Stormwater Master Plan

2025

CITY OF BEND

Acknowledgments

Submitted to:

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Abbreviations and Acronyms

ADT	Average Daily Trips
BDC	Bend Development Code
BMC	Bend Municipal Code
BMPs	Best Management Practices
BNSF	Burlington Northern Santa Fe
BPRD	Bend Park and Recreation District
CFA	Climate Friendly Area
CFEC	Climate Friendly and Equitable Communities
CIP	Capital Improvement Program
COBA	Central Oregon Business Association
COIC	Central Oregon Intergovernmental Council
COSM	Central Oregon Stormwater Manual
CWA	Clean Water Act
DEQ	Oregon Department of Environmental Quality
DLCD	Department of Land Conservation and Development
EPA	U.S. Environmental Protection Agency
FTE	Full-Time Equivalent
FY	Fiscal Year
GIS	Geographic Information Systems
ISMP	Integrated Stormwater Management Plan
LID	Low Impact Design
LOS	Level of Service
MS4	Municipal Separate Storm Sewer System

Abbreviations and Acronyms

NPDES	National Pollutant Discharge Elimination System
ODOT	Oregon Department of Transportation
ROW	Right-of-Way
SDWA	Safe Drinking Water Act
SMP	Stormwater Master Plan
TMDL	Total Maximum Daily Load
UIC	Underground Injection Control
UGB	Urban Growth Boundary
UPAG	Utilities Public Advisory Group
WAG	Water Advisory Group
WOZ	Waterway Overlay Zone

Executive Summary

The Bend Stormwater Master Plan (SMP) builds on and expands the 2014 SMP. It also acknowledges and builds on the City's work to manage stormwater in compliance with two permits from the Oregon Department of Environmental Quality (DEQ) which regulate stormwater discharges to groundwater and surface water. Since publication of the 2014 SMP, the City has grown dramatically, and new stormwater regulations and issues have arisen. The City has taken action to address these emerging priorities and seeks a plan to guide the implementation of stormwater projects and policies for the next 20 years. The SMP collects and assesses the current suite of stormwater issues and concerns. These include capital improvement needs such as drainage, water quality, and system condition. They also include policies seeking efficient and effective processes for stormwater management to serve development, setting level of service expectations and tracking measures, and preparing for future changes to the City's density and precipitation patterns.

The SMP proposes a balance between addressing immediate concerns and preparing for the future. This executive summary and implementation plan will help the City sequence its efforts over the next 20 years and adapt to changing circumstances and priorities.

Stormwater Program Goals

Completion of infrastructure master plans, including this update to the SMP, is a stated goal of City Council for 2025 to 2027. Implementation of the SMP will help Bend address public concerns with drainage, stakeholder priorities for public safety and environmental stewardship, and City Council's goals.

Public Drainage Concerns

Several intense rainstorms with severe localized flooding have occurred in the last decade, drawing increasing public attention to private property damage and traffic safety resulting from lack of collection and/or conveyance capacity in the City's storm systems. These intense storms include, but are not limited to, two storms over Pilot Butte in August 2025 as this plan was reaching its conclusion. Addressing severe localized flooding is a priority for staff and affected members of the public and could serve to reduce the City's liability.

Staff and Stakeholder Goals

Both City staff and stakeholders have emphasized public safety as a priority that can be served by attending equally to both drainage problems that impact pedestrians or traffic safety or private property and to water quality protection. Stakeholders have emphasized environmental stewardship and projects that serve multiple purposes. Compliance with the City's two stormwater permits is a priority for staff and stakeholders and is the driver of several of the recommendations.

City Council Goals

The following elements of the 2025-2027 City Council Work Plan are pertinent to the SMP:

- Prioritizing policies that support affordable, attainable housing, and livability contribute to Council's "Safety + Belonging" principle.
- Prioritizing environmental resilience to ensure a thriving and livable Bend contributes to Council's "Environment and Climate" guiding principle and honors the original stewards of the land.
- Adopting development code and entitlement process improvements that remove barriers and speed up missing middle-income, affordable housing, and infill development serve Council's Housing objectives.

- Several objectives of the Transportation & Infrastructure goal are pertinent:
  - Enhancing safety for all modes of travel.
  - Developing projects and funding solutions to improve safety, reliability, maintenance, and capital needs, aligning revenue options with planning and performance metrics and goals.
  - Ensuring stormwater systems are aligned with the needs of a growing city and understanding capacity for growth.
  - Finishing the Stormwater Master Plan, prioritizing infill development.
- Leveraging public-private partnerships that catalyze investment in the Bend Central District.
- Improving permitting processes and reducing review times to support housing and economic development.

The SMP addresses each of these principles or goals through capital improvements and policy recommendations.

Stormwater Issues and Solutions

Context

Bend's topography and soils, along with its high desert landscape and climate, create variable conditions for drainage and stormwater management over the City's 35 square miles.

Although there is relatively little annual rainfall, it often comes in short, intense bursts, particularly in the spring and fall, causing considerable localized flooding throughout the City. During the winter months, when drainage systems are sometimes blocked by snow and ice, rapid snowmelt and rain-on-snow events exacerbate flooding.

Bend's volcanic geology created a landscape with many ridges, drops, sinks, and hills. Volcanic rock is at or near the surface throughout the City, and its permeability and topography vary greatly, with three primary types of permeability present. Soils close to or within the Deschutes River channel are primarily river deposits composed of gravels, sand, and silt, and they have variable permeability. Portions of the City are underlain by basalt that is relatively fractured with a sufficiently high permeability to allow for high rates of stormwater infiltration. Some areas of the City are underlain by consolidated basalt or tuff, which is highly impermeable and does not provide acceptable conditions for the use of shallow infiltration techniques, including drywells.

Within this context, Bend's system of public stormwater infrastructure relies on large number of drywells (6,083) and drillholes (933), which are known as underground injection controls (UICs), to dispose of stormwater directly into the ground. Each UIC is the terminus of an individual small stormwater system that is not connected to other City stormwater systems. As Bend began to regulate stormwater systems on private property during development, and to require that most rainfall be kept on each site, many private UICs were also installed where soil conditions are favorable to infiltration. In addition to UICs, the City also has 36 public stormwater outfalls to the Deschutes River, draining approximately 2.2 square miles through small to medium-sized connected pipe systems.

Issues

This stormwater system serves a growing population. City planning staff are relying on growth projections that estimate the City population will increase from approximately 104,000 today to more than 130,000 by

2035. The urban growth boundary (UGB) was expanded in 2016 and has been expanded two additional times since then, and the City is pursuing a UGB amendment to add 100 more acres in 2025 or 2026.

As the population has grown, Bend has become denser. Managing stormwater on individual lots by relying on areas of superior infiltration has become increasingly difficult as lots sizes decrease and/or lot coverage increases. The need to provide stormwater facilities that also protect water quality can increase the footprint of the required systems, exacerbating the rising competition for space on lots and in the City's rights-of-way (ROW). Also related to rapid development, the total number of Bend's stormwater system assets has increased. For example, the inventories of catch basins and UICs have been growing at an annual average rate of 1.9% and 1.5%, respectively, since 2015.

With urbanization comes a decrease in undeveloped land, which is generally pervious, does not produce much runoff, and may often act as an unofficial stormwater management facility for adjacent roads and lots. As these more pervious areas disappear, adjacent existing stormwater systems may be overwhelmed by new flows they were not designed to handle. New localized flooding has occurred on streets, bike lanes, sidewalks, and property.

Intense storms, which produce significant rainfall in a short period of time, may stress or overwhelm stormwater systems that are otherwise adequate to handle the same amount of rainfall over a longer period of time. A literature review provided for the SMP indicates that the rainfall data used to determine design capacity of Bend's stormwater conveyance and management facilities is outdated by several decades and may underrepresent both the intensity and the overall precipitation depths in storms over Bend. The national dataset used also may not address how Bend's topography, with its steep buttes, can create a significant increase in storm intensity over a tiny area. Public awareness and complaints about flooding resulting from intense storms appears to be rising. The cost of providing additional storm system capacity, which may be needed only infrequently, must be balanced against the risks to public safety and to property from storm system flooding.

In addition to localized flooding, water quality is a concern. Historically, Bend's stormwater system did not mitigate or prevent impacts to the quality of groundwater or the river. In recent years, reducing pollutants in stormwater runoff to protect water quality has become increasingly important because of both regulation and public sentiment.

The SMP identifies a total of 103 stormwater issues related to Bend's drainage systems. Each issue is categorized into one of the following primary concerns: drainage, condition, maintainability, erosion, groundwater quality, or surface water quality. Table E-1 shows the number of issues that fall into each category.

Table E-1 Count of Stormwater Known Issues by Type

Type	Count	Category Description
Drainage	57	Drainage issues include ponding and flooding on streets and private properties where the drainage system is inadequate, damaged, or is not present
Water Quality – Groundwater	26	Groundwater quality issues are identified where underground injection controls such as drillholes and drywells may pose a contamination risk to groundwater because they are located near drinking water wells or do not have a spill control structure
Water Quality – Surface Water	7	Surface water quality issues are identified by analyzing the pollutant-causing characteristics of Bend's outfall basins and then prioritizing those outfalls that may discharge the most pollutants to the Deschutes River.

Table E-1 Count of Stormwater Known Issues by Type

Type	Count	Category Description
Condition	6	Condition issues are identified when the drainage system or stormwater facility is damaged
Maintainability	5	Maintainability issues are identified where the drainage system or stormwater facilities are difficult or dangerous for City staff to maintain due to location, design, or condition
Erosion	2	Erosion issues are identified where stormwater flows over denuded or sparsely vegetated landscaped or natural areas and deposits eroded soils into streets, catch basins, UICs, or other elements of the drainage system
Total	103	

In addition, the SMP also identifies policies related to drainage and density, level of service for the stormwater utility, and climate change as issues to be explored.

Recommended Solutions and Costs

The SMP recommends implementation of stormwater capital improvements that have been planned, designed, or started construction since the 2014 SMP. Most of these projects address drainage issues. It recommends planning for 11 new stormwater capital improvement program (CIP) projects to address larger-scale drainage and water quality issues and three programmatic solutions to systematically address smaller-scale water quality and storm system condition issues over time (Figure E-1, on page E-6).

Recommended capital improvements are estimated to cost more than $76 million in 2025 dollars. Planning-level estimates include the full cost of implementing capital improvements, from design through construction. Maintenance costs are not included.

The 20-year cost table (Table E-2, on page E-7) spreads the recommended capital investments over a 20-year horizon in phases correlating to the City's capital planning cycle: years one through five, years six through ten, and the remaining years 11 through 20. The table also includes stormwater CIPs that were in progress or planned for implementation prior to the completion of the SMP and that appear in the capital improvement budget or planning documents such as the Midtown Crossings Stormwater Report.

The SMP recommends policy initiatives. To address drainage and density, the SMP explores how the City could enforce stormwater standards more rigorously while allowing greater flexibility for centralizing stormwater management facilities. To address the pressures on available staffing and equipment resources resulting from growing storm system inventory and increasing regulation, the SMP recommends establishing and communicating about levels of service for the various stormwater services provided by the City and recommends more uniform and rigorous tracking of service metrics. Over time, these service expectations and metrics will assist in evaluating the costs and benefits of different levels of staffing and revenues. Finally, the SMP recommends the City take a watchful waiting stance to address the uncertainties of climate change, while pursuing an update to the outdated national precipitation data used to size stormwater facilities.

Funding and Implementation

The stormwater utility receives its funding from the Stormwater Fund, which collects revenue from the stormwater utility fee paid by property owners. The stormwater utility issued long-term debt for the first time in FY 2021 for capital projects. The SMP recommends capital investment of more than $76 million

over the next 20 years to address drainage issues, protect groundwater and surface water quality, and meet permit requirements for operating storm sewers and UICs. The costs of day-to-day stormwater operations and regulation of stormwater systems on private property have not been estimated in this plan; however, budgets for system operations, maintenance, and regulation can be expected to grow with increasing inventory of storm system assets, increasing growth in private development, and increasing regulation of the City.

Using cost inputs from the SMP, the City will study the cost of providing stormwater capital improvements and ongoing stormwater services to the community and assess how to align stormwater utility fees with City costs.

To address growing stormwater program demands, the SMP outlines strategic priorities that reflect City Council's goals and incorporate input from stakeholders gathered during the plan's development. The Implementation Plan, Section 8, serves as a guiding framework for implementing these priorities and adapting to changing conditions and changing funding over time.

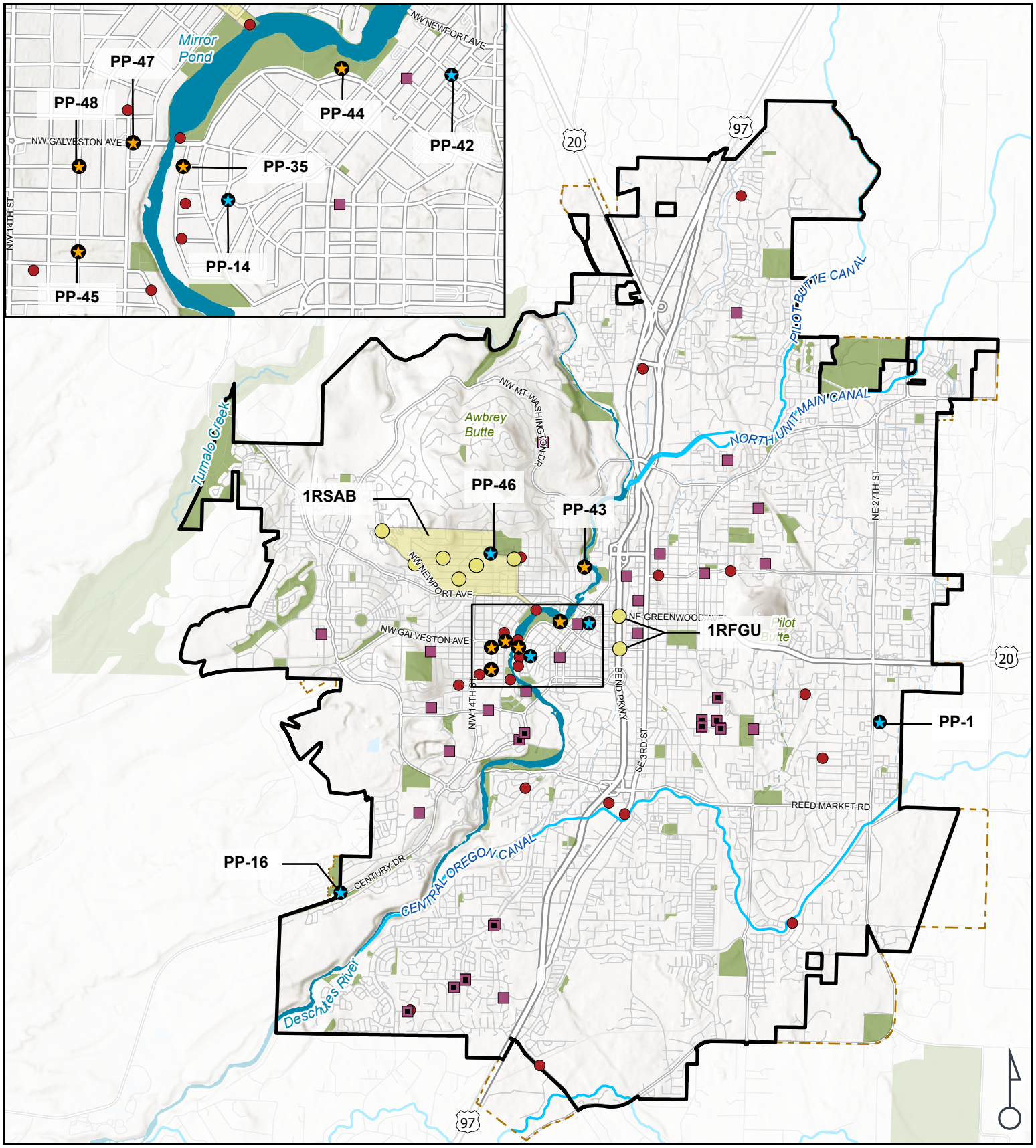

FIGURE E-1
STORMWATER MASTER PLAN PROJECTS & PROGRAMS
BEND STORMWATER MASTER PLAN
BEND, OREGON

LEGEND

- Bend City Limits
- Urban Growth Boundary
- Streams
- Canals
- CIP - Drainage
- CIP - Outfall Retrofit
- CIP In Progress
- Major Maintenance Program
- Drillhole Water Quality Retrofit Program
- Failing UIC Drainage Improvements Program

0 0.5 1 Mile

CITY OF BEND

Otak

Data Sources: City of Bend, Deschutes County, USGS, Google Maps.
Date: 10/28/2025
Disclaimer: This data is not to survey accuracy and is meant for planning purposes only.

