1.7	4.9	5.8	9.3	100-yr, 24-hr
SD3428	ST3426	ST3425	CIRCULAR	1.75	-	85.1	169.79	169.6	0.21	0.013	1.7	2.8	3.5	4.9	NF	3.4	5.2	6.3	8.0	100-yr, 24-hr
SD3429	ST3427	ST3426	CIRCULAR	1.5	-	297.3	173.44	169.8	1.20	0.013	1.7	2.8	3.5	4.9	NF	3.4	5.2	6.8	8.0	100-yr, 24-hr
SD3430	ST3428	ST3427	CIRCULAR	1.5	-	434.9	178.86	173.4	1.21	0.013	1.7	2.8	3.5	4.5	NF	3.4	5.2	6.3	8.3	NF
SD3431	ST3429	ST3428	CIRCULAR	1.5	-	171.5	179.89	178.9	0.59	0.013	1.7	2.8	3.5	4.5	NF	3.4	5.2	6.3	8.0	NF
SD3432	ST3430	ST3429	CIRCULAR	1.5	-	65.7	180.41	179.9	0.65	0.013	1.7	2.8	3.5	4.6	NF	3.4	5.3	6.4	8.0	NF
SD3434	ST3431	ST3400	CIRCULAR	3.5	-	51.4	160.46	159.0	0.90	0.013	7.6	11.5	13.7	16.9	NF	8.1	12.3	14.5	18.6	NF
SD3435	ST3432	ST3431	CIRCULAR	2.5	-	257.6	163.39	160.5	1.04	0.011	7.6	11.5	13.7	16.9	NF	8.1	12.3	14.5	17.8	NF
SD3436	ST3433	ST3432	CIRCULAR	2.5	-	287.9	166.73	163.4	1.09	0.011	7.6	11.5	13.7	16.9	NF	8.1	12.3	14.6	17.8	NF
SD3437	ST3434	ST3433	CIRCULAR	2.5	-	262.1	169.86	166.7	1.12	0.011	7.6	11.6	13.8	16.9	NF	8.1	12.3	14.6	17.9	NF
SD3438	ST3435	ST3434	CIRCULAR	2.25	-	318.2	174.35	169.9	1.34	0.011	7.6	11.6	13.8	17.0	NF	8.1	12.3	14.6	17.9	NF
SD3439	ST3436	ST3435	CIRCULAR	2.25	-	442.3	180.59	174.4	1.40	0.011	7.6	11.6	13.8	17.0	NF	8.1	12.3	14.6	17.9	NF
SD3440	ST3437	ST3436	CIRCULAR	1.75	-	240	186.74	180.6	2.50	0.013	1.4	2.2	2.7	3.4	NF	1.5	2.3	2.8	3.5	NF
SD3441	ST3438	ST3437	CIRCULAR	1.75	-	240	189.99	186.7	1.26	0.013	1.4	2.2	2.7	3.4	NF	1.5	2.3	2.8	3.5	NF
SD3442	ST3439	ST3438	CIRCULAR	1.75	-	240	191.55	190.0	0.56	0.013	1.4	2.2	2.7	3.4	NF	1.5	2.3	2.8	3.5	NF
SD3443	ST3440	ST3439	CIRCULAR	1.75	-	240	193.2	191.6	0.58	0.013	1.4	2.2	2.7	3.4	NF	1.5	2.3	2.8	3.5	NF
SD3444	ST3441	ST3440	CIRCULAR	1.75	-	194.9	195.11	193.2	0.88	0.013	1.4	2.2	2.7	3.4	NF	1.5	2.3	2.8	3.5	NF
SD3445	ST3442	ST3441	CIRCULAR	1.75	-	120	197.05	195.1	1.62	0.013	1.4	2.2	2.7	3.4	NF	1.5	2.3	2.8	3.5	NF
SD3446	ST3443	ST3442	CIRCULAR	1.75	-	177	198.16	197.1	0.54	0.013	1.4	2.2	2.7	3.4	NF	1.5	2.3	2.8	3.5	NF
SD3447	ST3444	ST6036	CIRCULAR	2	-	230	150.86	142.2	3.65	0.013	14.1	21.2	24.5	29.1	NF	14.1	21.2	24.1	29.0	NF
SD3448	ST3445	ST3444	CIRCULAR	1.5	-	66	156.67	150.9	7.70	0.013	14.1	21.2	27.1	32.0	25-yr, 24-hr	14.1	21.2	27.3	31.9	25-yr, 24-hr
SD3449	ST3446	ST3445	CIRCULAR	1.5	-	173.9	166.18	156.7	4.71	0.013	5.4	8.1	9.4	10.9	NF	5.4	8.1	9.4	10.9	NF
SD3450	ST3447	ST3446	CIRCULAR	1.5	-	29.7	166.66	166.2	1.62	0.013	5.4	8.1	9.3	10.2	NF	5.4	8.1	9.3	10.2	NF
SD3451	ST3448	ST3447	CIRCULAR	1.5	-	198.7	168.66	166.7	1.06	0.013	5.4	8.1	9.3	10.2	NF	5.4	8.1	9.3	10.2	NF

Table B-3. Hydaulic Model Inputs and Results																				
Conduit			Conduit Atributes								Existing Land Use Conditions					Future Land Use Conditions				
			Shape	Diameter (ft)/ Max Width (ft)	Depth (ft)	Length (ft)	Invert Elevation (ft)		Slope (%)	Manning's Roughness	Peak Flow (cfs)				When Hydraulically Deficient	Peak Flow (cfs)				When Hydraulically Deficient
ID	US Node	DS Node					US	DS			2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr		2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr	
SD3452	ST3449	ST3448	CIRCULAR	1.5	-	214.2	171.41	168.7	1.20	0.013	1.2	1.8	2.2	2.7	NF	1.2	1.8	2.2	2.7	NF
SD3453	ST3450	ST3449	CIRCULAR	1.25	-	178.4	175.05	171.4	2.20	0.013	1.2	1.8	2.2	2.7	NF	1.2	1.8	2.2	2.7	NF
SD3454	ST3451	ST3450	CIRCULAR	1.25	-	268.6	175.8	175.1	0.28	0.013	1.2	1.8	2.2	2.7	NF	1.2	1.8	2.2	2.7	NF
SD5204	ST3600	ST5203	BOECKMAN_CR_WILSC	42.5	5.5	49	95.2	94.5	1.53	0.035	158.4	210.4	236.5	299.5	NF	194.7	256.7	297.1	299.4	NF
SD3601	ST3602	ST3600	BOECKMAN_CR2	40	10	1250	103.45	95.2	0.66	0.035	144.2	190.0	212.1	292.0	NF	182.6	244.0	290.5	290.8	NF
SD3602	ST3603	ST3602	BOECKMAN_CR2	40	10	600	105.45	103.5	0.33	0.035	132.1	172.5	195.1	285.4	NF	173.2	231.5	284.5	284.8	NF
SD5503	ST3605	ST5501	S_FORK_MERIDIAN_CF	22	4	1250	167.45	111.5	4.48	0.035	16.7	24.7	29.1	35.3	NF	16.7	24.8	29.1	35.3	NF
SD3605	ST3606	ST3605	S_FORK_MERIDIAN_CF	22	4	530	184.96	167.5	3.31	0.035	16.8	25.0	29.3	35.5	NF	16.8	25.0	29.4	35.6	NF
SD4206	ST4000	ST4205	SEALY_DITCH	80	3.5	1450	138.45	138.0	0.03	0.035	238.1	298.7	322.9	432.6	2-yr, 24-hr	347.9	459.9	437.7	382.8	2-yr, 24-hr
SD4000	ST4001	ST4000	SEALY_DITCH	80	3.5	1600	138.95	138.5	0.03	0.035	231.5	286.9	307.7	330.4	2-yr, 24-hr	291.9	318.2	340.1	370.9	2-yr, 24-hr
SD4001	ST4002	ST4001	SEALY_DITCH	80	3.5	400	139.45	139.0	0.13	0.035	240.2	269.7	286.4	320.0	2-yr, 24-hr	272.0	306.5	325.4	345.5	2-yr, 24-hr
SD4002	ST4003	ST4002	COFFEE_CR2	80	3.5	150	139.95	139.5	0.33	0.035	158.6	212.3	215.6	236.8	2-yr, 24-hr	173.2	204.2	227.8	264.8	2-yr, 24-hr
SD4003	ST4004	ST4003	COFFEE_CR2	80	3.5	1400	149.66	140.0	0.69	0.035	29.5	50.8	54.5	58.5	NF	31.1	51.5	54.8	58.8	NF
SD4004	ST4005	ST4004	CIRCULAR	3	-	75	150.66	149.7	1.33	0.024	30.5	51.7	55.3	59.1	100-yr, 24-hr	32.0	52.4	55.6	59.3	100-yr, 24-hr
SD4005	ST4006	ST4005	CIRCULAR	3	-	300	154.66	150.7	1.33	0.024	30.5	51.7	55.3	59.1	10-yr, 24-hr	32.0	52.4	55.6	59.3	10-yr, 24-hr
SD4006	ST4007	ST4006	CIRCULAR	2.5	-	390	167.15	154.7	3.08	0.024	19.0	33.6	34.2	35.1	25-yr, 24-hr	21.3	34.0	34.6	35.3	25-yr, 24-hr
SD4007	ST4008	ST4007	CIRCULAR	2.5	-	146	168.68	167.2	1.05	0.024	19.0	33.0	33.8	34.8	10-yr, 24-hr	21.3	33.5	34.1	35.3	10-yr, 24-hr
SD4008	ST4009	ST4008	CIRCULAR	2	-	88.5	172.51	168.7	3.27	0.024	7.6	11.6	12.4	14.7	10-yr, 24-hr	8.4	12.4	13.7	15.9	10-yr, 24-hr
SD4009	ST4010	ST4009	CIRCULAR	2	-	21.1	172.71	172.5	0.95	0.024	7.6	11.3	12.4	14.7	25-yr, 24-hr	8.4	12.2	13.7	16.0	10-yr, 24-hr
SD4010	ST4011	ST4010	CIRCULAR	2	-	58.9	176.05	172.7	5.59	0.024	7.6	11.2	12.5	14.8	25-yr, 24-hr	8.4	12.0	13.7	16.0	10-yr, 24-hr
SD4011	ST4012	ST4011	CIRCULAR	2	-	429.3	185.15	176.1	2.12	0.024	7.6	11.6	13.3	15.2	100-yr, 24-hr	8.4	12.7	14.4	16.5	100-yr, 24-hr
SD4012	ST4013	ST4006	CIRCULAR	3	-	29.7	156.9	154.7	5.87	0.013	14.9	21.5	25.4	30.2	10-yr, 24-hr	14.9	21.6	25.4	30.2	10-yr, 24-hr
SD4013	ST4014	ST4013	CIRCULAR	3	-	195	159.2	156.9	0.92	0.013	14.9	22.7	25.7	30.5	100-yr, 24-hr	14.9	22.0	25.7	30.5	100-yr, 24-hr
SD4014	ST4015	ST4008	CIRCULAR	2.5	-	44.1	169.86	168.7	1.00	0.024	12.5	23.5	25.0	26.8	10-yr, 24-hr	13.8	24.2	25.6	27.0	10-yr, 24-hr
SD4015	ST4016	ST4206	S_COFFEE_CR5	16	2	700	143.95	141.7	0.29	0.035	47.7	59.0	62.8	69.7	10-yr, 24-hr	58.3	65.8	70.8	75.5	2-yr, 24-hr
SD4016	ST4017	ST4016	S_COFFEE_CR6	10	2	1150	150.25	144.0	0.55	0.035	48.5	65.6	65.8	73.3	10-yr, 24-hr	62.9	68.1	74.8	78.7	10-yr, 24-hr
SD4017	ST4018	ST4017	CIRCULAR	4.92	-	40	151.01	150.3	1.90	0.013	55.0	69.3	70.4	80.9	10-yr, 24-hr	63.7	73.8	81.3	84.7	10-yr, 24-hr
SD4018	ST4019	ST4018	S_COFFEE_CR4	9	2	90	152.72	151.0	1.90	0.035	54.9	69.6	70.8	82.0	10-yr, 24-hr	64.2	74.3	82.5	85.5	10-yr, 24-hr
SD4019	ST4020	ST4019	CIRCULAR	4.25	-	35	153.4	152.7	1.94	0.013	55.3	69.9	73.8	83.2	10-yr, 24-hr	64.7	75.2	83.7	86.3	10-yr, 24-hr
SD4020	ST4021	ST4020	S_COFFEE_CR4	9	2	580	164.48	153.4	1.91	0.035	54.5	73.8	75.3	91.8	100-yr, 24-hr	67.8	78.9	92.7	94.6	25-yr, 24-hr
SD4021	ST4022	ST4021	CIRCULAR	3.5	-	30	165.05	164.5	1.90	0.013	38.7	64.1	68.6	70.9	100-yr, 24-hr	50.1	70.4	73.0	74.8	25-yr, 24-hr
SD4022	ST4023	ST4022	CIRCULAR	3.5	-	30	165.63	165.1	1.90	0.013	38.7	67.4	72.0	73.5	100-yr, 24-hr	50.1	73.6	76.9	77.5	25-yr, 24-hr
SD4023	ST4024	ST4023	S_COFFEE_CR	16	2	540	175.95	165.6	1.91	0.035	39.1	51.4	56.3	69.2	NF	50.1	60.6	74.6	93.9	100-yr, 24-hr
SD4024	ST4025	ST4024	CIRCULAR	3	-	200	176.95	176.0	0.50	0.013	39.1	51.4	56.3	70.3	25-yr, 24-hr	50.1	60.7	76.9	95.5	10-yr, 24-hr
SD4025	ST4026	ST4021	CIRCULAR	1.75	-	400	168.35	164.5	0.83	0.013	15.9	20.7	22.4	24.8	10-yr, 24-hr	19.1	22.8	24.1	27.7	2-yr, 24-hr
SD4026	ST4027	ST4026	CIRCULAR	1.75	-	410	173.35	168.4	1.20	0.013	15.9	22.1	22.8	25.9	10-yr, 24-hr	19.4	23.2	25.5	28.7	2-yr, 24-hr
SD4027	ST4028	ST4027	CIRCULAR	1.75	-	390	175.76	173.4	0.59	0.013	16.1	21.0	23.7	27.4	10-yr, 24-hr	19.7	24.3	27.2	30.8	2-yr, 24-hr
SD4028	ST4029	ST4028	CIRCULAR	1.5	-	401.5	178.5	175.8	0.66	0.024	16.1	22.3	25.4	29.9	2-yr, 24-hr	18.9	26.2	29.7	34.5	2-yr, 24-hr
SD4200	ST4200	ST6205	RECT_CLOSED	24	7	75	135.3	135.0	0.47	0.013	298.6	357.8	386.5	416.9	NF	311.2	383.8	417.8	456.5	NF
SD4201	ST4201	ST4200	COFFEE_CR3	27	4	520	135.95	135.3	0.13	0.035	298.5	357.8	386.4	430.5	100-yr, 24-hr	311.2	423.0	417.8	456.5	10-yr, 24-hr
SD4202	ST4202	ST4201	COFFEE_CR3	27	4	500	136.95	136.0	0.20	0.035	298.5	357.8	386.4	441.2	100-yr, 24-hr	311.4	448.2	451.5	456.5	10-yr, 24-hr
SD4203	ST4203	ST4202	COFFEE_CR3	27	4	300	137.15	137.0	0.07	0.035	292.6	351.6	380.3	471.9	100-yr, 24-hr	319.3	494.6	471.4	451.4	10-yr, 24-hr
SD4204	ST4204	ST4203	COFFEE_CR3	27	4	250	137.45	137.2	0.12	0.035	291.6	350.4	379.2	507.8	100-yr, 24-hr	377.4	504.2	488.8	450.1	2-yr, 24-hr
SD4205	ST4205	ST4204	COFFEE_CR3	27	4	540	137.95	137.5	0.09	0.035	288.8	347.5	376.1	466.2	100-yr, 24-hr	414.9	469.4	461.7	446.9	2-yr, 24-hr
SD4207	ST4206	ST4205	S_COFFEE_CR7	12	2	400	141.67	138.0	0.99	0.035	55.0	66.5	69.7	97.9	10-yr, 24-hr	73.2	94.5	98.2	82.1	2-yr, 24-hr
SD4208	ST4207	ST4206	CIRCULAR	3.5	-	41.4	142.21	141.7	1.30	0.024	15.1	20.0	23.6	26.7	25-yr, 24-hr	16.0	23.9	24.6	24.9	10-yr, 24-hr
SD4209	ST4208	ST4207	CIRCULAR	3.5	-	233.4	142.32	142.2	0.05	0.024	15.4	20.4	23.3	26.5	25-yr, 24-hr	16.4	23.2	24.3	24.8	10-yr, 24-hr
SD4210	ST4209	ST4208	CIRCULAR	2.25	-	65.9	142.77	142.3	0.64	0.013	15.4	20.6	23.1	25.8	100-yr, 24-hr	16.6	22.4	24.1	25.1	25-yr, 24-hr
SD4211	ST4210	ST4209	CIRCULAR	2.25	-	319.3	144.47	142.8	0.50	0.013	15.5	20.6	23.1	25.5	100-yr, 24-hr	16.6	22.5	24.1	25.3	25-yr, 24-hr
SD4212	ST4211	ST4210	CIRCULAR	2.25	-	204	145.39	144.5	0.40	0.013	15.5	20.6	23.1	27.7	100-yr, 24-hr	16.8	22.5	23.6	26.7	25-yr, 24-hr
SD4213	ST4212	ST4211	CIRCULAR	2	-	290	147.56	145.4	0.65	0.013	15.5	20.6	23.1	26.1	NF	16.9	22.5	23.7	26.1	100-yr, 24-hr

Table B-3. Hydaulic Model Inputs and Results																				
Conduit			Conduit Atributes								Existing Land Use Conditions					Future Land Use Conditions				
			Shape	Diameter (ft)/ Max Width (ft)	Depth (ft)	Length (ft)	Invert Elevation (ft)		Slope (%)	Manning's Roughness	Peak Flow (cfs)				When Hydraulically Deficient	Peak Flow (cfs)				When Hydraulically Deficient
ID	US Node	DS Node					US	DS			2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr		2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr	
SD4214	ST4213	ST4212	CIRCULAR	2	-	57	148.95	147.6	1.91	0.013	15.5	20.6	23.1	26.3	100-yr, 24-hr	16.9	22.5	26.7	26.5	25-yr, 24-hr
SD4215	ST4214	ST4213	CIRCULAR	2	-	103.6	149.03	149.0	0.08	0.013	15.5	20.6	23.1	25.9	25-yr, 24-hr	16.9	22.5	25.5	26.9	10-yr, 24-hr
SD4216	ST4215	ST4214	CIRCULAR	2	-	317	151.3	149.0	0.72	0.013	10.5	13.6	14.9	17.9	100-yr, 24-hr	11.4	14.6	17.1	17.1	25-yr, 24-hr
SD4217	ST4216	ST4215	CIRCULAR	2	-	349.1	155.45	151.3	1.16	0.013	10.5	13.6	15.0	20.0	100-yr, 24-hr	11.3	14.6	20.1	20.0	25-yr, 24-hr
SD4218	ST4217	ST4216	CIRCULAR	2	-	265.9	159.75	155.5	1.47	0.011	5.7	6.4	8.0	16.1	100-yr, 24-hr	6.1	7.4	14.0	14.0	100-yr, 24-hr
SD4219	ST4218	ST4217	CIRCULAR	2	-	288.1	163.05	159.8	1.11	0.011	5.7	6.4	6.8	11.5	NF	6.1	6.8	8.4	10.6	NF
SD4220	ST4219	ST4218	CIRCULAR	1.5	-	39.1	164.14	163.1	1.38	0.011	5.7	6.4	6.7	8.3	NF	6.1	6.8	7.6	11.1	NF
SD4221	ST4220	ST4219	CIRCULAR	2	-	355	164.8	164.1	0.14	0.013	5.7	6.4	6.7	8.0	NF	6.1	6.8	7.6	9.3	100-yr, 24-hr
SD4222	ST4221	ST4220	CIRCULAR	2	-	355.8	165.89	164.8	0.29	0.013	5.7	6.4	6.7	7.9	NF	6.1	6.8	7.7	11.4	100-yr, 24-hr
SD6207	ST4223	ST6205	CIRCULAR	4	-	82.2	138.64	135.0	0.18	0.013	33.7	54.1	60.3	65.3	NF	35.1	56.3	62.1	66.8	NF
SD4224	ST4224	ST4223	CIRCULAR	4	-	371.1	139.59	138.6	0.20	0.013	33.7	54.1	60.4	65.3	NF	35.1	56.3	62.1	66.8	NF
SD4225	ST4225	ST4224	CIRCULAR	4	-	365	140.31	139.6	0.20	0.013	33.7	54.2	60.4	65.3	NF	35.1	56.4	62.2	66.9	NF
SD4226	ST4226	ST4225	CIRCULAR	4	-	398.1	141.53	140.3	0.30	0.013	30.5	49.3	54.6	58.4	NF	31.3	50.5	55.2	58.8	NF
SD4227	ST4227	ST4226	CIRCULAR	3	-	361	143.64	141.5	0.58	0.013	15.8	24.8	29.9	34.6	NF	16.5	26.3	30.8	35.1	NF
SD4228	ST4228	ST4227	CIRCULAR	3	-	268.4	145.19	143.6	0.57	0.013	15.8	24.8	30.5	34.8	NF	16.5	26.3	31.4	35.1	NF
SD4229	ST4229	ST4228	CIRCULAR	3	-	68.6	145.77	145.2	0.85	0.024	2.2	3.5	4.4	5.1	NF	2.2	3.6	4.5	5.3	NF
SD4230	ST4230	ST4229	CIRCULAR	2.5	-	244	147	145.8	0.45	0.013	2.2	3.5	4.3	5.2	NF	2.2	3.6	4.3	5.3	NF
SD4231	ST4231	ST4230	CIRCULAR	2.5	-	246.4	147.7	147.0	0.28	0.013	2.2	3.5	4.3	5.2	NF	2.2	3.6	4.3	5.5	NF
SD4232	ST4232	ST4228	CIRCULAR	2.5	-	173.8	146.98	145.2	0.60	0.013	2.7	5.4	7.4	8.1	NF	3.2	6.6	7.6	8.5	NF
SD4233	ST4233	ST4232	CIRCULAR	1.75	-	471.6	151.25	147.0	0.76	0.013	2.7	5.4	7.4	8.1	NF	3.2	6.6	7.6	8.5	NF
SD4234	ST4234	ST4233	CIRCULAR	1.5	-	426	159.45	151.3	1.88	0.013	2.7	5.4	7.4	8.1	NF	3.2	6.6	7.7	8.5	NF
SD4235	ST4235	ST4234	CIRCULAR	1.5	-	27.5	164.24	159.5	1.49	0.013	2.7	5.5	7.5	8.1	NF	3.2	6.6	7.7	8.5	NF
SD4236	ST4236	ST4235	CIRCULAR	1.5	-	110.9	166.85	164.2	2.21	0.013	2.7	5.5	7.5	8.1	NF	3.2	6.6	7.8	8.5	NF
SD4241	ST4241	ST4242	CIRCULAR	2.5	-	80.5	143.45	142.1	1.74	0.013	0.6	0.7	0.9	1.3	NF	0.6	0.7	0.9	1.3	NF
SD4242	ST4242	ST4202	CIRCULAR	2.5	-	564	142.05	137.0	0.90	0.013	0.6	0.7	0.9	4.0	NF	0.6	3.1	2.7	1.3	NF
SD6413	ST4400	ST6413	CIRCULAR	4	-	100	161.45	159.5	2.00	0.013	52.4	71.8	80.9	92.7	NF	53.9	74.2	82.4	94.3	NF
SD4400	ST4401	ST4400	ARROWHEAD_CR2	28	6	400	163.45	161.5	0.50	0.035	32.7	47.0	55.5	65.6	NF	32.8	47.1	55.7	65.9	NF
SD4401	ST4402	ST4401	ARROWHEAD_CR	32	4	800	169.67	163.5	0.78	0.035	33.2	47.8	56.3	75.3	NF	33.2	47.8	56.5	76.0	NF
SD4402	ST4403	ST4402	ARROWHEAD_CR	32	4	100	170.45	169.7	0.78	0.035	25.4	35.8	42.1	58.0	NF	25.5	35.9	42.5	58.5	NF
SD4403	ST4404	ST4402	CIRCULAR	1.25	-	355	178.69	169.7	2.23	0.013	1.7	3.1	3.9	5.2	NF	1.7	3.1	3.9	5.2	NF
SD4500	ST4500	ST4204	CIRCULAR	2	-	421	143.57	137.5	1.44	0.013	8.1	13.0	15.9	21.2	NF	9.9	16.6	20.4	24.1	100-yr, 24-hr
SD4501	ST4501	ST4500	CIRCULAR	2	-	561	149.45	143.6	0.99	0.013	8.1	13.0	16.0	20.7	NF	9.9	15.6	18.9	24.4	NF
SD4502	ST4502	ST4501	CIRCULAR	1.5	-	473.6	167.3	149.5	2.81	0.013	4.4	7.6	9.5	12.5	NF	4.5	7.7	9.6	12.9	NF
SD4503	ST4503	ST4001	SEALY_CR	58	2	400	146.55	139.0	1.90	0.035	33.9	53.4	65.1	82.2	100-yr, 24-hr	63.2	94.0	110.8	133.4	25-yr, 24-hr
SD4600	ST4601	ST4600	CIRCULAR	2	-	57.2	195.67	190.2	0.49	0.013	3.0	4.1	4.6	5.8	NF	3.0	4.3	4.7	5.8	NF
SD4601	ST4602	ST4601	CIRCULAR	2	-	101.1	195.67	195.7	0.01	0.013	3.0	4.1	4.6	5.8	NF	3.0	4.1	4.7	5.8	NF
SD4602	ST4603	ST4602	CIRCULAR	2	-	135	195.87	195.7	0.15	0.013	3.0	4.3	4.6	5.8	NF	3.0	4.2	4.7	5.8	NF
SD4603	ST4604	ST4603	CIRCULAR	2	-	265.6	197.91	195.9	0.29	0.011	3.0	4.6	5.0	5.8	NF	3.0	4.5	5.0	5.8	NF
SD4604	ST4605	ST4604	CIRCULAR	2	-	165.8	198.78	197.9	0.40	0.011	3.0	4.5	5.3	6.1	NF	3.0	4.5	5.3	6.0	NF
SD4605	ST4606	ST4605	CIRCULAR	2	-	352.4	200.59	198.8	0.43	0.011	3.0	4.5	5.3	6.6	NF	3.0	4.5	5.3	6.6	NF
SD4606	ST4607	ST4606	CIRCULAR	1.5	-	58.5	201.4	200.6	1.04	0.011	3.0	4.5	5.3	6.4	NF	3.0	4.5	5.3	6.4	NF
SD4607	ST4608	ST4607	CIRCULAR	1.5	-	186.5	202.57	201.4	0.41	0.011	3.0	4.5	5.3	6.4	NF	3.0	4.5	5.3	6.4	NF
SD4612	ST4609	ST4614	CIRCULAR	2.5	-	36	196.32	196.0	0.28	0.01	7.1	8.3	8.5	11.2	NF	7.1	8.2	8.5	11.2	NF
SD4609	ST4610	ST4609	CIRCULAR	2.5	-	86	196.84	196.3	0.08	0.011	6.6	7.8	8.1	10.5	NF	6.6	7.8	8.0	10.5	NF
SD4610	ST4611	ST4610	CIRCULAR	2.5	-	125	197.42	196.8	0.16	0.011	4.8	5.8	6.7	9.2	NF	4.8	5.8	6.7	9.2	NF
SD4611	ST4612	ST4611	CIRCULAR	2.5	-	102	198.17	197.4	0.34	0.011	4.8	5.8	6.7	9.2	NF	4.8	5.8	6.7	9.2	NF
SD4613	ST4613	ST4609	CIRCULAR	1.5	-	42	197.53	196.3	0.50	0.01	0.5	0.6	0.6	0.8	NF	0.5	0.6	0.6	0.8	NF
SD4608	ST4614	ST4600	CIRCULAR	3	-	36	195.97	190.2	0.92	0.011	15.0	20.3	23.1	28.9	NF	15.5	20.8	24.0	29.7	NF
SD4614	ST4615	ST4600	CIRCULAR	2.5	-	103.5	195.7	190.2	0.38	0.013	5.8	8.1	9.5	12.6	NF	5.8	8.0	9.5	12.7	NF
SD4615	ST4616	ST4615	CIRCULAR	2.5	-	58.3	196.06	195.7	0.27	0.013	5.8	8.2	9.5	12.6	NF	5.8	8.1	9.5	12.8	NF
SD4616	ST4617	ST4616	CIRCULAR	2.5	-	151.3	196.68	196.1	0.28	0.013	5.8	8.5	9.5	12.6	NF	5.8	8.4	9.5	12.7	NF

Table B-3. Hydaulic Model Inputs and Results																				
Conduit			Conduit Atributes								Existing Land Use Conditions					Future Land Use Conditions				
			Shape	Diameter (ft)/ Max Width (ft)	Depth (ft)	Length (ft)	Invert Elevation (ft)		Slope (%)	Manning's Roughness	Peak Flow (cfs)				When Hydraulically Deficient	Peak Flow (cfs)				When Hydraulically Deficient
ID	US Node	DS Node					US	DS			2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr		2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr	
SD4617	ST4618	ST4617	CIRCULAR	2.5	-	191.5	197.23	196.7	0.18	0.013	4.3	6.4	7.1	9.2	NF	4.3	6.4	7.0	9.2	NF
SD4618	ST4619	ST4618	CIRCULAR	2	-	134.6	198.35	197.2	0.68	0.011	1.4	2.2	2.5	3.2	NF	1.4	2.2	2.5	3.3	NF
SD4619	ST4620	ST4619	CIRCULAR	1.5	-	355.3	199.97	198.4	0.40	0.011	1.4	2.2	2.6	3.3	NF	1.4	2.2	2.7	3.3	NF
SD4620	ST4621	ST4620	CIRCULAR	1.5	-	142	200.83	200.0	0.46	0.011	1.4	2.2	2.6	3.3	NF	1.4	2.2	2.6	3.3	NF
SD4621	ST4622	ST4621	CIRCULAR	1.5	-	94.8	201.43	200.8	0.42	0.011	1.4	2.2	2.6	3.3	NF	1.4	2.2	2.6	3.3	NF
SD4622	ST4623	ST4622	CIRCULAR	1.5	-	106.3	202.53	201.4	0.85	0.011	1.4	2.2	2.6	3.3	NF	1.4	2.2	2.6	3.3	NF
SD4623	ST4624	ST4618	CIRCULAR	2	-	52.2	197.64	197.2	0.40	0.011	3.0	4.4	5.1	6.1	NF	3.0	4.4	5.1	6.2	NF
SD4624	ST4625	ST4624	CIRCULAR	2	-	47.6	198.06	197.6	0.46	0.011	3.0	4.4	5.2	6.1	NF	3.0	4.4	5.1	6.2	NF
SD4625	ST4626	ST4625	CIRCULAR	2	-	69.4	198.46	198.1	0.29	0.011	3.0	4.4	5.3	6.1	NF	3.0	4.4	5.2	6.2	NF
SD4626	ST4627	ST4626	CIRCULAR	2	-	58.4	198.89	198.5	0.39	0.011	3.0	4.4	5.3	6.2	NF	3.0	4.4	5.3	6.2	NF
SD4627	ST4628	ST4627	CIRCULAR	2	-	118.1	199.56	198.9	0.40	0.011	3.0	4.4	5.3	6.3	NF	3.0	4.4	5.3	6.3	NF
SD4628	ST4629	ST4628	CIRCULAR	1.5	-	44.5	200.15	199.6	0.88	0.011	3.0	4.4	5.3	6.5	NF	3.0	4.4	5.3	6.5	NF
SD4629	ST4630	ST4629	CIRCULAR	1.5	-	104.2	200.85	200.2	0.48	0.011	3.0	4.5	5.3	6.4	NF	3.0	4.5	5.3	6.4	NF
SD4630	ST4631	ST4630	CIRCULAR	1.5	-	95.2	201.33	200.9	0.29	0.011	3.0	4.5	5.3	6.5	NF	3.0	4.5	5.3	6.5	NF
SD4641	ST4633	ST4634	CIRCULAR	2.5	-	18.1	190.22	190.2	0.39	0.013	10.4	18.4	24.7	35.2	NF	10.5	18.9	25.5	36.5	NF
SD4633	ST4634	ST4635	CIRCULAR	2.5	-	100.3	190.15	189.3	0.54	0.013	10.4	18.4	24.7	35.2	NF	10.6	18.9	25.5	36.5	NF
SD4634	ST4635	ST4636	CIRCULAR	2.5	-	259.5	189.31	187.4	0.62	0.013	10.7	18.4	24.7	35.2	NF	11.6	18.9	25.5	36.5	NF
SD4635	ST4636	ST4637	CIRCULAR	3	-	262.3	187.4	189.4	-0.76	0.013	10.5	18.4	24.7	35.2	NF	10.6	18.9	25.5	36.5	NF
SD4637	ST4638	ST4639	CIRCULAR	2.5	-	85.7	189.38	188.4	1.10	0.013	9.6	17.1	18.4	19.8	NF	9.7	17.3	18.5	19.9	NF
SD4638	ST4639	ST4403	ARROWHEAD_CR	32	4	1200	188.44	170.5	1.50	0.035	12.5	20.1	23.3	27.8	NF	12.5	20.4	23.6	28.0	NF
SD4640	ST4640	O-SDDI	CIRCULAR	3	-	3151.9	189.38	168.1	0.68	0.013	0.9	1.3	6.1	15.2	NF	0.9	1.6	6.8	16.3	NF
3594	ST4656	ST4767	CIRCULAR	2.5	-	67.9	200.74	197.9	3.89	0.013	7.9	12.3	15.1	18.5	NF	8.3	12.9	16.0	19.3	NF
SD4654	ST4767	ST4614	CIRCULAR	2.5	-	59	197.9	196.0	3.27	0.013	7.9	12.3	14.9	18.4	NF	8.3	12.9	15.8	19.1	NF
949	ST4768	ST4656	CIRCULAR	2.5	-	55.2	201.23	200.7	0.62	0.013	7.9	12.3	14.8	18.5	NF	8.3	12.9	15.5	19.3	NF
950	ST4802	ST4768	CIRCULAR	2.5	-	109.6	202.54	201.2	1.01	0.013	7.9	12.3	14.8	18.5	NF	8.3	12.9	15.5	19.3	NF
SD4741	ST4803	ST4802	CIRCULAR	2.5	-	129.9	203.75	202.5	0.39	0.013	7.9	12.3	14.8	18.5	NF	8.3	12.9	15.5	19.3	NF
SD4830	ST4804	ST4803	CIRCULAR	2.5	-	268.2	205.38	203.8	0.53	0.013	6.2	9.8	11.8	14.8	NF	6.7	10.4	12.5	15.5	NF
SD4742	ST4805	ST4804	CIRCULAR	2.5	-	149.4	206.36	205.4	0.52	0.013	6.2	9.8	11.9	14.8	NF	6.7	10.4	12.5	15.5	NF
SD4789	ST4806	ST4805	CIRCULAR	2.5	-	116.6	207.03	206.4	0.40	0.013	6.2	9.8	11.9	14.8	NF	6.7	10.4	12.5	15.6	NF
SD4790	ST4828	ST4806	CIRCULAR	2	-	335.2	208.63	207.0	0.42	0.013	3.0	4.8	5.9	7.4	NF	3.5	5.4	6.5	8.1	NF
SD4752	ST4829	ST4828	CIRCULAR	2	-	335.2	211.99	208.6	1.00	0.013	3.0	4.9	5.9	7.4	NF	3.5	5.5	6.6	8.1	NF
SD5000	ST5000	ST5209	CIRCULAR	1	-	56	108.6	90.9	32.36	0.024	11.4	14.0	14.6	15.3	2-yr, 24-hr	11.4	14.0	14.6	15.3	2-yr, 24-hr
SD5001	ST5001	ST5000	CIRCULAR	1.25	-	120	124.12	108.6	12.89	0.024	11.4	14.3	14.7	15.3	10-yr, 24-hr	11.5	14.4	14.7	15.3	10-yr, 24-hr
SD5002	ST5002	ST5001	CIRCULAR	2	-	113	138.96	124.1	14.63	0.024	11.4	17.8	19.5	20.2	10-yr, 24-hr	11.5	17.8	19.5	20.2	10-yr, 24-hr
SD5003	ST5003	ST5002	CIRCULAR	1.5	-	34	145.4	139.0	2.44	0.024	6.5	10.0	11.3	13.3	10-yr, 24-hr	6.5	10.0	11.3	13.3	10-yr, 24-hr
SD5004	ST5004	ST5003	CIRCULAR	1.5	-	154.8	158.38	145.4	8.41	0.011	6.5	9.9	11.7	14.9	NF	6.5	9.9	11.7	14.9	NF
SD5005	ST5005	ST5004	CIRCULAR	1.5	-	129	161.19	158.4	2.02	0.011	4.5	6.7	7.9	10.2	NF	4.5	6.7	7.9	10.2	NF
SD5006	ST5006	ST5005	CIRCULAR	1.5	-	319.1	163.74	161.2	0.74	0.011	4.5	6.7	7.9	10.2	NF	4.5	6.7	7.9	10.2	NF
SD5007	ST5007	ST5006	CIRCULAR	1.25	-	84.1	164.9	163.7	0.43	0.011	1.2	1.7	2.0	3.1	NF	1.2	1.7	2.0	3.0	NF
SD5008	ST5008	ST5007	CIRCULAR	1.25	-	82.4	165.39	164.9	0.59	0.011	1.2	1.7	2.0	3.4	NF	1.2	1.7	2.0	3.4	NF
SD5009	ST5009	ST5008	CIRCULAR	1.25	-	100	165.88	165.4	0.49	0.011	1.2	1.7	2.0	3.4	NF	1.2	1.7	2.0	3.4	NF
SD5010	ST5010	ST5009	CIRCULAR	1.25	-	100	166.39	165.9	0.51	0.011	1.2	1.7	2.0	3.4	NF	1.2	1.7	2.0	3.4	NF
SD5011	ST5011	ST5010	CIRCULAR	1	-	100	166.89	166.4	0.50	0.011	1.2	1.7	2.0	3.2	NF	1.2	1.7	2.0	3.2	NF
SD5012	ST5012	ST5011	CIRCULAR	1	-	100	167.39	166.9	0.50	0.011	1.2	1.7	2.0	3.2	NF	1.2	1.7	2.0	3.2	NF
SD5013	ST5013	ST5012	CIRCULAR	1	-	100	167.89	167.4	0.50	0.011	1.2	1.7	2.0	3.2	NF	1.2	1.7	2.0	3.2	NF
SD5014	ST5014	ST5013	CIRCULAR	1	-	70.5	168.05	167.9	0.23	0.011	1.2	1.7	2.0	3.2	NF	1.2	1.7	2.0	3.2	NF
SD5015	ST5015	ST5014	CIRCULAR	1.5	-	292.7	169.56	168.1	0.43	0.011	1.2	1.7	2.0	3.5	NF	1.2	1.7	2.0	3.5	NF
SD5016	ST5016	ST5015	CIRCULAR	1.5	-	248.9	170.98	169.6	0.49	0.011	1.2	1.7	2.0	3.7	NF	1.2	1.7	2.0	3.7	NF
SD5017	ST5017	ST5016	CIRCULAR	1.5	-	132.4	171.76	171.0	0.44	0.011	1.2	1.7	2.0	3.6	NF	1.2	1.7	2.0	3.6	NF
SD5018	ST5017	ST5018	CIRCULAR	1.5	-	169.7	171.76	171.1	0.23	0.011	0.8	1.2	1.5	1.8	NF	0.8	1.2	1.5	1.8	NF
SD5019	ST5018	ST5019	CIRCULAR	1.5	-	167.1	171.09	170.0	0.45	0.011	0.8	1.2	1.5	2.0	NF	0.8	1.2	1.5	2.0	NF

Table B-3. Hydaulic Model Inputs and Results																				
Conduit			Conduit Atributes								Existing Land Use Conditions					Future Land Use Conditions				
			Shape	Diameter (ft)/ Max Width (ft)	Depth (ft)	Length (ft)	Invert Elevation (ft)		Slope (%)	Manning's Roughness	Peak Flow (cfs)				When Hydraulically Deficient	Peak Flow (cfs)				When Hydraulically Deficient
ID	US Node	DS Node					US	DS			2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr		2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr	
SD5020	ST5019	ST5020	CIRCULAR	1.5	-	109.3	170	169.4	0.38	0.011	4.2	6.3	7.2	7.6	NF	4.2	6.3	7.2	7.6	NF
SD5021	ST5020	ST3448	CIRCULAR	1.5	-	87.6	169.38	168.7	0.59	0.011	4.2	6.3	7.1	7.6	NF	4.2	6.3	7.1	7.6	NF
SD5022	ST5021	ST5017	CIRCULAR	1.25	-	100	172.92	171.8	0.96	0.011	2.0	2.9	3.4	4.1	NF	2.0	2.9	3.4	4.1	NF
SD5023	ST5022	ST5021	CIRCULAR	1.25	-	100	173.42	172.9	0.50	0.011	2.0	2.9	3.4	4.1	NF	2.0	2.9	3.4	4.1	NF
SD5024	ST5023	ST5019	CIRCULAR	1.5	-	154.3	171.31	170.0	0.63	0.011	3.4	5.1	5.9	7.0	NF	3.4	5.1	5.9	7.0	NF
SD5025	ST5024	ST5023	CIRCULAR	1.25	-	159.8	172.11	171.3	0.38	0.011	3.4	5.1	5.9	7.0	NF	3.4	5.1	5.9	7.0	NF
SD5026	ST5025	ST5002	CIRCULAR	2	-	88	145.03	139.0	0.92	0.024	4.1	6.5	6.9	7.6	10-yr, 24-hr	4.1	6.5	6.9	7.6	10-yr, 24-hr
SD5027	ST5026	ST5025	CIRCULAR	2	-	181	146.43	145.0	0.66	0.024	4.1	6.8	8.7	9.0	25-yr, 24-hr	4.1	6.8	7.7	9.0	25-yr, 24-hr
SD5028	ST5027	ST5026	CIRCULAR	1.25	-	180	152.77	146.4	3.36	0.024	4.1	6.6	7.3	7.9	25-yr, 24-hr	4.1	6.6	7.1	7.9	25-yr, 24-hr
SD5029	ST5028	ST5027	CIRCULAR	1.25	-	97	157.4	152.8	4.53	0.024	4.1	6.7	7.3	8.3	25-yr, 24-hr	4.1	6.6	7.2	8.3	25-yr, 24-hr
SD5030	ST5029	ST5028	CIRCULAR	1.25	-	27	157.89	157.4	1.37	0.024	1.9	3.0	4.1	4.9	100-yr, 24-hr	1.9	3.0	4.0	4.8	100-yr, 24-hr
SD5031	ST5030	ST5029	CIRCULAR	1.25	-	38.1	159.14	157.9	1.60	0.011	1.9	3.9	4.0	4.8	100-yr, 24-hr	1.9	3.8	4.0	4.8	100-yr, 24-hr
SD5032	ST5031	ST5030	CIRCULAR	1.25	-	88.3	160.04	159.1	0.79	0.011	1.9	3.3	3.9	4.8	NF	1.9	3.3	3.9	4.7	NF
SD5033	ST5032	ST5031	CIRCULAR	1.25	-	47.8	160.69	160.0	0.94	0.011	1.9	2.9	4.1	4.7	NF	1.9	2.9	4.1	4.7	NF
SD5034	ST5033	ST5032	CIRCULAR	1.25	-	372.1	164.77	160.7	1.04	0.011	1.9	2.9	3.8	4.7	100-yr, 24-hr	1.9	2.9	3.7	4.7	100-yr, 24-hr
SD5035	ST5034	ST5002	CIRCULAR	1.25	-	372	152.22	139.0	2.00	0.024	0.9	1.5	2.6	3.0	25-yr, 24-hr	0.9	1.5	2.6	3.0	25-yr, 24-hr
SD5036	ST5035	ST5034	CIRCULAR	1.25	-	179	161.98	152.2	5.21	0.024	0.9	1.5	1.8	2.0	NF	0.9	1.5	1.8	2.0	NF
SD5037	ST5036	ST5035	CIRCULAR	1.25	-	119	167.87	162.0	4.74	0.024	0.9	1.5	1.8	2.0	NF	0.9	1.5	1.8	2.0	NF
SD5038	ST5037	ST5036	CIRCULAR	1.25	-	188	169.38	167.9	0.69	0.024	0.9	1.5	1.8	2.0	NF	0.9	1.5	1.8	2.0	NF
SD5219	ST5038	POND_LIBRARY	CIRCULAR	4	-	190	143.45	140.8	1.11	0.013	38.9	59.9	71.1	88.2	NF	43.5	66.0	78.4	96.6	NF
SD5039	ST5039	ST5038	CIRCULAR	4	-	308.1	155.16	143.5	0.92	0.013	35.1	54.3	64.4	79.2	NF	39.7	60.7	71.4	87.5	NF
SD5200	ST5200	ST5204	BOECKMAN_CR2	40	10	1200	78.85	71.7	0.60	0.035	199.1	271.7	306.4	352.8	NF	234.8	306.3	337.9	380.4	NF
SD5201	ST5201	ST5200	BOECKMAN_CR2	40	10	930	94.45	78.9	1.68	0.035	158.2	210.3	236.4	299.5	NF	194.6	256.4	297.1	299.1	NF
SD5202	ST5202	ST5201	KOLBE_BRIDGE	55	11	70	92.45	94.5	-2.86	0.035	158.2	210.3	236.4	299.5	NF	194.6	256.4	297.1	299.2	NF
SD5203	ST5203	ST5202	BOECKMAN_CR2	40	10	430	94.45	92.5	0.47	0.035	158.3	210.3	236.4	299.5	NF	194.6	256.6	297.1	299.3	NF
SD5205	ST5204	ST5205	MEMORIAL_PARK_BRII	88	20	55	71.7	71.7	0.02	0.035	198.5	271.3	305.9	351.5	NF	234.6	304.8	336.3	379.1	NF
SD5206	ST5205	05200	BOECKMAN_CR2	40	10	1500	71.69	63.5	0.55	0.035	198.3	271.1	305.7	350.9	NF	234.5	304.2	335.7	378.7	NF
SD5207	ST5206	ST5200	BOECKMAN_CR	37	9	500	83.65	78.9	0.96	0.035	40.9	57.6	64.5	69.5	NF	43.2	59.3	66.3	71.8	NF
SD5208	ST5207	ST5206	BOECKMAN_CR	37	9	150	85.1	83.7	0.97	0.035	24.7	38.1	45.0	49.8	NF	26.2	39.8	46.7	52.0	NF
SD5210	ST5208	ST5207	CIRCULAR	2	-	201	87.14	85.1	1.02	0.024	11.4	14.0	14.6	15.3	NF	11.4	14.0	14.6	15.3	NF
SD5211	ST5209	ST5208	CIRCULAR	1.5	-	50	90.89	87.1	6.65	0.024	11.4	14.0	14.6	15.3	NF	11.5	14.0	14.6	15.3	NF
SD5212	ST5210	ST5206	CIRCULAR	1.75	-	164.3	102.15	83.7	5.61	0.024	19.3	20.0	21.9	21.9	NF	19.8	20.2	21.7	21.8	NF
SD5213	ST5211	ST5210	CIRCULAR	1.75	-	125	109.15	102.2	5.61	0.024	19.3	20.1	20.8	21.0	NF	20.0	20.2	21.0	20.8	NF
SD5214	ST5212	ST5211	CIRCULAR	1.75	-	105.4	115.05	109.2	5.61	0.024	19.3	20.1	20.8	21.1	NF	20.0	20.2	20.8	20.8	NF
SD5215	ST5213	ST5212	CIRCULAR	1.75	-	123.2	121.95	115.1	5.61	0.024	19.3	20.2	20.7	21.4	NF	20.0	20.2	20.7	20.7	NF
SD5216	ST5214	ST5213	CIRCULAR	1.75	-	108.9	128.05	122.0	5.61	0.024	19.3	20.8	20.9	21.6	NF	20.9	20.9	20.9	20.8	NF
SD5217	ST5215	ST5214	CIRCULAR	1.75	-	141.1	135.95	128.1	5.61	0.024	19.3	20.8	20.9	21.6	NF	20.8	20.9	20.9	20.8	NF
SD5501	ST5500	05500	S_FORK_MERIDIAN_CF	22	4	282.7	71.45	63.5	2.83	0.035	20.7	34.1	42.2	54.1	NF	20.7	34.1	42.3	54.2	NF
SD5502	ST5501	ST5500	S_FORK_MERIDIAN_CF	22	4	1130	111.45	71.5	3.54	0.035	20.8	34.3	42.5	54.4	NF	20.8	34.3	42.5	54.4	NF
SD5701	ST5701	05701	CIRCULAR	1.25	-	79.1	84.07	72.0	15.48	0.024	5.5	9.2	10.9	12.8	NF	5.9	9.7	11.2	13.4	NF
SD5702	ST5702	ST5701	CIRCULAR	1.25	-	158	86.6	84.1	1.60	0.013	5.5	9.2	10.9	13.1	25-yr, 24-hr	5.9	9.8	11.2	13.3	25-yr, 24-hr
SD5703	ST5703	ST5702	CIRCULAR	1.25	-	126	89.82	86.6	2.40	0.013	5.5	9.2	10.9	12.9	100-yr, 24-hr	5.9	9.8	11.3	13.0	100-yr, 24-hr
SD5704	ST5704	ST5703	CIRCULAR	1	-	103	95.76	89.8	4.68	0.013	3.1	5.1	6.1	7.1	100-yr, 24-hr	3.3	5.4	6.4	7.3	100-yr, 24-hr
SD5705	ST5705	ST5704	CIRCULAR	1.25	-	160	96.61	95.8	0.40	0.013	3.1	5.1	6.1	7.1	100-yr, 24-hr	3.3	5.4	6.4	7.2	25-yr, 24-hr
SD5706	ST5706	ST5705	CIRCULAR	1.25	-	199.8	97.61	96.6	0.40	0.013	3.1	5.1	6.1	7.6	25-yr, 24-hr	3.3	5.4	7.0	7.9	25-yr, 24-hr
SD5719	ST5707	ST5719	CIRCULAR	3.5	-	260	100.45	99.0	0.56	0.013	18.4	24.0	25.9	28.7	25-yr, 24-hr	19.8	24.6	27.1	29.6	10-yr, 24-hr
SD5708	ST5708	ST5707	CIRCULAR	4	-	270	101.32	100.5	0.32	0.013	18.4	24.6	28.6	33.5	25-yr, 24-hr	19.9	25.1	31.0	35.0	10-yr, 24-hr
SD5709	ST5709	ST5708	CIRCULAR	3.5	-	165	102.47	101.3	0.70	0.013	18.4	26.5	29.9	37.5	10-yr, 24-hr	19.9	27.5	33.7	39.5	10-yr, 24-hr
SD5710	ST5710	ST5709	CIRCULAR	4	-	246	107.43	102.5	1.79	0.011	10.6	18.1	19.9	24.2	NF	10.6	15.7	20.0	23.7	NF
SD5711	ST5711	ST5710	CIRCULAR	4	-	224.6	121.09	107.4	6.00	0.011	10.6	17.4	19.9	22.4	NF	10.6	17.4	19.4	22.4	NF
SD5712	ST5712	ST5711	CIRCULAR	4	-	314	137.34	121.1	5.15	0.011	10.6	15.9	18.7	22.4	NF	10.6	15.9	18.7	22.4	NF

Table B-3. Hydaulic Model Inputs and Results																				
Conduit			Conduit Atributes								Existing Land Use Conditions					Future Land Use Conditions				
			Shape	Diameter (ft)/ Max Width (ft)	Depth (ft)	Length (ft)	Invert Elevation (ft)		Slope (%)	Manning's Roughness	Peak Flow (cfs)				When Hydraulically Deficient	Peak Flow (cfs)				When Hydraulically Deficient
ID	US Node	DS Node					US	DS			2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr		2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr	
SD5713	ST5713	ST5712	CIRCULAR	4	-	358.4	150.79	137.3	3.73	0.011	10.6	15.9	18.7	22.4	NF	10.6	15.9	18.7	22.4	NF
SD5714	ST5714	O5702	CIRCULAR	1.25	-	67	88.49	62.5	44.03	0.024	18.4	22.5	24.4	26.5	100-yr, 24-hr	19.7	22.9	25.0	26.9	100-yr, 24-hr
SD5209	ST5715	ST5207	BOECKMAN_CR	37	9	267	90	85.1	0.92	0.035	9.4	17.4	21.8	22.9	NF	10.9	19.1	23.5	25.0	NF
SD5715	ST5716	ST5715	CIRCULAR	2.5	-	198	90.69	90.0	0.35	0.013	9.5	17.6	21.9	23.1	NF	10.9	19.2	23.6	25.2	NF
SD5716	ST5717	ST5716	CIRCULAR	2.5	-	131	91.23	90.7	0.26	0.013	9.5	17.6	21.9	23.1	NF	10.9	19.3	23.6	25.2	NF
SD5717	ST5718	ST5717	CIRCULAR	2.5	-	123	91.7	91.2	0.22	0.013	9.6	17.6	21.9	23.1	NF	11.0	19.3	23.6	25.2	NF
SD5707	ST5719	ST5714	CIRCULAR	1.75	-	108	99	88.5	10.99	0.024	18.4	22.5	24.4	26.6	10-yr, 24-hr	19.7	22.9	25.1	27.0	10-yr, 24-hr
SD6000	ST6000	O6000	CIRCULAR	2.5	-	466.3	117.95	60.5	11.84	0.013	29.7	43.8	51.2	60.3	NF	29.7	43.8	51.2	60.3	NF
SD6001	ST6001	ST6000	CIRCULAR	2.5	-	182.4	122.86	118.0	4.23	0.013	29.8	43.9	51.3	60.3	NF	29.8	43.9	51.3	60.3	NF
SD6002	ST6002	ST6001	CIRCULAR	2.5	-	632.1	135.95	122.9	1.54	0.013	23.1	31.7	36.0	41.9	NF	23.1	31.7	36.1	41.9	NF
SD6003	ST6003	ST6002	CIRCULAR	2.5	-	167.5	137.28	136.0	0.79	0.013	23.1	31.8	36.1	41.5	NF	23.1	31.8	36.2	41.5	NF
SD6004	ST6004	ST6003	CIRCULAR	2.5	-	196.6	138.85	137.3	0.80	0.013	18.8	25.8	28.3	32.2	NF	18.8	25.8	28.3	32.2	NF
SD6005	ST6005	ST6004	CIRCULAR	2.5	-	68	139.17	138.9	0.47	0.013	14.0	18.2	20.0	22.6	NF	14.0	18.2	20.0	22.6	NF
SD6006	ST6006	ST6005	CIRCULAR	1.5	-	297.9	141.48	139.2	0.87	0.013	14.0	18.1	20.0	22.6	10-yr, 24-hr	14.0	18.1	20.0	22.6	10-yr, 24-hr
SD6007	ST6007	ST6006	CIRCULAR	2	-	302	142.11	141.5	0.21	0.013	14.0	18.5	20.4	23.3	10-yr, 24-hr	14.0	18.5	20.4	23.3	10-yr, 24-hr
SD6008	ST6008	ST6007	CIRCULAR	2	-	79	142.55	142.1	0.30	0.013	3.7	6.7	6.8	6.9	10-yr, 24-hr	3.7	6.5	6.8	6.9	10-yr, 24-hr
SD6009	ST6009	ST6008	CIRCULAR	2	-	112	142.9	142.6	0.31	0.013	3.7	6.2	6.1	6.2	10-yr, 24-hr	3.7	6.2	6.2	6.2	10-yr, 24-hr
SD6010	ST6010	ST6009	CIRCULAR	1.5	-	197	143.59	142.9	0.30	0.013	3.7	5.6	5.3	5.3	10-yr, 24-hr	3.7	5.6	5.4	5.3	10-yr, 24-hr
SD6011	ST6011	ST6010	CIRCULAR	1.5	-	154	144.25	143.6	0.30	0.013	3.5	4.8	4.8	5.4	10-yr, 24-hr	3.8	4.8	4.8	5.2	10-yr, 24-hr
SD6012	ST6012	ST6011	CIRCULAR	1.5	-	79	144.69	144.3	0.30	0.013	3.6	5.5	6.3	6.0	10-yr, 24-hr	4.0	5.4	5.8	6.3	10-yr, 24-hr
SD6013	ST6013	ST6012	CIRCULAR	1.5	-	177	145.43	144.7	0.31	0.013	3.5	6.2	5.5	7.5	10-yr, 24-hr	3.7	5.3	6.9	6.9	10-yr, 24-hr
SD6014	ST6014	ST6004	CIRCULAR	1.75	-	303.3	141.45	138.9	0.82	0.013	4.9	7.7	8.7	9.7	NF	4.9	7.7	8.7	9.7	NF
SD6015	ST6015	ST6014	CIRCULAR	1.5	-	290	143.21	141.5	0.52	0.013	4.9	7.7	8.8	9.7	NF	4.9	7.7	8.8	9.7	NF
SD6016	ST6016	ST6015	CIRCULAR	1.5	-	251	144.97	143.2	0.70	0.013	4.9	7.7	8.8	9.7	NF	4.9	7.7	8.8	9.7	NF
SD6017	ST6017	ST6016	CIRCULAR	1.5	-	89	145.42	145.0	0.51	0.013	4.9	7.8	8.8	9.7	NF	4.9	7.8	8.8	9.7	NF
SD6018	ST6018	ST6017	CIRCULAR	1.5	-	60	145.99	145.4	0.95	0.013	4.9	7.8	8.8	9.7	100-yr, 24-hr	4.9	7.8	8.8	9.7	100-yr, 24-hr
SD6019	ST6019	ST6018	CIRCULAR	1.5	-	160	147.08	146.0	0.68	0.013	4.9	7.8	8.8	9.8	100-yr, 24-hr	4.9	7.8	8.8	9.8	100-yr, 24-hr
SD6020	ST6020	ST6019	CIRCULAR	1.5	-	177	147.97	147.1	0.50	0.013	4.9	7.8	8.8	10.0	100-yr, 24-hr	4.9	7.8	8.8	10.0	100-yr, 24-hr
SD6021	ST6021	ST6020	CIRCULAR	1.25	-	114	148.43	148.0	0.18	0.013	4.9	7.8	8.8	10.3	25-yr, 24-hr	4.9	7.8	8.8	10.3	25-yr, 24-hr
SD6022	ST6022	O6001	I5	16	2	300	108.45	73.5	11.75	0.035	26.3	39.3	45.8	54.5	NF	26.3	39.3	45.9	54.4	NF
SD6023	ST6023	ST6022	I5	16	2	80	111.36	108.5	3.64	0.035	19.2	28.5	32.0	38.0	NF	19.2	28.5	32.0	37.9	NF
SD6024	ST6024	ST6023	CIRCULAR	3.5	-	50	120.41	111.4	18.40	0.013	19.2	28.5	32.0	38.0	NF	19.2	28.5	32.0	37.9	NF
SD6025	ST6025	ST6024	I5	16	2	20	123.14	120.4	13.78	0.035	19.2	28.5	32.0	38.0	NF	19.2	28.5	32.0	37.9	NF
SD6026	ST6026	ST6025	I5	16	2	700	132.99	123.1	1.41	0.035	19.2	28.5	32.0	38.0	NF	19.2	28.5	32.0	37.9	NF
SD6027	ST6027	ST6026	CIRCULAR	3.5	-	33	133.08	133.0	0.27	0.013	19.3	28.5	32.0	38.0	NF	19.3	28.5	32.0	38.0	NF
SD6028	ST6028	ST6027	CIRCULAR	3.5	-	394	134.09	133.1	0.26	0.013	19.3	28.5	32.0	38.1	NF	19.3	28.5	32.0	38.0	NF
SD6029	ST6029	ST6028	CIRCULAR	3.5	-	394	135.08	134.1	0.25	0.013	19.3	28.6	32.1	38.1	NF	19.3	28.6	32.1	38.1	NF
SD6030	ST6030	ST6029	CIRCULAR	3.5	-	394	136.06	135.1	0.25	0.013	19.3	28.7	32.1	38.3	NF	19.3	28.7	32.2	38.2	NF
SD6031	ST6031	ST6030	CIRCULAR	3.5	-	394	137.05	136.1	0.25	0.013	19.4	28.7	32.1	38.4	NF	19.4	28.7	32.2	38.4	NF
SD6032	ST6032	ST6031	CIRCULAR	3.5	-	394	138.03	137.1	0.25	0.013	14.1	21.1	23.4	27.6	NF	14.1	21.1	23.1	27.5	NF
SD6033	ST6033	ST6032	CIRCULAR	3.5	-	246	138.62	138.0	0.24	0.013	14.1	21.1	23.5	27.7	NF	14.1	21.1	23.3	27.6	NF
SD6034	ST6034	ST6033	CIRCULAR	3.5	-	254.4	139.24	138.6	0.24	0.013	14.1	21.2	23.8	27.8	NF	14.1	21.2	23.4	27.6	NF
SD6035	ST6035	ST6034	CIRCULAR	3	-	131	139.88	139.2	0.49	0.013	14.1	21.2	24.1	27.9	NF	14.1	21.2	23.5	27.7	NF
SD6036	ST6036	ST6035	CIRCULAR	2.25	-	131	142.21	139.9	1.40	0.013	14.1	21.2	24.3	28.0	NF	14.1	21.2	23.6	27.8	NF
SD6200	ST6200	O6200	COFFEE_CR4	27	4	650	79.45	62.2	2.66	0.035	370.6	484.3	525.3	529.3	NF	427.5	479.5	515.4	633.0	NF
SD6201	ST6201	ST6200	COFFEE_CR4	27	4	420	88.45	79.5	2.14	0.035	370.7	484.3	525.4	529.3	NF	427.6	479.7	515.6	633.1	NF
SD6202	ST6202	ST6201	ARROWHEAD_CR2	28	6	850	125.45	88.5	4.36	0.035	60.8	86.5	97.5	111.9	NF	64.3	92.2	102.9	117.2	NF
SD6203	ST6203	ST6202	ARROWHEAD_CR2	28	6	900	143.45	125.5	2.00	0.035	61.2	86.7	97.5	111.9	NF	64.5	92.4	103.0	117.3	NF
SD6205	ST6204	ST6201	COFFEE_CR4	27	4	900	123.95	88.5	3.95	0.035	323.6	384.7	413.8	443.0	NF	347.4	399.3	437.7	479.8	NF
SD6206	ST6205	ST6204	COFFEE_CR4	27	4	1300	134.95	124.0	0.85	0.035	323.6	384.7	413.8	443.1	NF	347.5	399.3	437.7	479.8	NF
SD6400	ST6400	O6400	CIRCULAR	2.5	-	10	146.95	145.0	20.41	0.011	4.5	7.3	9.0	11.5	NF	4.5	7.3	9.0	11.5	NF

Table B-3. Hydaulic Model Inputs and Results																				
Conduit			Conduit Atributes								Existing Land Use Conditions					Future Land Use Conditions				
			Shape	Diameter (ft)/ Max Width (ft)	Depth (ft)	Length (ft)	Invert Elevation (ft)		Slope (%)	Manning's Roughness	Peak Flow (cfs)				When Hydraulically Deficient	Peak Flow (cfs)				When Hydraulically Deficient
ID	US Node	DS Node					US	DS			2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr		2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr	
SD6401	ST6401	ST6400	CIRCULAR	2.5	-	109	148.55	147.0	0.59	0.013	4.5	7.3	9.0	11.5	NF	4.5	7.3	9.0	11.5	NF
SD6402	ST6402	ST6401	CIRCULAR	2.5	-	229.6	149.5	148.6	0.25	0.013	4.5	7.3	9.0	11.6	NF	4.5	7.3	9.0	11.6	NF
SD6403	ST6403	ST6402	CIRCULAR	2.5	-	217.4	150.99	149.5	0.46	0.011	4.5	7.3	9.0	11.6	NF	4.5	7.3	9.0	11.6	NF
SD6404	ST6404	ST6403	CIRCULAR	2.5	-	207	151.76	151.0	0.33	0.011	4.5	7.4	9.1	11.6	NF	4.5	7.4	9.1	11.6	NF
SD6405	ST6405	ST6404	CIRCULAR	2	-	75.4	152.6	151.8	0.85	0.011	4.5	7.4	9.1	11.6	NF	4.5	7.4	9.1	11.6	NF
SD6406	ST6406	ST6405	CIRCULAR	2	-	89	153.47	152.6	0.98	0.011	2.6	4.2	5.2	6.6	NF	2.6	4.2	5.2	6.6	NF
SD6407	ST6407	ST6406	CIRCULAR	2	-	172.2	155.78	153.5	1.34	0.011	2.6	4.2	5.2	6.6	NF	2.6	4.2	5.2	6.6	NF
SD6408	ST6408	ST6407	CIRCULAR	1.5	-	109.3	158.01	155.8	1.47	0.011	2.6	4.2	5.2	6.6	NF	2.6	4.2	5.2	6.6	NF
SD6409	ST6409	ST6408	CIRCULAR	1.5	-	45.3	158.66	158.0	1.35	0.011	2.6	4.2	5.2	6.6	NF	2.6	4.2	5.2	6.6	NF
SD6410	ST6410	ST6409	CIRCULAR	1.25	-	219.7	161.47	158.7	1.17	0.011	2.6	4.2	5.2	6.6	NF	2.6	4.2	5.2	6.6	NF
SD6411	ST6411	ST6410	CIRCULAR	1.25	-	346	164.48	161.5	0.81	0.011	2.6	4.3	5.2	6.6	NF	2.6	4.3	5.2	6.6	NF
SD6204	ST6412	ST6203	CIRCULAR	4	-	70	149.45	143.5	8.60	0.013	61.4	86.8	97.5	111.9	NF	64.6	92.5	103.0	117.3	NF
SD6414	ST6413	ST6414	ARROWHEAD_CR2	28	6	50	159.45	158.7	1.56	0.035	51.8	71.4	80.6	92.6	NF	53.1	73.8	82.6	94.2	NF
SD6415	ST6414	ST6415	CIRCULAR	3.5	-	100	158.67	157.1	1.56	0.024	51.2	71.3	80.0	92.6	NF	52.2	73.6	82.2	94.2	NF
SD6412	ST6415	ST6412	ARROWHEAD_CR2	28	6	490	157.1	149.5	1.56	0.035	50.9	71.2	80.0	92.6	NF	51.8	73.6	82.2	94.2	NF
SD6601	ST6601	06600	CIRCULAR	1.5	-	37.1	100.63	97.1	9.58	0.013	8.9	12.4	14.4	17.3	NF	9.1	12.5	14.5	17.4	NF
SD6602	ST6602	ST6601	CIRCULAR	1.5	-	53.4	114.29	100.6	26.04	0.013	8.9	12.4	14.4	17.3	NF	9.1	12.5	14.5	17.4	NF
SD6603	ST6603	ST6602	CIRCULAR	1.5	-	149.2	129.78	114.3	10.30	0.013	8.9	12.4	14.4	17.3	NF	9.1	12.5	14.5	17.4	NF
SD6604	ST6604	ST6603	CIRCULAR	1.75	-	233.4	139.31	129.8	4.00	0.013	8.9	12.4	14.4	17.3	NF	9.1	12.5	14.5	17.4	NF
SD6605	ST6605	ST6604	CIRCULAR	1.75	-	178.1	147.4	139.3	4.43	0.013	8.9	12.4	14.4	17.3	NF	9.1	12.5	14.5	17.4	NF
SD6606	ST6606	ST6605	CIRCULAR	0.83	-	144.2	150.98	147.4	2.35	0.013	4.2	5.3	5.9	6.8	10-yr, 24-hr	4.3	5.4	6.0	6.9	10-yr, 24-hr
SD6607	ST6607	ST6606	CIRCULAR	1	-	120.7	153.15	151.0	1.62	0.013	4.2	5.4	6.1	7.1	10-yr, 24-hr	4.3	5.5	6.3	7.3	10-yr, 24-hr
SD6608	ST6608	ST6607	CIRCULAR	1	-	245	156.07	153.2	1.10	0.013	4.2	5.7	6.4	7.6	10-yr, 24-hr	4.3	5.8	6.6	7.8	10-yr, 24-hr
SD6609	ST6609	ST6608	CIRCULAR	1	-	165.6	158.29	156.1	1.08	0.013	4.2	6.0	7.1	8.6	10-yr, 24-hr	4.3	6.2	7.3	8.8	10-yr, 24-hr
SD6610	ST6610	ST6609	CIRCULAR	1	-	77	159.64	158.3	1.40	0.013	4.2	6.4	7.7	9.6	10-yr, 24-hr	4.4	6.7	8.0	9.8	10-yr, 24-hr
SD6630	ST6618	ST6619	CIRCULAR	0.83	-	117.9	160.03	155.8	3.32	0.013	0.0	0.0	0.1	0.4	NF	0.0	0.0	0.2	1.9	NF
SD6632	ST6619	ST6606	CIRCULAR	0.83	-	348.8	155.79	151.0	1.35	0.013	0.0	1.1	1.2	1.5	NF	0.0	1.2	1.2	1.5	100-yr, 24-hr
SD6616	ST6653	ST6654	CIRCULAR	1.5	-	210.7	171.05	167.7	1.57	0.013	3.4	5.1	6.1	7.5	NF	3.4	5.2	6.2	7.6	NF
SD6617	ST6654	ST6655	CIRCULAR	1.5	-	197	167.65	161.9	2.89	0.013	3.4	5.1	6.1	7.5	NF	3.4	5.2	6.2	7.6	NF
SD6619	ST6655	STD6604	CIRCULAR	2	-	213.9	161.85	161.0	0.42	0.013	3.4	5.1	6.1	7.4	NF	3.4	5.2	6.2	7.6	NF
SD9000	ST9001	09000	CIRCULAR	3	-	74	100.78	100.6	0.24	0.024	34.8	51.9	62.5	71.6	NF	34.8	51.9	62.5	70.7	NF
SD9001	ST9002	ST9001	CIRCULAR	3.5	-	317	101.89	100.8	0.32	0.024	34.8	51.9	62.5	71.6	10-yr, 24-hr	34.8	51.9	62.5	70.7	10-yr, 24-hr
SD9002	ST9003	ST9002	CIRCULAR	3.5	-	504.5	109.78	101.9	1.54	0.024	35.2	55.0	65.2	72.1	25-yr, 24-hr	35.2	55.0	65.2	71.1	25-yr, 24-hr
SD9003	ST9004	ST9003	CIRCULAR	3	-	436.8	119.75	109.8	2.17	0.013	21.1	33.2	40.0	45.9	NF	21.1	33.2	40.0	46.4	NF
SD9004	ST9005	ST9004	CIRCULAR	3	-	498	126.25	119.8	1.29	0.013	21.1	33.2	40.4	45.9	NF	21.1	33.2	40.4	46.6	NF
SD9005	ST9006	ST9005	CIRCULAR	3	-	460	127.45	126.3	0.24	0.013	21.1	33.2	40.5	53.2	NF	21.1	33.2	40.5	53.4	100-yr, 24-hr
SD9006	ST9007	ST9006	CIRCULAR	3	-	402.2	139.5	127.5	2.97	0.013	14.5	22.7	27.3	31.7	NF	14.5	22.7	27.3	31.9	NF
SD9007	ST9008	ST9007	CIRCULAR	3	-	283.7	141.13	139.5	0.57	0.013	14.5	22.7	27.3	31.7	NF	14.5	22.7	27.3	31.7	NF
SD9008	ST9009	ST9008	CIRCULAR	3	-	86.3	141.35	141.1	0.26	0.013	14.6	22.7	27.3	31.7	NF	14.6	22.7	27.3	31.7	NF
SD9009	ST9010	ST9009	CIRCULAR	3	-	379.9	143.25	141.4	0.50	0.013	14.6	22.7	27.4	31.7	NF	14.6	22.7	27.4	31.7	NF
SD9010	ST9011	ST9010	CIRCULAR	3	-	432.6	144.96	143.3	0.40	0.013	14.6	22.8	27.5	31.9	NF	14.6	22.8	27.5	31.9	NF
SD9011	ST9012	ST9011	CIRCULAR	2	-	315	147.48	145.0	0.27	0.013	14.7	22.9	27.6	31.9	NF	14.7	22.9	27.6	31.9	NF
SD9012	ST9013	ST9012	CIRCULAR	2	-	332	148.38	147.5	0.27	0.013	14.7	22.9	27.6	31.9	100-yr, 24-hr	14.7	22.9	27.6	31.9	100-yr, 24-hr
SD9013	ST9014	09001	CIRCULAR	2.5	-	117	97.82	93.0	4.11	0.018	54.8	83.2	88.4	94.1	100-yr, 24-hr	54.8	83.2	88.1	94.2	100-yr, 24-hr
SD9014	ST9015	ST9014	CIRCULAR	3	-	217	100.35	97.8	0.76	0.011	40.2	62.1	64.8	70.3	25-yr, 24-hr	40.3	62.2	64.5	70.4	25-yr, 24-hr
SD9015	ST9016	ST9015	CIRCULAR	3	-	701.7	109.33	100.4	1.70	0.011	14.4	19.6	22.5	27.6	NF	14.5	19.7	22.3	27.6	NF
SD9016	ST9017	ST9016	CIRCULAR	3	-	311	113.58	109.3	0.31	0.011	14.5	19.6	21.2	24.0	NF	14.5	19.7	21.2	24.0	NF
SD9017	ST9018	ST9017	CIRCULAR	1.75	-	240	115.7	113.6	0.84	0.024	14.5	19.7	21.2	23.7	2-yr, 24-hr	14.5	19.7	21.2	23.7	2-yr, 24-hr
SD9060	ST9019	ST9018	CIRCULAR	1.75	-	121.7	116.62	115.7	0.67	0.024	14.8	20.0	21.5	24.5	2-yr, 24-hr	14.8	20.0	21.5	24.6	2-yr, 24-hr
SD9018	ST9020	ST9019	CIRCULAR	1.5	-	309	118.6	116.6	0.56	0.013	3.9	6.1	6.3	7.4	10-yr, 24-hr	3.8	6.2	6.4	7.5	10-yr, 24-hr
SD9019	ST9021	ST9020	CIRCULAR	1.25	-	395	130.67	118.6	2.99	0.013	2.9	5.3	5.6	6.5	10-yr, 24-hr	3.0	5.4	5.7	6.5	10-yr, 24-hr

Table B-3. Hydaulic Model Inputs and Results																				
Conduit			Conduit Atributes								Existing Land Use Conditions					Future Land Use Conditions				
			Shape	Diameter (ft)/ Max Width (ft)	Depth (ft)	Length (ft)	Invert Elevation (ft)		Slope (%)	Manning's Roughness	Peak Flow (cfs)				When Hydraulically Deficient	Peak Flow (cfs)				When Hydraulically Deficient
ID	US Node	DS Node					US	DS			2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr		2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr	
SD9020	ST9022	ST9021	CIRCULAR	1.25	-	351	140.33	130.7	2.72	0.013	2.9	4.9	6.2	8.0	25-yr, 24-hr	3.0	4.9	6.3	8.0	25-yr, 24-hr
SD9021	ST9023	ST9022	CIRCULAR	1.25	-	453.5	145.89	140.3	1.20	0.013	3.0	4.9	6.2	7.9	100-yr, 24-hr	3.0	4.9	6.3	7.9	100-yr, 24-hr
SD9022	ST9024	ST9015	CIRCULAR	3	-	159.4	103.27	100.4	1.51	0.011	27.0	43.2	46.6	50.3	25-yr, 24-hr	27.0	43.5	46.4	62.5	25-yr, 24-hr
SD9023	ST9025	ST9024	CIRCULAR	3	-	238.4	106.07	103.3	1.17	0.011	18.8	29.5	30.4	34.5	100-yr, 24-hr	18.8	29.7	32.9	45.9	100-yr, 24-hr
SD9024	ST9026	ST9025	CIRCULAR	2.5	-	175.8	110.34	106.1	2.39	0.011	18.9	29.2	30.2	34.5	100-yr, 24-hr	18.9	29.4	32.9	38.3	25-yr, 24-hr
SD9025	ST9027	ST9026	CIRCULAR	2.5	-	271.6	117.35	110.3	2.58	0.011	18.9	29.1	30.2	35.0	NF	18.9	29.1	32.8	34.8	NF
SD9026	ST9028	ST9027	CIRCULAR	2	-	142	121.35	117.4	2.75	0.024	14.7	21.9	23.1	25.7	100-yr, 24-hr	14.7	21.9	23.0	25.7	100-yr, 24-hr
SD9027	ST9029	ST9028	CIRCULAR	2	-	160	125.35	121.4	2.44	0.024	14.7	21.9	23.1	25.9	100-yr, 24-hr	14.7	21.9	23.0	25.8	100-yr, 24-hr
SD9028	ST9030	ST9029	CIRCULAR	2	-	258	131.45	125.4	2.33	0.024	14.7	21.9	23.1	26.5	10-yr, 24-hr	14.7	21.9	23.0	26.4	10-yr, 24-hr
SD9029	ST9031	ST9030	CIRCULAR	2.5	-	296	135.35	131.5	1.28	0.024	14.7	22.9	27.0	28.8	25-yr, 24-hr	14.7	22.9	26.9	28.8	25-yr, 24-hr
SD9030	ST9032	ST9014	CIRCULAR	3	-	263.3	102.61	97.8	1.49	0.011	15.4	22.3	25.1	27.5	100-yr, 24-hr	15.4	22.3	25.1	30.4	100-yr, 24-hr
SD9031	ST9033	ST9032	CIRCULAR	1.75	-	202.4	103.63	102.6	0.45	0.024	7.7	10.9	13.1	16.7	100-yr, 24-hr	7.7	10.9	13.1	17.2	100-yr, 24-hr
SD9032	ST9034	ST9033	CIRCULAR	1.75	-	306.4	105.2	103.6	0.48	0.024	7.7	10.9	13.1	13.6	25-yr, 24-hr	7.7	10.9	13.1	14.9	25-yr, 24-hr
SD9033	ST9035	ST9034	CIRCULAR	1.5	-	118.7	107.06	105.2	0.40	0.013	7.7	10.9	12.8	12.6	25-yr, 24-hr	7.7	10.9	12.8	12.7	10-yr, 24-hr
SD9034	ST9036	ST9035	CIRCULAR	1.5	-	276	108.14	107.1	0.39	0.013	7.7	10.9	12.1	12.5	10-yr, 24-hr	7.7	10.9	12.1	12.5	10-yr, 24-hr
SD9035	ST9037	ST9036	CIRCULAR	1.5	-	242	108.87	108.1	0.39	0.013	7.7	10.6	12.5	13.5	10-yr, 24-hr	7.7	10.6	12.5	13.5	10-yr, 24-hr
SD9036	ST9038	ST9037	CIRCULAR	1.25	-	212.2	109.62	108.9	0.22	0.013	7.7	11.2	13.5	14.7	2-yr, 24-hr	7.7	11.2	13.5	14.7	2-yr, 24-hr
SD9037	ST9039	ST9038	CIRCULAR	1.25	-	260.1	110.29	109.6	0.22	0.013	7.9	12.4	15.1	16.6	2-yr, 24-hr	7.9	12.4	15.1	16.6	2-yr, 24-hr
SD9058	ST9040	ST9041	CIRCULAR	2.5	-	203	111.71	108.3	1.51	0.013	15.5	24.9	29.8	37.0	NF	15.5	24.9	29.8	37.0	NF
SD9057	ST9041	ST9068	CIRCULAR	2.5	-	275	108.31	104.0	1.21	0.013	15.5	24.9	29.7	37.0	NF	15.5	24.9	29.7	37.0	NF
SD9038	ST9042	ST9040	CIRCULAR	2	-	294.3	114.63	111.7	0.98	0.013	6.8	11.2	13.6	16.8	NF	6.8	11.2	13.6	16.8	NF
SD9053	ST9043	ST9066	CIRCULAR	1.5	-	961	122.65	108.0	1.51	0.013	4.0	6.0	6.7	8.0	NF	4.0	6.1	6.8	8.1	NF
SD9045	ST9044	ST9042	CIRCULAR	2	-	250	116.13	114.6	0.60	0.013	6.8	11.2	13.6	16.8	NF	6.8	11.2	13.6	16.8	NF
SD9054	ST9045	ST9044	CIRCULAR	1.5	-	249.8	117.91	116.1	0.51	0.013	3.0	4.9	6.1	7.5	NF	3.0	4.9	6.1	7.5	NF
SD9056	ST9046	ST9045	CIRCULAR	1.5	-	150	118.6	117.9	0.33	0.013	3.0	5.0	6.1	7.4	NF	3.0	5.0	6.1	7.4	NF
SD9055	ST9047	ST9046	CIRCULAR	1.25	-	168.6	120.31	118.6	0.87	0.013	3.0	5.0	6.1	7.4	NF	3.0	5.0	6.1	7.4	NF
SD9046	ST9048	ST9047	CIRCULAR	1.25	-	148.2	121.19	120.3	0.59	0.013	3.0	5.0	6.1	7.4	NF	3.0	5.0	6.1	7.4	NF
SD9047	ST9049	ST9040	CIRCULAR	2.25	-	217.2	114.26	111.7	1.06	0.013	8.8	13.8	16.2	20.2	NF	8.8	13.8	16.2	20.2	NF
SD9048	ST9050	ST9049	CIRCULAR	2	-	200.7	115.86	114.3	0.80	0.013	8.8	13.8	16.2	20.3	NF	8.8	13.8	16.2	20.3	NF
SD9049	ST9051	ST9050	CIRCULAR	2	-	118	116.69	115.9	0.70	0.013	8.8	13.8	16.2	20.3	NF	8.8	13.8	16.2	20.3	NF
SD9050	ST9052	ST9051	CIRCULAR	1.75	-	208	118.6	116.7	0.80	0.013	6.6	10.2	12.3	15.7	NF	6.6	10.2	12.3	15.7	NF
SD9044	ST9053	ST9052	CIRCULAR	1.75	-	143	119.74	118.6	0.80	0.013	6.6	10.2	12.3	15.7	NF	6.6	10.2	12.3	15.7	NF
SD9051	ST9054	ST9053	CIRCULAR	1.75	-	157	120.84	119.7	0.70	0.013	3.1	4.8	5.8	7.4	NF	3.1	4.8	5.8	7.4	NF
SD9040	ST9055	ST9054	CIRCULAR	1.75	-	180	121.74	120.8	0.50	0.013	3.1	4.8	5.8	7.4	NF	3.1	4.8	5.8	7.4	NF
SD9043	ST9056	ST9055	CIRCULAR	1.5	-	125	122.87	121.7	0.70	0.013	3.1	4.8	5.8	7.4	NF	3.1	4.8	5.8	7.4	NF
SD9041	ST9057	ST9056	CIRCULAR	1.5	-	150	123.62	122.9	0.50	0.013	3.1	4.8	5.8	7.4	NF	3.1	4.8	5.8	7.4	NF
SD9042	ST9058	ST9057	CIRCULAR	1.5	-	150	124.37	123.6	0.50	0.013	3.1	4.8	5.9	7.4	NF	3.1	4.8	5.9	7.4	NF
SD9039	ST9059	ST9058	CIRCULAR	1.25	-	135	125.5	124.4	0.65	0.013	3.1	4.8	5.9	7.4	NF	3.1	4.8	5.9	7.4	NF
SD9059	ST9060	ST9061	CIRCULAR	1.25	-	248.8	129.87	124.3	2.25	0.013	4.0	6.1	6.8	8.1	NF	4.1	6.2	6.8	8.2	NF
SD9052	ST9061	ST9043	CIRCULAR	1.25	-	65.9	124.27	122.7	2.26	0.024	4.0	6.1	6.8	8.1	NF	4.1	6.2	6.8	8.1	NF
SD9061	ST9062	ST9063	CIRCULAR	1.5	-	265.8	97.57	95.7	0.70	0.011	4.2	7.5	8.1	10.6	NF	4.5	7.8	8.5	11.0	NF
SD9067	ST9063	ST9069	CIRCULAR	1.5	-	128	95.65	94.8	0.75	0.011	4.1	7.5	8.0	10.6	NF	4.5	7.8	8.5	11.1	NF
SD9062	ST9064	ST9062	CIRCULAR	1.5	-	138.1	99.06	97.6	1.08	0.011	4.2	7.6	8.2	10.6	NF	4.5	7.9	8.5	11.0	NF
SD9063	ST9065	ST9064	CIRCULAR	1.25	-	98.2	99.89	99.1	0.54	0.011	4.2	7.6	8.2	10.6	NF	4.5	7.9	8.6	11.0	NF
SD9064	ST9066	ST9067	CIRCULAR	2.5	-	205	107.95	103.8	2.00	0.013	10.7	16.2	18.8	21.7	NF	10.7	16.3	18.9	21.8	NF
SD9065	ST9067	09003	CIRCULAR	3	-	145	103.75	100.0	2.60	0.013	26.2	40.9	48.4	58.6	NF	26.2	40.9	48.5	58.7	NF
SD9066	ST9068	ST9067	CIRCULAR	3	-	10	103.95	103.8	2.00	0.013	15.5	24.9	29.7	37.0	NF	15.5	24.9	29.7	37.0	NF
SD9068	ST9069	ST9070	CIRCULAR	1.5	-	110	94.81	92.8	1.44	0.011	4.1	7.5	8.0	10.6	NF	4.5	7.8	8.5	11.0	NF
SD9069	ST9070	09002	CIRCULAR	1.5	-	30	92.83	92.9	-0.27	0.011	4.1	7.5	8.0	10.6	NF	4.4	7.8	8.5	11.0	NF
1207	STD3400	ST4221	CIRCULAR	1.5	-	290.7	169.61	165.9	1.11	0.013	5.7	6.4	6.7	7.9	NF	6.1	6.8	7.7	9.7	NF
SD4592	TOOZE_POND	ST4503	CIRCULAR	2	-	264	147.24	146.6	0.26	0.013	3.6	5.8	7.0	8.7	NF	3.8	6.0	7.3	9.0	NF

Table B-3. Hydaulic Model Inputs and Results																					
Conduit			Conduit Atributes								Existing Land Use Conditions					Future Land Use Conditions					
			Shape	Diameter (ft)/ Max Width (ft)	Depth (ft)	Length (ft)	Invert Elevation (ft)		Slope (%)	Manning's Roughness	Peak Flow (cfs)				When Hydraulically Deficient	Peak Flow (cfs)				When Hydraulically Deficient	
ID	US Node	DS Node					US	DS			2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr		2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr		
1323	WILSONVILLE_DIST_CTR_POND	ST4226	CIRCULAR	1	-	38	146.45	141.5	1.32	0.013	1.8	2.7	3.5	22.9	100-yr, 24-hr	1.8	2.7	3.5	22.9	100-yr, 24-hr	
4826	WILSONVILLE_DIST_CTR_POND	ST4226	CIRCULAR	1.5	-	30	146.45	141.5	22.88	0.024	14.9	22.9	22.3	4.4	100-yr, 24-hr	14.9	22.9	22.3	4.4	100-yr, 24-hr	

NF = No Flooding

Appendix C: TM #2: Stream Assessment

Technical Memorandum: Geomorphic Reconnaissance of Parts of Boeckman, Meridian, Arrowhead, Newland and Kruse Creeks

WATERWAYS CONSULTING, INC.

Ecological Restoration Design ~ Civil Engineering ~ Natural Resource Management

TECHNICAL MEMORANDUM - FINAL UPDATED

To: Angela Wieland, Brown and Caldwell

From: Waterways Consulting, Inc.

Date: January 30, 2024

Re: Geomorphic Reconnaissance of Parts of Boeckman, Meridian, Arrowhead Creeks, Newland, and Kruse Creeks

Introduction

Brown and Caldwell (BC) was hired by the City of Wilsonville (COW) to prepare an updated Stormwater Master Plan that will develop an integrated and long-term approach for managing stormwater in the city. Wilsonville is one of Oregon's fastest growing cities, and its rapid growth has necessitated updates to previous Stormwater Master Plans (URS, 2012) to reflect changes in land use and improvements to stormwater management practices.