O:\PROJECT\20300\20359\04 CAD\GIS\APRX\20359 BEND MASTER PLAN MAPS JR.APRX

Table E-2 Recommended Stormwater Capital Improvements 20-Year Costs and Prioritization

Rank	ID	Project Name	Total Cost*	Information Source	Notes	Years 1-5†	Years 6-10	Years 11-20
Existing CIPs – Individual Projects								
1A‡	1SSW3	SW Sewer Basin Improvements Phase 3	$400,000	2025-27 Proposed Biennial Budget	Costs included in this table begin in 2026-27. Estimated completion in 2026-27.	$500,000		
1A	1RSAB	South Awbrey Butte Drainage Improvements	$12,500,000	2025-27 Proposed Biennial Budget	Costs included in this table begin in 2026-27. PP-2, PP-3, PP-4, PP-5, PP-6, PP-7 are all part of the drainage improvements; Estimated completion date of 2029	$15,450,000		
1A	1RFGU	Franklin Stormwater Improvements, Phase 1	$620,000	Midtown Crossing Stormwater Report	PP-51; Estimated completion date of 2026; Franklin is included in the budget with Greenwood, though they are separate project locations	$1,216,000		
1A	1RFGU	Greenwood Stormwater Improvements, Phase 1	$1,000,000	Midtown Crossing Stormwater Report	PP-39; Greenwood is included in the budget with Franklin, though they are separate project locations; Estimated completion date of 2026	$1,824,000		
					Existing CIPs Subtotal	*$18,990,000*	*$0*	*$0*
Planned CIPs – Individual Projects								
1B‡	1RFGU, Ph 2	Franklin Stormwater Improvements, Phase 2	$850,000	Midtown Crossing Stormwater Report	Date of Implementation TBD; Franklin is included in the budget with Greenwood, though they are separate project locations		§	
1B	1RFGU, Ph 2	Greenwood Stormwater Improvements, Phase 2	$3,800,000	Midtown Crossing Stormwater Report	Date of Implementation TBD; Greenwood is included in the budget with Franklin, though they are separate project locations		§	
1	PP-35	Riverfront Street Stormwater Improvements	$880,000	CIP Fact Sheet	Date of implementation TBD. Note that the 2025-27 Proposed Biennial Budget has a placeholder for Outfall Improvements (1ROTI) with expenditures beginning in 2028-29.		$880,000	
2	PP-42	Downtown Pedestrian Safety Drainage Improvements	$770,000	CIP Fact Sheet	Date of implementation TBD.		$385,000	$385,000
3	PP-44	Drake Park Stormwater Quality Improvements	$4,140,000	CIP Fact Sheet	Date of implementation TBD. Note that the 2025-27 Proposed Biennial Budget has a placeholder for Outfall Improvements (1ROTI) with expenditures beginning in 2028-29.		$2,070,000	$2,070,000
4	PP-14	Congress Street Drainage Improvements	$1,320,000	CIP Fact Sheet	Date of implementation TBD.			$1,320,000
5	PP-46	Vicksburg Avenue Drainage Improvements	$490,000	CIP Fact Sheet	Date of implementation TBD.		$490,000	
6	PP-47	Galveston Avenue Stormwater Quality Improvements	$5,820,000	CIP Fact Sheet	Date of implementation TBD. Note that the 2025-27 Proposed Biennial Budget has a placeholder for Outfall Improvements (1ROTI) with expenditures beginning in 2028-29.		$5,820,000	
7	PP-48	Fresno Avenue Stormwater Improvements	$4,230,000	CIP Fact Sheet	Date of implementation TBD. Note that the 2025-27 Proposed Biennial Budget has a placeholder for Outfall Improvements (1ROTI) with expenditures beginning in 2028-29.			$4,230,000
8	PP-45	12th Street Stormwater Quality Improvements	$1,040,000	CIP Fact Sheet	Date of implementation TBD. Note that the 2025-27 Proposed Biennial Budget has a placeholder for Outfall Improvements (1ROTI) with expenditures beginning in 2028-29.			$1,040,000
9	PP-1	Dove Lane Drainage Improvements	$390,000	CIP Fact Sheet	Date of implementation TBD.			$390,000
10	PP-43	Saginaw Avenue Stormwater Quality Improvements	$2,620,000	CIP Fact Sheet	Date of implementation TBD. Note that the 2025-27 Proposed Biennial Budget has a placeholder for Outfall Improvements (1ROTI) with expenditures beginning in 2028-29.			$2,620,000
11	PP-16	Campbell Rd Drainage Improvements	$130,000	CIP Fact Sheet	Date of implementation TBD.			$130,000
					Planned CIPs Subtotal	*$0*	*$9,645,000*	*$12,185,000*
					Individual CIPs Total	**$18,990,000**	**$9,645,000**	**$12,185,000**

Table E-2 continues on next page

Table E-2 Recommended Stormwater Capital Improvements 20-Year Costs and Prioritization

Rank	ID	Project Name	Total Cost*	Information Source	Notes	Years 1-5†	Years 6-10	Years 11-20
Programmatic Solutions								
n/a	1RDHD	Drillhole Water Quality Retrofit Program	$5,700,000	Program Fact Sheet and 2025-27 Biennial Budget	Total costs include the priority locations documented in the fact sheet for a five-year implementation schedule and subsequent lower-priority projects implemented at a slower pace in future years.	$750,000	$3,375,000	$ 1,575,000
n/a	TBD	Failing UIC Drainage Improvement Program	$5,340,000	Program Fact Sheet	10-year implementation schedule to begin after completion of the high priority projects in the 1RDHD program. This program will be rolled into Stormwater Major Maintenance after the priority issues completed.		$2,670,000	$2,670,000
n/a	1RCAP	Stormwater Major Maintenance Program	Annual allocation	Annual allocation	Currently "Stormwater Capital Repair and Replacement" (1RCAP) in 2025-27 Proposed Biennial Budget. Assume continuation of this program at a set annual level of $1.5 million from years 6 to 20.	$6,620,000	$4,830,000	$13,155,000
					Programmatic Solutions Total	**$7,370,000**	**$10,875,000**	**$17,400,000**
					Total by Planning Horizon	**$26,360,000**	**$20,520,000**	**$29,585,000**
					Grand Total	**$76,465,000**		

** All costs are in 2025 dollars*
† Year 1 is the fiscal year 2025-2026
‡ Ranks 1A and 1B are given to projects that were not ranked by the SMP project team but are considered high-priority because they are either ongoing or budgeted capital improvements (1A) or contained in an existing master plan or infrastructure improvement plan that is being implemented by the City (1B)
§ City of Bend is determining if this work will be addressed through a City-funded CIP or through private development

Section 1. Introduction

The City of Bend has experienced rapid growth over the past 20 years, resulting in increased impervious area and more stormwater runoff. Historically, due to the City's semi-arid climate and well-draining soils, stormwater management was not a major priority. Bend's early development was close to the Deschutes River, and piped systems conveyed stormwater to the river. As the City expanded, drillholes became the primary method of stormwater management, followed by drywells. Drywells have been predominantly used for many years to manage the City's stormwater because they are relatively low-cost, easy to install, and generally effective at dissipating runoff flows without needing to be connected to a City conveyance system. However, they have also been used in areas with natural impermeable layers which impede their intended function, and near drinking water wells, which have raised concerns about pollutants in stormwater interacting with water supply sources.

Drywells and drillholes require regular maintenance. Road cinders (used to improve traction for the motoring public during icy weather), eroded soils, and debris accumulate in structures, reduce the effectiveness of infiltration if not properly maintained. Failed or failing drillholes and drywells, drywells installed in inappropriate places, and the increase in impervious surface area all contribute to the frequent and widespread nuisance stormwater flooding that now takes place in Bend.

Population growth and the resulting increase in development and density have exacerbated drainage problems by increasing flooding intensity, volume, and timing of peak flows. More intense storms possibly brought about by climate change may also play a role. In some locations, stormwater flooding has become a public safety issue and a threat to private homes and businesses as well as public infrastructure.

Stormwater quality is also a critical topic. The federal Safe Drinking Water Act (SDWA) and the State of Oregon's Underground Injection Control (UIC) rules regulate the City's drywells and drillholes to protect groundwater. The federal and state National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Phase II rules regulate the City's discharges to the Deschutes River. Both regulatory programs require the City to obtain and comply with a permit and to use Best Management Practices (BMPs) to reduce the pollutants discharged to the environment.

1.1. Purpose and Objectives

The primary purpose of the Stormwater Master Plan (SMP) is to identify and prioritize projects, programs, and policies that improve and extend the City of Bend's stormwater infrastructure and management practices over the next 20 years. The community will benefit from the provision of adequate stormwater facilities that reduce current nuisance flooding during frequent storms and protect the quality of groundwater and surface water. In addition, the SMP has two additional goals of reducing disruptions from emergency repairs and supporting redevelopment and development through policy updates.

The City retained Otak, Inc. (Otak) to update and replace the 2014 Stormwater Master Plan (URS, 2014). This SMP includes recommended projects, programs, and policies. The SMP will be implemented primarily by the Engineering Department and Water Services Department

1.2. Organization of the Master Plan

The SMP planning process encompassed several steps with the goal of identifying system improvement priorities and developing programmatic solutions and capital improvement projects (CIPs) to address those priorities.

- **Executive Summary** summarizes the planning context, key issues, and priorities for stormwater planning. It describes the recommended capital plan and policy initiatives. This section can be read alone.
- **1.0 Introduction** introduces the SMP by describing the regulatory background and relationships this plan has with other City plans and programs.
- **2.0 Planning Area** describes the planning area and its characteristics in detail. The planning area for this SMP is the City of Bend with some consideration of the urban growth boundary (UGB).
- **3.0 Planning Process and Analysis** describes the process of identifying and categorizing known issues, then developing solutions and projects to implement those solutions. Known issues were compiled by reviewing project lists, community complaints, work order databases, and drainage problem areas (hotspot) map, as well as interviewing staff from the City of Bend. CIPs and programs of smaller projects were developed to meet the City's goals.
- **4.0 Stormwater Capital Improvement Projects** presents the CIP selection process and the recommended projects. Eleven projects were selected to develop into CIPs with concept level designs and cost estimates.
- **5.0 Programmatic Solutions** presents recommendations for three programs to systematically improve performance of existing stormwater management infrastructure. Each program groups similar types of projects that would be too small or otherwise ineligible to become a standalone stormwater CIP.
- **6.0 Policy Discussion** explores potential policy initiatives regarding climate change, managing stormwater as the city becomes denser (development and density), and stormwater operations level of service. The full text of two white papers and a presentation on climate change are included in Appendix D.
- **7.0 Public Involvement and Outreach** describes the involvement of the community in the creation of this plan.
- **8.0 Implementation Plan** describes a plan for implementing the recommendations which includes timing considerations, budget, and priorities.

1.3. Regulatory Context and Relationships

Generally, stormwater discharges from developed areas may create adverse impacts on streams, rivers, and lakes in a variety of ways including short-term changes in water quality associated with runoff from storms, long-term changes in water quality resulting from cumulative impacts of pollutant discharges over time from many sources, and habitat-altering physical changes such as erosion, sedimentation, and scour resulting from changes to the volume, frequency, and duration of stream flows (United States Environmental Protection Agency, 1999). Bend's storm system and stormwater discharges to natural resources are regulated by a variety of federal, state, and local laws, rules, and guidelines designed to mitigate these impacts.

1.3.1. Federal

National Pollutant Discharge Elimination System (NPDES)

The federal Clean Water Act of 1972 (CWA) created the National Pollutant Discharge Elimination System (NPDES) permit program to address sources of pollution in rivers, creeks, and streams. The program requires municipalities of certain sizes to apply for and obtain a municipal NPDES permit for storm systems that discharge to rivers, streams, and other surface water bodies. In Oregon, these permits are administered by the Oregon Department of Environmental Quality (DEQ). These municipal NPDES permits, known as Municipal Separate Storm Sewer System (MS4) permits, are separated into two types

based on jurisdictional sizes. Larger jurisdictions are managed under individual Phase I permits, while smaller jurisdictions are managed under general Phase II permits.

Bend obtained an individual MS4 Phase II permit in 2007 and is currently the only individual Phase II permittee in Oregon. The goal of receiving an individual permit was to respond to and manage unique drainage and regulatory conditions. Bend's MS4 Phase II permit was renewed in 2021 with an effective date of January 1, 2022, and will expire in 2026. Permits are issued for five-year periods but may be administratively extended by DEQ. The MS4 permitted area ultimately drains to the Deschutes River.

The MS4 Permit guides many of Bend's stormwater management program's goals, policies, and day-to-day operations. Permit compliance represents a significant investment for Bend.

Total Maximum Daily Load (TMDL)

The CWA describes a program of Total Maximum Daily Loads (TMDLs) to protect water quality when other measures have failed to reduce pollutants from stormwater. A TMDL establishes the limit of each pollutant that can be present in a water body for the water body to achieve or maintain water quality standards.

Under the CWA, DEQ is responsible for identifying waters that do not meet water quality standards (known as the 303(d) list). Water quality standards are intended to protect human health, aquatic life, and designated beneficial uses, such as irrigation, recreation, hydropower, or water supply. DEQ is also responsible for calculating the allowable pollutant loads and developing water quality management plans, which allocate pollutant limits among dischargers and describe how a TMDL will be implemented.

As of 2024, there are no EPA approved TMDLs for the Deschutes River. The DEQ listed the Deschutes River as impaired on the 303(d) list but has not yet established TMDLs. The DEQ 2022 Integrated Report listed the following impairments for the Deschutes River near Bend (see Figure 1 at CityofBend_FY2324_MS4_AnnualReport_Final_20241028.pdf_signed_2024.10.29.08.53.25.pdf):

- North Unit Diversion Dam to Whychus Creek – impaired for Year-Round Temperature
- Spring River to North Unit Diversion Dam – impaired for Turbidity, pH, Year-Round Temperature, and Sedimentation

The MS4 Permit requires Bend to evaluate whether stormwater discharges from the MS4 system are likely to either cause or contribute to 303(d) list impairments, whether existing BMPs are effective in addressing those impairments, and if any changes or modifications are required. This evaluation was submitted to DEQ as an attachment with the FY23-24 annual stormwater report in November of 2024. Due to existing pre-treatment for the MS4, best management practices in place, and general nature of stormwater management throughout the City with a focus on infiltration, no modifications were required. Modifications to BMPs are recommended to incorporate new impairment pollutants if any are identified by DEQ in the future.

1.3.2. State

Statewide Planning Goals and Priorities

Oregon Administrative Rules 660 Division 15 establishes several Statewide Land Use Planning Goals. Goal 5 describes the protection of natural resources, including wetlands and riparian corridors. Statewide Planning Goal 6 describes the protection of air, water quality, and land resources quality, and Goal 7 describes protection of areas subject to natural disasters and hazards. Goal 11 describes the steps needed to plan utility infrastructure along with the growth and urbanization (Oregon Department of Land

Conservation and Development, 2019). These goals are addressed through the local jurisdictions' comprehensive plans and Bend's community development rules and standards.

Recent updates to Goal 10, Housing, along with other legislation has increased production goals for all types of housing, including affordable housing, increased the type and variety of housing density possible within urban areas, and is requiring cities to evaluate how and where to increase housing density.

The Oregon legislature adopted climate-related pollution reduction goals in 2007. The Oregon Department of Land Conservation and Development (DLCD) adopted the Climate-Friendly and Equitable Community (CFEC) requirements to reduce climate pollution in 2022 and 2023. The DLCD adopted transportation planning rules that require certain jurisdictions to evaluate and update their standards and codes to create more walkable communities, which should reduce the volume of transportation-related emissions. The CFEC also includes requirements for annual reporting.