As part of this process BC requested that Waterways Consulting, Inc. (Waterways) conduct geomorphic stream assessments of a subset of stream segments within and adjacent to the City of Wilsonville to inform the updated Stormwater Master Plan. The assessments are meant to improve the understanding of stream processes in the selected reaches and to identify infrastructure risks associated with changes in creek hydrology as the city develops. The assessment was conducted in two phases with an initial phase that included evaluations of portions of Boeckman, Meridian and Arrowhead Creeks. The second phase, conducted in Fall 2023, included evaluations of portions of Newland Creek and an unnamed tributary to the Willamette River, referred to as Kruse Creek in this report.

Boeckman, Meridian, Arrowhead creeks (tributary to Coffee Lake Creek), Newland, and Kruse Creeks are small tributaries of the Willamette River flowing in narrow canyons bordered by thick deposits of fine-grained sediment deposited by the Missoula Floods. These creeks flow in confined valleys with steep, landslide-prone valley walls. In some areas, residential development encroaches to the edge of the adjacent terraces[1], while in other areas, including the assessed portions of Arrowhead Creek, Newland Creek, and Kruse Creek, the adjacent land use is agricultural, rural residential, or industrial. Large portions of the watersheds upstream of the assessment reaches have, are in the process of, or will be converted from open space to suburban residential neighborhoods. These land use changes have, and will continue to have, the potential to impact the morphology of these streams as the channels respond to changes in flow, direct modifications, and changes in sediment supply. This assessment focuses on evaluating the current condition of the channels within the study reach, identifies any ongoing infrastructure concerns associated with past hydromodification impacts, and evaluates the susceptibility of the streams to future hydromodification impacts.

[1] This assessment focuses only on stream-based hazards and concerns and does not address landslide risks on the valley walls.

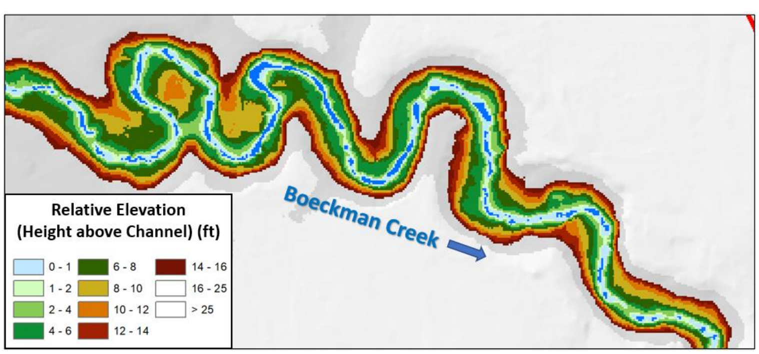
Approach

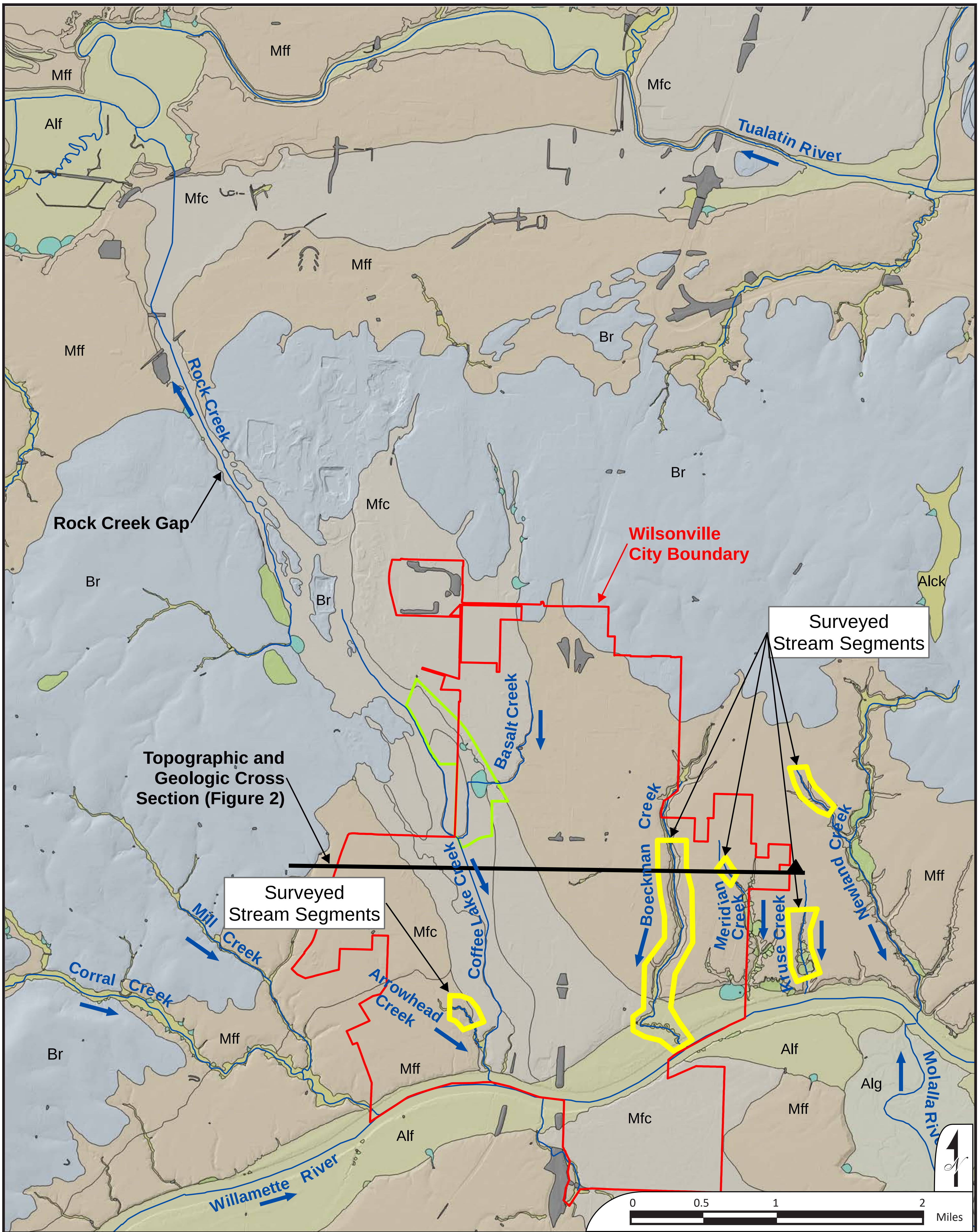
The purpose of the assessment is to understand and map the dominant geomorphic processes in the assessment reaches and identify any infrastructure-related issues that should be considered within the context of the updated Stormwater Master Plan. A key component of the assessment is the understanding that the reaches may be impacted by further hydromodification in the near future as a result of new upstream residential development or changes in other land use, such as agriculture or road development. Future efforts will include using the assessment information to identify potential Capital Improvement Projects (CIPs) or stream restoration actions that would address the identified risks to infrastructure or improve the resiliency of the stream corridor to impacts associated with hydromodification.

The assessments consisted of reconnaissance-level field observations supported by desktop mapping and analysis. The field protocols involved an experienced geomorphologist walking a designated stream reach twice in one day, starting and ending at the same location. In the first pass, the geomorphologist traversed the channel by wading, mapping and collecting georeferenced photographs of individual point features of interest, such as beaver dams, bridges, culverts, exposed pipes, affected roads and trails, headcuts, bedrock outcrops, heavily eroding banks, etc. The locations of these point-scale features were recorded in a tabular format and later digitized (these point-scale observations are presented in the tables in **Appendix A** of this report). During the first pass, the geomorphologist subdivided the stream into mappable "subreaches," typically several hundreds to thousands of feet long, within which geomorphic conditions are relatively consistent and could be characterized. The second pass consisted of walking back through the reach and evaluating the subreaches' key geomorphic features, conditions, infrastructure risks, restoration opportunities, etc. The reach-scale observations were recorded in a matrix-based field form specifically developed for this project. Subreach summary tables for the surveyed reaches are provided later in this report.

The desktop component of this assessment included compilation and analysis of geospatial data, including infrastructure data, topographic data, and geologic information. Waterways used the 2014 LiDAR data to create "Relative Elevation Models" (REMs) for each of the creeks within the assessment area. An REM is a topographic model created from a LiDAR elevation surface that shows the height of the ground surface relative to the adjacent streambed, which is helpful for identifying and interpreting geomorphic surfaces relative to the stream (e.g., **Figure 1**). The REMs for the creeks are provided as .tif files in a digital appendix to this report (**Appendix B**). In addition, as part of the desktop portion of the assessment Waterways created and analyzed topographic and geologic cross sections and stream longitudinal profiles and produced a set of field maps identifying streams and stormwater infrastructure identified during the field component. The field maps are provided as **Appendix C**.

Figure 1. *Example of Relative Elevation Model of Part of Lower Boeckman Creek*





Legend

- City Limits
- Stream Centerline
- Coffee Lake Wetlands (City of Wilsonville)

Surficial Geology (from compilation by Ma et al., 2012)

- Af - Artificial Fill
- Alck - Creek Alluvium
- Alf - Fine Alluvium
- Alg - Coarse Alluvium
- Br - Columbia River Basalts
- Df - Debris Flow Fans
- Ls - Large Landslides
- Mfc - Missoula Flood Coarse Bedload Deposits
- Mff - Missoula Fine Flood Deposits

Ma, L., Madin, I.P., Duplantis, S., and K.J. Williams. 2012. LiDAR- Based Surficial Geologic Map and Database of the Greater Portland Area, Clackamas, Columbia, Marion, Multnomah, Washington, and Yamhill Counties, Oregon, and Clark County, Washington. State of Oregon Department of Geology and Mineral Industries, Open File Report O-12-02.

Geologic and Geomorphic Setting Overview Map	Geomorphic Assessment of Wilsonville Creeks	WATERWAYS CONSULTING, INC. Santa Cruz, CA · watways.com · Portland, OR	FIGURE 2

Geologic and Geomorphic Setting

Geomorphic processes in the creeks that dissect the Wilsonville area are influenced by their recent geologic history (**Figure 2**). Wilsonville sits on sedimentary deposits laid down by the Missoula Floods (Bretz, 1969), a series of dozens of gigantic floods that inundated the Willamette Valley between approximately 20,000 and 14,000 years ago (O'Connor et al., 2020). These cataclysmic floods originated from Glacial Lake Missoula in Montana and traveled down the Columbia River valley. A constriction downstream from Portland hydraulically impounded these flows, causing backwater flooding up the Willamette Valley. One of the main flow pathways for the Missoula Floods into the Willamette Valley was through a path that includes Lake Oswego and the "Rock Creek Gap" north of Wilsonville (O'Connor et al., 2001) (**Figure 3**). At these locations, huge flows moving south into the Willamette Valley were concentrated through narrow gaps in bedrock, forming underwater vortices powerful enough to carve deep channels ("scablands") and lakes ("kolks") in the resistant basalt bedrock in these locations.

The City of Wilsonville lies on an alluvial fan that formed in these floods where concentrated floodwater moving into the Willamette Valley spread out after moving through the Rock Creek Gap. The sudden widening downstream of the gap caused giant lobes of poorly sorted gravel and boulders to deposit along a pathway that bisects the City of Wilsonville (**Figure 2**). Drill logs from Canby and Wilsonville indicate that these coarse-grained, poorly sorted Missoula Flood deposits (labeled ***Mfc*** on **Figure 2**) range from 50 to 120 feet thick and are typically covered with 5-15 feet of sand and silt (Allison, 1978). In Wilsonville, the north-south oriented swath of ***Mfc*** is bounded on both sides by finer grained Missoula Flood deposits (***Mff*** in **Figure 2**). These sediments are thick, stratified silt and clay deposits that cover much of the lowland Willamette Valley floor. The finer-grained sediments (***Mff***) were laid down at a later phase in the Missoula Floods when the Willamette Valley was ponded as the main floods moved through the Columbia River.

Figure 4 is an east-west topographic and geologic profile through the main creeks of Wilsonville, passing through several of the reaches included in this assessment. The profile illustrates the differences between the parallel north-south creeks flowing through Wilsonville. Coffee Lake Creek, the largest creek in the city, flows in an "underfit" valley created by the Missoula Floods, and is underlain by coarse Missoula Flood sediments (***Mfc***). This geological setting explains why the Coffee Lake Creek valley is a wide, flat valley containing ecologically important wetlands, along with other unique geologic features of Wilsonville area, such as scablands and kolks, including the ecologically important Coffee Lake Wetlands as well as the 3.5-acre kolk pond at the Tonquin geologic area managed by Metro.

In contrast with Coffee Lake Creek, Boeckman, Meridian, Arrowhead, Newland, and Kruse Creeks carved deeper canyons in thick deposits of fine-grained Missoula Flood deposits (***Mff***) (**Figure 4**). Boeckman Creek is in a narrow canyon as much as 100 feet deep, with steep, unstable hillslopes prone to landslides. Boeckman, Meridian, Arrowhead, and Newland Creeks appear to have incised through the softer deposits to the point where their beds have encountered more consolidated clay deposits, or in the case of Arrowhead, where it reached the base level established by Coffee Lake Creek. Th presence of marginally resistant, consolidated clay in the streambed in some locations on all of these creeks provides a degree of base level stability. In some cases, including Boeckman and Arrowhead, the creeks appear to be no longer incising, especially in the lower reaches of these watersheds. Conversely, the headwater reaches assessed on Meridian and Newland Creek, appear to be experiencing incision despite exposures of more consolidated substrates. The morphology of the channel and valley on Kruse Creek is more dominated by the presence of valley-wide landslides and a high groundwater table.

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Figure 3. *Pathway of Missoula Floods into the Willamette Valley through Wilsonville (modified from Minervini et al., 2003)*

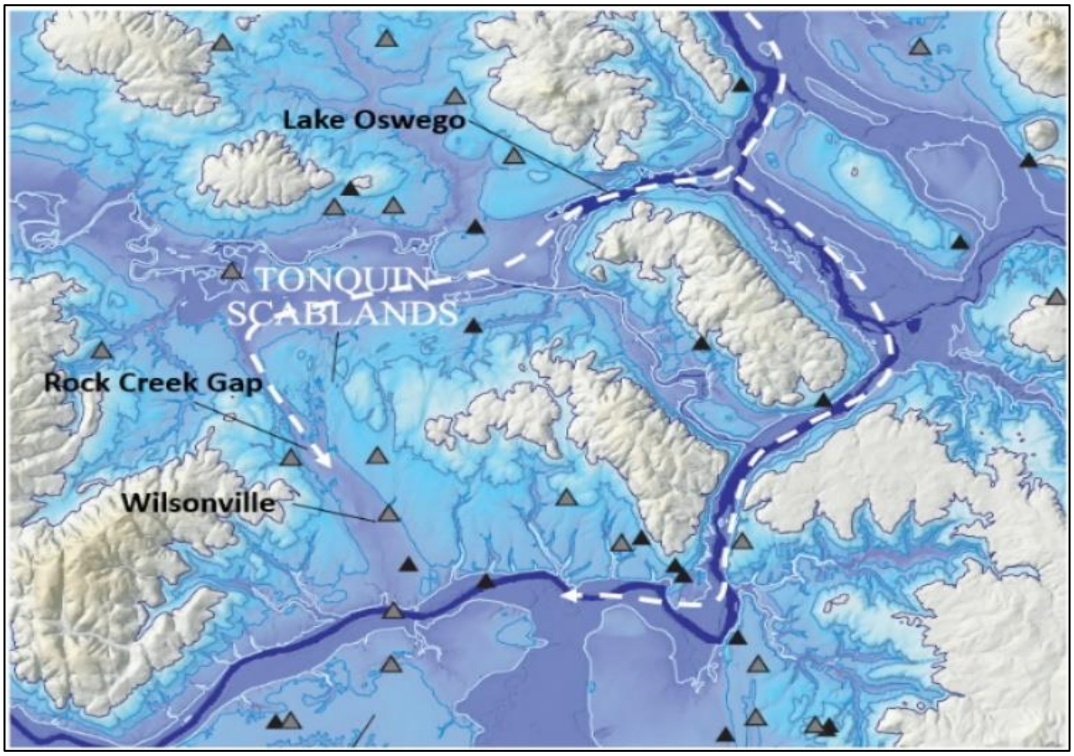
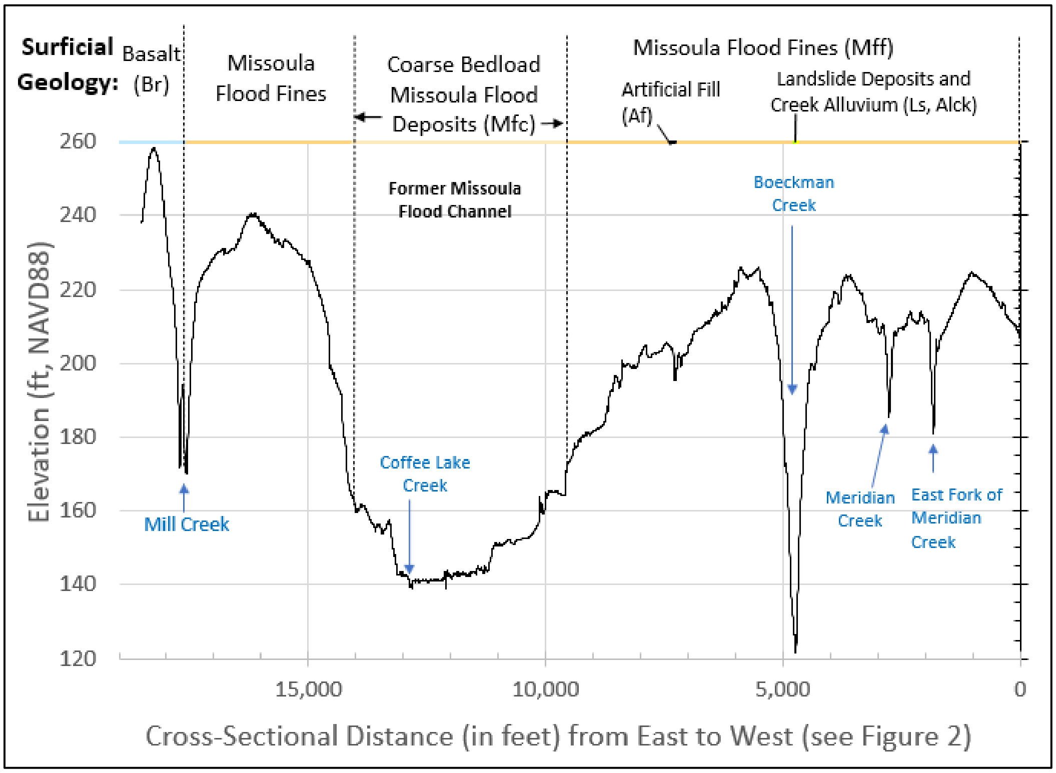


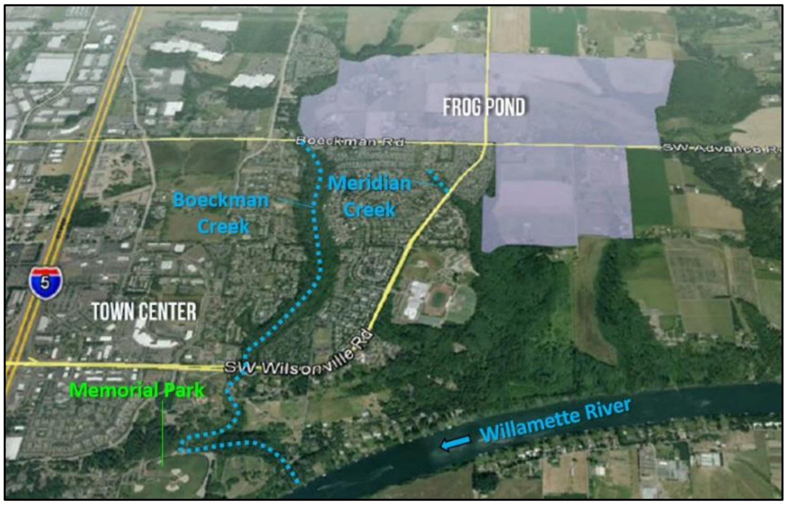
Figure 4. *Topographic and Geologic Cross Section Across the Wilsonville Area (See Fig. 2 for Profile Location)*



Human Impacts and Infrastructure

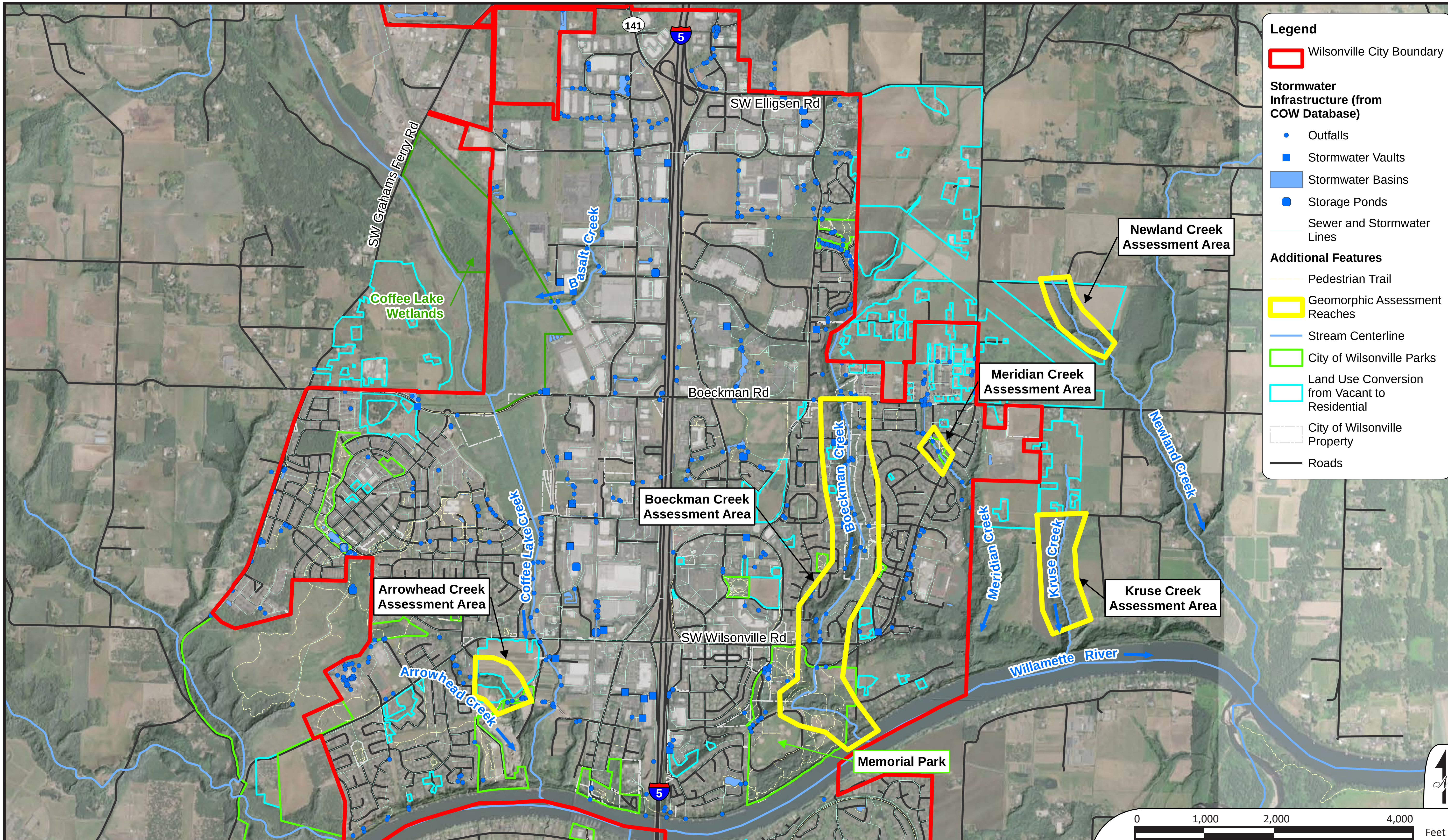
Most of the assessment reaches are adjacent to existing developed areas or are downstream of zones in the process of, or anticipated to be, converted from agricultural uses to residential developments (***Figure 5***). Hydromodification impacts in the assessment reaches are not limited to impacts associated with urban and residential development. Hydromodification impacts on these stream channels have been ongoing for over a century when the forested landscape was converted to agriculture, roads were built, culverts were installed, and fields were tile drained. These land use changes specifically intended to reduce water storage on the landscape while increasing the efficiency of runoff to adjacent waterbodies.

Figure 5. *Location of Phase 1 Assessment Reaches (dashed blue lines) relative to Existing and Planned Developed Areas (modified from APG. 2015)*



In the assessment reaches, Boeckman, Meridian, Arrowhead, Newland and Kruse Creeks flow in incised canyons. Along Boeckman and Meridians Creeks, residences are built to the edges of the canyons and the streams flow in confined valleys 20 to 100 feet deep. Water enters the streams from paved areas through a complex network of stormwater pipes that discharge along the steep valley walls (***Figure 6***).

The assessment reaches in Boeckman and Meridian are downstream of recently developed areas within the Frog Pond Development Area, a 500-acre residential neighborhood under construction within the urban growth boundary (**Figure 5**). The Newland and Kruse Creek assessment reaches are located downstream of an undeveloped portion of the Frog Pond Development area located to the east of Wilsonville and Stafford Roads. The long-planned development will include residences, schools, parks, transit, and trails, including a new regional trail following Boeckman Creek along the assessment reach (APG, 2015). To mitigate for potential hydromodification impacts from the existing and proposed portions of the Frog Pond Development area on the assessment reaches and other receiving streams, the developments are implementing Best Management Practices (BMP's) that are specifically designed to maintain the natural hydrology and limit the discharge of stormflow off of newly created impervious surfaces. Both "upland" and "in-stream" strategies for mitigating hydromodification risks have been adopted by the City and are being implemented within newly developed portions of Wilsonville, including the Frog Pond area (Brown and Caldwell, 2015). Those BMP's include infiltration and detention facilities, neighborhood-based Low Impact Development strategies, retrofitting existing stormwater detention basins, rehabilitating stormwater outfalls along the creek, culvert upgrades, and riparian vegetation improvements. The assessment reaches, especially along Newland and Kruse Creeks, provides an opportunity to establish a baseline of channel conditions prior to development occurring in the contributing watershed.



Human Impacts and Infrastrucure Overview Map

Geomorphic Assessment of Wilsonville Creeks

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FIGURE 6

Field Observations

The assessment included 5 days of field time to document conditions in priority reaches of Boeckman, Meridian, Arrowhead, Newland, and Kruse Creeks. These reaches were prioritized by the City of Wilsonville based on the importance of the streams, likelihood of hydromodification impacts, land access, and available budget. Additional reaches may be added to the assessment in the future.

The highest priority reach was the section of Boeckman Creek from Boeckman Road to the Willamette River, an along-stream distance of 12,200 feet (2.3 miles) (**Figure 7**). The second priority for the assessment was the 600-foot-long (0.1-mile) reach of Meridian Creek adjacent to Willow Creek/Landover Park (also shown in the top right corner of **Figure 7**). Sections of Basalt Creek and Arrowhead Creek were also identified as potential assessment reaches. Arrowhead was prioritized for the assessment over Basalt Creek due to the lack of landowner agreements along Basalt Creek.

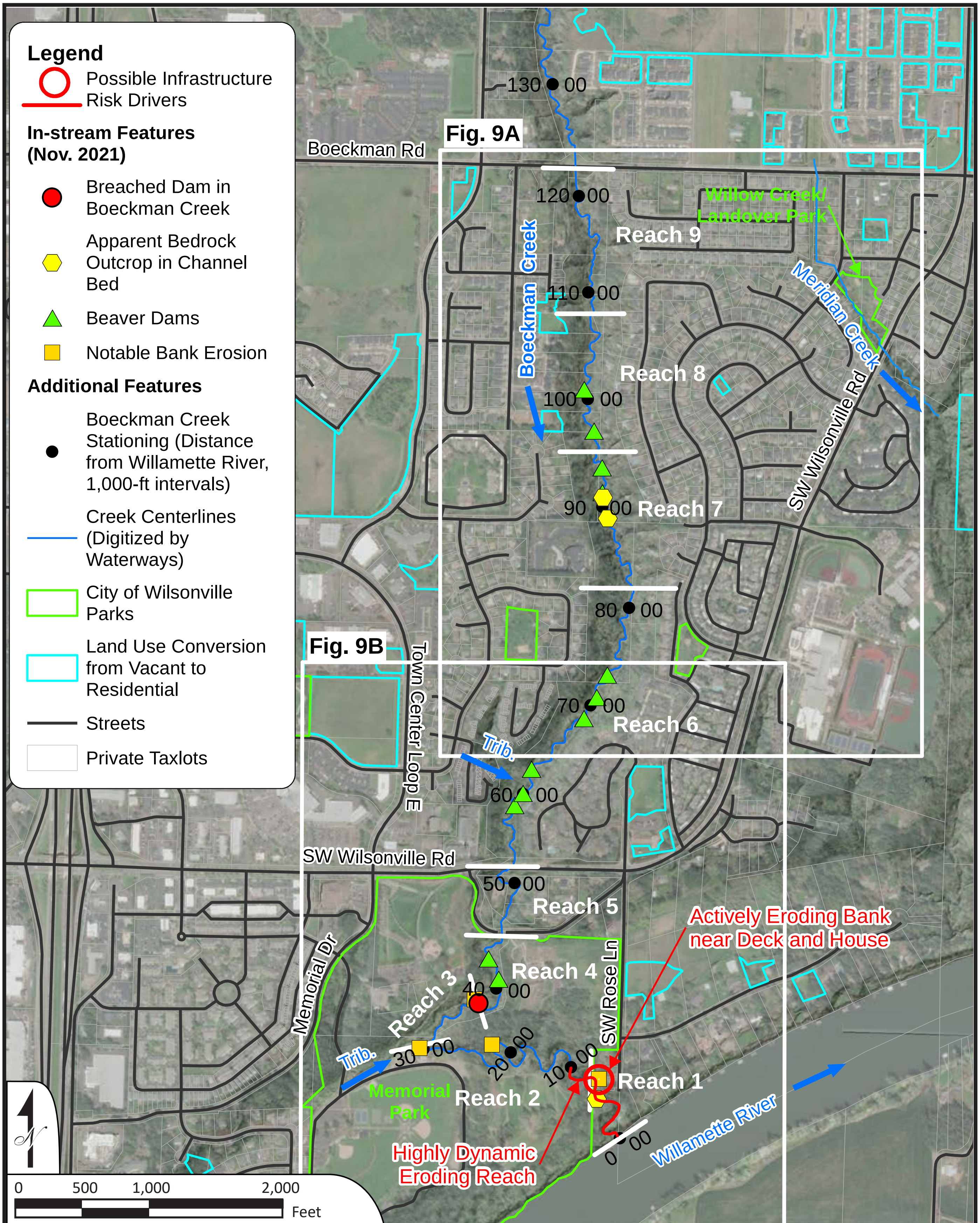
Approximately 1,000 feet (0.2 miles) was assessed on Arrowhead Creek. In Fall 2023, portions of Newland and Kruse Creeks that have the potential to be impacted by the Frog Pond Development or any additional eastward expansion of Wilsonville were also included in the assessment. Approximately 1,700 feet (0.3 miles) of Newland Creek and 2,200 feet (0.4 miles) of Kruse Creek was evaluated.

Boeckman Creek

The field assessment for Boeckman Creek occurred on November 19 and 24, 2021. The first day covered the lower reach within Memorial Park, from the private property boundary at Station 750 to Kolbe Lane (Sta. 4,500). The second day covered the reach from Wilsonville Road (Sta. 5,300) to Boeckman Road (Sta. 12,200). Two sections between the Willamette River and the private property boundary (Sta. 0 to 750) and between Kolbe Lane and Wilsonville Road (Sta. 4,500 to 5,300) were not accessed because those sections were on private property and Waterways did not have access permission. Permissions for the portion of private property located near the Willamette River were received in January 2022 and this section of channel (from Sta. 0 to 750) was assessed on January 25, 2022.

General Observations and Interpretations

- Specific point-scale observations of this section of Boeckman Creek are listed in **Appendix A1**.
- Boeckman Creek is confined within a narrow canyon bounded by steep valley walls prone to erosion and landsliding. At the bottom of the canyon, there is a meandering channel and a narrow, discontinuous floodplain covered by dense invasive species, especially Himalayan blackberry, reed canary grass, and English ivy. Very dense blackberry made for a difficult and slow traverse of the channel.
- Within the assessment reaches, Boeckman Creek has incised to a stable base level with a straight profile and relatively low gradient (about 0.6%), as illustrated in the longitudinal profile (**Figure 8**). The valley is graded to the Willamette River, and Boeckman Creek appears to no longer be actively incising, except in the most downstream reach at the confluence with the Willamette.
- The assessment area was subdivided into nine geomorphic sub-reaches ranging in length from 750 feet to 2,850 feet, within which geomorphic conditions and processes are relatively consistent. The subreaches are shown on the overview map (**Figures 7**), longitudinal profile (**Figure 8**), and detailed maps (**Figures 9a and 9b**). **Table 1** provides information and observations that characterize the geomorphic conditions and infrastructure features within each reach.



Boeckman Creek
Geomorphic Survey Overview

Geomorphic Assessment of Wilsonville Creeks

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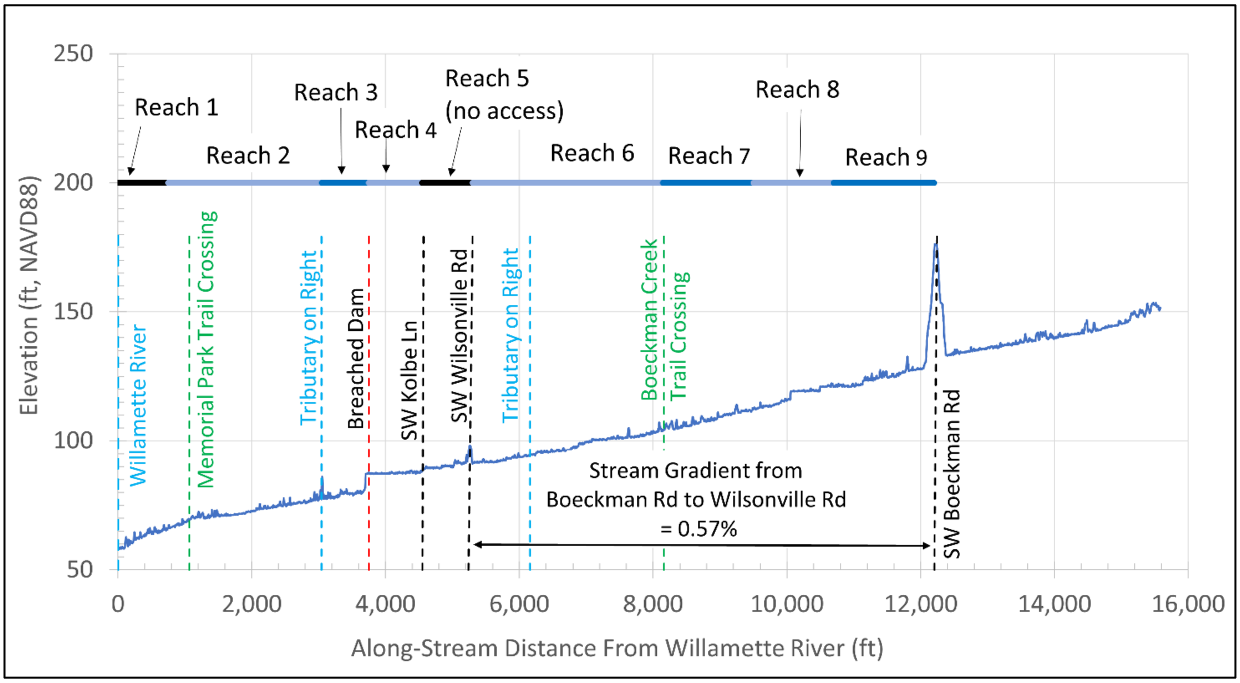
FIGURE
7

Figure 8. *Longitudinal Profile of Boeckman Creek (from 2014 LiDAR data)*



- Beaver are abundant throughout most of the assessment reaches and have a dominant impact on processes along Boeckman Creek. The most obvious impacts are from the channel-spanning dams that create a stairstep of flat water environments. Most of the grade control features shown on the field result map (**Figures 9a and 9b**) are beaver dams. The beaver dams range in height from about 1 foot to about 5 feet and pond long, continuous sections of the assessment area. The dams are actively maintained by beaver and most of them appear to be stable through typical floods in Boeckman Creek. Beaver are less prevalent or absent in the lower reaches of Boeckman Creek (Reaches 1 and 2), and are most abundant in the upper section (Reaches 6 through 9).
- The lack of stable beaver dams and seasonal variability in the backwater extent of the Willamette River along lower Boeckman Creek creates a highly dynamic condition with increased risk of erosion of the bed and banks. Dams throughout the Willamette River watershed, and the associated flow storage that those dams provide, results in a low stage in the Willamette River, relative to historic condition. Hydromodification impacts can potentially exacerbate channel instability by producing high flow events in early fall when the Willamette River is still low and the backwater influence is absent. This reach of Boeckman Creek is the most at-risk from hydrologic changes in the watershed.
- The breached former dam at Sta. 3,750 has an important reach-scale influence on the geomorphology in Boeckman Creek. Although the dam is breached, the remaining concrete and boulders are still present and provide a significant grade control feature, holding about 7 feet of grade (**Figure 8**). A wedge of fine sediment deposited upstream of the dam is covered with reed canary grass and extends as much as 800 feet upstream to the SW Kolbe Lane bridge.

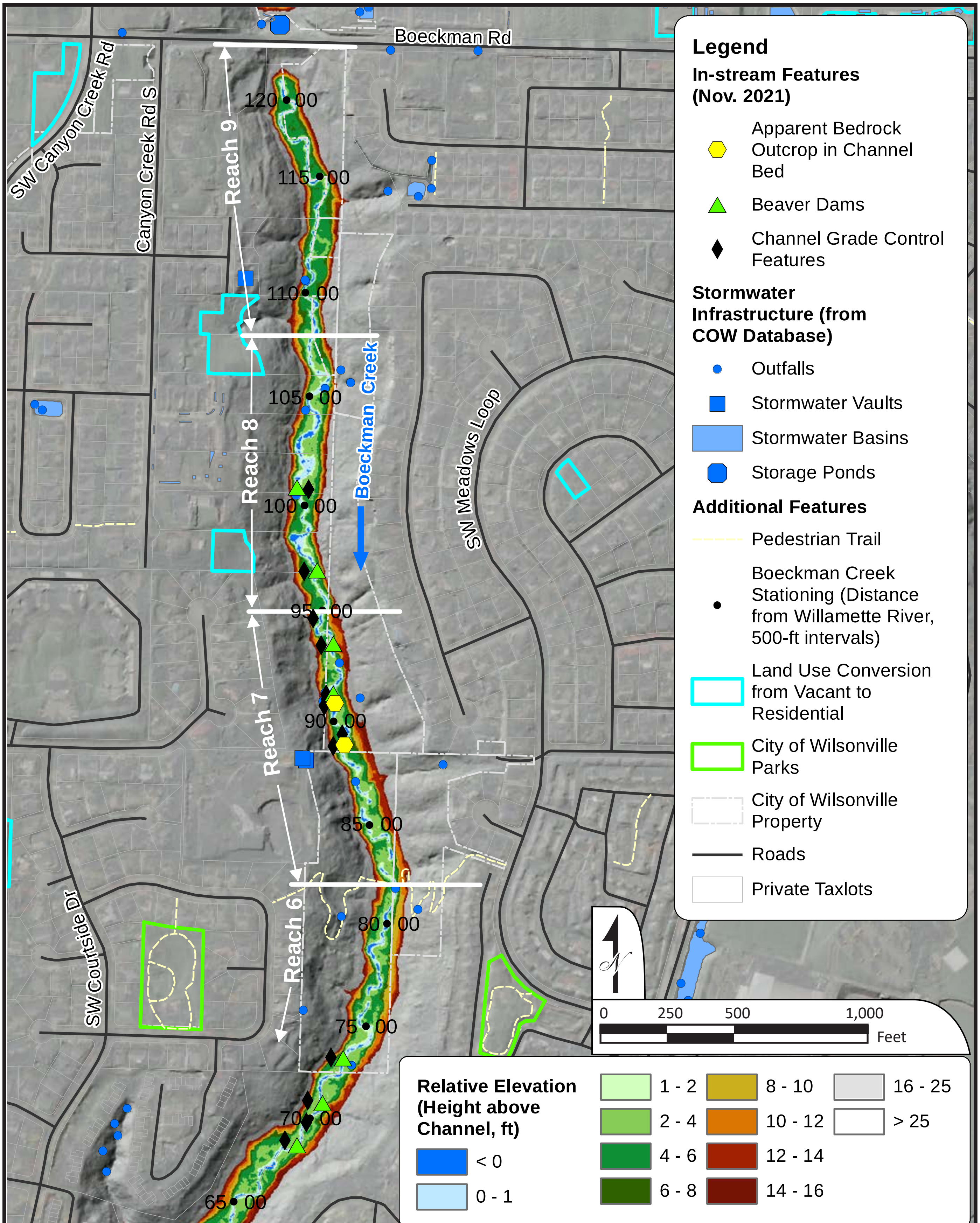
- There are at least three places where consolidated bedrock or other resistant material was observed within the channel bed in Boeckman Creek. These were noted by feel underfoot while wading. It was not possible to observe these resistant bed features due to the presence of turbid water about two to three feet deep at the time of the site visit.
- The presence of stable grade control – including resistant bed material, abundant stable beaver dams, fallen logs, boulders, and the 7-foot-high concrete and boulder grade control at the former dam – distributed throughout the project reach implies that much of Boeckman Creek cannot continue to incise. Collectively these features stabilize most of the channel bed, which is not susceptible to further incision due to hydromodification (**Figures 9a and 9b; Appendix A**).
- Waterways' geomorphologist also inspected the lower portions of two tributaries that enter Boeckman Creek from the west: one at Station 3,050 in Memorial Park, and one at Station 6,020 draining a residential area upstream of Wilsonville Road. Both tributaries appeared to be stable with no obvious infrastructure-related concerns:
    - The downstream tributary enters Boeckman Creek on river-right through a culvert under a road crossing in Memorial Park. The lower section of this tributary is deeply incised, low-gradient, gravel- and sand-bed stream in a dense blackberry thicket. Some bank erosion was observed along the steep banks but was not identified as an infrastructure concern. There is a partially clogged culvert on this tributary at a road crossing several hundred feet upstream of the confluence with Boeckman Creek. The clogged culvert backs water up to a footbridge in a grassy field in the park but does not appear to have any detrimental impacts. More descriptions are provided in **Appendix A1,** and photographs of this tributary can be found in the photo log (**Figure 10a**).
    - The upstream tributary drains the residential area along the west side of the creek north of Wilsonville Road. The tributary was only accessible at one location due to dense blackberry. At that location the channel bed was alluvial fine gravel and appeared stable.

SUMMARY CONCLUSIONS FROM BOECKMAN CREEK

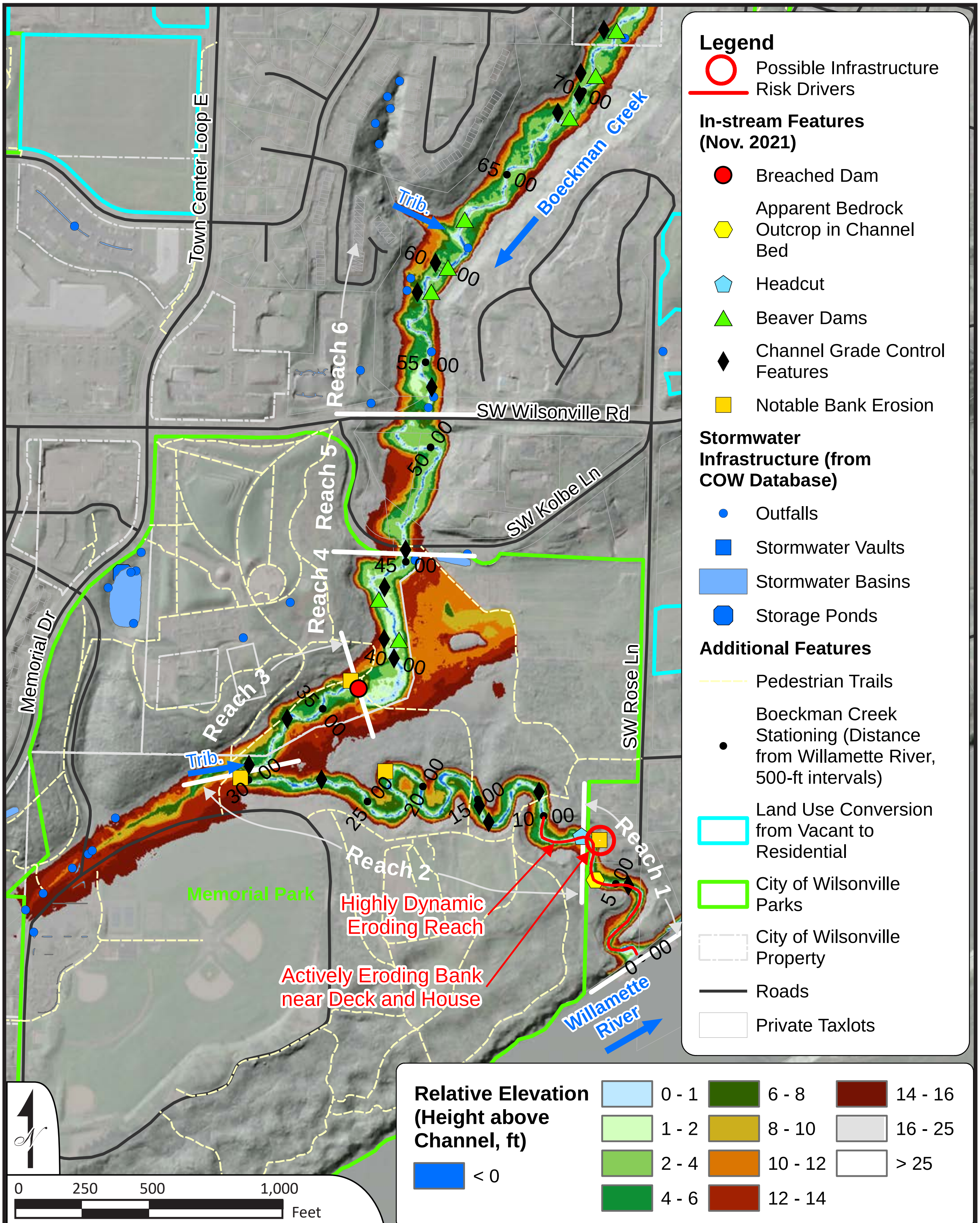
- With the exception of Reach 1, the field reconnaissance did not identify any obvious concerns or infrastructure risk drivers related to geomorphology and hydromodification in the assessed portion of Boeckman Creek. No infrastructure appears at risk in the valley bottom. The stream in the assessment reach is laterally confined and vertically stable, and relatively little infrastructure is in the stream. Any increases to stormwater related to land use changes at the Frog Pond Development area are not expected to pose significant specific infrastructure risks. (*Note that the assessment area did not include the Boeckman Road crossing above the upstream extent of the assessment reach*).
- Within Reach 1, there is a risk of continued channel incision and bank erosion. Several properties have experienced bank failures and loss of land over the past several decades, and an active bank failure is impacting the backyard and deck of one of the properties. This study does not make any findings regarding the cause(s) and extent of bank failure in Reach 1. Further investigation of the bank failure should be conducted by a geotechnical engineer to determine if the source is associated with fill placed behind a now failed retaining wall, or if there is a larger slope stability issue at the site. If a further investigation to determine cause(s), extent, and possible remediation is conducted, then the investigation should consist of a slope stability analysis along with recommendations to address the instability within the context of existing site conditions. There is currently insufficient data to understand erosion rates and associated

risks. Longer-term geomorphic monitoring of this reach might be warranted, which would include establishing cross-sections that would be resurveyed every three to five years to document erosional or depositional trends over time.

- The most significant risks in the canyons may relate to instability of the valley walls, which is outside the scope of this study. In a large rainstorm or possibly during an earthquake, mass wasting (landslides) from the valley wall could potentially occur, possibly blocking the channel, potentially endangering infrastructure near the top of the canyon walls.
- It is possible that a large flood could breach one or more of the apparently stable beaver dams. If that were to happen, one or more waves of incision could move upstream through parts of the assessment reach. However, the consequences of such an event appear to be relatively low given the stable base level, lack of infrastructure in the valley bottom, and the likelihood that the beaver would reestablish impacted dam sites.
- Collapses of individual beaver dams should not endanger or affect infrastructure in Boeckman Creek, but loss of all the beaver dams could have significant negative consequences, including significant loss of ecological value and an increase in infrastructure risks. Therefore, maintaining a healthy riparian corridor consisting of a mix of native riparian species in Boeckman Creek would be a beneficial long term management strategy to maintain the beaver population.
- **Figures 10a and 10b** provides some summary photographs showing conditions within the assessed portion of Boeckman Creek in November 2021 and January 2022.



Boeckman Creek Geomorphic Survey (Upstream)	Geomorphic Assessment of Wilsonville Creeks	WATERWAYS CONSULTING, INC. Santa Cruz, CA · watways.com · Portland, OR	FIGURE 9A



Boeckman Creek Geomorphic Survey (Downstream)

Geomorphic Assessment of Wilsonville Creeks

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FIGURE **9B**

Table 1. *Field Observations for Geomorphic Subreaches Within Boeckman Creek*

				Observational Data							Interpretive or Subjective Information						
Subreach	Downstream Station	Upstream Station	Reach Summary Description	Gradient	Dominant Channel Morphology	Dominant Substrates	Current Condition	Base Level Control	Lateral Constraints	Beaver Presence	Geomorphic Trajectory (Incising, Stable, Aggrading)	Bed Stability	Lateral Stability	Suscept-ibility to Hydro-modification	Infrastructure Risk in Reach	Potential Stream Enhancements	Reach Description
				Based on Profile Extracted from 2014 LiDAR		Bedrock, Boulders, Cobble, Gravel, Sand, Fines (dominant listed first)	Incised, Aggraded, Stable	Site Specific: e.g., Bedrock in Streambed, Culvert, Trunk Stream Confluence, etc. "None" if No Specific Controls Present	Site Specific: Valley Walls, Root Strength, Rock Bank Protection, etc. (listed roughly in orrder of importance)	Yes, No, Maybe	Incising, Stable, Aggrading	1= Stable or Aggrading; 5= Incising	1 = Stable Banks, 5 = Heavily Eroding Banks	1 = Not Susceptible, 5 = Highly Susceptible	1 = No Identified Risks; 5 = Obvious Potential Risks	Site Specific: Add Large Wood, Remove Invasive Species, Floodplain Benching, etc.	
1	0	750	Dynamic reach with seasonal backwater from Willamette River	1.07%	Pool-Riffle	gravel / fines	Incised	Willamette River	Valley walls susceptible to mass wasting	Yes, but no dams	Incising and wideneing	4	3	5	5	Grade control and bank stabilization	Actively incising and eroding, especially upper extent of reach where active small headcuts still migrating. Lower Willamette water level combined with high intensity rainfall in fall cause incision and widening. Recommend detailed geotechnical slope stability analysis in locatoin of active bank erosion and landsliding.
2	750	3,050	Incised Meandering Reach in Willamette Floodplain	0.44%	Pool riffle	Mud, wood, boulder, cobble	Incised, Stable	Some boulder steps, downed logs, Willamette base level	High mud terraces; tree roots	Yes upstream of 2,400' ; Maybe downstream of 2,400'	Stable	2	3	2	1	Remove invasive blackberry and ivy	From property boundary at downstream end to the tributary on right in Memorial Park. Reach is within the historic Willamette River floodplain and river terrace. Single-thread, incised meanders with banks between 6 feet and 40 feet high. Generally the amount of incision increases in the downstream direction. Banks are massive mud deposits from Missoula Flood fines and/or Willamette River floodplain deposits. Bed contains mud, wood, and some gravel reaches. From about Station 1,400' downstream, Willamette River bedload deposits are visible in the banks. Little to no beaver presence below Sta 2,400'; beaver present between 2,400 and 3,040'.
3	3,050	3,700	Meander Reach below Breached Dam	0.37%	Pool riffle	Mud, wood	Incised, Stable	Beaver dams, downed logs	Valley walls, reed canary grass root mass	Yes, abundant	Stable	2	2	2	1	Remove invasives, add wood	From right bank tributary in Memorial Park to site of breached dam. Meandering channel with stable banks, beaver dams, relatively low floodplains covered in reed canary grass. Inundated areas are mostly reed canary grass, less blackberry than in other parts of the creek.
4	3,700	4,500	Low Gradient Depositional Reach above Former Dam	0.01%	Pool riffle	Mud, wood	Stable	Breached dam; beaver dam	reed canary grass in floodplain	Yes	Stable	1	2	1	1	Good reach for potential floodplain restoration	Reach from breached dam to SW Kolbe Lane in Memorial Park. Low gradient, meandering reach with relatively low, frequently inundated floodplain. Abundant beaver presence consisting of dams, canals, burrows, slides, and lot of chewed wood. Banks heavily covered with reed canary grass. Water is about 2 to 3 feet dep at this flow (moderately high flow), with mud dominated bed. A floodplain vegetation restoration project to replace reed canary grass with willow and alder could work well here.
5	4,500	5,300	Not Surveyed														Skipped this reach due to property access constraints

				Observational Data							Interpretive or Subjective Information						
Subreach	Downstream Station	Upstream Station	Reach Summary Description	Gradient	Dominant Channel Morphology	Dominant Substrates	Current Condition	Base Level Control	Lateral Constraints	Beaver Presence	Geomorphic Trajectory (Incising, Stable, Aggrading)	Bed Stability	Lateral Stability	Suscept-ibility to Hydro-modification	Infrastructure Risk in Reach	Potential Stream Enhancements	Reach Description
				Based on Profile Extracted from 2014 LiDAR		Bedrock, Boulders, Cobble, Gravel, Sand, Fines (dominant listed first)	Incised, Aggraded, Stable	Site Specific: e.g., Bedrock in Streambed, Culvert, Trunk Stream Confluence, etc. "None" if No Specific Controls Present	Site Specific: Valley Walls, Root Strength, Rock Bank Protection, etc. (listed roughly in orrder of importance)	Yes, No, Maybe	Incising, Stable, Aggrading	1= Stable or Aggrading; 5= Incising	1 = Stable Banks, 5 = Heavily Eroding Banks	1 = Not Susceptible, 5 = Highly Susceptible	1 = No Identified Risks; 5 = Obvious Potential Risks	Site Specific: Add Large Wood, Remove Invasive Species, Floodplain Benching, etc.	
6	5,300	8,150	Stepped Beaver Pond Reach above Wilsonville Road	0.47%	Ponded by beaver dams	Mud, gravel, some bedrock	Incised and stable	Beaver dams	Reed canary grass root mass; valley walls	Yes, abundant	Stable	1	3	1	1 (some trail erosion)	Remove invasives, add wood	Reach from Wilsonville Road to Boeckman Trail footbridge. Reach is mostly ponded by a series of beaver dams, most are small but with at least 2 large dams at Sta 6,250 and 7,300. The dams are built so that ponds are mostly continuous throughout the entire reach, with the toe of each dam close to the head of each pool of the downstream beaver pond. Reach is moderately incised but not as much as in other reaches of Boeckman Creek.
7	8,150	9,500	Mostly Free-Flowing Reach between Beaver Dammed Reaches	0.59%	Pool riffle	Gravel, mud	Stable, little to moderate incision	Beaver dams, bedrock	Reed canary grass root mass; valley walls	Yes, abundant	Stable	2	3	1	1 (some trail erosion)	Remove invasives, add wood	From Boeckman Trail footbridge to big beaver dam at Sta 9,500. Free flowing reach without much beaver activity. Riffle pool, gravel bed with some resistant bedrock in channel bed within the upper part of the reach. Some small beaver dams present but are not dominant.
8	9,500	10,700	Floodplain Inundated by Ponding at Several Large Beaver Dams	0.86%	Ponded by beaver dams	Mud	Stable, low banks	Beaver dams, bedrock	Reed canary grass root mass; valley walls	Yes, abundant	Stable	1	3	1	1	Remove invasives, add wood	From beaver dam at Sta 9,500 to transition to more free-flowing reach. Deep ponded reach, with inundated floodplain over large areas. It is like this because either (1) dams are larger than those inreaches 6 and 9; and/or (2) the reach is less incised with lower banks. Viewed from trail on river left with some stops; unlike downstream reaches, I did not traverse the channel through this entire reach due to difficult access and need to speed up assessment. Did not visit outfall at Sta. 10,500
9	10,700	12,200	Incised Beaver Pond Reach	0.61%	Ponded, pool riffle	Mud, gravel, possible bedrock	Incised and stable	Beaver dams	Reed canary grass root mass; valley walls	Yes, abundant	Stable	2	3	3	1	Remove invasives, add wood	Similar to Reach 6, but deeper incision. Reach dominated by a series of beaver dams, not all were mapped due to difficult access. Did not visit crossing under Boeckman Road due to apparent private property


View across valley in Reach 8


Beaver Dam Near Station 9,600


Beaver Dam Near Station 6,200


Breached Dam At Station 3,700


Incised Tributary in Memorial Park


Entrenched Meanders around Station 1,800

Selected Photos From Boeckman Creek, November 2021	Geomorphic Assessment of Wilsonville Creeks	WATERWAYS CONSULTING, INC. Santa Cruz, CA · watways.com · Portland, OR	FIGURE 10A

Selected Photos From Boeckman Creek, January 2022	Geomorphic Assessment of Wilsonville Creeks	WATERWAYS CONSULTING, INC. Santa Cruz, CA · watways.com · Portland, OR	FIGURE **10B**

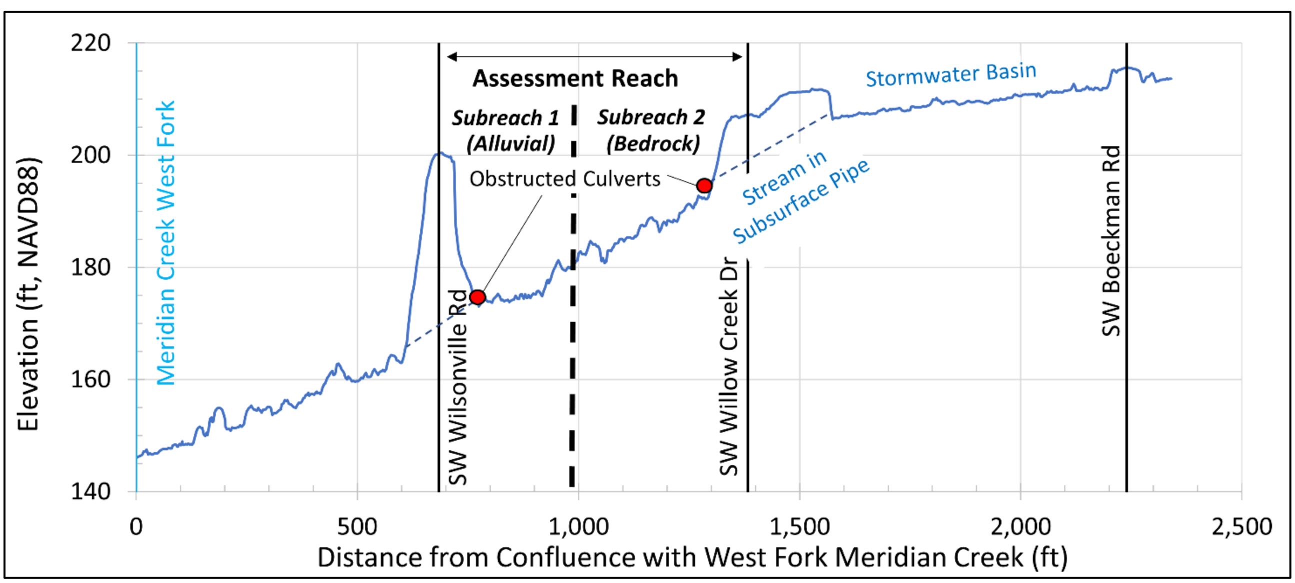
Meridian Creek in Landover Park

The field assessment for Meridian Creek occurred on November 26, 2021. The assessment included a 600-foot-long section of Meridian Creek between Wilsonville Road and SW Willow Creek Drive (**Figure 11**). This reach is immediately downstream of part of the Frog Pond Development Area. **Figure 12** is a longitudinal profile of the creek. **Table 2** summarizes the reach scale observations and interpretations from this site visit, and the point-specific observations are listed in **Appendix A2**. **Figure 13** contain photographs from this section of Meridian Creek.

General Observations and Interpretations

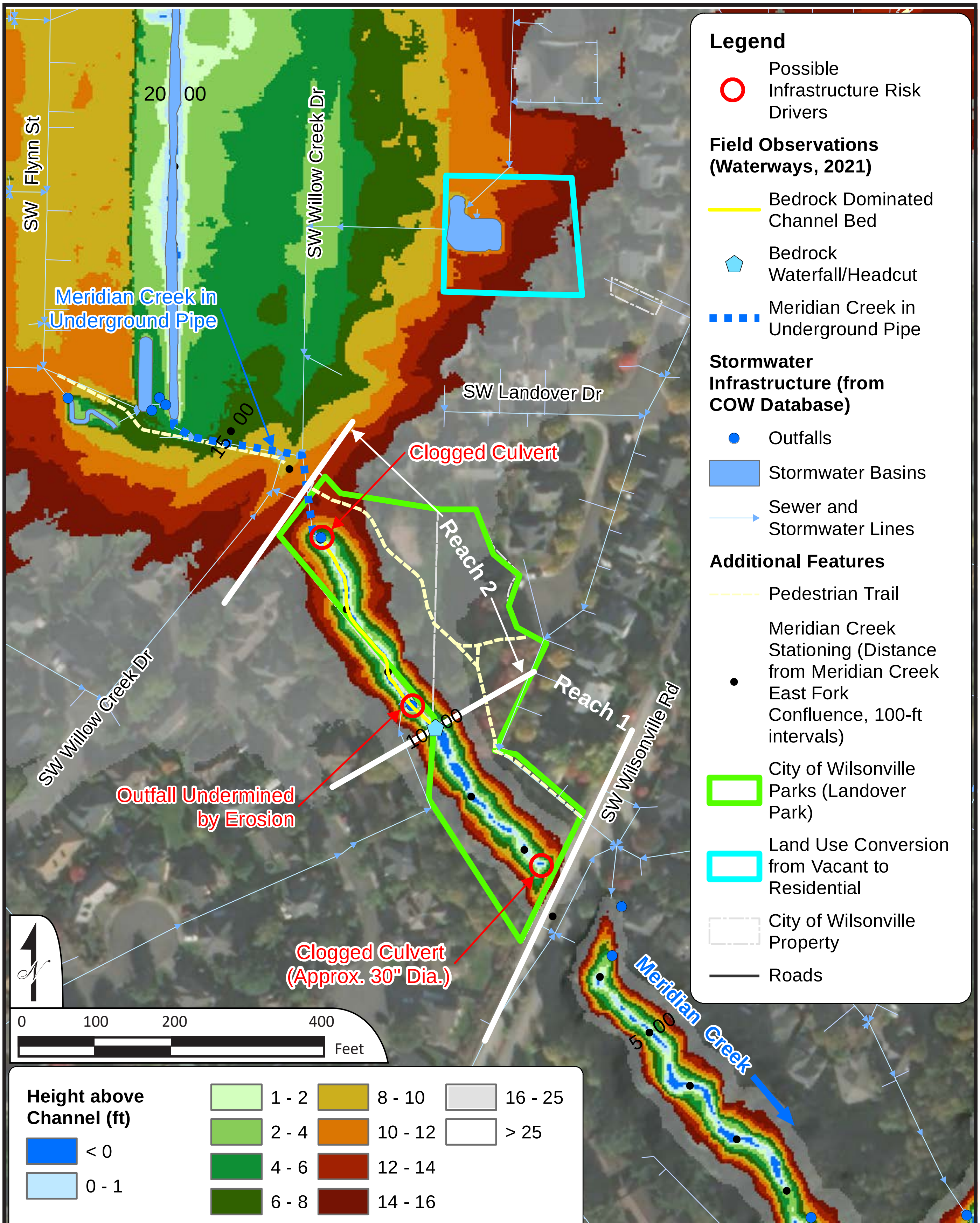
- This portion of Meridian Creek is incised in a very narrow canyon without any floodplains, whose steep slopes bound one side of the channel with a developed park on the other. The canyon is not as deep as the Boeckman Creek canyon, as can be seen in **Figure 4,** but the valley walls are steep with potentially unstable slopes underlain by fine-grained sediments and covered with dense blackberry thickets. The western valley wall is more at risk of landslides because Meridian Creek flows along the western margin of the canyon (right bank looking downstream).
- There are two distinct subreaches within the assessed area, delineated at a 4-foot-high bedrock/hardpan waterfall at Station 1,000 (**Figure 12**). The waterfall does not appear to be an active headcut advancing upstream and appears relatively stable. Downstream of the waterfall, the channel has an alluvial bed and is influenced by an obstructed culvert at Wilsonville Road. Upstream of the waterfall, a resistant layer of consolidated fine-grained sediment is exposed over most of the channel bed.
- The culvert at SW Willow Creek Drive appears to be undersized which may limit more significant hydromodification impacts from occurring downstream. Rock placed downstream of the culvert suggests that streambed erosion has been a concern in the past. This reach likely experienced significant channel incision and headcutting in the past but the active headcutting has been mostly arrested by the presence of hardpan material in the streambed. The discontinuity in the longitudinal profile across SW Willow Creek Drive (**Figure 12**) provides evidence for this field-based interpretation.

Figure 12. *Longitudinal Profile of portion of Meridian Creek (from 2014 LiDAR data)*



Summary Conclusions from Meridian Creek

- The stream is stable in this reach due to the bedrock base level control and being confined laterally by valley walls and culverts at the upstream and downstream end.
- The main risk drivers are the culverts at the downstream and upstream ends of the reach:
    - There is a sediment-clogged culvert at the Meridian Creek crossing at Wilsonville Road (Station 775). The culvert under the high road prism is mostly obstructed and appears to cause ponding during storm runoff (**Figure 12**). It is unlikely that ponded water would overtop Wilsonville Road, but backwatering behind the road could result in significant ponding and potential for piping through the road prism, which was not likely designed to act as a dam. The risks at the crossing should be further evaluated as part of the Stormwater Master Plan. Hydraulic modeling may provide an opportunity to understand maximum inundation depths if the culvert were to plug.
    - The grate at the outlet of the culvert at the Willow Creek Drive appears to have been modified to address past channel incision and headcut migration. This location should be monitored to determine if the stabilization measures installed downstream of the culvert provide adequate, long-term grade stabilization.
- The PVC stormwater outfall on the creek at Station 1,100 is undermined and a 6-foot section has washed out and moved downstream.



Meridian Creek Geomorphic Survey

Geomorphic Assessment of Wilsonville Creeks

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FIGURE 11

Table 2. *Field Observations for Geomorphic Subreaches Within Meridian Creek*

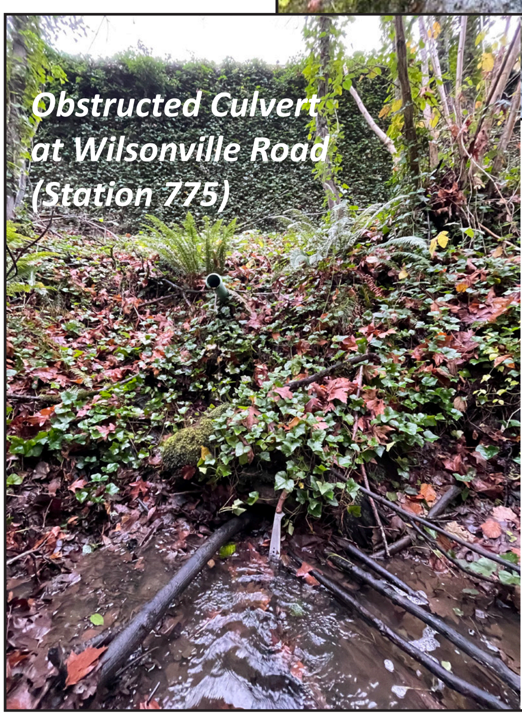
				Observational Data							Interpretive or Subjective Information						
Subreach	Downstream Station	Upstream Station	Reach Summary Description	Gradient	Dominant Channel Morphology	Dominant Substrates	Current Condition	Base Level Control	Lateral Constraints	Beaver Presence	Geomorphic Trajectory (Incising, Stable, Aggrading)	Bed Stability	Lateral Stability	Suscept-ibility to Hydro-modification	Infrastructure Risk in Reach	Potential Stream Enhancements	Reach Description
				Based on Profile Extracted from 2014 LiDAR		Bedrock, Boulders, Cobble, Gravel, Sand, Fines (dominant listed first)	Incised, Aggraded, Stable	Site Specific: e.g., Bedrock in Streambed, Culvert, Trunk Stream Confluence, etc. "None" if No Specific Controls Present	Site Specific: Valley Walls, Root Strength, Rock Bank Protection, etc. (listed roughly in orrder of importance)	Yes, No, Maybe	Incising, Stable, Aggrading	1= Stable or Aggrading; 5= Incising	1 = Stable Banks, 5 = Heavily Eroding Banks	1 = Not Susceptible, 5 = Highly Susceptible	1 = No Identified Risks; 5 = Obvious Potential Risks	Site Specific: Add Large Wood, Remove Invasive Species, Floodplain Benching, etc.	
1	775	1,000	Gravel depositional reach behind clogged culvert	1.05%	Step Pool	Gravel, fines, wood	Incised, Stable	Culvert at Wilsonville Road	Narrow valley wall	No	Stable or aggrading	1	3	4	4	Address downstream drainage, invasives removal	Short alluvial reach behind the obstructed culvert at Wilsonville Road. Gravel bed, one or more small steps formed by fallen logs. Channel is incised to base level at the culvert, but could incise more if culvert is cleared. Small incised channel in narrow valley with unstable mud valley walls subject to landsliding. Obstructed culvert at Wilsonville road could become a problem, and should be evaluated further as to whether it is a risk that should be addressed.
2	1,000	1,300	Reach incised to bedrock above waterfall	3.74%	Plane Bed	Bedrock (consolidated mud)	Incised, Stable	Bedrock channel bed	Narrow valley wall	No	Stable	1	3	3	3	Address upstream culvert drainage, invasives removal	Bedrock reach upstream of a 4'-high waterfall. Reach incised to consolidated mud bedrock. There are at least 2 waterfalls in reach, and at least one boulder step h from probable artificially placed boulders. Dense blackberry throughout reach. The culvert at the upstream end of reach is clogged and backs up water underneath Willow Creek drive.


Clogged Culvert Outlet at SW Willow Creek Drive (Station 1,300)


Close Up of Clogged Culvert at Station 1,300


Resistant Bed Material in Reach 2


Undermined Outfall at Station 1,100


Obstructed Culvert at Wilsonville Road (Station 775)


Close Up of Obstructed Culvert at Wilsonville Rd

Selected Photos From Meridian Creek, November 2021	Geomorphic Assessment of Wilsonville Creeks	WATERWAYS CONSULTING, INC. Santa Cruz, CA · watways.com · Portland, OR	FIGURE 13

Arrowhead Creek

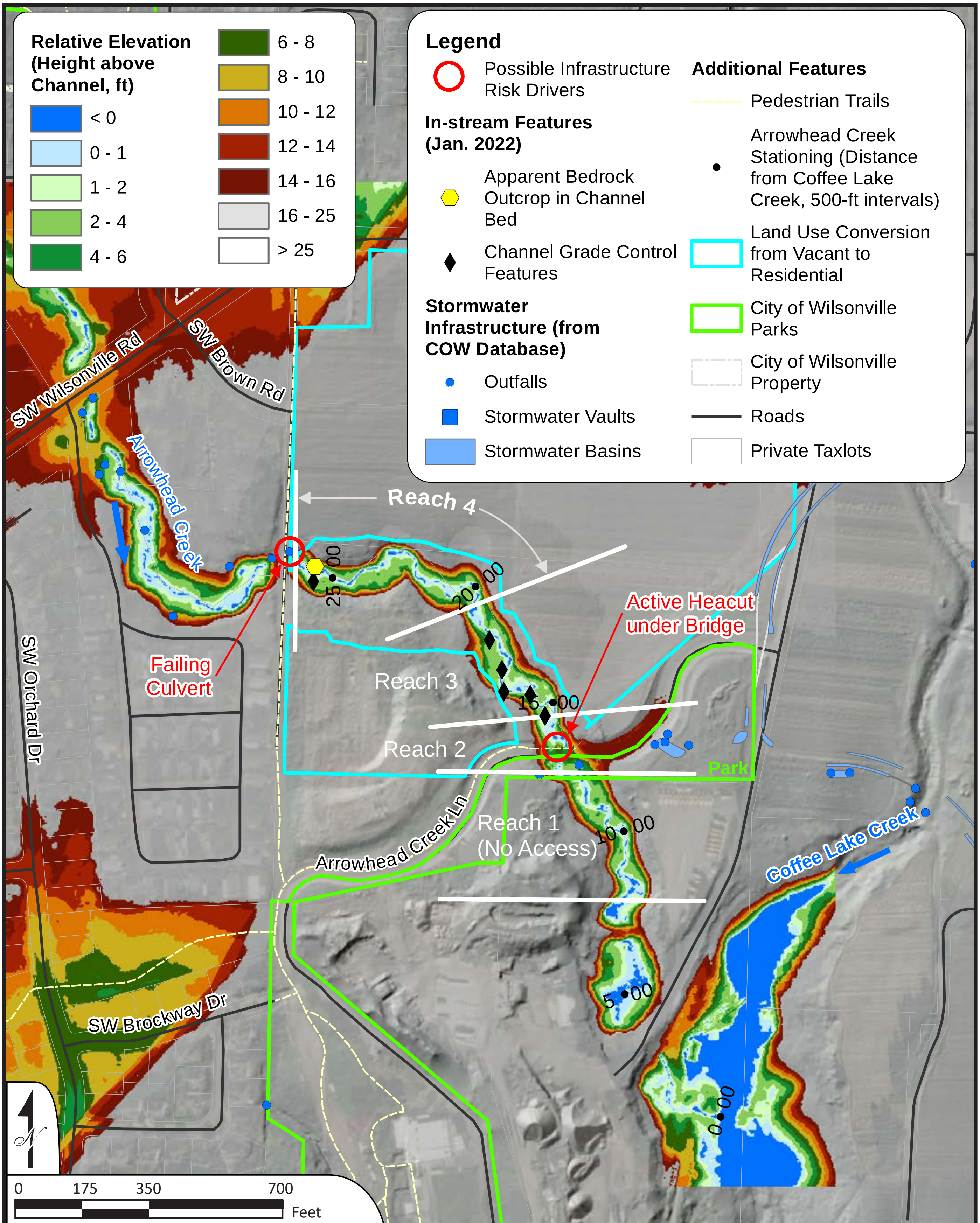
The field assessment for Arrowhead Creek occurred on January 25, 2021. The assessment included a 1,400-foot-long section of Arrowhead Creek between an asphalt pedestrian crossing and Arrowhead Creek Road (**Figure 14**). **Figure 15** is a longitudinal profile of the creek. **Table 3** summarizes the reach scale observations and interpretations from this site visit, and the point-specific observations are listed in **Appendix A3**. **Figure 16** contain photographs from this section of Arrowhead Creek.

General Observations and Interpretations

- The assessment area on Arrowhead Creek was divided into three subreaches based primarily on where beaver are active and have established stable dams that act as both local and regional grade control for the channel at the time of the assessment.
- Throughout the assessment area Arrowhead Creek consists of a meandering channel that is moderately incised within a broad floodplain that ranges between 40 and 80 feet. The channel and floodplain are inset 30 to 40 feet into the fine Missoula Flood deposits.
- Moderate incision of the channel limits high flow access to much of the broad floodplain except where beaver have built dams across the channel, and in some cases across the entire floodplain. In Reach 3, where the beaver dams create continuous backwater conditions along the entire reach, water engages the floodplain creating a complex mosaic of backwater and secondary channels.
- The culvert located at the pedestrian crossing at the upstream extent of the assessment area is in the process of failing and should be considered for replacement. It appeared from the downstream end that water may be piping through the fill and creating void spaces that are causing the culvert to fail. We did not evaluate the upstream end of the culvert due to lack of landowner permissions.
- English ivy dominates much of the project area and has the potential to limit the food and dam building resources for the beaver which could be detrimental to the beaver population and associated channel stability over the longer term. The ivy has already killed, or is at risk of killing, many of the alder and maple throughout the project area.

Summary Conclusions from Arrowhead Creek

- The stream is stable in this reach due to the presence of shallow hardpan and abundant beaver dams that act as local base level control and the fact that the channel is small and meanders across a broad floodplain with stable valley wall confinement.
- The main risk drivers consist of the following:
  - Failing condition of the upstream culvert. The fill prism appears to consist of relatively coarse material and therefore may be somewhat porous, limiting the potential for catastrophic failure of the prism. Further investigation by a geotechnical engineer is recommended.
  - Some instability was observed where Arrowhead Creek flows under the Arrowhead Creek Road bridge that appears to be related to construction of the channel under the crossing. Given the degree of channel stability observed upstream and downstream of the crossing the poor conditions at the crossing was determined to be relatively low risk unless there are significant changes to the active maintenance of the beaver dams.
  - Long-term, the loss of riparian trees and understory associated with dominance of English ivy does present some risk if there is a significant loss of food resources and dam building material for beaver.



Arrowhead Creek Geomorphic Survey

Geomorphic Assessment of Wilsonville Creeks

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FIGURE 14

Figure 15. *Longitudinal Profile of portion of Arrowhead Creek (from 2014 LiDAR data)*

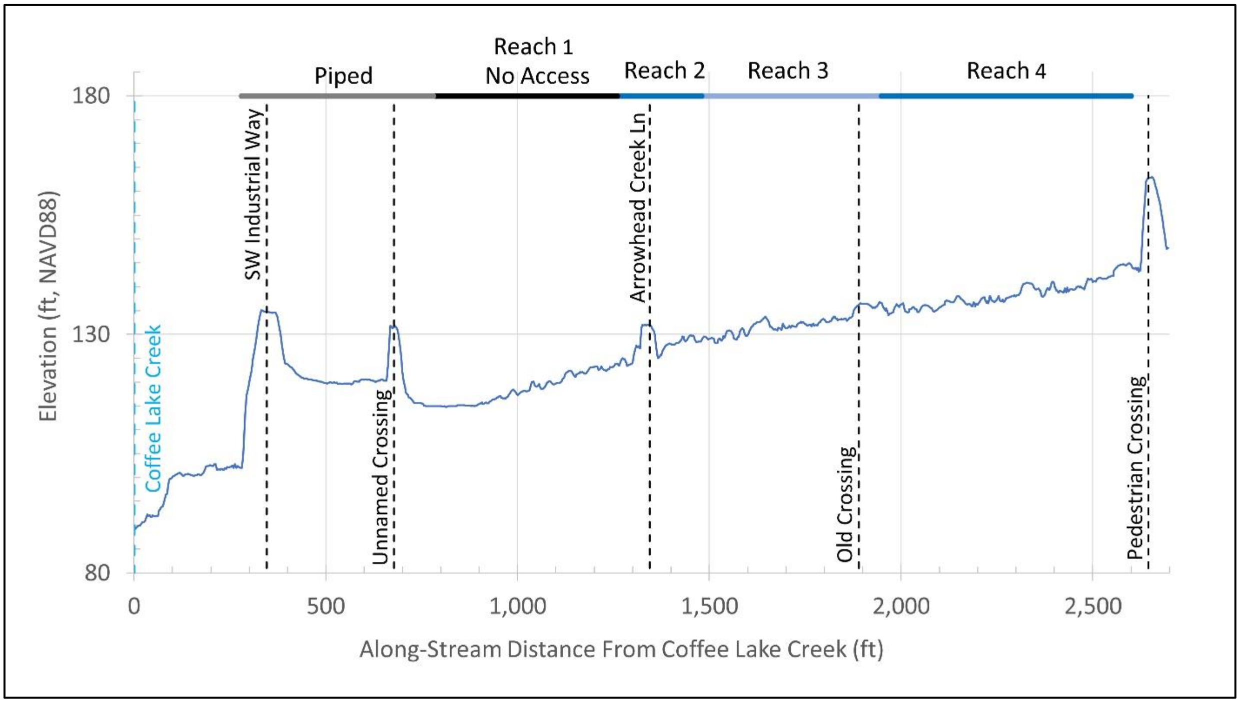
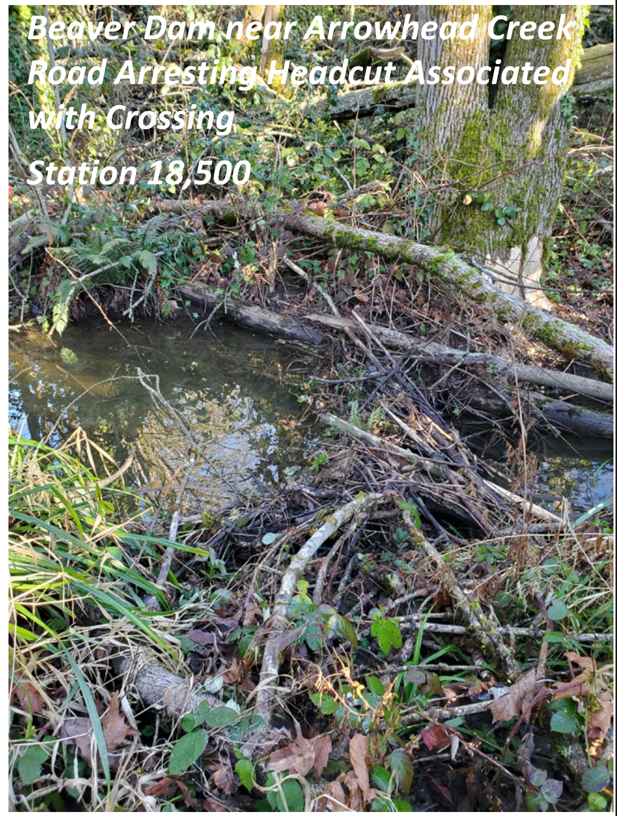


***Table 3.** Field Observations for Geomorphic Subreaches Within Arrowhead Creek*

			Observational Data								Interpretive or Subjective Information						
Subreach	Downstream Station	Upstream Station	Reach Summary Description	Gradient	Dominant Channel Morphology	Dominant Substrates	Current Condition	Base Level Control	Lateral Constraints	Beaver Presence	Geomorphic Trajectory (Incising, Stable, Aggrading)	Bed Stability	Lateral Stability	Suscept-ibility to Hydro-modification	Infrastructure Risk in Reach	Potential Stream Enhancements	Reach Description
				Based on Profile Extracted from 2014 LiDAR		Bedrock, Boulders, Cobble, Gravel, Sand, Fines (dominant listed first)	Incised, Aggraded, Stable	Site Specific: e.g., Bedrock in Streambed, Culvert, Trunk Stream Confluence, etc. "None" if No Specific Controls Present	Site Specific: Valley Walls, Root Strength, Rock Bank Protection, etc. (listed roughly in orrder of importance)	Yes, No, Maybe	Incising, Stable, Aggrading	1= Stable or Aggrading; 5= Incising	1 = Stable Banks, 5 = Heavily Eroding Banks	1 = Not Susceptible, 5 = Highly Susceptible	1 = No Identified Risks; 5 = Obvious Potential Risks	Site Specific: Add Large Wood, Remove Invasive Species, Floodplain Benching, etc.	
1	7+80	12+60	Not Surveyed														Did not visit this reach due to property access constraints.
2	12+60 (GPS 11)	14+80	Unstable reach associated with bridge replacement at Arrowhead Creek Road but low risk due to good stability in upstream and downstream reaches	1.95%	plane bed meandering	gravel	incised	limited. Could impact upstream reach	bridge and valley walls	Y, but limited by vegetation	incising but limited activity	3	1	3	3 - irrigation pipe at risk	remove blackberry and revegetate	Bridge reach at Arrowhead Road. Construction of crossing appears to have impacted channel with limited mitigation measures. Riparian not restored so blackberry dominates. Irrigation line crosses channel unburied.
3	14+80	19+50	Meandering channel in highly stable reach associated with actively maintained beaver dams	1.44%	plane bed meandering	hardpan bedrock gravel	incised but stable	bedrock hardpan and beaver dams	valley wall ~25'-30' with low energy	Y	stable	1	2	2	1	Ivy removal and riparian	Beaver dominated. Very similar to Reach 1, but beaver present which have built successive dams backwatering channel. Increased floodplain engagement. Poor ripariain condition long-term. Cottonwood/maple dominated.
4	19+50	26+00	Stable reach with hardpan grade control. Culvert at upstream extent of reach is in the process of failing	1.31%	plane bed meandering	hardpan bedrock gravel	incised but stable	shallow alluvium intermittent on hardpan bedrock	valley walls ~25-ft high with low energy	N	stable	1	2	2	2	Ivy removal and riparian restoration	Subreach consists of 50'-75' valley bottom confined by 25'-30' of 1:1 valley walls. Channel incised 2'-5' into valley bottom with some active inset foodplains. Creek flows on hardpan bedrock. Cottonwood/alder/fir canopy threatened by ivy which dominates groundcover.



Selected Photos From Arrowhead Creek, January 2022	Geomorphic Assessment of Wilsonville Creeks	WATERWAYS CONSULTING, INC. Santa Cruz, CA · watways.com · Portland, OR	FIGURE 16

Newland Creek

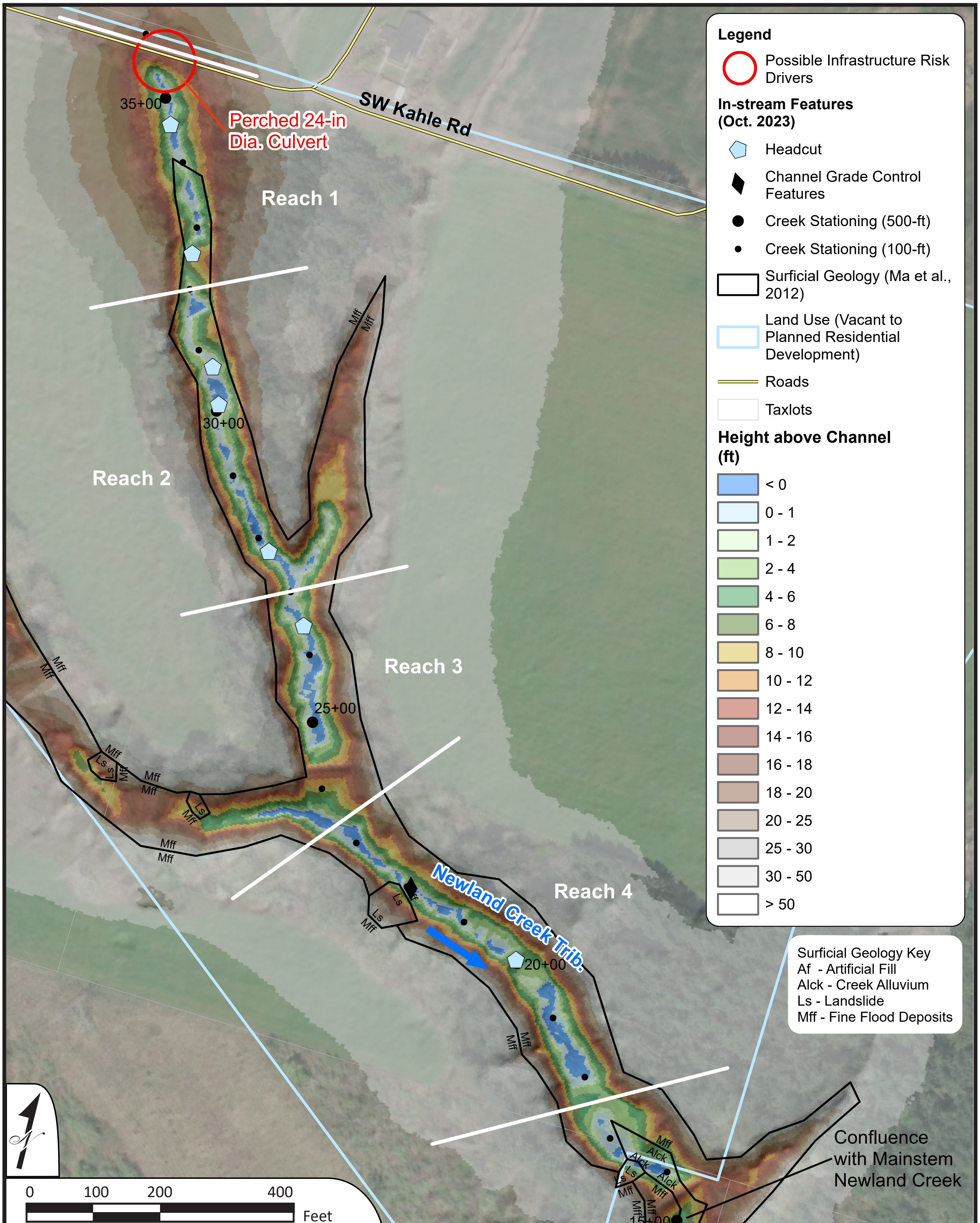
The field assessment for Newland Creek occurred on October 26, 2023. The assessment included a 1,700-foot-long section of a tributary to the mainstem of Newland Creek with the Urban Growth Boundary (UGB) with the upstream extent located at SW Kahle Road (**Figure 17**). **Figure 18** is a longitudinal profile of the creek. **Table 4** summarizes the reach scale observations and interpretations from this site visit, and the point-specific observations are listed in **Appendix A4**. **Figure 19** contain photographs from this section of Newland Creek.

GENERAL OBSERVATIONS AND INTERPRETATIONS

- The assessment area on Newland Creek was divided into four subreaches based primarily on the assessment boundaries and two tributaries that entered that had an influence on channel size.
- The culvert located at SW Kahle Road looked relatively new, consisting of a 24" corrugated plastic pipe. The culvert is significantly perched with about a 6-ft drop to the channel bed. Moderately sized angular rock was placed to dissipate energy. SW Kahle Road likely has prevented continued upstream movement of a large headcut by acting as a grade control.
- Upstream of SW Kahle Road the channel is small and the adjacent fields have been tiled and the tile drains closest to the road are exposed and eroding. The road probably also contributes a significant amount of stormwater.
- Reach 1 and 2 are highly incised with a least a half dozen headcuts that are eroding into erodible hardpan material. The channel is a notch in many places, characterized by a channel that is 3 to 4 feet wide and equally as deep cut into a narrow, confined valley that is 20 to 30 feet deep.
- The tributary entering from river left is also very incised.
- The gradient of Reach 4 is much flatter, after a larger tributary enters from river right. The channel is larger but still very incised and a deeper valley.
- Only one large headcut was observed in Reach 4. This reach may be in a widening phase in response to past incision as more bank instability was observed.
- More in-channel wood was observed in Reach 4 along with several debris jams that were holding grade.
- The riparian corridor is in good condition with a mix of mature coniferous and deciduous trees.
- Blackberry is the dominant understory in some areas though there are also significant stands of dogwood and vine maple.

SUMMARY CONCLUSIONS FROM NEWLAND CREEK

- Reaches 1, 2, and 3 are highly unstable and likely to incise further and widen over time independent of additional upstream development.
- Reach 4 is at risk of bank instability.
- All reaches were considered to be at risk from hydromodification.
- The main risk drivers consist of the following:
  - Condition of the culvert at SW Kahle Road. Although the risk of failure of this culvert does not appear to be imminent, future development will likely increase downstream risks. As mentioned above, the culvert is likely acting as a grade control, preventing the downstream channel incision from moving upstream. Any future replacement of the crossing will need to incorporate grade control to prevent future upstream channel incision.
  - Instability in the tributaries entering Reach 2 and 3 should be considered if adjacent agricultural lands are developed. The riparian buffers on these tributaries are narrower.



Newland Creek Geomorphic Survey	Geomorphic Assessment of Wilsonville Creeks	WATERWAYS CONSULTING, INC. Santa Cruz, CA · watways.com · Portland, OR	FIGURE 17

Figure 18. *Longitudinal Profile of portion of Newland Creek (from 2014 LiDAR data)*

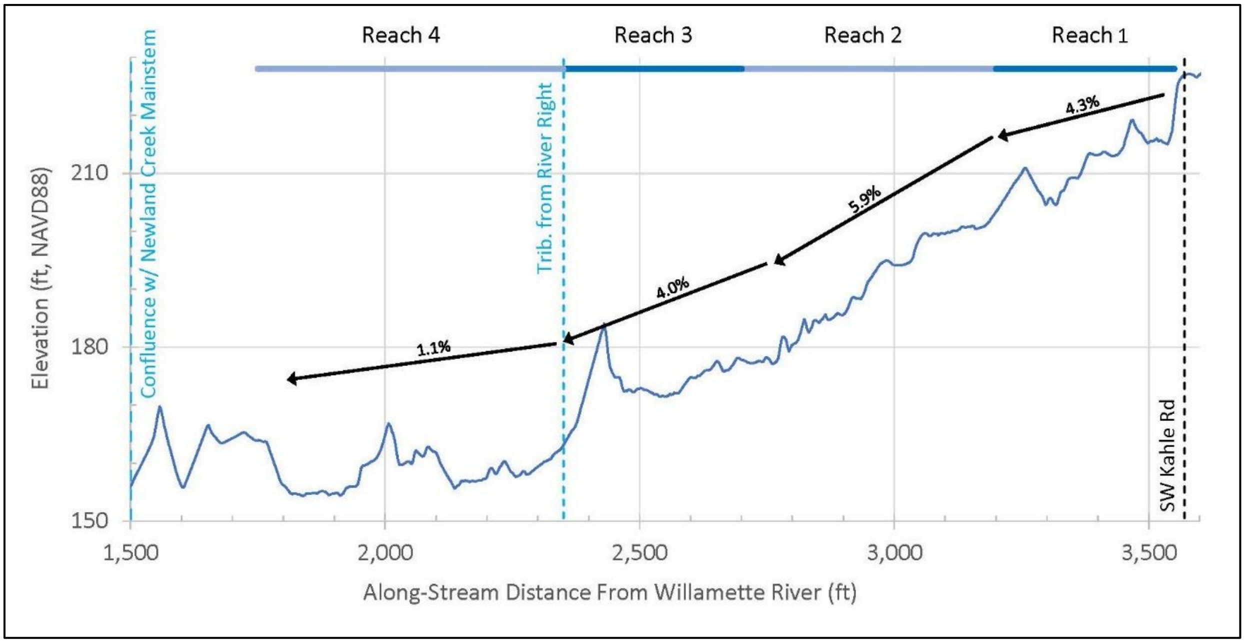


Table 4. *Field Observations for Geomorphic Subreaches Within Newland Creek Tributary*

			Observational Data							Interpretive or Subjective Information						
Subreach	Downstream Station	Upstream Station	Gradient	Channel Pattern Type	Dominant Substrates	Current Condition	Base Level Control	Lateral Constraints	Beaver Presence	Geomorphic Trajectory (Incising, Stable, Aggrading)	Bed Stability	Lateral Stability	Suscept-ability to Hydro-modification	Infrastructure Risk in Reach	Potential Stream Enhancements	Reach Description
			LiDAR-based	Based on Montgomery and Buffington, 1997 (dominant form is listed first)	Bedrock, Boulders, Cobble, Gravel, Sand, Fines (dominant listed first)	Incised, Aggraded, Stable	Site Specific: e.g., Bedrock in Streambed, Culvert, Trunk Stream Confluence, etc. "None" if No Specific Controls Present	Site Specific: Valley Walls, Root Strength, Rock Bank Protection, etc. (listed roughly in order of importance)	Yes, No, Maybe	Incising, Stable, Aggrading	1= Stable or Aggrading; 5= Incising	1 = Stable Banks, 5 = Heavily Eroding Banks	1 = Not Susceptible, 5 = Highly Susceptible	1 = No Identified Risks; 5 = Obvious Potential Risks	Site Specific: Add Large Wood, Remove Invasive Species, Floodplain Benching, etc.	
1	32+00	35+50	4.31%	bedrock/hardpan; confined	hardpan	incised	none	steep hillslopes	No	incising	5	3, but maybe not in widening phase	5	4, upstream culvert and road	Address profile instability if culvert is replaced	Steep, actively incising reach with several large to moderate headcuts. Early stage of channel evolution.
2	27+00	32+50	5.92%	bedrock/hardpan; confined	hardpan	incised	none, though harder bedrock outcrops observed	steep valley walls	No	incising	5	3, but could be entering a widening phase	5	increased bank erosion. Loss of mature riparian trees	Headcuts should be monitored and addressed if results suggest rapid incision	Channel lower slope then reach 1 but highly and actively incising. Good riparian canopy with some non-natives but large mature trees including maple and douglas fir. Some ivy which should be addressed to keep trees healthy.
3	23+50	27+00	4.03%	bedrock/hardpan; confined	hardpan	incised	none	steep valley walls	No	incising	5	3	5	increased incision + bank erosion + loss of canopy trees	Headcuts should be monitored and addressed if results suggest rapid incision	Similar to upstream reach. Small headcut + 2 large ones though hardpan material seems more competent. Valley walls less steep.
4	17+50	23+50	1.12%	plane bed; confined	hardpan w/ angular cobble	incised	hardpan but only limited effectiveness	steep valley walls	No	incising	4	4, some softer bank material, maybe landslides	5	same as previous reaches	Consider adding large wood to channel to improve profile stability channel; though access is poor	Hardpan is more solid in this reach. Hillslopes not as steep though bank material is less consolidated. Maybe old landslides. Most of bed is hardpan though some coarse substrate consisting of basalt from tributary. More wood in channel.

Selected Photos From Newland Creek, October 2023

Geomorphic Assessment of Wilsonville Creeks

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FIGURE
19

Kruse Creek

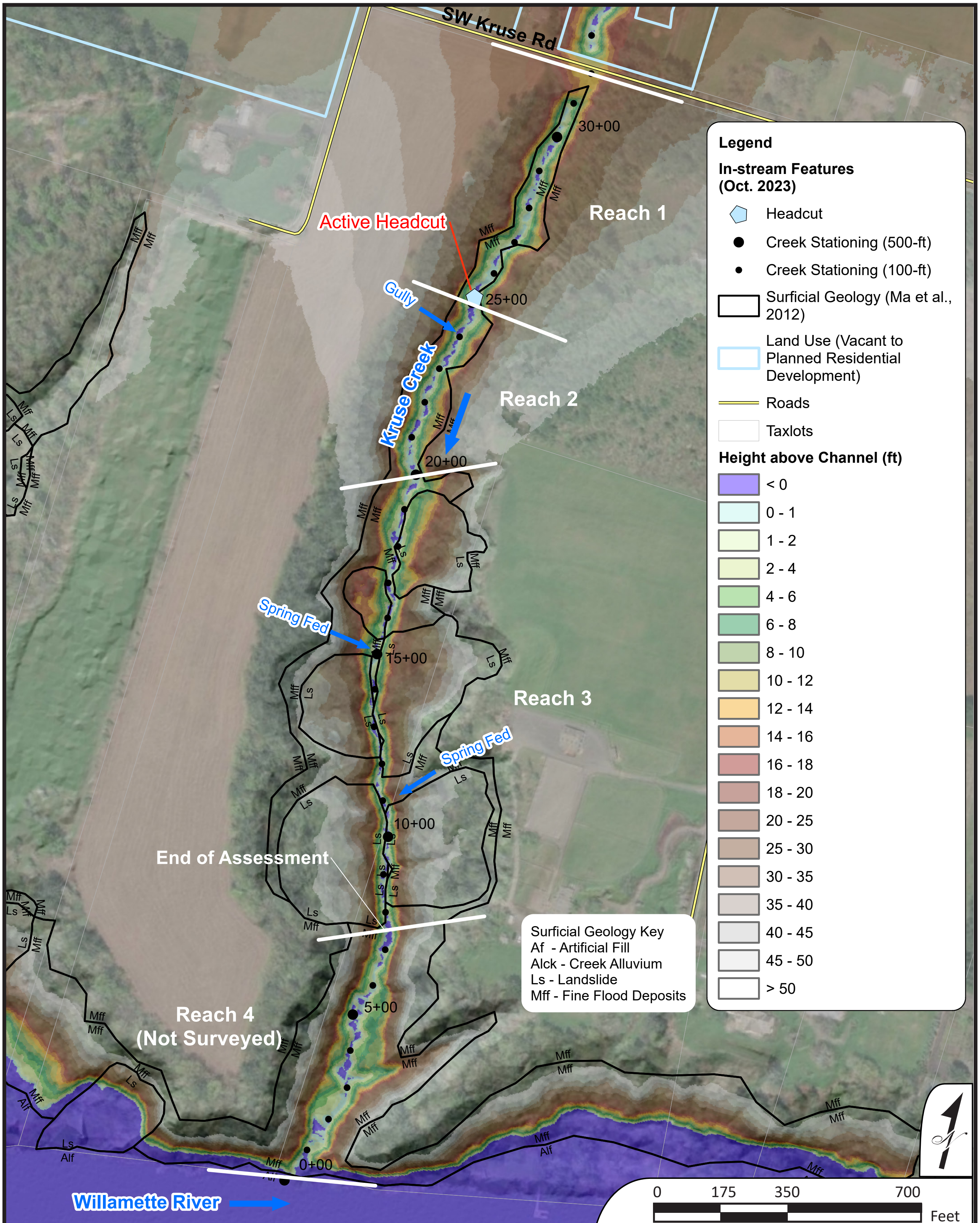
The field assessment for Kruse Creek occurred on October 26, 2023. The assessment included a 2,500-foot-long section of Kruse Creek between SW Kruse Road and the confluence with the Willamette River (**Figure 20**). **Figure 21** is a longitudinal profile of the creek. **Table 3** summarizes the reach scale observations and interpretations from this site visit, and the point-specific observations are listed in **Appendix A5**. **Figure 22** contains photographs from this section of Kruse Creek.

General Observations and Interpretations

- Reaches 1 and 2 are geomorphically distinct from Reach 3 and 4 due to the presence of large landslides from both the western and eastern hillslopes that extend continuously along approximately 1,400 feet of Kruse Creek.
- Although the channel is moderately incised in both Reaches 1 and 2, only one headcut was observed with the rest of the channel being relatively stable. This is likely due to the downstream landslides, which begin at the Reach 2 to 3 transition, and act as a downstream base level for these upstream reaches.
- The culvert at SW Kruse Road was difficult to access due to heavy growth of vegetation but it was perched which suggests some past channel incision that was likely arrested at the crossing.
- Reach 3 and 4 were very inaccessible due to deep channel incision and unstable banks associated with the adjacent large landslides.
- Active landslides and bank failures followed by subsequent channel incision through unconsolidated landslide debris is indicative of channel conditions through all of Reach 3 and potentially Reach 4. High ground water tables and seeps and springs through much of Reach 3 adds to the instability.
- The riparian corridor is in relatively good condition and consists of a mix of mature coniferous and deciduous trees with a good understory. Ivy is prevalent throughout the assessment reach and is climbing up many of the trees.
- On the eastern terrace in Reach 1 there is an extensive area of non-native English holly that was likely part of a former commercial holly farm.

Summary Conclusions from Kruse Creek

- Due to the presence of active landslides through Reach 3, Kruse Creek could be considered naturally unstable. This fact should be considered if the area were to develop in the future with riparian buffers adjusted to account for existing landslide activity and the potential for landward movement of the landslide scarps.
- It is unclear what the risk of hydromodification would be on this section of Kruse Creek. In Reaches 1 and 2 there would likely be additional channel incision and widening. A geotechnical engineer should be consulted to better understand the risk of increased sediment transport in Reach 3 that could cause rapid channel incision and destabilization of the toes of the existing landslides.
- Protection of the existing mature forest should be a priority in this area including management of ivy and removal of holly.
- Profile stabilization will need to be considered if the crossing at SW Kruse Road is upgraded.



Kruse Creek Geomorphic Survey	Geomorphic Assessment of Wilsonville Creeks	WATERWAYS CONSULTING, INC. Santa Cruz, CA · watways.com · Portland, OR	FIGURE 20

Figure 21. *Longitudinal Profile of portion of Kruse Creek (from 2014 LiDAR data)*

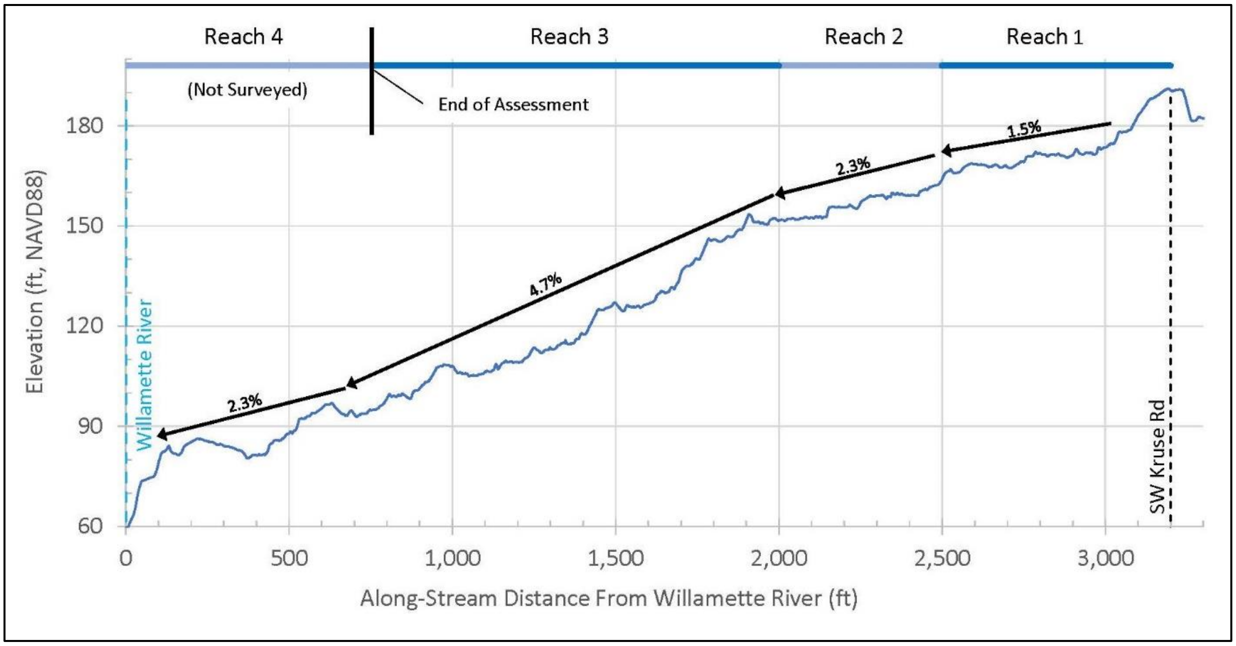


Table 5. *Field Observations for Geomorphic Subreaches Within Kruse Creek*

			Observational Data							Interpretive or Subjective Information						
Subreach	Downstream Station	Upstream Station	Gradient	Channel Pattern Type	Dominant Substrates	Current Condition	Base Level Control	Lateral Constraints	Beaver Presence	Geomorphic Trajectory (Incising, Stable, Aggrading)	Bed Stability	Lateral Stability	Suscept-ability to Hydro-modification	Infrastructure Risk in Reach	Potential Stream Enhancements	Reach Description
			LiDAR-based	Based on Montgomery and Buffington, 1997 (dominant form is listed first)	Bedrock, Boulders, Cobble, Gravel, Sand, Fines (dominant listed first)	Incised, Aggraded, Stable	Site Specific: e.g., Bedrock in Streambed, Culvert, Trunk Stream Confluence, etc. "None" if No Specific Controls Present	Site Specific: Valley Walls, Root Strength, Rock Bank Protection, etc. (listed roughly in order of importance)	Yes, No, Maybe	Incising, Stable, Aggrading	1= Stable or Aggrading; 5= Incising	1 = Stable Banks, 5 = Heavily Eroding Banks	1 = Not Susceptible, 5 = Highly Susceptible	1 = No Identified Risks; 5 = Obvious Potential Risks	Site Specific: Add Large Wood, Remove Invasive Species, Floodplain Benching, etc.	
1	25+00 (PM 3)	32+00 (at culvert)	1.51%	plane bed; confined	fines with some gravel	stable	none, some wood debris	valley slopes adjacent to small floodplain	No	stable, headcut downstream reach boundary	1, high incision potential	2, stable but rate of movement of downstream headcut could increase risk	4	No	ivy removal to save large trees	Low to moderate gradient channel. Small with adjacent low floodplain. Channel 6-ft top, 0.5-ft depth. Overall valley bottom width 20-ft. Lots of blackberry and ivy. Good canopy of douglas fir, cedar, but ivy is growing up a lot of trees. Reach break at headcut.
2	20+00 (PM 5)	25+00	2.29%	bedrock/hardpan; confined	hardpan	incised	none, though harder bedrock outcrops observed	steep valley walls	No	incising	5	3, but could be entering a widening phase	5	increased bank erosion. Loss of mature riparian trees	ivy removal to save large trees	Channel lower slope then reach 1 but highly and actively incising. Good riparian canopy with some non-natives but large mature trees including maple and douglas fir. Some ivy which should be addressed to keep trees healthy.
3	7+50	20+00	4.66%	colluvial; confined	hardpan	incised	none	steep valley walls	No	incising	5	3	5	increased incision + bank erosion + loss of canopy trees	Access is poor; Establish valley wide buffer to limit future infrastructure impacts	Similar to upstream reach. Small headcut + 2 large ones though hardpan material seems more competent. Valley walls less steep.

Selected Photos From Kruse Creek, October 2023	Geomorphic Assessment of Wilsonville Creeks	WATERWAYS CONSULTING, INC. Santa Cruz, CA / watways.com / Portland, OR	FIGURE 22

Summary of Findings

Boeckman Creek

Boeckman Creek flows in a deep valley that appears to have formed quickly following the Missoula Floods, which ended about 15,000 years ago. The creek appears to have achieved a stable base level thousands of years ago, with a flat slope graded to the Willamette River. The assessment identified several smooth, hard surfaces in the channel bed that may be resistant bedrock or hardpan, which would prevent further downcutting and indicate that the stream has reached its limit of incision.

A major base level control in the reach is at the site of a breached concrete dam within Memorial Park (**Figure 9b**). The remnants of the dam are large concrete and boulders, creating a cascade, which should remain stable under future flood scenarios.

Upstream of the dam, and especially above Wilsonville Road, beaver are the primary controller of the morphology of the Boeckman Creek channel. Although the channel itself is moderately incised, beaver dams create a stair-stepped backwater condition that allow high flows to access the floodplain and reduce stream power and associated erosional forces. Numerous large and small dams were identified during the field investigation. The beaver dams create ponded areas and form complex environments and habitats in addition to providing base level stability in Boeckman Creek. Most of the dams appear stable, although they may be more likely to collapse as a result of larger or more frequent floods. The collapse of individual dams should not endanger or affect infrastructure in Boeckman Creek, but loss of all the dams could have significant negative consequences, including significant loss of ecological value and an increase in infrastructure risks. Therefore, maintaining a healthy beaver population in Boeckman Creek would be a beneficial long term management strategy. Riparian restoration, which would include removal of blackberry and ivy, would benefit beaver and improve the long-term resiliency of the reaches dominated by beaver.

The most at-risk area to past and future changes in the hydrology associated with hydromodification within the watershed is near the confluence with the Willamette River (**Figure 9b**). In this reach the combination of high flow conditions, an incised channel, and seasonal backwatering from the Willamette River appear to limit the long-term stability of beaver dams that provide local grade control elsewhere along Boeckman Creek. Although seasonally the Willamette River does provide base level control, hydromodification impacts, especially in fall when the Willamette River is typically low, has led to channel incision and widening in the reach downstream of Memorial Park.

Meridian Creek

Meridian Creek is incised in a small canyon between houses on the west and Landover Park on the east. Meridian Creek is incised to "bedrock," which is a resistant layer of consolidated fine-grained sediment. The valley walls confine the channel on both sides. The valley slopes are covered with dense blackberry and are prone to landsliding, which could affect some backyards. A stormwater outfall pipe on the west side of the stream, near the Reach 1 and Reach 2 boundary, is undermined and a section has washed away (**Figure 11; Photo on Figure 13**).

The primary infrastructure issue in this reach is the crossing of Meridian Creek under Wilsonville Road (**Figure 11; Photos on Figure 13**). The culvert appears to be undersized and is nearly clogged with fine sediment. This obstruction caused a wedge of sediment to accumulate in the channel upstream. The lack of drainage appears to cause some ponding under current conditions, and complete plugging of the culvert seems like a reasonable possibility. It is unlikely that ponded water would overtop Wilsonville Road, but repeated ponding behind the road could cause geotechnical instability through other mechanisms. The risks at this crossing should be further evaluated as part of the Stormwater Master Plan.

Secondary infrastructure issues in this reach are:

- The debris rack at the outlet of the culvert under Willow Creek Drive is clogged with leaves, debris and sediment, backing up water under Willow Creek Drive (**Figure 11; Photo on Figure 13)**. The undersized culvert at Willow Creek Drive may limit future hydromodification impacts downstream.

Arrowhead Creek

The Arrowhead Creek channel meanders across a broad floodplain that is inset approximately 30-40 feet from the upper Missoula Flood terraces. Grade control is provided through a combination of localized exposures of hardpan "bedrock" and beaver dams that are continuous and redundant along more than 60% of the project reach.

The primary infrastructure risk observed through the project reach is the condition of the culvert at the pedestrian pathway at the upstream extent of the assessment area, which is piping and failing and should be evaluated further by a structural engineer (**Figure 14; Photo on Figure 16**). An additional risk factor that was considered low to moderate and should be monitored in the future was the potential for instability and headcut migration within the vicinity of the Arrowhead Creek Lane crossing. The constructed streambed under the relatively new bridge crossing lacks adequate grade control and has the potential to incise further and threaten the series of beaver dams in the upstream, stable reach (**Figure 14).** The lack of grade control may be due to downstream mobilization of the streambed substrate that was installed during construction of the crossing. A pile of angular cobble was noted approximately 200 feet downstream of the crossing that may have been eroded from the channel at the bridge. An indirect risk factor in the assessment area relates to the condition of the riparian corridor. Much of the riparian vegetation is being impacted by the growth of English ivy, which has the potential to impact long-term beaver use of this section of creek, which could impact the primary source for grade control in this section of Arrowhead.

Newland Creek

The assessment reach included a portion of a tributary to the mainstem of Newland Creek within the existing Urban Growth Boundary. The channel is highly incised, and relatively steep, and flows within a canyon that increases in width in the downstream direction as it incises into a broader terrace surface. Past and active channel incision has resulted in a highly perched condition at the culvert at SW Kahle Road which is the upstream boundary of the assessment area. A half dozen headcuts were mapped through the project reach that ranges from 2 feet to 4 feet high with likely low to moderate rates of upstream movement as the bed of the channel flows over hardpan material.

The primary infrastructure risk identified in the project reach is the perched culvert at SW Kahle Road (**Figure 17; Photo on Figure 19**). Although this culvert isn't immediately at risk due to placement of energy dissipation rock at the outlet, upgrades to the road will need to address the profile discontinuity and also consider the likelihood of additional channel incision associated with future headcut migration. This reach lacks grade control other than exposure of hardpan material in the bed, which will slow channel incision, but not eliminate it, especially if there are significant flow increases that occur in the future associated with development. Channel incision and active headcuts along the two tributary channels entering the assessment reach should also be considered in any future development planning.

Kruse Creek

Geomorphic conditions in the assessed portion of Kruse Creek are dominated by the presence of the presence of large landslides through the lower quarter mile of the canyon. These landslides are associated with a high water table, active springs and seeps along the entire lower canyon, and sets the base level control for the upper sub reaches of the assessment area. Active slumping into and across the Kruse Creek channel, followed by reincision into landslide debris characterizes channel conditions which were difficult to directly access during the assessment.

The primary infrastructure risk observed through the project reach is the condition of the culvert at W Kruse Road (**Figure 20**). The corrugated metal pipe is perched and, although not immediately at risk of failure, would need to be addressed, along with the apparent profile discontinuity, if the crossing was replaced during upgrades to the road, which is currently a narrow, relatively undeveloped asphalt road. Although there is no direct infrastructure risk associated with the mapped landslides, any planned development might have an impact on their rate of movement. Creating large buffers along Kruse Creek that considers existing geologic and geotechnical conditions as well as how those might be exacerbated by changes to watershed hydrology will be important to limit future impacts to infrastructure. Addressing non-native species, especially the potential for English ivy to impact mature trees, would also benefit the Kruse Creek corridor.

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APPENDIX A

Field Observations in Boeckman, Meridian, Arrowhead, Newland, and Kruse Creeks

***Appendix A1** : Record of Field Observations in Boeckman Creek*

Dates: 11/19/2021, 11/24/2021 and 01/25/2022

Location		Bank Features				Tribu-tary	Channel Bed Features			Infrastructure Features							
Approx River Station (Distance from Willamette R. in ft)	GPS photo ID	Right or Left Bank	Significant Bank Erosion (Length, Height, ft)	Eroding Bank Intensity (1-5)	Bank Protection (type, length, height)	Tributary (Name, R or L, Channel Type)	Bedrock Type	Headcut or step height (ft); Risk level (1-5)	Beaver Dam (Height, ft)	Pipe/Culvert Outfall (Side of channel; Diameter,ft)	Bridge (Name, Type)	Pipe Crossing (type, material, diameter)	Other Feature (type)	Hydromodification Risk	Grade Control Feature	Capital Project Needs	Notes
450	1										Steel beam, full span			3	Rock grade control in channel		Private bridge at upstream extent of Willamette backwater. Accesses 1 property. Landowner there since 1976. Creek has incised and widened when Memorial Park bridge replaced culvert. Rock grade control provides limited protection. Rocks are small and could get flanked.
580	2						X										Bedrock exposed in bed along right bank. Shale. May not be continuous across bed. Overlain by fine sediments.
700	3	L	Active, 50'x25'	5	None								Deck and House	5			Actively eroding bank. Local incision and widening of channel undermined bank. May be exacerbated by fill/retaining wall at house. Retaining wall has since failed.
780	4							18"					Old crossing				Old crossing. Some road fill still present. Upstream extent of ??? headcut migration. Possibly associated with debris log jam.
1000-800	2115-2121																Reach below bridge to private property boundary consist of a 100' section with boulders and gravel, followed downstream by a 100' section of mud and wood bed before reaching property boundary. Appears to be significant bank erosion in the downstream section underneath the private homes (see photo 2121)
1050	2109, 2111, 2127-2129										Trail footbridge						High foot bridge over creek. Low chord is about 20 feet above creek, well engineered. A few boulders and rounded gravel lag deposits in the channel under the bridge
1100	2107, 2112-2113							12" boulder drop							X		Small step with boulder rip rap just upstream of bridge
1400	2096-2100						Willamete River bed material								X		Outcrop of a contact between overlying fine-grained sediments and underlying partially cemeted gravel close to the current water level. Gravel is well rounded basalt pebbles and cobbles, looks like probably old Willamette River bed material. This suggests stream from here down is probably not susceptible to much further incision due to exposing the coarser bed material and also as approaching the base level of the Willamette River
1500	2093-2094														X		Large, recently fallen cedar tree in channel. Log jam beginning to form, accumulating wood, and will probably persist for many years
2000 - 1500	2080-2093																Deeply incised meanders in low gradient channel. Not actively moving meanders. Bank walls as high as 40' and as low as 12 feet above channel Steps are formed at several fallen logs, mostly featureless runs. Abandoned floodplain is covered with mostly ivy (not as much blackberry here)
2050	2079-2080							30" high step, log							X		step from fallen log and debris. Doesn't appear to be a beaver dam

Location		Bank Features				Tributary	Channel Bed Features			Infrastructure Features							
Approx River Station (Distance from Willamette R. in ft)	GPS photo ID	Right or Left Bank	Significant Bank Erosion (Length, Height, ft)	Eroding Bank Intensity (1-5)	Bank Protection (type, length, height)	Tributary (Name, R or L, Channel Type)	Bedrock Type	Headcut or step height (ft); Risk level (1-5)	Beaver Dam (Height, ft)	Pipe/Culvert Outfall (Side of channel; Diameter,ft)	Bridge (Name, Type)	Pipe Crossing (type, material, diameter)	Other Feature (type)	Hydromodification Risk	Grade Control Feature	Capital Project Needs	Notes
2200	2069-2071	L	50' Long by 30' high	2													Bank erosion on outside of a sharp bend in incised meandering reach. 30' high near-vertical brank held up by several large fir trees composed of Missoula Flood fines. There's foot traffic at top of bank, trail may be endangered from erosion (didn't climb up to top to be sure)
2700-2200	2069-2078																Mud and wood channel bottom, 2' to 4' deep at current high flows. Channel bed about 12 feet wide, mostly runs. Ivy/blackberry floodplain, incised. Floodplain is about 6 to 12 feet above floodplain
2700	2066-2068								18"						X		Small step within mud reach, likely beaver dam but not clearly so. Could be a downed log covered with debris. Low gradient, mud reach. Lots of ivy on floodplain
3000	2026-2031	R				Tributary enters from River Right											Tributary enters from river right through a large (>36") corrugated metal culvert under a road fill. Culvert is open but backwatered by Boeckman Creek about 24" deep. Scour pool at mouth of tributary
3050 to 2700	2059-2065; 2132-2134														X		Relatively featureless reach below tributary junction; incised, heavy blackberry and ivy on terraces; mud bed; lots of wood in channel bed
3050	2058	R	75' long by 6' high	3													Bank erosion and incision on river right below fence and facility on the top of bank downstream of tributary.
3050	**TRIBUTARY DESCRIPTION**																Inspected the lower end of tributary at request from B&C. Visited lower portion of tributary up to the road crossing in Memorial Park. Low gradient, deeply incised. For the first 200 to 300 feet upstream of confluence, upstream of access road, the channel is incised in blackberry thicket with no floodplain. Channel is about 5-10' bottom width, about 20' top width. Occasional lower benches, mud in channel
3350	2016, 2024														X		100-foot-long boulder riffle with boulder bank protection on river right @ 3350. Some of the boulders transported a short distance downstream forming a stable base level control over about 50-100' distance
3450	2019-2023; 2135-2138	R															Relatively broad floodplain surface covered with blackberry
3675	2003-2004	R	50' long by 16' high	5													Big eroding bank on right bank just downstream of dam. Banks composed of Missoula Flood fine facies

Location		Bank Features				Tribu-tary	Channel Bed Features			Infrastructure Features							
Approx River Station (Distance from Willamette R. in ft)	GPS photo ID	Right or Left Bank	Significant Bank Erosion (Length, Height, ft)	Eroding Bank Intensity (1-5)	Bank Protection (type, length, height)	Tributary (Name, R or L, Channel Type)	Bedrock Type	Headcut or step height (ft); Risk level (1-5)	Beaver Dam (Height, ft)	Pipe/Culvert Outfall (Side of channel; Diameter,ft)	Bridge (Name, Type)	Pipe Crossing (type, material, diameter)	Other Feature (type)	Hydromodification Risk	Grade Control Feature	Capital Project Needs	Notes
3700	1990-1999, 2145-2147														X		Breached dam in creek. Dam made from stone and mortar, about 15' wide. Even though it is breached it is still a 4 to 5 foot drop over a distance of about 30 feet, and provides a stable base level control. Boulders on the downstream side of dam. Possible fish passage barrier at low flows (not at the current high flow). Currently an aluminum pipe ~8" crosses above channel at former dam, looks like it is no longer used.
3700 to 4000	2148-2156	R											depositional floodplain				Relatively broad, flat surface covered in reed canary grass. Appears to be a deposit in an impoundment behind former dam at 3700
4000	1983	R			2 to 3' boulders								boulder riffle		X		Boulder bank protection and boulders in streambed. It looks like the boulders were installed to protect the right bank and provide grade control. There is about a 2 foot drop over the riffle
4100	1975-1979								2 to 3'						X		2 to 3' high beaver dam. Exact height not clear due to high flows. Appears to be stable
4300	2157, 1968, 1970								18"						X		Beaver dam (?) with reed canary grass root mat. Unclear height due to high flow. Chewed sticks. RCG is providing added strength to apparent damn
4450	1965, 1966	L								30" PVC							Stormwater outfall from parking lot in park. Discharges onto slope about 4 feet above channel. Rocked around outfall, no notable erosion
4500	1960 - 1964										SW Kolbe Lane Single lane vehicle bridge				X		Single lane auto bridge at Kolbe lane. Wood single span lower chord about 12 to 15 feet above channel. Headcuts or small beaver dams under the bridge
11/24/2021 - Wilsonville Road to SW Boeckman Road																	
5250	2168, 2183	R								18"	SW Wilsonville Road Bridge						High bridge with 4 sets of 3 large concrete piers about 40-50' above the streambed. No apparent hazards related to the stream. There is a record of a past stream realignment project here but no obvious evidence of what was done here. Old concrete stormwater outfall into the channel on river right under the bridge
5350	no photo	R															Drainage off senior living community parking lot creates a ponded area on the floodplain on river right, at least during wet season.
5400	2186								2'						X		Small beaver dam a short distance upstream of bridge backs up water around 400 feet. The pond is confined within banks about 15' wide, only about 2' above water level.
5800	2199																Upstream end of beaver pond from dam at 5400' . Flow into pond comes from a beaver dam just 50' upstream of top of pool. Beaver clearly know how to build dams so that the pond ends just below the toe of next upstream dam.

Location		Bank Features				Tributary	Channel Bed Features			Infrastructure Features							
Approx River Station (Distance from Willamette R. in ft)	GPS photo ID	Right or Left Bank	Significant Bank Erosion (Length, Height, ft)	Eroding Bank Intensity (1-5)	Bank Protection (type, length, height)	Tributary (Name, R or L, Channel Type)	Bedrock Type	Headcut or step height (ft); Risk level (1-5)	Beaver Dam (Height, ft)	Pipe/Culvert Outfall (Side of channel; Diameter,ft)	Bridge (Name, Type)	Pipe Crossing (type, material, diameter)	Other Feature (type)	Hydromodification Risk	Grade Control Feature	Capital Project Needs	Notes
5850	2201-2202								2'						X		2 foot high beaver dam just above ponded area from downstream dam
5900	2205	R								Surface water from outfall							Trickle of water entering from gully which begins at a stormwater outfall high up on hillslope/valley wall. The gully is protected with sandbags, minor erosion
6000	2206-2208								1.5'						X		Beaver dam around 18" high at upstream end of pond from the dam at 5850
6200	2220-2226	R				Small tributary											Small tributary from river right, incised in dense blackberry, enters just downstream of the small tributary. I was only able to reach the stream in one spot about 100' from Boeckman Creek confluence due to blackberry. Creek has pebble gravel bed and appears reasonably stable. No clear hazards noted
6250	2213-2216								**4 to 5' high**						X		Big (4 to 5' high) beaver dam inundating lot of area upstream from here. High dam spreads water onto floodplain for as much as 500' upstream
6200-6600	2217-2234																Ponded, meandering reach upstream of large beaver dam at 6250. Water spreads out onto floodplain. Lots of blackberry, slow walking through here.
6550	2233-2235																Large fallen cedar tree across channel. 3'-4' DBH within the ponded area upstream of dam at 6250. Seems certain to trap any wood traveling through this reach for many years to come.
6650	2240-2242								1'						X		Small beaver dam just upstream of the pond behind the dam at 6250
7000	2245-2246							2' high step							X		Small (2') step or beaver dam. Could be behind a collapsed block of root mats, or a fallen tree. Unclear due to accumulated debris, but it's backing up water similar to beaver dam
7100	2248								2'						X		Apparently stable 2' high step in channel as a rsult of a beaver dam reinforced by reed canary grass sod. Looks very stable and long lived
7300	2259-2267								**3-4'**						X		Big beaver dam with lots of reed canary grass covered floodplain that is flooded by this dam
7300-8000	2270-2282																Reach mostly impounded by the big dam at 7300. Impounded area continues almost up to the footbridge. Impenetrable blackberry throughout this reach
8150	2284-2286										Boeckman Creek Trail Bridge						Boeckman Creek trail footbridge crosses over creek. At this location, stream is flowing, not ponded; gravel, with riffle-pool morphology and small wood. Lots of blackberry

Location		Bank Features				Tribu-tary	Channel Bed Features			Infrastructure Features							
Approx River Station (Distance from Willamette R. in ft)	GPS photo ID	Right or Left Bank	Significant Bank Erosion (Length, Height, ft)	Eroding Bank Intensity (1-5)	Bank Protection (type, length, height)	Tributary (Name, R or L, Channel Type)	Bedrock Type	Headcut or step height (ft); Risk level (1-5)	Beaver Dam (Height, ft)	Pipe/Culvert Outfall (Side of channel; Diameter,ft)	Bridge (Name, Type)	Pipe Crossing (type, material, diameter)	Other Feature (type)	Hydromodification Risk	Grade Control Feature	Capital Project Needs	Notes
8150-8650																	Mostly gravel riffle-pool reach from bridge to 8650; low floodplain with blackberries, not ponded reach
8650	2299-2303	L															Gully and drainage from river left. It appears that a PVC culvert pipe under the trail had washed out and was moved out of the way. Former homeless encampment here.
8890															X		Resistant bedrock in channel underwater near the dam.
8900	2308								2' high dam						X		Beaver dam, around 2 feet high. Lots of blackberry
9070															X		Apparent bedrock under water
9075	2315								2' high dam						X		Another beaver dam short distance upstream of the one at 8900, also resistant bed here underwater based on feel (not visible due to turbid water). Clearly a stable base level here
9100	2317-2324									18" pipe and box							Stormwater outfall and energy dissipator on the right bank, just above the beaver dam. It appears to be sitting on basalt bedrock. It remains clear of debris. Appears to be working well, no concerns or hazards noted
9300	2329-2331								2' high dam						X		Small beaver dam ~2' high; pond backs up to toe of the next upstream dam
9500	2335-2337								**5' high**						X		Tall but narrow beaver dam. Dam is built off of one large fallen log. 5 feet high by 15 feet wide
9700	2343-2344								**3-4' high beaver dam**						X		Large beaver dam, difficult to access. Ponds water a far distance upstream.
10000	2345-2346								2' high dam						X		Beaver dam near mapped outfall. Only viewed from the trail, did not get close to it. Difficult access
10000-10500	2350-2351																Reach with mostly ponded water. Beaver pond is effectively inundating much of the valley floor throughout this reach
10500		R								plastic pipe							Large pipe down long hillside on river right valley wall. Did not visit except from trail across the valley

***Appendix A2** : Record of Field Observations in Meridian Creek*

Date: 11/26/2021

Location		Bank Features				Tribu-tary	Channel Bed Features			Infrastructure Features							
Approx River Station	GPS photo ID	Right or Left Bank	Significant Bank Erosion (Length, Height, ft)	Eroding Bank Intensity (1-5)	Bank Protection (type, length, height)	Tributary (Name, R or L, Channel Type)	Bedrock Type	Headcut or step height (ft); Risk level (1-5)	Beaver Dam (Height, ft)	Pipe/Culvert Outfall (Side of channel; Diameter,ft)	Bridge (Name, Type)	Pipe Crossing (type, material, diameter)	Other Feature (type)	Hydromodification Risk	Grade Control Feature	Capital Project Needs	Notes
11/26/2021 - SW Wilsonville Road to SW Willow Creek Dr																	
775	2372-2383										Wilsonville Road				X	Fix drainage at culvert	Meridian Creek crossing at Wilsonville Road. Clogged, apparently undersized (approx 30") culvert under high road prism under Wilsonville Road. Culvert is clogged on the upstream end with about 2 feet of sediment which is backing up a wedge of sediment for about 50 feet. There is a outfall (or possibly overflow pipe inlet) above main culvert, 6" plastic pipe. This is a hydromodification risk factor that should be evaluated. Unlikely there's enough water that it could overtop the road. But could plugging the culvert and an extended period of standing water following a storm destabilize the road embankment?
850	2388-2392									18" PVC							Section of corrugated plastic culvert pipe, about 6' long, along side of the channel. It appears to have been washed down from upstream
875	2393							18" step							X		Small log jam forming a 1.5' foot high step in the channel. Gravel sediment stored in a wedge behind it. If this were to fail or collapse, sediment could easily clog the rest of the culvert at Wilsonville road
1000	2415-2417							4' high waterfall in bedrock`							X		Waterfall in consolidated fine-grained bedrock. Marks transition from alluvial bed below and a bedrock stream above the waterfall.
1050	2421-2425									18" PVC							Stormwater outfall, 18" PVC on river right, about 6' above where the channel is in bedrock.There is a concrete support under the outfall which is undermined and failing. This is where the 6' long piece of pipe at Sta. 850 came from
1200	2448-2452							2' step							X		Boulder step in consolidated mud bedrock. Boulders may have been placed here for some reason,. Perhaps they were installed as bank protection and fell into the creek.
1300	2456-2466														X		Culvert outlet at top of reach under SW Willow Creek Drive. Culvert has a metal grate at the outlet that is clogged mostly by leaves. Some water is leaking through but this is a low flow. It is probably backwatered during storm flow. Currently, there is standing water about 2' deep under Willow Creek Drive behind the clogged grate. The channel upstream of Willow Creek drive is a stormwater basin which may reduce the amount of runoff from the developed area, but this culvert should be evaluated in the context of hydromodification upstream.

***Appendix A3** : Record of Field Observations in Arrowhead Creek*

Date: 1/25/2022

Location		Bank Features				Tribu-tary	Channel Bed Features			Infrastructure Features							
Approx River Station	GPS photo ID	Right or Left Bank	Significant Bank Erosion (Length, Height, ft)	Eroding Bank Intensity (1-5)	Bank Protection (type, length, height)	Tributary (Name, R or L, Channel Type)	Bedrock Type	Headcut or step height (ft); Risk level (1-5)	Beaver Dam (Height, ft)	Pipe/Culvert Outfall (Side of channel; Diameter,ft)	Bridge (Name, Type)	Pipe Crossing (type, material, diameter)	Other Feature (type)	Hydromodification Risk	Grade Control Feature	Capital Project Needs	Notes
13+50	10							3 (2')			Arrowhead Road; freespan truss			3			Arrowhead Road. Freespan concrete truss. Active headcutting at creek under bridge. Mitigated somewhat by beaver activity upstream. Unknown irrigation line (6" PVC) in channcel crosses creek several times.
18+50	5-9								Series of 5 beaver dams. See notes for locations and height								Series of beaver dams. Ramps and chew suggest active site. Dams (Stationing and Height): 18+50 and 17+30 = 18" high; 16+80 = 24" high; 15+90 = 12" high; 14+80=30" high
18+80	4												old crossing	1			Old road bed/crossing. Approach fill still present and evident in LiDAR. Crossing not evident.
23+00	3												rock groin on left bank				Boulder groin on left bank at toe at apex of meander bend. Upper bank ~55' high but no evidence of active erosion. Remnant training structure.
25+50	2						hardpan										Channel flowing on hardpan. Channel 6' wide incised 2'-3' feet into floodplain. No evidence of floodplain activation. Stable channel profile.
26+00	1									Culvert at trail				3			Double concrete box cultert 5'x5' (x2). Only looked at outlet. Drop of 2'-3' to channel. Concrete base of culvert failing. Water subbing under structure. High risk to infrastructure.

Reach Name: Newland Creek Trib. - Reach 1 Date: 10/26/2023 **Appendix A4**

Location		Bank Features				Tributary	Channel Bed Features			Infrastructure Features							
Approx River Station	GPS photo ID	Right or Left Bank	Significant Bank Erosion (Length, Height, ft)	Eroding Bank Intensity (1-5)	Bank Protection (type, length, height)	Tributary (Name, R or L, Channel Type)	Bedrock Type	Headcut or step height (ft); Risk level (1-5)	Beaver Dam (Height, ft)	Pipe/Culvert Outfall (Side of channel; Diameter,ft)	Bridge (Name, Type)	Pipe Crossing (type, material, diameter)	Other Feature (type)	Hydromodification Risk	Grade Control Feature	Capital Project Needs	Notes
35+50	PM 1									24" Dia CPP							Culvert at Kahle Rd 24-in CPP perched 6-ft above channel bed. Stormwater from road enters uncontrolled. Concrete rubble placed at culvert outlet. Outfall relatively stable though channel downstream is highly incised compared to upstream.
34+50	PM 2							3-ft over 10-ft (4)									Channel highly incised into erodible hardpan. Steep on both banks with a narrow channel notch 4-ft wide by 4-ft deep. Headcut 3-ft distributed over 10-ft channel not even deeper and narrower downstream of headcut.
32+50	PM 3							4-ft over 6-ft (5)									Larger headcut 4-ft over 6-ft incised into erodible hardpan. Steep banks.
30+75	PM 5							3-ft (3)									Headcut 3-ft held up by maple roots.
30+00	PM 6							4-ft over 15-ft (3)									Two closely spaced headcuts. 4-ft over 115-ft. Harder bedrock exposure along right bank. Unsure if its continuous across channel.
28+00	PM 7							4-ft (5)									Headcut 4-ft tall. Risk level 5.
26+50	PM 9							3-ft (5)									Headcut 3-ft tall. Risk is 5.
22+00	PM 12								debris jam of small wood								Debris jam holds 18-in of grade. Fine sediment accumulated upstream.
20+00	PM 14							2-ft (3)									Downstream extent of assessment

Reach Name: Kruse Creek

Date: 10/26/2023

Appendix A5

Location		Bank Features				Tributary	Channel Bed Features			Infrastructure Features							
Approx River Station	GPS photo ID	Right or Left Bank	Significant Bank Erosion (Length, Height, ft)	Eroding Bank Intensity (1-5)	Bank Protection (type, length, height)	Tributary (Name, R or L, Channel Type)	Bedrock Type	Headcut or step height (ft); Risk level (1-5)	Beaver Dam (Height, ft)	Pipe/Culvert Outfall (Side of channel; Diameter,ft)	Bridge (Name, Type)	Pipe Crossing (type, material, diameter)	Other Feature (type)	Hydromodification Risk	Grade Control Feature	Capital Project Needs	Notes
32+00	PM 1									24" Dia CMP							Culvert 24-in CMP perched 4-ft above channel. Large scour hole and circular erosion. Undercut.
25+00	PM 3							4-ft (5)									Headcut 4-ft. Risk 5
24+00	PM 4					right gully											Small gully entering from right bank 2-ft wide, 3-ft wide. Appears to be stormwater runoff. Extends to conifers 40-ft upslope.
15+00	PM 6					right spring fed											Drainage from landslide area enters from right bank. Flow equal to or exceeds main channel flow. Flow is piping through landslide along bank.
11+00	PM 7					left spring fed											Tributary or drainage input from left bank. Might be from landslide. Steep drainage. Could be highly erosive if additional water is delivered to the drainage.

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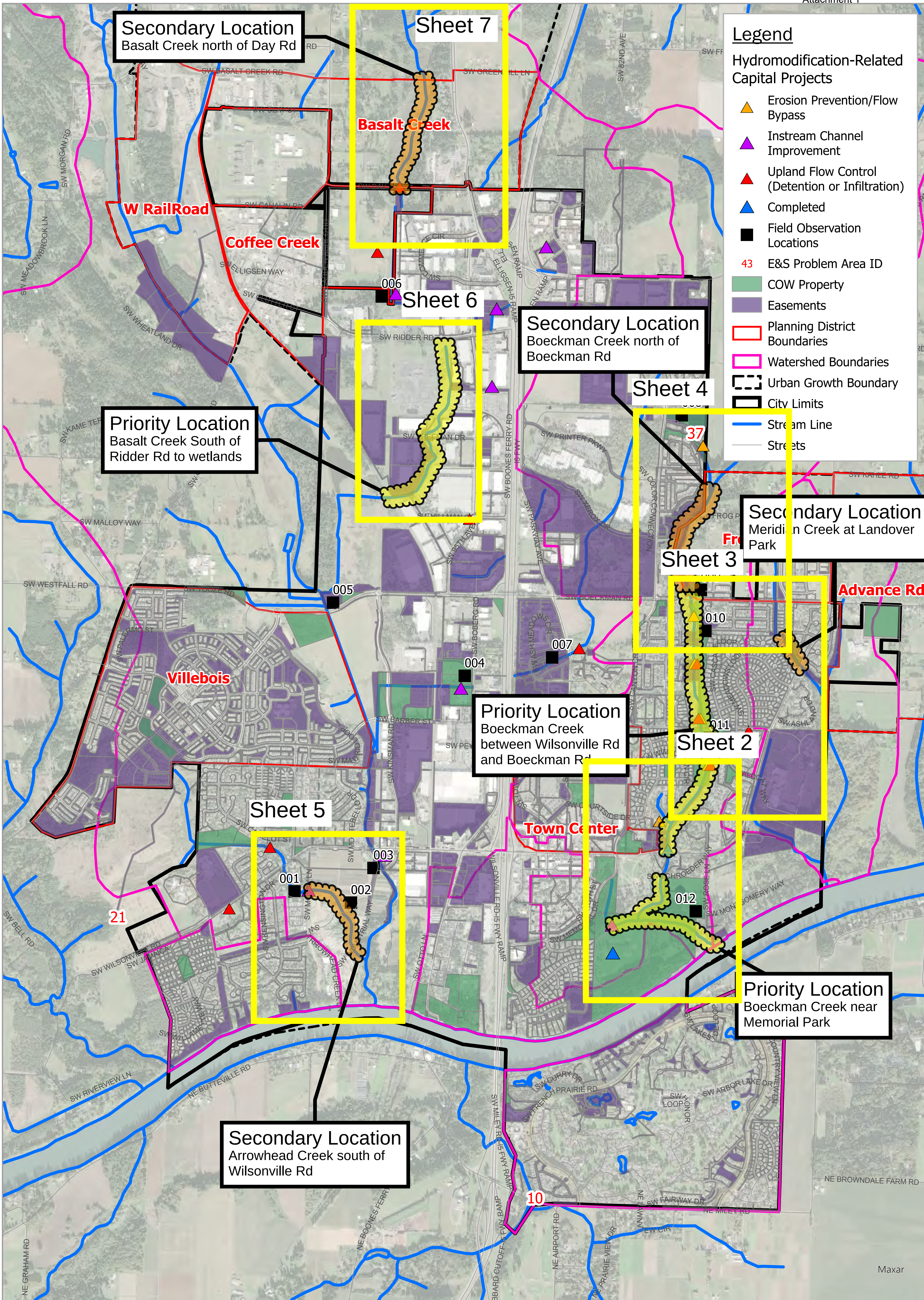
APPENDIX B

Field Maps for

Boeckman, Meridian, Arrowhead,

Newland, and Kruse Creeks

Attachment 1



Accessed By: MGLASS at 08/23/2021

Path: Q:\156157 - Wilsonville Stormwater Master Plan\GIS_Internal BC\APRX\Modeling Workshop\Stream Assessment.aprx

Brown AND Caldwell

City of Wilsonville/
Project # 156157

Stormwater Master Plan

Notes:

Drawn By: MRG
Checked By:

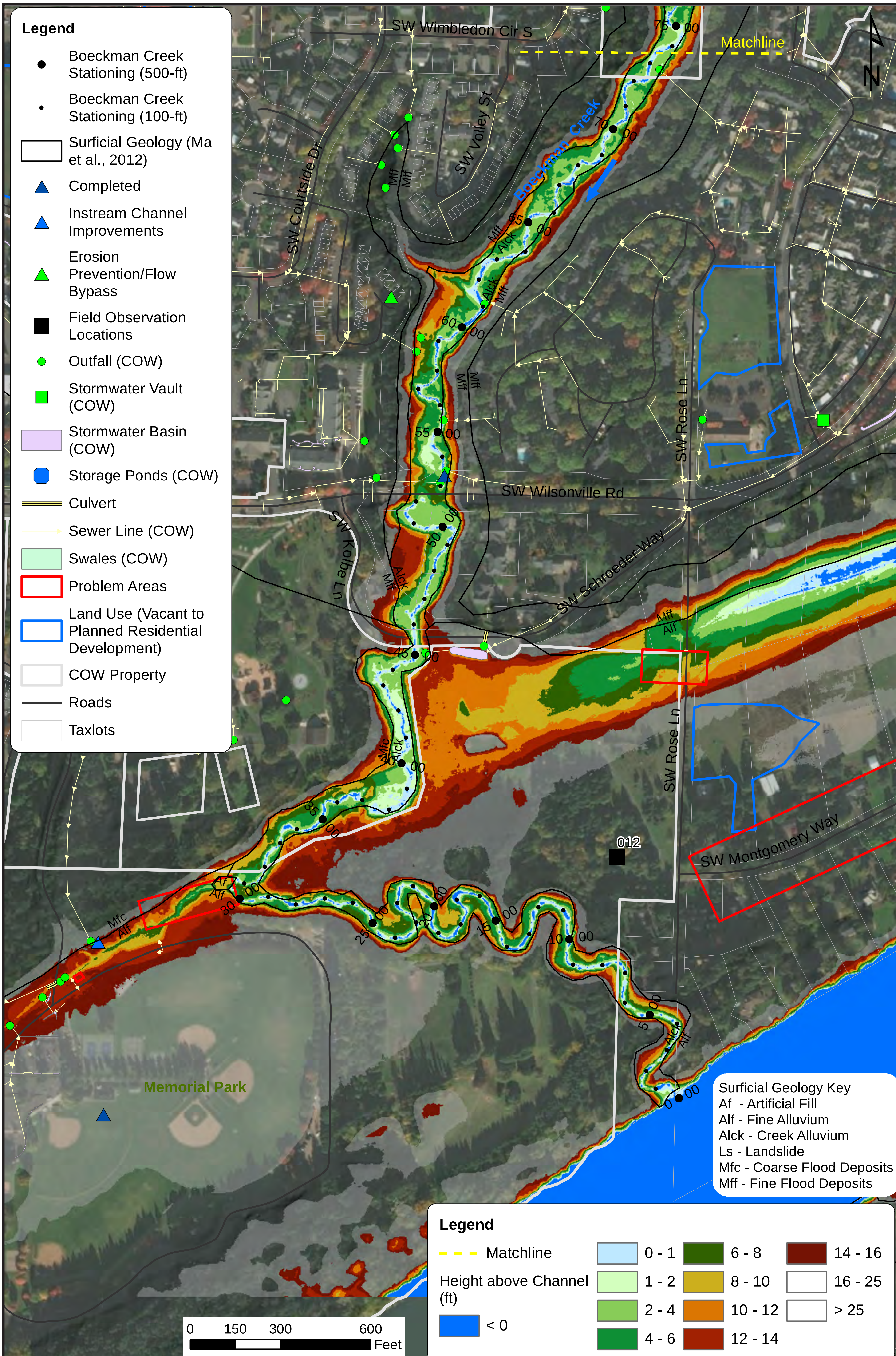
Spatial Reference:
Name: NAD 1983 HARN StatePlane Oregon North FIPS 3601 Feet Intl

N

0 1,000 2,000 4,000 Feet

Stream Assessment

Date: 8/23/2021



Boeckman Creek Downstream (1 of 3) - Priority Location

Wilsonville Stormwater Master Plan

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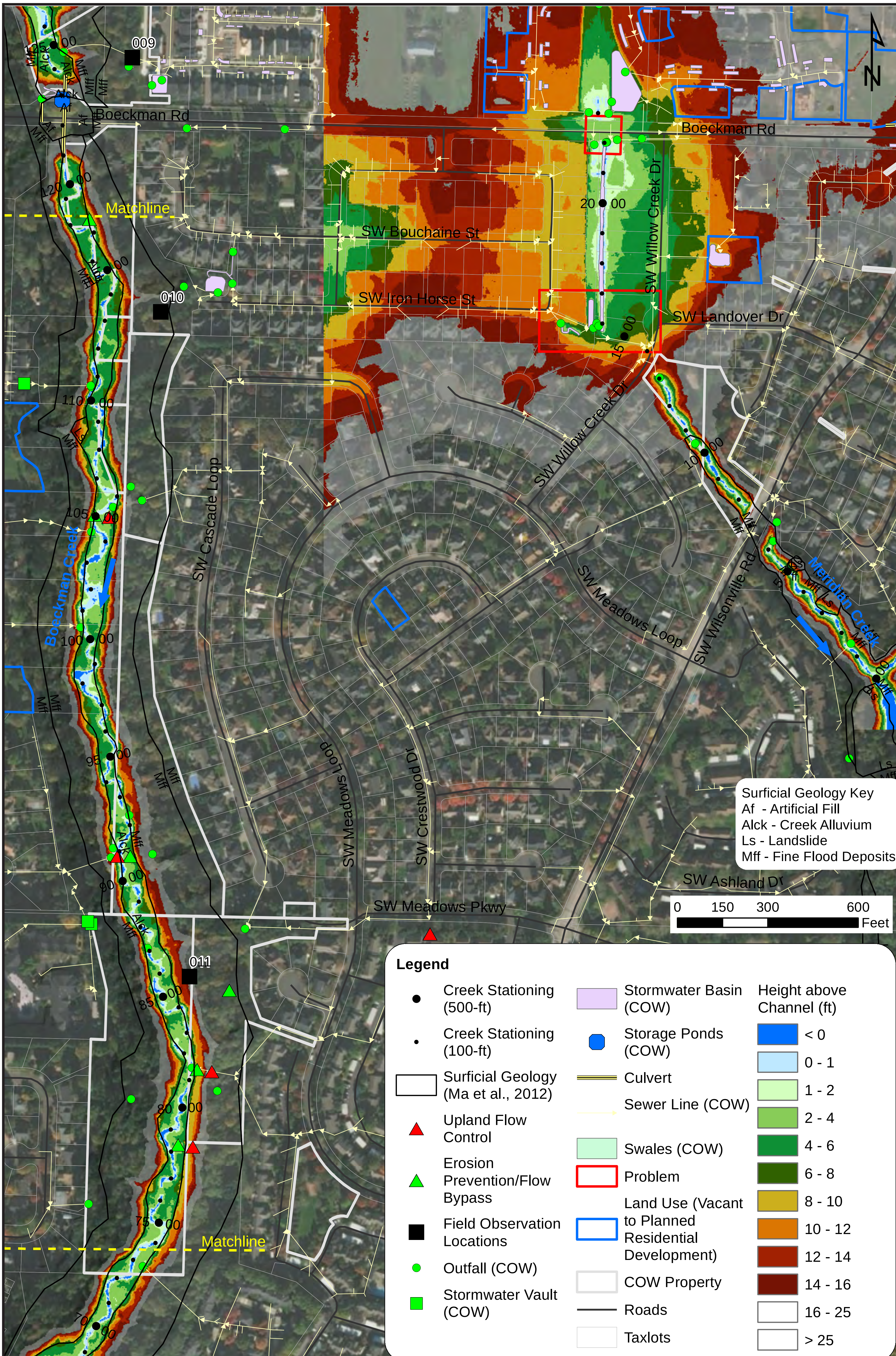
FIGURE 2



Boeckman Creek Mid (2 of 3) - Priority Location

Wilsonville Stormwater Master Plan

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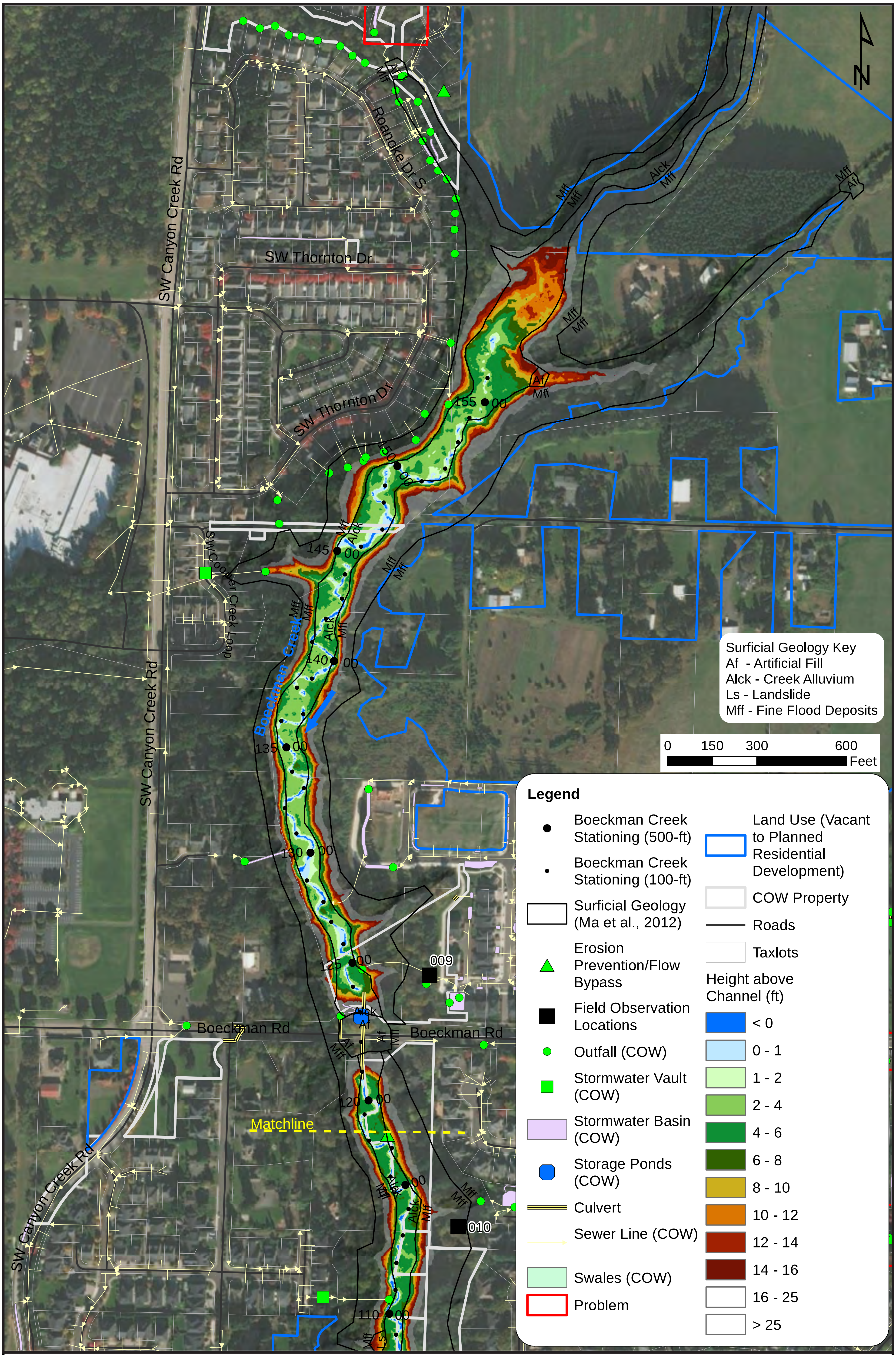
FIGURE 3



Boeckman Creek Upstream (3 of 3) - Secondary Location

Wilsonville Stormwater Master Plan

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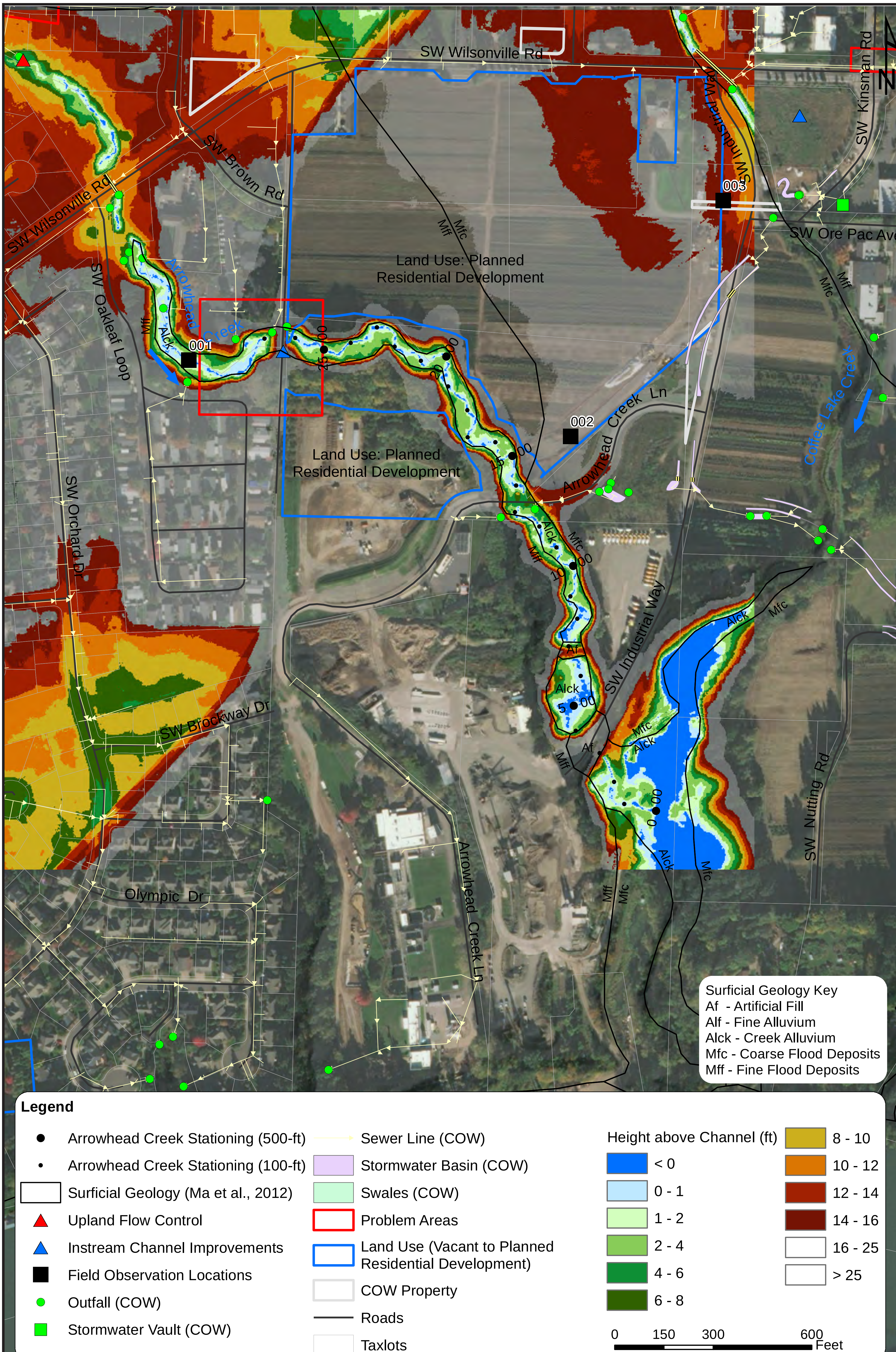
FIGURE 4

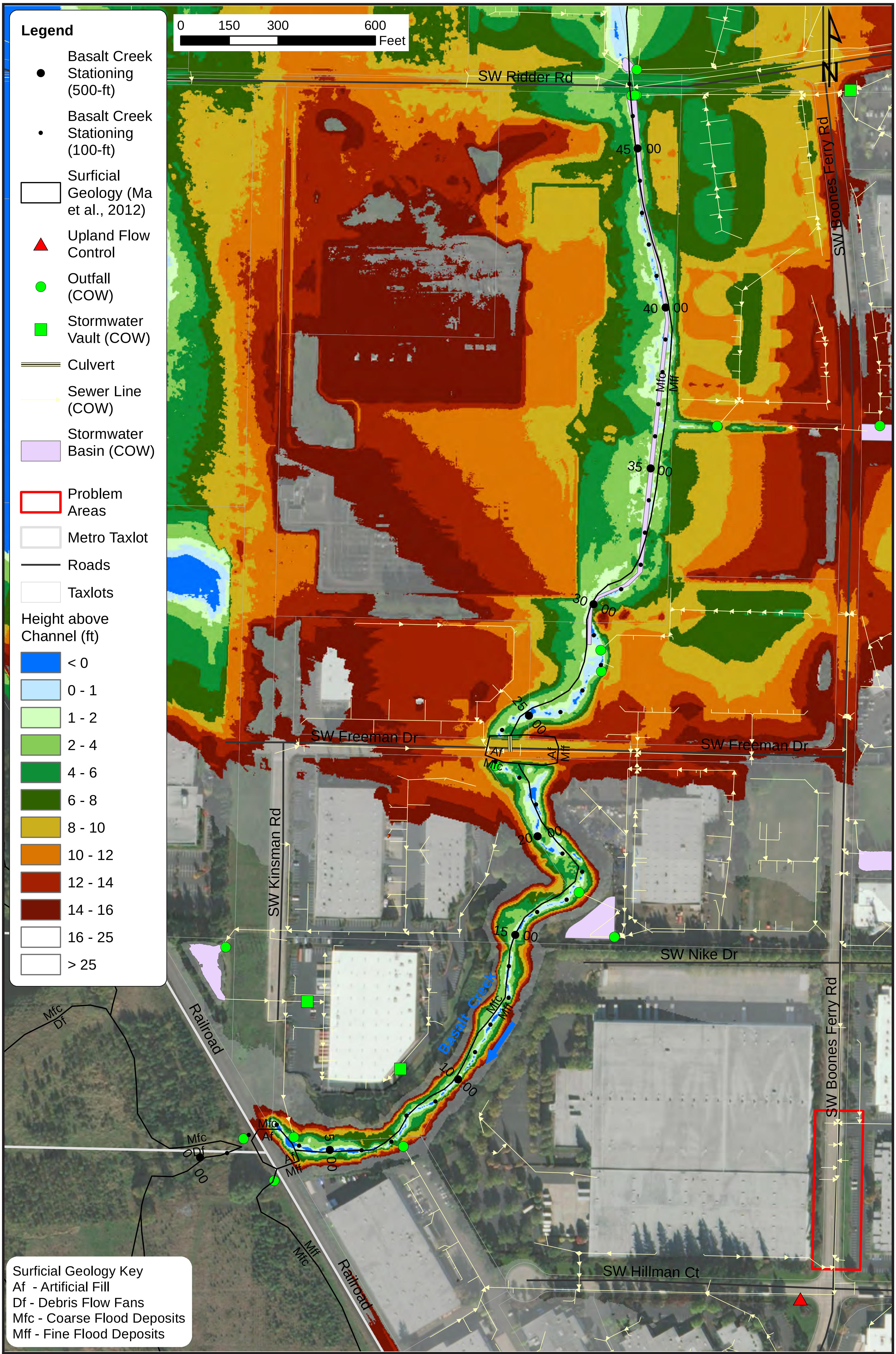


Arrowhead Creek Overview - Secondary Location

Wilsonville Stormwater Master Plan

WATERWAYS CONSULTING, INC.
Santa Cruz, CA | watways.com | Portland, OR

FIGURE 5



Basalt Creek Overview - Priority Location

Wilsonville Stormwater Master Plan

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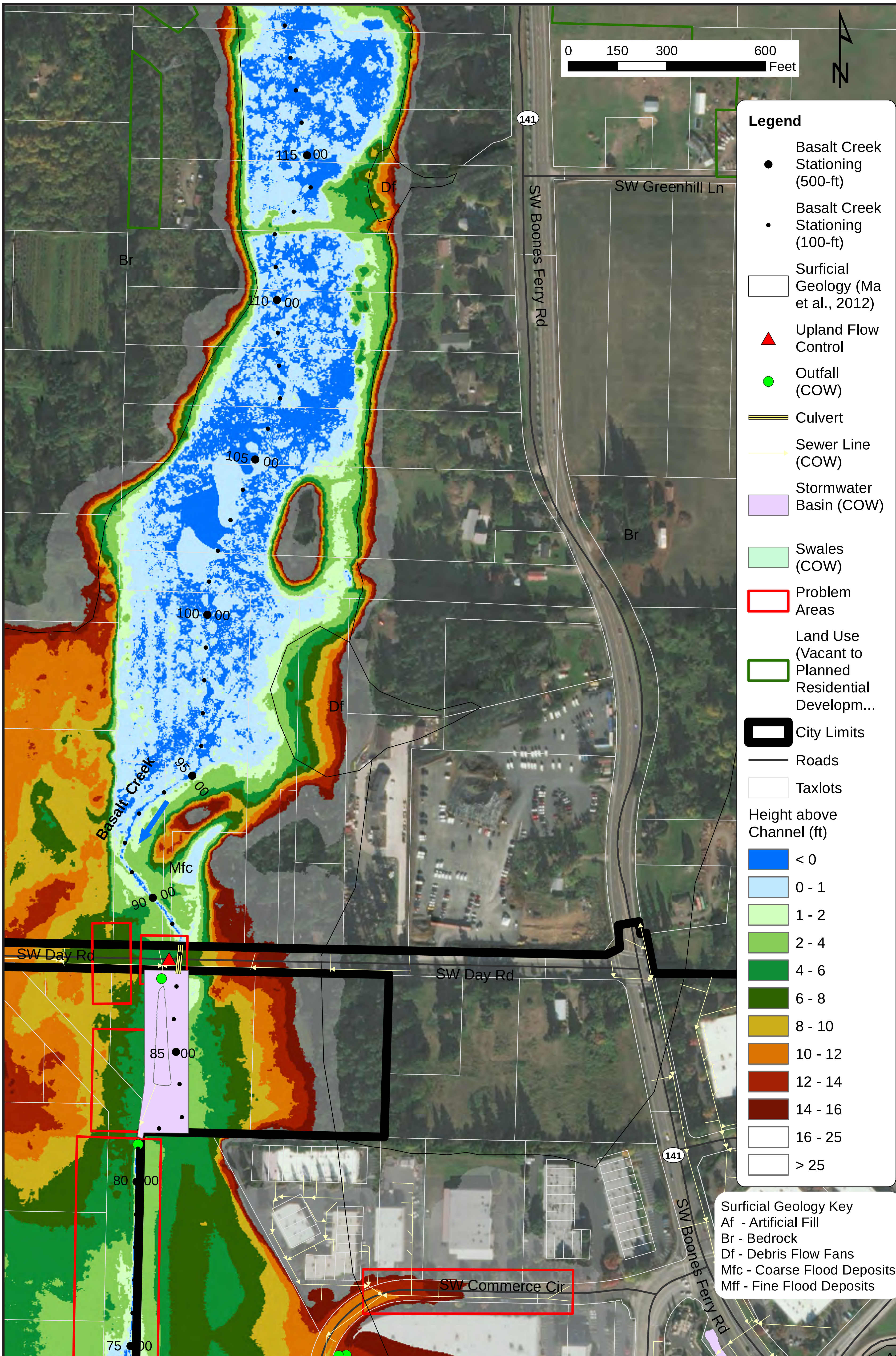
FIGURE 6



Basalt Creek Overview - Secondary Location

Wilsonville Stormwater Master Plan

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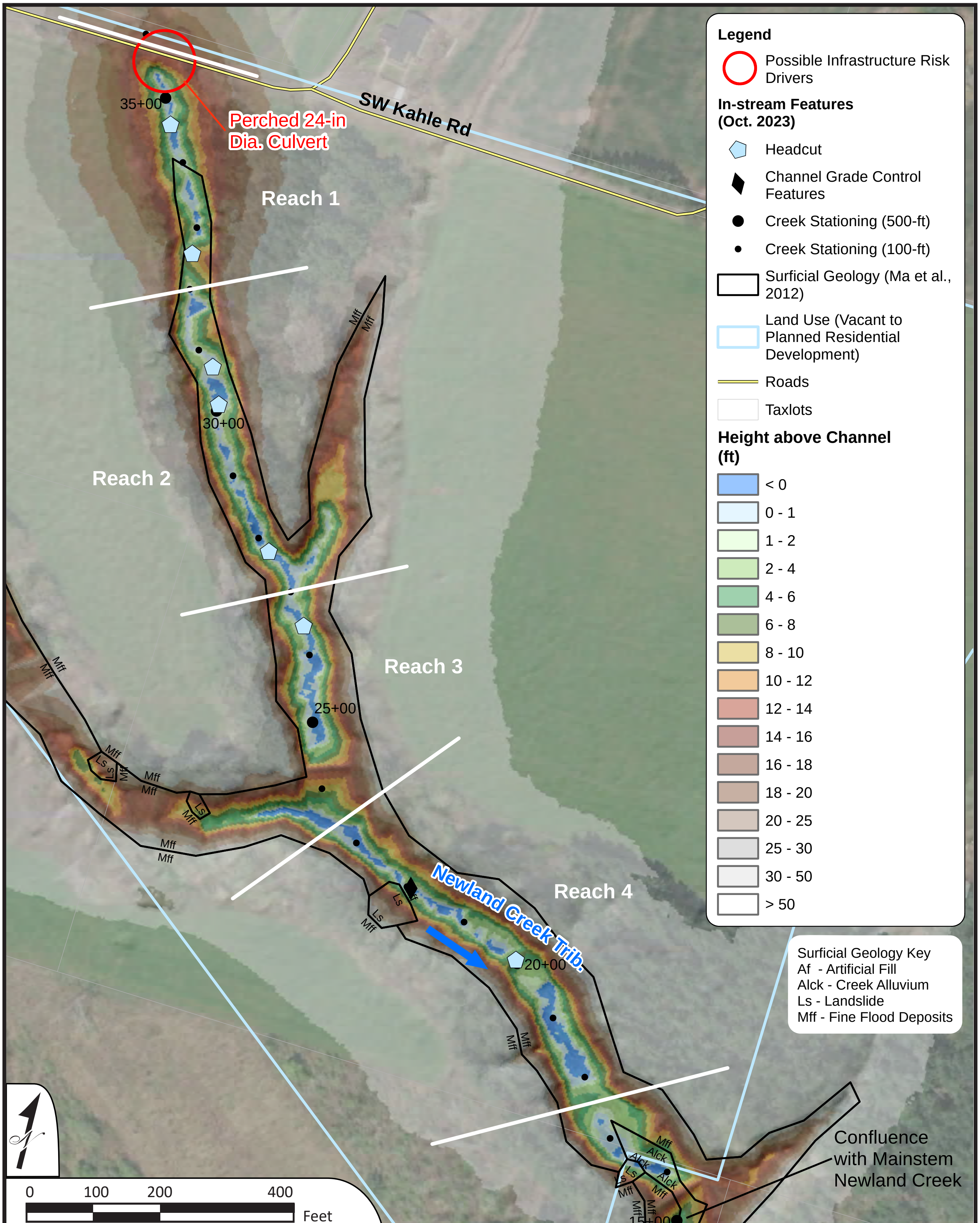
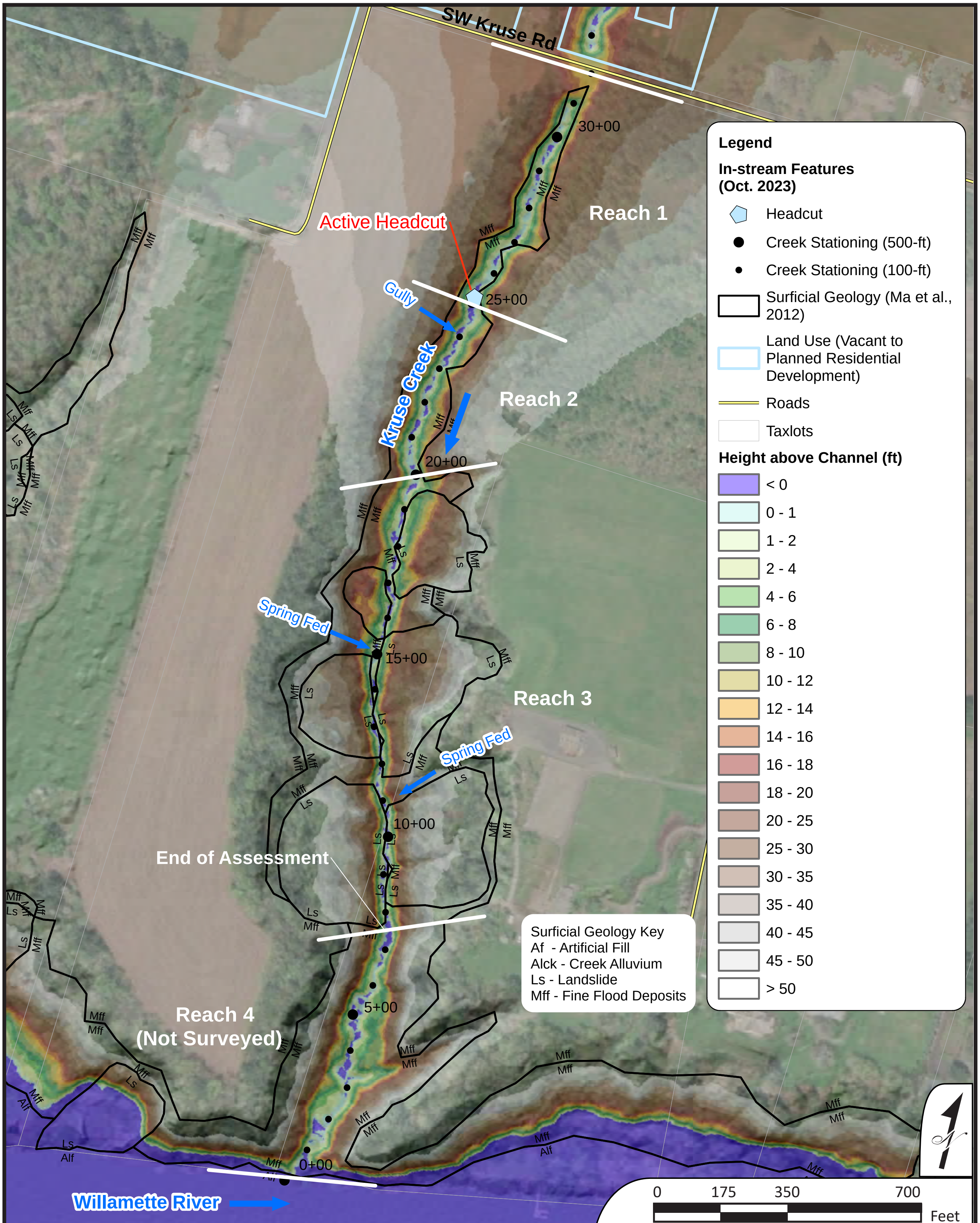
FIGURE 7



Newland Creek Geomorphic Survey	Geomorphic Assessment of Wilsonville Creeks	WATERWAYS CONSULTING, INC. Santa Cruz, CA · watways.com · Portland, OR	FIGURE 8

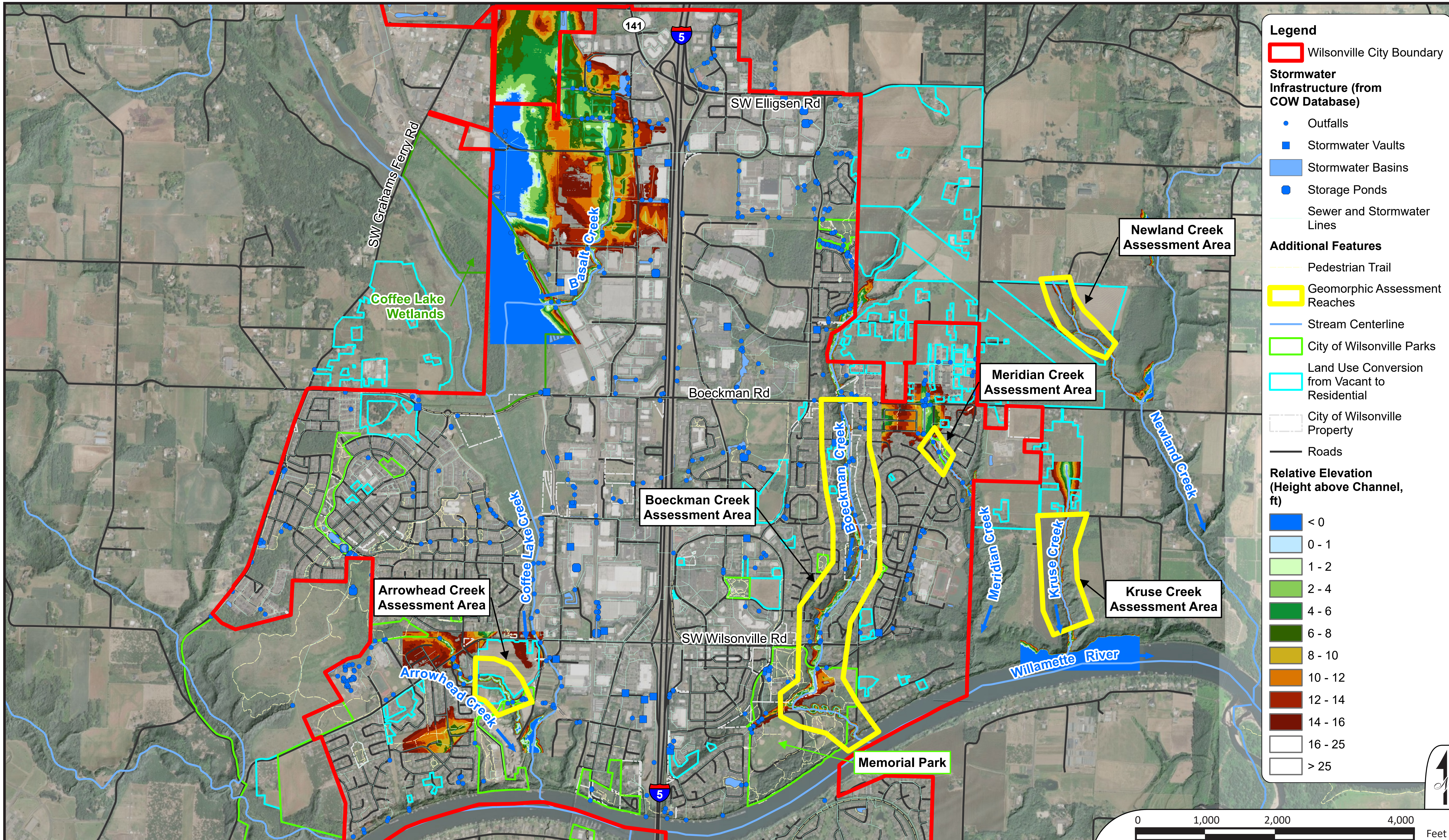


Kruse Creek Geomorphic Survey	Geomorphic Assessment of Wilsonville Creeks	WATERWAYS CONSULTING, INC. Santa Cruz, CA · watways.com · Portland, OR	FIGURE 9

APPENDIX C

Relative Elevation Maps for Boeckman, Meridian, Arrowhead, Newland, and Kruse Creeks in Wilsonville Oregon

(Overview PDF; full data sets are provided as .tif digital files)



Relative Elevation (Height above Channel) Overview Map

Geomorphic Assessment of Wilsonville Creeks

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FIGURE C1

APPENDIX D (provided separately)

Digital Folders Containing Georeferenced Photographs from Boeckman and Meridian Creeks (including .kmz files with geolocated thumbnails)

Appendix D: Capital Project Fact Sheets

BC-1: Library Pond Retrofit

BC-2: Ash Meadows Flow Mitigation

BC-3: Wiedemann Ditch and Canyon Creek Park Retrofit, Phase 1 & 2

BC-4: Boeckman Creek Stabilization at Colvin Lane

BC-5: Memorial Park Swale Retrofit

BC-6: Gesellschaft Water Well Channel Restoration

CLC-1: Day Road Stormwater Improvements, Phase 1 & 2

CLC-2: Arrowhead Creek Culvert Replacement at Jobsey Lane

CLC-3: Garden Acres Pond Retrofit

NC-1: Frog Pond East and South Conveyance Pipe Installation

WR-1: Willamette Way East/Morey's Landing Stormwater Improvements, Phase 1 & 2

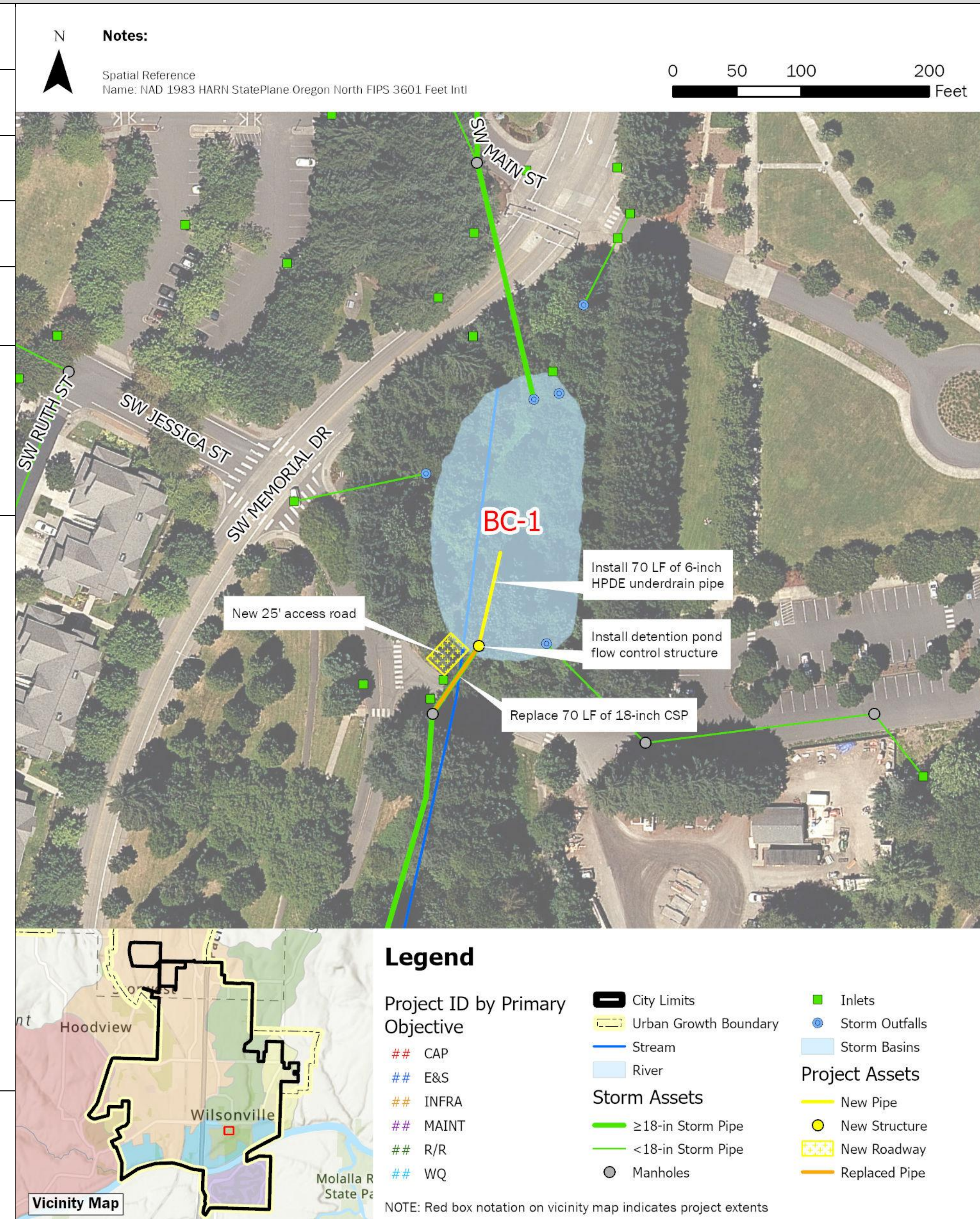
WR-2: Miley Road Stormwater Improvements, Phase 1 & 2

WR-3: Rose Lane Culvert Replacement

WR-4: Charbonneau East Stormwater Improvements, Phase 1 & 2

WR-5: Charbonneau West - SW French Prairie Road and SW Boones Bend Road

BC-1	Library Pond Retrofit		
Project Objective(s)	Capacity (Mitigation) Water Quality		
Project Opportunity ID	4		
Contributing Drainage Area	132 acres		
Estimated Existing Impervious Area (%)	47%	**Estimated Future Impervious Area (%)**	53%
Project Location	The project site is located adjacent to Memorial Park, north of the Wilsonville Public Library parking lot and east of SW Memorial Drive.		
Statement of Need	The current configuration of Library Pond does not support routine maintenance activities (ongoing challenges are reported related to debris removal at the existing outlet structure), nor does it have a flow control/orifice structure or emergency overflow to provide downstream flow mitigation. Retrofit of the Library Pond is proposed to provide regional water quality treatment and flow control for the Town Center redevelopment, as part of the fee-in-lieu program.		
Project Description	This project retrofits the existing Library Pond to meet current City Standards and accommodate future condition flows associated with the Town Center Development Plan, which anticipates full build out in the next 20+ years. Project details are as follows: • Install a pond outlet structure in compliance with current design standards. • Install 70 LF of 6-inch HDPE underdrain pipe. • Clear, regrade, and replant the 0.7-acre detention pond, including amending the pond bottom to include the 3 feet of required rocks and media. • Install 15-ft wide, 25-feet long access road for maintenance access. • Replace 70 LF of 18" CSP pipe (SD5213) at new design depth, approx. 15 feet deep.		