WPCF Permit

The federal Safe Drinking Water Act (SDWA) regulates underground discharges in order to protect drinking water resources. These discharges are categorized by type of material being discharged; discharges related to stormwater are classified as Class V Underground Injection Controls (UICs). In Oregon, the DEQ is authorized to regulate Underground Injection Control (UIC) systems through Water Pollution Control Facilities (WPCF) permits to jurisdictions and property owners. Similar to the MS4 Permit, the WPCF Permits require jurisdictions to manage and operate public UICs in ways that are protective of water resources.

The DEQ issued Bend's first WPCF Permit in 2013 and re-issued the WPCF Permit in 2025. WPCF Permits are issued for ten years but may be administratively extended. The WPCF Permit allows the City to discharge stormwater and specific incidental non-stormwater fluids to UICs owned and operated by the City. The permit also requires Bend to identify UICs that may be out of compliance with groundwater quality protection standards and develop a process to bring their performance into compliance. Bend's approximately 7,000 UICs consist of approximately 6,000 drywells/sumps, which were designed to infiltrate stormwater, and approximately 1,000 drillholes, which provide stormwater management. Drillholes are no longer permitted in City standards and specifications for public infrastructure due to maintenance challenges and potential impacts to groundwater quality. Bend's WPCF Permit was reissued in July of 2025 and does not contain major changes to the permit's requirements.

Integrated Stormwater Management Plan

Bend's MS4 and WPCF Permits have similar requirements for managing public stormwater systems, including developing a management plan. Bend submitted its most recent Integrated Stormwater Management Plan (ISMP) to DEQ in 2023 to meet the management plan requirements of both permits. The ISMP includes details on each of the BMPs required by each permit. Many of the BMPs required by each permit are similar, such as conducting public outreach and education, illicit discharge detection and elimination, construction site stormwater activities, post-construction stormwater management for new and re-development, and municipal operations and maintenance.

1.3.3. Local

Bend Municipal Code Title 16

The Bend Community Development Department manages the application, plan review, permit issuance, construction inspection, and acceptance process for private development, including any construction of public improvements required as a condition of development. The Community Development Department reviews proposed projects against adopted standards to support statewide and local goals, such as

increasing the rate of completed housing production. The Private Development Engineering Division provides review of privately funded public improvements, such as stormwater infrastructure in the public right of way, and calculation of system development charges.

Title 16 of the Bend Municipal Code includes the adopted requirements for grading, erosion control, stormwater management, illicit discharges, tree protection, and well drilling. This title provides authority for Bend to establish minimum standards for new development and redevelopment on property or in the right of way. Title 16 references and adopts technical standards for stormwater engineering as detailed in the Central Oregon Stormwater Manual.

Central Oregon Stormwater Manual

The Central Oregon Intergovernmental Council (COIC) supported jurisdictions in Central Oregon in collaborating to develop a regional stormwater manual. Bend has adopted the Central Oregon Stormwater Manual (COSM), last updated in 2010, as the design manual for stormwater. The COSM provides minimum standards for stormwater/drainage applicability, plan review, and guidance for stormwater management from design through post-construction. Jurisdictions can choose to adopt the COSM for use within their local development process. The COSM was completed in 2010 and includes guidance for stormwater management systems that discharge stormwater to surface waters or through soil layers to groundwater.

Bend Standards and Specifications, Part II – Design Standards

Bend's Standards and Specifications is a document that outlines the process for designing, bidding, and constructing City infrastructure for both public and private development. Part II – Design Standards contains the required design constraints, methodologies, features, and practices that must be implemented in all designs of Public Works facilities, which includes stormwater infrastructure. Chapter 6 regulates stormwater and reflects many of the COSM's technical standards.

Sensitive Areas and Infiltration

The City established a Waterway Overlay Zone (WOZ) in Article V of the Bend Development Code (BDC) Chapter 2.7, Special Planned Districts, Refinement Plans, Areas Plans and Master Plans, to preserve and enhance the Deschutes River and the Tumalo Creek stream corridors within the urban growth boundary.

The City encourages use of infiltration to manage stormwater and provides tools to assist in implementing infiltration facilities on development project sites, including soil maps showing where infiltration may be favorable, maps and guidance for horizontal distance from drinking water wells, and maps of groundwater depths. The SMP will provide recommendations for siting criteria and spill control requirements for deep drywells, an emerging stormwater management technique that uses a structure similar to a typical drywell near the surface paired with a drilled pipe shaft below reaching depths necessary to provide needed discharge of flows, while maintaining minimum separation from groundwater.

Bend Climate Friendly Areas

Bend's response to CFEC has included changes to local codes and standards, in addition to the required annual reporting. Bend identified 10 potential Climate Friendly Areas (CFAs) where additional public and private investment could result in walkable communities (Bend, 2023). Additional changes to code and standards will likely be necessary after the CFAs are adopted. Creating walkable communities will also help Bend meet housing unit targets and goals. Densities required to meet CFA goals could impact space available for stormwater management on development sites, which is a topic of concern addressed in this SMP.

1.4. City Organization

The City of Bend operates under a Council-Manager form of government. The City Council, composed of six elected councilors and a mayor, serves as the legislative and policy-making body. The mayor, elected at large, presides over Council meetings and serves a ceremonial role but holds no additional legislative authority beyond that of other council members.

The City Manager, appointed by the Council, oversees daily operations, implements Council policies, manages City departments and staff, and prepares the annual budget. City departments carry out essential services under the City Manager's direction. Various Council-appointed advisory boards and commissions provide input on planning, transportation, environmental issues, and budgeting, ensuring community involvement in local governance.

Several departments will implement this plan. Design and implementation of larger capital projects will be conducted within the Engineering Department, and the Water Services Department will be responsible for major maintenance, routine maintenance, and stormwater regulatory functions. Some policy and development permitting related recommendations will also involve other departments, including the Community Development Department.

Stormwater functions are carried out primarily within the Water Services Department and are funded by a stormwater utility (Figure 1). Other departments such as Community Development, Engineering, and Transportation and Mobility also interface with the stormwater program or perform essential stormwater functions and activities.

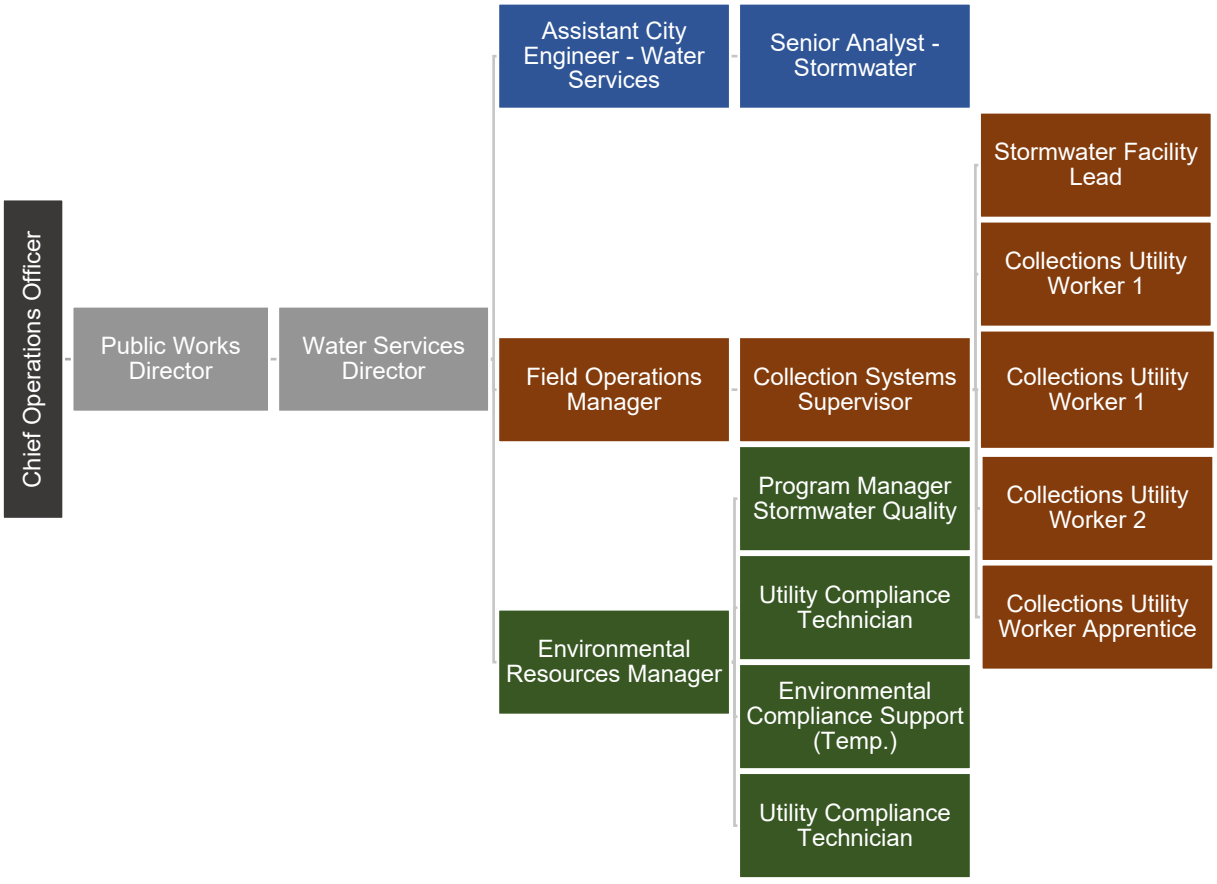

Figure 1 Organization Chart of the Stormwater Utility

1.5. Planning History

The City of Bend began developing its first Stormwater Master Plan in 2006. In 2007, the City started documenting drainage and flooding problems and analyzing hydrologic, hydraulic, and geologic data within the context of stormwater management. As the City grew and increased its impervious surface area, reported drainage and flooding problems increased.

The first formal Stormwater Master Plan (SMP) was developed for the City of Bend in 2008. The purpose of the plan was to evaluate the City's stormwater drainage needs within the 2007 UGB, and to meet increasingly stringent state and federal regulations governing stormwater. To assess the impact of upcoming permit requirements, the draft plan was paused. The document remained a draft while the City implemented several of its recommendations.

In 2013, the City received its WPCF permit governing UICs. The Stormwater Master Plan draft was revisited and completed in 2014. This plan provided an overall strategy for stormwater management, delineated drainage areas and runoff quantities, and outlined programmatic goals for addressing stormwater quantity and quality concerns.

Section 2. Planning Area

The planning area for the SMP encompasses approximately 21,320 acres (35 square miles) in the City of Bend and its urban growth boundary (UGB) as shown in Figure 2, Vicinity Map. All recommended capital improvements are located within Bend's UGB.

2.1. Characteristics

The combination of Bend's environment, natural features, and built infrastructure influences stormwater runoff variables and impacts.

2.1.1. Location

The City of Bend is the county seat of Deschutes County in Central Oregon. On a high plateau in the foothills east of the Cascade Range, the City is about 16 miles south of Redmond and 30 miles north of LaPine. Its clear view of Mt. Bachelor and the Three Sisters, along with a bounty of year-round outdoor recreational activities, make Bend a very desirable place to live. Highways 97, 97 Business, and 20 run through the City. The City Council adopted its current UGB in 2016 and has adopted two additional amendments to the UGB since then.

2.1.2. Climate

Bend has a mild climate, classified as semi-arid or High Desert. With average annual precipitation of only 11.7 inches, the City experiences an average of 300 days of sunshine per year. In addition to rainfall, Bend averages 34 inches of snowfall, most of which occurs between October and May. Bend is to the east of the Cascade Mountains and in their rain shadow and receives a fraction of the precipitation experienced west of the mountains as storms from the Pacific Ocean bring warm moist air inland. Although there is relatively little annual rainfall, it often comes in short, intense bursts, particularly in the spring and fall, causing considerable localized flooding throughout the City. During the winter months, when drainage systems are blocked by snow and ice, rapid snowmelt and rain-on-snow events exacerbate flooding.

The average annual high temperature in Bend is 60 degrees Fahrenheit (°F), with average highs in the summer ranging from 72 to 84°F and average highs in the winter ranging from 39 to 44°F. The average annual low temperature is 33°F, with average lows in the summer ranging from 42 to 47°F and average lows in the winter ranging from 23 to 24°F (US Climate Data, 2025).

Due to its semi-arid climate, irrigation is required for vegetated stormwater facilities and landscaping.

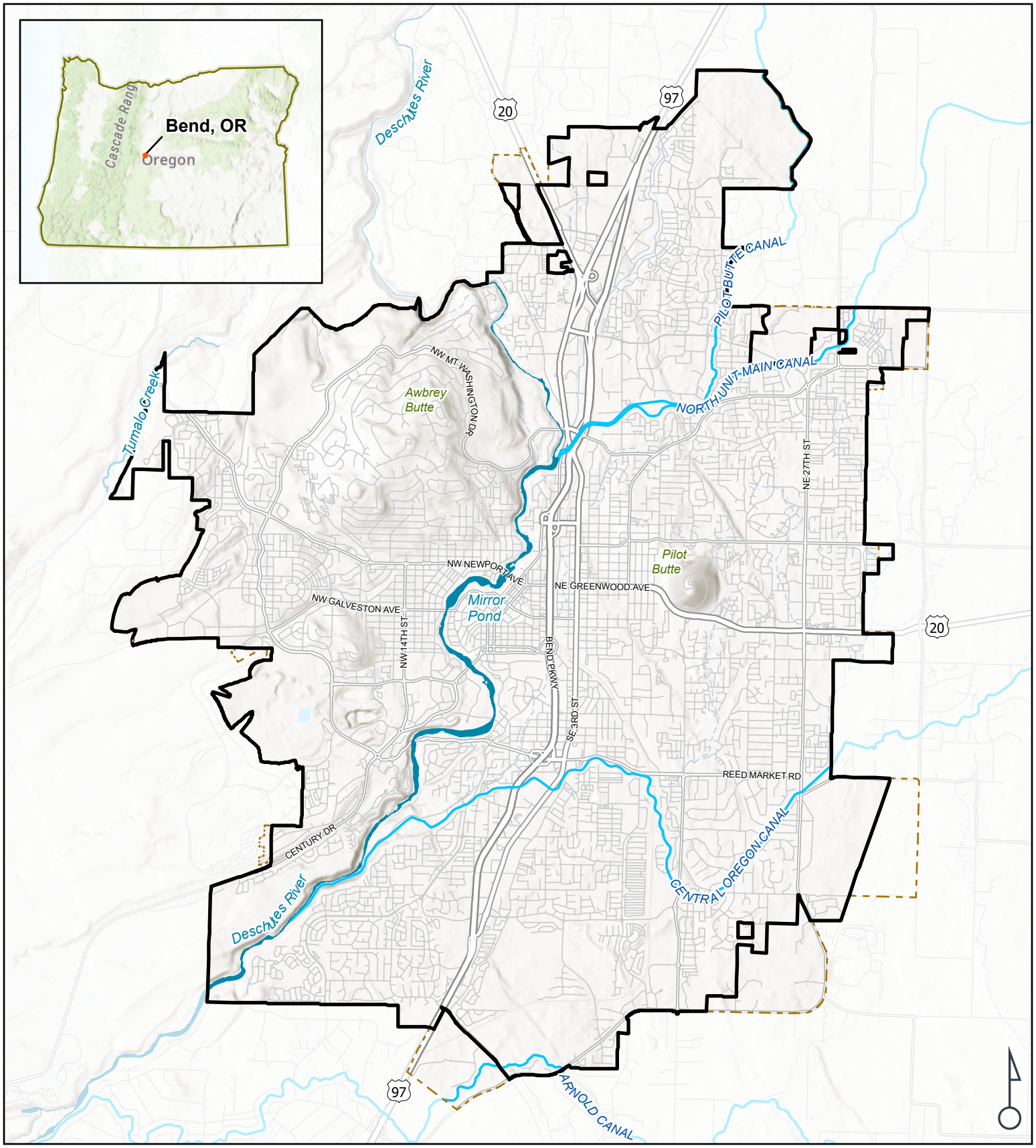

FIGURE 2
VICINITY MAP
BEND STORMWATER MASTER PLAN
BEND, OREGON

LEGEND

- Bend City Limits
- Urban Growth Boundary
- Streams
- Canals

Data Sources: City of Bend, USGS, Google Maps.
Date: 10/28/2025
Disclaimer: This data is not to survey accuracy and is meant for planning purposes only.