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City of Wilsonville
Project No: 156157

Wilsonville Stormwater Master Plan
Page 1 of 2

Capital Project Summary

BC-1 – Library Pond Retrofit

BC-1	Library Pond Retrofit	
Design Considerations / Assumptions	• The existing pond footprint remains unchanged due to roadway and development constraints. Interior side slopes are assumed to be 3H:1V. • Facility sizing is based on adherence to the City's 2015 PWS Section 3 requiring flow matching to pre-development conditions (classified as Oak Savanna). Sizing utilizes the BMP Sizing Tool. • To size the pond in accordance with PWS design standards, approximately 48 acres (50% of total new and redeveloped impervious area associated with the Town Center redevelopment) require onsite treatment and flow control prior to discharge into Library Pond detention facility. • Total pond depth includes drain rock (15-inches), separation layer (3-inches), and growing media (18-inches), in accordance with the PWS Section 3, Appendix A landscape and soil media requirements. • Upstream (SD5053) and downstream (SD5213) pipe sizes are anticipated to remain unchanged. • Inlet structure into the pond (CARTE ID: 27) to remain unchanged. • Outlet structure (standard drawing ST-6110) assumes an additional field inlet for the 100-year overflow event. • Assuming bottom of the pond shape is roughly 70' x 100' - placing underdrain through 2/3 of the of the pond (based on ST-6060), approx. 70 LF.	
Estimated Project Cost	Capital Expense Total	$1,407,000
	Design / Construction Admin. (13.5%)	$190,000
	Engineering & Permitting (20%)	$281,000
	Total Cost	**$1,880,000**
Project Cost Notes	• Cost is for the Library Pond retrofit only. It does not include any additional LID BMPs that are needed to offset some of the contributing drainage area. • Assumes upstream inlet pipe (SD5053) and inlet structure to Library Pond (no ENG ID available) can remain unaltered. • Limited traffic control/utility relocation and surveying will be required, as the site is already developed and has access and staging areas.	

Additional Figures

Overview of the detention pond from maintenance entrance to Memorial Park near the intersection of SW Memorial Drive and SW Jessica Street (Jan 2023)

Outlet of pond that functions as the ditch inlet (Sep 2021)

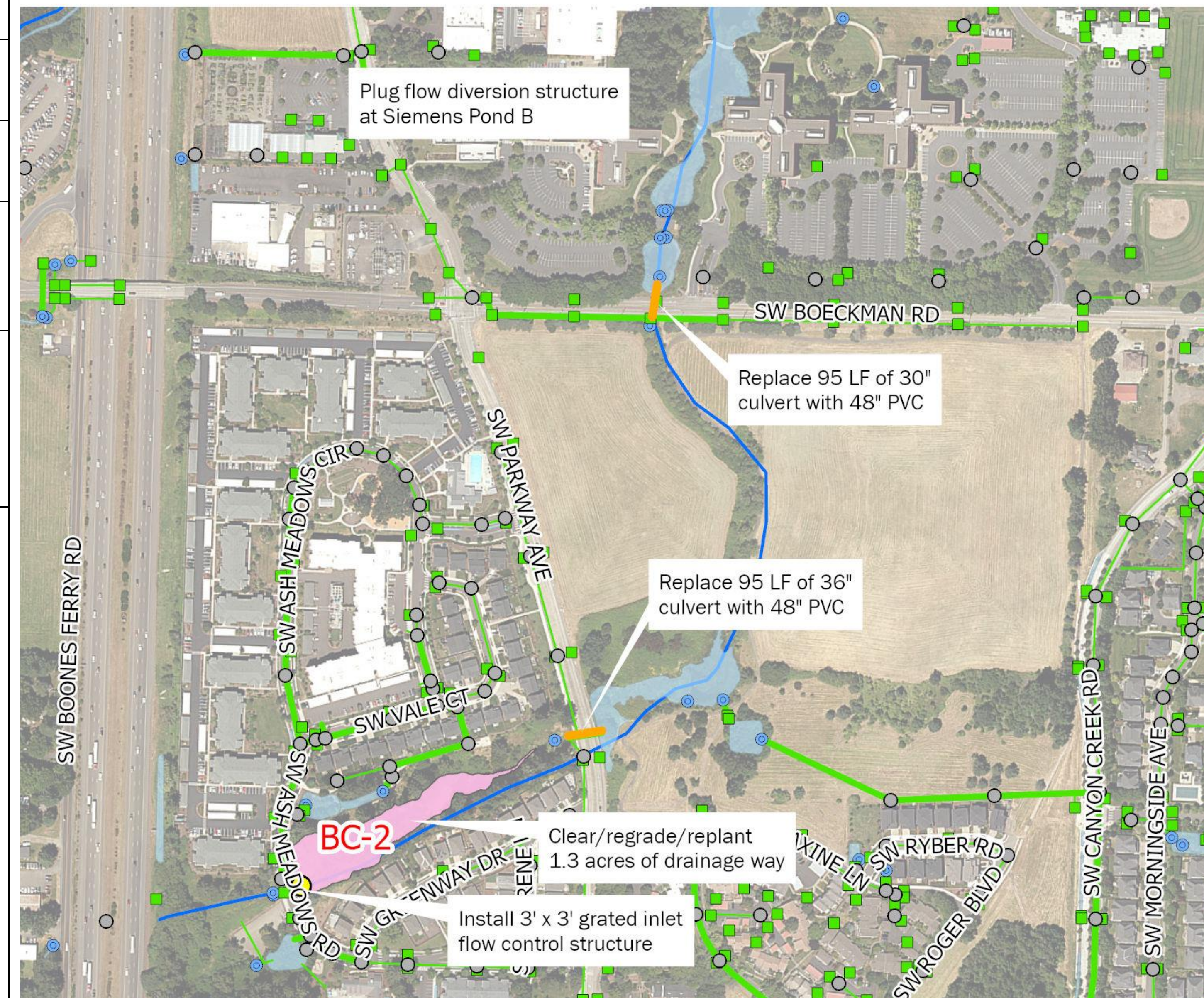
BC-2	Ash Meadows Flow Mitigation		
Project Objective(s)	Capacity (Mitigation) Water Quality		
Project Opportunity ID	25 and 26		
Contributing Drainage Area	295 acres		
Estimated Existing Impervious Area (%)	37.6%	Estimated Future Impervious Area (%)	51.6%
Project Location	This project is in a residential area near the Ash Meadows apartment complex. The area is bounded to the west by Interstate-5, SW Vale Court to the north, SW Parkway Avenue to the east, and SW Greenway Drive to the south.		
Statement of Need	The Boeckman Road Corridor Project requires mitigation of increased flow in Boeckman Creek due to the planned removal of the flow control structure at Boeckman Road. This project reestablishes historic flow patterns to Coffee Lake Creek by rerouting high flows from the Siemens Pond B (Opp. ID 25) and Boeckman Creek back to the Coffee Lake Creek basin.		
Project Description	This project mitigates flow to Boeckman Creek by plugging the diversion structure that currently routes high flows from the Siemens Pond B (Opp. ID 25) east to Boeckman Creek. Rerouted flows will be conveyed through the culvert under Boeckman Road and down the natural drainage path toward Coffee Lake Creek. To mitigate the rerouted high flows, in-line storage will be enhanced between Ash Meadows Lane and Parkway Ave (Opp. ID 26). Project details are as follows: • Plug the flow diversion structure at Siemens Pond B. • Upsize 95 LF of 30-inch culvert at Boeckman Road to 48-inch diameter PVC. • Upsize 80 LF of 36-inch culvert at Parkway Ave (main barrel) to 48-inch diameter PVC. • Install a 3-foot x 3-foot grated inlet to serve as a flow control structure at SW Ash Meadows Circle. • Clear, regrade, and replant 1.3-acres of drainage way and embankment to ensure a low-flow drainage path and healthy vegetation.		

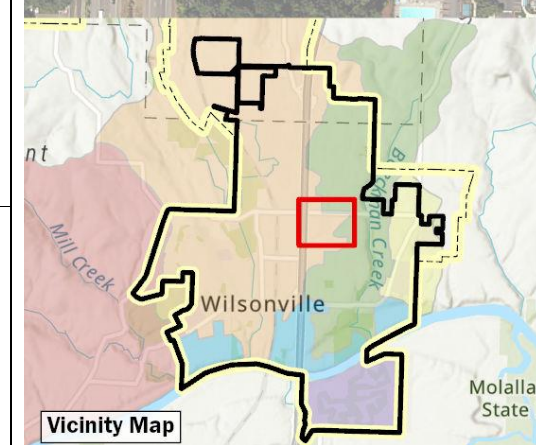
N

Notes:

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

0 250 500 1,000 Feet





Legend

Project ID by Primary Objective
- ## CAP
- ## E&S
- ## INFRA
- ## MAINT
- ## R/R
- ## WQ

City Limits
Urban Growth Boundary
Stream
River

Storm Assets
- ≥18-in Storm Pipe
- <18-in Storm Pipe
- Manholes
- Inlets
- Storm Outfalls
- Storm Basins

Project Assets
- New Structure
- New Facility
- Replaced Pipe

NOTE: Red box notation on vicinity map indicates project extents

Brown AND Caldwell	City of Wilsonville Project No: 156157 **Wilsonville Stormwater Master Plan** Page 1 of 2	**Capital Project Fact Sheet** **BC-2 – Ash Meadows Flow Mitigation**

BC-2	Ash Meadows Flow Mitigation

Design Considerations / Assumptions

- This project is predicted to mitigate 75% of the increased peak flow to Boeckman Creek resulting from the removal of the Boeckman Creek flow control structure during the 25-year storm, under existing hydrological conditions.
- This project and cost estimate do not include any modification of the area east of SW Parkway Avenue and south of Boeckman Road.
- Existing topography at the Ash Meadows site ranges between 182 -190 feet in elevation, with an estimated storage potential of 181,000 cubic feet.
- This project is intended to mitigate additional flow to the culvert under I-5, approximately 300 feet downstream of the Ash Meadows site, and mimic existing flow conditions.
- The flow control structure will store 25-year peak flows at a maximum water surface elevation (WSE) of 190 feet. This max WSE will maintain 2 feet of freeboard to neighboring residential properties. Final design will include confirmation of flow control structure sizing.

Estimated Project Cost

Capital Expense Total	$1,737,000
Design / Construction Admin. (13.5%)	$234,000
Engineering & Permitting (50%)	$869,000
Geotechnical	$100,000
Total Cost	**$2,940,000**

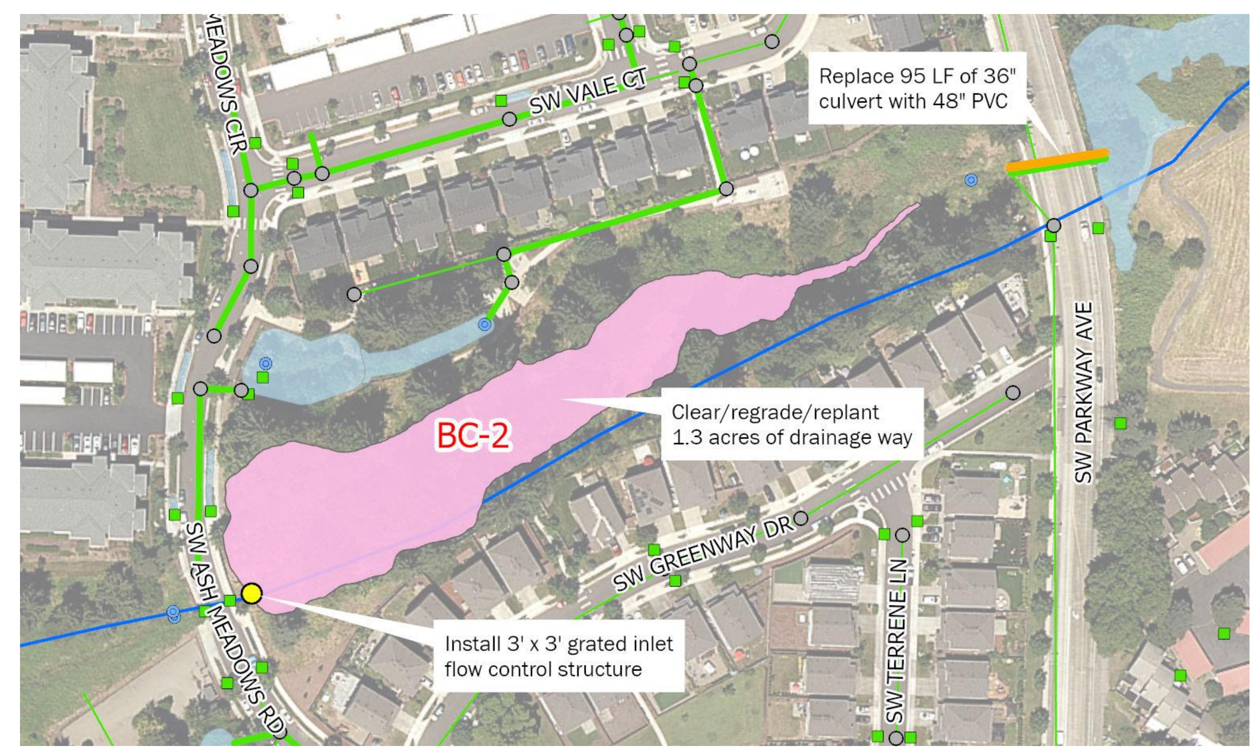
Project Cost Notes

- The Ash Meadows site is approximately 55,000 square feet. Earthwork estimates assume 1.5-feet of excavation and 6-inches of amended soils over the site area.
- Clearing and plant restoration is necessary for entire area to 190 ft elevation.
- Project concept and cost estimates developed in conjunction with the Boeckman Road Corridor Project.
- A 50% Engineering and Permitting multiplier was applied based on design cost estimate.
- A 15% Traffic Control/Utility Relocation multiplier was applied based on design cost estimate.
- A 20% Surveying multiplier was applied based on design cost estimate.
- A $100,000 lump sum cost was included for Geotechnical work based on design cost estimate.

Additional Figures

Ash Meadows Drainage Way (Jan 2023)

Siemens Pond Diversion (Nov 2021)



Area map showing zoomed in view of Ash Meadows drainage way.

Brown AND Caldwell

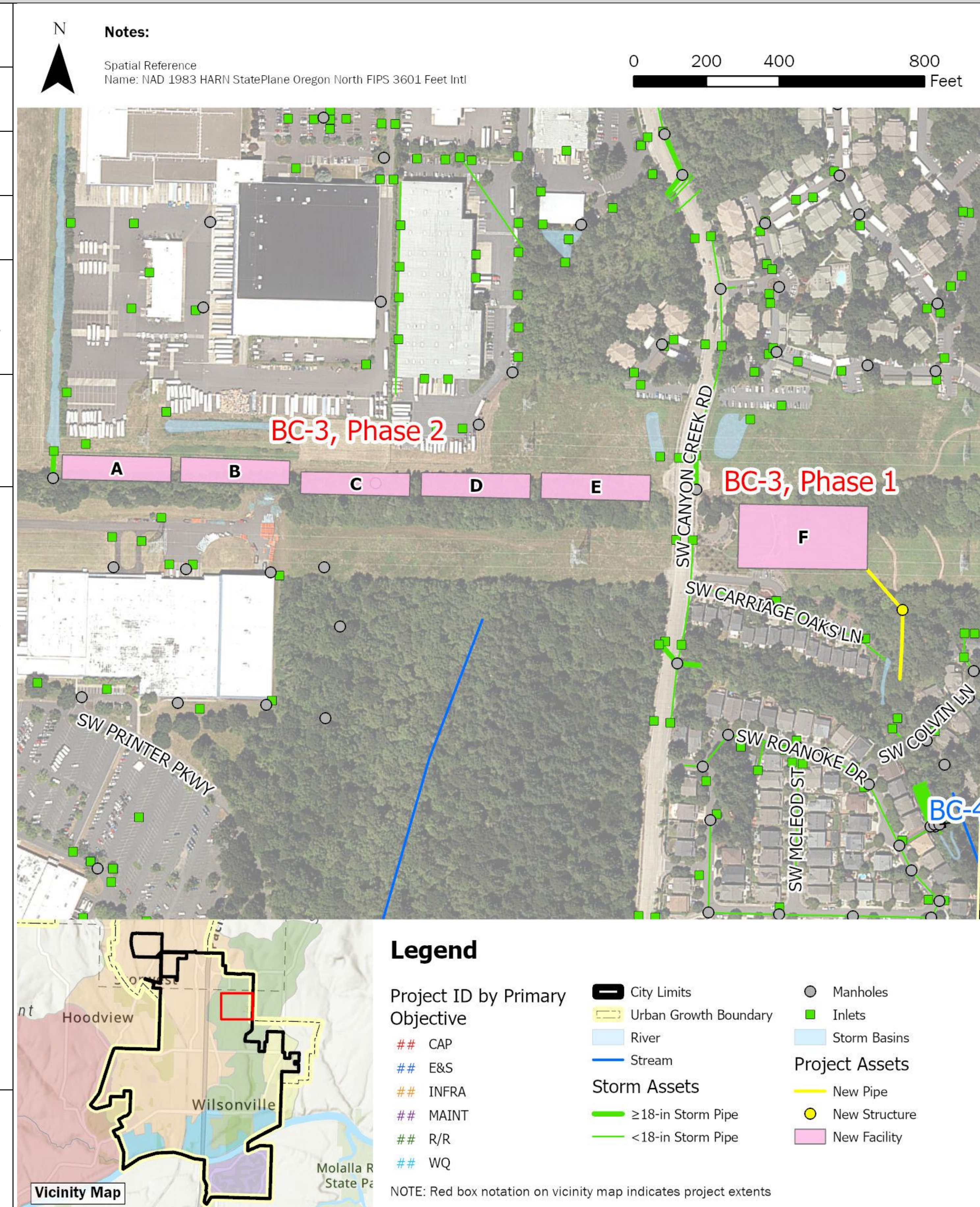
City of Wilsonville
Project No: 156157

Wilsonville Stormwater Master Plan
Page 2 of 2

Capital Project Summary

BC-2 – Ash Meadows Flow Mitigation

BC-3	Wiedemann Ditch and Canyon Creek Park Retrofit		
Project Objective(s)	Capacity (Mitigation) Water Quality		
Project Opportunity ID	24		
Contributing Drainage Area	295 acres		
Estimated Existing Impervious Area (%)	38.1%	**Estimated Future Impervious Area (%)**	47.0%
Project Location	This project is located east and west of SW Canyon Creek Road along the existing BPA easement. Phase 1 is located at Canyon Creek Park, north of SW Carriage Oaks Lane. Phase 2 extends west to east along the existing Wiedemann Ditch alignment, south of the Sysco property.		
Statement of Need	The Boeckman Road Corridor Project requires mitigation of increased flow in Boeckman Creek due to the planned removal of the flow control structure at Boeckman Road. This project provides additional floodplain storage through enhancement of the existing Wiedemann Ditch alignment and installation of a storage facility at Canyon Creek Park.		
Project Description	This project mitigates flow to Boeckman Creek through the creation of a series of linear wetland complexes along the existing Wiedemann Ditch within the BPA easement (Facilities A-E). Discharge from the linear wetland complexes will be routed through the existing 48-inch culvert underneath Canyon Creek Rd. prior to entering the proposed vegetated storage facility (Facility F) within available, undeveloped space at Canyon Creek Park. Due to project complexity and size, this project is costed as two phases and numbered based on recommended sequencing. Project details by phase are as follows: Phase 1 (Canyon Creek Park) • Clear, regrade, and replant approximately the 1.6-acre proposed vegetated storage facility. • Install a flow control/outlet structure with emergency overflow at the storage facility. • Install 350 LF of 36-inch diameter PVC to discharge from the southeast corner of the site towards Boeckman Creek. • Install one new manhole at bend in new 36-inch pipe. Phase 2 (Wiedemann Ditch) • Clear, regrade, and replant approximately 2.1-acres along the existing ditch alignment to install five, tiered wetland complexes. • Install a 12-foot wide, 1,500-foot-long access road west of Canyon Creek Road.		



Brown AND Caldwell	City of Wilsonville Project No: 156157 **Wilsonville Stormwater Master Plan** Page 1 of 2	**Capital Project Summary** **BC-3 – Wiedemann Ditch and Canyon Creek Park Retrofit**

BC-3 Wiedemann Ditch and Canyon Creek Park Retrofit

Design Considerations / Assumptions

- This project is predicted to mitigate 98% of the increased peak flow to Boeckman Creek resulting from the removal of the Boeckman Creek flow control structure during the 25-year storm, under existing hydrological conditions.
- Coordination with both Sysco and BPA is necessary prior to design and construction.
- The Canyon Creek Park facility (Phase 1) is to be designed per the City's surface water requirements with an assumed active storage depth of four feet and 3:1 side slope. Sizing is based on the desire to maximize the flow mitigation potential of the site. If less flow mitigation is needed, the pond footprint and/or depth may be reduced.
- The Wiedemann Ditch alignment (Phase 2) receives drainage from the existing north-south Sysco ditch on Sysco property. Sysco has identified this location as a potential mitigation site for their planned facility expansion.
- The linear wetlands (Phase 2) will be hydraulically connected, using weirs to provide a storage depth of two feet within each cell.

Estimated Project Cost

	Phase 1	*Phase 2*
Capital Expense Total	$3,491,000	$5,253,000
Design / Construction Admin. (3.5% + $200K)	$322,000	$384,000
Engineering & Permitting (30%)	$1,047,000	$1,576,000
Total Cost	**$4,860,000**	**$7,210,000**

Project Cost Notes

- The Canyon Creek Park site (Phase 1) is approximately 69,000 sf. Earthwork estimates assume 1.5-feet of excavation over the site area and the 6-inches of amended soil, per City Standards.
- Final design will include confirmation of weir sizing and layout.
- Final design will include confirmation of vegetated facility plantings and structure sizing.
- Project concept and cost estimates were initially developed in conjunction with the Boeckman Road Corridor Project. A modified construction administration multiplier was applied per direction from the City. No cap on engineering and permitting was applied, given potential design and permitting complexity of the project.

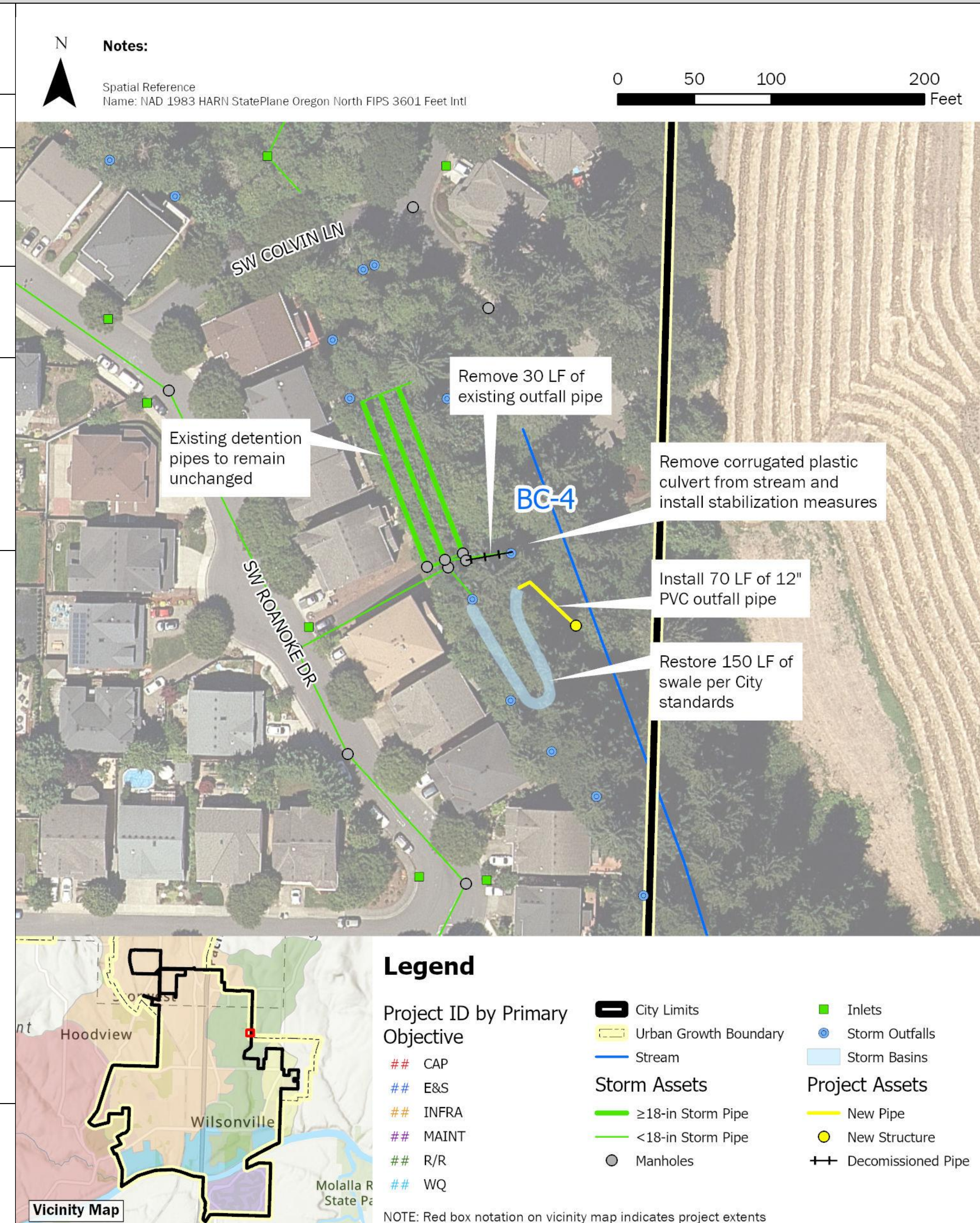
Additional Figures

Canyon Creek channel (Jan 2023)

Canyon Creek channel (Jan 2023)

Wiedemann Ditch alignment (Sep 2021)

BC-4	Boeckman Creek Stabilization at Colvin Lane		
Project Objective(s)	Erosion/Sediment Control Repair/Replace Maintenance		
Project Opportunity ID	15		
Contributing Drainage Area	358 acres		
Estimated Existing Impervious Area (%)	36.7%	**Estimated Future Impervious Area (%)**	45.3%
Project Location	This project is located along the Boeckman Creek corridor, adjacent to a residential neighborhood (Canyon Creek Estates) and bounded to the west by SW Roanoke Drive. SW Colvin Lane is directly north of the project location.		
Statement of Need	Streambank erosion and channel migration have been observed in the Boeckman Creek tributary segment, which discharges to Boeckman Creek downstream of SW Colvin Lane. The 2012 Master Plan identified this location as a project need (BC-8), and subsequent site visits and conversations with City staff confirmed the need. Corrugated plastic piping installed by a resident with the intention of mitigating erosion was not approved by the City. Trees have fallen and additional tree loss may occur due to streambank loss.		
Project Description	This project includes riparian and in-channel bank stabilization measures to address resident concerns and stabilize the section of the tributary channel bank. This project also includes restoration of the existing water quality swale. Project details are as follows: • Removal of approx. 30 LF of existing outfall pipe. • Installation of approx.70 LF of 12-inch PVC to serve as a new outfall. • Install planting and bioengineered restoration/stabilization measures along approx. 600 LF of stream corridor. • Reconstruction of approx. 150 LF of vegetated swale in accordance with the City's Public Works Standards (PWS).		



Brown AND Caldwell

City of Wilsonville
Project No: 156157

Wilsonville Stormwater Master Plan

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Capital Project Summary

BC-4 – Boeckman Creek Stabilization at Colvin Lane

BC-4	Boeckman Creek Stabilization at Colvin Lane

Design Considerations / Assumptions

- The pipe system upstream of the outfall, including detention pipes in the City easement adjacent to 7590 Roanoke Drive N. will be preserved. Issues have not been reported and these pipes are assumed to be functioning as intended.
- Assumes that access to the outfall stabilization area can be attained via the City easement between 7590 and 7598 Roanoke Drive N.
- Exact stabilization measures to be determined during project design. Stabilization measures may include targeted planting, bio-engineered solutions such as live stakes or fascines, and gabion walls if necessary.
- Swale reconstruction to be confirmed with final design.

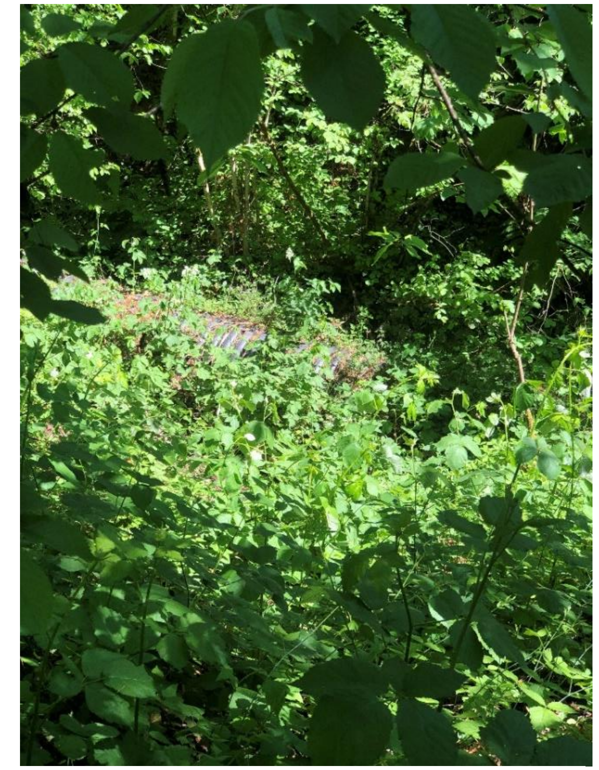
Estimated Project Cost

Capital Expense Total	$282,000
Design / Construction Admin. (13.5%)	$38,000
Engineering & Permitting (30%)	$85,000
Total Cost	**$410,000**

Project Cost Notes

- Assumes clearing/grubbing including stump removal and removal of existing corrugated pipe.
- No costs included for access. Assumes access can be attained through an existing temporary City easement.

Additional Figures



Streambank with resident-installed corrugated plastic pipe (May 2023)

City-owned outfall pipe (May 2023)

Upstream detention pipes location (May 2023)

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City of Wilsonville
Project No: 156157

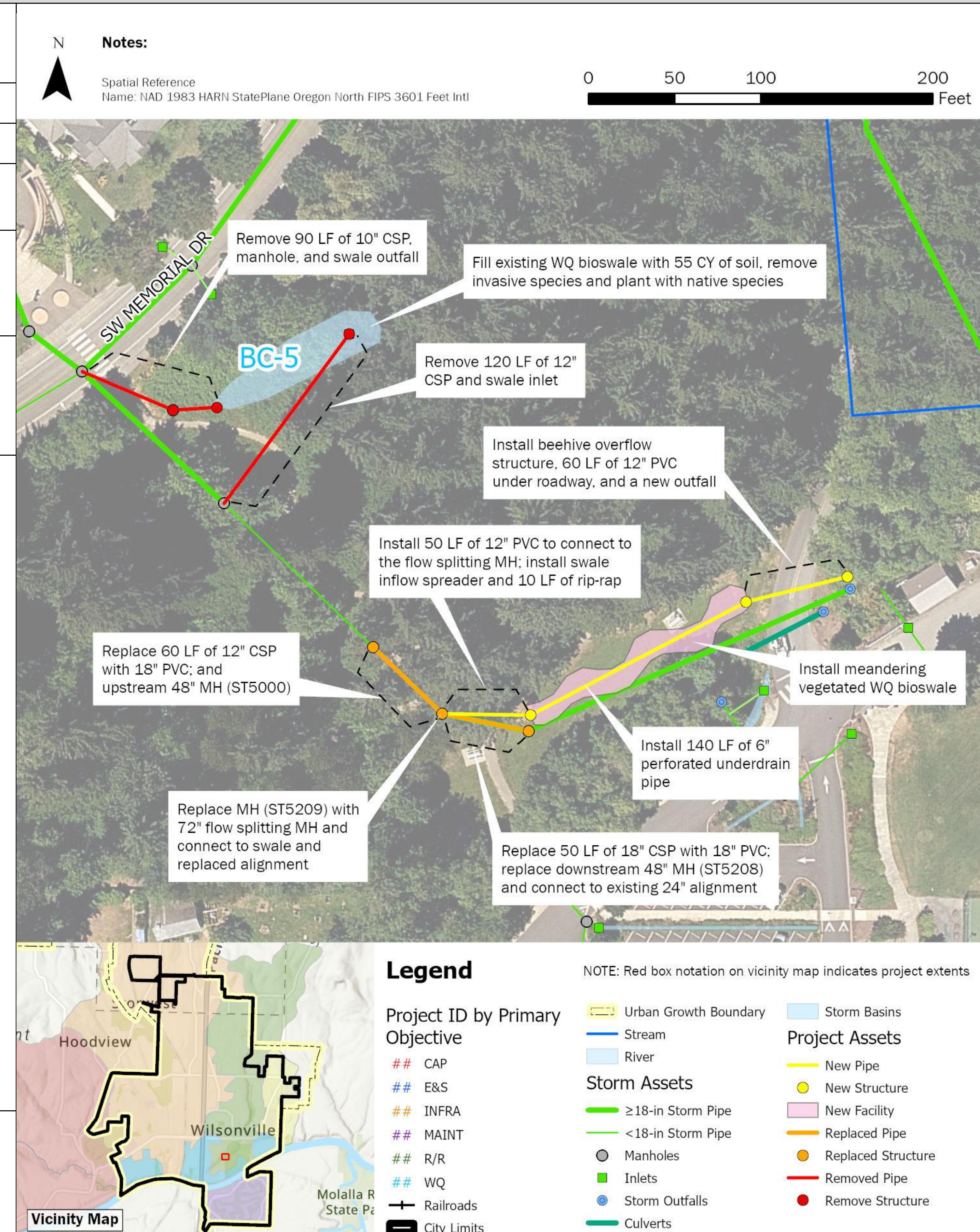
Wilsonville Stormwater Master Plan

Capital Project Summary

BC-4 – Boeckman Creek Stabilization at Colvin Lane

BC-5	Memorial Park Swale Retrofit		
Project Objective(s)	Water Quality Erosion/ Sediment Control Maintenance		
Project Opportunity ID	21		
Contributing Drainage Area	33 acres		
Estimated Existing Impervious Area (%)	56.3%	**Estimated Future Impervious Area (%)**	57.7%
Project Location	This project site is located in the southeast portion of the City within the Boeckman Creek watershed. The project is bounded by SW Memorial Drive to the north, the Memorial Park parking lot/baseball fields to the south, and forested area within Memorial Park to the east and west.		
Statement of Need	The water quality bioswale at SW Memorial Drive is eroded, not draining properly, and not providing a water quality benefit. Modeling evaluation indicates that the pipe system after the convergence point at SW Memorial Drive has a constriction resulting in backwater and upstream system flooding.		

Project Description	This project includes removal and relocation of an existing water quality bioswale off SW Memorial Drive and installation of a new water quality bioswale and associated infrastructure at the downslope near the Memorial Park parking lot.
	
	Project details are as follows:
	• Remove existing water quality swale (ENG IDs provided in parentheses when applicable, CARTE ID provided when ENG ID is not available):
	  ○ Remove 90 LF of 10-inch CSP (SD5041 and SD5042).
	  ○ Remove 120 LF of 12-inch CSP (SD5044).
	  ○ Remove manhole (ST5098).
	  ○ Remove swale inlet structure (CARTE ID 568).
	  ○ Remove swale outfall structure (CARTE ID 19).
	  ○ Fill existing swale and revegetate area.
	• Replace two 48-inch manholes (ST5000 and ST5208).
	• Replace 60 LF of 12-inch CSP with 18-inch PVC pipe (SD5046).
	• Replace 50 LF of 18-inch CSP with 18-inch PVC pipe (SD5206).
	• Install a new meandering water quality swale near the Memorial Park parking lot:
	  ○ Replace manhole ST5209 with a 72-inch flow splitting/WQ manhole.
	  ○ Install 50 LF of 12-inch PVC pipe.
	  ○ Install 140 LF of 6-inch perforated HDPE underdrain pipe.
	  ○ Install swale inflow spreader.
	  ○ Install 10 ft x 4 ft rip-rap pad in front of inflow spreader.
	  ○ Install beehive overflow structure.
	  ○ Install new outfall into the creek.
	  ○ Install vegetated swale with required 1 foot of drain rock and 1.5 feet of amended soil.		



BC-5	Memorial Park Swale Retrofit

Design Considerations / Assumptions

- Installation of the water quality bioswale is a water quality retrofit project, as the site is space constrained limiting the use of the BMP Sizing Tool for required facility sizing. Approx. size of the facility is 200 ft x 12 ft = 2,400 SF.
  - Existing swale (to be removed) is estimated to be approx. 1,500 SF.
- Soil infiltration rates are anticipated to be very low (0.02-0.07 in/hr based on USDA NRCS survey).
- The maximum width of the swale is 12 feet.
- Maximum side slopes of the swale are 3H:1V with a 2-foot minimum width flat bottom.
- The maximum depth from growing media to overflow elevation is 1 foot.
- Three feet of required media (12-inches of drain rock, 3-inches of open graded aggregate, and 18-inches of growing media minimum).
  - Table 3.11 of the PWS notes that by increasing the growing media by 12 inches or more the facility surface area can be reduced by 25 percent.
- A small portion of the facility resides within the FEMA 100-year floodplain. As this is not an infiltration site it does not require additional seasonal high groundwater testing.
- Upsizing the 12-inch CSP (SD5046) with 18-inch PVC reduces the duration of modeled flooding at ST5000. Given the significant amount of vegetation and steep slopes in the area, full replacement of the alignment is not proposed.
- Installation of a diversion manhole upstream of the swale may result in periodic surcharge of the swale that will overflow into the nearby creek.

Standard Detail references:

- Vegetated swale – filtration reference ST-6045.
- Swale inflow spreader reference S-2225.
- Planter, Rain Garden, Swale Flow Control Structure reference ST-6105.

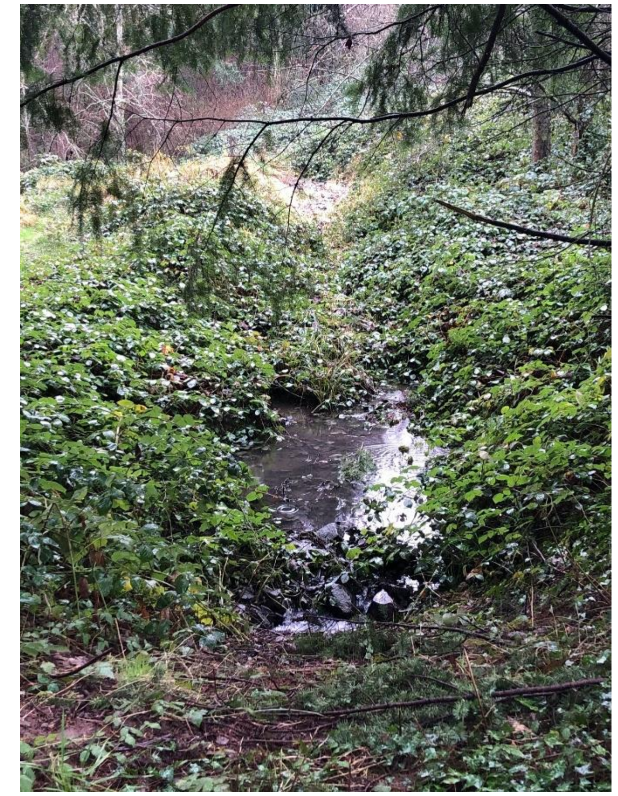
Estimated Project Cost

Capital Expense Total	$631,000
Design / Construction Admin. (13.5%)	$85,000
Engineering & Permitting (30%)	$189,000
Total Cost	**$910,000**

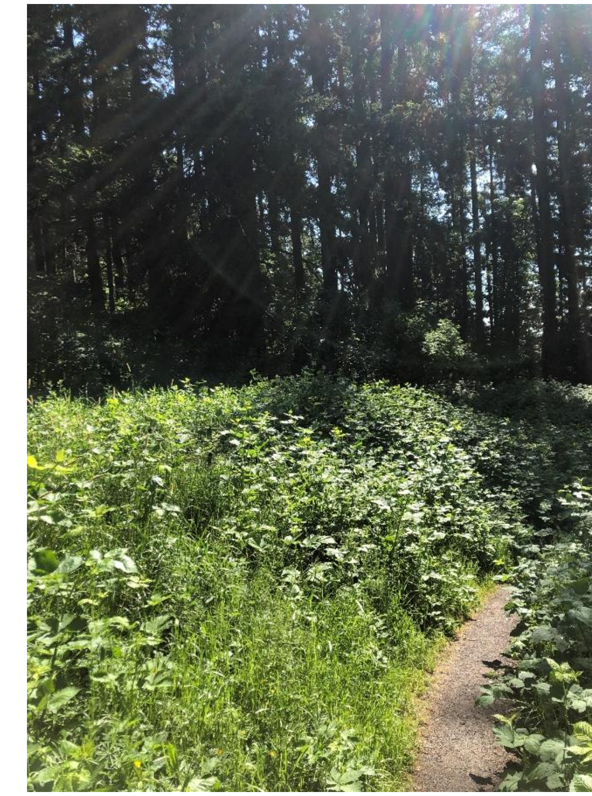
Project Cost Notes

- Onsite fill from excavation of new swale to be stockpiled and used to fill existing swale footprint.
- All existing conveyance piping and manholes to remain in place except for those identified for removal from the existing swale and replacement from manholes ST5000 to ST5208.
- Project cost estimate assumes a single meandering, vegetated swale. Parallel vegetated swales may also be considered to increase capacity of the facility at this site.
- Engineering and permitting estimate reflect in water work required for outfall installation.

Additional Figures

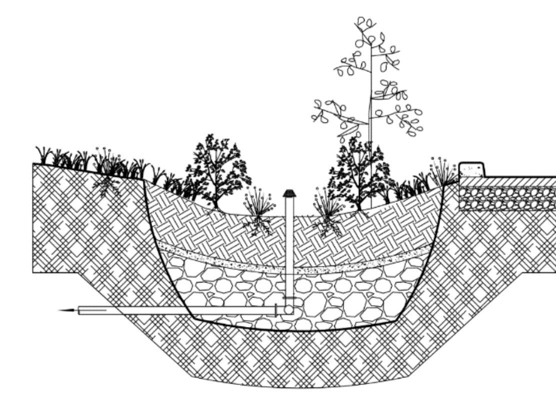


Current water quality swale near SW Memorial Drive (Jan 2023)



Water quality swale in the spring overgrown with invasive species (May 2023)

Open area along the creek to relocate the Memorial Park Swale (May 2023)



Vegetated Swale – Filtration (ST-6045)

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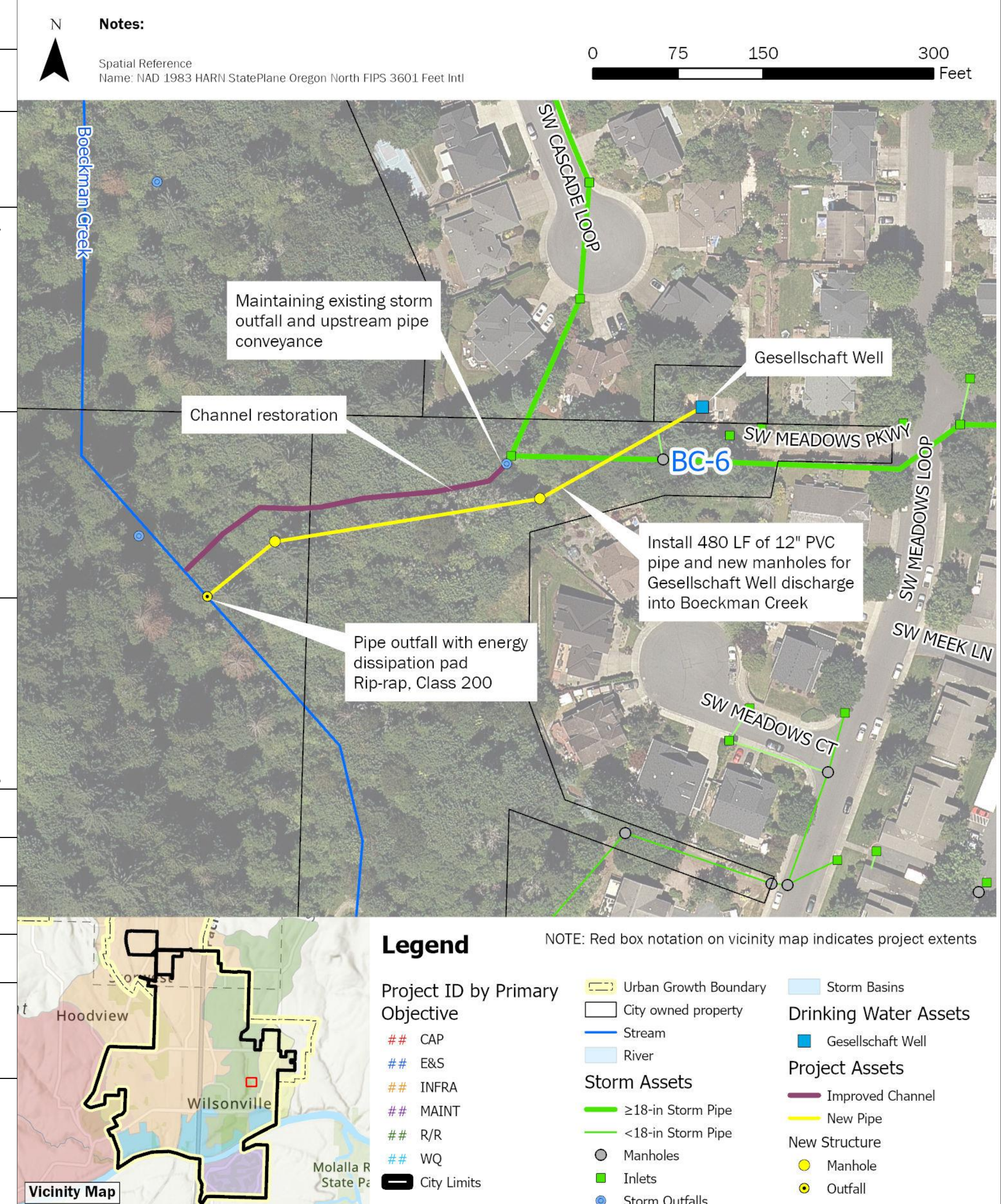
Wilsonville Stormwater Master Plan

Capital Project Summary

BC-5 - Memorial Park Swale Retrofit

BC-6	Gesellschaft Water Well Channel Restoration		
Project Objective(s)	Erosion/Sediment Control Maintenance		
Project Opportunity ID	41	**Contributing Drainage Area (acres)**	25 acres
Estimated Existing Impervious Area (%)	39.7%	**Estimated Future Impervious Area (%)**	39.9%
Project Location	This project is in the Boeckman Creek riparian area, near Wilsonville High School, at the Gesellschaft Well site (29001 SW Meadows Parkway). The area is directly west of SW Meadows Loop and bounded to the west by Boeckman Creek and SW Meadows Parkway to the north.		
Statement of Need	Weekly potable discharge from the Gesellschaft drinking water well and contributing stormwater runoff have caused severe erosion of the existing drainage channel to Boeckman Creek. The Gesellschaft well provides backup water supply and the City exercises the water well weekly to maintain quality and regulatory compliance. Under Capital Project #7054 (Fiscal Year 2015-2017) the City installed an asphalt apron and gabion boxes in three locations, but they have been undermined and are no longer effective at dissipating energy. The area is currently overgrown with blackberry brambles and inaccessible to conduct routine maintenance.		
Project Description	Project details are as follows: • Install approximately 480 LF of 12" PVC with 2 new MHs top pipe the weekly discharge from the well to the bottom of the slope into Boeckman Creek and bypass the existing drainage channel. • Install outfall and energy dissipation pad with Class 200 riprap. • Restore the eroded discharge channel (approximately 310 LF) through the installation of coir log check dams, coir matting, and re-vegetating with native trees and shrubs.		
Design Considerations / Assumptions	• Project need was identified in the 2012 SMP (BC-4). • Existing outfall (STD3008) and upstream stormwater pipes can remain as is for the contributing 25-acre drainage area. • The weekly discharge rate from the drinking water well is unknown. The pipe is sized based on the City's PWS and the smallest acceptable diameter for the public system. ODWR well logs were reviewed to verify pipe sizing. • Water discharge conveyance designed to comply with stormwater conveyance standards.		
Estimated Project Cost	Capital Expense Total	$279,000	
	Design / Construction Admin. (13.5%)	$38,000	
	Engineering & Permitting (30%)	$84,000	
	Total Cost	**$400,000**	
Project Cost Notes	• Connection to the well discharge point unknown and not included in cost estimate. • Channel restoration estimates are based on 2012 SMP and City staff feedback; the site was inaccessible during site visits.		



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City of Wilsonville
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Wilsonville Stormwater Master Plan

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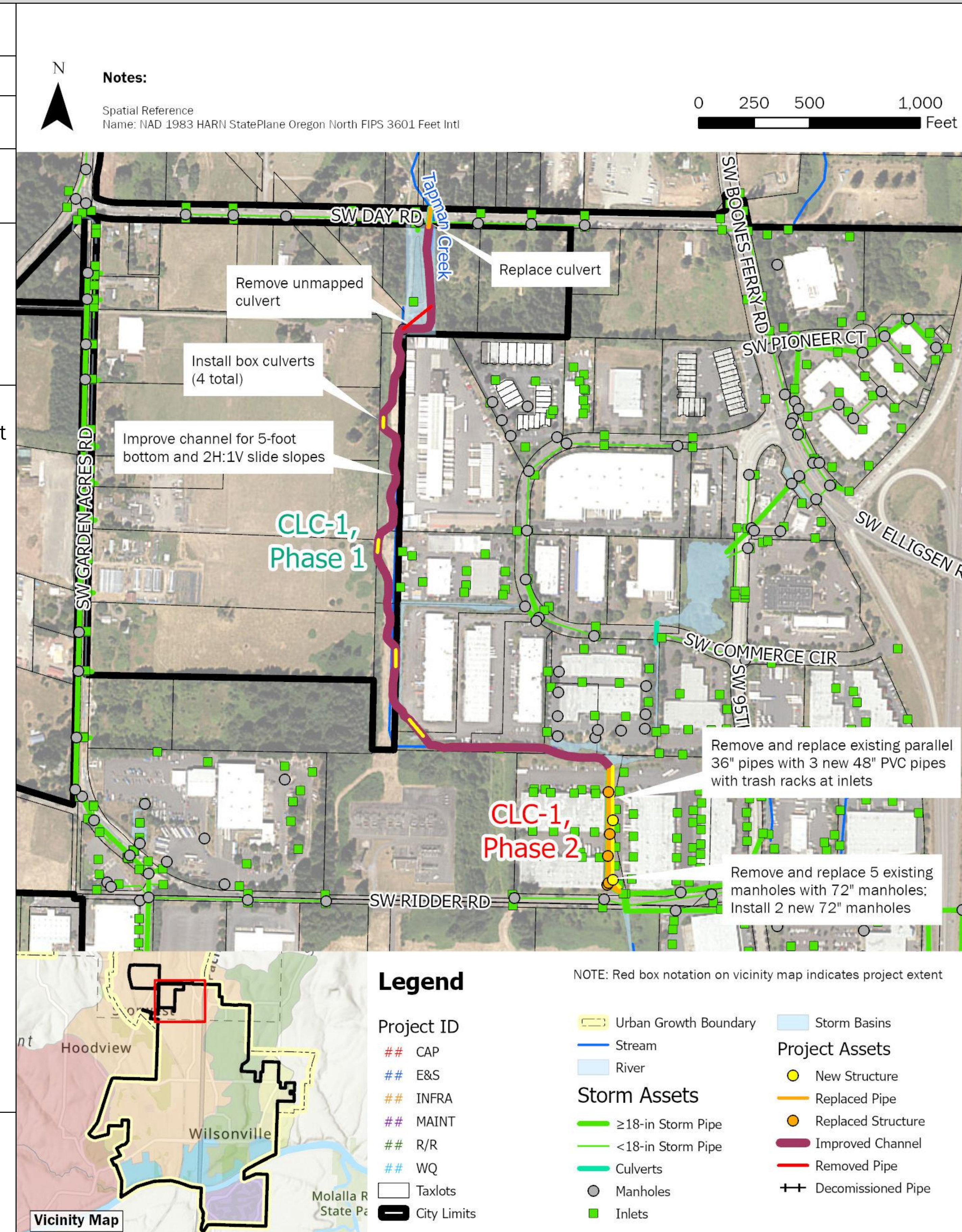
Capital Project Summary

BC-6 - Gesellschaft Water Well Channel Restoration

CLC-1	Day Road Stormwater Improvements		
Project Objective(s)	Repair and Replacement Capacity		
Project Opportunity ID	9	**Contributing Drainage Area**	944 acres
Estimated Existing Impervious Area (%)	30.4%	**Estimated Future Impervious Area (%)**	49.1%
Project Location	This project is in an industrial area south of Day Road and north of Ridder Road. The project extents run along the Bonneville Power Authority (BPA) easement before crossing the parking lot of industrial Tax Lot 500.		
Statement of Need	Stormwater conveyance between Day Road and Ridder Road includes a series of culverts and open channels and is limited in capacity and storage potential. Portions of the channel have a negative slope. Flooding is routinely observed at adjacent properties. Development in the Tapman Creek basin may increase the frequency and severity of flooding. In 2019, AKS prepared a facility siting alternatives report, which included design concepts to alleviate existing flooding, but future development conditions were not evaluated.		
Project Description	This project includes a phased approach to mitigate flooding of adjacent industrial properties. Phase 1 includes construction of the channel improvements and culvert installation consistent with AKS' Alt A-3 per the 2019 report. Phase 2 includes upsizing the two existing 36-inch parallel pipes to 48-inch beneath the parking lot of Tax Lot 500 and installing a third, parallel 48-inch pipe to reduce modeled flooding expected in the future development condition. Project details are as follows: Phase 1 - refer to Alt A-3 of the AKS report for full details. • Regrade and reconstruct approx. 4,500 feet of open channel to eliminate negative slope. The resulting channel shall be approximately 5-foot wide (bottom width) ranging from 1-foot to 6-feet deep. The channel widens at elevation 223.0 to create a floodplain. Side slopes are designed at 2H:1V. • Construct a structural earth wall at bends in the channel and along the east-west portion of the alignment, as specified in the AKS report. • Install 200 LF of open-bottom or box culverts (4 culverts total) to provide access to the existing BPA utility poles while also maximizing conveyance. • Remove the unmapped, 50-foot existing culvert at the northwest corner of the northernmost industrial property south of Day Road. • Install approx. 190 LF of two barrel, 36-inch diameter PVC culverts at Day Road. Phase 2 • Remove and replace the two existing, approx. 600 LF, 36-inch parallel storm pipes located beneath the parking lot of Tax Lot 500 with approx. 600 LF, 48-inch PVC parallel storm pipes. • Remove and replace five existing manholes along existing pipes with 72-inch manholes. • Install a third 600 LF of 48-inch PVC storm pipe parallel to the upsized pipes. • Construct two new 72-inch manholes on the new 48" pipe alignment. • Construct trash racks at the inlet at each of the three new pipes.		



Brown AND Caldwell	City of Wilsonville Project No: 156157 **Wilsonville Stormwater Master Plan** Page 1 of 2	**Capital Project Summary** **CLC-1 – Day Road Stormwater Improvements**

CLC-1 Day Road Stormwater Improvements

Design Considerations / Assumptions

- The AKS project concept was modeled and incorporated into the updated InfoSWMM model for this SMP, which reflects updated hydrology.
- Model results indicate that the proposed concept alleviates flooding in the existing land use condition. Future land use conditions assume unmitigated flow from new/ redevelopment. Modeled flooding is still predicted in the future land use condition, but adherence to PWS requiring onsite retention should reduce future flows to this area.
- Assessment of flooding during the 100-year storm was based on maximum WSE in relation to the elevation of adjacent structures.
- PWS design criteria for culverts (using the 100-year storm) is met at both Day Road and Ridder Road. The criteria are not met under future (unmitigated) land use condition.
- The catchment area draining to this project includes areas outside of City limits within the City of Tualatin. Application of local design standards in Tualatin may impact future flow conditions to this location.
- Access to BPA alignment, towers, and overhead power lines must be maintained.
- The small pond at inlet of culverts across Ridder Road is assumed landscape features, not detention and were not modeled - it is assumed that there is adequate space for outlets of the three proposed 48" pipes to this pond.

Estimated Project Cost

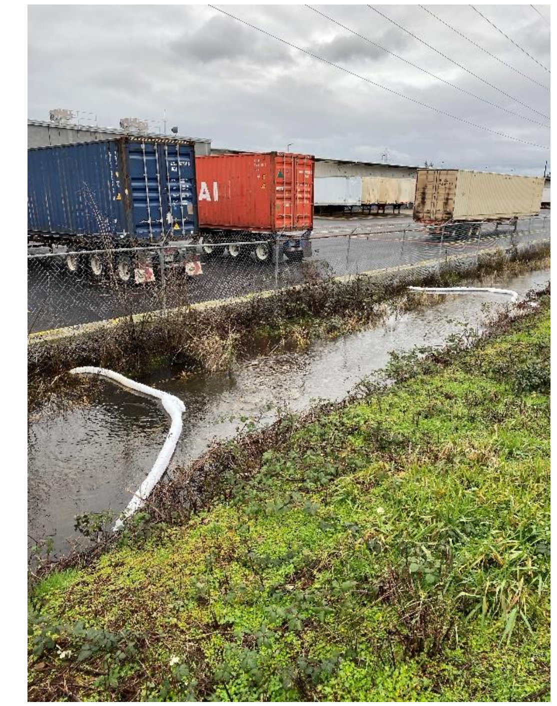
	Phase 1	*Phase 2*
Capital Expense Total	$5,860,000	$2,738,000
Design / Construction Admin. Phase 1: 3.5% + $200K Phase 2: 13.5%	$405,000	$370,000
Engineering & Permitting (30%)	$1,758,000	$821,000
Total Cost	**$8,020,000**	**$3,930,000**

Project Cost Notes

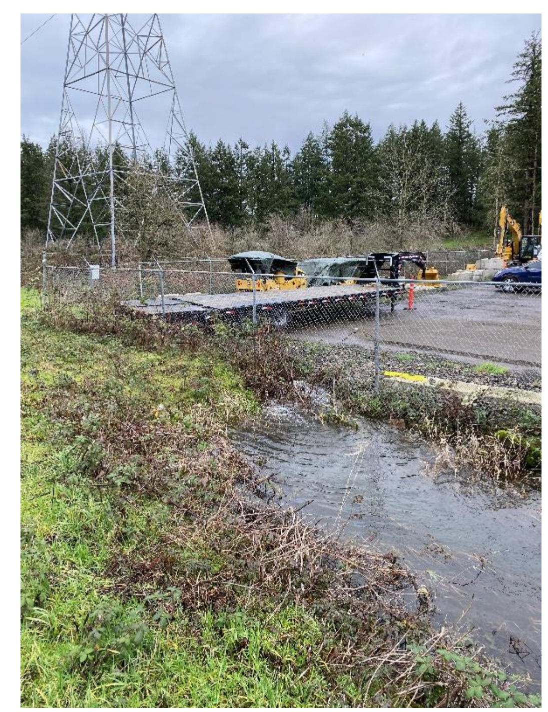
- Where possible, quantities for project components listed in the 2019 AKS report were verified and maintained. Costs are calculated based on the unit costs developed for this SMP. Unit costs for items derived directly from the 2019 AKS report were escalated to 2023 based on ENR CCI.
- Multipliers were applied as consistent with other capital projects. Lump sum costs used in the AKS estimate were not carried over.
- The AKS cost estimate did not include costs for Design/Construction Admin or Engineering/Permitting. These multipliers have been included for consistency with other capital project estimates. A modified construction administration multiplier was applied per direction from the City. No cap on engineering and permitting was applied, given potential design and permitting complexity of the project.

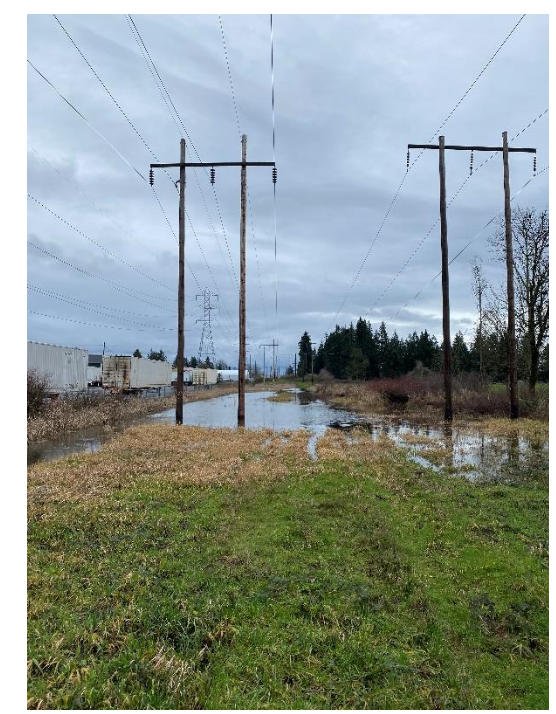
Additional Figures

Ponding north of Day Road (Jan 2022)



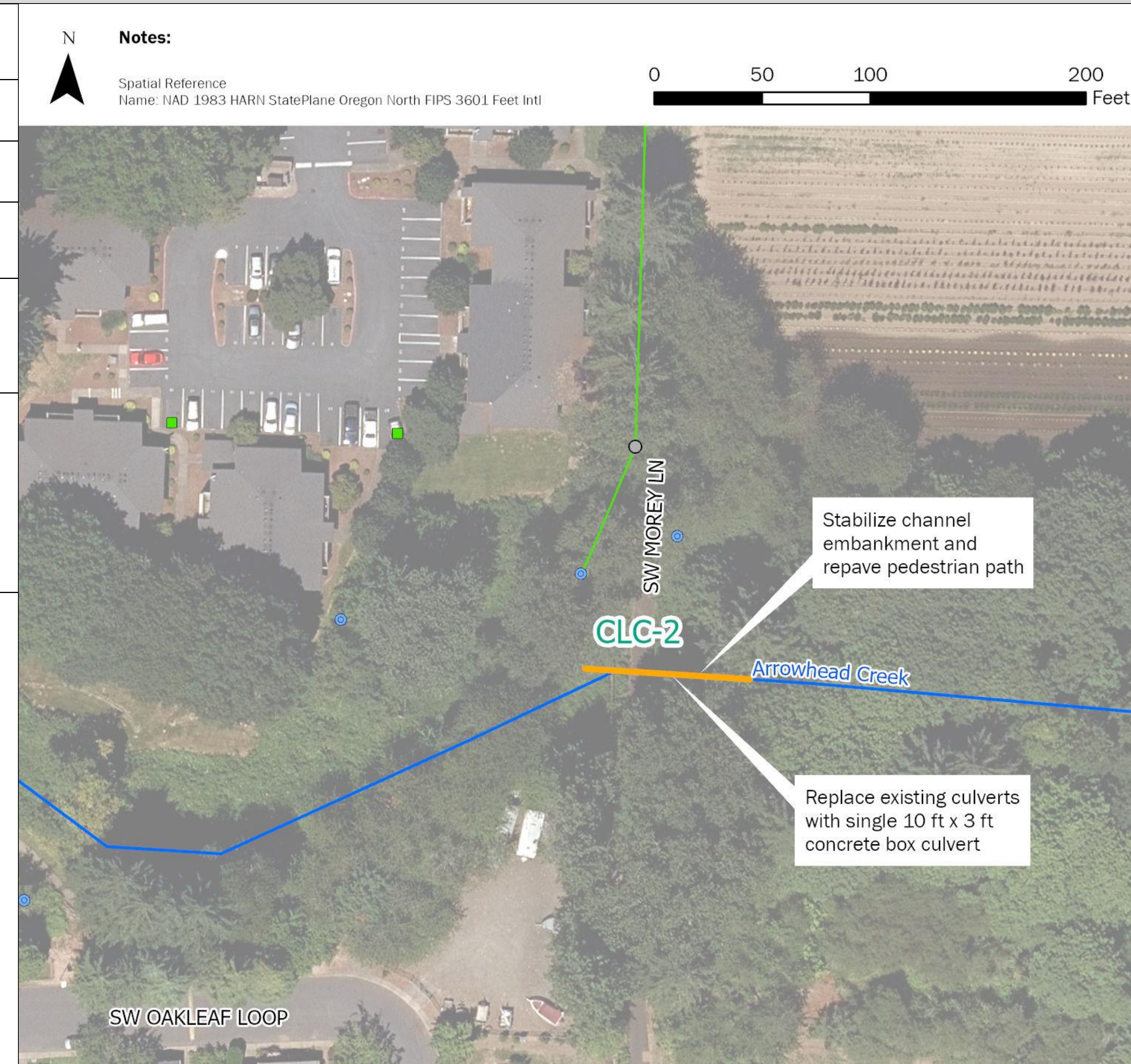
Conveyance channel south of Day Road (Jan 2022)

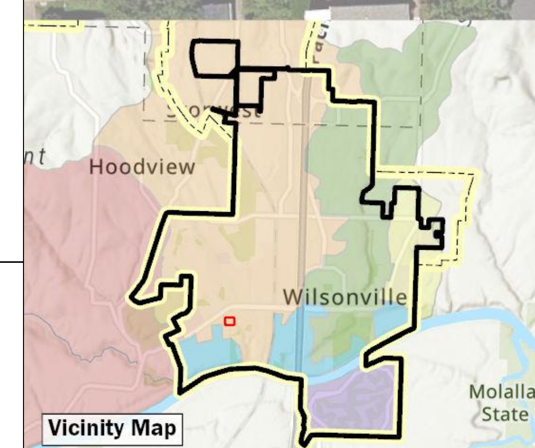




Conveyance channel and impoundment south of Day Road after storm (Jan 2022)

CLC-2	Arrowhead Creek Culvert Replacement at Arrowhead Creek Trail		
Project Objective(s)	Repair/Replacement Maintenance		
Project Opportunity ID	14		
Contributing Drainage Area	421 acres		
Estimated Existing Impervious Area (%)	35.25	Estimated Future Impervious Area (%)	37.29
Project Location	This project is located at the Arrowhead Creek culvert crossings under the Arrowhead Creek Trail. SW Oakleaf Loop is directly to the south of the project location.		
Statement of Need	The two existing, parallel 5-foot x 5-foot concrete box culverts that convey Arrowhead Creek under the pedestrian path are failing and in need of replacement. The 2012 Stormwater Master Plan identified this location as a project need (CLC-9), and subsequent site visits, results and findings of the 2022 stream assessment conducted for this SMP, and conversations with City staff confirmed the need.		
Project Description	This project includes replacement of the existing parallel 5-foot x 5-foot concrete box culverts with new 10-foot by 3-foot concrete box culverts to address the failing culverts and stabilize the Arrowhead Creek channel and pedestrian trail's creek crossing. Project details are as follows: • Remove and replace approx. 70 LF existing double 5 ft x 5 ft concrete box culverts with a 10 ft x 3 ft concrete box culvert. • Install planting and bioengineered restoration/stabilization measures after replacement of the culvert to stabilize an area approximately 20 feet along the pedestrian path length and approximately 50 feet upstream and downstream of the crossing. • Repave approx. 30 LF of the approx. 20-foot-wide pedestrian path after culvert replacement.		





Legend

Project ID by Primary Objective
- ## CAP
- ## E&S
- ## INFRA
- ## MAINT
- ## R/R
- ## WQ

City Limits
Urban Growth Boundary
Stream

Storm Assets
- ≥18-in Storm Pipe
- <18-in Storm Pipe

Manholes
Inlets
Storm Outfalls

Project Assets
- Replaced Pipe

NOTE: Red box notation on vicinity map indicates project extents

CLC-2	Arrowhead Creek Culvert Replacement at Arrowhead Creek Trail	
Design Considerations / Assumptions	• Model results indicate that a 10-foot x 3-foot concrete box culvert has sufficient capacity to convey the 100-year design storm flow in Arrowhead Creek without decreasing freeboard when compared to the current twin 5-foot x 5-foot culverts. • Culvert sizing to be confirmed with final design. • Assumes that access to the site for construction equipment can be obtained via the pedestrian path at Arrowhead Creek Lane. • Exact stabilization measures to be determined during project design. Stabilization measures may include targeted planting, bio-engineered solutions such as live stakes or fascines, and gabion walls if necessary. • Note that the City's GIS includes a 48" diameter culvert at this location, which is inconsistent with field observations from Stream Assessment conducted May 2022.	
Estimated Project Cost	Capital Expense Total	$179,000
	Design / Construction Admin. (Cap)	$35,000
	Engineering & Permitting (Cap)	$75,000
	Total Cost	**$290,000**
Project Cost Notes	• Assumes clearing/grubbing with stump removal in immediate areas as necessary for construction. • No costs included for access - assumed access can be attained through pedestrian path. • A minimum cap on Design/ Construction Admin and Engineering & Permitting was applied at the direction of the City.	

Additional Figures

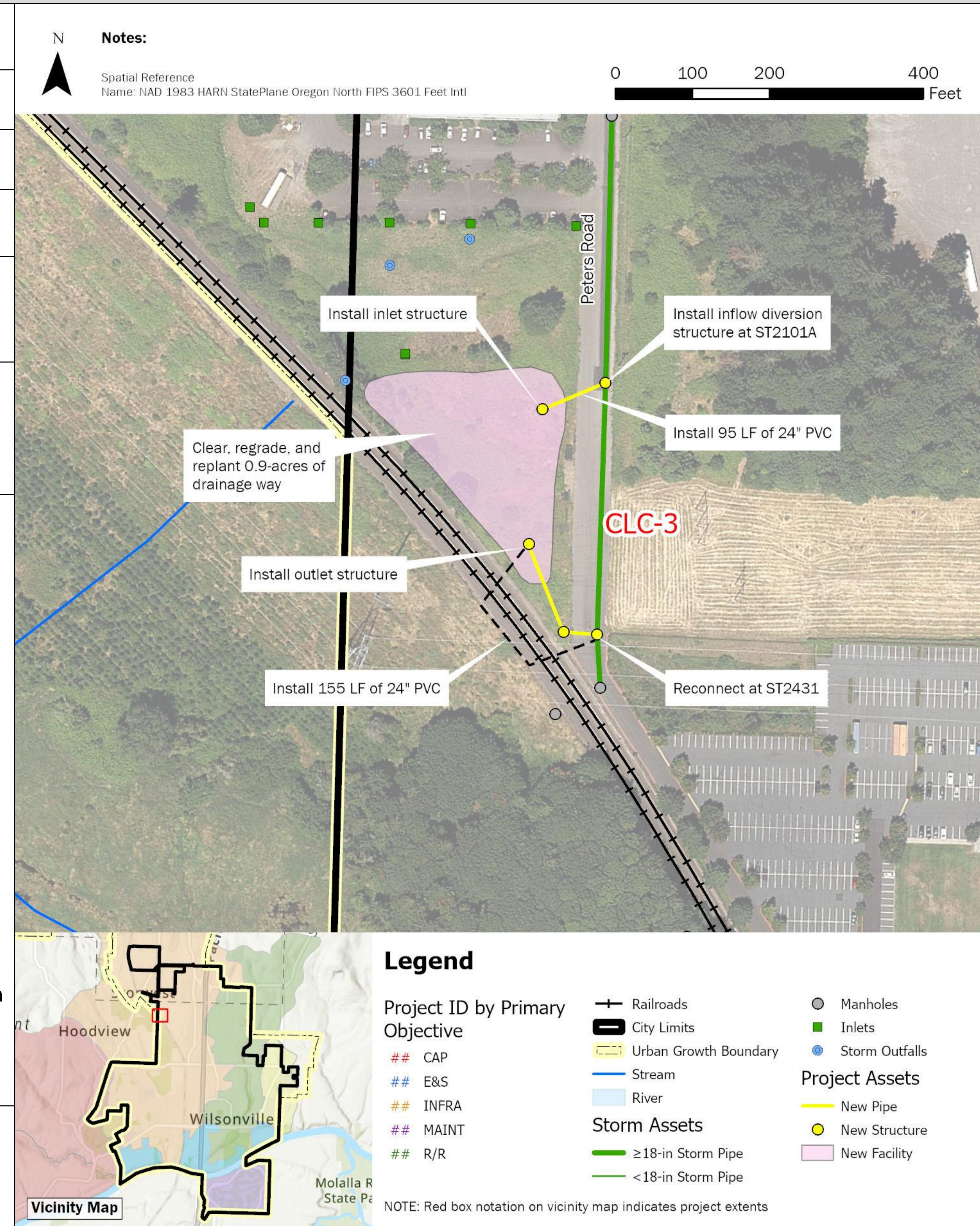
Failing twin 5 ft x 5 ft culverts under pedestrian crossing looking upstream

(Source: Geomorphic Stream Assessment, Waterways Consulting, May 2022)

Capital Project Summary

CLC-2 - Arrowhead Creek Culvert Replacement at Arrowhead Creek Trail

CLC-3	Garden Acres Pond Retrofit		
Project Objective(s)	Capacity (Mitigation) Water Quality		
Project Opportunity ID	32		
Contributing Drainage Area	231 acres		
Estimated Existing Impervious Area (%)	34.1%	**Estimated Future Impervious Area (%)**	52.8%
Project Location	This project is located at an existing public pond in an industrial area along Peters Road. The area is bounded to the west by SW Graham's Ferry Rd, SW Day Road to the north, SW 95th Ave to the east, and the Coffee Lake Wetlands to the south.		
Statement of Need	The stormwater collection system along Peters Road is undersized with several pipe constrictions limiting flow upstream of the railroad crossing. Future development is anticipated to increase runoff to the system. Options to upsize the collection system at the railroad crossing are limited due to required coordination with the railroad and METRO.		
Project Description	This project entails the retrofit of an existing public pond, located in a greenfield east of Peters Road, to provide additional storage of stormwater during high flow events. Retrofit of the pond includes increasing its current storage capacity from 13,200 to 39,200 cubic feet. Stormwater will be diverted towards the pond to reduce flow through undersized storm piping along Peters Road. Rerouted flow from the pond will reconnect to the main network prior to discharge in Coffee Lake Wetlands. Project details are as follows: • Install a flow diversion structure at Peters Road (ST2101A). • Install 95 LF of 24-inch PVC pipe from Peters Road to the inlet of the detention pond. • Increase existing detention pond capacity by 26,000 cubic feet and lower pond bottom invert to an elevation of 196-ft. • Clear, regrade, and replant 0.9-acres of pond footprint area. • Install an outlet control structure within the detention pond. • Install 155 LF of 24-inch diameter PVC pipe from the detention pond to the stormwater conveyance system on Peters Road (ST2431). • Install 50 LF of 6-inch HDPE underdrain pipe. • Install pond underdrain media in accordance with the 2015 PSW Section 3, Appendix A landscape and soil media requirements. Including 15" of drain rock, a 3" separation layer, and 18" of growing media.		



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Capital Project Summary

CLC-3 – Garden Acres Pond Retrofit

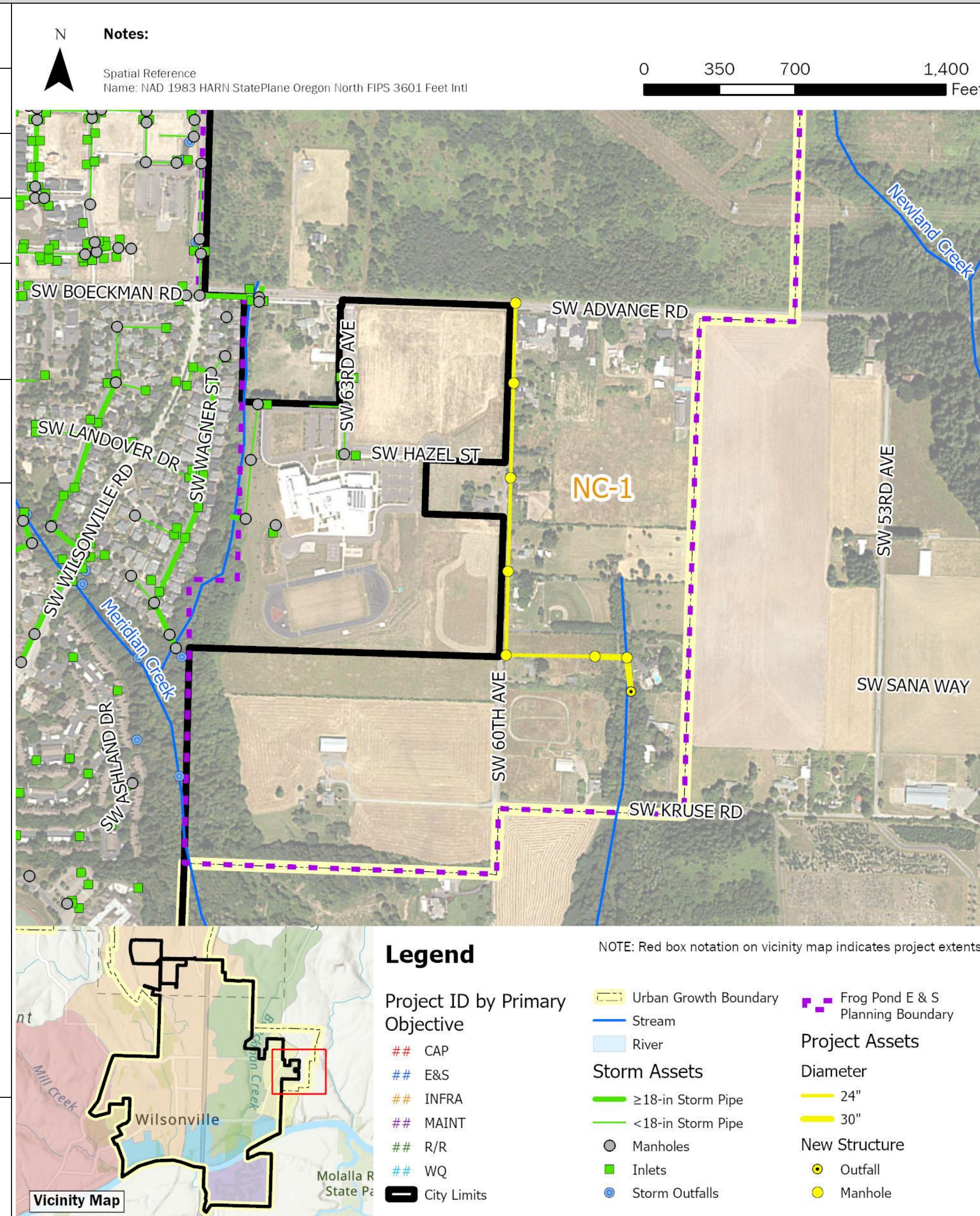
CLC-3	Garden Acres Pond Retrofit	
Design Considerations / Assumptions	• As-builts were received for the existing public pond and existing storage volume estimated from the as-builts. • All proposed improvements are within the public pond boundaries. Property lines to be verified by survey. • This project is intended to alleviate modeled flooding of the Peters Road system under current land use conditions; however, future development conditions may still result in flooding along Peters Road and SW Garden Acres Road. Future development will be required to adhere to current stormwater design standards and retain/mitigate flow to pre-development conditions. • H/H modeling was used to confirm the flow diversion structure configuration and pond operation up to the 25-year storm event. The proposed design incorporates an emergency spillway to the railroad ditch for higher storm events.	
Estimated Project Cost	Capital Expense Total	$2,897,000
	Design / Construction Admin. (3.5% + $200K)	$301,000
	Engineering & Permitting (20%)	$579,000
	Total Cost	**$3,780,000**
Project Cost Notes	• The proposed detention facility footprint is approximately 39,200 square feet. Earthwork estimates assume additional excavation of 25,600 cubic feet to provide the required storage. • Final design will include confirmation of vegetation enhancement and structure sizing. • A modified construction administration multiplier was applied per direction from the City. No cap on engineering and permitting was applied, given potential design and permitting complexity of the project.	