O:\PROJECT\20300\20359\04 CAD\GIS\APRX\20359 BEND MASTER PLAN MAPS JR.APRX

CITY OF BEND

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2.1.3. Vegetation

Except where it is irrigated, vegetation is limited to drought-tolerant species in the arid, high desert climate of Bend. Several deciduous and evergreen trees and shrubs are drought tolerant; these include plants native to Central Oregon (Native Plants of Oregon, 2008) such as juniper (*Juniperus occidentalis*) and ponderosa pine (*Pinus ponderosa*). Deciduous trees growing in Bend include alder (*Alnus sp.*), ash (*Fraxinus latifolia*), aspen (*Populus tremuloides*), larch (*Larix occidentalis*), and maple (*Acer macrophyllum*). Chokecherry (*Prunus virginiana*), elderberry (*Sambucus racemosa* or *Sambucus nigra ssp. cerulea*), rabbitbrush (*Chrysothamnus sp.*), and snowberry (*Symphoricarpos albus*) are a few of the local shrubs. Sagebrush and bunch grasses thrive in the area. Xeriscaping, landscaping with vegetation that requires minimal amounts of water, is widely practiced.

Invasive species create problems for wildlife by removing habitat, increasing soil erosion, and outcompeting native vegetation. Concern over the spread of invasive weeds is being addressed through a public information program, including the creation and distribution of pamphlets describing how to identify and eradicate problem vegetation. Some of the major invasive weeds of concern are cheatgrass, Canadian thistle, Scotch thistle, poison hemlock, whitetop, perennial pepperweed, spotted knapweed, diffused knapweed, Dalmatian toadflax, and purple loosestrife.

2.1.4. Wetlands

Wetlands within Bend were inventoried and evaluated by the City in 2000, as shown on Figure 3, Natural Resources. The Comprehensive Plan lists and maps wetlands that are significant State Planning Goal 5 resources to be protected through the City's riparian corridor standards. These wetlands may not have been field verified, and evaluation by a wetland scientist to verify their protection status under state or federal rules may be appropriate before any activity that could affect them is undertaken. Many of the City's significant wetlands are adjacent to the Deschutes River and are within the WOZ, which intends to conserve wetlands as a natural resource and requires additional processes for proposed changes to the land.

2.1.5. Topography

Central Oregon's topography ranges from relatively flat to hilly, with two distinctive buttes in the vicinity of Bend. Awbrey Butte is the highest point in the City, at an elevation of 4,214 feet, and Pilot Butte is nearly as high at 4,138 feet (Figure 4). The volcanic geology created a landscape with many ridges, drops, sinks, and hills. Anecdotally, this topography creates a variety of precipitation patterns and microclimates which may cause some areas of the City to experience storm events in greater severity than other areas. Drainage patterns and directions vary throughout the City, although both surface and subsurface flows are generally northward. The Deschutes River divides the City into eastern and western drainage basins while roughly dividing the City in half. Tumalo Creek influences the drainage patterns in the northwestern area of the City. There are no other creeks or significant drainage ways in the City. East of the river the ground slopes in a northeasterly direction, directing stormwater away from the river.

Mirror Pond, an icon in the heart of the City, was created by the construction of a hydroelectric dam in 1905. This dam is privately owned by PacifiCorp. The pond is in an approximately one-mile-long stretch of the Deschutes River, bordered roughly by the Galveston Bridge to the south and Newport Bridge to the north. The dam is a few hundred feet downstream from Newport Bridge.

Several large irrigation canals run through the City, conveying water from the Deschutes River to serve agricultural areas as far away as Madras, approximately 50 miles to the north. These canals and laterals still have a large influence on drainage patterns within the City. Discharge of stormwater to an irrigation canal requires approval from the relevant irrigation district and therefore is typically avoided.

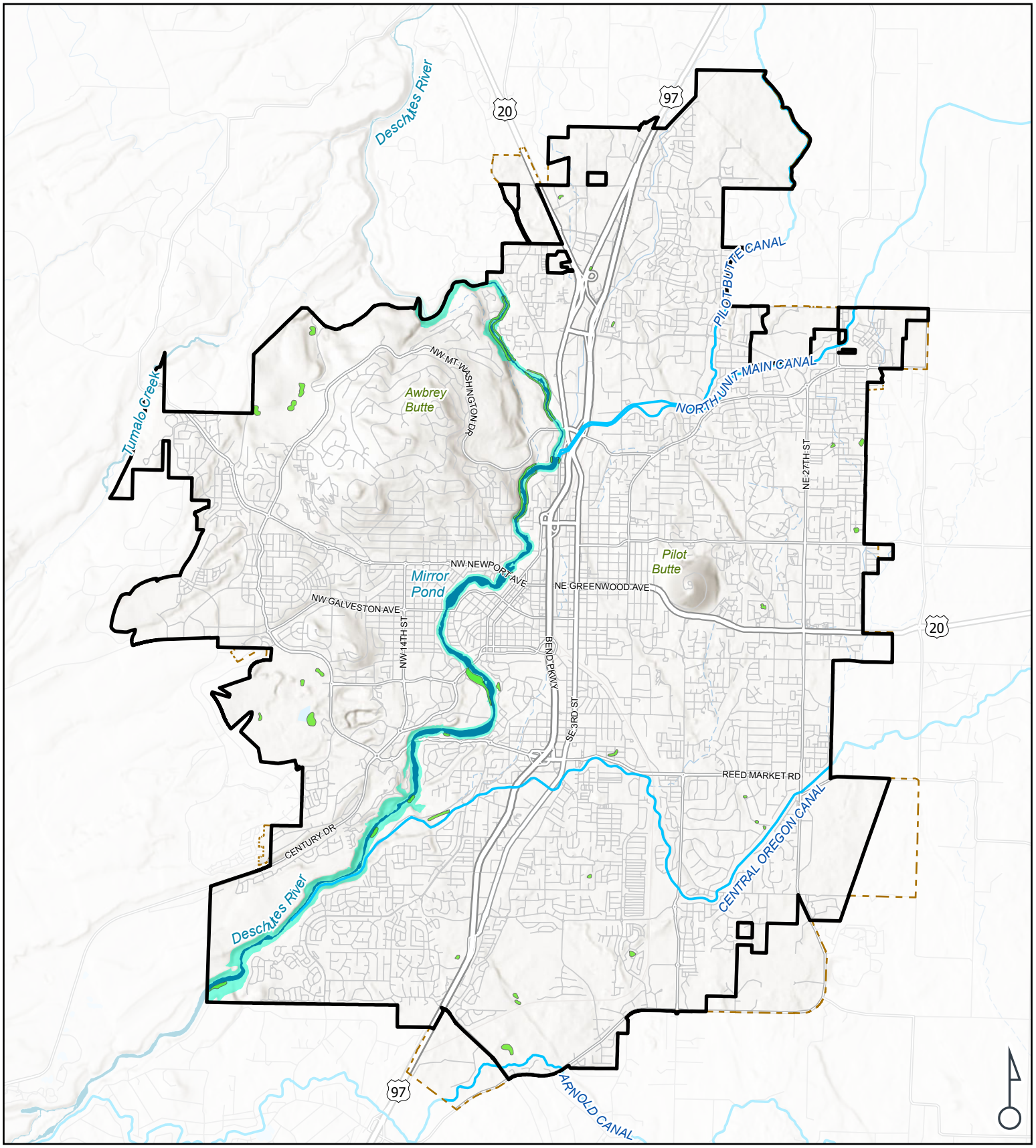

FIGURE 3
NATURAL RESOURCES
BEND STORMWATER MASTER PLAN
BEND, OREGON

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LEGEND

- Bend City Limits
- Urban Growth Boundary
- Waterway Overlay Zone
- Local Wetlands Inventory
- Streams
- Canals

Data Sources: City of Bend, USGS, Google Maps.
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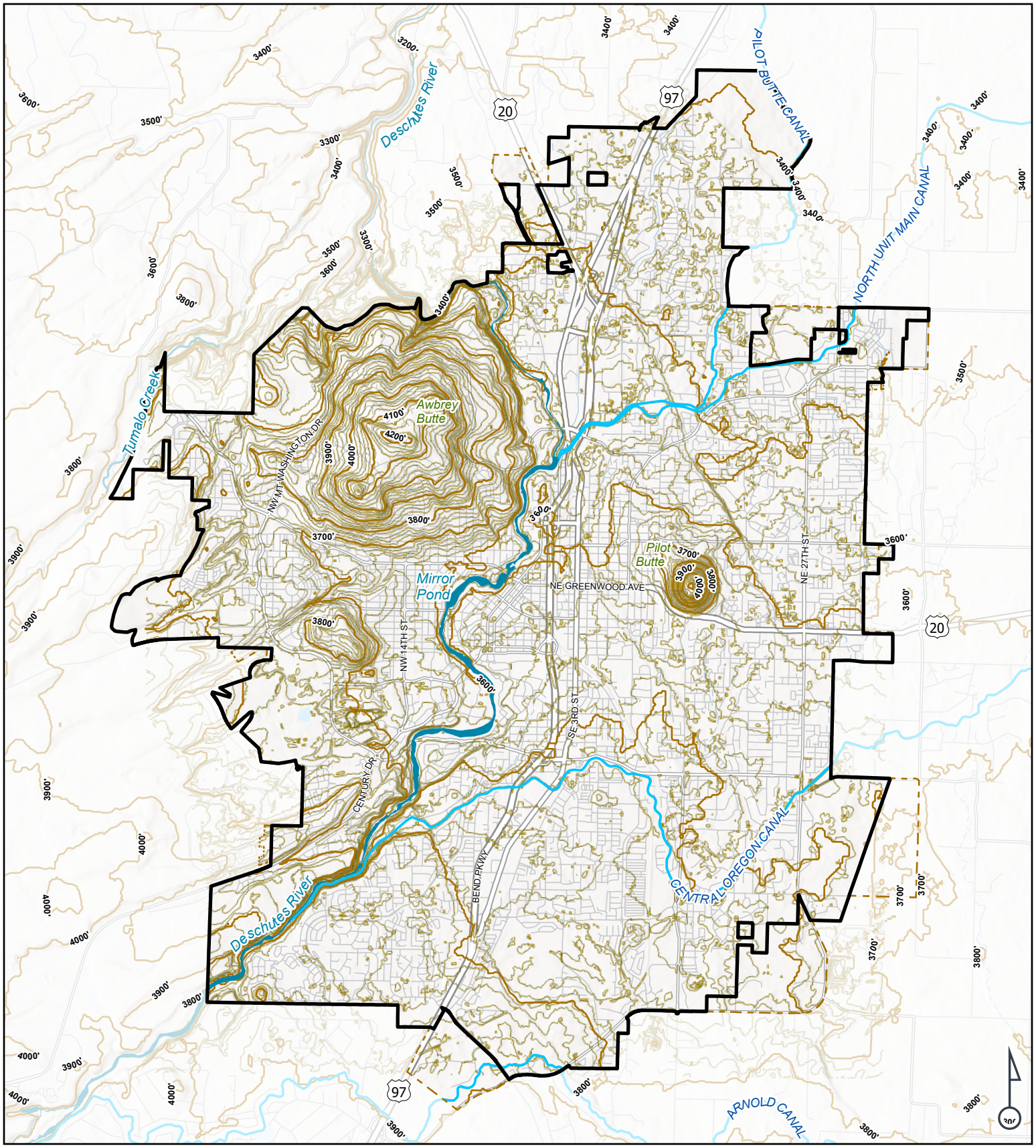

FIGURE 4
TOPOGRAPHY
BEND STORMWATER MASTER PLAN
BEND, OREGON

LEGEND

- Bend City Limits
- Urban Growth Boundary
- Contour (100')
- Contours (20')
- Streams
- Canals

Data Sources: City of Bend, USGS, Google Maps.
Date: 10/28/2025
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2.1.6. Geologic and Hydrogeologic Conditions

The following summary of geologic and hydrogeologic conditions within the City of Bend and surrounding area is based on the more technical and comprehensive text provided in GeoEngineers' 2007 report and GSI's 2020 update. This report is a geologic and geotechnical study based on existing documentation and provides general guidance on the effectiveness of drywells and drillholes in various areas of Bend.

Regional geologic features are largely the result of volcanic activity and subsequent weathering along the Cascade Range. These processes have resulted in the relatively recent deposition of a thick sequence of volcanic and volcanically derived sedimentary rocks (GeoEngineers, 2007). For example, Awbrey Butte, in the northwestern part of town, is a volcanic vent composed of basalt. Volcanic rock is at or near the surface throughout the City, and its permeability and topography vary, creating many areas where stormwater infiltration is very slow with a high risk of localized flooding.

As the volcanic and sedimentary rocks weather, they create a thin soil layer that ranges in depth from 0 to 60 inches or more. In some areas, the soil layer is too thin to allow for deeply rooted vegetation. Soil within the City tends to drain well, with some exceptions, such as Tumalo and Plainview sandy loams. Soil close to or within the Deschutes River channel is primarily river deposits composed of gravels, sand, and silt. The soil layers adjacent to the river have variable permeability (GeoEngineers, 2007).

Portions of the City are underlain by basalt that is relatively fractured with a sufficiently high permeability to allow for infiltration of stormwater at relatively high rates, particularly given the relatively low annual rainfall experienced in Central Oregon. Before the City was developed, the permeability of this basalt was generally high enough to allow infiltration of large quantities of stormwater runoff, even for large storm events. Drywells for disposal of stormwater runoff performed reasonably well when Bend was a smaller town with a smaller impervious area. However, when stormwater runoff is concentrated to a higher volume and increased rate of runoff because of the increase in impervious area, the permeability of the basalt does not always allow the increased stormwater runoff to infiltrate quickly enough, and flooding occurs.

Some areas of the City are underlain by consolidated basalt or tuff, which is highly impermeable and does not provide acceptable geotechnical conditions for the use of drywells or drillholes that are not deep enough to penetrate through it. Many of these areas can be identified by the presence of drillholes, installed to allow stormwater to be disposed of below near-surface low-permeability layers. Drillholes are generally about 6 inches in diameter with casing in the top several feet.

With Bend's rapid growth in the past 30 years, the number of UIC systems in the public right-of-way has increased to over 7,000. Many private properties also have UICs which are required to be registered through DEQ and are not part of the City's system. Construction of piped drainage is expensive in Bend due to the rocky geology and has been avoided in most areas of the City. The City has not had the time or resources to develop adequate drainage infrastructure to keep up with the growth in population and the resulting increase in impervious areas. Many of the existing UICs no longer handle the design volume and rate of stormwater runoff for reasons such as improper installation, inappropriate geotechnical conditions, plugging by sediment and/or road traction cinders, and having been constructed according to standards and specifications that are now outdated.

In their 2007 report, GeoEngineers identified three major drainage areas. These areas were refined in a 2020 *Stormwater Infiltration Evaluation Update*. This report updated drainage area maps and characteristics (see Figure 5, Drainage Areas), UIC ageing, water well locations, and mapped potential perched groundwater.

Drainage Area A, located east of the Deschutes River, is composed of fractured basalt and generally provides the best geotechnical conditions for the use of drywells, drillholes and infiltration. Drainage Area B, in the Awbrey Butte area, is characterized by soils that are not well-draining. Drainage Area C, located in southwest Bend, has an impermeable layer of volcanic rock known as “tuff” and is generally not suitable for drywells or infiltration BMPs that cannot penetrate the upper layer of material. More details on each of these drainage areas can be found in GSI’s 2020 update.

The infiltration capabilities of underlying soil and rock are only one consideration in the siting and operation of infiltration facilities. State and federal regulations, drinking water wells located throughout the City, steepness of topography, protection of drinking water sources, and maintenance of these facilities are all issues to evaluate when considering whether to construct infiltration facilities. Current standards for new development also typically require all storm drainage to remain on-site using infiltration-focused surface or subsurface disposal methods, imposing another consideration.