Additional Figures

Garden Acres Pond Existing Inflow Pipe (May 2023)

Garden Acres Detention Pond (May 2023)

NC-1	Frog Pond East and South Conveyance Piping (Basin K1 only)		
Project Objective(s)	Infrastructure Need (New Development)		
Project Opportunity ID	44		
Contributing Drainage Area (acres)	61 acres		
Estimated Existing Impervious Area (%)	12.1%	**Estimated Future Impervious Area (%)**	57.0%
Project Location	This project is located east of Stafford Road and the Frog Pond West development area in Wilsonville, outside of the current city limits and UGB. This future planning area is bounded to the west by SW Stafford Road and bisected into east and south by SW Advance Road.		
Statement of Need	The Frog Pond East and South Master Plan (2022) identified stormwater improvements required for development of the Frog Pond East and South neighborhoods.		
Project Description	The full 2022 Frog Pond East and South Master Plan stormwater conveyance layout has been simplified for this CP to only include the storm main and outfall along SW 60th Ave to outfall near unnamed tributary (under SW Kruse Rd). This drainage basin is referred to in the Master Plan as K1 (encompassing approx. 61 acres). Project details are as follows: • Install 2,050 LF of 24-inch PVC pipe. • Install 310 LF of 30-inch PVC pipe. • Install seven 60-inch manholes. • Install 1 outfall.		



Brown AND Caldwell	City of Wilsonville Project No: 156157 **Wilsonville Stormwater Master Plan** Page 1 of 2	**Capital Project Summary** **NC-1 Frog Pond E and S Conveyance Piping**

NC-1	Frog Pond E and S Conveyance Piping

Design Considerations / Assumptions

- Infrastructure sizing is based on recommendations in the Frog Pond East and South Master Plan (Dec 2022). No additional modeling was performed using InfoSWMM per this SMP for this area.
- The Frog Pond East and South Master Plan divides the planning area into 11 basins. The breakdown of proposed infrastructure by basin is detailed below:
  - **K1**: install 1,200 LF of 18-inch PVC pipe, 2,050 LF of 24-inch PVC pipe, and 310 LF of 30-inch PVC pipe; 3- 48-inch manholes, 7-60-inch manholes and 1 outfall.
  - **K2**: install 220 LF of 12-inch PVC pipe, 2- 48-inch manholes, and 1 outfall.
  - **M1-A**: install 2,630 LF of 12-inch PVC pipe, 8- 48-inch manholes, and 1 outfall.
  - **M1-B**: install 1,050 LF of 24-inch PVC pipe, 5- 60-inch manholes, and 1 outfall.
  - **M2**: install 400 LF of 12-inch PVC pipe, 2- 48-inch manholes, and 1 outfall.
  - **M3**: install 1,160 LF of 24-inch PVC pipe, 5- 60-inch manholes, and 1 outfall.
  - **N1**: install 670 LF of 18-inch PVC pipe, 2- 48-inch manholes, and 1 outfall.
  - **N2**: install 7,670 LF of 18-inch PVC pipe, 3- 48-inch manholes, and 1 outfall.
  - **N3**: install 670 LF of 18-inch PVC pipe, 2- 48-inch manholes, and 1 outfall.
  - **N4**: install 1,150 LF of 18-inch PVC pipe, 5- 48-inch manholes, and 1 outfall.
  - **N5**: install 730 LF of 12-inch PVC pipe, 3- 48-inch, and 1 outfall.
- Proposed public LID and water quality treatment facilities have not been costed as part of this project, given development-driven installation needs.
- Future stream assessments in conjunction with planning-related capital projects will be conducted in the area to evaluate natural system prior to and during development activities.

Estimated Project Cost

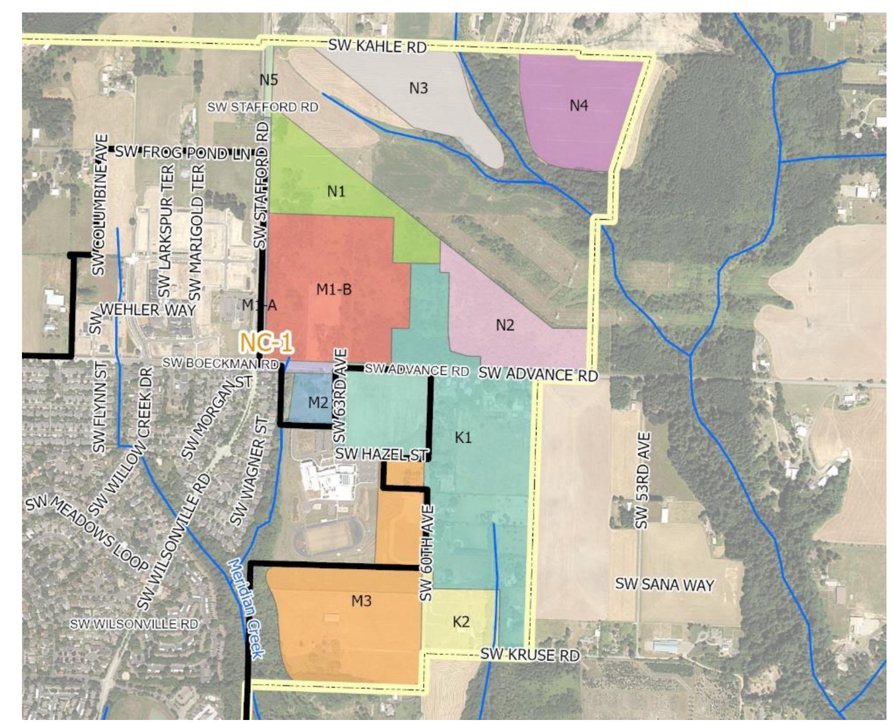
Capital Expense Total	$3,064,000
Design / Construction Admin. (13.5%)	$414,000
Engineering & Permitting (20%)	$613,000
Total Cost	**$4,090,000**

Project Cost Notes

- Cost estimates assume use of PVC for all new pipe materials.
- Project cost assumes pipe installation will occur in roadways. Pavement restoration and trenching are assumed in the pipe unit costs.
- No earthwork beyond trenchwork is included.
- Only the main stormwater pipes along SW 60th Ave towards the outfall (24-inch and 30-inch in diameter) are included in the project estimate, per City direction.
- Regional stormwater storage facilities and low impact development (LID) facilities are not included in this project estimate.

Additional Figures

Frog Pond East & South Master Plan Areas from Master Plan (Dec 2022)



Frog Pond East & South Basins from Master Plan (Dec 2022)

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City of Wilsonville
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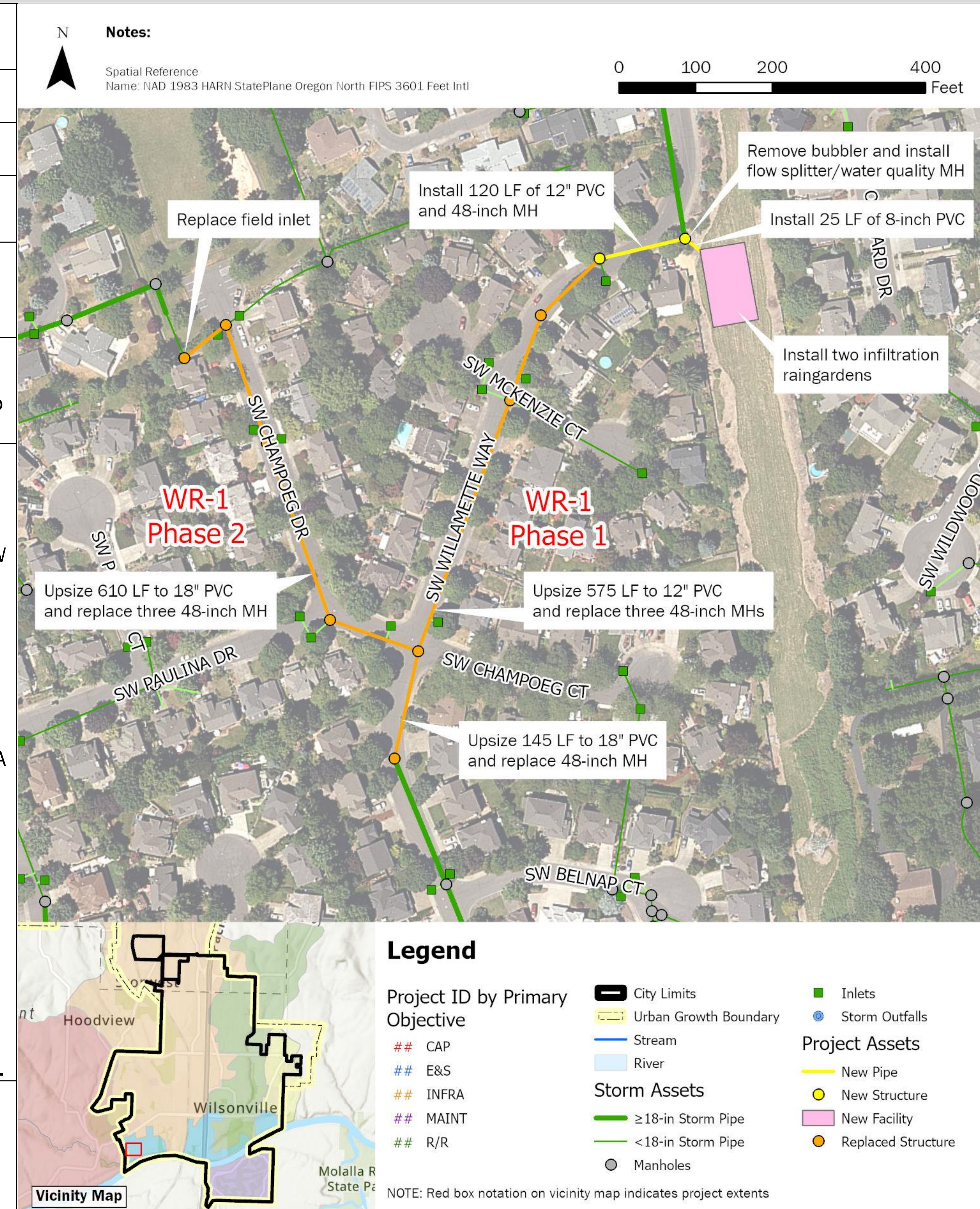
Wilsonville Stormwater Master Plan

Capital Project Summary

NC-1 Frog Pond E and S Conveyance Piping

WR-1	SW Willamette Way / Morey's Landing Stormwater Improvements		
Project Objective(s)	Capacity (Mitigation) Water Quality		
Project Opportunity ID	1		
Contributing Drainage Area	46 acres		
Estimated Existing Impervious Area (%)	45.4%	Estimated Future Impervious Area (%)	46.3%
Project Location	This project is in a residential area near the Willamette River. The project area is located along SW Willamette Way and SW Champoeg Dr, approximately 1,200 feet north of the Belknap Outfall to the Willamette River.		
Statement of Need	The Morey's Landing Bubbler at SW Willamette Way results in local flooding and impacts to neighboring residential property during large rainfall events. Downstream capacity deficiencies were identified by H/H modeling, and current public storm drainage pipe sizes do not adhere to the City's PWS.		
Project Description	This project mitigates flooding by removing the existing bubbler structure (STD6604) and reroutes the water quality (1-inch/24 hr storm) flows to a nearby Bonneville Power Administration (BPA) easement, utilizing the Belknap Court Outfall to bypass high flow events. Water quality events will drain to two proposed infiltration raingardens constructed within the adjacent BPA easement. High flows will bypass to new 12-inch and 18-inch PVC pipes along SW Willamette Way, upstream of the Belknap Court Outfall. Additional capacity deficiencies will be addressed by upsizing pipes along SW Willamette Way and SW Champoeg Ct. Due to project complexity and size, this project is costed as two phases and numbered based on recommended sequencing. Project details by phase are as follows: Phase 1 (Morey's Landing Bubbler): • Remove existing Morey's Landing Bubbler (STD6604). • Clear, grade, and replant 0.12-acres to create two infiltration raingardens within the BPA easement. • Install a flow control diversion structure and 25 LF of 8-inch PVC to route water quality events (low flow) to new raingardens and high flow events to the Belknap Court outfall. • Install 120 LF of 12-inch PVC for flow exceeding the water quality event. • Upsize 575 LF of 10-inch CPS to 12-inch PVC (SD6629, SD6630, SD6632). • Upsize 145 LF of 10-inch CSP to 18-inch PVC (SD6638). • Install one 48-inch manhole and replace four 48-inch manholes (ST6618, ST6619, ST6606, and ST6605). Phase 2 (SW Champoeg Ct): • Upsize 610 LF of 12-inch CSP to 18-inch PVC on SW Champoeg Dr E (SD6634 – SD6637). • Replace three 48-inch manholes (ST6607, ST6608, and ST6609) and field inlet (6647).		



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Wilsonville Stormwater Master Plan

Capital Project Summary

WR-1 – SW Willamette Way / Morey's Landing Stormwater Improvements

WR-1 | SW Willamette Way / Morey's Landing Stormwater Improvements

Design Considerations / Assumptions

- This project is intended to mitigate stormwater overflow from an existing bubbler and increase capacity of downstream piped infrastructure to the Belknap Court outfall.
- The raingarden facilities (Phase 1) were sized as a water quality, filtration raingarden using the BMP Sizing Tool. Due to design constraints and lack of feasible outlet, this BMP may be constructed as an infiltration facility, pending infiltration testing.
- Pipe replacement/upsizing along SW Willamette Way is proposed to adhere to the minimize pipe size required for public infrastructure.
- The conveyance along SW Champoeg Ct (Phase 2) is identified as under capacity and will be upsized from existing 12-inch to 18-inch.
- H/H modeling was used to confirm the flow diversion structure configuration, which uses an 8-inch low flow pipe and weir to divert the water quality event to the raingarden and bypass high flows to the piped collection system.
- Coordination with BPA will be required to obtain easement for the raingarden facilities.

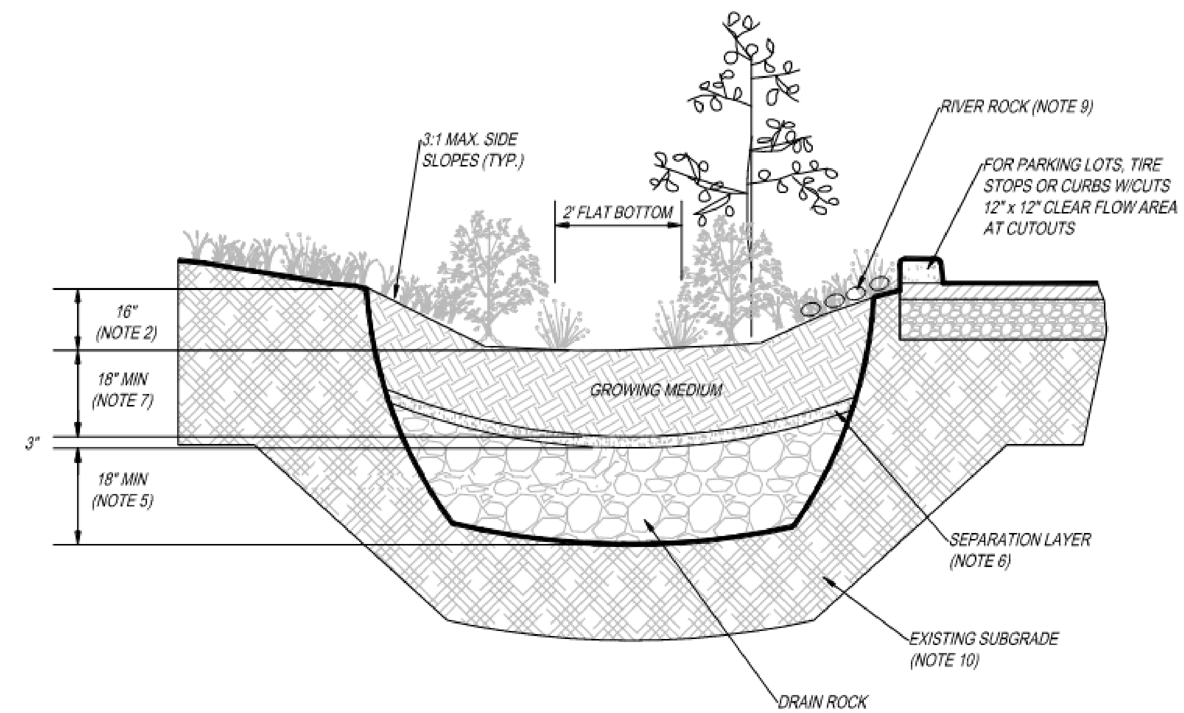
Estimated Project Cost

	Phase 1	*Phase 2*
Capital Expense Total	$ 1,729,000	$811,000
Design / Construction Admin. (13.5%)	$233,000	$109,000
Engineering & Permitting (20%)	$ 346,000	$162,000
Total Cost	**$2,310,000**	**$1,080,000**

Project Cost Notes

- The required raingarden facility footprint is approximately 5,800 square feet. Earthwork estimates assume 5 feet of over excavation to an elevation of 163-ft to accommodate the low flow pipe grade.
- Final design will include confirmation of vegetated facility plantings and structure sizing.

Additional Figures



BMP Sizing Tool Standard Detail – Infiltration Raingarden

Existing Bubbler Structure (May 2023)

Brown AND Caldwell

City of Wilsonville
Project No: 156157

Wilsonville Stormwater Master Plan

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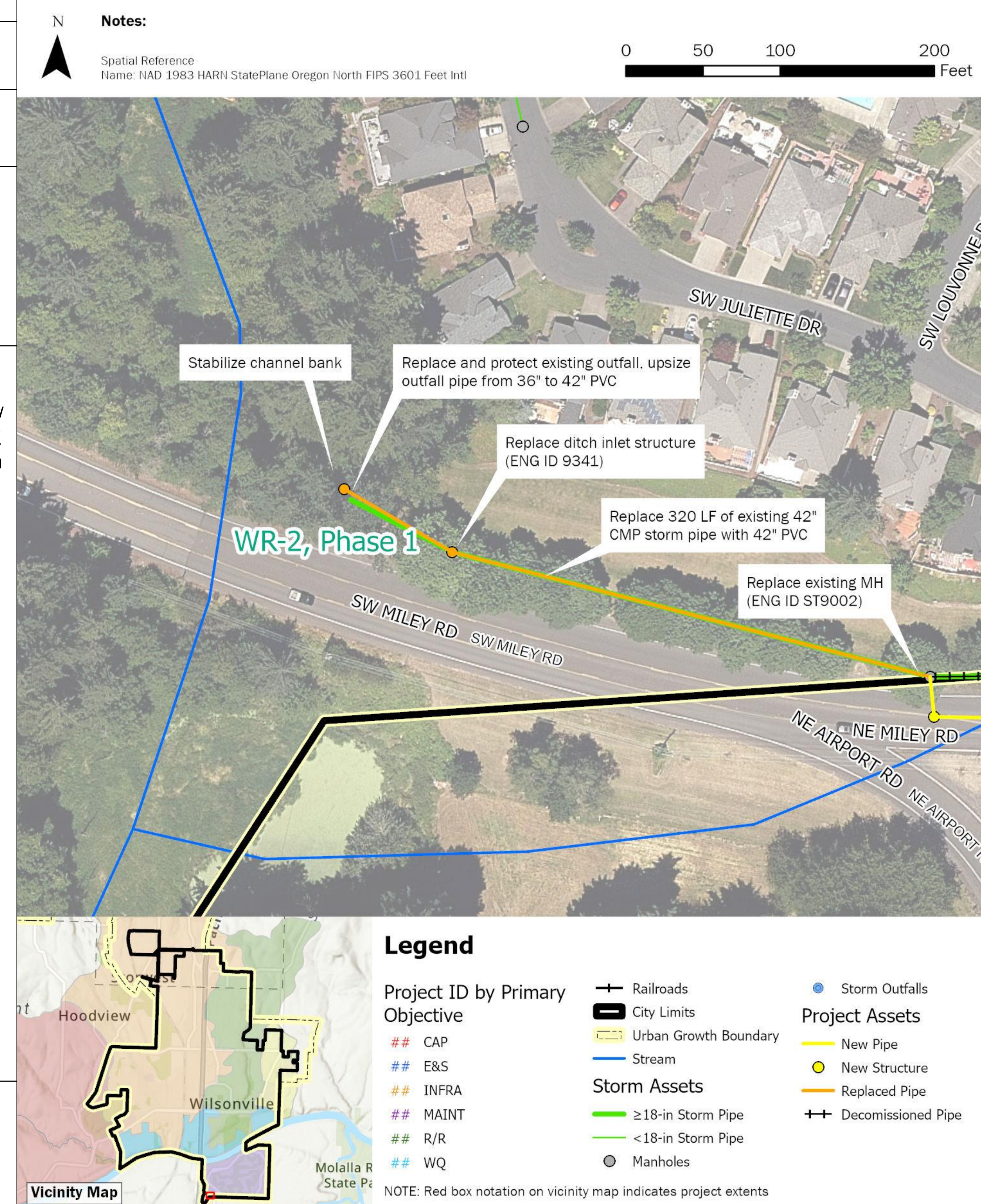
Capital Project Summary

WR-1 – SW Willamette Way / Morey's Landing Stormwater Improvements

WR-2	Miley Road Stormwater Improvements		
Project Objective(s)	Repair/Replace, Erosion/Sediment Control, Maintenance		
Project Opportunity ID	5	**Contributing Drainage Area**	138.0 acres
Estimated Existing Impervious Area (%)	46.1%	**Estimated Future Impervious Area (%)**	46.1%
Project Location	This project is located along Miley Road, from the outfall just north of SW Miley Road east approximately 1,200 feet from the corner of NE Miley Road and NE Eilers Road. Phase 1 of the project is located outside of the ROW. Phase 2 is located within the NE Miley Road ROW.		
Statement of Need	The Miley Road outfall is in poor condition with overgrown vegetation and difficult access. The outfall is causing scouring into the adjacent jurisdictional wetland. Further upstream, the existing storm main that runs parallel with Miley Road has collapsed due to age, pipe corrosion, and potential settling of a private brick wall installed along a portion of the alignment. The pipe failure has caused a sinkhole at the upstream (eastern) edge of the pipe alignment. Upstream capacity deficiencies were identified by H/H modeling. This location was identified in the 2012 SMP as CIP SD9000 to SD9069.		
Project Description	This project includes a phased approach to improve the stormwater system along Miley Road, which serves a significant portion of the Charbonneau development. Phase 1 includes replacement of the outfall and approximately 400 LF of pipe outside of the ROW. Phase 2 includes construction of a new pipe alignment in the Miley Road ROW to replace the failing storm pipe, and extension of the existing main connections to the new alignment. This new alignment includes upsizing of 650 LF of pipe from 24-inches to 36-inches to address capacity deficiencies in this area. Project details are as follows: Phase 1 • Upsize 80 LF of 36-inch CMP to 42inch PCV from area drain (ENG ID 9341) to outfall. • Restore approx. 30 ft of channel bank on either side of new outfall. • Replace area drain (ENG ID 9341). • Replace 320 LF of existing storm pipe with same diameter 42-inch PVC between area drain (ENG ID 9341) and manhole (ST9002). • Replace and lower invert of manhole (ST9002) to ensure 3 ft cover requirement is met for incoming pipe. Maintain 0.2 ft drop within MH. Phase 2 • Install 530 LF of 42-inch PVC from replaced manhole (ST9002) to new manhole at the near intersection with SW French Prairie Road. • Install three 72-inch manholes for the above 42-inch line, the most upstream of which is at the SW French Prairie Road. • Install ten 60-inch manholes and 3,015 LF of 36-inch PVC along NE Miley Road from SW French Prairie Road to new manhole adjacent to manhole ST9011. • Install two 48-inch manholes and 650 LF of 24-inch PVC from the new manhole adjacent to manhole ST9011 to the new manhole at upstream most lateral. • Extend six total existing main connections to the new pipe alignment (approx. 40 LF each, varying diameters). Note that these points of connection run under the existing brick wall. • Reconnect all existing curb inlets (approx. 13) along new NE Miley Road alignment.		



Brown AND Caldwell	City of Wilsonville Project No: 156157 **Wilsonville Stormwater Master Plan** Page 1 of 2	**Capital Project Summary** **WR-2 – Miley Road Stormwater Improvements**

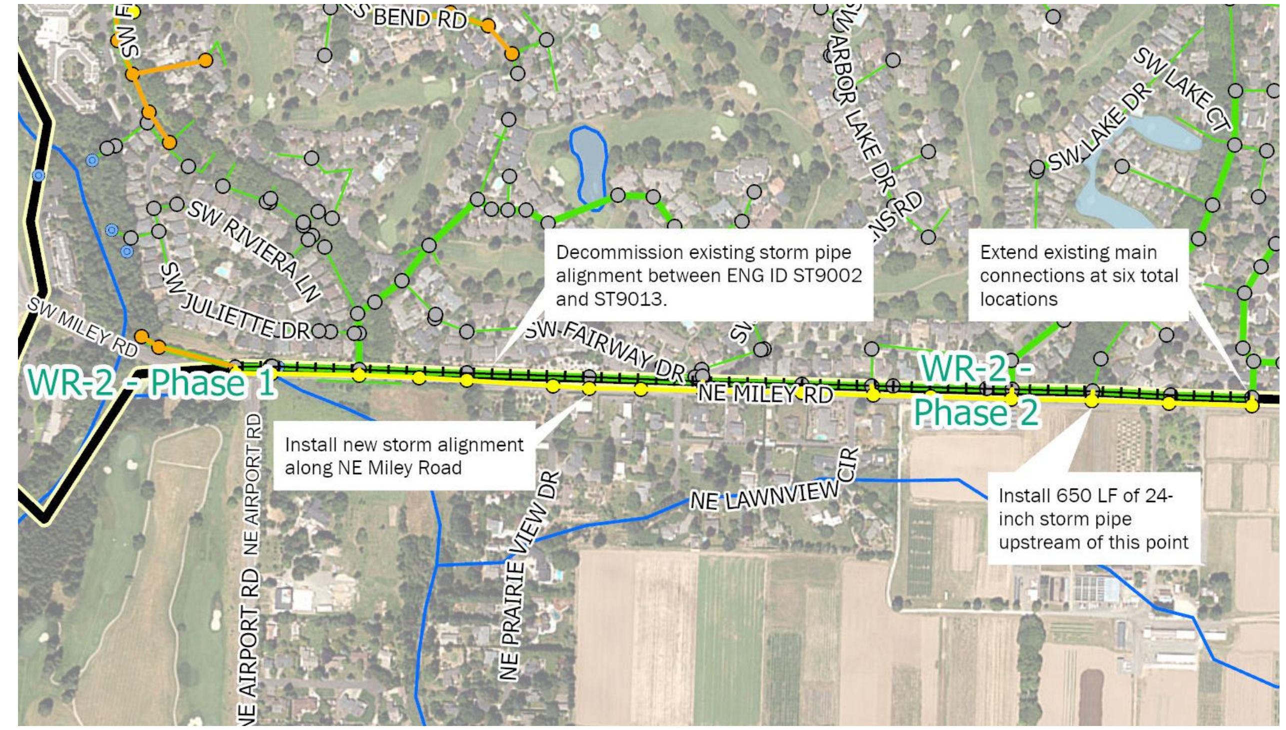
WR-2	Miley Road Stormwater Improvements
Design Considerations / Assumptions	• Access to the outfall is assumed to be feasible without significant permitting requirements. • Pipe sizing for the new alignment was conducted using changes to the existing pipe alignment, including the existing inverts, to confirm capacity. As such, capacity using inverts for the new pipe alignment should be confirmed during project design. • Extending the connections to the existing alignment may require work underneath the private brick wall that stands on top of much of the existing alignment. Constructability considerations and trenchless methods should be investigated during design. • Miley Road lies outside of Wilsonville City limits. Clackamas County requirements and permitting should be reviewed during project design.

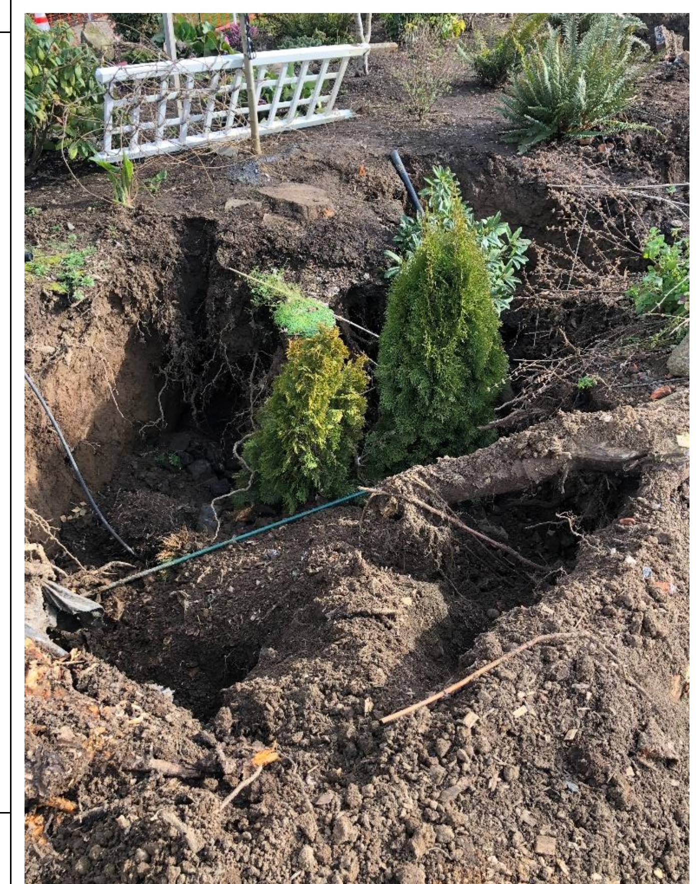
Estimated Project Cost

	Phase 1	*Phase 2*
Capital Expense Total	$574,000	$7,720,000
Design / Construction Admin. Phase 1: 13.5% Phase 2: 3.5% + $200K	$77,000	$470,000
Engineering & Permitting (30%)	$172,000	$2,316,000
Total Cost	**$820,000**	**$10,510,000**

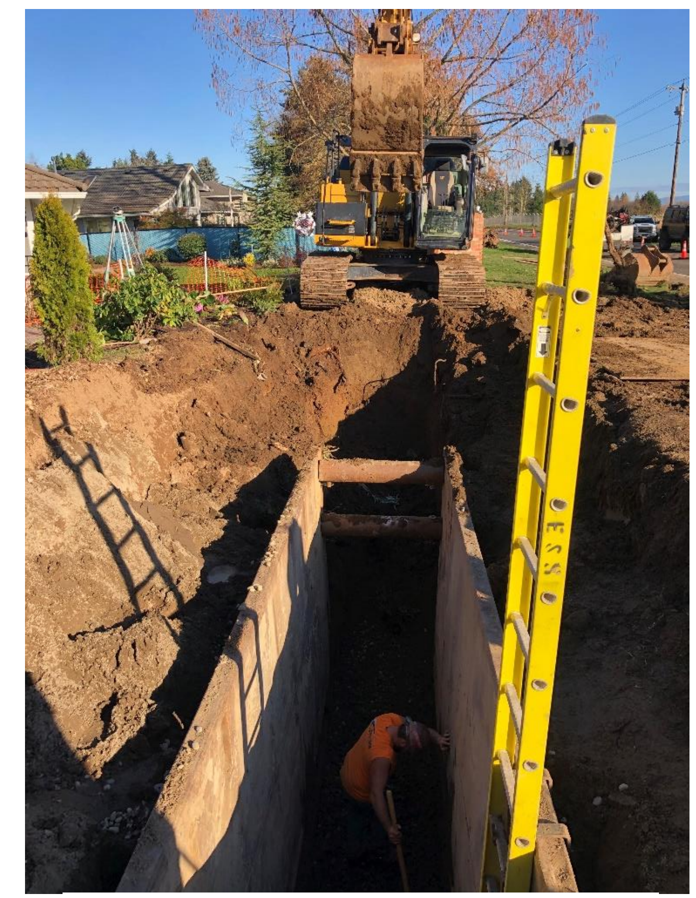
Project Cost Notes

- Costs have not been included for access requirements.
- Costs for connections to existing system under brick wall have been assumed based on the existing number of connections and associated pipe length only.
- Costs assume that existing pipe alignment (where not replaced, where moved to ROW) will be abandoned and filled with grout at key connection points.
- Replacement of inlets and laterals along Miley Road is not accounted for.
- Miley Road lies outside of Wilsonville City limits. An 8.83% multiplier has been applied to the project cost to account for Clackamas County permitting costs.
- A modified construction administration multiplier was applied per direction from the City. No cap on engineering and permitting was applied, given potential design and permitting complexity of the project.



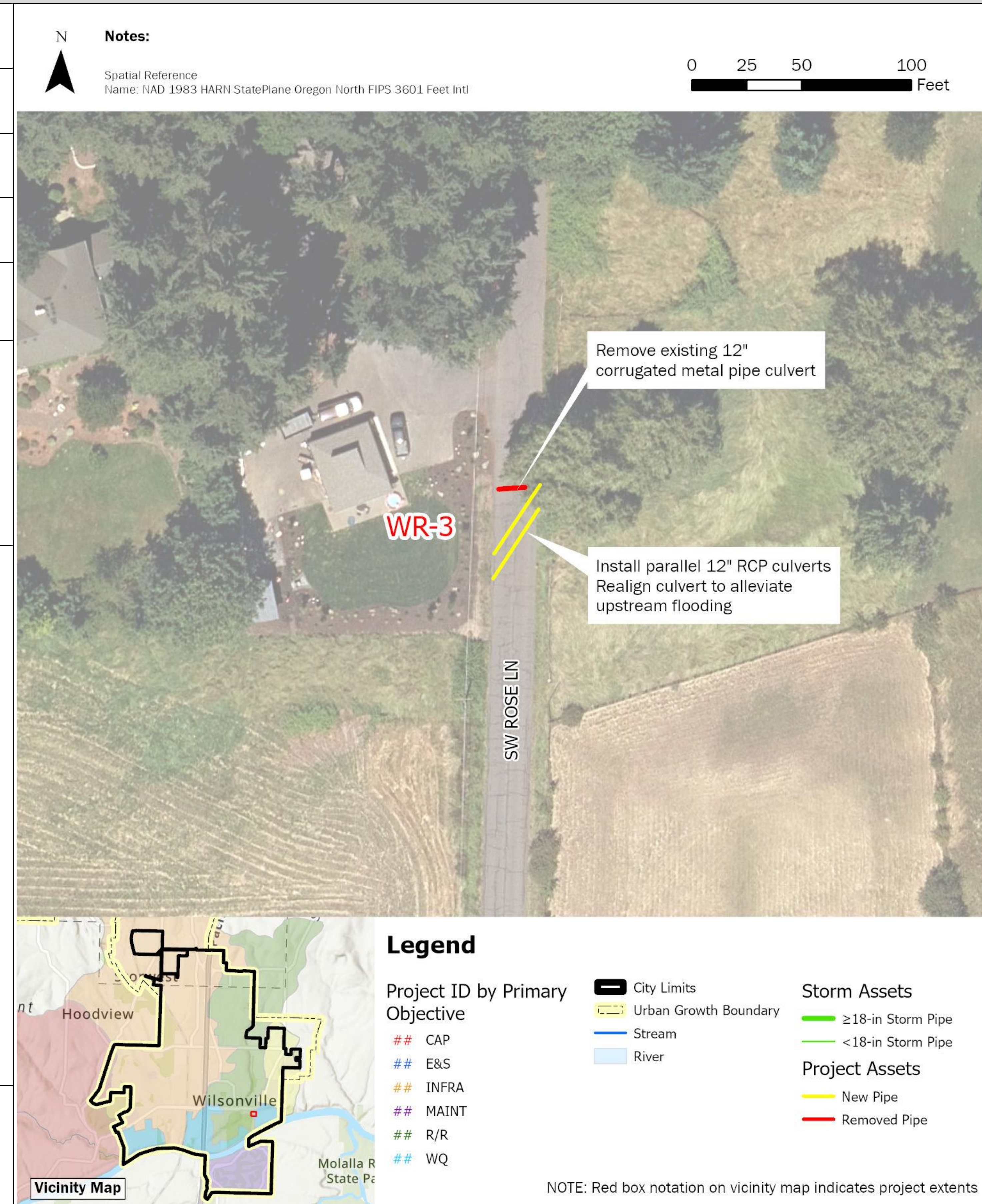


Sinkhole observed at upstream end of Miley Road alignment



Temporary construction work on sinkhole

WR-3	Rose Lane Culvert Replacement		
Project Objective(s)	Capacity Maintenance		
Project Opportunity ID	7		
Contributing Drainage Area	Approx. 14 acres (estimated as a portion of subbasin 5200)		
Estimated Existing Impervious Area (%)	21.6%	**Estimated Future Impervious Area (%)**	23.9%
Project Location	This project is located in the Boeckman Creek watershed, along SW Rose Lane between SW Wilsonville Road and SW Montgomery Way near tax lot 31W24A 03900.		
Statement of Need	The culvert under SW Rose Lane appears to be undersized, causing flooding on the road and neighboring private property on upstream side. This area is very flat with undefined drainage patterns. The existing culvert alignment is perpendicular to the upstream open channel alignment, which limits the ability to route/divert flow east. In addition, the roadway and associated culvert are located at a lower elevation than surrounding upstream or downstream property, causing water to collect and flood over the roadway. This project was originally identified as WD-2 in the 2012 SMP.		
Project Description	This project replaces an existing 12-inch corrugated metal pipe culvert under Rose Lane with realigned dual 12-inch RCP culverts to adequately convey flows. Project details are as follows: • Remove the existing 25 LF of 12-inch culvert (CARTE ID: 24370, ENG ID not available). • Install approximately 40 LF of parallel 12-inch RCP culverts. • Realign the existing culvert at a diagonal across the road so that the culvert outlet location remains the same, but the culvert inlet is at least 30 feet to the south (away from the residential structure). This will also help soften the hard bends in the system. • Reinforce stormwater conveyance around property near culvert to move water into ditch and avoid overland sheet flow and potential flooding.		



Brown AND Caldwell	City of Wilsonville Project No: 156157 **Wilsonville Stormwater Master Plan** Page 1 of 2	**Capital Project Summary** **WR-3 - Rose Lane Culvert Replacement**

WR-3	Rose Lane Culvert Replacement

Design Considerations / Assumptions

- Project was identified in the 2012 SMP (WD-2) with a proposed culvert sizing of 36-inches and roadway modifications. To avoid raising the roadway this project utilizes parallel 12-inch RCP culverts to convey flows under Rose Lane with the required amount of pipe cover.
- Minimum 12-inch cover on top of culvert.
- Surveying is required for this project as available topography displayed minor changes in elevation that may require additional grading of both the ditch and roadway.
- Maximum allowable depth for roadside ditches is 2-feet.
- Minimum separation distance between parallel storm sewers and other utilities is 5-feet measured from the edge of each pipe.
- Waterbody is a seasonal stream with open marsh/wetlands on upstream and downstream sides. This channel and the culvert were not surveyed or reflected in the H/H modeling associated with this SMP.
- Most future land use for the contributing area to this project location is designated as Parks and Open Space/Natural Area. However, some surrounding areas are anticipated to develop as Planned Development Residential (PDR1 and PDR2) that may influence stormwater runoff patterns to this project location in the future.

Estimated Project Cost

Capital Expense Total	$86,000
Design / Construction Admin. (Cap)	$35,000
Engineering & Permitting (Cap)	$75,000
Total Cost	**$200,000**

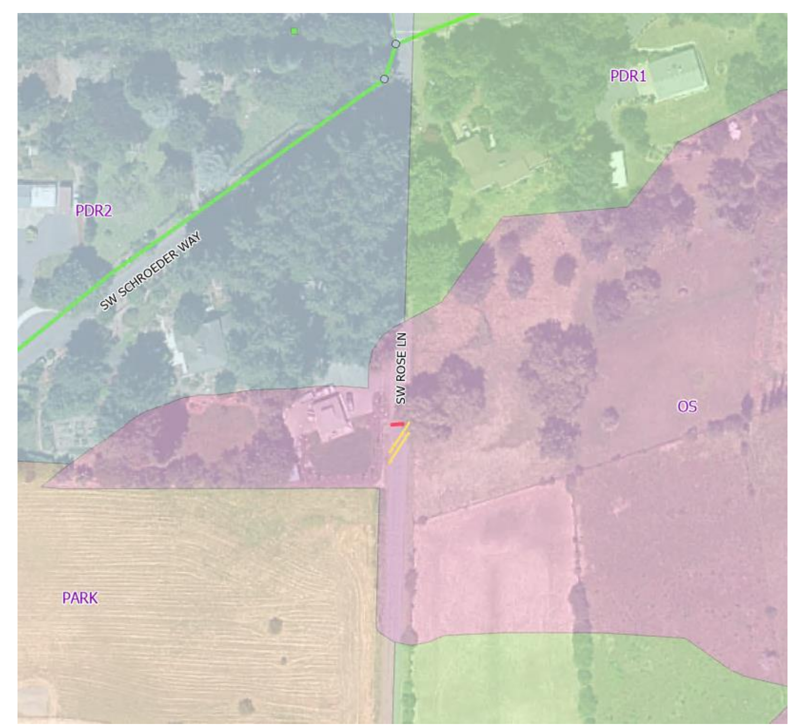
Project Cost Notes

- Modifications to the roadway beyond trenching were not developed as part of the cost estimate.
- Surveying is required.
- Clearing and grubbing 1,000 SF of vegetation on both sides of the road is included.
- A minimum cap on Design/ Construction Admin and Engineering & Permitting was applied at the direction of the City.

Additional Figures

Upstream ditch along west side of Rose Lane (May 2023)

Culvert inlet under Rose Lane (May 2023)



Future Land Use Zoning around project area

Downstream of culvert, east side of Rose Lane (May 2023)

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Wilsonville Stormwater Master Plan

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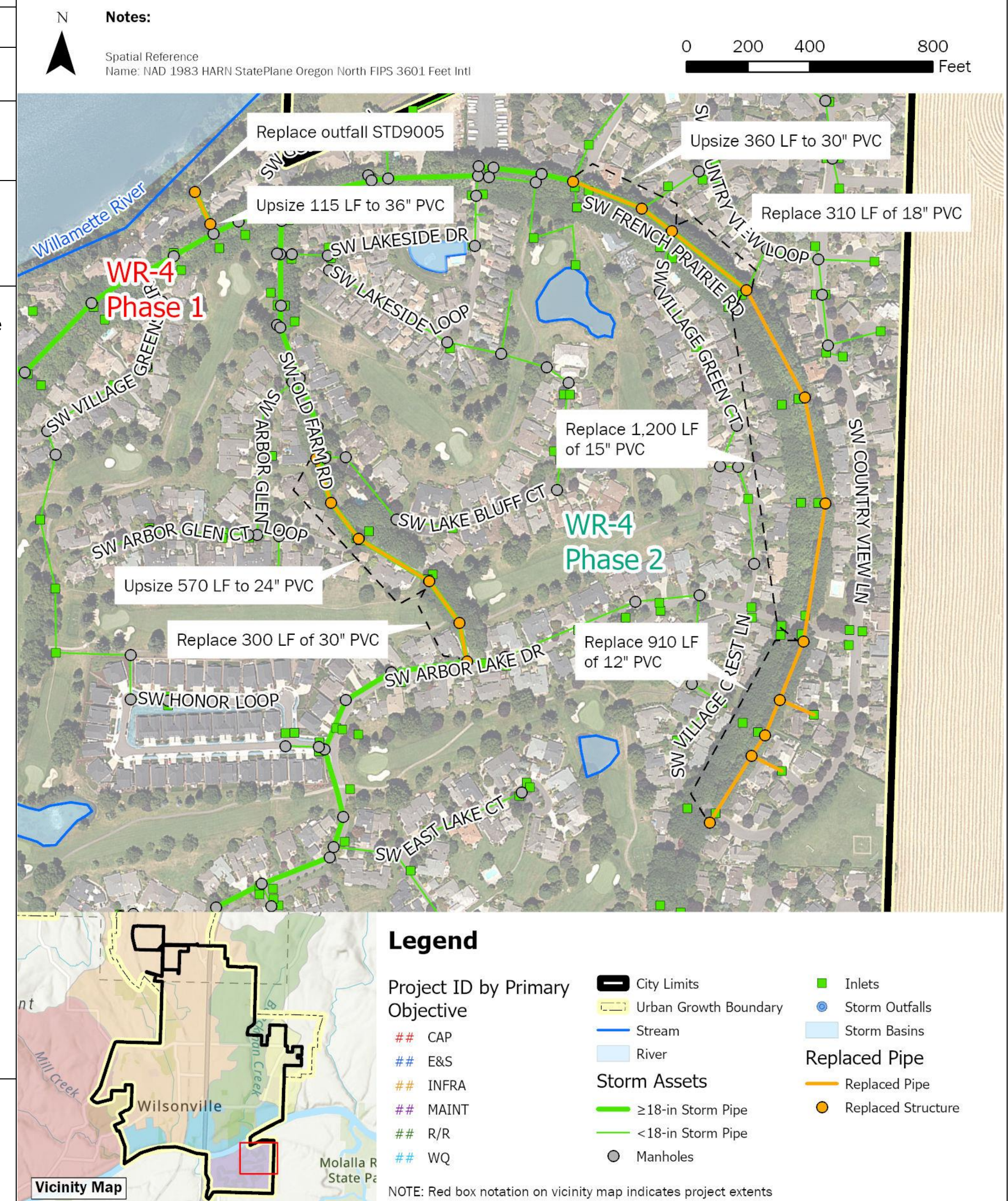
Capital Project Summary

WR-3 - Rose Lane Culvert Replacement

WR-4	Charbonneau East Stormwater Improvements		
Project Objective(s)	Capacity Repair and Replacement		
Project Opportunity ID	30	Contributing Drainage Area	159 acres
Estimated Existing Impervious Area (%)	43.1%	Estimated Future Impervious Area (%)	43.1%
Project Location	This project is located in the Charbonneau residential area near the Willamette River. The area is bounded to the west by Village Green Circle, the Willamette River to the north, SW Country View Lane to the east, and the SW Lake Drive to the south.		
Statement of Need	Charbonneau East reflects replacement and select upsizing of stormwater pipe and associated structures along SW French Prairie Rd and SW Old Farm Road. System upsizing and replacement was reflected in the 2012 SMP as well as the Charbonneau Consolidated Improvement Plan (2014).		
Project Description	This project mitigates modeled flooding along SW French Prairie Rd and/or SW Old Farm Rd by increasing the diameter of the outfall pipe discharging to the Willamette River (Phase 1). Select pipe upsizing (per modeled capacity limitations) and replacement (due to reported system condition issues) along SW French Prairie Rd and SW Old Farm Rd are reflected as Phase 2 of the project, subject to flow monitoring results. Due to project complexity and size, this project is costed as two phases and numbered based on recommended sequencing. Project details by phase are as follows: Phase 1 (Charbonneau East Outfall): • Replace existing Charbonneau East Outfall (STD9005). • Replace one 72-inch manhole (ST9014). • Upsize 115 LF of 30-inch pipe to 36-inch diameter PVC discharging to Willamette River (STD9005 to ST9014). Phase 2 (Storm Sewer Replacement): • Replace 230 LF of 10-inch pipe with 12-inch PVC on SW French Prairie Rd (ST9087 to end, and ST9088 to end). • Replace 680 LF of 12-inch pipe with 12-inch PVC on SW French Prairie Rd (ST9023 to ST9242). • Replace 1,200 LF of 15-inch pipe with 15-inch PVC on SW French Prairie Rd (ST9023 to ST9020). • Replace 310 LF of 18-inch pipe with 18-inch PVC on SW French Prairie Rd (ST9020 to ST9019). • Upsize 360 LF of 21-inch pipe to 30-inch PVC on SW French Prairie Rd (ST9019 to ST9017). • Replace 570 LF of 24-inch pipe with 24-inch PVC on Old Farm Rd (ST9030 to ST9027). • Replace 300 LF of 30-inch pipe with 30-inch PVC on Old Farm Rd (ST9031 to ST9030). • Replace eight 48-inch manholes (ST9020 to ST9242). • Replace nine 60inch manholes (ST9017 to ST9019, and ST9027 to ST9031).		



Brown AND Caldwell

City of Wilsonville
Project No: 156157

Wilsonville Stormwater Master Plan

Capital Project Summary

WR-4 – Charbonneau East Stormwater Improvements

WR-4 | Charbonneau East Stormwater Improvements

Design Considerations / Assumptions

- This project mitigates projected flooding along SW French Prairie Rd and/or SW Old Farm Rd by increasing the diameter of the outfall pipe discharging to the Willamette River (Phase 1). Due to space limitations, above ground detention cannot be used to provide flow control. Additional configurations, including various inline detention along SW French Prairie Rd and/or SW Old Farm Rd, were explored as part of CIP development. Flow monitoring and model calibration in this area are recommended to confirm simulated flooding results and pipe upsizing needs.
- Portions of the stormwater conveyance along Old Farm Road and SW Prairie Road have been replaced in conjunction with the Charbonneau Consolidated Improvement Plan. These pipe segments include ST003 to ST9017 along SW French Prairie Road and ST9369 to ST9027 along Old Farm Road.
- Pipes indicated as upsizing needs (Phase 2) do not include replacement of recently replaced piping per modeled capacity needs. Pipes indicated as replacement are identified due to condition.
- Design and construction of CIP SD9030-9037 (Edgewater Drive E and French Prairie Road) per the 2012 SMP is in progress and not reflected in this project.
- Phase 2 sizing and overall need may be influenced by system conditions following implementation of Phase 1 of each project. Ongoing monitoring of site conditions should be considered prior to initiating work on Phase 2.

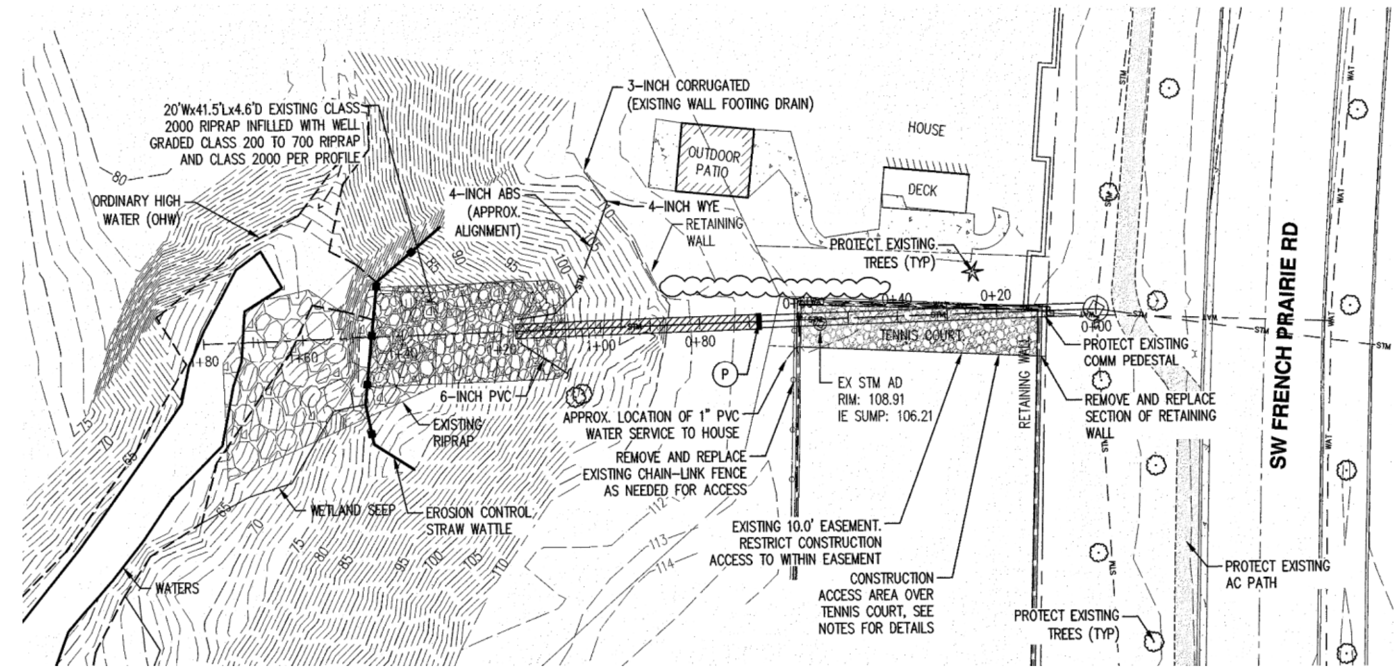
Estimated Project Cost

	Phase 1	*Phase 2*
Capital Expense Total	$201,000	$3,325,000
Design / Construction Admin. Phase 1: 25% Phase 2: 13.5%	$50,000	$449,000
Engineering & Permitting Phase 1: 50% Phase 2: 20%	$101,000	$665,000
Outreach Coordination (Flat Rate - Phase 1 only)	$250,000	N/A
Total Cost	**$600,000**	**$4,400,000**

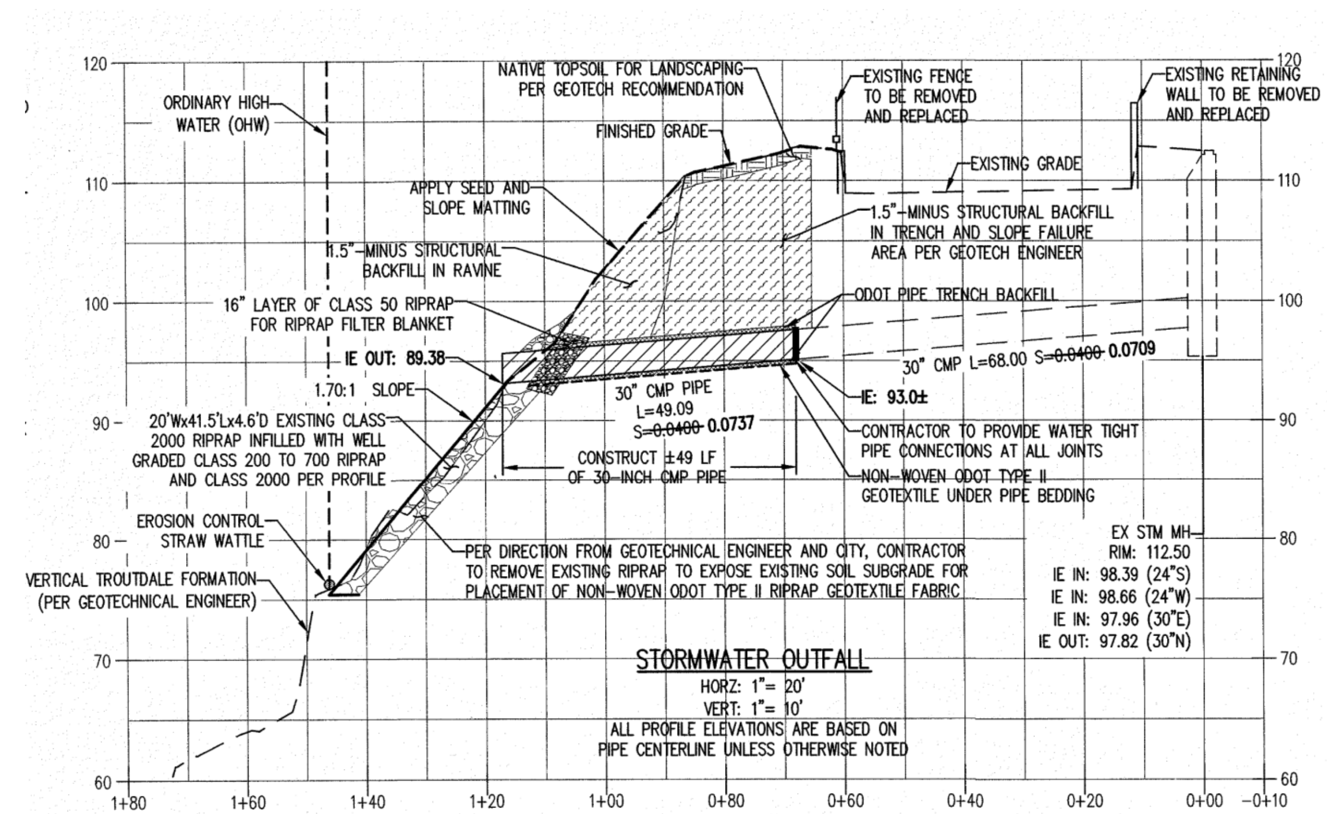
Project Cost Notes

- Due to in-water work and private property constraints, Phase 1 engineering and permitting multiplier was set to 50%. Design/Construction Administration multiplier was set to 25% per direction from the City.
- Cost estimates use PVC for all new and replacement pipe materials.
- Project contingency increased to 50% for Phase 1 due to private property constraints.

Additional Figures



Outfall to Willamette River Emergency Replacement As-builts (Plan View, 2019)

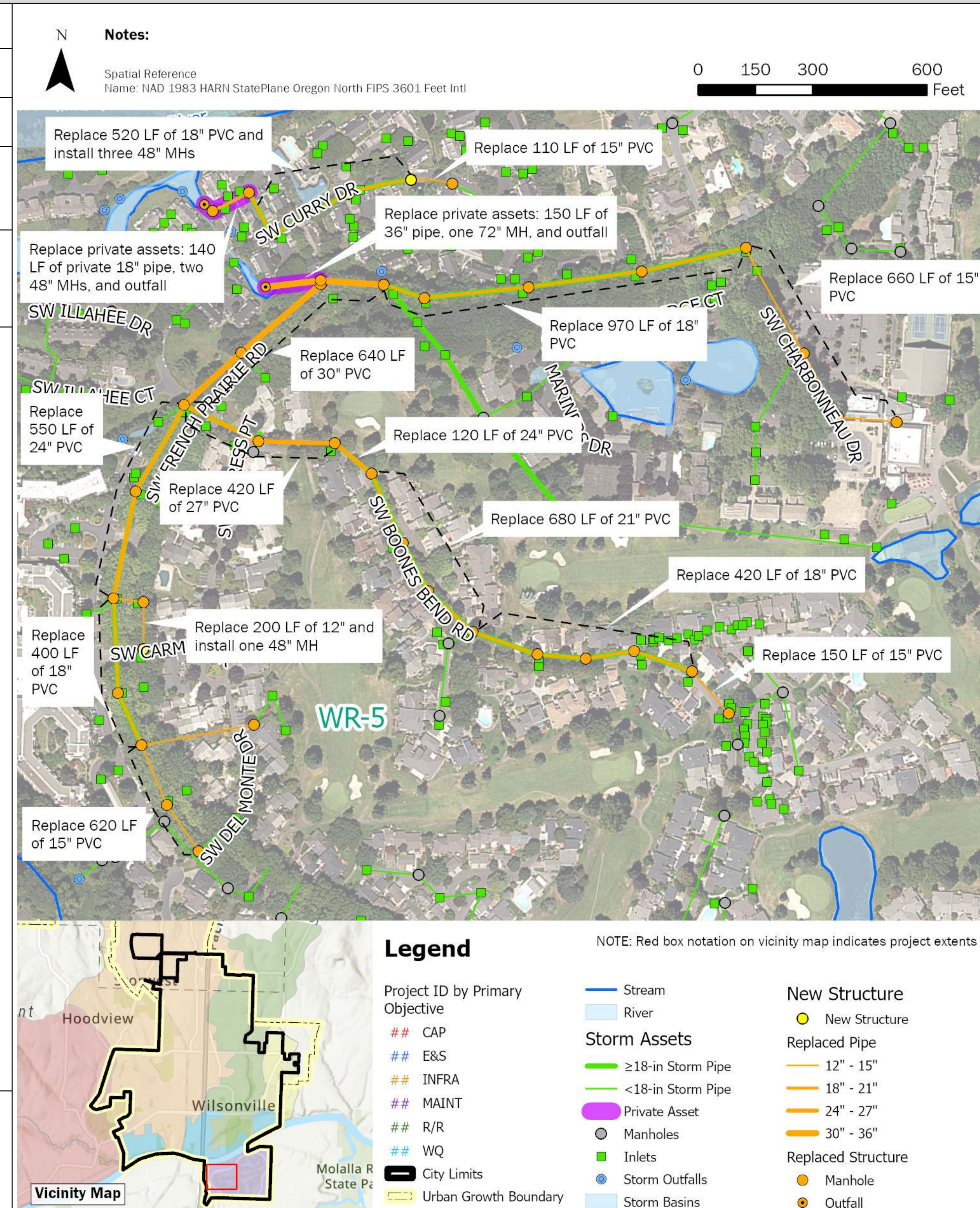


Outfall to Willamette River Emergency Replacement As-builts (Profile View, 2019)

Capital Project Summary

WR-4 – Charbonneau East Stormwater Improvements

WR-5	Charbonneau West Stormwater Improvements		
Project Objective(s)	Repair and Replacement, Maintenance		
Project Opportunity ID	28	**Contributing Drainage Area (acres)**	54 acres
Estimated Existing Impervious Area (%)	46.5%	**Estimated Future Impervious Area (%)**	46.5%
Project Location	This project is located in the Charbonneau residential area near the Willamette River. The area is bounded to the west by Interstate 5, the Willamette River to the north, Charbonneau Golf Club to the east, and NE Miley Road to the south.		
Statement of Need	Charbonneau West reflects replacement of stormwater pipe and associated structures along SW French Prairie Rd. SW Curry Dr., and SW Boones Bend Rd. System replacement needs were reflected in the 2012 SMP as well as the Charbonneau Consolidated Improvement Plan (2014).		
Project Description	This project replaces select public and private stormwater infrastructure throughout the Charbonneau West area, as identified in the Charbonneau Consolidated Improvement Plan. Private system improvements are specifically referenced on the figures and project details as identified per the City's GIS mapping. Project details are as follows (ENG IDs provided in parentheses when applicable, CARTE ID provided when ENG ID is not available): • Pipe replacement along SW Curry Drive: ○ Replace 110 LF of 15-in pipe with PVC (PST9012 to new manhole). ○ Replace 520 LF of 18-in pipe with PVC (new manhole to private manhole CARTE ID: 1892). ○ Replace 140 LF of 18-in private pipe with PVC (private manhole CARTE ID: 1892 to private outfall CARTE ID: 15). ○ Replace private outfall (CARTE ID: 15). ○ Replace two private 48-in manholes (CARTE ID 1892 and 1383). ○ Install three 48-inch manholes. • Pipe replacement along SW French Prairie Road: ○ Replace 200 LF of 12-in pipe with PVC (ST9331 to ST9044) ○ Replace 1,280 LF of 15-in pipe with PVC (ST9048 to ST9046; ST9269 to ST9046; and ST9281 to ST9043). ○ Replace 1,370 LF of 18-in pipe with PVC (ST9046 to ST9044 and ST9043 to CARTE ID: 1859 – ENG ID unknown) ○ Replace 550 LF of 24-in pipe with PVC (ST9044 to ST9040). ○ Replace 640 LF of 30-in pipe with PVC (ST9040 to ST9067, ST9041 to ST9067, and unknown to ST9041). ○ Replace 20 LF of 36-in pipe with PVC (unknown to ST9067). ○ Replace 150 LF of private 36-in PVC pipe (ST9041 to private outfall – ID unknown). ○ Replace private outfall; install one 48-in manholes and replace 14 48-in manholes; replace four 60-in manholes; and replace two 72-in manholes. *Continued on page 2.*		



WR-5	Charbonneau West Stormwater Improvements

Project Description (*continued*)

- Pipe replacement along SW Boone's Bend Road:
  - Replace 150 LF of 15-in pipe with PVC (ST9059 to ST9058).
  - Replace 420 LF of 18-in pipe with PVC (ST9058 to ST9055).
  - Replace 680 LF of 21-in pipe with PVC (ST9055 to ST9051).
  - Replace 120 LF of 24-in pipe with PVC (ST9051 to ST9050).
  - Replace 420 LF of 27-in pipe with PVC (ST9050 to ST9040).
  - Replace eight 48-in manholes; and replace three 60-in manholes.

Design Considerations / Assumptions

- This project is summarized in conjunction with the Charbonneau Consolidated Improvement Plan 2014. Pipe segments greater than 12 inches in diameter and identified as Priority 1 or 2 in the Charbonneau Consolidated Improvement Plan were incorporated.
- Pipes with unknown diameters were assumed to have the same diameter as the adjoined downstream pipe.
- Manholes with unknown diameters were sized based on incoming and outgoing pipe diameters.
- The following manholes (ENG IDs) are anticipated to be replaced in conjunction with pipe replacement:
  - Twenty-five 48-in: ST9281 to ST9066, unknown (CARTE ID 1859), ST9059 to ST9052, ST9278 to ST9045, ST9269, ST9165, PST9012, two private manholes (CARTE ID 1383 and 1892).
  - Seven 60-in: ST9051, ST9050, ST9049, ST9044, ST9042, ST9040, and ST9041.
  - Two 72-in: ST9067 and ST9041

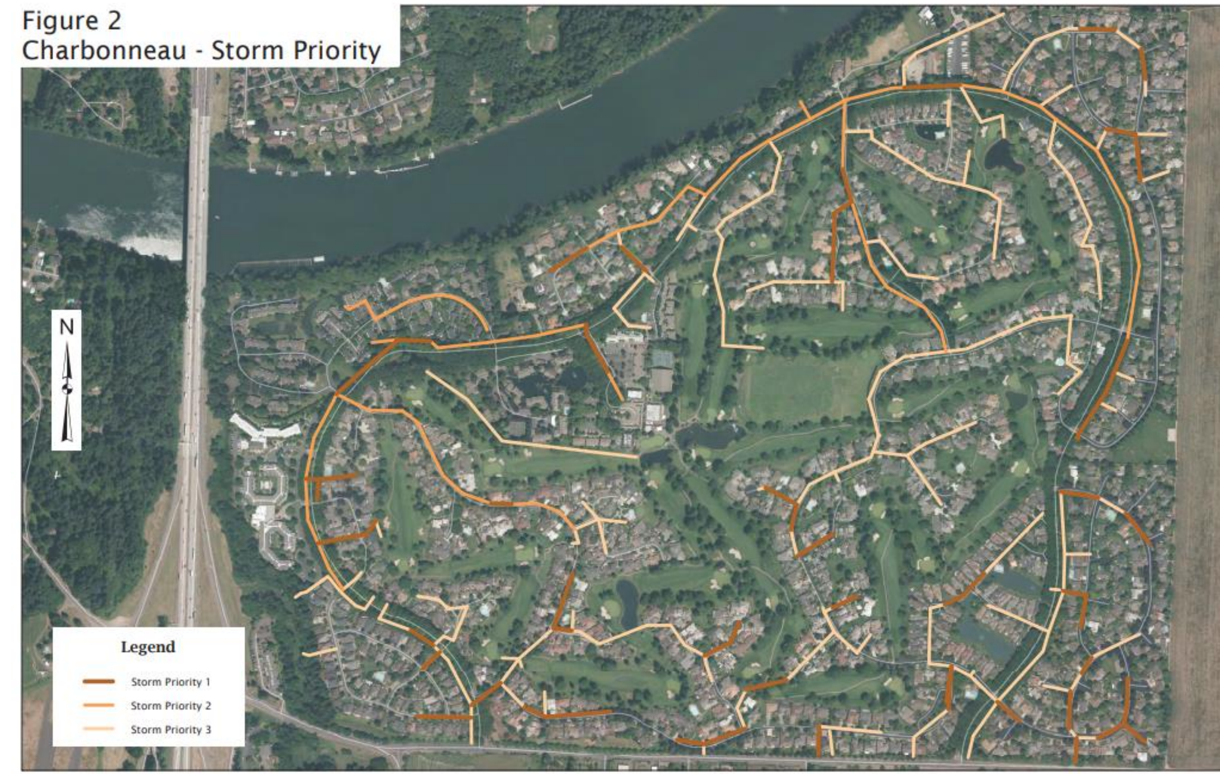
Estimated Project Cost

Capital Expense Total	$8,235,000
Design / Construction Admin. (3.5% + $200K)	$488,000
Engineering & Permitting (20%)	$1,647,000
Total Cost	**$10,370,000**

Project Cost Notes

- A modified Design/Construction Administration multiplier was applied per direction from the City.
- All assumed as PVC replacement.
- Private pipe and outfall replacement are included in cost estimate to maintain consistency with the Charbonneau Consolidated Improvement Plan 2014.
- Connections to existing public stormwater mains greater than 12-inches in diameter are included in the cost estimate.
- Connections to laterals not included in cost estimate.

Additional Figures



Stormwater replacement prioritization from Charbonneau Consolidated Improvement Plan (2014)

Capital Project Summary

WR-5 Charbonneau West Stormwater Improvements

Appendix E: Capital Project Cost Estimates

Unit Cost Table			
Item	Unit	Proposed Unit Cost Mar 2023	Notes, Unit Cost Mar 2023
Earthwork			
General Earthwork/Excavation	CY	78	City of Wilsonville, provided by Zach Weigel December 2023
Excavation, to onsite stockpile	CY	20	For site grading (not structural). Source: BC Assembly using RSMeans pricing.
Fill, imported clean	CY	115	For site grading (not structural), includes compaction. Source: BC Assembly using RSMeans pricing.
Fill, from onsite stockpile	CY	60	For site grading (not structural), includes compaction. Source: BC Assembly using RSMeans pricing.
Embankment	CY	35	City of Wilsonville, provided by Zach Weigel December 2023
Structural Earth Wall	SF	50	City of Wilsonville, provided by Zach Weigel December 2023
Clear and Grub brush including stumps	AC	22,000	Source: ODOT 2022Q4, Item 0320-010000R, avg award + 10%. This item INCLUDES stump removal
Clearing and Grubbing	AC		ODOT does not have a bid item without stump removal.
Amended Soils and Mulch	CY	165	Source: ODOT 2022Q3, Item 1040-0194000K (Compost mulch), avg award + 10%
Jute Matting, Biodegradeable	SY	8	Source: ODOT 2022Avg, Item 0280-0105010,20,30,40 avg, avg award + 10%
Tree removal	EA	1,200	City of Wilsonville, provided by Zach Weigel December 2023
Geotextile	SY	7	Source: ODOT 2022Q4, Item 0350-010000J (drainage geotex Type 1), avg award + 10%
Energy dissapation pad - Rip-Rap, Class 50	CY	161	Source: ODOT 2022Avg, Item 0390-010500K, avg award + 10% - **ANDREW SAID NOT TO USE THIS ONE**
Energy dissapation pad - Rip-Rap, Class 100	CY	124	Source: ODOT 2022Avg, Item 0390-010800K, avg award + 10%
Energy dissapation pad - Rip-Rap, Class 200	CY	81	Source: ODOT 2022Avg, Item 0390-011000K, avg award + 10%
Dewatering (pipeline construction)	DAY	550	Recommend $550/day minimum for pipeline construction
Dewatering (other)	LS	5,000 - 50,000	Select as needed based on project needs (T. Suesser April 2023)
Drain Rock	CY	110	City of Wilsonville, provided by Zach Weigel December 2023
Streambed Cobble	TON	120	City of Wilsonville, provided by Zach Weigel December 2023
Water Quality Facility Installation			
Outflow Control Structure	EA	20,000	City of Wilsonville, provided by Zach Weigel December 2023
Swale Flow Spreader	EA	20,000	Unique facility (ditch inlet + outflow control) - City spec S-2225
Facility Inlet Structure	EA	10,000	Same as Outflow Control Structure
Water Quality Facility Plantings with Trees	SF	40	City of Wilsonville, provided by Zach Weigel January 2024
Rain Garden/ Swale	SF	130	City of Wilsonville, provided by Zach Weigel December 2023
Stormwater Planter	SF	180	City of Wilsonville, provided by Zach Weigel December 2023
Gravel Access Road	SF	5	2023RSMeans, for 9" thick gravel with geotextile
Beehive Overflow	EA	6,100	City of Wilsonville, provided by Zach Weigel December 2023
Structure Installation			
Field Ditch Inlet	EA	5,600	City of Wilsonville, provided by Zach Weigel December 2023
Precast Concrete Manhole (48", 0-8' deep)	EA	12,000	City of Wilsonville, provided by Zach Weigel December 2023
Precast Concrete Manhole (48", 9-12' deep)	EA	15,000	City of Wilsonville, provided by Zach Weigel December 2023
Precast Concrete Manhole (48", 13-20' deep)	EA	18,000	City of Wilsonville, provided by Zach Weigel December 2023
Precast Concrete Manhole (60", 0-8' deep)	EA	14,000	City of Wilsonville, provided by Zach Weigel December 2023
Precast Concrete Manhole (60", 9-12' deep)	EA	18,000	City of Wilsonville, provided by Zach Weigel December 2023
Precast Concrete Manhole (60", 13-20' deep)	EA	22,000	City of Wilsonville, provided by Zach Weigel December 2023
Precast Concrete Manhole (72", 0-8' deep)	EA	18,000	City of Wilsonville, provided by Zach Weigel December 2023
Precast Concrete Manhole (72", 9-12' deep)	EA	23,000	City of Wilsonville, provided by Zach Weigel December 2023
8'x8'x10' Concrete Vault	EA		
Precast Concrete Manhole (72", >12' deep)	EA	28,000	City of Wilsonville, provided by Zach Weigel December 2023
Flow Splitter/WQ Manhole (72", all depths)	EA	28,000	City of Wilsonville, provided by Zach Weigel December 2023
Contech CDS (Model CDS3025, 72")	EA		
StormFilter (2-cartridge catch basin unit, 18" cartridges)	EA		
Drywell (48", 20-25' deep)	EA	14,100	Source: BC Assembly using RSMeans pricing
Curb Inlet	EA	8,300	Source: ODOT 2022Q4, Item 0470-0304000E (Concrete inlet, Type CG-1), avg award + 10%
ADA Ramp	EA	10,000	City of Wilsonville, provided by Zach Weigel December 2023
Catch Basin, all types	EA	8,300	Same as Curb Inlet
Concrete Fill - UIC Decomissioning	EA		
Connection to Existing Lateral	EA	6,000	City of Wilsonville, provided by Zach Weigel December 2023
Connection to Existing Structure, standard	EA	10,000	City of Wilsonville, provided by Zach Weigel December 2023
Abandon Existing Pipe, no excavation (12")	FT		Use pipe plugs priced below or fill with grout item
Abandon Existing Pipe, no excavation (15"-18")	FT		Use pipe plugs priced below or fill with grout item
Abandon Existing Pipe, no excavation (21"-24")	FT		Use pipe plugs priced below or fill with grout item
Abandon Existing Pipe, no excavation (27"-36")	FT		Use pipe plugs priced below or fill with grout item
Abandon Existing Pipe, fill with grout	CF	8	Source: BC Assembly using previous bid pricing
Abandon Existing Structure	EA	3,400	Source: ODOT 2022Q4, Item 0490-0117000E (filling abandoned structures), avg award + 10%
Demo pipe	LF	30	Assumes 12" RCP pipe. Does not include excavation. Source: BC Assembly using RSMeans pricing
Remove existing pavement	SY	120	City of Wilsonville, provided by Zach Weigel January 2024
Remove structure	EA	1,700	Source: ODOT 2022Q4, Item 0310-0105000E (removal of manholes), avg award + 10%
Plug Existing Pipe, up to 18" dia, at manhole	EA	1,800	Source: BC Assembly using RSMeans pricing.
Plug Existing Pipe, up to 36" dia, at manhole	EA	2,300	Source: BC Assembly using RSMeans pricing.
Retrofit diversion structure	EA	50,000	Conservative estimate to retrofit diversion structure on seimens property. Options include raising invert elevation, plugging altogether, etc.
Check dams	EA	570	Aggregate Type 1 (Erosion Control) check dam. Source: ODOT 2022Q4, Item 0280-0106010E, avg award + 10%
Stem wall check dam	LF	600	Assume similar to retaining wall, 4' wide footing x 1' deep (buried 1' deep) with 4' tall wall x 12" th. Includes excavation/backfill. Source: BC Assembly using RSMeans pricing.
Headwall with wingwalls, larger than 48" pipe	EA	35,000	Assume approx 8' tall x 15' long. Includes excavation/backfill. Source: BC Assembly using RSMeans pricing.
Headwall with wingwalls, up to 48" pipe	EA	25,000	Assume approx 5' tall x 15' long. Includes excavation/backfill. Source: BC Assembly using RSMeans pricing.
Headwall with wingwalls, up to 48" pipe	EA		
Outfall Improvements	EA		
Restoration/Resurfacing			
Non-Water Quality Facility Landscaping	AC	27,000	City of Wilsonville, provided by Zach Weigel December 2023
Riparian/Wetland Planting (Non-irrigated)	AC	36,000	City of Wilsonville, provided by Zach Weigel December 2023
Riparian/Wetland Planting (w/temporary irrigation)	AC	60,000	City of Wilsonville, provided by Zach Weigel December 2023
Planting and Bioengineered Restoration	SY	60	City of Wilsonville, provided by Zach Weigel December 2023
4-foot Chain Link Fence	LF	60	City of Wilsonville, provided by Zach Weigel December 2023
Split Rail Fence	LF	60	City of Wilsonville, provided by Zach Weigel December 2023
Hydroseed, large quantities	AC	22,000	Source: ODOT 2022Avg, Item 1030-0110000R (Perm seeding, mix No. 2), avg award + 10%
Seeding, small quantities (< 5,000 sf)	SF	0.68	Source: ODOT 2022Q4, Item 1030-0138000J (lawn seeding), avg award + 10%
Sidewalk Installation	SF	17	Source: ODOT 2022Avg, Item 0759-0128000J (concrete walks), avg award + 10%
Trench resurfacing, Permanent ACP, 6-Inch Depth	SY	144	Source: ODOT 2022Avg, Item 0495-0100000J, avg award + 10%

Unit Cost Table			
Item	Unit	Proposed Unit Cost Mar 2023	Notes, Unit Cost Mar 2023
Permeable Paver Installation	SF	46	Source: ODOT 2022Avg, Item 0760-010000J (Unit pavers), avg award + 10%
Porous Asphalt Paving	SF	5	Source: 2023RSMeans, Item 32-12-16.13, 0600 (1" porous friction course over 3" bit course) adjusted to include hauling
Concrete Curbs	FT	74	Source: ODOT 2022Avg, Item 0759-0103000F (conc curb & gutter), avg award + 10%
Retaining wall, block	SF	119	Source: ODOT 2022Avg, Item 0596-B002000A (Retaining wall, prefab modular gravity), avg award + 10%
Retaining wall, CIP concrete	SF	250	City of Wilsonville
Retaining wall, sheet pile	SF	190	Up to 20' high exposed face. Source: BC Assembly using RSMeans pricing.
Retaining wall, soldier pile	SF	210	Up to 20' high exposed face. Source: BC Assembly using RSMeans pricing.
Root wad	EA	61	Source: Oregon, OH bid tab 2019 escalated
Trash rack	EA	5,600	Same as Field Ditch Inlet. City of Wilsonville, provided by Zach Weigel December 2023
Pipe Unit Cost			
Underdrain Pipe, 4"	LF	55	City of Wilsonville
Underdrain, 6" perforated HDPE	LF	60	City of Wilsonville
HDPE, 12", 10' to invert, not in road	FT	171	See PipeCostBasis tab Notes, increase by 10% per City of Wilsonville
HDPE, 12", 15' to invert, not in road	FT	179	See PipeCostBasis tab Notes, increase by 10% per City of Wilsonville
HDPE, 12", 10' to invert, in road	FT	470	See PipeCostBasis tab Notes, increase by 10% per City of Wilsonville
HDPE, 12", 15' to invert, in road	FT	567	See PipeCostBasis tab Notes, increase by 10% per City of Wilsonville
HDPE, 24", 10' to invert, not in road	FT	298	See PipeCostBasis tab Notes, increase by 10% per City of Wilsonville
HDPE, 24", 15' to invert, not in road	FT	310	See PipeCostBasis tab Notes, increase by 10% per City of Wilsonville
HDPE, 24", 10' to invert, in road	FT	649	See PipeCostBasis tab Notes, increase by 10% per City of Wilsonville
HDPE, 24", 15' to invert, in road	FT	778	See PipeCostBasis tab Notes, increase by 10% per City of Wilsonville
PVC, 8", 10' to invert, not in road	FT	136	Interpolated
PVC, 12", 10' to invert, not in road	FT	206	See PipeCostBasis tab Notes, increase by 10% per City of Wilsonville
PVC, 18", 10' to invert, not in road	FT	293	Interpolated from equivalants at 12" and 24" diam, SG 6/20/23
PVC, 12", 15' to invert, not in road	FT	215	See PipeCostBasis tab Notes, increase by 10% per City of Wilsonville
PVC, 18", 15' to invert, not in road	FT	304	Interpolated from equivalants at 12" and 24" diam, SG 6/20/23
PVC, 12", 10' to invert, in road	FT	506	See PipeCostBasis tab Notes, increase by 10% per City of Wilsonville
PVC, 12", 15' to invert, in road	FT	602	See PipeCostBasis tab Notes, increase by 10% per City of Wilsonville
PVC, 15", 10' to invert, in road	FT	535	Interpolated from equivalants at 12" and 18" diam, MT 7/7/24
PVC, 15", 15' to invert, in road	FT	666	Interpolated from equivalants at 12" and 18" diam, SG 1/23/24
PVC, 15", 10' to invert, not in road	FT	249	Interpolated from equivalants at 12" and 18" diam, SG 1/23/24
PVC, 15", 15' to invert, not in road	FT	259	Interpolated from equivalants at 12" and 18" diam, SG 1/23/25
PVC, 18", 10' to invert, in road	FT	563	Interpolated from equivalants at 12" and 24" diam, MT 6/22/23
PVC, 18", 15' to invert, in road	FT	731	Interpolated from equivalants at 12" and 24" diam, MT 6/22/23
PVC, 24", 10' to invert, not in road	FT	381	See PipeCostBasis tab Notes, increase by 10% per City of Wilsonville
PVC, 24", 15' to invert, not in road	FT	393	See PipeCostBasis tab Notes, increase by 10% per City of Wilsonville
PVC, 21", 10' to invert, in road	FT	647	Interpolated from equivalants at 18" and 24" diam, MT 7/7/23
PVC, 21", 15' to invert, in road	FT	796	Interpolated from equivalants at 18" and 24" diam, SG 1/23/24
PVC, 21", 15' to invert, not in road	FT	348	Interpolated from equivalants at 18" and 24" diam, SG 1/23/25
PVC, 24", 10' to invert, in road	FT	732	See PipeCostBasis tab Notes, increase by 10% per City of Wilsonville
PVC, 24", 15' to invert, in road	FT	860	See PipeCostBasis tab Notes, increase by 10% per City of Wilsonville
PVC, 27", 10' to invert, in road	FT	805	Interpolated from equivalants at 24" and 30" diam, MT 7/7/23
PVC, 30", 10' to invert, not in road	FT	477	Interpolated from equivalants at 24" and 36" diam, MT 6/29/23
PVC, 30", 10' to invert, in road	FT	879	Interpolated from equivalants at 24" and 36" diam, MT 6/29/24
PVC, 36", 10' to invert, not in road	FT	573	See PipeCostBasis tab Notes, increase by 10% per City of Wilsonville
PVC, 36", 15' to invert, not in road	FT	591	See PipeCostBasis tab Notes, increase by 10% per City of Wilsonville
PVC, 36", 10' to invert, in road	FT	1,027	See PipeCostBasis tab Notes, increase by 10% per City of Wilsonville
PVC, 36", 15' to invert, in road	FT	1,220	See PipeCostBasis tab Notes, increase by 10% per City of Wilsonville
PVC, 42", 10' to invert, not in road	FT	703	Interpolated from equivalants at 36" and 48" diam, T. Suesser 6/14/23
PVC, 42", 10' to invert, in road	FT	1,169	Interpolated from equivalants at 36" and 48" diam, T. Suesser 6/14/23
PVC, 48", 10' to invert, not in road	FT	834	See PipeCostBasis tab Notes, increase by 10% per City of Wilsonville
PVC, 48", 15' to invert, not in road	FT	855	See PipeCostBasis tab Notes, increase by 10% per City of Wilsonville
PVC, 48", 10' to invert, in road	FT	1,310	See PipeCostBasis tab Notes, increase by 10% per City of Wilsonville
PVC, 48", 15' to invert, in road	FT	1,536	See PipeCostBasis tab Notes, increase by 10% per City of Wilsonville
RCP, 12", 10' to invert, not in road	FT	198	See PipeCostBasis tab Notes, increase by 10% per City of Wilsonville
RCP, 12", 15' to invert, not in road	FT	207	See PipeCostBasis tab Notes, increase by 10% per City of Wilsonville
RCP, 12", 10' to invert, in road	FT	498	See PipeCostBasis tab Notes, increase by 10% per City of Wilsonville
RCP, 12", 15' to invert, in road	FT	594	See PipeCostBasis tab Notes, increase by 10% per City of Wilsonville
RCP, 15", 15' to invert, in road	FT	326	Interpolated from equivalants at 12" and 24" diam, MT 6/30/23
RCP, 18", 15' to invert, in road	FT	391	Interpolated from equivalants at 12" and 24" diam, MT 6/30/23
RCP, 24", 10' to invert, not in road	FT	303	See PipeCostBasis tab Notes, increase by 10% per City of Wilsonville
RCP, 24", 15' to invert, not in road	FT	315	See PipeCostBasis tab Notes, increase by 10% per City of Wilsonville
RCP, 24", 10' to invert, in road	FT	653	See PipeCostBasis tab Notes, increase by 10% per City of Wilsonville
RCP, 24", 15' to invert, in road	FT	782	See PipeCostBasis tab Notes, increase by 10% per City of Wilsonville
RCP, 27", 15' to invert, in road	FT	766	Interpolated from equivalants at 24" and 36" diam, MT 7/06/23
RCP, 30", 10' to invert, in road	FT	866	Interpolated from equivalants at 24" and 36" diam, MT 6/30/23
RCP, 36", 10' to invert, not in road	FT	625	See PipeCostBasis tab Notes, increase by 10% per City of Wilsonville
RCP, 36", 15' to invert, not in road	FT	642	See PipeCostBasis tab Notes, increase by 10% per City of Wilsonville
RCP, 36", 10' to invert, in road	FT	1,079	See PipeCostBasis tab Notes, increase by 10% per City of Wilsonville
RCP, 36", 15' to invert, in road	FT	1,272	See PipeCostBasis tab Notes, increase by 10% per City of Wilsonville
RCP, 48", 10' to invert, not in road	FT	877	See PipeCostBasis tab Notes, increase by 10% per City of Wilsonville
RCP, 48", 15' to invert, not in road	FT	898	See PipeCostBasis tab Notes, increase by 10% per City of Wilsonville
RCP, 48", 10' to invert, in road	FT	1,353	See PipeCostBasis tab Notes, increase by 10% per City of Wilsonville
RCP, 48", 15' to invert, in road	FT	1,579	See PipeCostBasis tab Notes, increase by 10% per City of Wilsonville
RCP, 72", 10' to invert, not in road	FT	1,375	See PipeCostBasis tab Notes, increase by 10% per City of Wilsonville
RCP, 72", 15' to invert, not in road	FT	1,401	See PipeCostBasis tab Notes, increase by 10% per City of Wilsonville
RCP, 72", 10' to invert, in road	FT	1,861	See PipeCostBasis tab Notes, increase by 10% per City of Wilsonville
RCP, 72", 15' to invert, in road	FT	2,151	See PipeCostBasis tab Notes, increase by 10% per City of Wilsonville
Box Culvert (8' x 3')	FT	705	Source: 2023RSMeans, Item 33-42-11.60, 0200, excavation/backfill not included
Box Culvert (10' x 3')	FT	950	Source: 2023RSMeans, Item 33-42-11.60, 0300, excavation/backfill not included
Box Culvert (12' x 3')	FT	2070	Source: 2023RSMeans, Item 33-42-11.60, 0400, excavation/backfill not included
Contingencies and Multipliers			
Mobilization/Demobilization	LS	10%	
Erosion and Sediment Control	LS	3%	
Contingency	LS	40%	Updated per City of Wilsonville
Traffic Control/Utility Relocation	LS	5-10%	Dependent on work in ROW
Surveying	LS	5%	
Clackamas County Permitting	LS	8.83%	Applicable to Miley Road, added 6/22/23 per Kerry's instructions
Capital Expense Total (including contingency)			

Unit Cost Table			
Item	Unit	Proposed Unit Cost Mar 2023	Notes, Unit Cost Mar 2023
Design/Construction Administration (%)	LS	13.5%	Reflects City staff technical and administrative needs to execute the project. Per City of Wilsonville, assume minimum of $35,000.
Engineering and Permitting (%)	LS	20-30%	In-water dependent and capped on a case-by-case basis at $500,000 per City of Wilsonville. Per City of Wilsonville, minimum of $75,000.

BC-1: Library Pond

Key Project Elements
- Retrofit the existing Library Pond stormwater detention facility to meet current City PWS and accommodate future condition flows associated with the Town Center Development Plan, which anticipates full build out in the next 20+ years.
- Install a pond outlet structure in compliance of current design standards.
- Clear, regrade, and replant the 0.7-acre detention pond, including amending the pond bottom to include the 3 feet of required rocks and media.
- Install 15-ft wide, 25-ft long access road for maintenance access. Assume existing gate can be maintained.
- Remove and replace 70 LF of 18" CSP pipe at new design depth, approx. 15' deep.

Design Assumptions
- The existing pond footprint remains unchanged due to roadway and development constraints. Interior side slopes are assumed to be 3H:1V.
- Facility sizing is based on adherence to the City's Public Works Standards (PWS), Chapter 3 requiring flow matching to pre-development conditions (classified as Oak Savanna). Sizing utilizes the BMP Sizing Tool.
- To size the pond in accordance with PWS design standards, approximately 48 acres require onsite treatment and flow control prior to discharge into Library Pond detention facility.
- Total pond depth includes drain rock (15"), separation layer (3"), and growing media (18"), in accordance with the 2015 PWS Section 3, Appendix A landscape and soil media requirements.
- Inlet and outlet pipe sizes are anticipated to remain unchanged. The outlet structure (standard drawing ST-6110) assumes an additional field inlet for 100-year overflow event.

Item	Unit	Unit Cost (2023)	Quantity	Total Cost
Earthwork				
Excavation, to onsite stockpile	CY	20	2,350	$47,000
Fill, from onsite stockpile	CY	60	1,289	$77,340
Clear and Grub brush including stumps	AC	22,000	0.70	$15,400
Amended Soils and Mulch	CY	165	389	$64,167
Drain Rock	CY	110	324	$35,648
Water Quality Facility Installation				
Outflow Control Structure	EA	20,000	1	$20,000
Gravel Access Road	SF	5	375	$1,875
Water Quality Facility Plantings with Trees	SF	40	13,550	$542,000
Structure Installation				
Field Ditch Inlet	EA	5,600	1	$5,600
Demo pipe	LF	30	70	$2,100
Remove existing pavement	SY	120	210	$25,200
Remove structure	EA	1,700	1	$1,700
Pipe Unit Cost				
Underdrain, 6" perforated HDPE	LF	60	70	$4,200
PVC, 18", 15' to invert, not in road	FT	304	70	$21,252
Project Sub-Total				$863,000
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$86,300
Erosion and Sediment Control	LS	3%		$25,890
Contingency	LS	40%		$345,200
Traffic Control/Utility Relocation	LS	5%		$43,150
Surveying	LS	5%		$43,150
Capital Expense Total (including contingency)				$1,407,000
Design/Construction Administration (%)	LS	13.5%		$190,000
Engineering and Permitting (%)	LS	20%		$281,000
			TOTAL	$1,880,000

BC-2: Ash Meadows Flow Mitigation

Key Project Elements
- Plug flow diversion structure at Siemens Pond B.
- Upsize culvert under Boeckman Road from 30" to 48" PVC.
- Upsize culvert under SW Parkway Ave. from 36" to 48" PVC.
- Construct flow control structure at upstream end of culverts under Ash Meadows Road.
- Regrade and restore drainage way between Ash Meadows Road and Parkway Avenue.

Design Assumptions
- Excavate 18" depth for amended soils for entire 55,000 sq ft footprint area, per City Standards.
- Final design will include confirmation of flow control structure sizing.
- Cost estimates were developed directly with the City, without input or review by the TSJV, the Design-Builder.

Item	Unit	Unit Cost (2023)	Quantity	Total Cost
Earthwork				
General Earthwork/Excavation	CY	78	3,056	$238,368
Clear and Grub brush including stumps	AC	22,000	1.3	$28,600
Amended Soils and Mulch	CY	165	1,019	$168,135
Tree removal	EA	1,200	30	$36,000
Energy dissapation pad - Rip-Rap, Class 200	CY	81	40	$3,240
Dewatering (other)	LS	50,000	1	$50,000
Water Quality Facility Installation				
Outflow Control Structure	EA	20,000	1	$20,000
Structure Installation				
Demo pipe	LF	30	175	$5,250
Retrofit diversion structure	EA	50,000	1	$50,000
Restoration/Resurfacing				
Riparian/Wetland Planting (w/temporary irrigation)	AC	60,000	1.3	$78,000
Trash rack	EA	5,600	3	$16,800
Pipe Unit Cost				
PVC, 48", 10' to invert, in road	FT	1,310	175	$229,268
Project Sub-Total				$924,000
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$92,400
Erosion and Sediment Control	LS	3%		$27,720
Contingency	LS	40%		$369,600
Traffic Control/Utility Relocation	LS	15%		$138,600
Surveying	LS	20%		$184,800
Capital Expense Total (including contingency)				$1,737,000
Design/Construction Administration (%)	LS	13.5%		$234,000
Engineering and Permitting (%)	LS	50%		$869,000
Geotechnical	LS	Flat Rate		$100,000
			TOTAL	$2,940,000

BC-3: Wiedemann Ditch and Canyon Creek Park Retrofit, Phase 1				

Key Project Elements
- Construct a detention pond at Canyon Creek Park that would receive drainage from the wetland complexes described under Phase 2.

Design Assumptions
- Canyon Creek (phase 1) work includes only the installation of a vegetated facility at Canyon Creek Park and necessary conveyance.
- Excavate 18" depth for amended soils for entire vegetated facility footprint area, per City Standards.
- Final design will include confirmation of vegetated facility plantings and structure sizing.
- Cost estimates were developed directly with the City, without input or review by the TSJV, the Design-Builder.

Item	Unit	Unit Cost (2023)	Quantity	Total Cost
Earthwork				
General Earthwork/Excavation	CY	78	13,900	$1,084,200
Clear and Grub brush including stumps	AC	22,000	1.6	$34,470
Amended Soils and Mulch	CY	165	3,792	$625,625
Energy dissapation pad - Rip-Rap, Class 200	CY	81	20	$1,620
Water Quality Facility Installation				
Outflow Control Structure	EA	20,000	1	$20,000
Structure Installation				
Precast Concrete Manhole (60", 0-8' deep)	EA	14,000	1	$14,000
Restoration/Resurfacing				
Riparian/Wetland Planting (w/temporary irrigation)	AC	60,000	1.6	$94,008
4-foot Chain Link Fence	LF	60	1,130	$67,800
Pipe Unit Cost				
PVC, 36", 10' to invert, not in road	FT	573	350	$200,585
Project Sub-Total				$2,142,000
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$214,200
Erosion and Sediment Control	LS	3%		$64,260
Contingency	LS	40%		$856,800
Traffic Control/Utility Relocation	LS	5%		$107,100
Surveying	LS	5%		$107,100
Capital Expense Total (including contingency)				$3,491,000
Design/Construction Administration (%)	LS	3.5% + $200K		$322,000
Engineering and Permitting (%)	LS	30%		$1,047,000
			TOTAL	$4,860,000

BC-3: Wiedemann Ditch and Canyon Creek Park Retrofit, Phase 2				

Key Project Elements

- Construct a series of linear wetland complexes to replace the existing Wiedemann ditch. Existing ditch would be enhanced to provide additional floodplain storage and mitigate flows received from Sysco ditch.

Design Assumptions

- Excavate 18" depth for amended soils for entire vegetated facility footprint area, per City Standards.
- Final design will include confirmation of weir sizing and layout.
- Final design will include confirmation of vegetated facility plantings and structure sizing.
- Cost estimates were developed directly with the City, without input or review by the TSJV, the Design-Builder.

Item	Unit	Unit Cost (2023)	Quantity	Total Cost
Earthwork				
General Earthwork/Excavation	CY	78	25,600	$1,996,800
Clear and Grub brush including stumps	AC	22,000	3.6	$79,924
Amended Soils and Mulch	CY	165	3,792	$625,625
Energy dissapation pad - Rip-Rap, Class 200	CY	81	20	$1,620
Water Quality Facility Installation				
Facility Inlet Structure	EA	10,000	1	$10,000
Structure Installation				
Gravel Access Road	SF	5	18,000	$90,000
Restoration/Resurfacing				
Riparian/Wetland Planting (w/temporary irrigation)	AC	60,000	3.6	$217,975
Pipe Unit Cost				
PVC, 36", 10' to invert, not in road	FT	573	350	$200,585
Project Sub-Total				$3,223,000
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$322,300
Erosion and Sediment Control	LS	3%		$96,690
Contingency	LS	40%		$1,289,200
Traffic Control/Utility Relocation	LS	5%		$161,150
Surveying	LS	5%		$161,150
Capital Expense Total (including contingency)				$5,253,000
Design/Construction Administration (%)	LS	3.5% + $200K		$384,000
Engineering and Permitting (%)	LS	30%		$1,576,000
			TOTAL	$7,210,000

BC-4: Boeckman Creek Stabilization at Colvin Lane

Key Project Elements

- Remove existing outfall pipe.
- Install approx. 70 LF of new outfall pipe with angle closer to parallel with creek channel.
- Install bioengineered plantings to stabilize streambank.
- Remove corrugated plastic pipe in existing channel bottom.

Design Assumptions

- Assumes that access to the outfall stabilization area can be attained via the City easement between 7590 and 7598 Roanoke Drive N. No cost included for access.
- Exact stabilization measures to be determined during project design.
- Assumes clearing/grubbing including stumps can include removal of existing corrugated pipe.

Item	Unit	Unit Cost (2023)	Quantity	Total Cost
Earthwork				
General Earthwork/Excavation	CY	78	194	$15,132
Clear and Grub brush including stumps	AC	22,000	0.20	$4,400
Jute Matting, Biodegradeable	SY	8	90	$720
Embankment	CY	35	50	$1,750
Amended Soils and Mulch	CY	165	83	$13,695
Tree removal	EA	1,200	5	$6,000
Energy dissapation pad - Rip-Rap, Class 100	CY	124	10	$1,240
Drain Rock	CY	110	56	$6,160
Water Quality Facility Installation				
Water Quality Facility Plantings with Trees	SF	40	1,500	$60,000
Structure Installation				
Demo pipe	LF	30	30	$900
Restoration/Resurfacing				
Planting and Bioengineered Restoration	SY	60	360	$21,600
Pipe Unit Cost				
HDPE, 12", 15' to invert, not in road	FT	179	150	$26,895
PVC, 12", 10' to invert, not in road	FT	206	70	$14,399
Project Sub-Total				$173,000
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$17,300
Erosion and Sediment Control	LS	3%		$5,190
Contingency	LS	40%		$69,200
Traffic Control/Utility Relocation	LS	5%		$8,650
Surveying	LS	5%		$8,650
Capital Expense Total (including contingency)				$282,000
Design/Construction Administration (%)	LS	13.5%		$38,000
Engineering and Permitting (%)	LS	30%		$85,000
			TOTAL	$410,000

BC-5 Memorial Park Swale Retrofit

Key Project Elements

- Remove the existing WQ swale and relocate it at the bottom of the hill.
- Only designing for the WQ storm event (treatment only in the BMP Sizing Tool).
- Swale design is based on a retrofit approach. Facility sizing per PWS is not possible within available space. Design of swale with variance from design criteria (top width maximum) may allow for optimization of available space.
- Ideally keep swale outside of the 100-yr floodplain, but not a permit issue if within since it is not infiltration based.

Design Assumptions

- Remove 90 LF of 10-inch corrugated steel pipe (SD5041 and SD5042).
- Remove 120 LF of 12-inch corrugated steel pipe (SD5044).
- Remove: manhole (ST5098); inlet structure (CARTE ID 568); and outfall structure (CARTE ID 19).
- Fill existing swale and revegetate area.
- Replace 60 LF of 12" CSP with 18" PVC (SD5046); replace 2 48" MHs (ST5200 and ST5208).
- Replace 50 LF of 18-inch CSP with 18-inch PVC pipe (SD5206).
- Replace manhole ST5209 with a 72-inch flow splitting/WQ manhole.
- Install 50 LF of 12-inch PVC.
- Install 140 LF of 6-inch perforated HDPE underdrain pipe.
- Install inflow spreader with rip-rap pad, beehive overflow structure, and outfall to the creek.
- Install a new meandering water quality swale with 1 ft of drain rock and 1.5 ft of amended soil.
- Install split rail fence along pedestrian path north of the swale.

Item	Unit	Unit Cost (2023)	Quantity	Total Cost
Earthwork				
Excavation, to onsite stockpile	CY	20	55	$1,100
Fill, from onsite stockpile	CY	60	55	$3,300
General Earthwork/Excavation	CY	78	265	$20,670
Energy dissapation pad - Rip-Rap, Class 200	CY	81	2.2	$178
Drain Rock	CY	110	90	$9,900
Amended Soils and Mulch	CY	165	135	$22,275
Water Quality Facility Installation				
Beehive Overflow	EA	6,100	1	$6,100
Swale Flow Spreader	EA	20,000	1	$20,000
Facility Inlet Structure	EA	10,000	1	$10,000
Water Quality Facility Plantings with Trees	SF	40	2,400	$96,000
Structure Installation				
Demo pipe	LF	30	210	$6,300
Remove structure	EA	1,700	3	$5,100
Connection to Existing Structure, standard	EA	10,000	2	$20,000
Flow Splitter/WQ Manhole (72", all depths)	EA	28,000	1	$28,000
Outfall Improvements	EA	10,000	1	$10,000
Precast Concrete Manhole (48", 0-8' deep)	EA	12,000	2	$24,000
Restoration/Resurfacing				
Non-Water Quality Facility Landscaping	AC	27,000	0.5	$13,500
Split Rail Fence	LF	60	160	$9,600
Pipe Unit Cost				
Underdrain, 6" perforated HDPE	LF	60	140	$8,400
PVC, 12", 10' to invert, not in road	FT	206	50	$10,285
PVC, 12", 10' to invert, in road	FT	506	60	$30,360
PVC, 18", 10' to invert, not in road	FT	293	110	$32,247
Project Sub-Total				$387,000
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$38,700
Erosion and Sediment Control	LS	3%		$11,610
Contingency	LS	40%		$154,800
Traffic Control/Utility Relocation	LS	5%		$19,350
Surveying	LS	5%		$19,350
Capital Expense Total (including contingency)				$631,000
Design/Construction Administration (%)	LS	13.5%		$85,000
Engineering and Permitting (%)	LS	30%		$189,000
			TOTAL	$910,000

BC-6 - Gesellschaft Water Well Channel Restoration

Key Project Elements
- Existing outfall (STD3008) and upstream stormwater pipes can remain unchanged for the contributing 25 acres.
- Bypass the channel entirely by piping the weekly discharge from the well to the bottom of the slope into Boeckman Creek.
- Pipe is sized using PWS, smallest diameter (12-inch) to convey the flows.
- Weekly discharge of well volume is unknown, ODWR well logs were reviewed to verify that pipe size works with likely flows.
- Water discharge conveyance designed to comply with stormwater conveyance standards.

Design Assumptions
- Install approx. 480 LF of 12-inch PVC.
- Install 2 MHs along the new pipe alignment.
- Intall outfall and energy dissipation pad with Class 200 riprap.
- Restore the eroded discharge channel (approx. 310 LF) through the installation of coir log check dams, coir matting, and re-vegetating with native trees and shrubs.

Item	Unit	Unit Cost (2023)	Quantity	Total Cost
Earthwork				
General Earthwork/Excavation	CY	78	214	$16,692
Energy dissapation pad - Rip-Rap, Class 200	CY	81	8	$648
Structure Installation				
Outfall Improvements	LS	10,000	1	$10,000
Precast Concrete Manhole (48", 0-8' deep)	EA	12,000	2	$24,000
Restoration/Resurfacing				
Planting and Bioengineered Restoration	SY	60	345	$20,700
Pipe Unit Cost				
PVC, 12", 10' to invert, not in road	FT	206	480	$98,736
Project Sub-Total				$171,000
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$17,100
Erosion and Sediment Control	LS	3%		$5,130
Contingency	LS	40%		$68,400
Traffic Control/Utility Relocation	LS	5%		$8,550
Surveying	LS	5%		$8,550
Capital Expense Total (including contingency)				$279,000
Design/Construction Administration (%)	LS	13.5%		$38,000
Engineering and Permitting (%)	LS	30%		$84,000
			TOTAL	$400,000

CLC-1: Day Road Stormwater Improvements, Phase 1				

Key Project Elements
- Replace the double-barrel 36-inch culverts that cross Day Road.
- Construct the channel improvements and culvert installations proposed by AKS in 2019 report (concept A-3).

Design/ Cost Assumptions
- The AKS concept was modeled and incorporated into BC's updated InfoSWMM model, which included updated hydrology.
- Assessment of flooding during the 100-year storm was based on maximum WSE in relation to the elevation of adjacent structures.
- The catchment area draining to this project includes areas outside of City limits.
- Access to BPA alignment, towers, and overhead power lines must be maintained.
- Where possible, quantities listed in the 2019 AKS report for Alt A-3 were used and costs recalculated using City-reviwed unit costs of similar items developed for this SMP.
- Unit costs for project elements not reflected in this SMP's unit cost list were derived directly from the 2019 AKS report were escalated to 2023 based on ENR CCI.
- Contingency multipliers such as Mobilization were applied as consistent with other capital projects. Lump sum costs for these items used in the AKS estimate were not carried over.
- The AKS cost estimate did not include costs for Design/Construction Admin or Engineering/Permitting. These multipliers were maintained in this estimate for consistency with other capital project estimates.

Item	Unit	Unit Cost (2023)	Quantity	Total Cost
Earthwork				
General Earthwork/Excavation	CY	78	26,500	$2,067,000
Structural Earth Wall	SF	50	16,900	$845,000
Clear and Grub brush including stumps	AC	22,000	3	$66,000
Jute Matting, Biodegradeable	SY	8	4,950	$39,600
Energy dissapation pad - Rip-Rap, Class 100	CY	124	125	$15,500
Streambed Cobble	TON	120	900	$108,000
Water Quality Facility Installation				
Gravel Access Road	SF	5	15,000	$75,000
Structure Installation				
Demo pipe	LF	30	50	$1,500
Restoration/Resurfacing				
Riparian/Wetland Planting (w/temporary irrigation)	AC	60,000	3.2	$192,000
Pipe Unit Cost				
PVC, 36", 10' to invert, in road	FT	1,027	180	$184,932
Box Culvert (10' x 3')	FT	950	200	$190,000
Project Sub-Total				$3,595,000
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$359,500
Erosion and Sediment Control	LS	3%		$107,850
Contingency	LS	40%		$1,438,000
Traffic Control/Utility Relocation	LS	5%		$179,750
Surveying	LS	5%		$179,750
Capital Expense Total (including contingency)				$5,860,000
Design/Construction Administration (%)	LS	3.5% + $200K		$405,000
Engineering and Permitting (%)	LS	30%		$1,758,000
			TOTAL	$8,020,000

CLC-1: Day Road Stormwater Improvements, Phase 2

Key Project Elements

- Upsize the two existing parallel storm pipes located beneath the parking lot of Tax Lot 500, from 36-inch to 48-inch.
- Install a third, parallel 48-inch storm pipe.

Design/ Cost Assumptions

- Assessment of flooding during the 100-year storm was based on maximum WSE in relation to the elevation of adjacent structures.
- The catchment area draining to this project includes areas outside of City limits. The establishment of similar onsite retention standards for Tualatin discharge may mitigate future flooding of this area.
- The small ponds at inlet of culverts across Ridder was not modeled - it is assumed that there is adequate space for outlets of the three proposed 48" pipes to this pond.
- Where possible, quantities listed in the 2019 AKS report for Alt A-3 were used and costs recalculated using City-reviwed unit costs of similar items developed for this SMP.
- Unit costs for project elements not reflected in this SMP's unit cost list were derived directly from the 2019 AKS report were escalated to 2023 based on ENR CCI.
- Contingency multipliers such as Mobilization were applied as consistent with other capital projects. Lump sum costs for these items used in the AKS estimate were not carried over.

Item	Unit	Unit Cost (2023)	Quantity	Total Cost
Structure Installation				
Precast Concrete Manhole (72", 0-8' deep)	EA	18,000	7	$126,000
Demo pipe	LF	30	1,200	$36,000
Restoration/Resurfacing				
Trash rack	EA	5,600	3	$16,800
Pipe Unit Cost				
PVC, 48", 10' to invert, not in road	FT	834	1,800	$1,500,840
Project Sub-Total				$1,680,000
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$168,000
Erosion and Sediment Control	LS	3%		$50,400
Contingency	LS	40%		$672,000
Traffic Control/Utility Relocation	LS	5%		$84,000
Surveying	LS	5%		$84,000
Capital Expense Total (including contingency)				$2,738,000
Design/Construction Administration (%)	LS	13.5%		$370,000
Engineering and Permitting (%)	LS	30%		$821,000
			TOTAL	$3,930,000

CLC-2: Arrowhead Creek Culvert Replacement at Arrowhead Creek Trail

Key Project Elements
- Remove and replace approx. 70 LF existing double 5 ft x 5 ft concrete box culverts with a 10 ft x 3 ft concrete box culvert.
- Stabilize and restore embankment and channel after culvert replacement.
- Repave pedestrian path after culvert replacement.

Design Assumptions
- Assumes clearing/grubbing with stump removal in immediate areas as necessary for construction.
- No costs included for access - assumed access can be attained through pedestrian path.

Item	Unit	Unit Cost (2023)	Quantity	Total Cost
Earthwork				
General Earthwork/Excavation	CY	78	45	$3,510
Fill, imported clean	CY	115	45	$5,175
Embankment	CY	35	90	$3,150
Clear and Grub brush including stumps	AC	22,000	0.10	$2,200
Energy dissapation pad - Rip-Rap, Class 200	CY	81	10	$810
Structure Installation				
Demo pipe	LF	30	70	$2,100
Restoration/Resurfacing				
Planting and Bioengineered Restoration	SY	60	270	$16,200
Trench resurfacing, Permanent ACP, 6-Inch Depth	SY	144	70	$10,080
Pipe Unit Cost				
Box Culvert (10' x 3')	FT	950	70	$66,500
Project Sub-Total				$110,000
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$11,000
Erosion and Sediment Control	LS	3%		$3,300
Contingency	LS	40%		$44,000
Traffic Control/Utility Relocation	LS	5%		$5,500
Surveying	LS	5%		$5,500
Capital Expense Total (including contingency)				$179,000
Design/Construction Administration (%)	LS	13.5%		$35,000
Engineering and Permitting (%)	LS	30%		$75,000
			TOTAL	$290,000

CLC-3: Garden Acres Pond Retrofit				

Key Project Elements

- Retrofit existing detention pond to increase storage capacity and water quality treatment along Peters Road and provide detention during high flow events.

Design Assumptions

- Install an inflow diversion structure at Peters Road (ST2101A).
- Install 95 LF of 24-inch PVC culvert at inlet of upsized detention pond.
- Increase existing detention pond capacity by 25,600 ft3 and lower pond invert to 196-ft elevation.
- Clear, regrade, and replant 0.9-acres of drainage way to ensure a low-flow drainage path and healthy vegetation.
- Install 155 LF of 24-inch PVC culvert at outlet of upsized detention pond.
- Install an outlet control structure at Peters Road (ST2431).
- Install pond underdrain in accordance with the 2015 PSW Section 3, Appendix A landscape and soil media requirements. Including 15" of drain rock, a 3" separation layer, and 18" of growing media.

Item	Unit	Unit Cost (2023)	Quantity	Total Cost
Earthwork				
General Earthwork/Excavation	CY	78	3,220	$251,160
Clear and Grub brush including stumps	AC	22,000	0.9	$19,800
Amended Soils and Mulch	CY	165	1,240	$204,600
Drain Rock	CY	110	1,030	$113,300
Water Quality Facility Installation				
Water Quality Facility Plantings with Trees	SF	40	22,310	$892,400
Outflow Control Structure	EA	20,000	1	$20,000
Structure Installation				
Flow Splitter/WQ Manhole (72", all depths)	EA	28,000	1	$28,000
Precast Concrete Manhole (60", 0-8' deep)	EA	14,000	1	$14,000
Precast Concrete Manhole (72", 0-8' deep)	EA	18,000	1	$18,000
Restoration/Resurfacing				
4-foot Chain Link Fence	LF	60	980	$58,800
Pipe Unit Cost				
Field Ditch Inlet	EA	5,600	1	$5,600
Connection to Existing Structure, standard	EA	10,000	4	$40,000
PVC, 24", 10' to invert, not in road	FT	381	205	$78,023
PVC, 24", 10' to invert, in road	FT	732	45	$32,918
Project Sub-Total				$1,777,000
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$177,700
Erosion and Sediment Control	LS	3%		$53,310
Contingency	LS	40%		$710,800
Traffic Control/Utility Relocation	LS	5%		$88,850
Surveying	LS	5%		$88,850
Capital Expense Total (including contingency)				$2,897,000
Design/Construction Administration (%)	LS	3.5% + $200K		$301,000
Engineering and Permitting (%)	LS	20%		$579,000
			TOTAL	$3,780,000

NC-1: Frog Pond E and S Conveyance Pipe Installation

Key Project Elements

- Install stormwater collection system for main alignments in basin K1 identified in the Frog Pond East and South Master Plan.

Design Assumptions

- Pipe sizes and alignment was taken directly from the Frog Pond E and S Master Plan. This area was not included in the InfoSWMM modeling effort for this SMP.
- Install 2,050 LF of 24-inch PVC pipe.
- Install 310 LF of 30-inch PVC pipe.
- Install seven 60-inch manholes.
- Install 1 outfall.

Item	Unit	Unit Cost (2023)	Quantity	Total Cost
Structure Installation				
Precast Concrete Manhole (60", 0-8' deep)	EA	14,000	7	$98,000
Outfall Improvements	EA	10,000	1	$10,000
Pipe Unit Cost				
PVC, 24", 10' to invert, in road	FT	732	2,050	$1,499,575
PVC, 30", 10' to invert, in road	FT	879	310	$272,630
Project Sub-Total				$1,880,000
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$188,000
Erosion and Sediment Control	LS	3%		$56,400
Contingency	LS	40%		$752,000
Traffic Control/Utility Relocation	LS	5%		$94,000
Surveying	LS	5%		$94,000
Capital Expense Total (including contingency)				$3,064,000
Design/Construction Administration (%)	LS	13.5%		$414,000
Engineering and Permitting (%)	LS	20%		$613,000
			TOTAL	$4,090,000

WR-1: Willamette Way East/ Morey's LandingStormwater Improvements - Phase 1				

Key Project Elements

- Remove existing Morey's Landing Bubbler (STD6604).
- Clear, grade, and replant 0.12-acres to create two infiltration raingardens within the BPA easement.
- Install a flow control diversion structure and low flow pipe at Willamette Way E to route water quality events to new raingardens and high flow events to the stormwater collection system along SW Willamette Way.
- Install a flow control diversion structure and 25 LF of 8-inch PVC to route water quality events (low flow) to new raingardens and high flow events to the Belknap Court outfall.
- Install 120 LF of 12-inch PVC on SW Willamette Way for flow exceeding the water quality event.
- Upsize 575 LF of 10-inch CPS to 12-inch PVC on SW Willamette Way (SD6629, SD6630, SD6632).
- Upsize 145 LF of 10-inch CSP to 18-inch PVC on Willamette Way (SD6638).
- Install one 48-inch manhole and replace four 48-inch manholes (ST6618, ST6619, ST6606, and ST6605).

Design Assumptions

- The raingardens (Phase 1) were sized as a filtration facility using the BMP Sizing Tool. Due to design constraints and lack of feasible outlet, this BMP will be constructed as an infiltration facility, pending infiltration testing. It is to be designed per the City's standard details for the selected BMP structure and used to treat the 1" water quality event.

Item	Unit	Unit Cost (2023)	Quantity	Total Cost
Earthwork				
Excavation, to onsite stockpile	CY	20	2,055	$41,100
Fill, from onsite stockpile	CY	60	1,289	$77,340
Amended Soils and Mulch	CY	165	389	$64,167
Drain Rock	CY	110	376	$41,360
Water Quality Facility Installation				
Rain Garden/ Swale	SF	130	120	$15,600
Geotextile	SY	7	2.5	$18
Energy dissapation pad - Rip-Rap, Class 100	CY	124	1	$124
Water Quality Facility Plantings with Trees	SF	40	5,782	$231,280
Restoration/Resurfacing				
4-foot Chain Link Fence	LF	60	305	$18,300
Flow Splitter/WQ Manhole (72", all depths)	EA	28,000	1	$28,000
Structure Installation				
Remove structure	EA	1,700	6	$10,200
Precast Concrete Manhole (48", 0-8' deep)	EA	12,000	5	$60,000
Pipe Unit Cost				
PVC, 8", 10' to invert, not in road	FT	136	25	$3,394
PVC, 12", 15' to invert, not in road	FT	215	120	$25,740
PVC, 12", 10' to invert, in road	FT	506	575	$290,950
PVC, 18", 10' to invert, in road	FT	563	145	$81,635
Connection to Existing Structure, standard	EA	10,000	4	$40,000
Project Sub-Total				$1,029,000
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$102,900
Erosion and Sediment Control	LS	3%		$30,870
Contingency	LS	40%		$411,600
Traffic Control/Utility Relocation	LS	10%		$102,900
Surveying	LS	5%		$51,450
Capital Expense Total (including contingency)				$1,729,000
Design/Construction Administration (%)	LS	13.5%		$233,000
Engineering and Permitting (%)	LS	20%		$346,000
			TOTAL	$2,310,000

WR-1: Willamette Way East/ Morey's LandingStormwater Improvements - Phase 2				

Key Project Elements
- Upsize 610 LF of 12-inch CSP to 18-inch PVC on SW Champoeg Dr E (SD6634 – SD6637).
- Replace three 48-inch manholes (ST6607, ST6608, and ST6609) and field inlet (6647).

Design Assumptions
- Flows over the water quality event will be routed to the Belknap Court outfall (part of Phase 2 network).
- The conveyance along SW Champoeg Ct (Phase 2) is identified as under capacity and will be upsized from existing 12-inch to 18-inch.

Item	Unit	Unit Cost (2023)	Quantity	Total Cost
Structure Installation				
Demo pipe	LF	30	610	$18,300
Field Ditch Inlet	EA	5,600	1	$5,600
Precast Concrete Manhole (48", 0-8' deep)	EA	12,000	3	$36,000
Pipe Unit Cost				
PVC, 18", 10' to invert, in road	FT	563	610	$343,430
Connection to Existing Structure, standard	EA	10,000	8	$80,000
Project Sub-Total				$483,000
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$48,300
Erosion and Sediment Control	LS	3%		$14,490
Contingency	LS	40%		$193,200
Traffic Control/Utility Relocation	LS	10%		$48,300
Surveying	LS	5%		$24,150
Capital Expense Total (including contingency)				$811,000
Design/Construction Administration (%)	LS	13.5%		$109,000
Engineering and Permitting (%)	LS	20%		$162,000
			TOTAL	$1,080,000

WR-2: Miley Road Stormwater Improvements - Phase 1

Key Project Elements
- Upsize 80 LF of 36-inch CMP to 42inch PCV from area drain (ENG ID 9341) to outfall.
- Restore approx. 30 ft of channel bank on either side of new outfall.
- Replace area drain (ENG ID 9341).
- Replace 320 LF of existing storm pipe with same diameter 42-inch PVC between area drain (ENG ID 9341) and manhole (ST9002).
- Replace and lower invert of manhole (ST9002) to ensure 3 ft cover requirement is met for incoming pipe. Maintain 0.2 ft drop within MH.

Design Assumptions
- Access to outfall for removal and replacement is assumed feasible - costs have not been included for access requirements

Item	Unit	Unit Cost (2023)	Quantity	Total Cost
Earthwork				
General Earthwork/Excavation	CY	78	100	$7,800
Embankment	CY	35	100	$3,500
Clear and Grub brush including stumps	AC	22,000	0.1	$2,200
Jute Matting, Biodegradeable	SY	8	100	$800
Energy dissapation pad - Rip-Rap, Class 200	CY	81	50	$4,050
Structure Installation				
Field Ditch Inlet	EA	5,600	1	$5,600
Precast Concrete Manhole (72", 0-8' deep)	EA	18,000	1	$18,000
Demo pipe	LF	30	400	$12,000
Outfall Improvements	EA	10,000	1	$10,000
Remove structure	EA	1,700	2	$3,400
Restoration/Resurfacing				
Planting and Bioengineered Restoration	SY	60	55	$3,300
Pipe Unit Cost				
PVC, 42", 10' to invert, not in road	FT	703	400	$281,380
Project Sub-Total				$352,000
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$35,200
Erosion and Sediment Control	LS	3%		$10,560
Contingency	LS	40%		$140,800
Traffic Control/Utility Relocation	LS	5%		$17,600
Surveying	LS	5%		$17,600
Capital Expense Total (including contingency)				$574,000
Design/Construction Administration (%)	LS	13.5%		$77,000
Engineering and Permitting (%)	LS	30%		$172,000
			TOTAL	$820,000

WR-2: Miley Road Stormwater Improvements - Phase 2

Key Project Elements

- Install 530 LF of 42-inch PVC from replaced manhole (ST9002) to new manhole at the near intersection with SW French Prairie Road.
- Install three 72-inch manholes for the above 42-inch line, the most upstream of which is at the SW French Prairie Road.
- Install ten 60-inch manholes and 3,015 LF of 36-inch PVC along NE Miley Road from SW French Prairie Road to new manhole adjacent to manhole ST9011.
- Install two 48-inch manholes and 650 LF of 24-inch PVC from the new manhole adjacent to manhole ST9011 to the new manhole at upstream most lateral.
- Extend six total existing main connections to the new pipe alignment (approx. 40 LF each, varying diameters). Note that these points of connection run under the existing brick wall.
- Reconnect all existing curb inlets (approx. 13) along new NE Miley Road alignment.

Design Assumptions

- Costs for connections to existing system under brick wall have been assumed for connections and pipe length only. Constructability to be verified during detailed design.
- Costs assume that existing pipe alingment (where not replaced, where moved to ROW) will be abandoned and filled with grout at key connection points.

Item	Unit	Unit Cost (2023)	Quantity	Total Cost
Structure Installation				
Precast Concrete Manhole (48", 0-8' deep)	EA	12,000	2	$24,000
Precast Concrete Manhole (60", 0-8' deep)	EA	14,000	10	$140,000
Precast Concrete Manhole (72", 0-8' deep)	EA	18,000	3	$54,000
Connection to Existing Lateral	EA	6,000	19	$114,000
Abandon Existing Pipe, fill with grout	CF	8	3705	$29,640
Pipe Unit Cost				
PVC, 12", 15' to invert, in road	FT	602	80	$48,136
PVC, 18", 15' to invert, in road	FT	731	80	$58,476
PVC, 24", 10' to invert, in road	FT	732	650	$475,475
PVC, 24", 15' to invert, in road	FT	860	40	$34,408
PVC, 36", 10' to invert, in road	FT	1,027	3055	$3,138,707
PVC, 42", 10' to invert, in road	FT	1,169	530	$619,438
Project Sub-Total				$4,736,000
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$473,600
Erosion and Sediment Control	LS	3%		$142,080
Contingency	LS	40%		$1,894,400
Traffic Control/Utility Relocation	LS	5%		$236,800
Surveying	LS	5%		$236,800
Clackamas County Permitting	LS	8.83%		$418,189
Capital Expense Total (including contingency)				$7,720,000
Design/Construction Administration (%)	LS	3.5% + $200K		$470,000
Engineering and Permitting (%)	LS	30%		$2,316,000
			TOTAL	$10,510,000

WR 3 - Rose Lane Culvert Replacement

Key Project Elements
- Remove the existing 25 LF of 12-inch culvert (CARTE ID: 24370, ENG ID not available).
- Install approximately 40 LF of parallel 12-inch RCP culverts.
- Reconfiguring culvert diagonally across roadway to move it away from the residental building (garage) and remove hard bends.
- Maintain 12-inch pipe cover in roadway (minimum amount).

Design Assumptions
- Assuming recommended culvert sizing is sufficent to convey H/H flows. Unable to easily model due to lack of stream information (seasonal stream in wetland).
- Survey required.
- Roadwork beyond trenching not evaluated.
- Waterbody is a seasonal stream with open marsh/wetlands on upstream and downstream sides.

Item	Unit	Unit Cost (2023)	Quantity	Total Cost
Earthwork				
Clear and Grub brush including stumps	AC	22,000	0.05	$1,100
Structure Installation				
Demo pipe	LF	30	25	$750
Field Ditch Inlet	EA	5,600	2	$11,200
Pipe Unit Cost				
RCP, 12", 10' to invert, in road	FT	498	80	$39,864
Project Sub-Total				$53,000
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$5,300
Erosion and Sediment Control	LS	3%		$1,590
Contingency	LS	40%		$21,200
Traffic Control/Utility Relocation	LS	5%		$2,650
Surveying	LS	5%		$2,650
Capital Expense Total (including contingency)				$86,000
Design/Construction Administration (%)	LS	13.5%		$35,000
Engineering and Permitting (%)	LS	30%		$75,000
			TOTAL	$200,000

WR-4: Charbonneau East Stormwater Improvements, Phase 1

Key Project Elements
- Upsize and replace the existing stormwater outfall (serving Charbonneau development) along the Willamette River.

Design Assumptions
- Remove and replace existing Charbonneau East Outfall.
- Upsize 115 LF of 30-inch pipe discharging to Willamette River to 36-inch diameter PVC.
- Replace 72-inch manhole (ST9014).

Item	Unit	Unit Cost (2023)	Quantity	Total Cost
Structure Installation				
Precast Concrete Manhole (72", 0-8' deep)	EA	18,000	1	$18,000
Connection to Existing Structure, standard	EA	10,000	1	$10,000
Energy dissapation pad - Rip-Rap, Class 200	CY	81	145	$11,745
Restoration/Resurfacing				
Trench resurfacing, Permanent ACP, 6-Inch Depth	SY	144	70	$10,080
Pipe Unit Cost				
PVC, 36", 10' to invert, not in road	FT	573	115	$65,907
Project Sub-Total				$116,000
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$11,600
Erosion and Sediment Control	LS	3%		$3,480
Contingency	LS	50%		$58,000
Traffic Control/Utility Relocation	LS	5%		$5,800
Surveying	LS	5%		$5,800
Capital Expense Total (including contingency)				$201,000
Design/Construction Administration (%)	LS	25.0%		$50,000
Engineering and Permitting (%)	LS	50%		$101,000
Outreach Coordination	LS	Flat Rate		$250,000
			TOTAL	$600,000

WR-4: Charbonneau East Stormwater Improvements, Phase 2

Key Project Elements

- Upsize and replace stormwater network along SW French Prairie Rd or SW Old Farm Rd.

Design Assumptions

- Replace 230 LF of 10-inch pipe with 12-inch PVC on SW French Prairie Rd (ST9087 to end, and ST9088 to end).
- Replace 680 LF of 12-inch pipe with 12-inch PVC on SW French Prairie Rd (ST9023 to ST9242).
- Replace 1,200 LF of 15-inch pipe with 15-inch PVC on SW French Prairie Rd (ST9023 to ST9020).
- Replace 310 LF of 18-inch pipe with 18-inch PVC on SW French Prairie Rd (ST9020 to ST9019).
- Upsize 360 LF of 21-inch pipe to 30-inch PVC on SW French Prairie Rd (ST9019 to ST9017).
- Replace 570 LF of 24-inch pipe with 24-inch PVC on Old Farm Rd (ST9030 to ST9027).
- Replace 300 LF of 30-inch pipe with 30-inch PVC on Old Farm Rd (ST9031 to ST9030).
- Replace eight 48-inch manholes.
- Replace nine 60-inch manholes.

Item	Unit	Unit Cost (2023)	Quantity	Total Cost
Structure Installation				
Precast Concrete Manhole (48", 0-8' deep)	EA	12,000	4	$48,000
Precast Concrete Manhole (48", 9-12' deep)	EA	15,000	4	$60,000
Precast Concrete Manhole (60", 0-8' deep)	EA	14,000	5	$70,000
Precast Concrete Manhole (60", 13-20' deep)	EA	22,000	4	$88,000
Connection to Existing Structure, standard	EA	10,000	12	$120,000
Pipe Unit Cost				
PVC, 12", 10' to invert, in road	FT	506	910	$460,460
PVC, 15", 10' to invert, in road	FT	535	1,200	$641,400
PVC, 18", 10' to invert, in road	FT	563	310	$174,530
PVC, 30", 10' to invert, in road	FT	879	360	$316,602
PVC, 24", 10' to invert, in road	FT	732	570	$416,955
PVC, 30", 10' to invert, in road	FT	879	300	$263,835
Project Sub-Total				$1,979,000
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$197,900
Erosion and Sediment Control	LS	3%		$59,370
Contingency	LS	40%		$791,600
Traffic Control/Utility Relocation	LS	10%		$197,900
Surveying	LS	5%		$98,950
Capital Expense Total (including contingency)				$3,325,000
Design/Construction Administration (%)	LS	13.5%		$449,000
Engineering and Permitting (%)	LS	20%		$665,000
			TOTAL	$4,440,000

WR-4: Charbonneau West Stormwater Improvements

Key Project Elements

- Replace stormwater network along SW French Prairie Road, SW Curry Drive, SW Boones Bend Road

Design Assumptions

- Replace 200 LF of 12-inch pipe along SW French Prairie Road with PVC (ENG ID: ST9048 to ST9281)
- Replace a total of 1,540 LF of 15-inch pipe along SW Curry Drive, SW French Prairie Road, and SW Boones Bend Rd with PVC.
- Replace a total of 2,450 LF of 18-inch pipe along SW Curry Drive, SW French Prairie Road, and SW Boones Bend Rd with PVC.
- Replace 680 LF of 21-inch pipe along SW Boones Bend Road with PVC.
- Replace 670 LF of 24-inch pipe along SW French Prairie Road and SW Boones Bend Road with PVC.
- Replace 420 LF of 27-inch pipe along SW Boones Bend Road with PVC.
- Replace 640 LF of 30-inch pipe along SW Boones Bend Road with PVC.
- Replace 170 LF of 36-inch pipe along SW Boones Bend Road with PVC.

Item	Unit	Unit Cost (2023)	Quantity	Total Cost
Structure Installation				
Precast Concrete Manhole (48", 0-8' deep)	EA	12,000	29	$348,000
Precast Concrete Manhole (60", 0-8' deep)	EA	14,000	7	$98,000
Precast Concrete Manhole (72", 0-8' deep)	EA	18,000	2	$36,000
Connection to Existing Lateral	EA	6,000	15	$90,000
Outfall Improvements	EA	10,000	2	$20,000
Pipe Unit Cost				
PVC, 12", 10' to invert, in road	FT	506	200	$101,200
PVC, 15", 10' to invert, in road	FT	535	1,540	$823,130
PVC, 18", 10' to invert, in road	FT	563	2,450	$1,379,350
PVC, 21", 10' to invert, in road	FT	647	680	$440,130
PVC, 24", 10' to invert, in road	FT	732	670	$490,105
PVC, 27", 10' to invert, in road	FT	805	420	$338,300
PVC, 30", 10' to invert, in road	FT	879	640	$562,848
PVC, 36", 10' to invert, in road	FT	1,027	170	$174,658
Project Sub-Total				$4,902,000
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$490,200
Erosion and Sediment Control	LS	3%		$147,060
Contingency	LS	40%		$1,960,800
Traffic Control/Utility Relocation	LS	10%		$490,200
Surveying	LS	5%		$245,100
Capital Expense Total (including contingency)				$8,235,000
Design/Construction Administration (%)	LS	3.5% + $200K		$488,000
Engineering and Permitting (%)	LS	20%		$1,647,000
			TOTAL	$10,370,000

Charbonneau R&R Program

Key Project Elements

- Replace pipe in Charbonneau District that isn't being replaced by another CIP or hasn't been recently replaced. Recently replaced pipe was designated by the City as anything replaced between 2015-2022.
- Assume minimum pipe size of 12-inch. Assume all other pipe is replace-in-place.
- Assume replacements of all manholes (except those excluded from above mentioned projects).

Design Assumptions

- Replace 19,460 LF of 12-inch diameter PVC pipe.
- Replace 4,590 LF of 15-inch diameter PVC pipe.
- Replace 3,620 LF of 18-inch diameter PVC pipe.
- Replace 1,210 LF of 21-inch diameter PVC pipe.
- Replace 750 LF of 24-inch diameter PVC pipe.
- Replace 180 LF of 27-inch diameter PVC pipe.
- Replace 340 LF of 30-inch diameter PVC pipe.
- Replace 470 LF of 36-inch diameter PVC pipe.

Item	Unit	Unit Cost (2023)	Quantity	Total Cost
Structure Installation				
Precast Concrete Manhole (48", 0-8' deep)	EA	12,000	120	$1,440,000
Precast Concrete Manhole (48", 9-12' deep)	EA	15,000	13	$195,000
Precast Concrete Manhole (48", 13-20' deep)	EA	18,000	3	$54,000
Precast Concrete Manhole (60", 0-8' deep)	EA	14,000	15	$210,000
Precast Concrete Manhole (72", 9-12' deep)	EA	23,000	2	$46,000
Pipe Unit Cost				
PVC, 12", 10' to invert, in road	FT	506	13,470	$6,815,820
PVC, 12", 15' to invert, in road	FT	602	2,500	$1,504,250
PVC, 12", 10' to invert, not in road	FT	206	3,210	$660,297
PVC, 12", 15' to invert, not in road	FT	215	280	$60,060
PVC, 15", 10' to invert, in road	FT	535	2,220	$1,186,590
PVC, 15", 15' to invert, in road	FT	666	570	$379,805
PVC, 15", 10' to invert, not in road	FT	249	1,680	$419,034
PVC, 15", 15' to invert, not in road	FT	259	120	$31,086
PVC, 18", 10' to invert, in road	FT	563	1,870	$1,052,810
PVC, 18", 15' to invert, in road	FT	731	880	$643,236
PVC, 18", 10' to invert, not in road	FT	293	630	$184,685
PVC, 18", 15' to invert, not in road	FT	304	240	$72,864
PVC, 21", 10' to invert, in road	FT	647	670	$433,658
PVC, 21", 15' to invert, in road	FT	796	520	$413,699
PVC, 21", 15' to invert, not in road	FT	348	20	$6,963
PVC, 24", 10' to invert, in road	FT	732	410	$299,915
PVC, 24", 10' to invert, not in road	FT	381	340	$129,404
PVC, 27", 10' to invert, in road	FT	805	180	$144,986
PVC, 30", 10' to invert, in road	FT	879	340	$299,013
PVC, 36", 10' to invert, not in road	FT	573	240	$137,544
PVC, 36", 15' to invert, in road	FT	1,220	230	$280,577
Project Sub-Total				$17,101,000
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$1,710,100
Erosion and Sediment Control	LS	3%		$513,030
Contingency	LS	40%		$6,840,400
Traffic Control/Utility Relocation	LS	10%		$1,710,100
Surveying	LS	5%		$855,050
Capital Expense Total (including contingency)				$28,730,000
Design/Construction Administration (%)	LS	13.5%		$3,879,000
Engineering and Permitting (%)	LS	20%		$5,746,000
			TOTAL	$38,360,000

Appendix F: Library Pond Analysis

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Technical Memorandum

Prepared for: City of Wilsonville

Project Title: Wilsonville Stormwater Master Plan Update

Project No.: 156157

Technical Memorandum

Subject: Library Pond Evaluation

Date: June 14, 2023

To: Kerry Rappold, City of Wilsonville

From: Brown and Caldwell

Prepared by: Shelby Gilmartin, E.I.T

Reviewed by: Angela Wieland, P.E.

Limitations:

This document was prepared solely for City of Wilsonville in accordance with professional standards at the time the services were performed and in accordance with the contract between City of Wilsonville and Brown and Caldwell dated January 11, 2021. This document is governed by the specific scope of work authorized by City of Wilsonville; 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 Wilsonville and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

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Executive Summary

This Technical Memorandum (TM) describes a sizing evaluation conducted on the Library Pond stormwater detention facility (also referred to as the Memorial Park Pond). This evaluation was conducted as part of the City's 2023 Stormwater Master Plan (SMP) Update to determine capital project needs (specific to retrofit of the Library Pond), as well as policy recommendations (to be documented in the SMP) related to redevelopment of the Wilsonville Town Center, which contributes stormwater to the Library Pond.

This evaluation utilized the City of Wilsonville's BMP Sizing Tool, which is intended for use in conjunction with the *2015 Stormwater & Surface Water Design & Construction Standards,* as well as historic as-built drawings, results from the InfoSWMM model, Geographic Information System (GIS) data, and the *2019 Wilsonville Town Center Plan* to analyze pond sizing and ability to effectively mitigate stormwater flows under three development scenarios. The development scenarios reflect unique land cover and impervious conditions specific to pre-development (Oak Savanna) land use conditions, existing (current) land use conditions, and future (Town Center build-out) land use conditions.

Section 1: Background

The Library Pond Stormwater Detention Facility (Library Pond) was originally constructed in the 1980s. Modifications were made to the pond in 1992 as part of the Memorial Park site improvements. These improvements include enlarging the pond, installing new stormwater piping, an outfall, and inlet, as well as enclosing the pond with a chain-link fence.

The Library Pond receives drainage from approximately 180 acres of commercial property in the southeastern portion of Wilsonville, east of Interstate 5 and adjacent to Wilsonville Road. The Library Pond discharges to a piped collection system, which outfalls to an unnamed tributary to Boeckman Creek approximately 750 feet downstream of the Library Pond. Boeckman Creek is a tributary to the Willamette River. Water quality monitoring has been conducted at the Library Pond since the late 1990's in accordance with the City's National Pollutant Discharge Elimination System (NPDES) municipal separate storm sewer (MS4) permit. Although operating as a regional stormwater facility, there are several notable characteristics of the pond that may contribute to observed capacity and water quality issues:

- There is no flow control/orifice structure or emergency overflow type structure, thus providing limited detention benefit.
- Vegetation is overgrown with invasive species and sediment has accumulated along the pond bottom, limiting pond capacity and water quality function.
- As shown in the as-builts and verified on-site, the facility has very steep side slopes (estimated to be 2H:1V), limiting facility access and maintenance.
- City staff have experienced ongoing challenges with debris removal at existing ditch inlet, which serves as the outlet from the pond so impounded trash can quickly result in a flooding issue.

Hydraulic analysis of the Library Pond conducted for the SMP in 2022 indicates that flooding occurs during the 25-year future development condition. This finding is confirmed by City staff who have observed flooding of the Wilsonville Public Library parking lot and Memorial Drive near the entrance to Memorial Park. The contributing drainage area to the Library Pond is subject to redevelopment in both the near term and long term as part of the Wilsonville Town Center Plan (adopted May 6, 2019).

The three phases of the Willamette Town Center Plan include:

- Phase I - infill and redevelopment of vacant and/or underutilized land over the next 10 years (approx. 2019-2029). This will focus on areas where landowners can develop new buildings on vacant or underused parking without impacting existing businesses. The mostly likely type of redevelopment occurring will be existing retail and commercial buildings, multifamily residential, and some mixed-use development.
- Phase 2 - redevelopment, multiuse, and parking garage integration in the next 10-20 years (approx. 2029-2039). This phase includes office and mixed-use development with attached structured parking leading to the redevelopment of surface lots, redesign of the street grid because of development, and streetscape management.
- Phase 3 – the full build out will include high-density, mixed-use buildings, completion of pedestrian networks and vehicle roadways, and reallocation of parking facilities behind or integrated into buildings. This phase is anticipated to occur in the next 20+ years (approx. 2039-TBD).

The City anticipates using the Library Pond as a regional stormwater facility to mitigate stormwater treatment and flow control requirements associated with private redevelopment and public improvements in the Town Center Plan area. Design and construction of the Library Pond retrofit may be funded exclusively through system development charges (SDCs) applied to Town Center redevelopment, allowing the City to charge Town Center development a fee-in-lieu.

Section 2: City of Wilsonville Stormwater Design Standards

Over the past decade, stormwater management practices in Oregon have evolved to require consideration of hydromodification as well as more traditional water quality and peak flow (detention) requirements. Hydromodification is the change in runoff patterns caused by land use and impervious area changes that result in the degradation of stream channels and water quality (i.e., stream erosion from the extended duration of peak flows). Traditional stormwater treatment and detention design practices typically analyze pre- and post-development peak flows associated with a standard (i.e., 24-hour) synthetic design storm. A hydromodification standard requires continuous simulation flow modeling to evaluate both peak flow but also the duration of flows exceeding a specific recurrence interval. Adherence to a hydromodification standard assumes that peak flow and flow duration for the post-development condition does not exceed the pre-developed condition for a range of geomorphically significant flows—those capable of moving sediment and eroding streambanks. For the City of Wilsonville, the range of geomorphically significant flows is established as 42 percent of the 2-year flow to the 10-year flow.

Given the complexity of evaluating stormwater controls to adhere to a hydromodification standard, municipalities that have adopted a hydromodification standard have also developed tools to aid developers with design.

2.1 Design Standards

The City's Public Works Design Standards (PWS) (i.e., *City of Wilsonville's 2015 Stormwater & Surface Water Design & Construction Standards, Section 3*) were updated in December 2015 to emphasize low-impact development (LID) facilities that incorporate infiltration to address both pollutant reduction and flow control as well as develop facility sizing to address hydromodification impacts.

2.2 BMP Sizing Tool

The cities of Wilsonville and Oregon City, together with Clackamas Water Environment Services (WES) developed a custom tool, referred to as the BMP Sizing Tool, to help size stormwater facilities for hydromodification-based standards. The BMP Sizing Tool (last updated in 2017) is used in conjunction with the City's PWS and by developers and engineers to automate some of the required calculations to support sizing and design for a specific set of stormwater management facility types based on long-term rainfall records, soils, and land use cover data. The BMP sizing tool can be used to calculate the following BMP types:

- Rain Garden - Filtration and Infiltration
- Stormwater Planter - Filtration and Infiltration
- Vegetated Swale - Filtration and Infiltration
- Infiltrator
- Detention Pond

The BMP Sizing Tools offers two design options: (1) treatment and flow control, or (2) treatment only. The BMP types that are available for each design option depend on the native soil infiltration rate at the location of the BMP facility. The tool was developed based on local conditions (rainfall, soil characteristics, etc.) for Clackamas County, Oregon. The distinction between infiltration and filtration is based on the facility soil subgroup. Groups A1 – B3 include infiltration rates greater than 0.50 in/hr and are considered acceptable for use with infiltration facilities. Groups C1 – D1 reflect infiltration rates from 0.02 – 0.49 in/hr and are considered acceptable for use with filtration facilities. Infiltration facilities use only infiltration to manage runoff. Filtration facilities include piped underdrain systems and orifice controls.

The following table is an excerpt from the *User's Guide for the BMP Sizing Tool* which shows the BMP sizing dimension for each facility type. The focus for this analysis will be on the capabilities of the Detention Pond for treatment and flow control settings in the tool.

Table 4. BMP Dimensions Required for the Sizing Tool to Apply

Facility	Drain Rock, min. in.	Separation Layer, in.	Growing Media, min. in.	Ponding Depth, in.	Freeboard, min. in.	Side Slope, ratio	Bottom Width, min. in.	Liner
Stormwater Planter - Filtration	12	3	18	12	4	0	18	If required
Stormwater Planter - Infiltration	28	3	18	12	4	0	30	No
Rain Garden - Filtration	18	3	18	12	4	3:1 max	24	If required
Rain Garden - Infiltration	18	3	18	16	N/A	3:1 max	24	No
Vegetated Swale - Filtration	12	3	18	12	4	3:1 max	24	If required
Vegetated Swale - Infiltration	18	3	18	12	N/A	3:1 max	24n	No
Detention Pond	15	3	18	Per sizing model (12 in. min.)	12[a]	3:1 max	N/A	If required

a. The surface area of the detention pond, the filtration rain garden and the filtration swale sized by the tool does not take freeboard into account. In addition, see Note 12 on the Detention Pond detail regarding an emergency spillway.

Although the table states a side slope ratio of 3H:1V max for detention ponds, the 2015 PWS section 301.4.09 states a General Facility Design Requirement that stormwater management facilities shall not exceed 4H:1V up to the maximum design water elevation. The initial analyses used 4H:1V sizing requirements. After review by the City, the scenarios were refined to optimize pond sizing and incorporated a 3H:1V side slope to maximize potential storage at Library Pond.

For detention ponds, the tool can be used to either calculate a simple geometry or a custom geometry. A simple geometry uses a known surface area or depth and entered slope to calculate the bottom area and depth or surface area (whichever was initially an unknown variable). While the custom geometry relies on known depth, area, and flow values. For each configuration option, the BMP Sizing Tool routes the post-development flow through the pond, performs statistical analyses for flow duration and peak flow criteria, and reports if the pond is sized adequately.

For ponds sized using simple geometry, the required outlet dimensions for the pond will be calculated. This includes inverts and dimensions of lower orifice, upper orifice, and overflow weir which correspond to the provided facility schematic (see Figure 1). Figure 1 depicts the main features of the outlet structure with the locations of their inverts. The overflow weir is at 1 foot below the 10-year pond water surface elevation. It is assumed that the pond will need to include additional freeboard (typically 1 foot) above the 10-year water surface elevation.

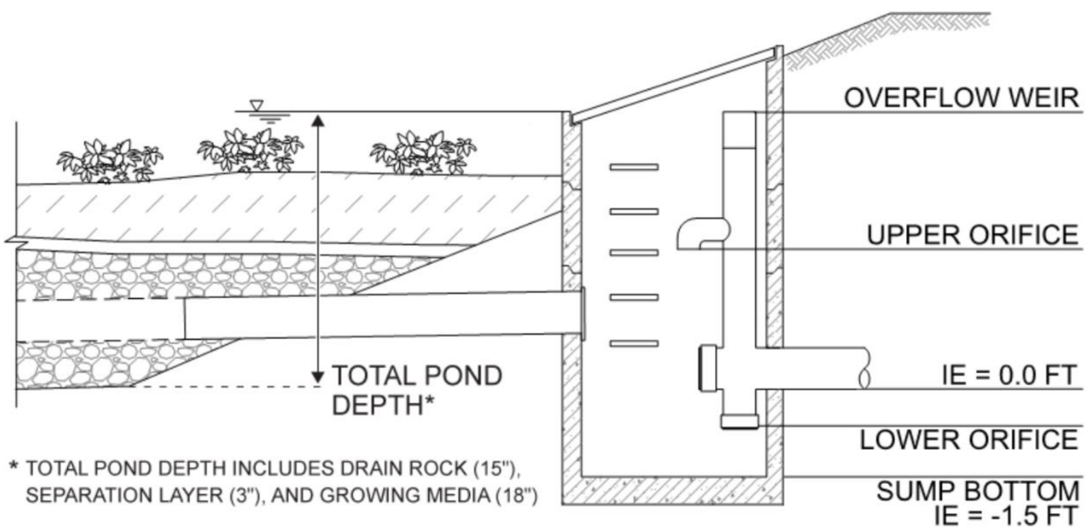


Figure 1. Detention pond facility schematic

The BMP Sizing Tool also calculates flow duration and peak flow frequency curves to compare pre-development to post-project flows. The curves represent the flow and duration over the range of geomorphically significant flows (i.e., lower threshold of 42 percent of the 2-yr storm and an upper threshold of the 10-yr storm). When a pond is adequately sized the mitigated post-development curve (blue per the BMP Sizing Tool output) falls below the pre-development curve (red per the BMP Sizing Tool output). It will also be sized to ensure treatment of 80 percent of the average annual runoff.

Section 3: Evaluation and Methodology

With the 2015 updates to the PWS, the Library Pond as it exists today does not meet the City's current stormwater design and construction specifications. This TM documents the evaluation of the existing pond location and footprint against several pre- and post- development scenarios. The process used for this evaluation of the facility includes:

1. Utilize facility as-builts, the InfoSWMM model, and the Town Center Plan to determine the current pond facility size, contributing drainage area and land use, and the pond's stage storage curve;
2. Determine if the current pond storage volume and outlet structure address current flows reflective of existing development conditions and pre-development flows reflective of historic land use conditions, as required in the 2015 PWS;
3. Use the BMP Sizing Tool to compare pond sizing and outlet adjustments, assuming existing development conditions and historic land use conditions, to meet the minimum criteria in the City's design standards;
4. Locate potential impervious areas within the Town Center redevelopment for upstream, low impact development (LID) planter facilities to meet the City's water quality treatment and flow control requirements associated with the City's established hydromodification standard;
5. Use the BMP Sizing Tool to iterate and optimize pond sizing and outlet configurations in conjunction with LID sizing/placement to meet the City's design standards in conjunction with future development of the Town Center and associated site constraints, and
6. Document LID placement needs associated with future development to determine fee-in-lieu policy implications.

To evaluate Library Pond sizing in conjunction with the above-mentioned process, the 11 subbasins (delineated as part of the SMP) that drain into the Library Pond were subdivided based on various land cover and impervious conditions reflective of pre-development, existing, and future development conditions. Under future development conditions, the Town Center development plans include demolition of existing stormwater infrastructure and installation of new pipes to convey stormwater drainage in conjunction with the proposed roadway configuration.

Because the existing footprint of the pond, approximately 0.7 acres, is constrained by limitations (roadways, trees, etc.), simple pond sizing was employed by holding the pond surface area constant and allowing the BMP Sizing Tool to calculate a required pond depth and bottom surface area.

3.1 Discharge Management Areas

The BMP Sizing Tool requires users to first delineate Discharge Management Areas (DMAs), also referred to as subcatchments, which are used to define a contributing drainage area to each planned BMP facility on a site. The BMP Sizing Tool has limitations on the size of individual DMAs to individual LID facilities. In addition, to facilitate iteration of scenarios related to BMP sizing, flexibility had to be incorporated into the DMAs. Therefore, the contributing drainage area to the Library Pond had to be categorized and subdivided.

The DMAs were initially developed by subdividing each of the 11 subbasins (totaling 179.8 acres) into their respective Hydrologic Soil Groups (HSGs) - either B, C, or D (note: soils that fell into a dual-HSG category are reflected by the less infiltrating soil. For example, a soil in group C/D was calculated as HSG D). The total area of analysis was found to be 35% HSG B, 42% HSG C, and 23% HSG D, with the actual site of Library Pond in HSG B soils.

The areas were then further subdivided by land cover to separate existing roadways/Right-of-ways (ROWs) from private property. Existing ROW areas were confirmed against the future Town Center Plan to ensure the area would remain roadways in the future development condition. Similarly, building (rooftop) area and pavement areas were also designated and digitized to inform the delineation of DMAs. An example of how this hierarchy was implemented is shown in Figure 2.

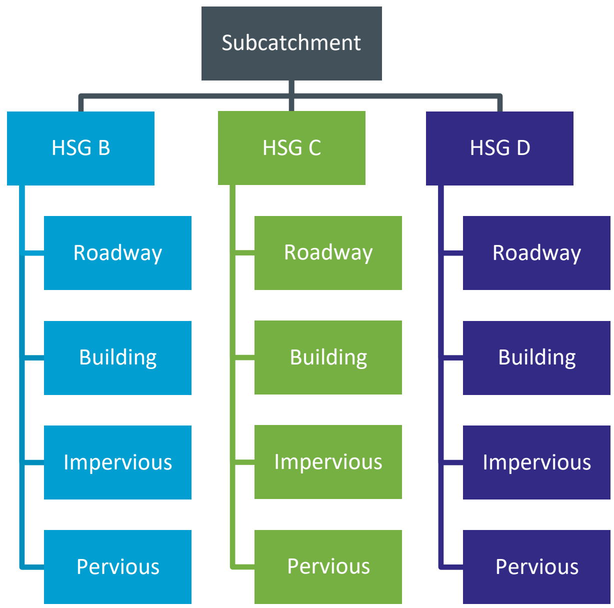


Figure 2. Example hierarchy of how the subcatchments were divided into DMAs

The DMAs were set-up to meet each of the three (3) initial scenarios for evaluation:

1. Pre-development (Oak Savanna) to existing conditions (today)
2. Pre-development (Oak Savanna) to future conditions (Town Center build out)
3. Existing conditions (today) to future conditions (Town Center build out)

To accommodate each of these scenarios, a total of 98 individual DMAs were established to represent the soil characteristics and development types over the 11 subcatchments. Each of the DMAs has a unique pre-development and post-development surface types associated with a specific soil type.

A database and specific naming convention was used to track DMAs and associated information. DMAs were named by subcatchment number, HSG letter, the existing development type, and the future development type. For example, a DMA from scenario 3 may read as 3414_D_Ex_Perv_Fu_Imp with an area of 3,995 square feet. This naming convention indicates that this DMA is currently a pervious surface (noted as Grass in the tool) but is anticipated to become an impervious surface (Conventional Concrete or Asphalt) under the full Town Center development.

3.2 Best Management Practices

Although the BMP Sizing Tool has eight (8) available facility types to develop sizing, this analysis focused on the Detention Pond with treatment and flow control to represent the Library Pond. Since the Library Pond is located in HGL B soils, the more conservative group B value (called B3 in the tool) with an infiltration rate of 0.50-0.99 in/hr was used to represent these soils. This range was verified against data from the United States Department of Agriculture (USDA) Natural Resources Conservation Services (NRCS) soil survey database which identified the soil in this area to be primarily Willamette silt loam with a saturated hydraulic conductivity (Ksat) between 0.57-1.98 in/hr.

The pond was modeled using both custom and simple geometry in the tool in order to compare existing pond sizing as well as determine sizing and outlet control adjustments. The custom geometry was used in the BMP Sizing Tool to represent the existing facility under current and future conditions to confirm if it meets design standards. For the custom sizing, the geometry data was extracted from the InfoSWMM model (based on the 1992 as-built data) to determine the depth in feet (ft), area in square feet (sq ft), and flow in cubic feet per second (cfs) based on modeled stage storage for the 10-year storm event. The stage storage information extracted from InfoSWMM is listed in Table 1.

Table 1. Library Pond Stage Storage

Depth (ft)	Area (sq ft)	Flow (cfs)
0	0	0
1	10,018	9.4
2	17,859	14.3
5	23,522	19.7
9	32,670	Not reached in 10-year storm
10	34,848	Not reached in 10-year storm

It is assumed that usable storage within the pond must remain below the elevation of the chain link fence at its lowest position (near the outlet structure where it passes under the road). This elevation contour of 147 ft is considered the upper limit of the pond with a calculated surface area of 30,130 sq ft. The lowest full elevation contour of the pond was calculated to be 137 ft with a surface area of 17,800 sq ft. It was assumed that the existing footprint of the pond is a hard constraint, and the surface area of the pond could not be expanded.

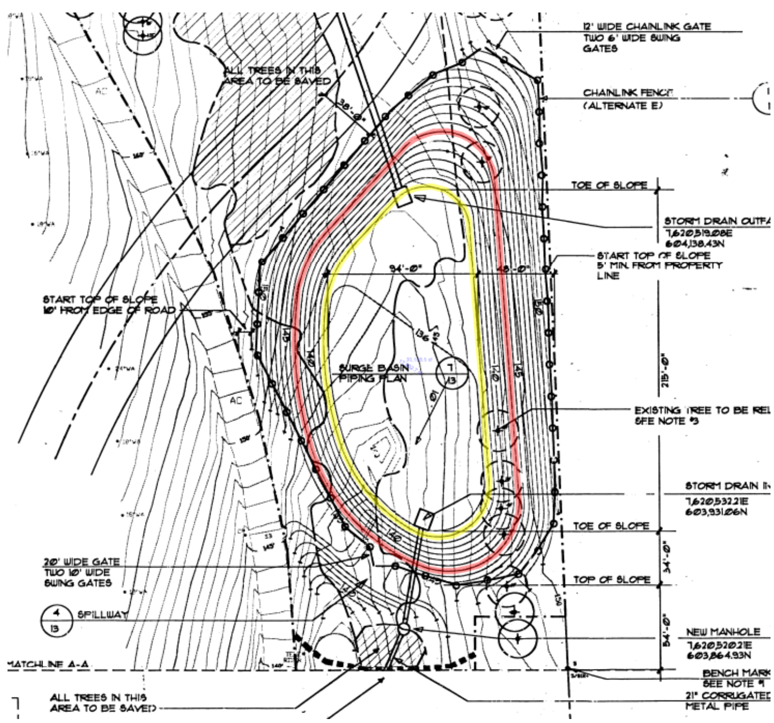


Figure 3. Library Pond 1992 as-builts, upper 147 ft contour (red) and lower 137 ft contour (yellow)

Alternatively, the simple geometry calculation was used to confirm modifications needed to retrofit the pond to current PWS design standards, based on each of the scenarios. The simple geometry could be run with either a known pond surface area, a known depth, or both. If one variable is unknown the tool calculates it based on the provided information for the surface area and/or depth and slope (H:V), as well as calculated the bottom area of the pond. Values for the surface area and slope were rounded to the nearest whole number for calculations.

Since the detention pond is being evaluated to meet both the water quality and flow control criteria, the BMP Sizing Tool was used to evaluate and size the pond facility to address peak flow duration matching for flows ranging from 42 percent of the 2-year peak flow to the 10-year peak flow as well as ensure treatment of 80 percent of the average annual runoff.

Section 4: Scenarios

The following three (3) scenarios were established to compare past, present, and future conditions of the Town Center Development area and associated sizing of the Library Pond. Each scenario was input into the BMP Sizing Tool to see how the system (pond) would respond under the varying development assumptions, with accompanying scenarios evaluated to confirm what level of retrofit or policy change regulating upstream LID installations are needed to meet the City's design standards.

4.1 Scenario 1: Pre-development to Existing Conditions

This scenario simulated pre-development conditions, referred to as Oak Savanna in the 2015 PWS, and existing development conditions to confirm whether the existing Library Pond sizing is adequate to meet design standards. The contributing drainage area under existing conditions is 47 percent impervious. In comparison, Oak Savanna is considered 100 percent pervious, with all DMAs identified as 'Grass' for the pre-development surface type.

Simply comparing the aerial photography from 1992 (which is not representative of Oak Savanna but represents the oldest web accessible archived image) to aerial imagery from 2022, it is evident that this area has experienced a large amount of development over the past 30 years.

Figure 4. Aerial images of site and surrounding area

Left: after retrofit in June 1994

Right: July 2022, representative of existing condition.

4.1.1 Pond Sizing Evaluation

Simulation of the Library Pond configuration in the BMP Sizing Tool indicates that the existing pond does not meet the current stormwater design standards per the 2015 PWS. The existing pond geometry was entered into the tool using stage storage information from the 1992 as-builts and SMP InfoSWMM model. As seen in Figure 5, the blue line represents the discharge occurring from the pond and it is consistently higher than the red, pre-development (Oak Savannah) flow frequency and flow duration curves. Library Pond in its current configuration does not adequately match the pre-development curves and additional pond storage is needed.

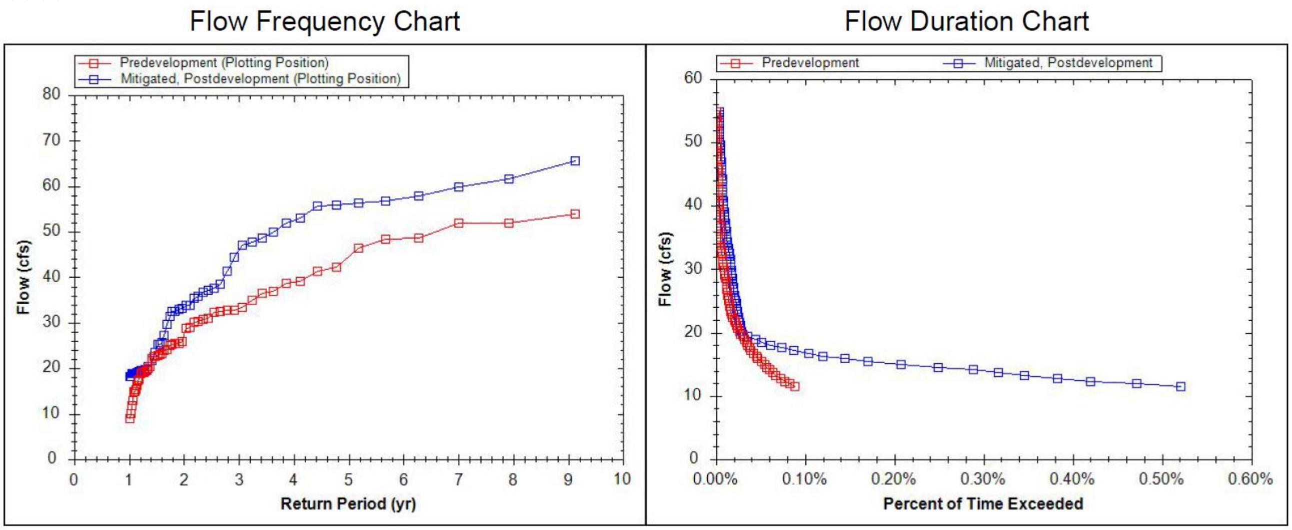


Figure 5. Curves based on existing stage storage information from as-builts

Pre-development shown in red. Mitigated, Post-Development shown in blue.

4.1.2 Pond Retrofit Evaluation

The BMP Sizing Tool was used to simulate additional scenarios associated with the pond configuration and size, as outlined in Table 2, to calculate pond retrofits required to meet current design standards. The BMP Sizing Tool calculations show that significant design modifications are required to ensure the pond is adequately sized; specifically the pond would need to be retrofit to have 1H:1V side slopes with a depth of nearly 24 feet (Figure 6) to adhere to the City's hydromodification standard (see Attachment A, Scenario 1A). This design fails to meet the design criteria for detention ponds having 3H:1V slopes and results in an excessively deep detention facility. Retrofit of the pond to meet City design standards based on existing development conditions is considered infeasible.

Table 2. Scenario 1 Iterations

Geometry Type	Slope (H:V)	Sizing Mode	Depth (ft)	Bottom Area (sq ft)	Does it Pass the Tool?
Custom Geometry	Stage Storage Information per as-builts				No, not large enough
Simple Geometry	4:1	Auto calculate depth	Cannot be calculated, bottom reaches zero before depth is reached		No, geometry doesn't work
	3:1	Auto calculate depth	Cannot be calculated, bottom reaches zero before depth is reached		No, geometry doesn't work
	2:1	Auto calculate depth	43.39	0	No, geometry doesn't work
	1:1	Auto calculate depth	23.98	15,780	Yes, sized adequately

Note: there is some variation between calculated depths with the same slope based on the tool and the outset structure sizing/configuration.

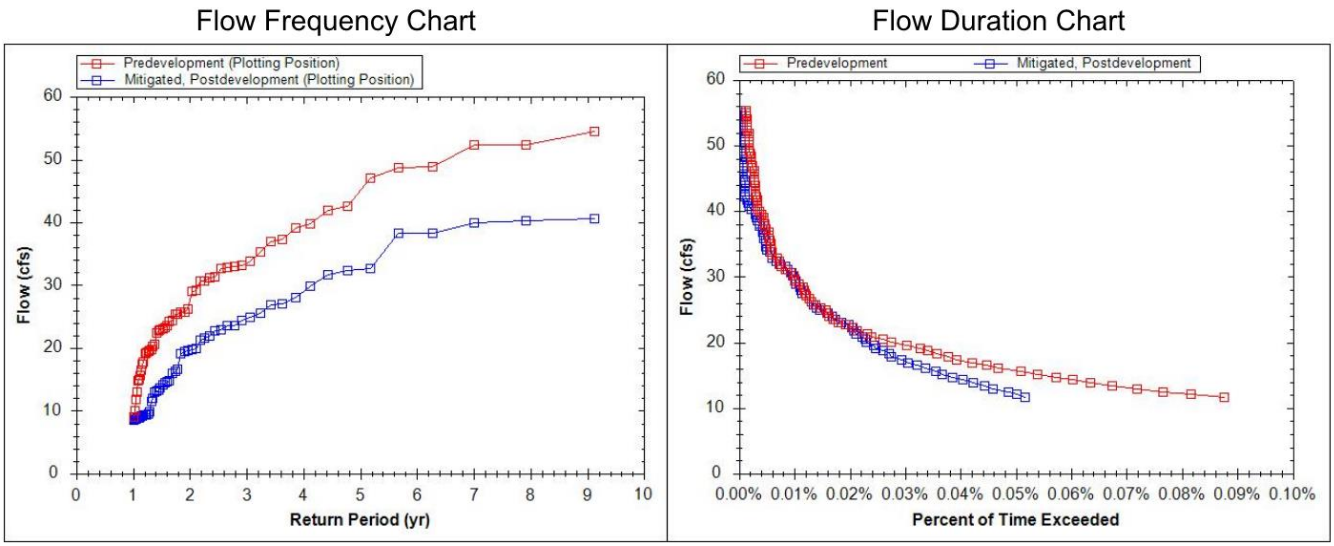


Figure 6. Flow frequency and duration curves if retrofit is to have 1H:1V side slopes and a depth of nearly 24 feet

Pre-development (red) to Existing condition (blue)

4.1.3 Onsite Flow Mitigation Evaluation

An additional, theoretical investigation was conducted to see how much of the current contributing drainage area to Library Pond would need to be managed onsite (i.e., routed to onsite LID) for the pond to meet current design standards.

To evaluate, the BMP Sizing Tool was used to automatically size the detention pond, maintaining the existing pond surface area of 30,130 sq. ft., and adjusting the side slopes to meet the PWS of 3H:1V. The automatic sizing mode to calculate the depth and bottom area of the pond. DMAs were then selectively removed from contributing area to the detention pond with the assumption that removed DMAs would require onsite stormwater management (retention) and use of LID such as planters or raingardens.

By removing approximately 20 percent of the existing total drainage area (roughly 36 acres of impervious surface or 43% of the contributing impervious area) to Library Pond, the BMP Sizing Tool was able to size the pond to meet PWS requirements. This reduces the total drainage area to the Library Pond to 143.3 acres. The resulting pond sizing requires deepening the Library Pond to 15.08 feet (including the 3 feet of media at the bottom) and maintaining a bottom area of 6,906 sq. ft. See Attachment A, Scenario 1B.

The pond schematic and structure sizing reflecting the reduced contributing drainage area, a depth of 15.08 feet and 3H:1V side slopes is as follows in Figures Figure 7 and Figure 8.

Structure	Size
Lower Orifice Diameter	9.9 in
Lower Orifice Invert	0.0 in
Upper Orifice Diameter	25.2 in
Upper Orifice Invert	9.8 ft
Weir Length	6.3 ft
Weir Invert	13.6 ft

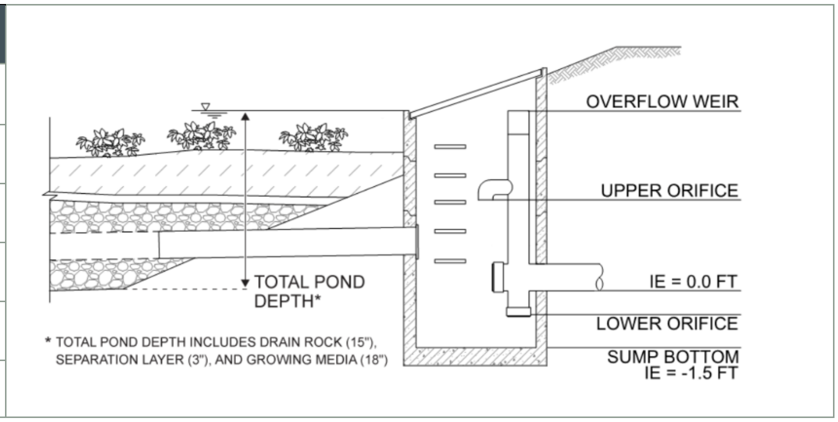


Figure 7. Scenario 1 outfall structure sizing and schematic for reduced contributing drainage area and 3H:1V sides slopes

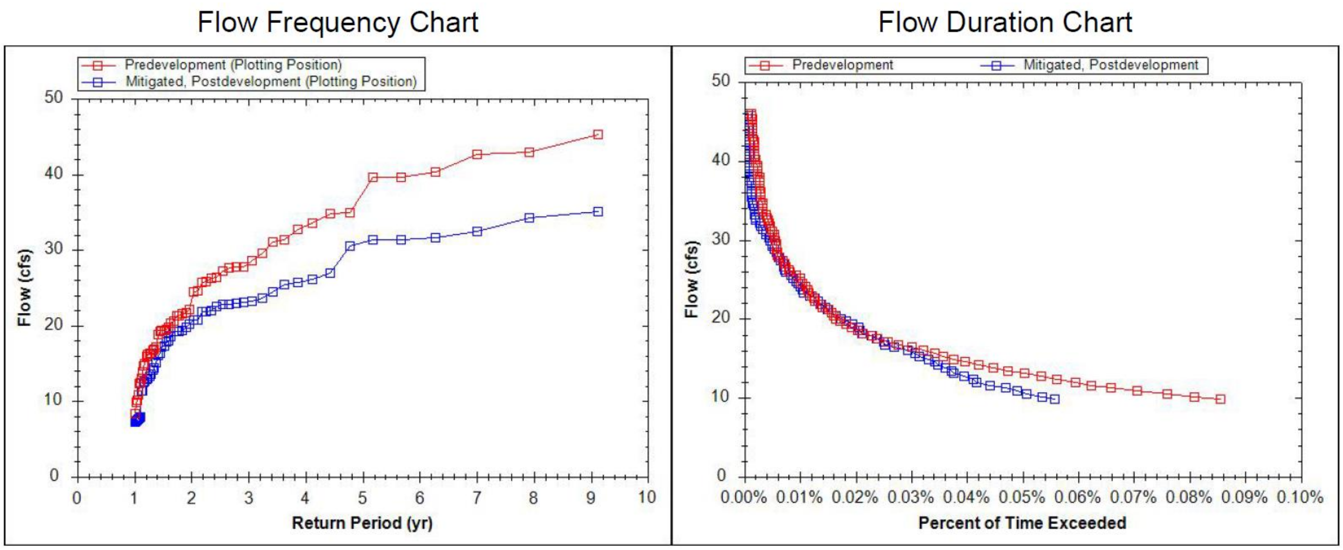


Figure 8. Reduced contributing drainage area for flow frequency and duration curves with a 3H:1V pond

Pre-development (red) to existing condition (blue)

4.2 Scenario 2: Pre-development to Future Conditions

The second scenario was simulated in the BMP Sizing Tool, comparing pre-development conditions, referred to as "Oak Savanna" in the 2015 PWS, to the future development conditions outlined in the Town Center Plan at full build out (20+ year planning horizon) to confirm sizing needs for the Library Pond. The contributing drainage area under future conditions is 53 percent impervious. In comparison, Oak Savanna is 100 percent pervious, with all DMAs identified as 'Grass' for the pre-development surface type. Like Scenario 1, expansion of the existing footprint of the pond, approximately 0.7 acres, is not possible due to constraining site limitations (roadways, trees, etc.).

4.2.1 Pond Sizing and Retrofit Evaluation

Based on Scenario 1 findings, it is assumed that the existing pond sizing would not meet the City's design standards as is in conjunction with future redevelopment of the Town Center area (Figure 9). Since the existing pond configuration does not meet the City's design standards for existing development conditions, it was not expected that the pond is adequately sized for future development conditions either.

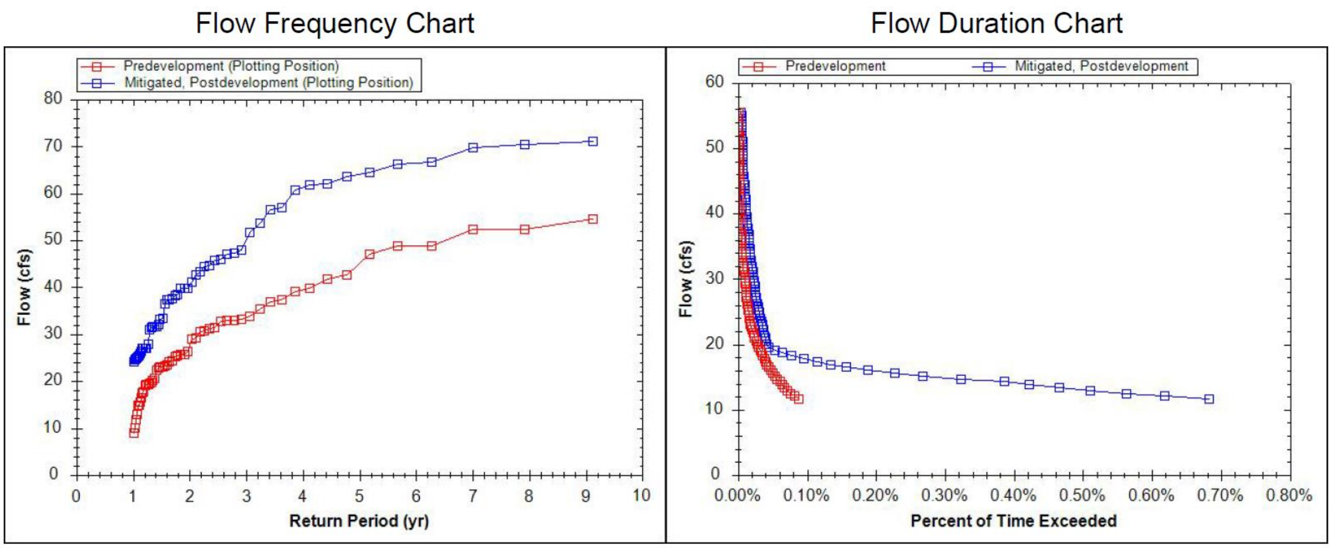


Figure 9. Flow frequency and duration curves based on existing stage storage information from as-builts

Pre-development shown in red and future development conditions shown in blue.

The BMP Sizing Tool was simulated for the additional scenarios outlined in Table 3 to calculate the required pond sizing and retrofit needs. As shown in Table 3 and Figure 10, like with the previous scenario, the BMP Sizing Tool calculated that the pond would have to be retrofit to have 1H:1V side slopes with a depth of approximately 30.4 feet and a bottom geometry of over just over 12,700 sq. ft to meet current design standards (see Attachment A, Scenario 2A). However, these detention pond design criteria do not meet the 2015 PWS requirements.