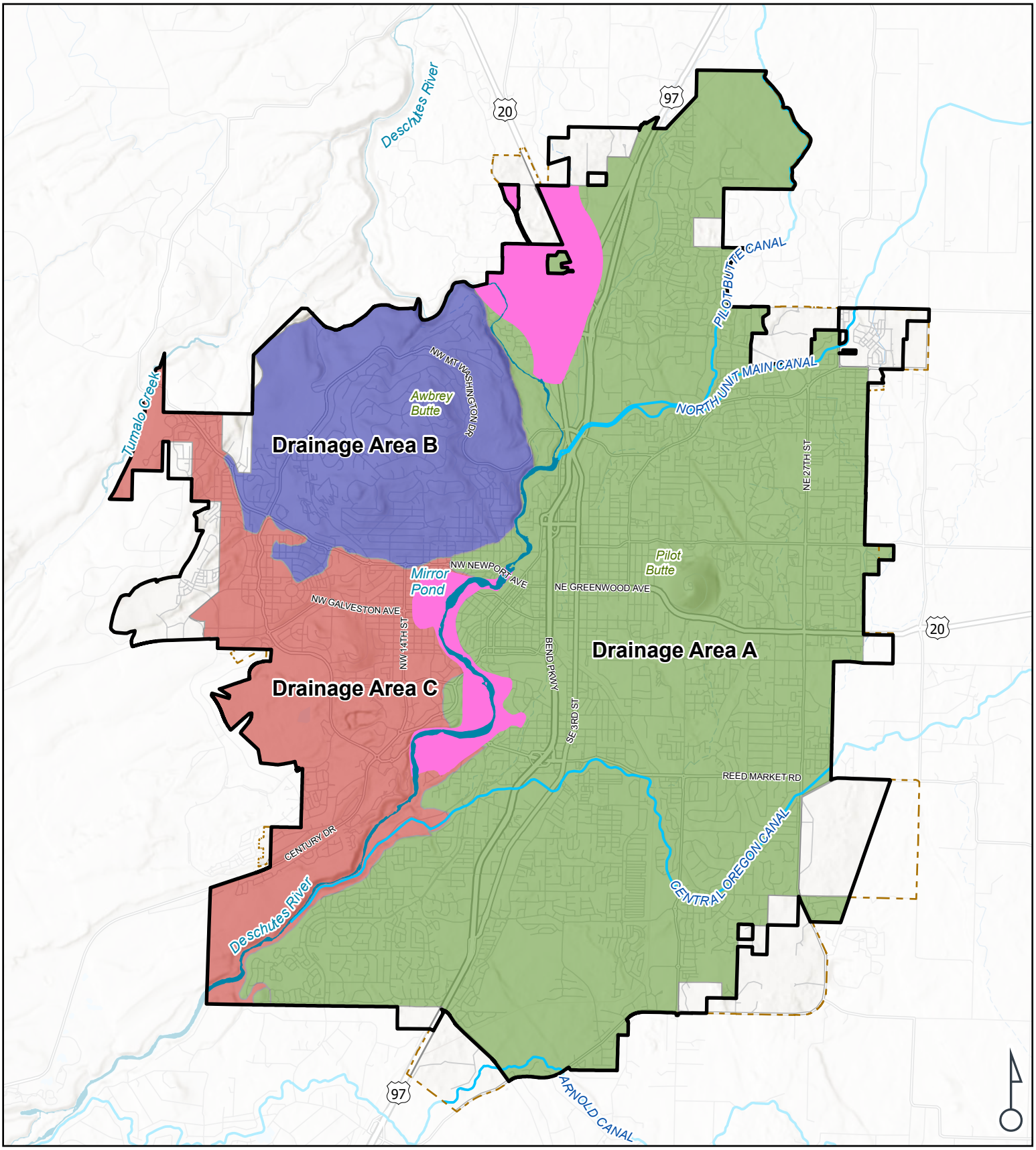

FIGURE 5
DRAINAGE AREAS
BEND STORMWATER MASTER PLAN
BEND, OREGON

LEGEND

- Bend City Limits
- Urban Growth Boundary
- Perched Aquifer
- Streams
- Canals

Drainage Areas

- Drainage Area A
- Drainage Area B
- Drainage Area C

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Data Sources: City of Bend, USGS, Google Maps.
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2.1.7. Water Quality

The City of Bend has a dual source drinking water supply system, with approximately 60 percent of water delivered by the City produced from the Bridge Creek surface water source located in the protected municipal watershed on US Forest Service land. The remainder of the drinking water supplied by the City, plus water supplied by private quasi-municipal sources, is groundwater, pumped from the Deschutes regional aquifer that underlies the City. The City has won several awards for the quality of its drinking water, and the City and its residents are committed to protecting this valuable resource.

Drinking water safety and quality are regulated through the SDWA. The SDWA and Oregon's equivalent rules establish protection areas and strictly regulate UICs that have the potential to contaminate or contribute to the contamination of sources of drinking water. Figure 6, Drinking Water Protection Areas, shows the two-year time of travel for groundwater travel to municipal and quasi-municipal drinking water wells. Figure 6 also shows two areas of shallow, perched groundwater (note that the entire City is underlain also by the deep, regional Deschutes Aquifer). The City's WPCF permit requires that UICs within these areas be equipped with additional protection measures to ensure that contaminants do not impact groundwater quality.

The City monitors the quality of stormwater entering UICs as required under the WPCF UIC permit from DEQ. Seven UICs are sampled annually with six high risk representative monitoring sites and one emerging pollutant site. These sites were selected based on land use zoning, access safety and average daily trip (ADT) data along with likeliness to receive adequate flow for sampling. Monitoring data is submitted annually to DEQ. Based on exceedances of permit-identified action levels, the City will initiate corrective actions and document activities conducted to resolve or address exceedances in the annual report. The City has experienced no exceedances to date.

The City has been collecting ambient water quality data from the Deschutes River since 2004 to assess water quality as the river enters, passes through, and exits the City (ESA, 2024). This voluntary collection of data is provided to DEQ and provides a basis for understanding water quality of surface waters within the City.

2.1.8. Population

Incorporated in 1905, Bend has grown from a small logging town of 300 residents to a City with an estimated population of 104,089 in 2024 (Portland State Population Research Center, 2024). Bend's abundant high-quality drinking water, dry climate, and year-round recreational opportunities have attracted many residents, and Bend is forecasted to continue its high growth rate. City planning staff are relying on growth projections that estimate the City population to exceed 130,000 by the year 2035.

The City is approximately 84.5% White, 9% two or more races, and two percent or less identify as American Indian/Alaska Native, Asian, Black or African American or Native Hawaiian or other Pacific Islander (US Census, 2020). Additionally, 9.2% identify as Hispanic or Latino of any race.

2.1.9. Land Use and Zoning

Land use in Bend currently consists of a mix of residential, commercial, public facility, and industrial uses. The downtown district is in the center of town near the Deschutes River. Figure 7, Zoning, depicts zoning by type within the current UGB.

Statewide Land Use Planning Goal 11 requires planning for water and sewer services within the City and all areas within an established UGB. This plan covers the City and UGB and does not call for piped

facilities outside of the UGB. All evaluations and alternatives in this plan involve serving only areas within the UGB and this plan is consistent with Goal 11.

Approximately 84 public parks in and around the City are operated and managed by the Bend Park and Recreation District (BPRD) (Figure 8, Public Parks), and additional facilities are being planned. Drake Park along Mirror Pond and Juniper Park in the eastern part of the City are two of the largest parks in Bend. BPRD separated from the City government in 1974, and 22 of the City's stormwater outfalls still pass through BPRD parks adjacent to the river. Pilot Butte, a popular hiking trail and scenic overlook, is managed by the Oregon State Parks Department.

2.1.10. Industry

Central Oregon is home to a diverse group of industries. Top employers include health care, retail, hospitality, construction, professional services, and manufacturing industries (ECONorthwest, 2025). Recreation and tourism-related industries are key economic drivers for the City. As Bend grows, industries continue to diversify and provide more jobs.

2.2. Future Growth

Bend adopted its current UGB and growth plan in 2016. Oregon state law requires that Bend reevaluate the land inventory within the UGB every six years to accommodate twenty years of projected growth. The City identified ten expansion areas, which added 2,380 acres to the UGB and nine opportunity areas for strategic growth within city limits. The City has amended the UGB two additional times since 2016 to include sites on which substantial amounts of affordable housing will be developed. In 2024, the City initiated a process activated by Senate Bill 1537 that allowed qualifying local governments to add up to 100 acres of residential land to the UGB. The City has selected a location and intends to apply for a UGB Amendment.

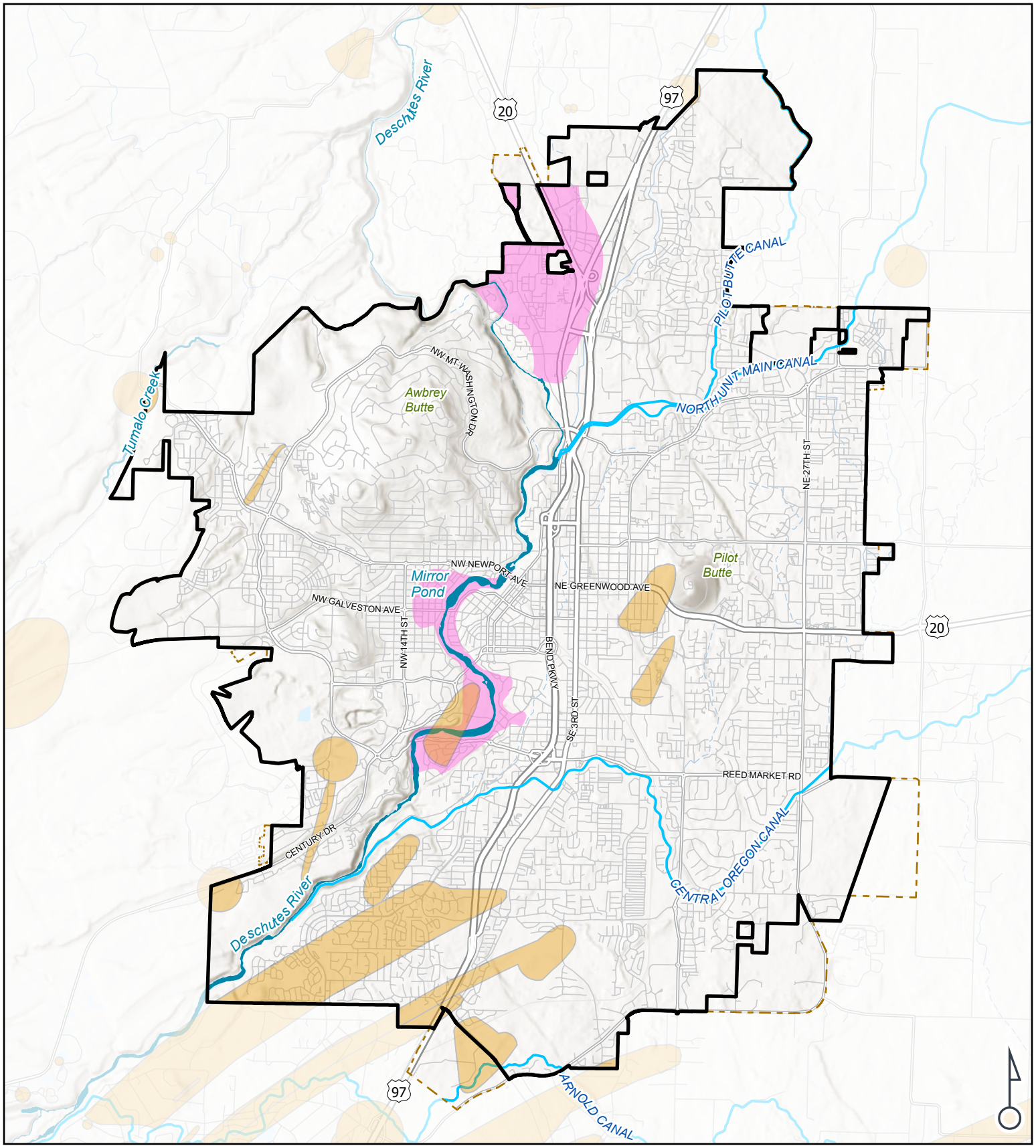

FIGURE 6
DRINKING WATER PROTECTION AREAS
BEND STORMWATER MASTER PLAN
BEND, OREGON

Data Sources: City of Bend, USGS, Google Maps.
Date: 10/28/2025
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LEGEND

- Bend City Limits
- Urban Growth Boundary
- Two-year Time of Travel to Public Well Water Zones
- Perched Aquifer
- Streams
- Canals

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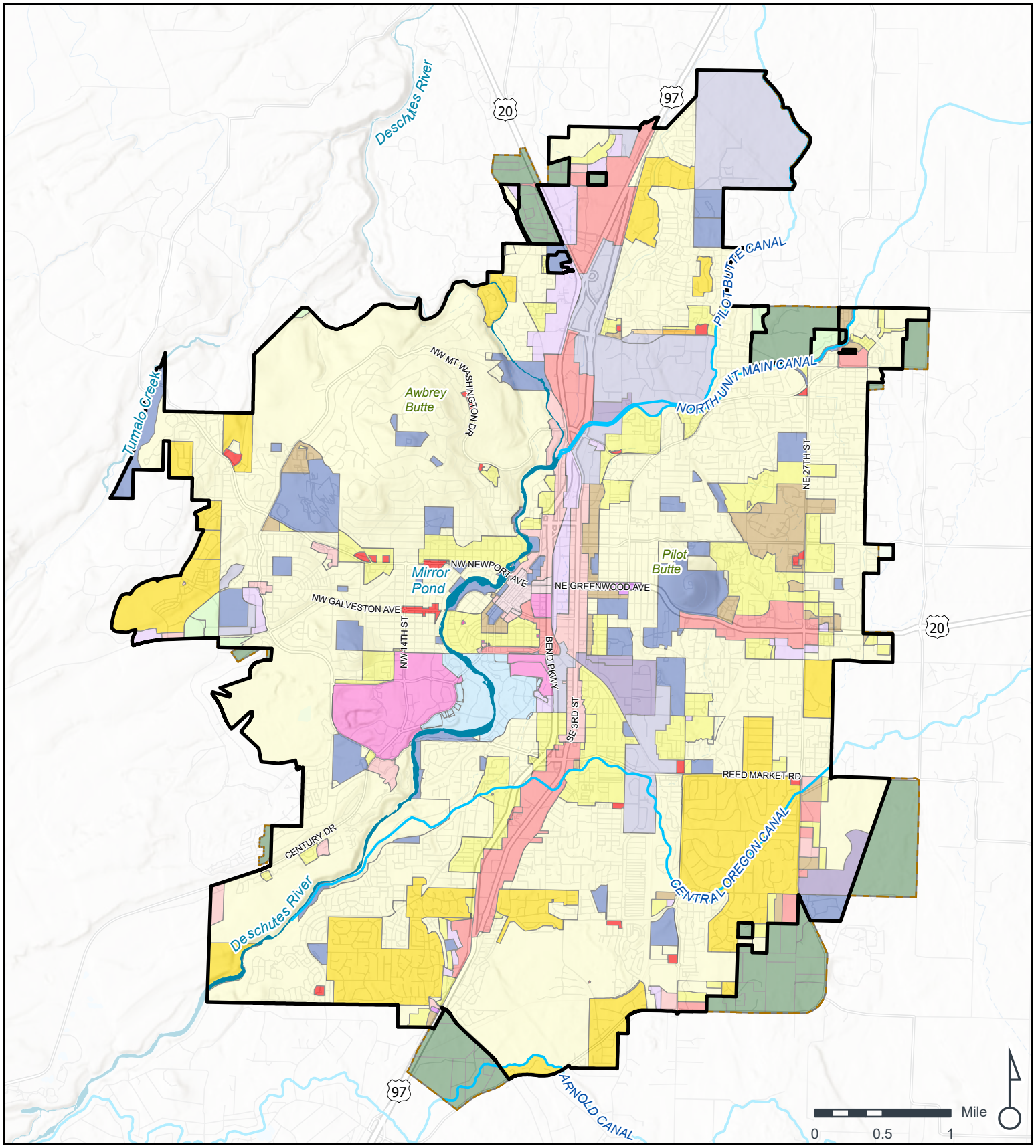

FIGURE 7
ZONING
BEND STORMWATER MASTER PLAN
BEND, OREGON

- Bend City Limits
- Urban Growth Boundary
- Canals
- Streams

ZONING

- Central Business (CB)
- Convenience Commercial (CC)
- General Commercial (CG)
- Limited Commercial (CL)
- Neighborhood Commercial (CN)
- Light Industrial (IL)
- General Industrial (IG)
- Mixed Employment (ME)
- Mixed-Use Neighborhood (MN)
- Mixed-Use Riverfront (MR)
- Mixed-Use Urban (MU)
- Public Facilities (PF)
- Professional Office (PO)
- PO/RM/RS
- Low Density Residential (RL)
- Standard Density Residential (RS)
- Medium Density Residential (RM)
- High Density Residential (RH)
- Urban Area Reserve (UAR-10)
- Urbanizable Area (UA)

CITY OF BEND

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Data Sources: City of Bend, USGS, Google Maps.
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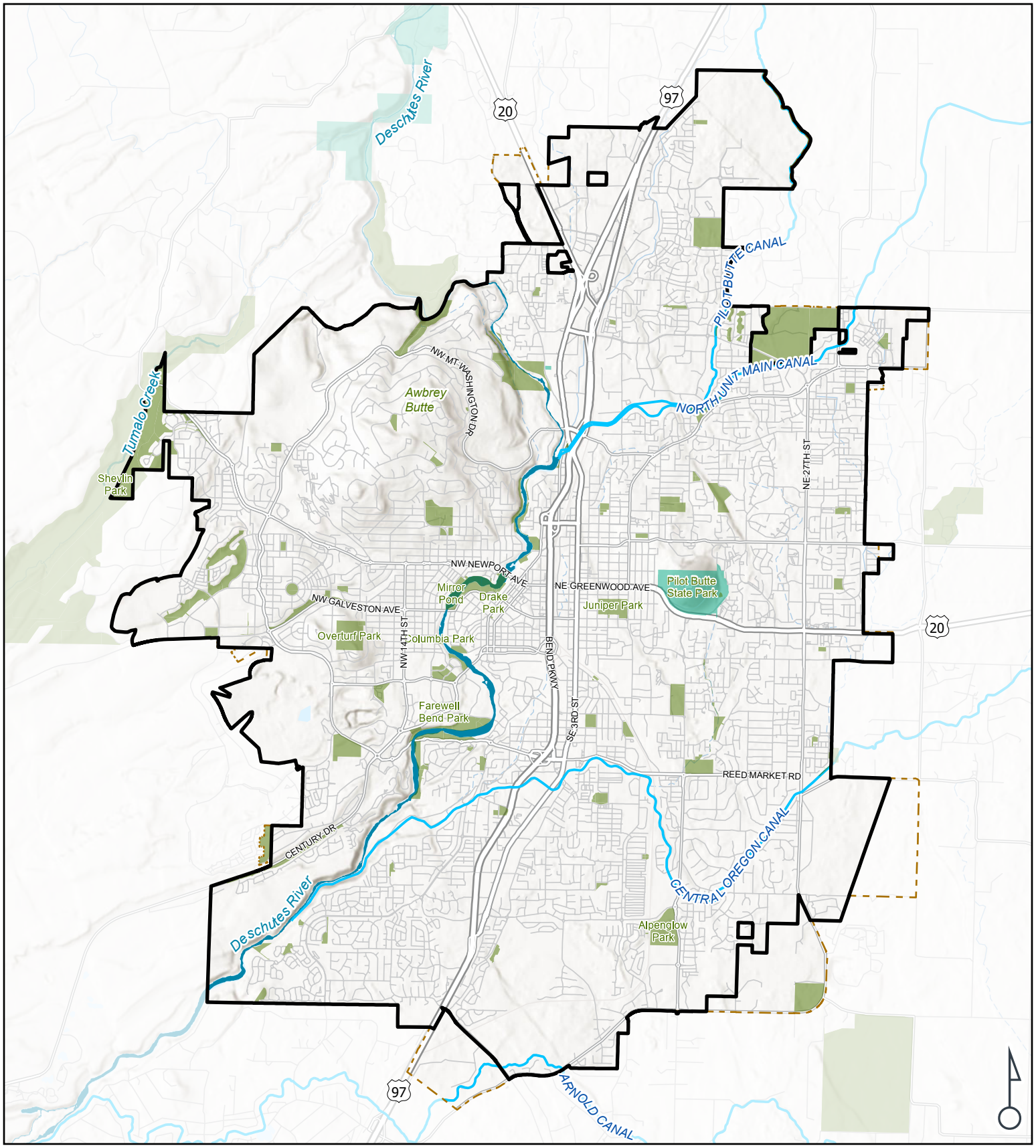

FIGURE 8
PUBLIC PARKS
BEND STORMWATER MASTER PLAN
BEND, OREGON

LEGEND

- Bend City Limits
- Urban Growth Boundary
- Streams
- Canals
- BPRD Parks
- Oregon State Parks

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Data Sources: City of Bend, USGS, Google Maps.
Date: 10/28/2025
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Section 3. Planning Process & Analysis

This section describes the data collection, verification, and analysis processes used to create an inventory and describe the current system, locations of known problems and issues, and to begin further investigation into potential solutions. Otak worked closely with City of Bend project managers to identify appropriate data sets; interview engineering, planning, and operations staff; and make field visits to both verify known and potential issues and identify potential solutions.

This analysis generated the specific CIPs and programmatic recommendations to address conveyance and water quality issues contained in Section 4, Stormwater Capital Improvement Projects.

3.1. Initial Stormwater System Review

The first step in the planning process was a system analysis to identify issues by reviewing reports, plans, and the storm sewer asset databases and by interviewing City staff. Sources of information included the 2014 Stormwater Master Plan, existing City Capital Improvement Programs (CIPs), the 2023 Integrated Stormwater Management Program (ISWMP), drainage and groundwater protection studies, and regulatory documents such as the City's WPCF and MS4 Permits. A complete annotated bibliography of reviewed sources is contained in the Bend Stormwater Master Plan Discovery Phase Summary Memo (Appendix A). Certain sites were selected for further investigation with field visits.

3.1.1. Fieldwork

Fieldwork was conducted at several sites in spring of 2024 and 2025 to confirm or learn more about the known issues and recent projects. Consultant staff engineers were accompanied on these site visits by city staff from the Water Services and Engineering Departments. Data recorded included the primary observed problem, underlying issues, potential solutions, project feasibility, and potential impacts of alternative solutions.

3.1.2. Inventory of Current Stormwater System Assets

The City of Bend maintains a database of utility assets, which includes stormwater assets maintained by the City as well as some private stormwater assets. For the purposes of this SMP, only the public stormwater assets were used for analysis and planning, which included the categories of UICs (drywells and drillholes), swales, storm pipe, catch basins, outfalls, and sedimentation manholes. Each asset record includes information about location, type, material, size, condition, age, status, and the source of information.

As of July 2025, the City owns approximately 35,500 individual stormwater assets (Table 1). This inventory is constantly shifting as assets are created or decommissioned through new development, capital construction, and maintenance activities.

Table 1 Bend's Active Stormwater System Assets

Stormwater Asset	Service Provided	Count*
Outfall to Deschutes River**	Conveyance	36
Other Outfalls (non-MS4)	Conveyance	207
Drywell	Infiltration	6,083
Drillhole	Infiltration	933
Swale (Grass, Rock, Vegetation, Infiltration)	Infiltration and/or Water Quality	290
Storm Pipe Segment	Conveyance	13,690
Storm Filter Vault	Water Quality	18
Catch Basin	Collection	9,908
Sedimentation Manhole	Water Quality	1,495
Storm Distribution Box	Conveyance	79

** Existing, in-service assets owned and maintained by the City of Bend*
*** Number of outfall structures is greater than the number of outfall basins studied in the Outfall Retrofit Needs Assessment Memo (Appendix A)*

Collection & Conveyance

Bend does not have a piped storm drain system that serves the entire City; the lack of defined drainage ways, the expense of digging in rock, and the difficult topography have limited the installation of piping. Areas nearest the river drain through storm pipes to one of 36 outfalls to the Deschutes River. Areas of the City outside of the MS4 boundary (See Figure 10) convey stormwater to UICs and other infiltration facilities for discharge to the ground. UIC's also are located in many areas within the MS4 boundary as well, providing supplemental stormwater management.

Bend's storm system varies in design and material based on the era of construction. As of July 2025, the City has 13,690 segments of public storm pipes, approximately 80 miles in total length, in active use.

Infiltration

Infiltration through UICs and swales is a common method of managing stormwater in Bend.

Water Quality Facilities

Stormwater facilities, or water quality facilities (WQFs) are intended to mitigate the impacts of stormwater runoff on streams and natural systems at the point of discharge. WQFs can be designed to reduce pollutants and manage flow rates and/or volumes. Pollutant reduction can occur through settling or filtering the water through vegetation or soil. This can remove sediments and particulates; examples include vegetated swales, grassy filter strips, and vegetated planters. Facilities that manage flow rates and/or volume detain flows and release stormwater at a specific rate, such as with detention ponds. Some facilities are also designed to provide infiltration, which reduces the volume of stormwater released into surface water bodies.

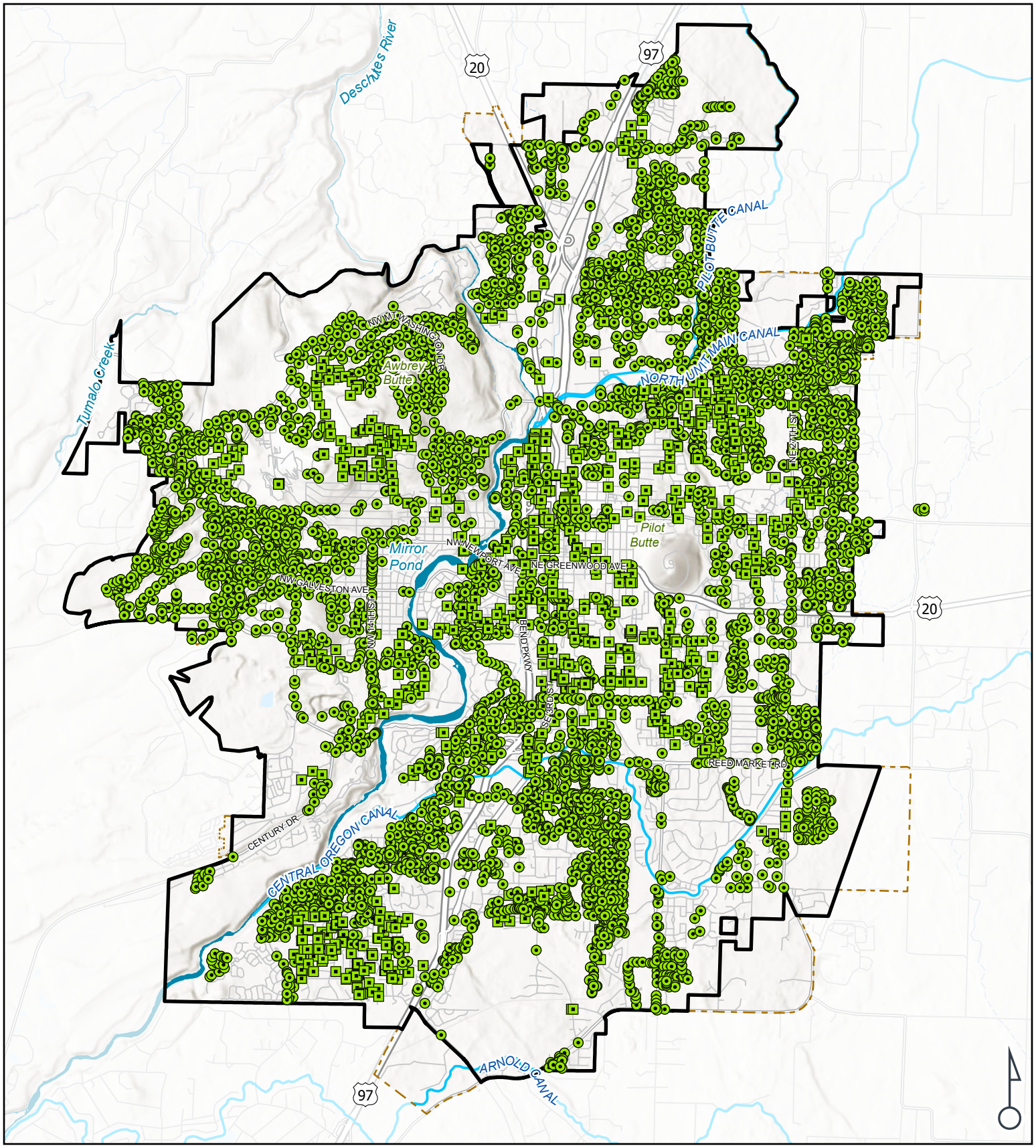

FIGURE 9

UIC SYSTEM EXTENT

BEND STORMWATER MASTER PLAN

BEND, OREGON

LEGEND

- Bend City Limits
- Urban Growth Boundary
- Streams
- Canals

Underground Injection Control

- Drillhole, Active
- Drywell, Active

Data Sources: City of Bend, Deschutes County, USGS, Google Maps.
Date: 10/28/2025
Disclaimer: This data is not to survey accuracy and is meant for planning purposes only.

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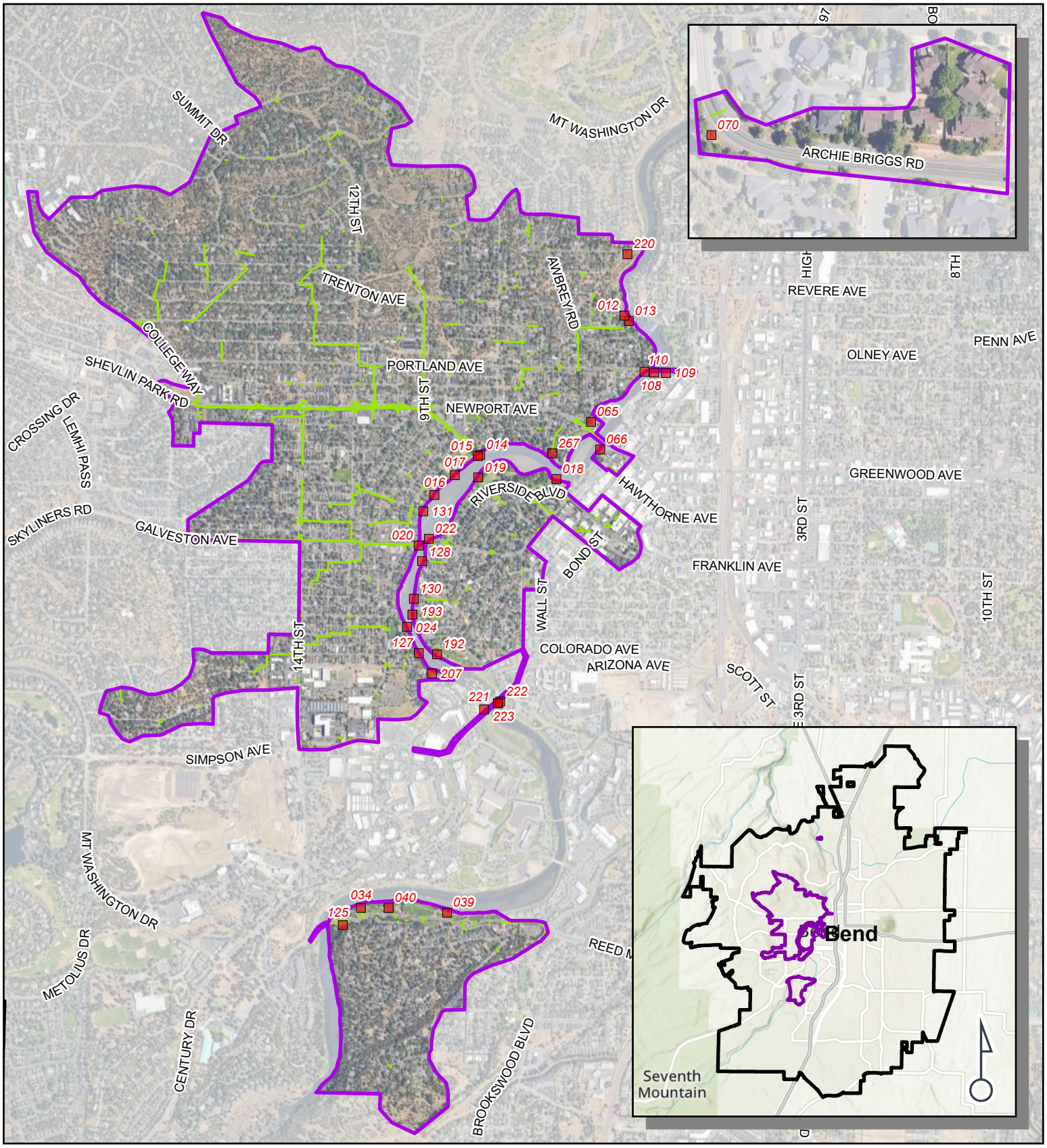

FIGURE 10
MS4 SYSTEM
BEND STORMWATER MASTER PLAN
BEND, OREGON

LEGEND

- Bend City Limits
- MS4 Basin Delineation
- Storm Main
- Outfalls

0 0.5 1 Mile

Data Sources: City of Bend, USGS, Google Maps.
Date: 10/28/2025
Disclaimer: This data is not to survey accuracy and is meant for planning purposes only.