Table 3. Scenario 2 Iterations

Geometry Type	Slope (H:V)	Sizing Mode	Depth (ft)	Bottom Area (sq ft)	Does it Pass the Tool?
Custom Geometry	Stage Storage Information				No, not large enough
Simple Geometry	4:1	Auto calculate depth	Cannot be calculated, bottom reaches zero before depth is reached		No, geometry doesn't work
	3:1	Auto calculate depth	Cannot be calculated, bottom reaches zero before depth is reached		No, geometry doesn't work
	2:1	Auto calculate depth	43.39	0	No, not large enough
	1:1	Auto calculate depth	30.40	12,719	Yes, sized adequately

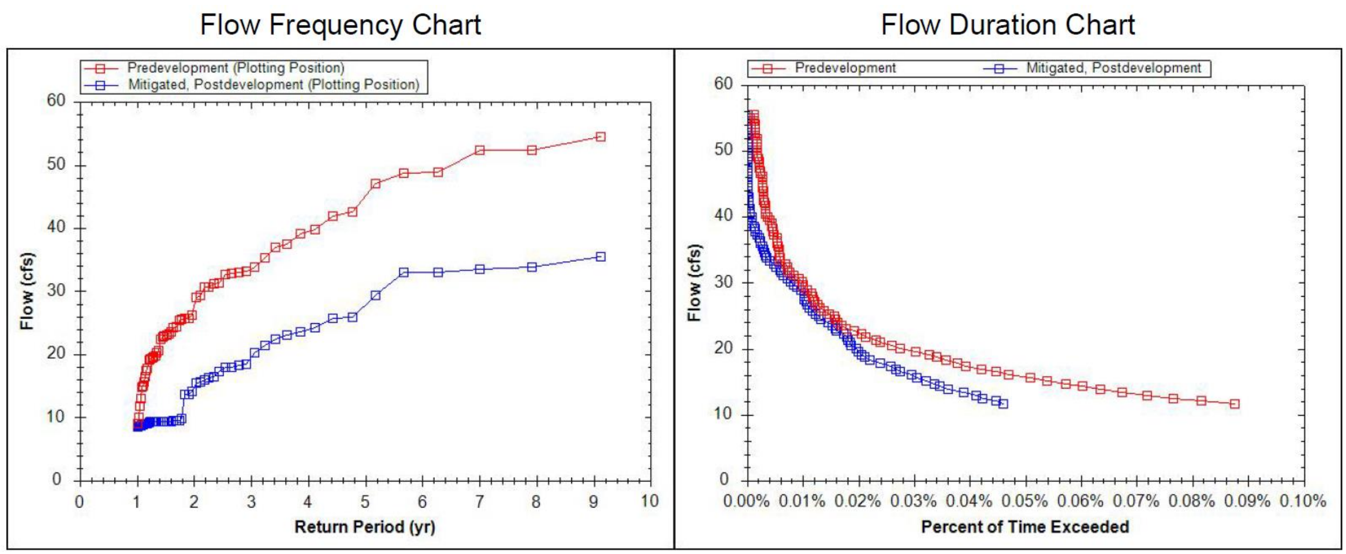


Figure 10. Flow and durations curves if retrofit was to have 1H:1V side slopes with a depth of over 30 feet.

Pre-development (red) to future development conditions (blue).

4.2.2 Onsite Flow Mitigation Evaluation

Based on these findings, a secondary analysis for Scenario 2 was developed. Similar to Scenario 1, this analysis removed select DMAs from contributing to the pond, assuming that these areas could be treated by additional LID facilities, to determine how much of Town Center property would require onsite stormwater management in order for Library Pond to meet City design standards.

Again, to evaluate the reduction in DMAs, the BMP Sizing Tool maintained the existing surface area of 30,130 sq. ft., set the slope to meet the City directed use of the PWS maximum of 3H:1V, and used the automatic sizing mode to calculate the depth and bottom area of the pond.

By removing approximately 27 percent of the total contributing drainage area (approximately 48 acres impervious area) to Library Pond, the BMP Sizing Tool was able to size the pond to meet PWS requirements. All 48 acres of removed DMAs were impervious surfaces and represents all roadways (approximately 27 acres) plus an additional 21 acres of impervious area. **The removed impervious surfaces to be redirected constitutes 50 percent of the total new or redeveloped impervious surfaces contributing to the pond.** This removed area was assumed rerouted to infiltration planters onsite and modeled in the BMP Sizing Tool through a series of Stormwater Water Planter BMPs that connect to Library Pond as upstream LIDs. Although site-specific infiltration testing would be needed to confirm whether an infiltration or filtration-based LID is needed, for integration into the BMP Sizing Tool an infiltration planter that provides treatment and flow control was selected. Since the facility infiltration rate at Library Pond is associated with HSG B3 (0.50-0.99 in/hr), for purposes of this initial analysis the same infiltration rate was assumed as a representative of the soils for the LID facilities. With a portion of contributing drainage area removed, the total drainage area to Library Pond to 131.8 acres. The resulting pond sizing requires deepening the Library Pond to 15.04 feet (including the 3 feet of media at the bottom) and maintaining a bottom area of 6,946 sq. ft. See Attachment A, Scenario 2B.

The pond schematic and structure sizing reflecting the reduced contributing drainage area, a depth of 15.04 feet and 3H:1V side slopes is as follows in Figure 11 and Figure 12.

Structure	Size
Lower Orifice Diameter	10.6 in
Lower Orifice Invert	0.0 in
Upper Orifice Diameter	27.4 in
Upper Orifice Invert	10.1 ft
Weir Length	6.3 ft
Weir Invert	14.0 ft

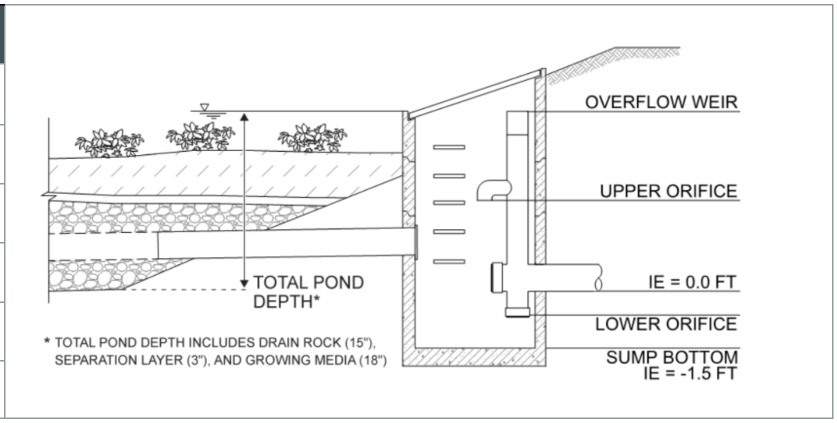


Figure 11. Scenario 2 outfall structure sizing and schematic for reduced contributing drainage area and 3H:1V sides slopes

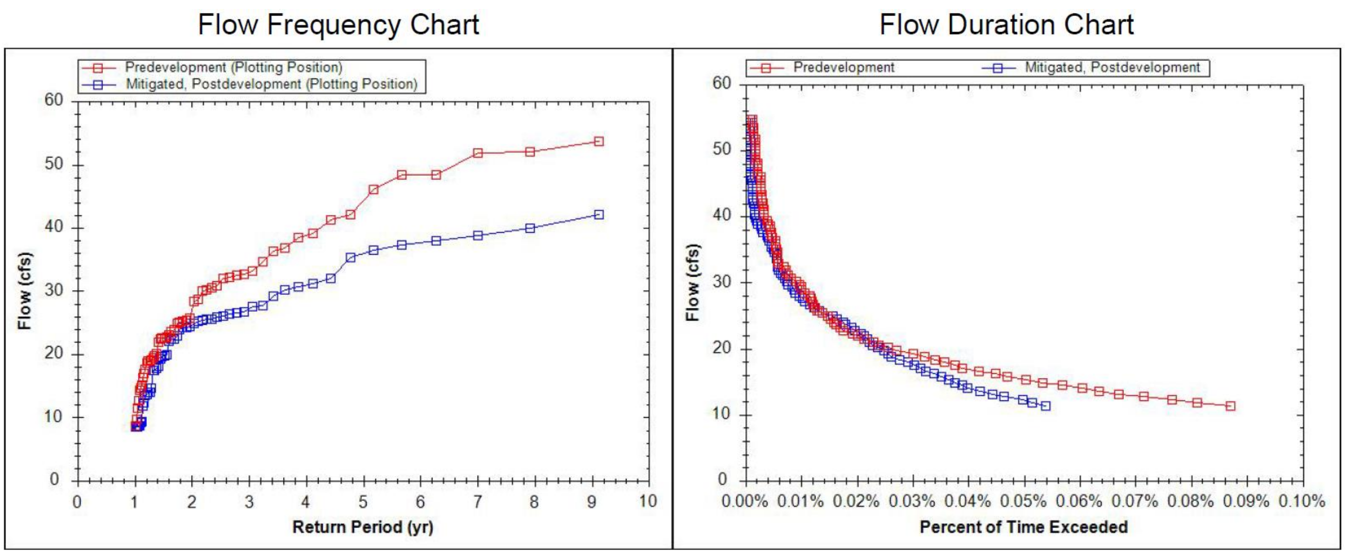


Figure 12. Reduced contributing drainage area for flow frequency and duration curves with a 3H:1V pond

Pre-development (red) to future development condition (blue).

4.3 Scenario 3: Existing to Future Conditions

The last scenario assumes that adherence to the City's design standards could be accomplished by allowing redevelopment of Town Center to adhere to predevelopment flows reflecting existing land use conditions as opposed to historic (Oak Savannah) land cover conditions. The contributing drainage area under existing conditions is 47 percent impervious and under future conditions increases to 53 percent impervious through both redevelopment and the addition of approximately 10 acres of impervious surface. As seen in Figure 13, the Town Center development plans anticipate redevelopment of many currently developed and impervious areas, which is why the amount of impervious area only increases by about 7 percent. However, all redevelopment area is subject to the City's design standards including utilization of Green Infrastructure and Low Impact Development (GI/LID) strategies to mitigate stormwater.

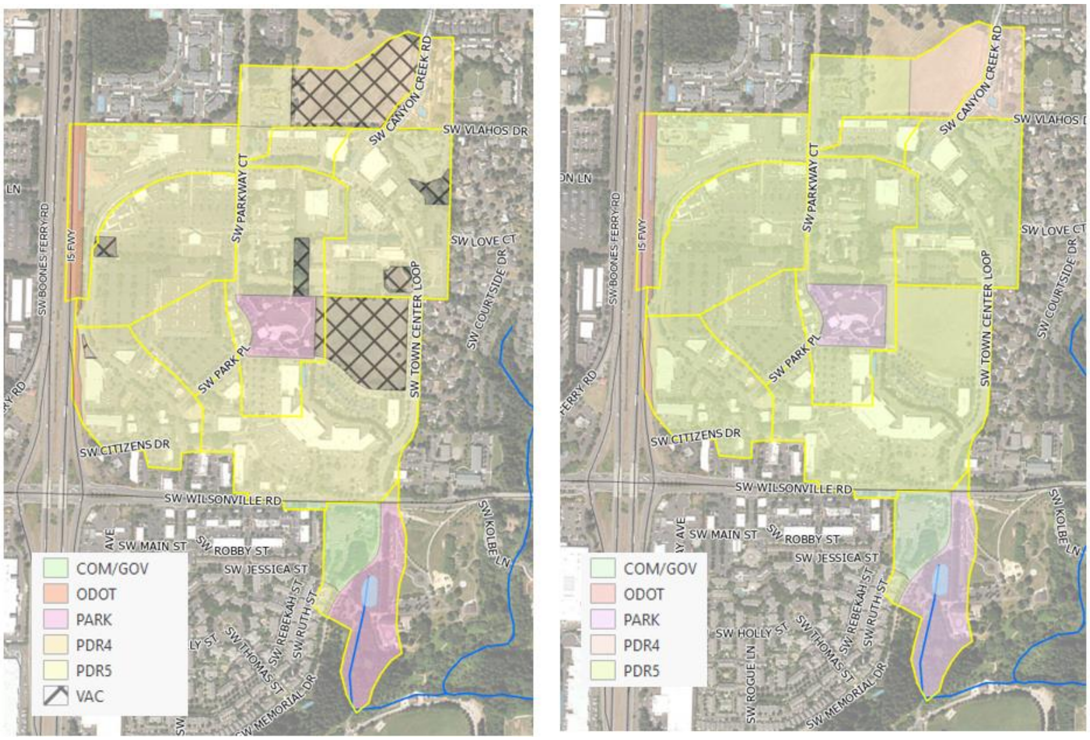


Figure 13. Existing land use at 47% impervious (left); future land use at 53% impervious (right)

The BMP Sizing Tool was run through the following scenarios outlined in Table 4 to calculate how the existing pond may handle future flows as well as design modifications that would be required.

Assuming pre-development conditions reflect existing land use, the pond as-is does not adequately meet City design standards for sizing. Some modifications to Library Pond are required, specifically the pond needs to be deepened to approximately 7.1 feet, which includes 3 feet of media at the bottom of the facility and adjustment of side slopes to 4:1 is required. Utilizing this comparison methodology, this approach requires a policy change since for the City since it redefines “pre-development” from historic (Oak Savanna) land coverage to current land use conditions.

Table 4. Scenario 3 Iterations

Geometry Type	Slope (H:V)	Sizing Mode	Depth (ft)	Bottom Area (sq ft)	Does it Pass the Tool?
Custom Geometry	Stage Storage Information				No, not large enough
Simple Geometry	4:1	Auto calculate depth	7.09	13,656	Yes, sized adequately
	3:1	Auto calculate depth	6.24	18,534	Yes, sized adequately

Note: Additional analysis of slopes 2H:1V and 1H:1V were not recorded as the 4H:1V and 3H:1V slope design standard slope meets sizing requirements.

The pond schematic and structure sizing reflect a depth of 7.09 feet and 4H:1V side slopes is as follows in Figure 14 and Figure 15.

Structure	Size
Lower Orifice Diameter	16.9 in
Lower Orifice Invert	0.0 in
Upper Orifice Diameter	40.9 in
Upper Orifice Invert	4.8 ft
Weir Length	6.3 ft
Weir Invert	6.1 ft

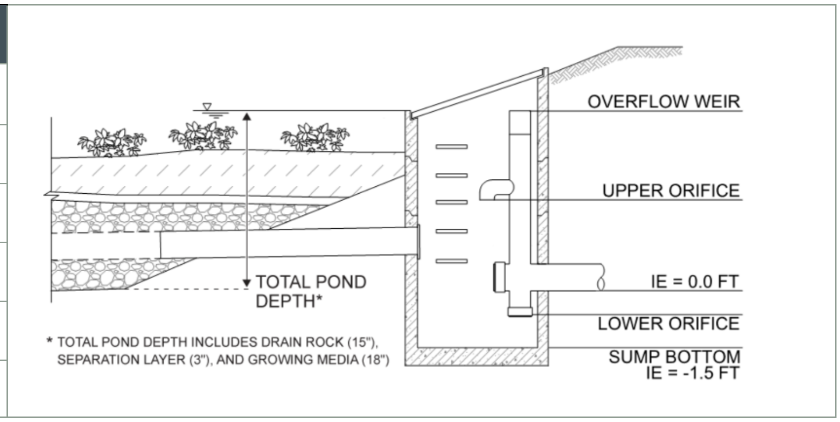


Figure 14. Scenario 3 outfall structure sizing and schematic for reduced contributing drainage area and 4H:1V sides slopes

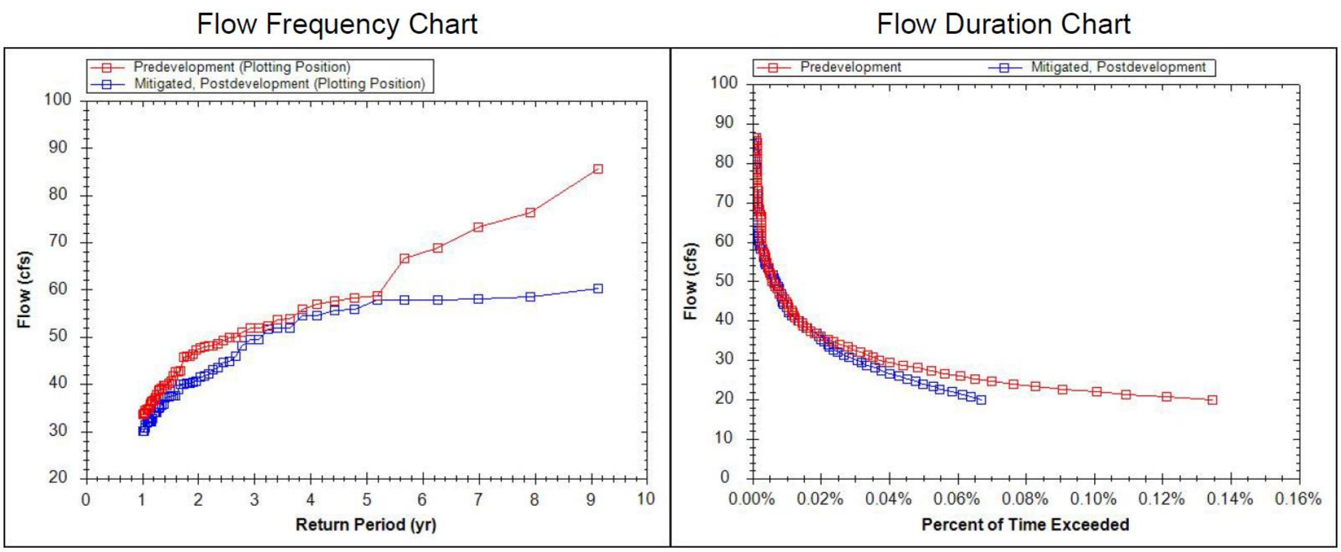


Figure 15. Flow and durations curves show adequate sizing for 4H:1V side slopes at 7.09 feet deep

Existing development conditions (red) to future development conditions (blue).

Section 5: Conclusions

Scenarios simulated using the BMP Sizing Tool for Library Pond indicate there are limited options to retrofit the pond to meet the existing stormwater design standards. Table 5 summarizes the scenarios iterated and the resulting design adjustments (retrofit) required for Library Pond based on assumptions discussed in Section 4.

Table 5. Scenario Summary							
Scenario No.	Scenario Description and Land Cover Conditions	Total Contributing Area (acres)	Meets Hydraulic Requirements?	Pond Retrofit Requirements		Meets Pond Design Criteria?	Notes
				Slope (H:V)	Depth (feet)		
1.A	Pre-Development Land Cover to Existing Land Cover	179.8	Yes	1:1	21.33	No	Pond sides are too steep and pond is too deep
1.B	Pre-Development Land Cover to Existing Land Cover	143.3	Yes	3:1	15.08	Yes	Requires onsite mitigation (retention) for 36 acres of existing impervious area
2.A	Pre-Development Land Cover to Future Land Cover	179.8	Yes	1:1	32.01	No	Pond sides are too steep, and pond is too deep
2.B	Pre-Development Land Cover to Future Land Cover	131.8	Yes	3:1	15.04	Yes	Requires onsite mitigation (retention) for 48 acres of existing impervious area
3	Existing Land Cover to Future Land Cover	179.8	Yes	4:1	7.09	Yes	Requires an established policy adjusting the definition of pre-developed land cover for Town Center redevelopment.

As seen in Table 5, Scenarios 1A and 2A are unable to meet the 2015 PWS stormwater design standards for ponds, specific to side slope (both are 1H:1V and the standard is 3H:1V) and depth. Only if onsite retention occurs for a portion of the upstream contributing drainage area will pond retrofit be able to meet the City's design standards. Only Scenario 3 allows for the entire upstream contributing drainage area to be managed by Library Pond and the pond adhere to design criteria outlined in the PWS. This pond retrofit can be designed with a more gradual 4H:1V slope, and results in a reasonable pond depth of 7.09 feet deep, which is shallower than the existing Library Pond with the 3 feet of required media in the bottom.

However, Scenario 3 mandates a policy change to adjust pre-development land cover from historic Oak Savanna to current land use conditions. This consideration will need to be evaluated by the City.

If a policy change related to the pre-development condition associated with Town Center is not possible, Scenarios 1B and 2B reflect the percentage and acreage of impervious area that would need to be retained or managed onsite using GI/LID BMP facilities and no longer routed to Library Pond. The following assumptions were made to estimate the amount of onsite infiltration planters required to offset 48 acres of impervious surfaces in the future condition (or 50% of the total new or redeveloped impervious area to Library Pond).

- Pre-development conditions are grass cover per PWS Oak Savanna designation with soil conditions reflective of the associated HSG;
- Soil and infiltration characteristics for the LID facilities are similar to that of the Library Pond, characterized as B3 (0.5-0.99 in/hr infiltration), which prompts use of an infiltration facility;
- Per Appendix B of the BMP Sizing Tool User Manual, onsite LID sizing would equate to a sizing factor of approximately 7.4, based on an area weighted average of sizing factors and soil characteristics for area removed from the Library Pond drainage area.

Using the above assumptions, onsite retention of 48 acres of impervious surface is possible using approximately 154,725 sq. ft. (3.6 acres) of infiltration planters located throughout the Town Center development. It should be noted that site-specific infiltration testing may result in adjustment of the LID sizing and/or need for a filtration-based facility to be used instead.

Retrofit of the Library Pond would require regrading and structural improvements, resulting in a 3:1 side slope and depth of 15.04 feet. This is a conservative design approach and conservative design assumptions based on onsite management of approximately 48 acres of the contributing drainage area to Library Pond onsite. Pond sizing may vary depending on the use and characteristics of upstream LID.

References

Stormwater & Surface Water Design & Construction Standards, Section 3, "Public Works Standards," City of Wilsonville, 2015, pp.1-104.

User's Guide for the BMP Sizing Tool, City of Wilsonville and City of Oregon City, 2017, pp. 1-23.

Wilsonville Town Center Plan, City of Wilsonville, 2019, pp. 1-104.

Attachment A: BMP Sizing Tool Scenario Reports

1. Scenario 1 – Stage Storage Report
2. Scenario 1A – Automatically Calculated Depth Report
3. Scenario 1B – Automatically Calculated Depth Report – Reduced Area
4. Scenario 2 – Stage Storage Report
5. Scenario 2A – Automatically Calculated Depth Report
6. Scenario 2B – Automatically Calculated Depth Report – Reduced Area
7. Scenario 3 – Stage Storage Report
8. Scenario 3A – Automatically Calculated Depth Report

WES BMP Sizing Software Version 1.6.0.2, May 2018

WES BMP Sizing Report

Project Information

Project Name	Library Pond_Predevelopment (Oak Savanna) to Existing
Project Type	Planning
Location	
Stormwater Management Area	30130
Project Applicant	
Jurisdiction	OutofDistrict

Drainage Management Area

Name	Area (sq-ft)	Pre-Project Cover	Post-Project Cover	DMA Soil Type	BMP
3218_D_Bdg	22,140	Grass	Roofs	D	Library Pond_Existing
3218_D_Imp	53,626	Grass	ConventionalConcrete	D	Library Pond_Existing
3218_D_Perv1	201,064	Grass	Grass	D	Library Pond_Existing
3218_D_Perv2	304,657	Grass	Grass	D	Library Pond_Existing
3218_D_Rd	47,500	Grass	ConventionalConcrete	D	Library Pond_Existing
3402_B_Bdg	188,724	Grass	Roofs	B	Library Pond_Existing
3402_B_Imp	141,471	Grass	ConventionalConcrete	B	Library Pond_Existing
3402_B_Perv	385,991	Grass	Grass	B	Library Pond_Existing
3402_B_Rd	128,278	Grass	ConventionalConcrete	B	Library Pond_Existing
3402_C_Bdg	98,396	Grass	Roofs	C	Library Pond_Existing
3402_C_Imp	42,160	Grass	ConventionalConcrete	C	Library Pond_Existing
3402_C_Perv	429,486	Grass	Grass	C	Library Pond_Existing
3402_C_Rd	105,818	Grass	ConventionalConcrete	C	Library Pond_Existing

3414_B_Bdg	58,379	Grass	Roofs	B	Library Pond_Existing
3414_B_Imp	63,926	Grass	ConventionalConcrete	B	Library Pond_Existing
3414_B_Perv	209,761	Grass	Grass	B	Library Pond_Existing
3414_B_Rd	49,096	Grass	ConventionalConcrete	B	Library Pond_Existing
3414_C_Bdg	126,069	Grass	Roofs	C	Library Pond_Existing
3414_C_Imp	82,826	Grass	ConventionalConcrete	C	Library Pond_Existing
3414_C_Perv	308,800	Grass	Grass	C	Library Pond_Existing
3414_C_Rd	25,301	Grass	ConventionalConcrete	C	Library Pond_Existing
3414_D_Bdg	14,315	Grass	Roofs	D	Library Pond_Existing
3414_D_Imp	49,279	Grass	ConventionalConcrete	D	Library Pond_Existing
3414_D_Perv	109,766	Grass	Grass	D	Library Pond_Existing
3414_D_Rd	22,834	Grass	ConventionalConcrete	D	Library Pond_Existing
3417_D_Bdg	28,358	Grass	Roofs	D	Library Pond_Existing
3417_D_Imp	26,856	Grass	ConventionalConcrete	D	Library Pond_Existing
3417_D_Perv	74,227	Grass	Grass	D	Library Pond_Existing
3417_D_Rd	33,919	Grass	ConventionalConcrete	D	Library Pond_Existing
3418A_B_Bdg	104,425	Grass	Roofs	B	Library Pond_Existing
3418A_B_Imp	86,889	Grass	ConventionalConcrete	B	Library Pond_Existing
3418A_B_Perv	312,748	Grass	Grass	B	Library Pond_Existing
3418A_B_Rd	148,903	Grass	ConventionalConcrete	B	Library Pond_Existing
3418B_B_Bdg	88,068	Grass	Roofs	B	Library Pond_Existing
3418B_B_Imp	139,481	Grass	ConventionalConcrete	B	Library Pond_Existing
3418B_B_Perv	100,636	Grass	Grass	B	Library Pond_Existing

3418B_B_Rd	28,000	Grass	ConventionalConcrete	B	Library Pond_Existing
3420_B_Imp	23,265	Grass	ConventionalConcrete	B	Library Pond_Existing
3420_B_Perv	39,389	Grass	Grass	B	Library Pond_Existing
3420_B_Rd	32,226	Grass	ConventionalConcrete	B	Library Pond_Existing
3420_C_Bdg	109,273	Grass	Roofs	C	Library Pond_Existing
3420_C_Imp	275,853	Grass	ConventionalConcrete	C	Library Pond_Existing
3420_C_Perv	386,959	Grass	Grass	C	Library Pond_Existing
3420_C_Rd	9,675	Grass	ConventionalConcrete	C	Library Pond_Existing
3425_C_Bdg	68,156	Grass	Roofs	C	Library Pond_Existing
3425_C_Imp	68,156	Grass	ConventionalConcrete	C	Library Pond_Existing
3425_C_Perv	202,555	Grass	Grass	C	Library Pond_Existing
3425_C_Rd	259,711	Grass	ConventionalConcrete	C	Library Pond_Existing
3425_D_Bdg	11,387	Grass	Roofs	D	Library Pond_Existing
3425_D_Imp	31,398	Grass	ConventionalConcrete	D	Library Pond_Existing
3425_D_Perv	40,770	Grass	Grass	D	Library Pond_Existing
3436_C_Bdg	88,720	Grass	Roofs	C	Library Pond_Existing
3436_C_Imp	80,765	Grass	ConventionalConcrete	C	Library Pond_Existing
3436_C_Perv	238,917	Grass	Grass	C	Library Pond_Existing
3436_C_Rd	47,127	Grass	ConventionalConcrete	C	Library Pond_Existing
3436_D_Bdg	96,205	Grass	Roofs	D	Library Pond_Existing
3436_D_Imp	75,308	Grass	ConventionalConcrete	D	Library Pond_Existing
3436_D_Perv	257,884	Grass	Grass	D	Library Pond_Existing
3436_D_Rd	76,800	Grass	ConventionalConcrete	D	Library Pond_Existing

3443_D_Bdg	27,464	Grass	Roofs	D	Library Pond_Existing
3443_D_Imp	5,664	Grass	ConventionalConcrete	D	Library Pond_Existing
3443_D_Perv	99,259	Grass	Grass	D	Library Pond_Existing
3443_D_Rd	72,345	Grass	ConventionalConcrete	D	Library Pond_Existing
5038_B_Bdg	35,902	Grass	Roofs	B	Library Pond_Existing
5038_B_Imp	71,437	Grass	ConventionalConcrete	B	Library Pond_Existing
5038_B_Perv	305,799	Grass	Grass	B	Library Pond_Existing
5038_B_Rd	64,436	Grass	ConventionalConcrete	B	Library Pond_Existing
5038_C_Bdg	46,318	Grass	Roofs	C	Library Pond_Existing
5038_C_Imp	18,733	Grass	ConventionalConcrete	C	Library Pond_Existing
5038_C_Perv	105,053	Grass	Grass	C	Library Pond_Existing
5038_C_Rd	16,137	Grass	ConventionalConcrete	C	Library Pond_Existing

LID Facility Sizing Details

Pond Sizing Details

Pond ID	Design Criteria(1)	Facility Soil Type	Max Depth (ft)(2)	Top Area (sq-ft)	Side Slope (1:H)	Facility Vol. (cu-ft)(3)	Water Storage Vol. (cu-ft)(4)	Adequate Size?
Library Pond_Existing	FCWQT	B3	5.00	30,130.0	0	150,650.0	96,416.0	No

1. FCWQT = Flow control and water quality treatment, WQT = Water quality treatment only
2. Depth is measured from the bottom of the facility and includes the three feet of media (drain rock, separation layer and growing media).
3. Maximum volume of the facility. Includes the volume occupied by the media at the bottom of the facility.
4. Maximum water storage volume of the facility. Includes water storage in the three feet of soil media assuming a 40 percent porosity.

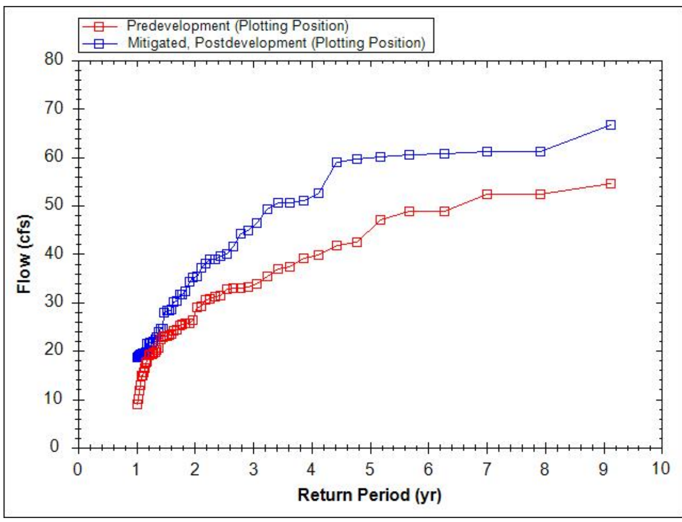
Custom Pond Geometry Configuration

Pond ID: Library Pond_Existing
Design: FlowControlAndTreatment

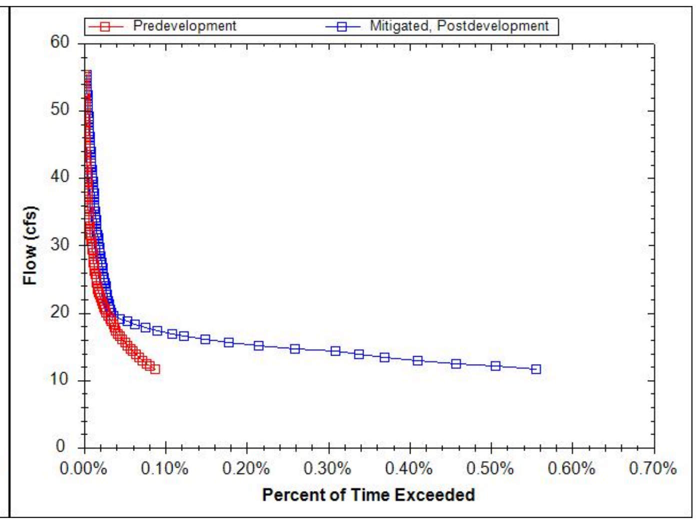
Shape Curve

Depth (ft)	Area (sq ft)	Discharge (cfs)
.0	.0	.0
1.0	10,018.0	9.4
2.0	17,859.0	14.3
5.0	23,522.0	19.7

Flow Frequency Chart



Flow Duration Chart



WES BMP Sizing Software Version 1.6.0.2, May 2018

WES BMP Sizing Report

Project Information

Project Name	Library Pond_Predevelopment (Oak Savanna) to Existing
Project Type	Planning
Location	
Stormwater Management Area	30130
Project Applicant	
Jurisdiction	OutofDistrict

Drainage Management Area

Name	Area (sq-ft)	Pre-Project Cover	Post-Project Cover	DMA Soil Type	BMP
3218_D_Bdg	22,140	Grass	Roofs	D	Library Pond_Existing
3218_D_Imp	53,626	Grass	ConventionalConcrete	D	Library Pond_Existing
3218_D_Perv1	201,064	Grass	Grass	D	Library Pond_Existing
3218_D_Perv2	304,657	Grass	Grass	D	Library Pond_Existing
3218_D_Rd	47,500	Grass	ConventionalConcrete	D	Library Pond_Existing
3402_B_Bdg	188,724	Grass	Roofs	B	Library Pond_Existing
3402_B_Imp	141,471	Grass	ConventionalConcrete	B	Library Pond_Existing
3402_B_Perv	385,991	Grass	Grass	B	Library Pond_Existing
3402_B_Rd	128,278	Grass	ConventionalConcrete	B	Library Pond_Existing
3402_C_Bdg	98,396	Grass	Roofs	C	Library Pond_Existing
3402_C_Imp	42,160	Grass	ConventionalConcrete	C	Library Pond_Existing
3402_C_Perv	429,486	Grass	Grass	C	Library Pond_Existing
3402_C_Rd	105,818	Grass	ConventionalConcrete	C	Library Pond_Existing

3414_B_Bdg	58,379	Grass	Roofs	B	Library Pond_Existing
3414_B_Imp	63,926	Grass	ConventionalConcrete	B	Library Pond_Existing
3414_B_Perv	209,761	Grass	Grass	B	Library Pond_Existing
3414_B_Rd	49,096	Grass	ConventionalConcrete	B	Library Pond_Existing
3414_C_Bdg	126,069	Grass	Roofs	C	Library Pond_Existing
3414_C_Imp	82,826	Grass	ConventionalConcrete	C	Library Pond_Existing
3414_C_Perv	308,800	Grass	Grass	C	Library Pond_Existing
3414_C_Rd	25,301	Grass	ConventionalConcrete	C	Library Pond_Existing
3414_D_Bdg	14,315	Grass	Roofs	D	Library Pond_Existing
3414_D_Imp	49,279	Grass	ConventionalConcrete	D	Library Pond_Existing
3414_D_Perv	109,766	Grass	Grass	D	Library Pond_Existing
3414_D_Rd	22,834	Grass	ConventionalConcrete	D	Library Pond_Existing
3417_D_Bdg	28,358	Grass	Roofs	D	Library Pond_Existing
3417_D_Imp	26,856	Grass	ConventionalConcrete	D	Library Pond_Existing
3417_D_Perv	74,227	Grass	Grass	D	Library Pond_Existing
3417_D_Rd	33,919	Grass	ConventionalConcrete	D	Library Pond_Existing
3418A_B_Bdg	104,425	Grass	Roofs	B	Library Pond_Existing
3418A_B_Imp	86,889	Grass	ConventionalConcrete	B	Library Pond_Existing
3418A_B_Perv	312,748	Grass	Grass	B	Library Pond_Existing
3418A_B_Rd	148,903	Grass	ConventionalConcrete	B	Library Pond_Existing
3418B_B_Bdg	88,068	Grass	Roofs	B	Library Pond_Existing
3418B_B_Imp	139,481	Grass	ConventionalConcrete	B	Library Pond_Existing
3418B_B_Perv	100,636	Grass	Grass	B	Library Pond_Existing

3418B_B_Rd	28,000	Grass	ConventionalConcrete	B	Library Pond_Existing
3420_B_Imp	23,265	Grass	ConventionalConcrete	B	Library Pond_Existing
3420_B_Perv	39,389	Grass	Grass	B	Library Pond_Existing
3420_B_Rd	32,226	Grass	ConventionalConcrete	B	Library Pond_Existing
3420_C_Bdg	109,273	Grass	Roofs	C	Library Pond_Existing
3420_C_Imp	275,853	Grass	ConventionalConcrete	C	Library Pond_Existing
3420_C_Perv	386,959	Grass	Grass	C	Library Pond_Existing
3420_C_Rd	9,675	Grass	ConventionalConcrete	C	Library Pond_Existing
3425_C_Bdg	68,156	Grass	Roofs	C	Library Pond_Existing
3425_C_Imp	68,156	Grass	ConventionalConcrete	C	Library Pond_Existing
3425_C_Perv	202,555	Grass	Grass	C	Library Pond_Existing
3425_C_Rd	259,711	Grass	ConventionalConcrete	C	Library Pond_Existing
3425_D_Bdg	11,387	Grass	Roofs	D	Library Pond_Existing
3425_D_Imp	31,398	Grass	ConventionalConcrete	D	Library Pond_Existing
3425_D_Perv	40,770	Grass	Grass	D	Library Pond_Existing
3436_C_Bdg	88,720	Grass	Roofs	C	Library Pond_Existing
3436_C_Imp	80,765	Grass	ConventionalConcrete	C	Library Pond_Existing
3436_C_Perv	238,917	Grass	Grass	C	Library Pond_Existing
3436_C_Rd	47,127	Grass	ConventionalConcrete	C	Library Pond_Existing
3436_D_Bdg	96,205	Grass	Roofs	D	Library Pond_Existing
3436_D_Imp	75,308	Grass	ConventionalConcrete	D	Library Pond_Existing
3436_D_Perv	257,884	Grass	Grass	D	Library Pond_Existing
3436_D_Rd	76,800	Grass	ConventionalConcrete	D	Library Pond_Existing

3443_D_Bdg	27,464	Grass	Roofs	D	Library Pond_Existing
3443_D_Imp	5,664	Grass	ConventionalConcrete	D	Library Pond_Existing
3443_D_Perv	99,259	Grass	Grass	D	Library Pond_Existing
3443_D_Rd	72,345	Grass	ConventionalConcrete	D	Library Pond_Existing
5038_B_Bdg	35,902	Grass	Roofs	B	Library Pond_Existing
5038_B_Imp	71,437	Grass	ConventionalConcrete	B	Library Pond_Existing
5038_B_Perv	305,799	Grass	Grass	B	Library Pond_Existing
5038_B_Rd	64,436	Grass	ConventionalConcrete	B	Library Pond_Existing
5038_C_Bdg	46,318	Grass	Roofs	C	Library Pond_Existing
5038_C_Imp	18,733	Grass	ConventionalConcrete	C	Library Pond_Existing
5038_C_Perv	105,053	Grass	Grass	C	Library Pond_Existing
5038_C_Rd	16,137	Grass	ConventionalConcrete	C	Library Pond_Existing

LID Facility Sizing Details

Pond Sizing Details

Pond ID	Design Criteria(1)	Facility Soil Type	Max Depth (ft)(2)	Top Area (sq-ft)	Side Slope (1:H)	Facility Vol. (cu-ft)(3)	Water Storage Vol. (cu-ft)(4)	Adequate Size?
Library Pond_Existing	FCWQT	B3	23.98	30,130.0	1	541,267.4	511,485.0	Yes

1. FCWQT = Flow control and water quality treatment, WQT = Water quality treatment only
2. Depth is measured from the bottom of the facility and includes the three feet of media (drain rock, separation layer and growing media).
3. Maximum volume of the facility. Includes the volume occupied by the media at the bottom of the facility.
4. Maximum water storage volume of the facility. Includes water storage in the three feet of soil media assuming a 40 percent porosity.

Simple Pond Geometry Configuration

Pond ID: Library Pond_Existing
Design: FlowControlAndTreatment

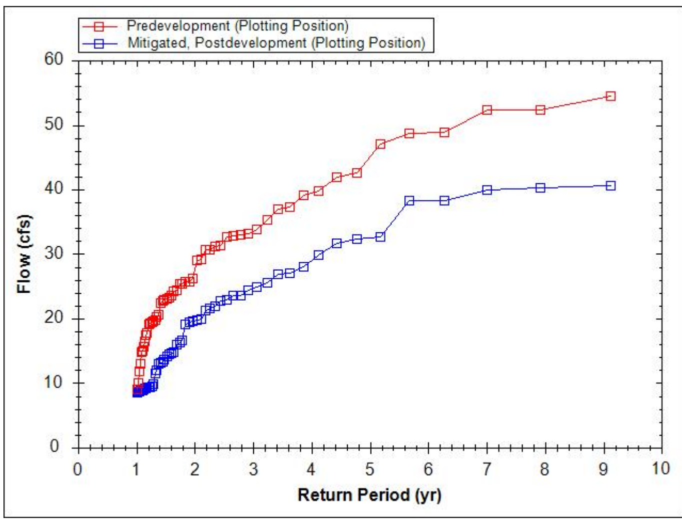
Shape Curve

Depth (ft)	Area (sq ft)
24.0	30,130.0

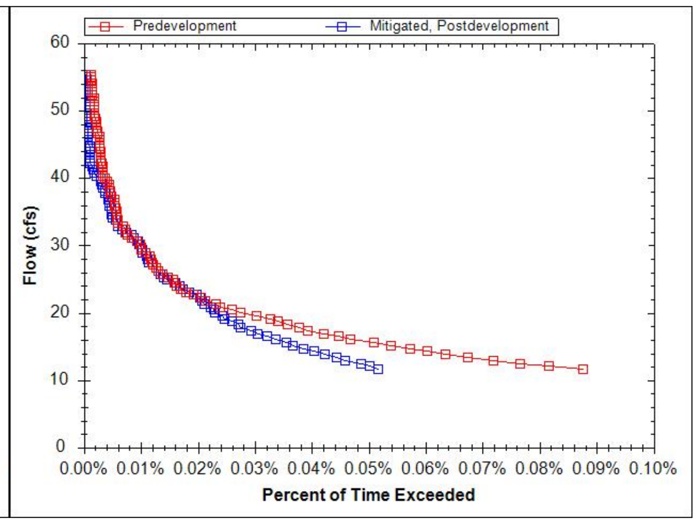
Outlet Structure Details

Lower Orifice Invert (ft)	0.0
Lower Orifice Dia (in)	9.5
Upper Orifice Invert(ft)	16.1
Upper Orifice Dia (in)	24.5
Overflow Weir Invert(ft)	23.0
Overflow Weir Length (ft)	6.3

Flow Frequency Chart



Flow Duration Chart



WES BMP Sizing Software Version 1.6.0.2, May 2018

WES BMP Sizing Report

Project Information

Project Name	Library Pond_Predevelopment (Oak Savanna) to Existing
Project Type	Planning
Location	
Stormwater Management Area	30130
Project Applicant	
Jurisdiction	OutofDistrict

Drainage Management Area

Name	Area (sq-ft)	Pre-Project Cover	Post-Project Cover	DMA Soil Type	BMP
3218_D_Bdg	22,140	Grass	Roofs	D	Library Pond_Existing
3218_D_Imp	53,626	Grass	ConventionalConcrete	D	NA
3218_D_Perv1	201,064	Grass	Grass	D	Library Pond_Existing
3218_D_Perv2	304,657	Grass	Grass	D	Library Pond_Existing
3218_D_Rd	47,500	Grass	ConventionalConcrete	D	NA
3402_B_Bdg	188,724	Grass	Roofs	B	Library Pond_Existing
3402_B_Imp	141,471	Grass	ConventionalConcrete	B	NA
3402_B_Perv	385,991	Grass	Grass	B	Library Pond_Existing
3402_B_Rd	128,278	Grass	ConventionalConcrete	B	NA
3402_C_Bdg	98,396	Grass	Roofs	C	Library Pond_Existing
3402_C_Imp	42,160	Grass	ConventionalConcrete	C	Library Pond_Existing
3402_C_Perv	429,486	Grass	Grass	C	Library Pond_Existing
3402_C_Rd	105,818	Grass	ConventionalConcrete	C	NA

3414_B_Bdg	58,379	Grass	Roofs	B	Library Pond_Existing
3414_B_Imp	63,926	Grass	ConventionalConcrete	B	Library Pond_Existing
3414_B_Perv	209,761	Grass	Grass	B	Library Pond_Existing
3414_B_Rd	49,096	Grass	ConventionalConcrete	B	NA
3414_C_Bdg	126,069	Grass	Roofs	C	Library Pond_Existing
3414_C_Imp	82,826	Grass	ConventionalConcrete	C	Library Pond_Existing
3414_C_Perv	308,800	Grass	Grass	C	Library Pond_Existing
3414_C_Rd	25,301	Grass	ConventionalConcrete	C	NA
3414_D_Bdg	14,315	Grass	Roofs	D	Library Pond_Existing
3414_D_Imp	49,279	Grass	ConventionalConcrete	D	Library Pond_Existing
3414_D_Perv	109,766	Grass	Grass	D	Library Pond_Existing
3414_D_Rd	22,834	Grass	ConventionalConcrete	D	NA
3417_D_Bdg	28,358	Grass	Roofs	D	Library Pond_Existing
3417_D_Imp	26,856	Grass	ConventionalConcrete	D	Library Pond_Existing
3417_D_Perv	74,227	Grass	Grass	D	Library Pond_Existing
3417_D_Rd	33,919	Grass	ConventionalConcrete	D	NA
3418A_B_Bdg	104,425	Grass	Roofs	B	Library Pond_Existing
3418A_B_Imp	86,889	Grass	ConventionalConcrete	B	NA
3418A_B_Perv	312,748	Grass	Grass	B	Library Pond_Existing
3418A_B_Rd	148,903	Grass	ConventionalConcrete	B	NA
3418B_B_Bdg	88,068	Grass	Roofs	B	Library Pond_Existing
3418B_B_Imp	139,481	Grass	ConventionalConcrete	B	NA
3418B_B_Perv	100,636	Grass	Grass	B	Library Pond_Existing

3418B_B_Rd	28,000	Grass	ConventionalConcrete	B	NA
3420_B_Imp	23,265	Grass	ConventionalConcrete	B	Library Pond_Existing
3420_B_Perv	39,389	Grass	Grass	B	Library Pond_Existing
3420_B_Rd	32,226	Grass	ConventionalConcrete	B	NA
3420_C_Bdg	109,273	Grass	Roofs	C	Library Pond_Existing
3420_C_Imp	275,853	Grass	ConventionalConcrete	C	Library Pond_Existing
3420_C_Perv	386,959	Grass	Grass	C	Library Pond_Existing
3420_C_Rd	9,675	Grass	ConventionalConcrete	C	NA
3425_C_Bdg	68,156	Grass	Roofs	C	Library Pond_Existing
3425_C_Imp	68,156	Grass	ConventionalConcrete	C	Library Pond_Existing
3425_C_Perv	202,555	Grass	Grass	C	Library Pond_Existing
3425_C_Rd	259,711	Grass	ConventionalConcrete	C	NA
3425_D_Bdg	11,387	Grass	Roofs	D	Library Pond_Existing
3425_D_Imp	31,398	Grass	ConventionalConcrete	D	Library Pond_Existing
3425_D_Perv	40,770	Grass	Grass	D	Library Pond_Existing
3436_C_Bdg	88,720	Grass	Roofs	C	Library Pond_Existing
3436_C_Imp	80,765	Grass	ConventionalConcrete	C	Library Pond_Existing
3436_C_Perv	238,917	Grass	Grass	C	Library Pond_Existing
3436_C_Rd	47,127	Grass	ConventionalConcrete	C	NA
3436_D_Bdg	96,205	Grass	Roofs	D	Library Pond_Existing
3436_D_Imp	75,308	Grass	ConventionalConcrete	D	Library Pond_Existing
3436_D_Perv	257,884	Grass	Grass	D	Library Pond_Existing
3436_D_Rd	76,800	Grass	ConventionalConcrete	D	NA

3443_D_Bdg	27,464	Grass	Roofs	D	Library Pond_Existing
3443_D_Imp	5,664	Grass	ConventionalConcrete	D	Library Pond_Existing
3443_D_Perv	99,259	Grass	Grass	D	Library Pond_Existing
3443_D_Rd	72,345	Grass	ConventionalConcrete	D	NA
5038_B_Bdg	35,902	Grass	Roofs	B	Library Pond_Existing
5038_B_Imp	71,437	Grass	ConventionalConcrete	B	Library Pond_Existing
5038_B_Perv	305,799	Grass	Grass	B	Library Pond_Existing
5038_B_Rd	64,436	Grass	ConventionalConcrete	B	NA
5038_C_Bdg	46,318	Grass	Roofs	C	Library Pond_Existing
5038_C_Imp	18,733	Grass	ConventionalConcrete	C	Library Pond_Existing
5038_C_Perv	105,053	Grass	Grass	C	Library Pond_Existing
5038_C_Rd	16,137	Grass	ConventionalConcrete	C	NA

LID Facility Sizing Details

Pond Sizing Details

Pond ID	Design Criteria(1)	Facility Soil Type	Max Depth (ft)(2)	Top Area (sq-ft)	Side Slope (1:H)	Facility Vol. (cu-ft)(3)	Water Storage Vol. (cu-ft)(4)	Adequate Size?
Library Pond_Existing	FCWQT	B3	15.08	30,130.0	3	258,676.8	243,359.2	Yes

1. FCWQT = Flow control and water quality treatment, WQT = Water quality treatment only
2. Depth is measured from the bottom of the facility and includes the three feet of media (drain rock, separation layer and growing media).
3. Maximum volume of the facility. Includes the volume occupied by the media at the bottom of the facility.
4. Maximum water storage volume of the facility. Includes water storage in the three feet of soil media assuming a 40 percent porosity.

Simple Pond Geometry Configuration

Pond ID: Library Pond_Existing
Design: FlowControlAndTreatment

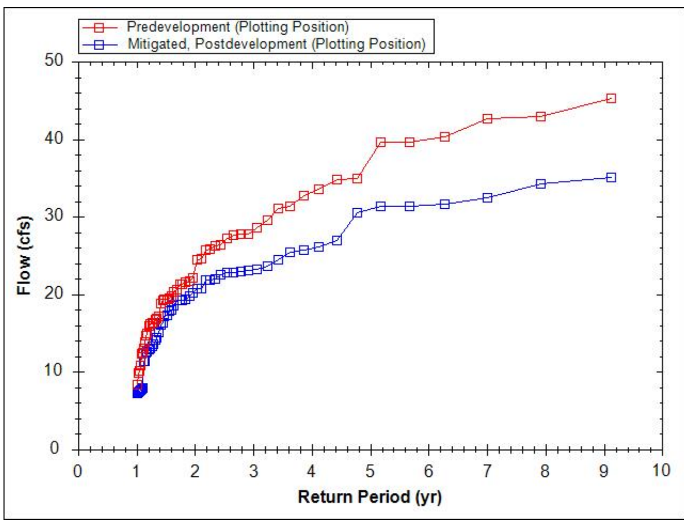
Shape Curve

Depth (ft)	Area (sq ft)
15.1	30,130.0

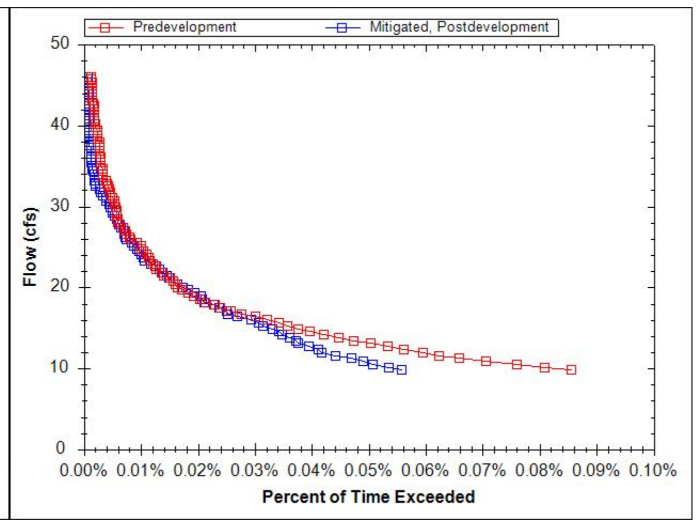
Outlet Structure Details

Lower Orifice Invert (ft)	0.0
Lower Orifice Dia (in)	9.9
Upper Orifice Invert(ft)	9.8
Upper Orifice Dia (in)	25.2
Overflow Weir Invert(ft)	13.6
Overflow Weir Length (ft)	6.3

Flow Frequency Chart



Flow Duration Chart



WES BMP Sizing Software Version 1.6.0.2, May 2018

WES BMP Sizing Report

Project Information

Project Name	Library Pond_Oak Savanna to Future
Project Type	Planning
Location	Wilsonville Public Library, 8200 SW Wilsonville Rd, Wilsonville, OR 97070
Stormwater Management Area	30130
Project Applicant	
Jurisdiction	OutofDistrict

Drainage Management Area

Name	Area (sq-ft)	Pre-Project Cover	Post-Project Cover	DMA Soil Type	BMP
5038_C_Perv	105,053	Grass	Grass	C	Library Pond_Future
5038_C_Rd	16,137	Grass	ConventionalConcrete	C	Library Pond_Future
5038_C_Bdg	50,147	Grass	Roofs	C	Library Pond_Future
5038_B_Perv	268,537	Grass	Grass	B	Library Pond_Future
5038_B_Rd	64,436	Grass	ConventionalConcrete	B	Library Pond_Future
5038_B_Bdg	36,815	Grass	Roofs	B	Library Pond_Future
5038_B_Imp	122,689	Grass	ConventionalConcrete	B	Library Pond_Future
3443_D_Perv	99,259	Grass	Grass	D	Library Pond_Future
3443_D_Rd	72,345	Grass	ConventionalConcrete	D	Library Pond_Future
3443_D_Bdg	27,464	Grass	Roofs	D	Library Pond_Future
3443_D_Imp	5,664	Grass	ConventionalConcrete	D	Library Pond_Future
3436_D_Perv	245,470	Grass	Grass	D	Library Pond_Future
3436_D_Rd	76,800	Grass	ConventionalCo	D	Library

			ncrete		Pond_Future
3436_D_Bdg	122,187	Grass	Roofs	D	Library Pond_Future
3436_D_Imp	61,740	Grass	ConventionalConcrete	D	Library Pond_Future
3436_C_Perv	213,971	Grass	Grass	C	Library Pond_Future
3436_C_Rd	47,127	Grass	ConventionalConcrete	C	Library Pond_Future
3436_C_Bdg	120,495	Grass	Roofs	C	Library Pond_Future
3436_C_Imp	73,935	Grass	ConventionalConcrete	C	Library Pond_Future
3425_D_Perv	40,770	Grass	Grass	D	Library Pond_Future
3425_D_Bdg	22,979	Grass	Roofs	D	Library Pond_Future
3425_D_Imp	19,807	Grass	ConventionalConcrete	D	Library Pond_Future
3425_C_Perv	202,555	Grass	Grass	C	Library Pond_Future
3425_C_Rd	259,711	Grass	ConventionalConcrete	C	Library Pond_Future
3425_C_Bdg	68,156	Grass	Roofs	C	Library Pond_Future
3425_C_Imp	68,156	Grass	ConventionalConcrete	C	Library Pond_Future
3420_C_Perv	379,853	Grass	Grass	C	Library Pond_Future
3420_C_Rd	9,675	Grass	ConventionalConcrete	C	Library Pond_Future
3420_C_Bdg	290,343	Grass	Roofs	C	Library Pond_Future
3420_C_Imp	101,889	Grass	ConventionalConcrete	C	Library Pond_Future
3420_B_Perv	39,389	Grass	Grass	B	Library Pond_Future
3420_B_Rd	32,226	Grass	ConventionalConcrete	B	Library Pond_Future
3420_B_Bdg	13,450	Grass	Roofs	B	Library Pond_Future
3420_B_Imp	9,815	Grass	ConventionalConcrete	B	Library Pond_Future
3418B_B_Perv	100,636	Grass	Grass	B	Library Pond_Future
3418B_B_Rd	28,000	Grass	ConventionalCo	B	Library

			ncrete		Pond_Future
3418B_B_Bdg	158,586	Grass	Roofs	B	Library Pond_Future
3418B_B_Imp	68,963	Grass	ConventionalCo ncrete	B	Library Pond_Future
3418A_B_Perv	312,748	Grass	Grass	B	Library Pond_Future
3418A_B_Rd	148,903	Grass	ConventionalCo ncrete	B	Library Pond_Future
3418A_B_Bdg	174,556	Grass	Roofs	B	Library Pond_Future
3418A_B_Imp	16,758	Grass	ConventionalCo ncrete	B	Library Pond_Future
3417_D_Perv	74,227	Grass	Grass	D	Library Pond_Future
3417_D_Rd	33,919	Grass	ConventionalCo ncrete	D	Library Pond_Future
3417_D_Bdg	55,214	Grass	Roofs	D	Library Pond_Future
3414_D_Perv	105,771	Grass	Grass	D	Library Pond_Future
3414_D_Rd	22,834	Grass	ConventionalCo ncrete	B	Library Pond_Future
3414_D_Bdg	52,414	Grass	Roofs	D	Library Pond_Future
3414_D_Imp	15,175	Grass	ConventionalCo ncrete	D	Library Pond_Future
3414_C_Perv	280,831	Grass	Grass	C	Library Pond_Future
3414_C_Rd	25,301	Grass	ConventionalCo ncrete	C	Library Pond_Future
3414_C_Bdg	236,864	Grass	Roofs	C	Library Pond_Future
3414_B_Perv	209,761	Grass	Grass	B	Library Pond_Future
3414_B_Rd	49,096	Grass	ConventionalCo ncrete	B	Library Pond_Future
3414_B_Bdg	88,565	Grass	Roofs	B	Library Pond_Future
3414_B_Imp	33,740	Grass	ConventionalCo ncrete	B	Library Pond_Future
3402_C_Perv	319,104	Grass	Grass	C	Library Pond_Future
3402_C_Rd	105,818	Grass	ConventionalCo ncrete	C	Library Pond_Future
3402_C_Bdg	250,938	Grass	Roofs	C	Library

					Pond_Future
3402_B_Perv	385,991	Grass	Grass	B	Library Pond_Future
3402_B_Rd	128,278	Grass	ConventionalConcrete	B	Library Pond_Future
3402_B_Bdg	330,195	Grass	Roofs	B	Library Pond_Future
3218_D_Perv	304,657	Grass	Grass	D	Library Pond_Future
3218_D_Rd	47,500	Grass	Grass	B	Library Pond_Future
3218_D_Bdg	22,140	Grass	Roofs	D	Library Pond_Future
3218_D_Imp	254,690	Grass	ConventionalConcrete	D	Library Pond_Future

LID Facility Sizing Details

Pond Sizing Details

Pond ID	Design Criteria(1)	Facility Soil Type	Max Depth (ft)(2)	Top Area (sq-ft)	Side Slope (1:H)	Facility Vol. (cu-ft)(3)	Water Storage Vol. (cu-ft)(4)	Adequate Size?
Library Pond_Future	FCWQT	B3	30.40	30,130.0	1	632,574.3	608,440.5	No

1. FCWQT = Flow control and water quality treatment, WQT = Water quality treatment only
2. Depth is measured from the bottom of the facility and includes the three feet of media (drain rock, separation layer and growing media).
3. Maximum volume of the facility. Includes the volume occupied by the media at the bottom of the facility.
4. Maximum water storage volume of the facility. Includes water storage in the three feet of soil media assuming a 40 percent porosity.

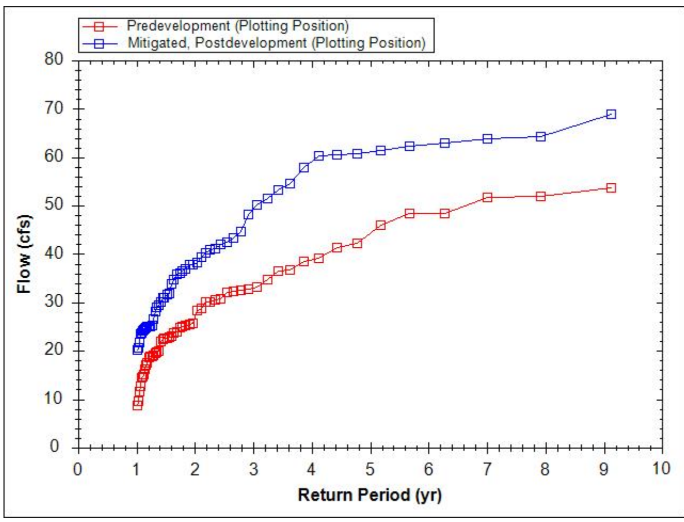
Custom Pond Geometry Configuration

Pond ID: Library Pond_Future
Design: FlowControlAndTreatment

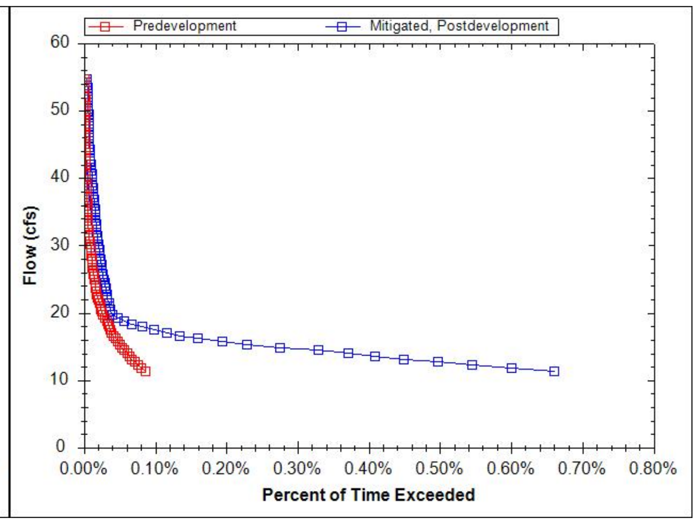
Shape Curve

Depth (ft)	Area (sq ft)	Discharge (cfs)
.0	.0	.0
1.0	10,018.0	9.4
2.0	17,859.0	14.3
5.0	23,522.0	19.7

Flow Frequency Chart



Flow Duration Chart



WES BMP Sizing Software Version 1.6.0.2, May 2018

WES BMP Sizing Report

Project Information

Project Name	Library Pond_Oak Savanna to Future
Project Type	Planning
Location	Wilsonville Public Library, 8200 SW Wilsonville Rd, Wilsonville, OR 97070
Stormwater Management Area	30130
Project Applicant	
Jurisdiction	OutofDistrict

Drainage Management Area

Name	Area (sq-ft)	Pre-Project Cover	Post-Project Cover	DMA Soil Type	BMP
5038_C_Perv	105,053	Grass	Grass	C	Library Pond_Future
5038_C_Rd	16,137	Grass	ConventionalConcrete	C	Library Pond_Future
5038_C_Bdg	50,147	Grass	Roofs	C	Library Pond_Future
5038_B_Perv	268,537	Grass	Grass	B	Library Pond_Future
5038_B_Rd	64,436	Grass	ConventionalConcrete	B	Library Pond_Future
5038_B_Bdg	36,815	Grass	Roofs	B	Library Pond_Future
5038_B_Imp	122,689	Grass	ConventionalConcrete	B	Library Pond_Future
3443_D_Perv	99,259	Grass	Grass	D	Library Pond_Future
3443_D_Rd	72,345	Grass	ConventionalConcrete	D	Library Pond_Future
3443_D_Bdg	27,464	Grass	Roofs	D	Library Pond_Future
3443_D_Imp	5,664	Grass	ConventionalConcrete	D	Library Pond_Future
3436_D_Perv	245,470	Grass	Grass	D	Library Pond_Future
3436_D_Rd	76,800	Grass	ConventionalCo	D	Library

			ncrete		Pond_Future
3436_D_Bdg	122,187	Grass	Roofs	D	Library Pond_Future
3436_D_Imp	61,740	Grass	ConventionalCo ncrete	D	Library Pond_Future
3436_C_Perv	213,971	Grass	Grass	C	Library Pond_Future
3436_C_Rd	47,127	Grass	ConventionalCo ncrete	C	Library Pond_Future
3436_C_Bdg	120,495	Grass	Roofs	C	Library Pond_Future
3436_C_Imp	73,935	Grass	ConventionalCo ncrete	C	Library Pond_Future
3425_D_Perv	40,770	Grass	Grass	D	Library Pond_Future
3425_D_Bdg	22,979	Grass	Roofs	D	Library Pond_Future
3425_D_Imp	19,807	Grass	ConventionalCo ncrete	D	Library Pond_Future
3425_C_Perv	202,555	Grass	Grass	C	Library Pond_Future
3425_C_Rd	259,711	Grass	ConventionalCo ncrete	C	Library Pond_Future
3425_C_Bdg	68,156	Grass	Roofs	C	Library Pond_Future
3425_C_Imp	68,156	Grass	ConventionalCo ncrete	C	Library Pond_Future
3420_C_Perv	379,853	Grass	Grass	C	Library Pond_Future
3420_C_Rd	9,675	Grass	ConventionalCo ncrete	C	Library Pond_Future
3420_C_Bdg	290,343	Grass	Roofs	C	Library Pond_Future
3420_C_Imp	101,889	Grass	ConventionalCo ncrete	C	Library Pond_Future
3420_B_Perv	39,389	Grass	Grass	B	Library Pond_Future
3420_B_Rd	32,226	Grass	ConventionalCo ncrete	B	Library Pond_Future
3420_B_Bdg	13,450	Grass	Roofs	B	Library Pond_Future
3420_B_Imp	9,815	Grass	ConventionalCo ncrete	B	Library Pond_Future
3418B_B_Perv	100,636	Grass	Grass	B	Library Pond_Future
3418B_B_Rd	28,000	Grass	ConventionalCo	B	Library

			ncrete		Pond_Future
3418B_B_Bdg	158,586	Grass	Roofs	B	Library Pond_Future
3418B_B_Imp	68,963	Grass	ConventionalConcrete	B	Library Pond_Future
3418A_B_Perv	312,748	Grass	Grass	B	Library Pond_Future
3418A_B_Rd	148,903	Grass	ConventionalConcrete	B	Library Pond_Future
3418A_B_Bdg	174,556	Grass	Roofs	B	Library Pond_Future
3418A_B_Imp	16,758	Grass	ConventionalConcrete	B	Library Pond_Future
3417_D_Perv	74,227	Grass	Grass	D	Library Pond_Future
3417_D_Rd	33,919	Grass	ConventionalConcrete	D	Library Pond_Future
3417_D_Bdg	55,214	Grass	Roofs	D	Library Pond_Future
3414_D_Perv	105,771	Grass	Grass	D	Library Pond_Future
3414_D_Rd	22,834	Grass	ConventionalConcrete	B	Library Pond_Future
3414_D_Bdg	52,414	Grass	Roofs	D	Library Pond_Future
3414_D_Imp	15,175	Grass	ConventionalConcrete	D	Library Pond_Future
3414_C_Perv	280,831	Grass	Grass	C	Library Pond_Future
3414_C_Rd	25,301	Grass	ConventionalConcrete	C	Library Pond_Future
3414_C_Bdg	236,864	Grass	Roofs	C	Library Pond_Future
3414_B_Perv	209,761	Grass	Grass	B	Library Pond_Future
3414_B_Rd	49,096	Grass	ConventionalConcrete	B	Library Pond_Future
3414_B_Bdg	88,565	Grass	Roofs	B	Library Pond_Future
3414_B_Imp	33,740	Grass	ConventionalConcrete	B	Library Pond_Future
3402_C_Perv	319,104	Grass	Grass	C	Library Pond_Future
3402_C_Rd	105,818	Grass	ConventionalConcrete	C	Library Pond_Future
3402_C_Bdg	250,938	Grass	Roofs	C	Library

					Pond_Future
3402_B_Perv	385,991	Grass	Grass	B	Library Pond_Future
3402_B_Rd	128,278	Grass	ConventionalConcrete	B	Library Pond_Future
3402_B_Bdg	330,195	Grass	Roofs	B	Library Pond_Future
3218_D_Perv	304,657	Grass	Grass	D	Library Pond_Future
3218_D_Rd	47,500	Grass	Grass	B	Library Pond_Future
3218_D_Bdg	22,140	Grass	Roofs	D	Library Pond_Future
3218_D_Imp	254,690	Grass	ConventionalConcrete	D	Library Pond_Future

LID Facility Sizing Details

Pond Sizing Details

Pond ID	Design Criteria(1)	Facility Soil Type	Max Depth (ft)(2)	Top Area (sq-ft)	Side Slope (1:H)	Facility Vol. (cu-ft)(3)	Water Storage Vol. (cu-ft)(4)	Adequate Size?
Library Pond_Future	FCWQT	B3	30.40	30,130.0	1	632,574.3	608,440.5	Yes

1. FCWQT = Flow control and water quality treatment, WQT = Water quality treatment only
2. Depth is measured from the bottom of the facility and includes the three feet of media (drain rock, separation layer and growing media).
3. Maximum volume of the facility. Includes the volume occupied by the media at the bottom of the facility.
4. Maximum water storage volume of the facility. Includes water storage in the three feet of soil media assuming a 40 percent porosity.

Simple Pond Geometry Configuration

Pond ID: Library Pond_Future
Design: FlowControlAndTreatment

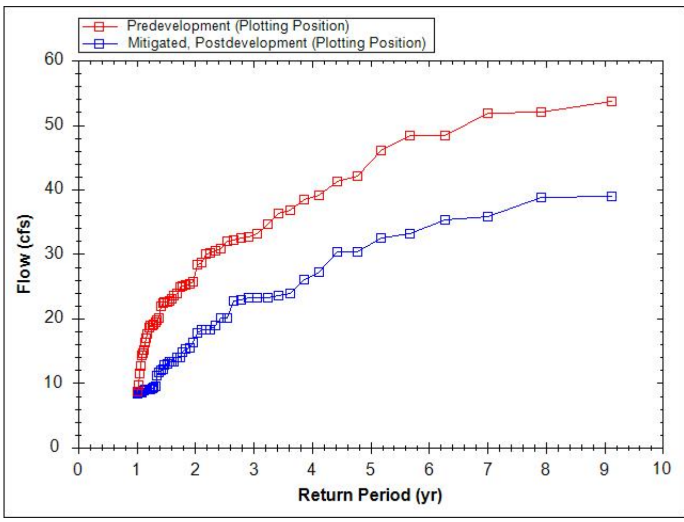
Shape Curve

Depth (ft)	Area (sq ft)
30.4	30,130.0

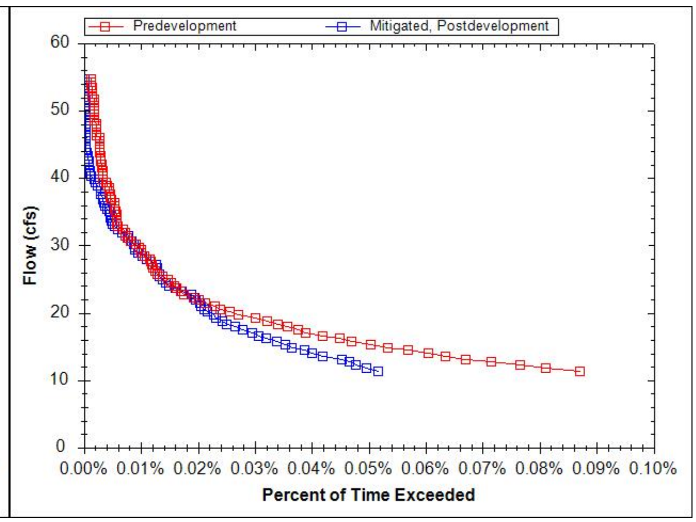
Outlet Structure Details

Lower Orifice Invert (ft)	0.0
Lower Orifice Dia (in)	7.5
Upper Orifice Invert(ft)	38.8
Upper Orifice Dia (in)	19.5
Overflow Weir Invert(ft)	56.9
Overflow Weir Length (ft)	6.3

Flow Frequency Chart



Flow Duration Chart



WES BMP Sizing Software Version 1.6.0.2, May 2018

WES BMP Sizing Report

Project Information

Project Name	Library Pond_Oak Savanna to Future
Project Type	Planning
Location	Wilsonville Public Library, 8200 SW Wilsonville Rd, Wilsonville, OR 97070
Stormwater Management Area	30130
Project Applicant	
Jurisdiction	OutofDistrict

Drainage Management Area

Name	Area (sq-ft)	Pre-Project Cover	Post-Project Cover	DMA Soil Type	BMP
5038_C_Perv	105,053	Grass	Grass	C	Library Pond_Future
5038_C_Rd	16,137	Grass	ConventionalConcrete	C	Planter 2
5038_C_Bdg	50,147	Grass	Roofs	C	Library Pond_Future
5038_B_Perv	268,537	Grass	Grass	B	Library Pond_Future
5038_B_Rd	64,436	Grass	ConventionalConcrete	B	Planter 2
5038_B_Bdg	36,815	Grass	Roofs	B	Library Pond_Future
5038_B_Imp	122,689	Grass	ConventionalConcrete	B	Library Pond_Future
3443_D_Perv	99,259	Grass	Grass	D	Library Pond_Future
3443_D_Rd	72,345	Grass	ConventionalConcrete	D	Planter 3
3443_D_Bdg	27,464	Grass	Roofs	D	Library Pond_Future
3443_D_Imp	5,664	Grass	ConventionalConcrete	D	Library Pond_Future
3436_D_Perv	245,470	Grass	Grass	D	Library Pond_Future
3436_D_Rd	76,800	Grass	ConventionalCo	D	Planter 2

			ncrete		
3436_D_Bdg	122,187	Grass	Roofs	D	Library Pond_Future
3436_D_Imp	61,740	Grass	ConventionalConcrete	D	Planter 4
3436_C_Perv	213,971	Grass	Grass	C	Library Pond_Future
3436_C_Rd	47,127	Grass	ConventionalConcrete	C	Planter 3
3436_C_Bdg	120,495	Grass	Roofs	C	Library Pond_Future
3436_C_Imp	73,935	Grass	ConventionalConcrete	C	Library Pond_Future
3425_D_Perv	40,770	Grass	Grass	D	Library Pond_Future
3425_D_Bdg	22,979	Grass	Roofs	D	Library Pond_Future
3425_D_Imp	19,807	Grass	ConventionalConcrete	D	Library Pond_Future
3425_C_Perv	202,555	Grass	Grass	C	Library Pond_Future
3425_C_Rd	259,711	Grass	ConventionalConcrete	C	Planter 1
3425_C_Bdg	68,156	Grass	Roofs	C	Library Pond_Future
3425_C_Imp	68,156	Grass	ConventionalConcrete	C	Library Pond_Future
3420_C_Perv	379,853	Grass	Grass	C	Library Pond_Future
3420_C_Rd	9,675	Grass	ConventionalConcrete	C	Planter 3
3420_C_Bdg	290,343	Grass	Roofs	C	Library Pond_Future
3420_C_Imp	101,889	Grass	ConventionalConcrete	C	Library Pond_Future
3420_B_Perv	39,389	Grass	Grass	B	Library Pond_Future
3420_B_Rd	32,226	Grass	ConventionalConcrete	B	Planter 3
3420_B_Bdg	13,450	Grass	Roofs	B	Planter 6
3420_B_Imp	9,815	Grass	ConventionalConcrete	B	Planter 4
3418B_B_Perv	100,636	Grass	Grass	B	Library Pond_Future
3418B_B_Rd	28,000	Grass	ConventionalConcrete	B	Planter 3

3418B_B_Bdg	158,586	Grass	Roofs	B	Library Pond_Future
3418B_B_Imp	68,963	Grass	ConventionalConcrete	B	Library Pond_Future
3418A_B_Perv	312,748	Grass	Grass	B	Library Pond_Future
3418A_B_Rd	148,903	Grass	ConventionalConcrete	B	Planter 2
3418A_B_Bdg	174,556	Grass	Roofs	B	Library Pond_Future
3418A_B_Imp	16,758	Grass	ConventionalConcrete	B	Library Pond_Future
3417_D_Perv	74,227	Grass	Grass	D	Library Pond_Future
3417_D_Rd	33,919	Grass	ConventionalConcrete	D	Planter 3
3417_D_Bdg	55,214	Grass	Roofs	D	Library Pond_Future
3414_D_Perv	105,771	Grass	Grass	D	Library Pond_Future
3414_D_Rd	22,834	Grass	ConventionalConcrete	B	Planter 2
3414_D_Bdg	52,414	Grass	Roofs	D	Library Pond_Future
3414_D_Imp	15,175	Grass	ConventionalConcrete	D	Library Pond_Future
3414_C_Perv	280,831	Grass	Grass	C	Library Pond_Future
3414_C_Rd	25,301	Grass	ConventionalConcrete	C	Planter 3
3414_C_Bdg	236,864	Grass	Roofs	C	Library Pond_Future
3414_B_Perv	209,761	Grass	Grass	B	Library Pond_Future
3414_B_Rd	49,096	Grass	ConventionalConcrete	B	Planter 3
3414_B_Bdg	88,565	Grass	Roofs	B	Library Pond_Future
3414_B_Imp	33,740	Grass	ConventionalConcrete	B	Library Pond_Future
3402_C_Perv	319,104	Grass	Grass	C	Library Pond_Future
3402_C_Rd	105,818	Grass	ConventionalConcrete	C	Planter 2
3402_C_Bdg	250,938	Grass	Roofs	C	Planter 6
3402_B_Perv	385,991	Grass	Grass	B	Library

					Pond_Future
3402_B_Rd	128,278	Grass	ConventionalConcrete	B	Planter 1
3402_B_Bdg	330,195	Grass	Roofs	B	Planter 5
3218_D_Perv	304,657	Grass	Grass	D	Library Pond_Future
3218_D_Rd	47,500	Grass	Grass	B	Planter 1
3218_D_Bdg	22,140	Grass	Roofs	D	Library Pond_Future
3218_D_Imp	254,690	Grass	ConventionalConcrete	D	Planter 4

LID Facility Sizing Details

LID ID	Design Criteria	BMP Type	Facility Soil Type	Minimum Area (sq-ft)	Planned Areas (sq-ft)	Orifice Diameter (in)
Planter 1	FlowControlAndTreatment	Stormwater Planter - Infiltration	B3	31,696.4	31,697.0	0.0
Planter 2	FlowControlAndTreatment	Stormwater Planter - Infiltration	B3	43,376.2	43,377.0	0.0
Planter 3	FlowControlAndTreatment	Stormwater Planter - Infiltration	B3	23,933.0	23,933.0	0.0
Planter 4	FlowControlAndTreatment	Stormwater Planter - Infiltration	B3	14,129.5	14,357.0	0.0
Planter 5	FlowControlAndTreatment	Stormwater Planter - Infiltration	B3	49,529.3	54,273.0	0.0
Planter 6	FlowControlAndTreatment	Stormwater Planter - Infiltration	B3	12,055.0	12,247.0	0.0

Pond Sizing Details

Pond ID	Design Criteria(1)	Facility Soil Type	Max Depth (ft)(2)	Top Area (sq-ft)	Side Slope (1:H)	Facility Vol. (cu-ft)(3)	Water Storage Vol. (cu-ft)(4)	Adequate Size?
Library Pond_Future	FCWQT	B3	15.04	30,130.0	3	258,400.3	243,002.9	Yes

1. FCWQT = Flow control and water quality treatment, WQT = Water quality treatment only
2. Depth is measured from the bottom of the facility and includes the three feet of media (drain rock, separation layer and growing media).
3. Maximum volume of the facility. Includes the volume occupied by the media at the bottom of the facility.

4. Maximum water storage volume of the facility. Includes water storage in the three feet of soil media assuming a 40 percent porosity.

Simple Pond Geometry Configuration

Pond ID: Library Pond_Future
Design: FlowControlAndTreatment

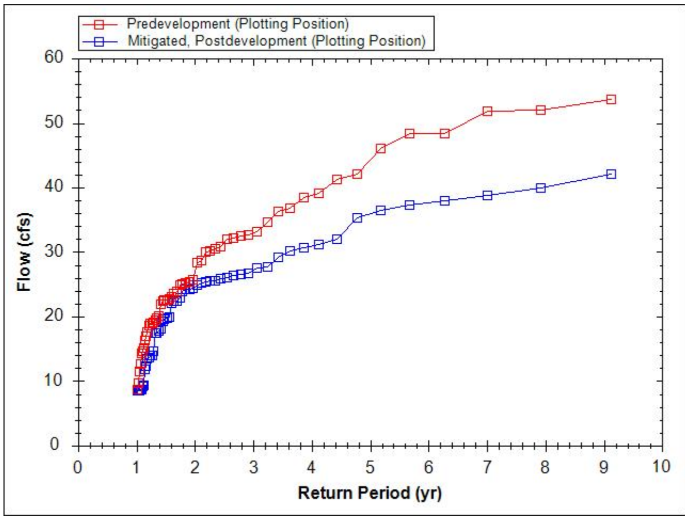
Shape Curve

Depth (ft)	Area (sq ft)
15.0	30,130.0

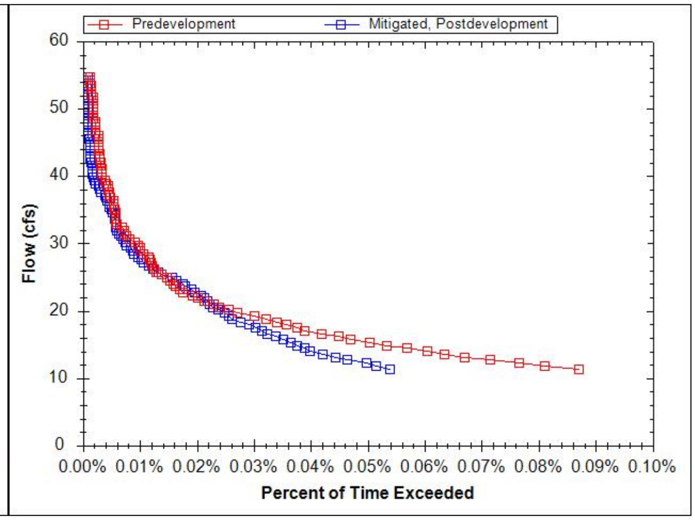
Outlet Structure Details

Lower Orifice Invert (ft)	0.0
Lower Orifice Dia (in)	10.6
Upper Orifice Invert(ft)	10.1
Upper Orifice Dia (in)	27.4
Overflow Weir Invert(ft)	14.0
Overflow Weir Length (ft)	6.3

Flow Frequency Chart



Flow Duration Chart



WES BMP Sizing Software Version 1.6.0.2, May 2018

WES BMP Sizing Report

Project Information

Project Name	Library Pond_Existing to Future
Project Type	Planning
Location	Wilsonville Public Library, 8200 SW Wilsonville Rd, Wilsonville, OR 97070
Stormwater Management Area	30130
Project Applicant	
Jurisdiction	OutofDistrict

Drainage Management Area

Name	Area (sq-ft)	Pre-Project Cover	Post-Project Cover	DMA Soil Type	BMP
3417_D_Ex_Imp_Fu_Bdg	26,856	Impervious	Roofs	D	Library Pond_existing to future
5038_C_Ex_Perv_Fu_Perv	105,053	Grass	Grass	C	Library Pond_existing to future
5038_C_Ex_Rd_Fu_Rd	16,137	Impervious	ConventionalConcrete	C	Library Pond_existing to future
5038_C_Ex_Bdg_Fu_Bdg	46,318	Impervious	Roofs	C	Library Pond_existing to future
5038_C_Ex_Imp_Fu_Bdg	3,829	Impervious	Roofs	C	Library Pond_existing to future
5038_C_Ex_Imp_Fu_Imp	14,903	Impervious	ConventionalConcrete	C	Library Pond_existing to future
5038_B_Ex_Perv_Fu_Imp	37,262	Grass	ConventionalConcrete	B	Library Pond_existing to future
5038_B_Ex_Perv_Fu_Perv	268,537	Grass	Grass	B	Library Pond_existing to future
5038_B_Ex_Rd_Fu_Rd	64,436	Impervious	ConventionalConcrete	B	Library Pond_existing to future

5038_B_Ex_Bdg_Fu_Bdg	35,902	Impervious	Roofs	B	Library Pond_existing to future
5038_B_Ex_Imp_Fu_Bdg	913	Impervious	Roofs	B	Library Pond_existing to future
5038_B_Ex_Imp_Fu_Imp	70,524	Impervious	ConventionalConcrete	B	Library Pond_existing to future
3436_D_Ex_Perv_Fu_Imp	12,414	Grass	ConventionalConcrete	D	Library Pond_existing to future
3436_D_Ex_Perv_Fu_Perv	245,470	Grass	Grass	D	Library Pond_existing to future
3436_D_Ex_Rd_Fu_Rd	76,800	Impervious	ConventionalConcrete	D	Library Pond_existing to future
3436_D_Ex_Bdg_Fu_Bdg	96,205	Impervious	Roofs	D	Library Pond_existing to future
3436_D_Ex_Imp_Fu_Bdg	25,982	Impervious	Roofs	D	Library Pond_existing to future
3436_D_Ex_Imp_Fu_Imp	49,326	Impervious	ConventionalConcrete	D	Library Pond_existing to future
3436_C_Ex_Perv_Fu_Bgd	12,532	Grass	Roofs	C	Library Pond_existing to future
3436_C_Ex_Perv_Fu_Imp	12,414	Grass	ConventionalConcrete	C	Library Pond_existing to future
3436_C_Ex_Perv_Fu_Perv	213,971	Grass	Grass	C	Library Pond_existing to future
3436_C_Ex_Rd_Fu_Rd	47,127	Impervious	ConventionalConcrete	C	Library Pond_existing to future
3436_C_Ex_Bdg_Fu_Bdg	88,720	Impervious	Roofs	C	Library Pond_existing to future
3436_C_Ex_Imp_Fu_Bdg	19,243	Impervious	Roofs	C	Library Pond_existing to future
3436_C_Ex_Imp_Fu_Imp	61,521	Impervious	ConventionalConcrete	C	Library Pond_existing to future
3425_D_Ex_Pe	40,770	Grass	Grass	D	Library

rv_Fu_Perv					Pond_existing to future
3425_D_Ex_Bdg_Fu_Bdg	11,387	Impervious	Roofs	D	Library Pond_existing to future
3425_D_Ex_Imp_Fu_Bdg3425_D_Ex_Imp_Fu_Bdg	11,592	Impervious	Roofs	D	Library Pond_existing to future
3425_D_Ex_Imp_Fu_Imp	19,807	Impervious	ConventionalConcrete	D	Library Pond_existing to future
3425_C_Ex_Perv_Fu_Perv	202,555	Grass	Grass	C	Library Pond_existing to future
3425_C_Ex_Rd_Fu_Rd	259,711	Impervious	ConventionalConcrete	C	Library Pond_existing to future
3425_C_Ex_Bdg_Fu_Bdg	68,156	Impervious	Roofs	C	Library Pond_existing to future
3425_C_Ex_Imp_Fu_Imp	68,156	Impervious	ConventionalConcrete	C	Library Pond_existing to future
3420_C_Ex_Perv_Fu_Bgd	7,106	Grass	Roofs	C	Library Pond_existing to future
3420_C_Ex_Perv_Fu_Perv	379,853	Grass	Grass	C	Library Pond_existing to future
3420_C_Ex_Rd_Fu_Rd	9,675	Impervious	ConventionalConcrete	C	Library Pond_existing to future
3420_C_Ex_Bdg_Fu_Bdg	109,273	Impervious	Roofs	C	Library Pond_existing to future
3420_C_Ex_Imp_Fu_Bdg	173,964	Impervious	Roofs	C	Library Pond_existing to future
3420_C_Ex_Imp_Fu_Imp	101,889	Impervious	ConventionalConcrete	C	Library Pond_existing to future
3420_B_Ex_Perv_Fu_Perv	39,389	Grass	Grass	B	Library Pond_existing to future
3420_B_Ex_Rd_Fu_Rd	32,226	Impervious	ConventionalConcrete	B	Library Pond_existing to future
3420_B_Ex_Im	13,450	Impervious	Roofs	B	Library

p_Fu_Bdg					Pond_existing to future
3420_B_Ex_Imp_Fu_Imp	9,815	Impervious	ConventionalConcrete	B	Library Pond_existing to future
3418B_B_Ex_Perv_Fu_Perv	100,636	Grass	Grass	B	Library Pond_existing to future
3418B_B_Ex_Rd_Fu_Rd	28,000	Impervious	ConventionalConcrete	B	Library Pond_existing to future
3418B_B_Ex_Bdg_Fu_Bdg	88,068	Impervious	Roofs	B	Library Pond_existing to future
3418B_B_Ex_Imp_Fu_Bdg	70,518	Impervious	Roofs	B	Library Pond_existing to future
3418B_B_Ex_Imp_Fu_Imp	68,963	Impervious	ConventionalConcrete	B	Library Pond_existing to future
3418A_B_Ex_Perv_Fu_Perv	312,748	Grass	Grass	B	Library Pond_existing to future
3418A_B_Ex_Rd_Fu_Rd	148,903	Impervious	ConventionalConcrete	B	Library Pond_existing to future
3418A_B_Ex_Bdg_Fu_Bdg	104,425	Impervious	Roofs	B	Library Pond_existing to future
3418A_B_Ex_Imp_Fu_Bdg	70,131	Impervious	Roofs	B	Library Pond_existing to future
3418A_B_Ex_Imp_Fu_Imp	16,758	Impervious	ConventionalConcrete	B	Library Pond_existing to future
3443_D_Ex_Perv_Fu_Perv	99,259	Grass	Grass	D	Library Pond_existing to future
3443_D_Ex_Rd_Fu_Rd	72,345	Impervious	ConventionalConcrete	D	Library Pond_existing to future
3443_D_Ex_Bdg_Fu_Bdg	27,464	Impervious	Roofs	D	Library Pond_existing to future
3443_D_Ex_Imp_Fu_Imp	5,664	Impervious	ConventionalConcrete	D	Library Pond_existing to future
3402_C_Ex_Perv_Fu_Bgd	110,382	Grass	Roofs	C	Library Pond_existing

					to future
3402_C_Ex_Perv_Fu_Perv	319,104	Grass	Grass	C	Library Pond_existing to future
3402_C_Ex_Rd_Fu_Rd	105,818	Impervious	ConventionalConcrete	C	Library Pond_existing to future
3402_C_Ex_Bdg_Fu_Bdg	98,396	Impervious	Roofs	C	Library Pond_existing to future
3402_C_Ex_Imp_Fu_Bdg	42,160	Impervious	Roofs	C	Library Pond_existing to future
3402_B_Ex_Perv_Fu_Perv	385,992	Grass	Grass	B	Library Pond_existing to future
3402_B_Ex_Rd_Fu_Rd	128,278	Impervious	ConventionalConcrete	B	Library Pond_existing to future
3402_B_Ex_Bdg_Fu_Bdg	188,724	Impervious	Roofs	B	Library Pond_existing to future
3402_B_Ex_Imp_Fu_Bdg	141,471	Impervious	Roofs	B	Library Pond_existing to future
3218_D_Ex_Perv_Fu_Imp	201,064	Grass	ConventionalConcrete	D	Library Pond_existing to future
3218_D_Ex_Perv_Fu_Perv	304,657	Grass	Grass	D	Library Pond_existing to future
3218_D_Ex_Rd_Fu_Rd	47,500	Impervious	ConventionalConcrete	D	Library Pond_existing to future
3218_D_Ex_Bdg_Fu_Bdg	22,140	Impervious	Roofs	D	Library Pond_existing to future
3218_D_Ex_Imp_Fu_Imp	53,626	Impervious	ConventionalConcrete	D	Library Pond_existing to future
3417_D_Ex_Bdg_Fu_Bdg	28,358	Impervious	Roofs	D	Library Pond_existing to future
3417_D_Ex_Rd_Fu_Rd	33,919	Impervious	ConventionalConcrete	D	Library Pond_existing to future
3417_D_Ex_Perv_Fu_Perv	74,227	Grass	Grass	D	Library Pond_existing to future

3414_B_Ex_Imp_Fu_Imp	33,740	Impervious	ConventionalConcrete	B	Library Pond_existing to future
3414_B_Ex_Imp_Fu_Bdg	30,186	Impervious	Roofs	B	Library Pond_existing to future
3414_B_Ex_Bdg_Fu_Bdg	58,379	Impervious	Roofs	B	Library Pond_existing to future
3414_B_Ex_Rd_Fu_Rd	49,096	Impervious	ConventionalConcrete	B	Library Pond_existing to future
3414_B_Ex_Perv_Fu_Perv	209,761	Grass	Grass	B	Library Pond_existing to future
3414_C_Ex_Imp_Fu_Bdg	82,826	Impervious	Roofs	C	Library Pond_existing to future
3414_C_Ex_Bdg_Fu_Bdg	126,069	Impervious	Roofs	C	Library Pond_existing to future
3414_C_Ex_Rd_Fu_Rd	25,301	Impervious	ConventionalConcrete	C	Library Pond_existing to future
3414_C_Ex_Perv_Fu_Perv	280,831	Grass	Grass	C	Library Pond_existing to future
3414_C_Ex_Perv_Fu_Bgd	27,969	Grass	Roofs	C	Library Pond_existing to future
3414_D_Ex_Imp_Fu_Imp	11,180	Impervious	ConventionalConcrete	D	Library Pond_existing to future
3414_D_Ex_Imp_Fu_Bdg	38,099	Impervious	Roofs	D	Library Pond_existing to future
3414_D_Ex_Bdg_Fu_Bdg	14,315	Impervious	Roofs	D	Library Pond_existing to future
3414_D_Ex_Rd_Fu_Rd	22,834	Impervious	ConventionalConcrete	D	Library Pond_existing to future
3414_D_Ex_Perv_Fu_Perv	105,771	Grass	Grass	D	Library Pond_existing to future
3414_D_Ex_Perv_Fu_Imp	3,995	Grass	ConventionalConcrete	D	Library Pond_existing to future

LID Facility Sizing Details

Pond Sizing Details

Pond ID	Design Criteria(1)	Facility Soil Type	Max Depth (ft)(2)	Top Area (sq-ft)	Side Slope (1:H)	Facility Vol. (cu-ft)(3)	Water Storage Vol. (cu-ft)(4)	Adequate Size?
Library Pond_existing to future	FCWQT	B3	7.09	30,130.0	4	151,419.6	121,444.8	No

1. FCWQT = Flow control and water quality treatment, WQT = Water quality treatment only
2. Depth is measured from the bottom of the facility and includes the three feet of media (drain rock, separation layer and growing media).
3. Maximum volume of the facility. Includes the volume occupied by the media at the bottom of the facility.
4. Maximum water storage volume of the facility. Includes water storage in the three feet of soil media assuming a 40 percent porosity.