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3.2. System Analyses

Three studies were conducted to analyze specific components of Bend's storm system. The full text of the studies contained in technical memoranda are included in Appendix A. The findings, which are summarized below, helped inform and identify known issues.

3.2.1. Outfall Retrofit Prioritization

This study, conducted by Otak, examines 32 basins that discharge stormwater through City-owned outfalls to the Deschutes River. A stormwater quality retrofit program is a requirement in the City's MS4 Permit. To prioritize which outfalls should receive retrofits, aspects of the outfall tributary areas which may increase pollutants or sediment in stormwater runoff were analyzed. The amount of untreated contributing area, sedimentation potential from steep slopes, estimated pollutant load by zoned land use, and related known issues were scored for each outfall area resulting in a priority ranking for the City's outfalls. This analysis identified six high priority outfalls for further consideration in this SMP.

3.2.2. Deep Drywell Considerations and Siting

This study, conducted by GSI, provides the City with information about new-to-Oregon stormwater infiltration facilities such as deep drywells (also known as modified drywells). A deep drywell is deeper than a conventional drywell which is currently used throughout the City. While not widely used in Oregon, deep drywells have been used in the desert southwest and other areas of the Pacific northwest to infiltrate below low-permeability soils. Recommendations for siting criteria, construction practices, spill mitigation, pretreatment, and operations and maintenance are discussed to minimize potential risks of permitting and implementing deep drywells in Bend.

3.2.3. Drillhole Prioritization

This study, conducted by GSI, provides the City with a prioritization ranking for drillhole replacement and retrofits. The City of Bend has a large inventory of drillholes to infiltrate stormwater. These facilities are typically 6-inch-wide boreholes up to 100 feet deep. Drillholes are more common in areas of the City that do not infiltrate well. Construction of new drillholes is no longer permitted in public infrastructure by City standards due to maintenance issues, lack of pretreatment, and the difficulty and expense of retrofitting. This study analyzed which existing drillholes pose the greatest risk to groundwater resources.

3.3. Identified Known Issues

After studying Bend's storm system, a total of 103 known issues were compiled (see Figure 11).

A geodatabase was used to organize the known issue points by location and allow for spatial analysis and visualization. Each known issue was assigned a unique identification number (KI-ID) within the geodatabase. In addition to the issue location, attribute fields for its full name, long description of the issue, and notes collected during site visits provided descriptive information for each issue. The database also contained a set of fields to indicate the type of primary concern for each issue. The primary concern categories include drainage, condition, maintainability, erosion, groundwater quality, or surface water quality. Table 2 shows the number of issues that fall into each category.

Table 2 Count of Known Issues by Type

Type	Count	Category Description
Drainage	57	Drainage issues include ponding and flooding on streets and private properties where the drainage system is inadequate, damaged, or is not present
Water Quality – Groundwater	26	Groundwater quality issues are identified where UICs may pose a contamination risk to groundwater because they are located near drinking water wells or do not have a spill control structure
Condition	6	Condition issues are identified when the drainage system or stormwater facility is damaged
Water Quality – Surface Water	7	Surface water quality issues are identified by analyzing the pollutant-causing characteristics of Bend's outfall basins and then prioritizing those outfalls that may discharge the most pollutants to the Deschutes River
Maintainability	5	Maintainability issues are identified where the drainage system or stormwater facilities are difficult or dangerous for City staff to maintain due to location, design, or condition
Erosion	2	Erosion issues are identified where stormwater flows over denuded or sparsely vegetated landscapes or natural areas and deposits eroded soils into streets, catch basins, UICs, or other elements of the drainage system
Total	103	

About half of the Known Issues have a secondary issue type which contributes to the problem (Table 3). The most frequent combination is a groundwater quality issue paired with an infrastructure condition issue. Most of these are drillholes that may pose a risk to water quality because they are located within the two-year time of travel for drinking water wells and/or have been damaged by long-term sediment build-up which impacts their function.

Table 3 Frequency of Primary and Secondary Issue Type Combinations

Primary Issue Type	Secondary Issue Type								Grand Total
	No Secondary Issue Type	Drainage	Water Quality – Surface Water	Water Quality – Groundwater	Maintainability	Condition	Erosion	Sedimentation	
Drainage	41			2	1	2	10	1	**57**
Water Quality-Surface Water	7								**7**
Water Quality-Groundwater			1			25			**26**
Maintainability	3					2			**5**
Condition	3	2			1				**6**
Erosion		2							**2**
Grand Total	**54**	**4**	**1**	**2**	**2**	**29**	**10**	**1**	**103**

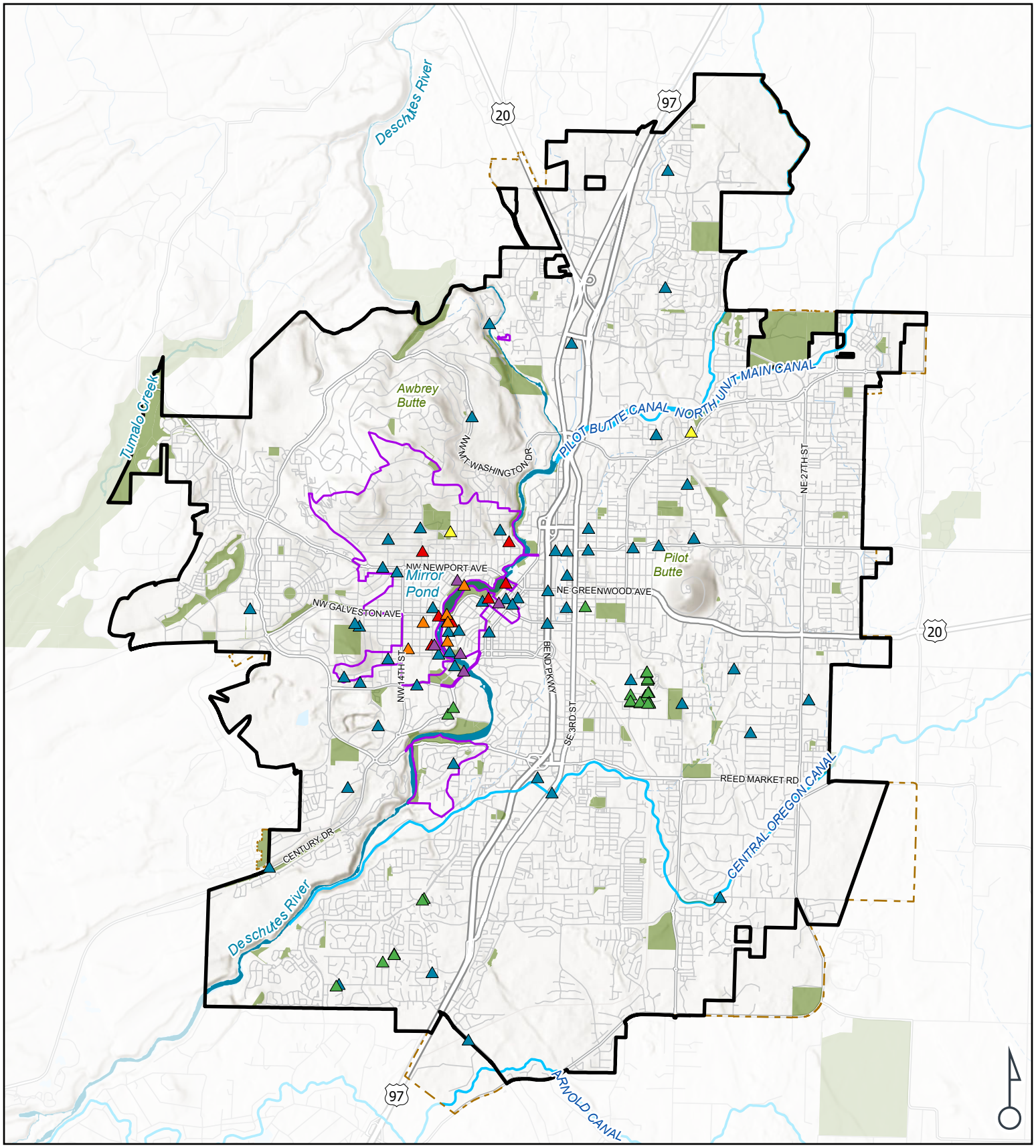

FIGURE 11
STORMWATER KNOWN ISSUES
BEND STORMWATER MASTER PLAN
BEND, OREGON

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LEGEND

- Bend City Limits
- Urban Growth Boundary
- MS4 Basin Delineation
- Parks
- Canals
- Streams

Stormwater Known Issue

- Drainage
- Water Quality-Surface Water
- Water Quality-Groundwater
- Maintainability
- Condition
- Erosion

Data Sources: City of Bend, USGS, Google Maps.
Date: 10/28/2025
Disclaimer: This data is not to survey accuracy and is meant for planning purposes only.

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3.3.1. Disposition of Issues and Solutions from 2014 SMP

Unresolved projects from the 2014 SMP contributed to the collection of known issues. Two remaining high priority projects have not been fully implemented, and numerous of the 58 lower priority projects from the prior plan have not been implemented. The status of each of the 2014 high priority projects is included in Table 4, followed by a narrative explanation of the current progress on the incomplete projects.

Table 4 Status of 2014 SMP High Priority Projects

Project Name	Priority (2014)	Description (2014)	Status
Westside Village Shopping Center and Bend Fire Station	1	An old commercial development, this area sits over shallow tuff where infiltration does not appear to work. In addition, catch basins are located away from the curb, allowing water to bypass existing drywells. A cascading effect starts at Safeway, adds flows from Ray's Foods, prior to inundating the fire station and added flows from a storage facility, cause large volumes of water to flow into and through Nosler's manufacturing plant.	Partially Resolved; The Ray's Foods site was redeveloped and resolved some issues.
Franklin Underpass	2	A low spot surrounded by a large amount of paving, this area floods readily during storms. Drywells are unable to keep up with the volume and this area floods during many storm events.	Unresolved; Project 1RFGU on current CIP
3rd Street Railway Underpass	3	Similar to Franklin St., 3rd Street is a low spot surrounded by a large impervious area, and floods easily during storm events.	Completed 2013*
Archie Briggs West Side	4	Archie Briggs has a very steep roadway slope that collects water from an even steeper hillside. The roadway in the lower areas is damaged from the large amount of water coming through the area. Stormwater blocks one of the lanes of traffic and then leaves the uncurbed roadway to drain into residential property.	Solved but Monitor
Fairway Heights at Awbrey Butte	5	Both public and private stormwater combine to create this problem area. A large part of Awbrey Butte drains to culverts and through residential sites, at one point entering peoples' homes, prior to draining to the golf course below. Easements are located throughout the development, and on the golf course. However, they don't line up well and water tends to go straight, detouring around some of the easements.	Completed 2019

**Project was prioritized in the 2008 draft SMP and was completed before adoption of the plan in 2014.*

The Westside Village Shopping Center was not completed as a capital project and is not on the City's CIP schedule. While ranked as Priority 1 in the 2014 SMP, private development in the project area has reduced the severity of the issue and changed the scope of the project alternatives. In this SMP, the project has been reclassified into the Failing UIC Drainage Improvement Program.

The 2014 SMP identified the Franklin Street underpass as a high priority drainage project location and identified the Greenwood Street underpass as a lower-priority project. In the intervening time, the City

began to think of and plan for both Franklin and Greenwood underpasses as a unified capital project (capital project budget number 1RFGU) under the same project umbrella. These underpasses are beneath BNSF rail tracks and frequently flood during rain events, halting east-west travel. The Franklin and Greenwood drainage basins were studied in a 2025 report by DOWL, LLC, *City of Bend Midtown Stormwater Improvements* (Appendix A). Stormwater improvements in these basins likely will be paired with transportation capital projects to improve the Franklin and Greenwood roadways and underpasses. While the projects are now paired in the CIP, as of July 2025, the City is currently planning to pursue only the Franklin underpass solution in the 1RFGU project. A recent "quick-build" transportation project on Greenwood did not include any of the drainage improvements recommended in the DOWL report. However, the City is gathering feedback to inform future changes of Greenwood, possibly including the drainage improvements.

The Archie Briggs project was not completed as proposed in the 2014 SMP. Instead, an asphalt berm was installed as a mitigation measure for flooding in the area and the problem appears to be resolved. Continued monitoring is recommended for the area. ODOT identified the Archie Briggs Road bridge, which crosses the Deschutes River, as structurally deficient. Because the bridge is downstream of the problem area, additional stormwater management measures should be considered in the design of the bridge if funding becomes available to replace or rehabilitate it.

The current stormwater CIP includes the South Awbrey Butte Drainage Improvements (1RSAB), which is a collection of drainage issues identified in the *South Awbrey Butte Drainage Stud*y (HDR, 2017). Developing this drainage plan was a non-priority stormwater infrastructure improvement project recommended in the 2014 SMP.

In addition to the five high priority projects, the 2014 SMP identified 58 potential stormwater improvement projects. Any of the projects from the 2014 SMP that have not been implemented and are still active issues were added to the known issues database. MB18A (Franklin Underpass), MB18B (Greenwood Underpass), MB14A Project 2 (NW Congress St), MB14A Project 3 (NW Riverfront St) were included in this SMP because the drainage issues in these locations are still active.

3.3.2. Issue Screening and Classification

The known issues list was screened to exclude any issues with a status that indicates it has been resolved or is in progress. The remaining active-status known issues were then grouped and classified with a solution type best aligned with the primary issue. Stormwater issues may be solved through individual capital projects, programmatic solutions, policy changes or a variety of other actions. Common types of solutions for each issue type are listed in Table 5.

Table 5 Primary Issue Types and Typical Solutions for Known Issues

Primary Issue Type	Typical Solutions				
		Programmatic Solution			
	CIP Project	Major Maintenance	Failing UICs	Drillhole Retrofit	Policy Change
Drainage / Flooding	x	x	x		x
Water Quality-Groundwater				x	x
Water Quality-Surface Water	x				x
Condition		x	x		
Maintainability		x			
Erosion		x			x

The 79 active known issues are shown by solution type in Figure 12. A small number of solution types do not fit the typical categories outlined in Table 5 or are too minor to qualify as a capital project or program. These are grouped as 'Other'.