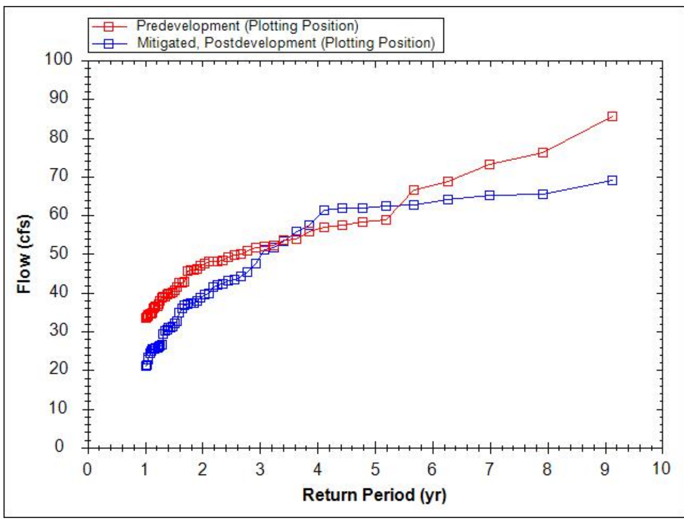
Custom Pond Geometry Configuration

Pond ID: Library Pond_existing to future
Design: FlowControlAndTreatment

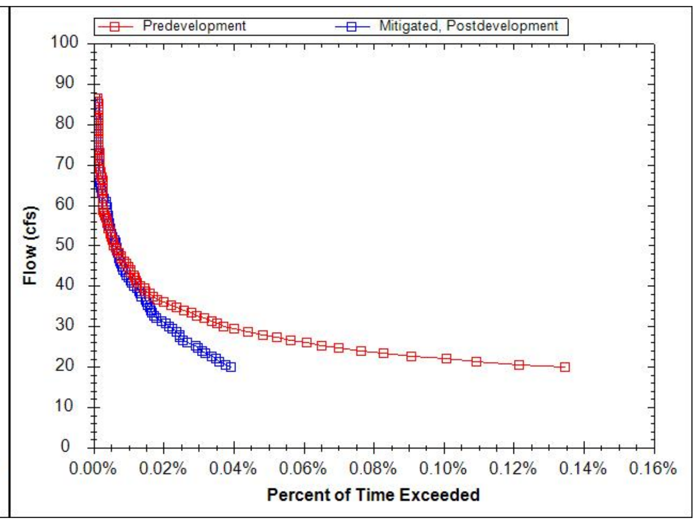
Shape Curve

Depth (ft)	Area (sq ft)	Discharge (cfs)
.0	.0	.0
1.0	10,018.0	9.4
2.0	17,859.0	14.3
5.0	23,522.0	19.7

Flow Frequency Chart



Flow Duration Chart



WES BMP Sizing Software Version 1.6.0.2, May 2018

WES BMP Sizing Report

Project Information

Project Name	Library Pond_Existing to Future
Project Type	Planning
Location	Wilsonville Public Library, 8200 SW Wilsonville Rd, Wilsonville, OR 97070
Stormwater Management Area	30130
Project Applicant	
Jurisdiction	OutofDistrict

Drainage Management Area

Name	Area (sq-ft)	Pre-Project Cover	Post-Project Cover	DMA Soil Type	BMP
3417_D_Ex_Imp_Fu_Bdg	26,856	Impervious	Roofs	D	Library Pond_existing to future
5038_C_Ex_Perv_Fu_Perv	105,053	Grass	Grass	C	Library Pond_existing to future
5038_C_Ex_Rd_Fu_Rd	16,137	Impervious	ConventionalConcrete	C	Library Pond_existing to future
5038_C_Ex_Bdg_Fu_Bdg	46,318	Impervious	Roofs	C	Library Pond_existing to future
5038_C_Ex_Imp_Fu_Bdg	3,829	Impervious	Roofs	C	Library Pond_existing to future
5038_C_Ex_Imp_Fu_Imp	14,903	Impervious	ConventionalConcrete	C	Library Pond_existing to future
5038_B_Ex_Perv_Fu_Imp	37,262	Grass	ConventionalConcrete	B	Library Pond_existing to future
5038_B_Ex_Perv_Fu_Perv	268,537	Grass	Grass	B	Library Pond_existing to future
5038_B_Ex_Rd_Fu_Rd	64,436	Impervious	ConventionalConcrete	B	Library Pond_existing to future

5038_B_Ex_Bdg_Fu_Bdg	35,902	Impervious	Roofs	B	Library Pond_existing to future
5038_B_Ex_Imp_Fu_Bdg	913	Impervious	Roofs	B	Library Pond_existing to future
5038_B_Ex_Imp_Fu_Imp	70,524	Impervious	ConventionalConcrete	B	Library Pond_existing to future
3436_D_Ex_Perv_Fu_Imp	12,414	Grass	ConventionalConcrete	D	Library Pond_existing to future
3436_D_Ex_Perv_Fu_Perv	245,470	Grass	Grass	D	Library Pond_existing to future
3436_D_Ex_Rd_Fu_Rd	76,800	Impervious	ConventionalConcrete	D	Library Pond_existing to future
3436_D_Ex_Bdg_Fu_Bdg	96,205	Impervious	Roofs	D	Library Pond_existing to future
3436_D_Ex_Imp_Fu_Bdg	25,982	Impervious	Roofs	D	Library Pond_existing to future
3436_D_Ex_Imp_Fu_Imp	49,326	Impervious	ConventionalConcrete	D	Library Pond_existing to future
3436_C_Ex_Perv_Fu_Bgd	12,532	Grass	Roofs	C	Library Pond_existing to future
3436_C_Ex_Perv_Fu_Imp	12,414	Grass	ConventionalConcrete	C	Library Pond_existing to future
3436_C_Ex_Perv_Fu_Perv	213,971	Grass	Grass	C	Library Pond_existing to future
3436_C_Ex_Rd_Fu_Rd	47,127	Impervious	ConventionalConcrete	C	Library Pond_existing to future
3436_C_Ex_Bdg_Fu_Bdg	88,720	Impervious	Roofs	C	Library Pond_existing to future
3436_C_Ex_Imp_Fu_Bdg	19,243	Impervious	Roofs	C	Library Pond_existing to future
3436_C_Ex_Imp_Fu_Imp	61,521	Impervious	ConventionalConcrete	C	Library Pond_existing to future
3425_D_Ex_Pe	40,770	Grass	Grass	D	Library

rv_Fu_Perv					Pond_existing to future
3425_D_Ex_Bdg_Fu_Bdg	11,387	Impervious	Roofs	D	Library Pond_existing to future
3425_D_Ex_Imp_Fu_Bdg3425_D_Ex_Imp_Fu_Bdg	11,592	Impervious	Roofs	D	Library Pond_existing to future
3425_D_Ex_Imp_Fu_Imp	19,807	Impervious	ConventionalConcrete	D	Library Pond_existing to future
3425_C_Ex_Perv_Fu_Perv	202,555	Grass	Grass	C	Library Pond_existing to future
3425_C_Ex_Rd_Fu_Rd	259,711	Impervious	ConventionalConcrete	C	Library Pond_existing to future
3425_C_Ex_Bdg_Fu_Bdg	68,156	Impervious	Roofs	C	Library Pond_existing to future
3425_C_Ex_Imp_Fu_Imp	68,156	Impervious	ConventionalConcrete	C	Library Pond_existing to future
3420_C_Ex_Perv_Fu_Bgd	7,106	Grass	Roofs	C	Library Pond_existing to future
3420_C_Ex_Perv_Fu_Perv	379,853	Grass	Grass	C	Library Pond_existing to future
3420_C_Ex_Rd_Fu_Rd	9,675	Impervious	ConventionalConcrete	C	Library Pond_existing to future
3420_C_Ex_Bdg_Fu_Bdg	109,273	Impervious	Roofs	C	Library Pond_existing to future
3420_C_Ex_Imp_Fu_Bdg	173,964	Impervious	Roofs	C	Library Pond_existing to future
3420_C_Ex_Imp_Fu_Imp	101,889	Impervious	ConventionalConcrete	C	Library Pond_existing to future
3420_B_Ex_Perv_Fu_Perv	39,389	Grass	Grass	B	Library Pond_existing to future
3420_B_Ex_Rd_Fu_Rd	32,226	Impervious	ConventionalConcrete	B	Library Pond_existing to future
3420_B_Ex_Im	13,450	Impervious	Roofs	B	Library

p_Fu_Bdg					Pond_existing to future
3420_B_Ex_Imp_Fu_Imp	9,815	Impervious	ConventionalConcrete	B	Library Pond_existing to future
3418B_B_Ex_Perv_Fu_Perv	100,636	Grass	Grass	B	Library Pond_existing to future
3418B_B_Ex_Rd_Fu_Rd	28,000	Impervious	ConventionalConcrete	B	Library Pond_existing to future
3418B_B_Ex_Bdg_Fu_Bdg	88,068	Impervious	Roofs	B	Library Pond_existing to future
3418B_B_Ex_Imp_Fu_Bdg	70,518	Impervious	Roofs	B	Library Pond_existing to future
3418B_B_Ex_Imp_Fu_Imp	68,963	Impervious	ConventionalConcrete	B	Library Pond_existing to future
3418A_B_Ex_Perv_Fu_Perv	312,748	Grass	Grass	B	Library Pond_existing to future
3418A_B_Ex_Rd_Fu_Rd	148,903	Impervious	ConventionalConcrete	B	Library Pond_existing to future
3418A_B_Ex_Bdg_Fu_Bdg	104,425	Impervious	Roofs	B	Library Pond_existing to future
3418A_B_Ex_Imp_Fu_Bdg	70,131	Impervious	Roofs	B	Library Pond_existing to future
3418A_B_Ex_Imp_Fu_Imp	16,758	Impervious	ConventionalConcrete	B	Library Pond_existing to future
3443_D_Ex_Perv_Fu_Perv	99,259	Grass	Grass	D	Library Pond_existing to future
3443_D_Ex_Rd_Fu_Rd	72,345	Impervious	ConventionalConcrete	D	Library Pond_existing to future
3443_D_Ex_Bdg_Fu_Bdg	27,464	Impervious	Roofs	D	Library Pond_existing to future
3443_D_Ex_Imp_Fu_Imp	5,664	Impervious	ConventionalConcrete	D	Library Pond_existing to future
3402_C_Ex_Perv_Fu_Bgd	110,382	Grass	Roofs	C	Library Pond_existing

					to future
3402_C_Ex_Perv_Fu_Perv	319,104	Grass	Grass	C	Library Pond_existing to future
3402_C_Ex_Rd_Fu_Rd	105,818	Impervious	ConventionalConcrete	C	Library Pond_existing to future
3402_C_Ex_Bdg_Fu_Bdg	98,396	Impervious	Roofs	C	Library Pond_existing to future
3402_C_Ex_Imp_Fu_Bdg	42,160	Impervious	Roofs	C	Library Pond_existing to future
3402_B_Ex_Perv_Fu_Perv	385,992	Grass	Grass	B	Library Pond_existing to future
3402_B_Ex_Rd_Fu_Rd	128,278	Impervious	ConventionalConcrete	B	Library Pond_existing to future
3402_B_Ex_Bdg_Fu_Bdg	188,724	Impervious	Roofs	B	Library Pond_existing to future
3402_B_Ex_Imp_Fu_Bdg	141,471	Impervious	Roofs	B	Library Pond_existing to future
3218_D_Ex_Perv_Fu_Imp	201,064	Grass	ConventionalConcrete	D	Library Pond_existing to future
3218_D_Ex_Perv_Fu_Perv	304,657	Grass	Grass	D	Library Pond_existing to future
3218_D_Ex_Rd_Fu_Rd	47,500	Impervious	ConventionalConcrete	D	Library Pond_existing to future
3218_D_Ex_Bdg_Fu_Bdg	22,140	Impervious	Roofs	D	Library Pond_existing to future
3218_D_Ex_Imp_Fu_Imp	53,626	Impervious	ConventionalConcrete	D	Library Pond_existing to future
3417_D_Ex_Bdg_Fu_Bdg	28,358	Impervious	Roofs	D	Library Pond_existing to future
3417_D_Ex_Rd_Fu_Rd	33,919	Impervious	ConventionalConcrete	D	Library Pond_existing to future
3417_D_Ex_Perv_Fu_Perv	74,227	Grass	Grass	D	Library Pond_existing to future

3414_B_Ex_Imp_Fu_Imp	33,740	Impervious	ConventionalConcrete	B	Library Pond_existing to future
3414_B_Ex_Imp_Fu_Bdg	30,186	Impervious	Roofs	B	Library Pond_existing to future
3414_B_Ex_Bdg_Fu_Bdg	58,379	Impervious	Roofs	B	Library Pond_existing to future
3414_B_Ex_Rd_Fu_Rd	49,096	Impervious	ConventionalConcrete	B	Library Pond_existing to future
3414_B_Ex_Perv_Fu_Perv	209,761	Grass	Grass	B	Library Pond_existing to future
3414_C_Ex_Imp_Fu_Bdg	82,826	Impervious	Roofs	C	Library Pond_existing to future
3414_C_Ex_Bdg_Fu_Bdg	126,069	Impervious	Roofs	C	Library Pond_existing to future
3414_C_Ex_Rd_Fu_Rd	25,301	Impervious	ConventionalConcrete	C	Library Pond_existing to future
3414_C_Ex_Perv_Fu_Perv	280,831	Grass	Grass	C	Library Pond_existing to future
3414_C_Ex_Perv_Fu_Bgd	27,969	Grass	Roofs	C	Library Pond_existing to future
3414_D_Ex_Imp_Fu_Imp	11,180	Impervious	ConventionalConcrete	D	Library Pond_existing to future
3414_D_Ex_Imp_Fu_Bdg	38,099	Impervious	Roofs	D	Library Pond_existing to future
3414_D_Ex_Bdg_Fu_Bdg	14,315	Impervious	Roofs	D	Library Pond_existing to future
3414_D_Ex_Rd_Fu_Rd	22,834	Impervious	ConventionalConcrete	D	Library Pond_existing to future
3414_D_Ex_Perv_Fu_Perv	105,771	Grass	Grass	D	Library Pond_existing to future
3414_D_Ex_Perv_Fu_Imp	3,995	Grass	ConventionalConcrete	D	Library Pond_existing to future

LID Facility Sizing Details

Pond Sizing Details

Pond ID	Design Criteria(1)	Facility Soil Type	Max Depth (ft)(2)	Top Area (sq-ft)	Side Slope (1:H)	Facility Vol. (cu-ft)(3)	Water Storage Vol. (cu-ft)(4)	Adequate Size?
Library Pond_existing to future	FCWQT	B3	7.09	30,130.0	4	151,419.6	121,444.8	Yes

1. FCWQT = Flow control and water quality treatment, WQT = Water quality treatment only

2. Depth is measured from the bottom of the facility and includes the three feet of media (drain rock, separation layer and growing media).

3. Maximum volume of the facility. Includes the volume occupied by the media at the bottom of the facility.

4. Maximum water storage volume of the facility. Includes water storage in the three feet of soil media assuming a 40 percent porosity.

Simple Pond Geometry Configuration

Pond ID: Library Pond_existing to future
Design: FlowControlAndTreatment

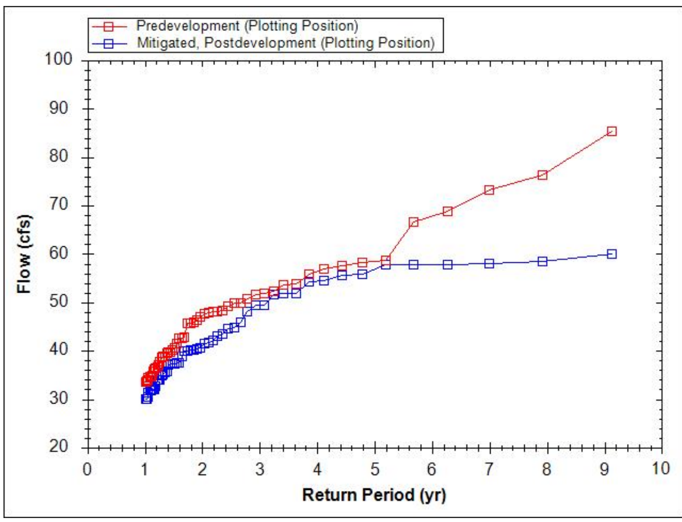
Shape Curve

Depth (ft)	Area (sq ft)
7.1	30,130.0

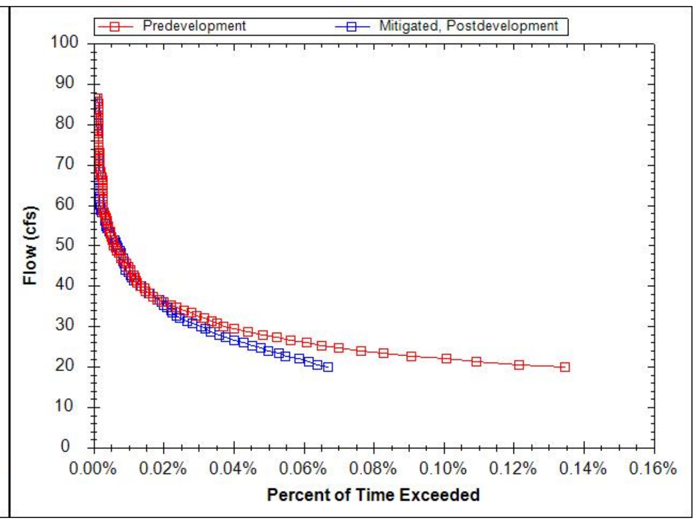
Outlet Structure Details

Lower Orifice Invert (ft)	0.0
Lower Orifice Dia (in)	16.9
Upper Orifice Invert(ft)	4.8
Upper Orifice Dia (in)	40.9
Overflow Weir Invert(ft)	6.1
Overflow Weir Length (ft)	6.3

Flow Frequency Chart



Flow Duration Chart



Appendix G: Staffing Evaluation

Brown AND Caldwell

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

T: 503.244.7005

Prepared for: City of Wilsonville

Project Title: Wilsonville Stormwater Master Plan

Project No.: 156157.002.001

Staff Analysis Tables

Subject: Stormwater Staffing Analysis

Date: January 24, 2024

To: Kerry Rappold, City of Wilsonville

From: Angela Wieland, Brown and Caldwell

Prepared by: Shelby Gilmartin, EIT

Reviewed by: Angela Wieland, PE

Table of Contents

List of Abbreviations

BMP	Best Management Practice
CCTV	Closed-circuit Television
City	City of Wilsonville
CP	Capital Project
CREST	Center for Research in Environmental Sciences & Technologies
DEI	Diversity, Equity, and Inclusion
EC	Construction Site Runoff Control
Ft	Feet
FTE	Full-Time Employee
FY	Fiscal Year
Hr	Hour
HPSE	High Pollutant Source Facilities
ILL	Illicit Discharge Detection and Elimination
IND	Industrial and Commercial Facilities
IPM	Integrated Pest Management
LF	Linear Feet
NPDES	National Pollution Discharge Elimination System
OM	Pollution Prevention and Good Housekeeping for Municipal Operations
OSHA	Occupational Safety and Health Administration
PC	Post-Construction Site Runoff for New Development and Redevelopment
PEO	Public Education and Outreach
PI	Public Involvement
SF	Square Feet
SMP	Stormwater Master Plan
SWMP	Stormwater Management Program
SWPPP	Stormwater Pollution Prevention Plan
TBD	To Be Determined
TM	Technical Memorandum (Tech Memo)
WERK	Wilsonville Environmental Resource Keepers

Assumptions

A. This staffing analysis assumes that existing City staff is able to implement the current stormwater program (pre-2022 conditions). Additional activities not previously conducted by the City under current staffing were used to create the estimates of additional staff resource needs. Additional activities include those associated with the reissued NPDES MS4 permit (2021) and implementation of the proposed Capital Projects (CP) in the Stormwater Master Plan (2023).

B. One (1) FTE represents 1,650 hrs (after deducting estimated annual leaves, training, and other non-task replaced hours); 0.02 FTE represents 40 hrs. For purposes of calculating an equivalent FTE cost estimate, an annual FTE labor cost was assumed at $200,000/year.

C. Assume that 100 percent of Engineering and Permitting Costs are for use of a consultant, and 100 percent of Design/Construction Administration Costs are required for internal City staff.

D. The NPDES program costs are based on an implementation schedule covering a 5-year permit term (Oct. 1, 2021 – Sept. 30, 2026) – reported in tables as Fiscal Years (FY) 2023-2027, with an anticipated administrative extension after FY 2027.

E. Stormwater Master Plan (SMP) implementation is projected on an annual basis and assumes a 20-year CP implementation schedule from 2024-2043, with higher project projects occurring sooner:
   - High Priority (2024-2028); Medium Priority (2029-2033); and Low Priority (2034-2043).
   - Capital Projects costs are averaged over the 20-year implementation period and shown as a standard annual value. While in practice there will be cycles of more and less staff time demands based on which projects are in construction/constructed.

Where applicable the following asset assumptions are divided between 1) those needed to maintain existing assets and commitments under the Stormwater Management Program (SWMP) BMPs and meet the requirements of the NPDES MS4 permit and 2) those for future assets constructed as part of the SMP Capital Projects. If not distinguished, the assumption applies to newly constructed assets.

F. **Piped Conveyance System**
   - *For SWMP BMPs*: CCTV and cleaning activities were evaluated as part of the maintenance evaluation in SMP TM#1 and this program requires an additional 0.5 FTE to meet current maintenance needs.
   - *For SMP CPs*: 250 ft of pipe cleaning can be accomplished per hour, and 200 ft of closed-circuit television inspections (CCTV) can be accomplished per hour. Inspection and maintenance to occur on at least 15 percent of City pipes annually (assuming cleaning/inspection will occur four times over 20-year CP cycle).
     - Perforated pipe does not require regular cleaning and inspection and is anticipated to only occur if needed.
     - Pipe connections/laterals are not included in the annual maintenance estimate.
     - Pipe inspection and maintenance activities require a 2-person crew.

G. **Manholes**
   - *For SWMP BMPs:* Cleaning activities associated with pollution control manholes and catch basins were evaluated as part of the maintenance evaluation in SMP TM#1, and this program requires an additional 0.25 FTE due to deferred maintenance.
   - For *SMP CPs:* 0.5 hr/facility/year is needed for maintenance of a standard manhole. 1.0 hr/facility/year is needed for inspection and maintenance of a water quality manhole.
     - Manhole inspection and maintenance activities require a 2-person crew.

H. **Catch Basins**

- *For SWMP BMPs:* Cleaning activities associated with pollution control manholes and catch basins were evaluated as part of the maintenance evaluation in SMP TM#1, and this program requires an additional 0.25 FTE due to deferred maintenance.
- *For SMP CPs:* 0.5 hr/facility/year is needed for maintenance.
  - Catch basin maintenance requires a 2-person crew.

I. **Vegetated Systems (swales, rain gardens, planters, etc.):**

- *For SWMP BMPs:* Maintenance activities associated with vegetated system were evaluated as part of the maintenance evaluation in SMP TM#1, and this program requires an additional 1.25 FTE to meet maintenance needs.
- *For SMP CPs:* 8 hr/facility/year for inspection and maintenance for public systems.
  - Vegetated system inspections and maintenance requires a 2-person crew.

J. **Ditches**: 20 ft of ditch maintenance can be accomplished per hour.

- Maintenance is required once every 5 years.
- Ditch maintenance requires a 2-person crew.

K. **Outfalls**: 0.5 hr/facility/year is needed for inspection and maintenance of outfalls.

- Outfall inspection and maintenance requires a 2-person crew.

L. **Inlets/Outlets**: 0.5 hr/facility/year is needed for inspection and maintenance of inlets/outlets.

- Inlet/outlet inspection and maintenance requires a 2-person crew.

M. **Detention Pond**: 16 hrs/facility/year is needed for inspection and maintenance of detention ponds.

- Detention pond inspection and maintenance requires a 2-person crew.

N. **Culverts:** 2 hr/facility/year is needed for culvert cleaning and inspection.

- Culvert inspection and cleaning requires a 2-person crew.

O. **Private Water Quality Facilities:** 4 hr/facility/year is required for inspections.

- The City holds *Stormwater Maintenance and Access Easement Agreements* with private water quality facilities owners to actively maintain facilities in conformance with City of Wilsonville's Public Work Standards and annually inspect and report on the facility.
- Private water quality facility inspections require a 1-person crew.

P. **Restoration/Stabilization:** Planting and bioengineered restoration/stabilization is a single installation and does not require annual maintenance.

Q. **Replacement or Removal:** Replacement or removal of assets does not require continued maintenance and is not accounted for as additional annual maintenance activity.

R. **Driveways/Pathways:** Addition of, or modifications to driveways, accessways, or paths does not require annual maintenance. These facilities will be maintained only when identified as needed.

S. **Street Sweeping:** 165 hr/year is needed for street sweeping of all curbed areas. This work is completed by a contractor.

T. **Training:** Assume general training includes 3 staff and industrial/commercial training includes 1 staff.

NOTE: Recommended Programs developed for the SMP (P-1 to P-3, and P-5 to P-6) are outlined in the SMP Table 7-1 as an annual cost only and not staff hours which is why it was removed from the Public Works/Maintenance Staffing and Community Development/Engineering Staffing sections. Program P-4 is included in *SMP Implementation - Community Development/Engineering Staffing Assessment* analysis.

NPDES MS4 Permit Driven Activities (per 2022 SWMP)

Public Works/Maintenance Staffing Assessment

NPDES MS4 Permit Driven Activities - Public Works/Maintenance Staffing Assessment														
Stormwater program implementation (post-2022)								Pre-2022 activities	Annual Public Works/Maintenance Staff Schedule (Hours and FTE)					
BMP Number	BMP name	Description	Increase in effort from pre-2022 activities (Y/N)	Cost assumptions	Implementation Need		Material costs (Y/N)	Activity description	2023	2024	2025	2026	2027	Annual Average
					Number of City Staff	Total Staff Time								
PEO-2	Staff Training	Staff training includes educational activities for City staff and crews on erosion control measures, proper spill response procedures, safe work practices, and record keeping.	Y	Trainings in addition to pre-2022 BMP activities: Annually: • City's inspection checklist training (assume 1-hr). • Review Dry Weather Screening SOP (assume 1-hr). Once per permit term: • IDDE SOP review training (assume 1-hr). • IDDE training modules (assume 1-hr). • Review ESC plan review check list and update as necessary (assume 1-hr). • Training on City's site inspection SOP (assume 1-hr). • Training on City's SOP and schedule for MS4 maintenance (assume 1-hr). • Training on the City's Industrial and Commercial Facilities Strategy (assume 1-hr).	3	2 hrs/yr 6 hrs/permit term	N	• 40 hr HAZWOPER and 8-hr annual refresher trainings. • Licensed pesticide training continuing education training (40-hr over 5 years requirement). • Training on City's IPM. • CESCL training (assume 8-hrs) every 3 years. • Internal training after the adoption of new or updated design standards. • Joint agency workshop or professional group presentation. • Training on City's municipal pollution prevention plan or SOPs. • Training on the City's SWPPP.	7.2 hrs (0.004 FTE)	7.2 hrs (0.004 FTE)	7.2 hrs (0.004 FTE)	7.2 hrs (0.004 FTE)	7.2 hrs (0.004 FTE)	7.2 hrs (0.004 FTE)
		Staff attend local trainings and conferences to improve skills related to stormwater controls and surface water quality.	N	No change.			Y – conference registration (as applicable)	Staff attended 4 conferences and trainings related to stormwater management during the 2021-22 reporting year.						
PI-2	Public Stewardship Opportunities	Continue to conduct/support a variety of stewardship events to increase public involvement and participation in stormwater-related programs.	N	• Annually, the City sponsors the Wilsonville Environmental Resource Keepers (WERK) day event, the Adopt-a-Road Program for trash and invasive species removal, Friends of Trees, and the Backyard Habitat Certification Program. Sponsorship generally includes staff time and associated City resources such as equipment. • City provides community workshops on IPM and native planting. • Collaboration with CREST.			Y – program/ equipment costs	• Organizing public outreach programs such as Adopt-a-Road and WERK Day. • Participate in the Backyard Habitat Certification Program and CREST to support workshops and environmental programs. • Support the planting of urban trees through partnering with Friends of Trees and providing native trees through the Tree Coupon program. • Promote stewardship- related events on the City's website and social media.						

NPDES MS4 Permit Driven Activities - Public Works/Maintenance Staffing Assessment															
Stormwater program implementation (post-2022)								Pre-2022 activities	Annual Public Works/Maintenance Staff Schedule (Hours and FTE)						
BMP Number	BMP name	Description	Increase in effort from pre-2022 activities (Y/N)	Cost assumptions	Implementation Need		Material costs (Y/N)	Activity description	2023	2024	2025	2026	2027	Annual Average
					Number of City Staff	Total Staff Time								
ILL-1	Illicit Discharge Detection and Elimination	The City prohibits illicit discharges into their MS4 system and conducts response and enforcement as needed.	N	No Change.			N	• Implement the City's IDDE Program as outlined in the IDDE SOP. • For identified illicit discharges, conduct appropriate actions to remove the discharge. Track enforcement activities related to investigation.						
ILL-2	Spill Prevention, Training, and Response	24-hr emergency response hotline and online reporting for illicit spills or activities contaminating stormwater.	N	No Change.			N	• Spill response within the public right-of-way is handled by the City's Public Works staff or the Tualatin Valley Fire and Rescue Hazardous Materials Team. • Select City staff are trained to the OSHA First Responder Operations level and can respond to spills with releases or potential releases of hazardous substances. Annual refresher courses are provided to City staff to maintain OSHA certifications. • Maintain a record of all spills both reported and responded to and follow up/mitigation measures.						
ILL-4	Dry Weather Field Screening	Conduct illicit discharge inspections, monitoring, and investigations annually during dry-weather conditions at 6 high priority field screening locations.	N	No Change.			N	• Track dry weather field screening locations inspected annually and any additional outfalls inspected during routine maintenance. • Summarize dry weather inspection results and indicate locations requiring monitoring (i.e., sampling) and/or investigations. • Indicate the outcome and resolution of any dry weather investigation activities conducted.						
EC-1	Erosion Control and Construction Site Management	The City implements an ESC program in accordance with City Code and Public Works Standards for proposed construction applications.	N	No Change.			N	• Track the number of approved erosion and sediment control plans for new and redevelopment >500 SF. • Track the number of 1200-CN and 1200-C permits issued. • Track the number and frequency of erosion control inspections conducted. • Track the number and type of enforcement actions taken by the City or DEQ.						

NPDES MS4 Permit Driven Activities - Public Works/Maintenance Staffing Assessment															
Stormwater program implementation (post-2022)								Pre-2022 activities	Annual Public Works/Maintenance Staff Schedule (Hours and FTE)						
BMP Number	BMP name	Description	Increase in effort from pre-2022 activities (Y/N)	Cost assumptions	Implementation Need: Number of City Staff	Implementation Need: Total Staff Time	Material costs (Y/N)	Activity description	2023	2024	2025	2026	2027	Annual Average
EC-2	Erosion Control Inspections and Enforcement	Implement, inspection, and maintain ESC prevention measures during and following construction.	N	• Conduct a minimum of 3 erosion control inspections on all construction sites issued an ECS Permit. • As necessary, enforce appropriate erosion and sediment control in conjunction with the progressive enforcement procedures as outlined in the City Code.			N	• Track the number of erosion and sediment control plans approved. • Track the number of 1200- CN and 1200-C permits issued. • Track the number and frequency of erosion control inspections conducted. • Track the number and type of enforcement actions taken by the City or DEQ.						
OM-1	Municipal Stormwater Pollution Prevention	Implement activities to promote stormwater pollution prevention per SWPPP.	N	No Change.			N	Implement BMPs outlined in the City's SWPPS on an ongoing basis.						
OM-2	Routine Road Maintenance	Conduct street sweeping, maintenance, and winter weather protocols.	N	No Change.			N	• Sweep all curbed City streets monthly. • Schedule and conduct street maintenance activities during dry weather conditions. • Continue to sponsor the Adopt-a-Road program, Bulky Waste Day, and Fall Leaf Collection Day.						
			Y	Implement Winter Weather Response Plan (2021) – including snow removal, sanding, chemical application, and proper management of materials. Staff time is winter conditions dependent, assume additional 40-hrs for additional tracking of materials and activities per year.	1	40 hrs/yr	N	N/A – New requirement.	40 hrs (0.02 FTE)	40 hrs (0.02 FTE)	40 hrs (0.02 FTE)	40 hrs (0.02 FTE)	40 hrs (0.02 FTE)	40 hrs (0.02 FTE)
OM-3	Pest Management	Follow the IPM Plan (2018) principles for public landscape maintenance.	N	No Change.			N	• Track the amount of pesticides and fertilizers applied to public property and general areas of application. • Estimate number and area of sites where the planting of native vegetation was incorporated into the maintenance activities.						
			Y	Publish annual IPM activity on City website (assume 1-hr/year).	1	1 hr/yr	N	N/A – New requirement.	1 hr (0.0006 FTE)	1 hr (0.0006 FTE)	1 hr (0.0006 FTE)	1 hr (0.0006 FTE)	1 hr (0.0006 FTE)	1 hr (0.0006 FTE)
OM-4	Conveyance System Cleaning	Maintain and repair public stormwater conveyance system components including the storm sewer pipes,	Y	• Conduct CCTV inspection of approximately 15% of the public stormwater conveyance system (>6-inch pipe) annually. • Inspect other public conveyance systems as required.	Analysis in SMP TM#1		N	• Inspect public conveyance system annually for maintenance needs. • Maintain and repair public conveyance system as needed based on inspections.	825 hrs (0.5 FTE)	825 hrs (0.5 FTE)	825 hrs (0.5 FTE)	825 hrs (0.5 FTE)	825 hrs (0.5 FTE)	825 hrs (0.5 FTE)

NPDES MS4 Permit Driven Activities - Public Works/Maintenance Staffing Assessment															
Stormwater program implementation (post-2022)								Pre-2022 activities	Annual Public Works/Maintenance Staff Schedule (Hours and FTE)						
BMP Number	BMP name	Description	Increase in effort from pre-2022 activities (Y/N)	Cost assumptions	Implementation Need: Number of City Staff	Implementation Need: Total Staff Time	Material costs (Y/N)	Activity description	2023	2024	2025	2026	2027	Annual Average
		manholes, outfalls, culverts, and swales.	Y	Refine the internal inspection guidelines annually to help facilitate ongoing inspection efforts (assume 40-hr for refinement, review and periodic update).	1	40 hr/permit term	N	N/A	8 hrs (0.005 FTE)	8 hrs (0.005 FTE)	8 hrs (0.005 FTE)	8 hrs (0.005 FTE)	8 hrs (0.005 FTE)	8 hrs (0.005 FTE)
OM-5	Catch Basin Cleaning	Inspect, maintain, and repair public stormwater catch basins annually during dry season.	N	No Change.	Analysis in SMP TM#1		N	• Clean all high-priority public catch basins annually and remaining public catch basins over a 4-year period. • Inspect catch basins for maintenance and repair needs during catch basin cleaning activities. Schedule repair activities as needed, based on inspections.	412.5 hrs (0.25 FTE)	412.5 hrs (0.25 FTE)	412.5 hrs (0.25 FTE)	412.5 hrs (0.25 FTE)	412.5 hrs (0.25 FTE)	412.5 hrs (0.25 FTE)
			Y	Refine the internal inspection guidelines to help facilitate ongoing inspection efforts (assume 40-hr for refinement, review and periodic update).	1	40 hrs/ permit term	N	N/A	8 hrs (0.005 FTE)	8 hrs (0.005 FTE)	8 hrs (0.005 FTE)	8 hrs (0.005 FTE)	8 hrs (0.005 FTE)	8 hrs (0.005 FTE)
			Y	Update tracking database during each maintenance cycle (assume 10-hr/year).	1	10 hrs/yr	N	N/A	10 hrs (0.006 FTE)	10 hrs (0.006 FTE)	10 hrs (0.006 FTE)	10 hrs (0.006 FTE)	10 hrs (0.006 FTE)	10 hrs (0.006 FTE)
OM-6	Public Structural Facility Operation and Maintenance	Tracks, inspect, maintain, and repairs City-owned structural control components of the stormwater system, specifically, water quality manholes, swales, proprietary treatment systems, raingardens, planters, and detention ponds.	N	No Change.	Analysis in SMP TM#1		N	• Inspect public structural controls annually; maintain and repair as needed. • Maintain GIS "atlas" for both public and private.	2,062.5 hrs (1.25 FTE)	2,062.5 hrs (1.25 FTE)	2,062.5 hrs (1.25 FTE)	2,062.5 hrs (1.25 FTE)	2,062.5 hrs (1.25 FTE)	2,062.5 hrs (1.25 FTE)
			Y	In conjunction with post-construction standards updates, by Dec. 1, 2024, update the City's internal inspection guidelines and Vegetated Stormwater Facility SOP to include all active stormwater facilities (including proprietary controls) used in the City (assume 40-hr for refinement, review and periodic update).	1	40 hrs by Dec. 2024	N	N/A	20 hrs (0.012 FTE)	20 hrs (0.012 FTE)	--	--	--	8 hrs (0.005 FTE)
IND-1	Industrial and Commercial Inspection Program	Maintain and annually update a database of identified potential high pollutant source facilities (HPSF).	N	No Change.			N	• Annually conduct windshield surveys of identified HPSF. • Annually conduct formal site inspections on up to 5 HPSF. • During permit term, review business license applications to see if NPDES permit is required.						

NPDES MS4 Permit Driven Activities - Public Works/Maintenance Staffing Assessment															
Stormwater program implementation (post-2022)								Pre-2022 activities	Annual Public Works/Maintenance Staff Schedule (Hours and FTE)					
BMP Number	BMP name	Description	Increase in effort from pre-2022 activities (Y/N)	Cost assumptions	Implementation Need: Number of City Staff	Implementation Need: Total Staff Time	Material costs (Y/N)	Activity description	2023	2024	2025	2026	2027	Annual Average
		Industrial and Commercial Facilities staff training.	Y	• Training once in permit term. Internal training based on the Industrial and Commercial Facilities Strategy, and joint agency workshop. • Assume 1 training meeting (2 hrs) and 1 joint agency workshop (4 hrs) annually over the permit term.	1	6 hrs/permit term	N	N/A	1.2 hrs (0.0006 FTE)	1.2 hrs (0.0006 FTE)	1.2 hrs (0.0006 FTE)	1.2 hrs (0.0006 FTE)	1.2 hrs (0.0006 FTE)	1.2 hrs (0.0006 FTE)
NPDES MS4 Driven Activities Subtotal of Public Works/Maintenance Staff Cost						Annual Staff Time (Hours)			3,395.4	3,395.4	3,375.4	3,375.4	3,375.4	3,383.4
						Annual Staff Time (FTE)			2.06	2.06	2.05	2.05	2.05	2.05
						Staffing contingency (FTE) (estimated at 20% to account for unscheduled maintenance and response)			0.41	0.41	0.41	0.41	0.41	0.41
						NPDES MS4 Public Works/Maintenance Activities Sub-Total staff cost (FTE)			2.47	2.47	2.46	2.46	2.46	2.46

Community Development/Engineering Staffing Assessment

NPDES MS4 Permit Driven Activities - Community Development/Engineering Staffing Assessment														
Stormwater program implementation (post-2022)								Pre-2022 activities	Annual Community Development/Engineering Staff Cost Schedule (Hours and FTE)					
BMP Number	BMP name	Description	Increase in effort from pre-2022 activities (Y/N)	Cost assumptions	Implementation Need		Material costs (Y/N)	Activity description	2023	2024	2025	2026	2027	Annual Average
					Number of City Staff	Total Staff Time								
PEO-1	Public Education Participation	• Promote public awareness through City newsletters, doorhangers, social media, and website. • Annually publish 2 articles/year in the Wilsonville Business Newsletter and 3 articles/year educating the public on stormwater issues.	N	No change.			Y – printing	During the 2021-22 reporting year, 5 educational/informational articles were published in the City newsletter and 4 were posted to the City's social media pages.						
		Engage the City's DEI Committee to identify additional language translations needs of the public, if necessary.	Y	Twice over permit term engage with the DEI Committee to verify that materials are translated into representative languages for the public. Assume two 1-hour meetings.	1	2 hrs/ permit term	N	N/A – Committee was formed in 2021.	--	1 hr (0.001 FTE)	--	1 hr (0.001 FTE)	--	0.4 hrs (0.001 FTE)
		Support regional public education campaigns and programs.	N	No change (varies by year).			Y - financial support	• Financially support regional public education campaigns and programs. • During the 2021-22 reporting year, the City contributed $15,000 to Friends of Trees.						
PEO-2	Staff Training	Staff training includes educational activities for City staff and crews on erosion control measures, proper spill response procedures, safe work practices, and record keeping.	Y	Trainings in addition to pre-2022 BMP activities: Annually: • City's inspection checklist training (assume 1-hr). • Review Dry Weather Screening SOP (assume 1-hr). Once per permit term: • IDDE SOP review training (assume 1-hr). • IDDE training modules (assume 1-hr). • Review ESC plan review check list and update as necessary (assume 1-hr). • Training on City's site inspection SOP (assume 1-hr). • Training on City's SOP and schedule for MS4 maintenance (assume 1-hr). • Training on the City's Industrial and Commercial Facilities Strategy (assume 1-hr). Assume 40-hr/yr to develop trainings.	2	40 hrs/yr	N	• 40 hr HAZWOPER and 8-hr annual refresher trainings. • Licensed pesticide training continuing education training (40-hr over 5 years requirement). • Training on City's IPM. • CESCL training (assume 8-hrs) every 3 years. • Internal training after the adoption of new or updated design standards. • Joint agency workshop or professional group presentation. • Training on City's municipal pollution prevention plan or SOPs. • Training on the City's SWPPP.	80 hrs (0.048 FTE)	80 hrs (0.048 FTE)	80 hrs (0.048 FTE)	80 hrs (0.048 FTE)	80 hrs (0.048 FTE)	80 hrs (0.048 FTE)
		Staff attend local trainings and conferences to improve skills related to stormwater controls and surface water quality.	N	No change.			Y – conference registration (as applicable)	Staff attended 4 conferences and trainings related to stormwater management during the 2021-22 reporting year.						

NPDES MS4 Permit Driven Activities - Community Development/Engineering Staffing Assessment													
Stormwater program implementation (post-2022)								Pre-2022 activities	Annual Community Development/Engineering Staff Cost Schedule (Hours and FTE)				
BMP Number	BMP name	Description	Increase in effort from pre-2022 activities (Y/N)	Cost assumptions	Implementation Need: Number of City Staff	Implementation Need: Total Staff Time	Material costs (Y/N)	Activity description	2023	2024	2025	2026	2027	Annual Average
		Staff attend Clackamas County co-permittee meetings to engage in collective efforts related to education, monitoring, and NPDES requirements.	N	No change.			Y – Cost sharing (as applicable).	Coordinate with other Clackamas County co-permittees regarding regional water quality efforts through scheduled co-permittee meetings.						
PI-1	Public Involvement and Participation	Provide opportunity for public participation in the development, implementation, and modification of the City's stormwater management program.	Y	• Maintain a publicly accessible website with the SWMP, Monitoring Plan, annual reports, program contact information, educational/reference materials, and reporting requirements for illicit discharges. • Provide a 30-day public comment period, and consider comments received for updates to the Monitoring Plan, the SWMP, and other strategy documents as required. • Maintain MS4 Document Library on website. Assume 8 hr/year for website management.	1	8 hrs/yr	N	N/A – new requirement.	8.0 hrs (0.005 FTE)	8.0 hrs (0.005 FTE)	8.0 hrs (0.005 FTE)	8.0 hrs (0.005 FTE)	8.0 hrs (0.005 FTE)	8.0 hrs (0.005 FTE)
PI-2	Public Stewardship Opportunities	Continue to conduct/support a variety of stewardship events to increase public involvement and participation in stormwater-related programs.	N	• Annually, the City sponsors the Wilsonville Environmental Resource Keepers (WERK) day event, the Adopt-a-Road Program for trash and invasive species removal, Friends of Trees, and the Backyard Habitat Certification Program. Sponsorship generally includes staff time and associated City resources such as equipment. • City provides community workshops on IPM and native planting. • Collaboration with CREST.			Y – program/equipment costs	• Organizing public outreach programs (e.g., Adopt-a-Road and WERK Day). • Participate in the Backyard Habitat Certification Program and CREST to support workshops and environmental programs. • Support the planting of urban trees through partnering with Friends of Trees and providing native trees through the Tree Coupon program. • Promote stewardship- related events on the City's website and social media.						
ILL-1	Illicit Discharge Detection and Elimination	The City prohibits illicit discharges into their MS4 system and conducts response and enforcement as needed.	N	No Change.			N	• Implement the City's IDDE Program as outlined in the IDDE SOP. • For identified illicit discharges, conduct appropriate actions to remove the discharge. Track enforcement activities related to investigation.						
		Review and update the City's IDDE SOP to clarify enforcement procedures and response timeframes in conjunction with the NPDES MS4 permit.	Y	Review and update IDDE SOP by Dec. 1, 2023. Assume 8-hrs to review and update annually. Consult will support 2023 update.	1	8 hr/yr	N	Implement existing IDDE SOP (2012).	8.0 hrs (0.005 FTE)	8.0 hrs (0.005 FTE)	8.0 hrs (0.005 FTE)	8.0 hrs (0.005 FTE)	8.0 hrs (0.005 FTE)	8.0 hrs (0.005 FTE)
ILL-2	Spill Prevention, Training, and Response	24-hr emergency response hotline and online reporting for illicit spills or activities contaminating stormwater.	N	No Change.			N	• Spill response within the public right-of-way is handled by the City's Public Works staff or the Tualatin Valley Fire and Rescue Hazardous Materials Team. • Select City staff are trained to the OSHA First Responder Operations level						

NPDES MS4 Permit Driven Activities - Community Development/Engineering Staffing Assessment															
Stormwater program implementation (post-2022)								Pre-2022 activities	Annual Community Development/Engineering Staff Cost Schedule (Hours and FTE)					
					Implementation Need									
BMP Number	BMP name	Description	Increase in effort from pre-2022 activities (Y/N)	Cost assumptions	Number of City Staff	Total Staff Time	Material costs (Y/N)	Activity description	2023	2024	2025	2026	2027	Annual Average
								and can respond to spills with releases or potential releases of hazardous substances. Annual refresher courses are provided to City staff to maintain OSHA certifications. • Maintain a record of all spills both reported and responded to and follow up/mitigation measures.						
ILL-3	MS4 Mapping	Continually maintain the online GIS mapping and digital inventory.	Y	• Continually maintain the online GIS mapping for public viewing. • Add municipal structural stormwater controls within 1 year of receiving the as-builts. • As necessary, create a tracking system for repeat illicit discharges. Assume 24-hr/year for updates.	1	24 hr/yr	N	N/A – new requirement.	24 hrs (0.015 FTE)	24 hrs (0.015 FTE)	24 hrs (0.015 FTE)	24 hrs (0.015 FTE)	24 hrs (0.015 FTE)	24 hrs (0.015 FTE)
ILL-4	Dry Weather Field Screening	Conduct illicit discharge inspections, monitoring, and investigations annually during dry-weather conditions at 6 high priority field screening locations.	Y	By Dec. 1, 2023, review and update high priority locations and criteria, as necessary, based on outcomes from inspections and other public reporting. Update locations on mapping and in the IDDE SOP (assume 10 hours for review).	1	10 hrs by Dec. 2023	N	• Track dry weather field screening locations inspected annually and any additional outfalls inspected during routine maintenance. • Summarize dry weather inspection results and indicate locations requiring monitoring (i.e., sampling) and/or investigations. • Indicate the outcome and resolution of any dry weather investigation activities conducted.	10 hrs (0.006 FTE)	--	--	--	--	2 hrs (0.001 FTE)
EC-1	Erosion Control and Construction Site Management	The City implements an ESC program in accordance with City Code and Public Works Standards for proposed construction applications.	Y	Report any updates or modifications to the 2020 Clackamas County Erosion Prevention and Sediment Control Planning and Design Manual (assume 20 hrs for review).	1	20 hrs by Dec. 2024	N	• Track the number of approved erosion and sediment control plans for new and redevelopment >500 SF. • Track the number of 1200-CN and 1200-C permits issued. • Track the number and frequency of erosion control inspections conducted. • Track the number and type of enforcement actions taken by the City or DEQ.	10 hrs (0.006 FTE)	10 hrs (0.006 FTE)	--	--	--	4 hrs (0.002 FTE)

NPDES MS4 Permit Driven Activities - Community Development/Engineering Staffing Assessment

Stormwater program implementation (post-2022)								Pre-2022 activities	Annual Community Development/Engineering Staff Cost Schedule (Hours and FTE)					
BMP Number	BMP name	Description	Increase in effort from pre-2022 activities (Y/N)	Cost assumptions	Implementation Need: Number of City Staff	Implementation Need: Total Staff Time	Material costs (Y/N)	Activity description	2023	2024	2025	2026	2027	Annual Average
EC-2	Erosion Control Inspections and Enforcement	Implement, inspection, and maintain ESC prevention measures during and following construction.	N	• Conduct a minimum of 3 erosion control inspections on all construction sites issued an ECS Permit. • As necessary, enforce appropriate erosion and sediment control in conjunction with the progressive enforcement procedures as outlined in the City Code.			N	• Track the number of erosion and sediment control plans approved. • Track the number of 1200- CN and 1200-C permits issued. • Track the number and frequency of erosion control inspections conducted. • Track the number and type of enforcement actions taken by the City or DEQ.						
		Update enforcement response procedures and escalating enforcement language.	Y	By Dec. 1, 2023, review and, if necessary, update enforcement response procedures and escalating enforcement specific to erosion and sediment control in City Code and Public Works Standards (assume 20-hrs for review). Consultant will support update.	1	20 hrs by Dec. 2023	N	N/A	20 hrs (0.012 FTE)	--	--	--	--	4 hrs (0.002 FTE)
PC-1	Stormwater Planning and Development Review	The City provides land use and planning review to meet goals related to the management of natural resources, transportation, housing, public facilities and services, and open spaces and parks.	N	Continue to require all new and redevelopment projects that add or replace 5,000 SF or more of impervious surface to implement the City's Stormwater and Surface Water Design and Construction Standards Review plans for compliance with stormwater requirements.			N	• Track number of development applications reviewed for compliance with the City's stormwater requirements. • Track new and redeveloped impervious surface in conjunction with annual reporting requirements.						
			Y	By Dec. 1, 2023, as necessary, review and document updates to the City's LID Guidebook and Public Works Standards to refine preferred LID/GI approaches and strategies for development within the ROW (assume 20-hrs for review). Consultant will support update.	1	20 hrs by Dec. 2023	N	N/A	20 hrs (0.012 FTE)	--	--	--	--	4 hrs (0.002 FTE)
			Y	By Dec. 1, 2024, as necessary, update Section 3 of the Public Works Standards to include reference to either the Numeric Stormwater Retention Requirement (NSSR) or Alternative Site Performance Standards (assume 100-hrs for review). Consultant will support update.	2	100 hrs by Dec. 2024	N	N/A	50 hrs (0.03 FTE)	50 hrs (0.03 FTE)	--	--	--	20 hrs (0.012 FTE)
OM-1	Municipal Stormwater Pollution Prevention	Implement activities to promote stormwater pollution prevention per SWPPP.	N	No Change.			N	Implement BMPs outlined in the City's SWPPS on an ongoing basis.						
			Y	Ensure litter control language is included in new event contracts and facility rental agreements (assume 8-hr for language draft and inclusion).	1	8 hrs (immediate update)	N	N/A – New requirement.	8 hrs (0.005 FTE)	--	--	--	--	1.6 hrs (0.001 FTE)
			Y	By Dec. 1, 2024, review and update the SWPPP for consistency with current use, practices, and new facility installations (assume 40-hr for review and 8-hr per year for updates). Consultant will support update.	1	40 hrs by Dec. 2024 + 8 hrs/yr	N	N/A	28 hrs (0.017 FTE)	28 hrs (0.017 FTE)	8 hrs (0.005 FTE)	8 hrs (0.005 FTE)	8 hrs (0.005 FTE)	16 hrs (0.010 FTE)

NPDES MS4 Permit Driven Activities - Community Development/Engineering Staffing Assessment														
Stormwater program implementation (post-2022)								Pre-2022 activities	Annual Community Development/Engineering Staff Cost Schedule (Hours and FTE)					
BMP Number	BMP name	Description	Increase in effort from pre-2022 activities (Y/N)	Cost assumptions	Implementation Need: Number of City Staff	Implementation Need: Total Staff Time	Material costs (Y/N)	Activity description	2023	2024	2025	2026	2027	Annual Average
OM-6	Public Structural Facility Operation and Maintenance	Tracks, inspect, maintain, and repairs City-owned structural control components of the stormwater system, specifically, water quality manholes, swales, proprietary treatment systems, raingardens, planters, and detention ponds.	N	No Change.			N	• Inspect public structural controls annually and maintain and repair as needed. • Ensure maintenance of new private structural stormwater facilities serving 5,000 square feet of area or greater through the tracking of Stormwater Maintenance and Access Easement agreements. • Maintain GIS "atlas" for both public and private.						
			Y	In conjunction with updates to post-construction standards, by Dec. 1, 2024, update the City's internal inspection guidelines and Vegetated Stormwater Facility SOP to include all active stormwater facilities (including proprietary controls) being used in the City (assume 120-hr for review).	1	120 hrs by Dec. 2024	N	N/A	60 hrs (0.036 FTE)	60 hrs (0.036 FTE)	--	--	--	24 hrs (0.015 FTE)
OM-7	Private Structural Facility Operation and Maintenance	The City requires maintenance of private structural stormwater controls through implementation of the Stormwater Maintenance and Access Easement agreements and submittal of a Stormwater Operations and Maintenance Plan.	N	No Change.			N	• Track agreements on file for private structural control facilities. • Track number of private annual inspection and maintenance reports received annually. • Maintain GIS database for private structural facilities.						
			N	No change, but as additional development and new facilities are added, additional time will be needed for tracking and inspection documentation (assume 8-hr/year for additional facility tracking).	1	8 hrs/yr	N	• Ensure maintenance of new private structural stormwater facilities serving 5,000 square feet of area or greater through the tracking of Stormwater Maintenance and Access Easement agreements. • Maintain GIS "atlas" for both public and private.	8 hrs (0.005 FTE)	8 hrs (0.005 FTE)	8 hrs (0.005 FTE)	8 hrs (0.005 FTE)	8 hrs (0.005 FTE)	8 hrs (0.005 FTE)
OM-8	Develop Planning Documents in Support of Water Quality	The City assesses flood control, transportation, and other infrastructure projects during planning stages to identify and mitigate potential negative impacts and/or enhance benefits for the water quality of receiving water bodies.	Y	• By Dec. 1, 2023, complete public outreach related to the updated 2023 Stormwater Master Plan (assume 30-hr for outreach).	1	30 hrs by Dec. 2023	N	N/A	30 hrs (0.018 FTE)	--	--	--	--	6 hrs (0.004 FTE)
			Y	• Implement water quality, flood control, and natural resource CIPs in accordance with the effective Stormwater Master Plan. • Track the status of the City's Stormwater Master Planning efforts. • Track the number of CIP/retrofit projects implemented each year and discuss the added benefit (water quality,	1	40 hrs/yr	N	N/A	40 hrs (0.024 FTE)	40 hrs (0.024 FTE)	40 hrs (0.024 FTE)	40 hrs (0.024 FTE)	40 hrs (0.024 FTE)	40 hrs (0.024 FTE)

NPDES MS4 Permit Driven Activities - Community Development/Engineering Staffing Assessment															
Stormwater program implementation (post-2022)								Pre-2022 activities	Annual Community Development/Engineering Staff Cost Schedule (Hours and FTE)						
BMP Number	BMP name	Description	Increase in effort from pre-2022 activities (Y/N)	Cost assumptions	Implementation Need		Material costs (Y/N)	Activity description	2023	2024	2025	2026	2027	Annual Average
					Number of City Staff	Total Staff Time								
				hydromodification, habitat restoration, etc.) of each. • Map the location and drainage area of water quality CIPs/retrofits as they are constructed. Assume 40-hrs/year for CIP implementation and tracking.										
			Y	By Dec. 1, 2023, document and submit a summary of outcomes the City's 2015 Retrofit Strategy and 2015 Hydromodification Assessment, in accordance with the 2023 Stormwater Master Plan (assume 20-hrs for review).	1	20 hrs by Dec. 2023	N	N/A	20 hrs (0.012 FTE)	--	--	--	--	4 hrs (0.002 FTE)
IND-1	Industrial and Commercial Inspection Program	Maintain and annually update a database of identified potential high pollutant source facilities (HPSF).	N	No Change.			N	• Annually conduct windshield surveys of identified HPSF. • Annually conduct formal site inspections on up to 5 HPSF. • During permit term, review business license applications to see if NPDES permit is required.						
		Industrial and Commercial Facilities staff training.	Y	• Training once in permit term. Internal training based on the Industrial and Commercial Facilities Strategy, and joint agency workshop. • Assume 1 training meeting (2 hrs) and 1 joint agency workshop (4 hrs) over permit term. • Assume 6-hrs annually for engineer.	1	6 hrs/yr	N	N/A	6 hrs (0.004 FTE)	6 hrs (0.004 FTE)	6 hrs (0.004 FTE)	6 hrs (0.004 FTE)	6 hrs (0.004 FTE)	6 hrs (0.004 FTE)
NPDES MS4 Permit Driven Activities Subtotal of Community Development/Engineering Staff Cost								Annual Staff Time (Hours*)	430	322	182	182	182	260
								Annual Staff Time (FTE)	0.26	0.19	0.11	0.11	0.11	0.16

**Summary values rounded to nearest whole hour.*

Note: No staffing contingency includes for Community Development/Engineering NPDES MS4 Permit Driven Activities .

NPDES MS4 Permit Driven Activities (per 2022 SWMP) Summary

NPDES MS4 Permit Driven Activities – Public Works/Maintenance and Community Development/Engineering Staffing Assessment Summary		Annual NPDES MS4 Activities Staff Cost Schedule (FTE)					
		2023	2024	2025	2026	2027	Annual Average
Public Works/Maintenance	Public Works/Maintenance Annual Staff Time	2.06	2.06	2.05	2.05	2.05	2.05
	Staffing contingency for Public Works/Maintenance (estimated at 20% to account unscheduled maintenance and response)	0.41	0.41	0.41	0.41	0.41	0.41
	Community Development/Engineering	0.26	0.19	0.11	0.11	0.11	0.16
	Total Staff Time (NPDES MS4 Activities)	2.73	2.66	2.57	2.57	2.57	2.62

Stormwater Master Plan Implementation

Master Plan implementation staffing timing varies based on CP implementation schedule and prioritization. Staffing assessment tables averages projects over 20-year planning period.

Public Works/Maintenance Staffing Assessment

SMP Implementation - Public Works/Maintenance Staffing Assessment										
Stormwater program implementation (post-2022)										
CP No.	CP Name	Description (New and replaced assets)	Increase in effort from pre-2022 activities (Y/N)	Cost Assumptions [E]		Implementation Need		Material costs (Y/N)	Annual Public Works/Maintenance Staff Schedule	
				Assumption Note	Hours/Year	Number of City Staff	Total Hours		Annual Average (hrs)	Annual Average (FTE)
BC-1	Library Pond Retrofit	Clear, regrade, and replant 0.7-acre detention pond.	Y	M	16 .0	2	32.0	Y	33.0	0.02
		Install 1 new outlet structure.		L	0.5	2	1.0			
		Install 70 LF of new perforated pipe.	N	F						
		Replace 70 LF of pipe.		Q						
		Install driveway for maintenance access.		R						
BC-2	Ash Meadows Flow Mitigation	Clear, regrade, and replant 1.3-acres of drainageway.	Y	M	16.0	2	32.0	Y	33.0	0.02
		Install 1 inlet.		L	0.5	2	1.0			
		Replace 175 LF of pipe.		Q						
BC-3	Wiedemann Ditch and Canyon Creek Park Retrofit	Clear, regrade, and replant 1.6-acres of storage facility (detention pond).	Y	M	16.0	2	32.0	Y	115.3	0.07
		Clear, regrade, and replant 2.1-acres along the existing ditch alignment to install 5 swales (tiered wetland complexes).		I	40.0	2	80.0			
		Install 1 new outlet structure.		L	0.5	2	1.0			
		Install 350 LF of pipe.		F	0.6	2	1.3			
		Install 1 new manhole.		G	0.5	2	1.0			
BC-4	Boeckman Creek Stabilization at Colvin Lane	Install 70 LF of new pipe.	Y	F	0.1	2	0.2	Y	16.2	0.01
		Reconstruct 150 LF of vegetated swale.		I	8.0	2	16.0			
		Install planting and bioengineered restoration of 600 LF of stream corridor.	N	P						
		Remove 30 LF of existing outfall pipe.		Q						
BC-5	Memorial Park Swale Retrofit	Install 2,400 SF vegetated water quality swale.	Y	I	8.0	2	16.0	Y	21.2	0.013
		Install 50 LF of new pipe.		F	0.1	2	0.2			
		Install 1 swale inflow spreader.		L	0.5	2	1.0			
		Install 1 overflow structure.		L	0.5	2	1.0			
		Install 1 new outfall.		K	0.5	2	1.0			
		Replace 1 manhole with a flow splitting/WQ manhole.		G	1.0	2	2.0			
		Replace 110 LF of pipe.	N	Q						
		Install 140 LF of perforated pipe.		F						
		Replace 2 manholes.		Q						
		Fill existing 1,500 SF swale and revegetate area.		P						

SMP Implementation - Public Works/Maintenance Staffing Assessment										
Stormwater program implementation (post-2022)										
CP No.	CP Name	Description (New and replaced assets)	Increase in effort from pre-2022 activities (Y/N)	Cost Assumptions [E]		Implementation Need		Material costs (Y/N)	Annual Public Works/Maintenance Staff Schedule	
				Assumption Note	Hours/Year	Number of City Staff	Total Hours		Annual Average (hrs)	Annual Average (FTE)
		Remove 210 LF of existing pipe.		Q						
		Remove 1 manhole.		Q						
		Remove 1 swale inlet structure.		Q						
		Remove 1 outlet structure.		Q						
BC-6	Gesellschaft Water Well Channel Restoration	Install 480 LF of new pipe.	Y	F	0.9	2	1.7	Y	4.7	0.003
		Install 2 new manholes.		G	1.0	2	2.0			
		Install 1 outfall.		K	0.5	2	1.0			
		Restore 310 LF of existing channel and re-vegetating with native trees and shrubs.	N	P						
CLC-1	Day Road Stormwater Improvements	Install 200 LF of open-bottom or box culverts (4 total).	Y	N	8.0	2	16.0	Y	27.1	0.016
		Install 180 LF of culverts (1 total).		N	2.0	2	4.0			
		Install 600 LF of pipe.		F	1.1	2	2.2			
		Install 2 manholes.		G	0.5	2	2.0			
		Install 3 trash racks at pipe inlets.		L	0.5	2	3.0			
		Regrade and reconstruct approx. 4,500 feet of open channel.	N	P						
		Replace 1,800 LF of pipe with 600 LF of pipe.		Q						
		Replace 7 manholes.		Q						
		Remove 50 LF of existing culvert.		Q						
CLC-2	Arrowhead Creek Culvert Replacement at Arrowhead Creek Trail	Replace 70 LF of box culvert.	N	N				Y	0.0	0.0
		Install 70 LF of planting and bioengineered restoration/stabilization measures along path.		P						
		Repave 600 SF of pedestrian path.		R						
CLC-3	Garden Acres Pond Retrofit	Install 1 flow diversion structure.	Y	L	0.5	2	1.0	Y	35.0	0.021
		Install 250 LF of new pipe.		F	0.5	2	1.0			
		Install 1 outlet control structure.		L	0.5	2	1.0			
		Clear, regrade, and replant 0.9-acres of pond.		M	16.0	2	32.0			
		Remove 25,600 CY of fill from existing pond.	N	Q						
		Install 50 LF of perforated pipe.		F						
NC-1	Frog Pond East and South Conveyance Pipe Installation	Install 2,360 LF of new pipe.	Y	F	4.2	2	8.5	Y	10.5	0.006
		Install 1 outfall.		K	0.5	2	1.0			
		Install 7 manholes.		G	0.5	2	1.0			
WR-1	SW Willamette Way/ Morey's Landing Stormwater Improvements	Clear, grade, and replant 0.12-acres of raingarden.	Y	I	8.0	2	16.0	Y	18.4	0.011
		Install 1 flow control diversion structure.		L	0.5	2	1.0			
		Install 120 LF of new pipe.		F	0.2	2	0.4			

SMP Implementation - Public Works/Maintenance Staffing Assessment										
Stormwater program implementation (post-2022)										
CP No.	CP Name	Description (New and replaced assets)	Increase in effort from pre-2022 activities (Y/N)	Cost Assumptions E		Implementation Need		Material costs (Y/N)	Annual Public Works/Maintenance Staff Schedule	
				Assumption Note	Hours/Year	Number of City Staff	Total Hours		Annual Average (hrs)	Annual Average (FTE)
		Install 1 manhole.		G	0.5	2	1.0			
		Replace 1,330 LF of pipe.	N	Q						
		Remove existing bubbler.		Q						
		Replace 7 manholes.		Q						
		Replace field inlet.		Q						
WR-2	Miley Road Stormwater Improvements	Install 4,195 of new pipe.	Y	F	7.6	2	15.1	Y	30.1	0.018
		Install 15 manholes.		G	7.5	2	15.0			
		Install 25 LF of planting and bioengineered restoration/stabilization measures after replacement of the culvert.	N	P						
		Replace 400 LF of pipe.		Q						
		Replace 1 manhole.		Q						
		Replace 1 area drain.		Q						
		Extend 240 LF of existing main connections to the new pipe alignment.		F						
		Reconnect 13 existing curb inlets.		F						
WR-3	Rose Lane Culvert Replacement	Install 80 LF of new pipe.	Y	F	0.1	2	0.2	Y	2.2	0.001
		Reinforce 100 LF of stormwater conveyance around property near culvert to move water into ditch.		J	1.0	2	2.0			
		Remove 25 LF of pipe.	N	Q						
WR-4	Charbonneau East Stormwater Improvements	Replace 3,765 LF of pipe.	N	Q				Y	0.0	0.0
		Replace 18 manholes.		Q						
		Replace 1 outfall.		Q						
WR-5	Charbonneau West Stormwater Improvements	Install 4 manholes.	Y	G	2.0	2	4.0	Y	4.0	0.002
		Replace 34 manholes.	N	Q						
		Replace 6,770 LF of pipe.		Q						
		Replace 2 outfalls.		Q						
City-1	Flow Monitoring and Rain Gauge Installation Hydromodification Assessment and Stream Survey	Install 1 rain gauge.	Y	Consultant Support				Y	Consultant Support	
		Install 3+ flow meters.								
City-2	Porous Pavement Pilot Study	Follow-up monitoring related to the 2022 geomorphic assessment, targeting select stream reaches.	Y	Consultant Support				Y	Consultant Support	
City-3	Boeckman Creek Geotechnical Evaluation	Project still being scoped.	Y	Consultant Support				Y	Consultant Support	
City-4	Flow Monitoring and Rain Gauge Installation	Project still being scoped.	Y	Consultant Support				Y	Consultant Support	
SMP Implementation Subtotal of Public Works/Maintenance Staff Cost						Average Annual Staff Time (hours)			350.7	
						Average Annual Staff Time (FTE)			0.21	

Community Development/Engineering Staffing Assessment

SMP Implementation - Community Development/Engineering Staffing Assessment

Stormwater program implementation (post-2022)

CP No.	CP Name	Description	Increase in effort from pre-2022 activities (Y/N)	Cost Calculations		Community Development/Engineering Schedule			
				Total Cost ($)	Design/Construction Administration (13.5% of total cost [A]) ($)	Total Staff Time (FTE)	Annual Average Staff Time (FTE)	Total Staff Time (Hr)	Annual Average Staff Time (Hr)
BC-1	Library Pond Retrofit	• Clear, regrade, and replant 0.7-acre detention pond. • Install 1 new outlet structure. • Install 70 LF of new perforated pipe. • Replace 70 LF of pipe. • Install driveway for maintenance access.	Y	$1,880,000	$190,000	0.95	0.048	1,567.5	78.4
BC-2	Ash Meadows Flow Mitigation	• Clear, regrade, and replant 1.3-acres of drainageway. • Install 1 inlet. • Replace175 LF of pipe.	Y	$2,940,000	$234,000	1.17	0.059	1,930.5	96.5
BC-3	Wiedemann Ditch and Canyon Creek Park Retrofit	• Clear, regrade, and replant 1.6-acres of storage facility (detention pond). • Clear, regrade, and replant 2.1-acres along the existing ditch alignment to install 5 swales (tiered wetland complexes). • Install 1 new outlet structure. • Install 350 LF of pipe. • Install 1 new manhole.	Y	Ph 1: $4,860,000	Ph 1: $322,000	1.61	0.081	2,656.5	132.8
				Ph 2: $7,210,000	Ph 2: $384,000	1.92	0.096	3,168.0	158.4
BC-4	Boeckman Creek Stabilization at Colvin Lane	• Install 70 LF of new pipe. • Reconstruct 150 LF of vegetated swale. • Install planting and bioengineered restoration of 600 LF of stream corridor. • Remove 30 LF of existing outfall pipe.	Y	$410,000	$38,000	0.19	0.010	313.5	15.7
BC-5	Memorial Park Swale Retrofit	• Install 2,400 SF vegetated water quality swale. • Install 50 LF of new pipe. • Install 1 swale inflow spreader, 1 overflow structure and 1 new outfall. • Replace 1 manhole with a flow splitting/WQ manhole. • Replace 110 LF of pipe. • Install 140 LF of perforated pipe. • Replace 2 manholes. • Fill existing 1,500 SF swale and revegetate area. • Remove 210 LF of existing pipe. • Remove 1 manhole, 1 swale inlet structure, and 1 outlet structure.	Y	$910,000	$85,000	0.43	0.021	701.3	35.1
BC-6	Gesellschaft Water Well Channel Restoration	• Install 480 LF of new pipe. • Install 2 new manholes. • Install 1 outfall. • Restore 310 LF of existing channel and re-vegetating with native trees and shrubs.	Y	$400,000	$38,000	0.19	0.010	313.5	15.7

SMP Implementation - Community Development/Engineering Staffing Assessment									
Stormwater program implementation (post-2022)									
CP No.	CP Name	Description	Increase in effort from pre-2022 activities (Y/N)	Cost Calculations		Community Development/Engineering Schedule			
				Total Cost ($)	Design/Construction Administration (13.5% of total cost A) ($)	Total Staff Time (FTE)	Annual Average Staff Time (FTE)	Total Staff Time (Hr)	Annual Average Staff Time (Hr)
CLC-1	Day Road Stormwater Improvements	• Install 200 LF of open-bottom or box culverts (4 total). • Install 180 LF of culverts (1 total). • Install 600 LF of pipe. • Install 2 manholes. • Install 3 trash racks at pipe inlets. • Regrade and reconstruct approx. 4,500 feet of open channel. • Replace 1,800 LF of pipe with 600 LF of pipe. • Replace 7 manholes. • Remove 50 LF of existing culvert.	Y	Ph 1: $8,020,000	Ph 1: $405,000	2.03	0.101	3,341.3	167.1
				Ph 2: $3,930,000	Ph 2: $370,000	1.85	0.093	3,052.5	152.6
CLC-2	Arrowhead Creek Culvert Replacement at Arrowhead Creek Trail	• Replace 70 LF of box culvert. • Install 70 LF of planting and bioengineered restoration/stabilization measures along path. • Repave 600 SF of pedestrian path.	Y	$290,000	$35,000	0.18	0.009	288.8	14.4
CLC-3	Garden Acres Pond Retrofit	• Install 1 flow diversion structure. • Install 250 LF of new pipe. • Install 1 outlet control structure. • Install 50 LF of perforated pipe. • Clear, regrade, and replant 0.9-acres of pond. • Remove 26,500 CY of fill from existing pond.	Y	$3,780,000	$302,000	1.51	0.076	2,491.5	124.6
NC-1	Frog Pond East and South Conveyance Pipe Installation	• Install 2,360 LF of new pipe. • Install 1 outfalls. • Install 7 manholes.	Y	$4,090,000	$414,000	2.07	0.104	3,415.5	170.8
WR-1	SW Willamette Way / Morey's Landing Stormwater Improvements	• Clear, grade, and replant 0.12-acres of raingarden. • Install 1 flow control diversion structure. • Install 120 LF of new pipe. • Install 1 manhole. • Replace 1,330 LF of pipe. • Remove existing bubbler. • Replace 7 manholes. • Replace field inlet.	Y	Ph 1: $2,310,000	Ph 1: $233,000	1.17	0.058	1,922.3	96.1
				Ph 2: $1,080,000	Ph 2: $109,000	0.55	0.027	899.3	45.0

SMP Implementation - Community Development/Engineering Staffing Assessment									
Stormwater program implementation (post-2022)									
CP No.	CP Name	Description	Increase in effort from pre-2022 activities (Y/N)	Cost Calculations		Community Development/Engineering Schedule			
				Total Cost ($)	Design/Construction Administration (13.5% of total cost [A]) ($)	Total Staff Time (FTE)	Annual Average Staff Time (FTE)	Total Staff Time (Hr)	Annual Average Staff Time (Hr)
WR-2	Miley Road Stormwater Improvements	• Install 4,195 of new pipe. • Install 15 manholes. • Install 25 LF of planting and bioengineered restoration/stabilization measures after replacement of the culvert. • Replace 400 LF of pipe. • Replace 1 manhole. • Replace 1 area drain. • Extend 240 LF of existing main connections to the new pipe alignment. • Reconnect 13 existing curb inlets.	Y	Ph 1: $820,000	Ph 1: $77,000	0.39	0.019	635.3	31.8
				Ph 2: $10,510,000	Ph 2: $470,000	2.35	0.118	3,877.5	193.9
WR-3	Rose Lane Culvert Replacement	• Install 80 LF of new pipe. • Reinforce 100 LF of stormwater conveyance around property near culvert to move water into ditch. • Remove 25 LF of pipe.	Y	$200,000	$35,000	0.18	0.009	288.8	14.4
WR-4	Charbonneau East Stormwater Improvements	• Replace 3,765 LF of pipe. • Replace 18 manholes. • Replace 1 outfall.	Y	Ph1: $600,000	Ph 1: $50,000	0.25	0.013	412.5	20.6
				Ph 2: $4,440,000	Ph 2: $449,000	2.25	0.112	3,704.3	185.2
WR-5	Charbonneau West Stormwater Improvements	• Install 4 manholes. • Replace 34 manholes. • Replace 6,770 LF of pipe. • Replace 2 outfalls.	Y	$10,370,000	$488,000	2.44	0.122	4,026.0	201.3
P-4[E]	Charbonneau Repair/ Replacement Program	• Replace 30,620 LF of pipe. • Replace 153 manholes.	Y	$38,360,000	$3,879,000	19.40	0.970	32,001.8	1,600.1
City-1	Flow Monitoring and Rain Gauge Installation	• Install 1 rain gauge. • Install 3+ flow meters.	Y	TBD, project will vary		Consultant Support			
City-2	Hydromodification Assessment and Stream Survey	Follow-up monitoring related to the 2022 geomorphic assessment, targeting select stream reaches.	Y	TBD, project will vary		Consultant Support			
City-3	Porous Pavement Pilot Study	Project still being scoped.	Y	TBD, project will vary		Consultant Support			
City-4	Boeckman Creek Geotechnical Evaluation	Project still being scoped.	Y	TBD, project will vary		Consultant Support			
SMP Implementation Subtotal of Community Development/Engineering Staff Cost				Total Staff Time				43.04 FTE / (71,008 hrs)	
				Annual Average Staff Time [B]				2.15 FTE / (3,550 hrs)	
				City Engineering Staff already designated for Capital Project work [C]				*1.0 FTE*	
				Additional Annual Average Community Development/Engineering Staff Time Needed [D]				**1.15 FTE**	

[A] *Most projects use a 13.5% multiplier for Design/Construction Administration, but a select group of projects were designated by the City to use a 3.5% + $200K value instead to better represent anticipated conditions.*

The projects with the adjusted multiplier include BC-3 Phases 1 & 2, CLC-1 Phase 1, CLC-3, WR-2 Phase 2, and WR-5.

WR-4 Phase 1 was designated by the City to use a 25% multiplier for Design/Construction Administration.

[B] *Summary values rounded to nearest whole hour.*

[C] *The City already has 1.0 FTE designated to work on Capital Projects, this amount was subtracted from the total calculated staff time.*

[D] *This value represents the additional annual average Community Development/Engineering staffing need of the City to complete the Capital Projects.*

[E] *Proposed program efforts are generally anticipated to be conducted using existing staffing resources or within allocated annual budgets. The Charbonneau R/R Program (P-4) will require dedicated City Engineering resources to schedule and manage specific contracts to adhere to the anticipated 20-year program duration. As such, Design/ Construction Administration costs were specifically calculated for this program and used to inform the required staffing needs.*

Stormwater Master Plan Staffing Summary

SMP Implementation - Public Works/Maintenance and Community Development/Engineering Staffing Assessment Summary						
	Annual SMP Implementation Staff Cost Schedule (FTE)					
	2023	2024	2025	2026	2027	Annual Average
Public Works/Maintenance	0.21	0.21	0.21	0.21	0.21	0.21
Community Development/Engineering	1.15	1.15	1.15	1.15	1.15	1.15
Total Staff Time	1.36	1.36	1.36	1.36	1.36	1.36

Combined Staffing Assessment Summary

Combined - Public Works/Maintenance and Community Development/Engineering Staffing Assessment Summary								
		Combined Annual Staff Cost Schedule (FTE)						
		2023	2024	2025	2026	2027	Annual Average
Public Works/Maintenance Staff Cost Schedule	NPDES MS4 Permit Driven Activities	2.06	2.06	2.05	2.05	2.05	2.05
	Staffing contingency for NPDES MS4 Driven Activities (estimated at 20% to account unscheduled maintenance and response)	0.41	0.41	0.41	0.41	0.41	0.41
	SMP Implementation	0.21	0.21	0.21	0.21	0.21	0.21
	Public Works/Maintenance Staffing Summary (FTE)	2.68	2.68	2.67	2.67	2.67	2.67
Community Development/Engineering Staff Cost Schedule	NPDES MS4 Permit Driven Activities	0.26	0.19	0.11	0.11	0.11	0.16
	SMP Implementation	1.15	1.15	1.15	1.15	1.15	1.15
	Community Development/Engineering Staffing Summary (FTE)	1.41	1.34	1.26	1.26	1.26	1.31

Appendix H: Comprehensive Plan Review

Comment Log

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

T: 503.244.7005

Prepared for: City of Wilsonville
Project Title: Stormwater Master Plan
Project No.: 156157
Subject: Review of Wilsonville Comprehensive Plan
Date: December 16, 2021

Comment Log Public Facilities and Services Section				
No.	Reviewer	Page	Section	Comment
1	K. Reininga	C-8	Storm Drainage Plan Paragraph 2, Line 2	Add other parameters here [currently includes temperature and turbidity] like metals, toxics, nutrients...
2	K. Reininga	C-8	Storm Drainage Plan Paragraph 3, Line 2	Remove word 'detention.'
3	K. Reininga	C-8	Storm Drainage Plan Paragraph 4, Line 2	Include mention of water quality.
4	K. Reininga	C-8	Storm Drainage Plan Paragraph 4, Line 3	Add "Prepared in X and updated in X" after Stormwater Master Plan.
5	K. Reininga	C-8	Policy 3.1.7	The need to prioritize green infrastructure and infiltration should be reflected in the policy statement. It may be preferred to keep language general and say compliance with the City's standards is required and then those priorities reside there. Or, an implementation measure could be added to address the new permit requirements for LID and retention. Numbering appears to be incorrect, as this should be Policy 3.1.9.
6	K. Reininga	C-8	Policy 3.1.7 Paragraph 1, Line 6	Add "peak rate" after "volume".
7	K. Reininga	C-9	Implementation Measure 3.1.7.b, Line 3	Add Municipal Separate Storm Sewer System (MS4) before the word permit as there are other types of NPDES permits.
8	K. Reininga	C-9	Implementation Measure 3.1.7.c, Line 9	Remove word 'detention.'
9	K. Reininga	C-9	Implementation Measure 3.1.7.e	City to confirm this implementation measure is still applicable.
10	K. Reininga	C-9	Implementation Measure 3.1.7.f, Line 3	Clarification need. It is not clear what Option A is referring to.
11	K. Reininga	C-10	Implementation Measure 3.1.7.h, Line 3	"Development Review Board" - Is this still the appropriate reference?

Comment Log Public Facilities and Services Section				
No.	**Reviewer**	**Page**	**Section**	**Comment**
12	K. Reininga	C-10	Implementation Measure 3.1.7.k, Line 5	Has this now been done? Reference: "For that area along Coffee Lake Creek, a hydrology study to establish the 100-year flood elevation will be required prior to development approval."
13	K. Reininga	C-10	Implementation Measure 3.1.7.n, Line 1	Insert word "peak" in single-storm drainage runoff.
14	K. Reininga	C-10	Implementation Measure 3.1.7.n, Line 5	Revise to say stormwater management facilities here instead of detention or retention facilities.
15	K. Reininga	C-11	Implementation Measure 3.1.7.n, Line 7	Has this been done? "The appropriate criteria will be established and implemented through the City's Public Works Standards."
16	K. Reininga	C-11	Implementation Measure 3.1.7.r, Line 3	Replace "detention/retention basin" with the term stormwater management facility.