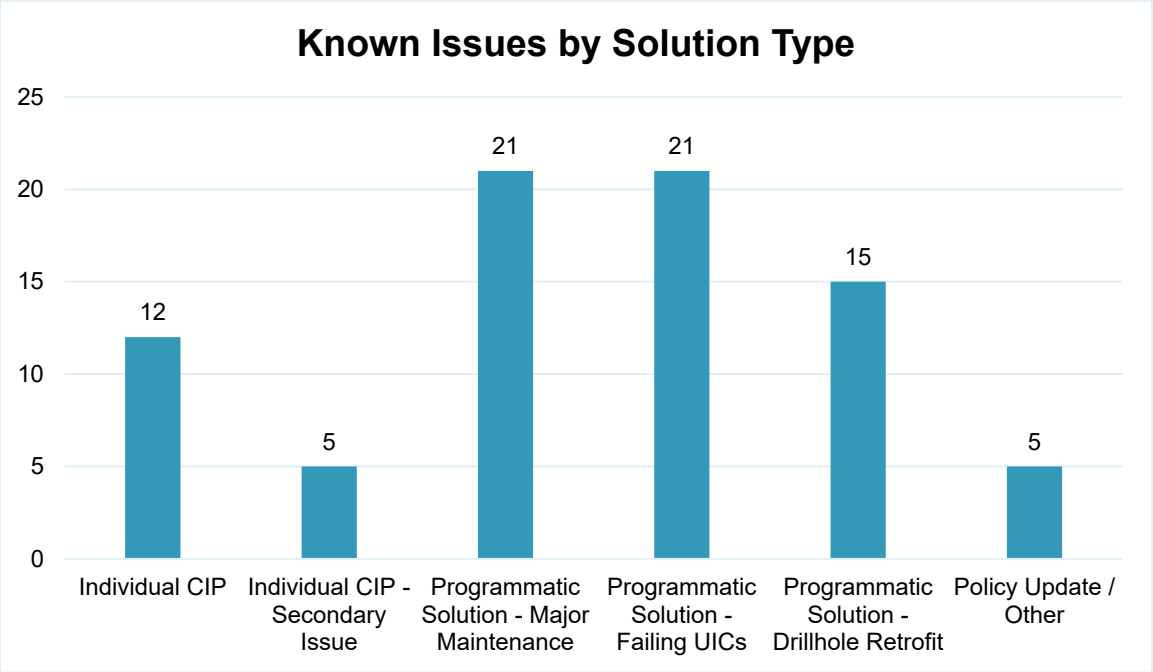

Figure 12 Chart of Recommended Solution Types for Known Issues

Individual CIPs are a solution type for large and/or complex drainage and surface water quality issues. These issues require complex site-specific engineering design. Either a significant improvement to existing facilities is needed, or storm system infrastructure is planned where none currently exists. Individual CIP Projects are often developed with the goal of solving multiple neighboring issues with a single project. *CIP-Secondary Issue* indicates that the known issue has been grouped with other issues to be solved with an individual CIP; these are common when several known issues are in proximity. CIPs are described in greater detail in Section 4, Stormwater Capital Improvement Projects.

Programmatic Solutions are a solution type when groups of issues have commonalities and can be solved with similar and easily implemented stormwater designs. These issues may not meet the criteria for individual CIPs. However, they are systematically tracked through the City's asset management program and grouped into programs to ensure they are addressed efficiently and consistently over time, The SMP recommends programmatic solutions for major maintenance, failing UICs, and drillhole water quality retrofits. These programs are described in greater detail in see Section 5, Programmatic

Policy Updates are a solution type when it becomes apparent that the City's policies for regulating, operating, or maintaining private or public stormwater systems contribute to systemic issues such as nuisance flooding or risk non-compliance with the City's stormwater-related permits from DEQ. Policy solutions require further evaluation and may involve recommendations for changes to internal policies or changes to the City's development codes or engineering standards. Three policy topics are explored further in Section 6, Policy Discussion.

Other solutions include education, enforcement, easement acquisition, and recommendations for further study before solution development.

A complete accounting of the 103 known issues, primary issue type, status, and solution type is included in Table 6.

Table 6 Stormwater Known Issues

Issue ID	Name	Primary Issue Type	Status	Solution Type
KI-1	1504 SW Overturf Drainage	Drainage	Active	Major Maintenance
KI-2	19th and Knoll Drainage	Drainage	Design	Study Recommended
KI-3	SE Dove Lane Flooding	Drainage	Active	Individual CIP - Drainage
KI-4	Stormwater Flooding Report 1515 NE 2nd St.	Drainage	Design	Solution Identified
KI-5	Stormwater Flooding Report 19 NW Mueller	Drainage	Active	Major Maintenance
KI-6	Stormwater Flooding Report 211-147-143 NW Congress	Drainage	Active	Individual CIP - Drainage
KI-7	Stormwater Flooding Report 717 NW Georgia	Drainage	Active	Failing UICs Program
KI-8	Stormwater Flooding Report 1213 Vicksburg Ave	Drainage	Active	Individual CIP - Drainage
KI-9	Stormwater Flooding Report 1300 SE 3rd St	Drainage	Active	Major Maintenance

Table 6 Stormwater Known Issues

Issue ID	Name	Primary Issue Type	Status	Solution Type
KI-10	Stormwater Flooding Report 1648 NE Eastwood Dr	Drainage	Active	Failing UICs Program
KI-11	Stormwater Flooding Report 2310 NE Shepard Rd	Drainage	Active	Failing UICs Program
KI-12	Stormwater Flooding Report 63673 Boyd Acres Rd (Cooley Neighborhood)	Drainage	Active	Major Maintenance
KI-13	Stormwater Flooding Report 19410 Century Dr	Drainage	Active	Individual CIP - Drainage
KI-14	Stormwater Flooding Report 633 NW York Dr	Drainage	Active	Major Maintenance
KI-15	Stormwater Flooding Report 63089 Nels Anderson Rd	Drainage	Active	Major Maintenance
KI-16	Stormwater Flooding Report 19650 SW Poplar	Drainage	Active	Major Maintenance
KI-17	Stormwater Flooding Report NW Summit/NW Mt. Washington	Drainage	Active	Failing UICs Program
KI-18	Stormwater Flooding Report 1936 SE Waco Dr	Drainage	Active	Major Maintenance
KI-19	Stormwater Flooding Report 858 NW Wall St	Drainage	Active	Failing UICs Program
KI-20	Stormwater Flooding Report 1125 NE 2nd St	Drainage	Active	Failing UICs Program
KI-21	Stormwater Flooding Report 1532 NE 9th St	Drainage	Active	Failing UICs Program
KI-22	Stormwater Flooding Report 902 SE Textron	Drainage	Solved, Monitor	Solved But Monitor
KI-23	Stormwater Flooding Report 1501 NE Neff Rd	Drainage	Active	Major Maintenance
KI-24	Stormwater Flooding Report 330 SE 15th St	Drainage	Active	Failing UICs Program
KI-25	Stormwater Flooding Report 151 SW Shevlin Ln	Drainage	Active	Failing UICs Program
KI-26	Stormwater Flooding Report 1212 SW Simpson (2014 SMP)	Drainage	Active	Failing UICs Program
KI-27	Stormwater Flooding Report 1757 Forest Ridge Ave	Drainage	Active	Failing UICs Program
KI-28	Stormwater Flooding Report 60924 SW McMullin	Drainage	Active	Failing UICs Program
KI-29	Stormwater Flooding Report 61553 Westridge Ave	Drainage	Active	Failing UICs Program
KI-30	Stormwater Flooding Report 63275 Wishing Well Ln	Drainage	Active	Failing UICs Program
KI-31	Stormwater Flooding Report 1567 SW Chandler Ave	Drainage	Active	Failing UICs Program

Table 6 Stormwater Known Issues

Issue ID	Name	Primary Issue Type	Status	Solution Type
KI-32	Stormwater Flooding Report NE 2nd St/NE Lafayette	Drainage	Active	Failing UICs Program
KI-33	Stormwater Flooding Report Ne 4th St/NE Revere Ave	Drainage	Active	Failing UICs Program
KI-34	Stormwater Flooding Report NE 4th at NE Olney Ave	Drainage	Active	Major Maintenance
KI-35	Stormwater Flooding Report 537 NW Riverfront	Drainage	Active	Individual CIP - Drainage
KI-36	Stormwater Flooding Report 1193 Ross Rd	Drainage	Active	Failing UICs Program
KI-37	Stormwater Flooding Report SE China Hat Rd-RR Tracks	Drainage	Active	Major Maintenance
KI-38	Stormwater Flooding Report 510 NW Sean Ct. (Overturf Park)	Drainage	Active	Failing UICs Program
KI-39	Stormwater Flooding Report 125 NE Franklin Ave.	Drainage	Design	Project in Process
KI-40	Stormwater Flooding Report 5 NW Greenwood	Drainage	Project in Process	Failing UICs Program
KI-41	Blocked Outfall in Miller's Landing Park (SMP Online Comment 2)	Drainage	Solved, Monitor	Solved But Monitor
KI-42	Damaged pipe in NW McKay Ave (SMP Online Comment 4)	Condition	Active	Major Maintenance
KI-44	Damaged pipe south of NW Baltimore Ave (SMP Online Comment 6)	Condition	Active	Major Maintenance
KI-43	Tear in pipe at NW Galveston Ave. (SMP Online Comment 5)	Condition	Active	CIP - Secondary Issue
KI-47	Inaccessible and damaged pipe, Drake Park (south) (SMP Online Comment 9)	Condition	Active	Major Maintenance
KI-46	Flooded home and damaged pipe at NW Hixon Ave (SMP Online Comment 8)	Condition	Active	CIP – Secondary Issue
KI-48	South Awbrey Butte Drainage Study	Drainage	Active	Project in Process
KI-49	Old Newport Ave. Outfall	Condition	Active	Major Maintenance
KI-50	Archie Briggs Rd Drainage Issues (2014 SMP)	Drainage	Solved, Monitor	Solved But Monitor
KI-51	Central District Lacks Drainage Options for Redevelopment	Water Quality-Groundwater	Active	Study Recommended
KI-52	Lack of easement for stormwater outfall and pipe	Maintainability	In Progress	Easement Acquisition
KI-53	Lack of easement for City stormwater facilities and outfall in Miller's Landing Park.	Maintainability	Active	Easement Acquisition

Table 6 Stormwater Known Issues

Issue ID	Name	Primary Issue Type	Status	Solution Type
KI-54	Lack of access to stormwater main	Maintainability	Active	CIP - Secondary Issue
KI-55	Sediment control at NW Congress and Louisiana	Drainage	Active	CIP - Secondary Issue
KI-56	Private drainage impacting ROW on Newport Ave	Drainage	Solved	Solved But Monitor
KI-57	Private drainage impacting public alley south of Newport Ave	Drainage	Solved	Solved But Monitor
KI-58	LID design causing maintainability issues	Maintainability	Active	Policy
KI-59	Stormwater Flooding Report, 576 NW Lindsay Ct. (Overturf Park)	Drainage	Solved	Solved But Monitor
KI-60	Stormwater Flooding Report, 59 SW Hayes Ave	Drainage	Active	Major Maintenance
KI-61	Stormwater Flooding Report, 162 NW Utica Ave	Drainage	Solved, Monitor	Solved But Monitor
KI-62	Stormwater Flooding Report, 1507 NE 1st St	Drainage	Active	Failing UICs Program
KI-63	Illicit discharge detected to outfall	Water Quality-Surface Water	Solved, Monitor	Education or Enforcement
KI-64	Location and status of outfall DOF000076 is unknown	Maintainability	Inactive	N/A
KI-65	Quiet Canyon Loop Erosion and Flooding	Erosion	Active	Education or Enforcement
KI-66	Drillhole Decommissioning Location – Priority Rank 1	Water Quality-Groundwater	Active	Drillhole Water Quality Retrofit
KI-67	Drillhole Decommissioning Location – Priority Rank 1	Water Quality-Groundwater	Solved	Drillhole Water Quality Retrofit
KI-68	Drillhole Decommissioning Location – Priority Rank 1	Water Quality-Groundwater	Active	Drillhole Water Quality Retrofit
KI-69	Drillhole Decommissioning Location – Priority Rank 1	Water Quality-Groundwater	Active	Drillhole Water Quality Retrofit
KI-70	Drillhole Decommissioning Location – Priority Rank 1	Water Quality-Groundwater	Active	Drillhole Water Quality Retrofit
KI-71	Drillhole Decommissioning Location – Priority Rank 1	Water Quality-Groundwater	Solved	Drillhole Water Quality Retrofit
KI-72	Drillhole Decommissioning Location – Priority Rank 1	Water Quality-Groundwater	Solved	Drillhole Water Quality Retrofit
KI-73	Drillhole Decommissioning Location – Priority Rank 1	Water Quality-Groundwater	Solved	Drillhole Water Quality Retrofit
KI-74	Drillhole Decommissioning Location – Priority Rank 1	Water Quality-Groundwater	Solved	Drillhole Water Quality Retrofit
KI-75	Drillhole Decommissioning Location – Priority Rank 1	Water Quality-Groundwater	Active	Drillhole Water Quality Retrofit

Table 6 Stormwater Known Issues

Issue ID	Name	Primary Issue Type	Status	Solution Type
KI-76	Drillhole Decommissioning Location – Priority Rank 1	Water Quality-Groundwater	Active	Drillhole Water Quality Retrofit
KI-77	Drillhole Decommissioning Location – Priority Rank 1	Water Quality-Groundwater	Solved	Drillhole Water Quality Retrofit
KI-78	Drillhole Decommissioning Location – Priority Rank 1	Water Quality-Groundwater	Solved	Drillhole Water Quality Retrofit
KI-79	Drillhole Decommissioning Location – Priority Rank 1	Water Quality-Groundwater	Solved	Drillhole Water Quality Retrofit
KI-80	Drillhole Decommissioning Location – Priority Rank 1	Water Quality-Groundwater	Active	Drillhole Water Quality Retrofit
KI-81	Drillhole Decommissioning Location – Priority Rank 1	Water Quality-Groundwater	Solved	Drillhole Water Quality Retrofit
KI-82	Drillhole Decommissioning Location – Priority Rank 1	Water Quality-Groundwater	Solved	Drillhole Water Quality Retrofit
KI-83	Flooding and ice at intersection	Drainage	Active	Individual CIP - Drainage
KI-84	Outfall Retrofit Need Identified, Outfall Basin 266 & 14N	Water Quality-Surface Water	Active	Individual CIP - Outfall Retrofit
KI-85	Outfall Retrofit Need Identified, Outfall Basin 024	Water Quality-Surface Water	Active	Individual CIP - Outfall Retrofit
KI-86	Outfall Retrofit Need Identified, Outfall Basin 020	Water Quality-Surface Water	Active	Individual CIP - Outfall Retrofit
KI-87	Outfall Retrofit Need Identified, Outfall Basin 013	Water Quality-Surface Water	Active	Individual CIP - Outfall Retrofit
KI-88	Outfall Retrofit Need Identified, Outfall Basin 018	Water Quality-Surface Water	Active	Individual CIP - Outfall Retrofit
KI-89	Outfall Retrofit Need Identified, Outfall Basin 128	Water Quality-Surface Water	Active	Individual CIP - Outfall Retrofit
KI-90	Flooding and ice at intersection	Drainage	Active	CIP – Secondary Issue
KI-93	Stormwater Flooding Report 21040 SE Gardenia Ave	Drainage	Active	Major Maintenance
KI-94	Stormwater Flooding Report 805 NW Columbia St	Drainage	Active	Major Maintenance
KI-95	Stormwater Flooding Report 61190 SE Ferguson Rd	Drainage	Active	Major Maintenance
KI-96	Stormwater Flooding Report 20019 SW Alderwood Cir	Drainage	Active	Major Maintenance
KI-97	Drillhole Decommissioning Location - Priority Rank 2	Water Quality-Groundwater	Active	Drillhole Water Quality Retrofit
KI-98	Drillhole Decommissioning Location - Priority Rank 2	Water Quality-Groundwater	Active	Drillhole Water Quality Retrofit
KI-99	Drillhole Decommissioning Location – Priority Rank 1	Water Quality-Groundwater	Active	Drillhole Water Quality Retrofit

Table 6 Stormwater Known Issues

Issue ID	Name	Primary Issue Type	Status	Solution Type
KI-100	Drillhole Decommissioning Location – Priority Rank 1	Water Quality-Groundwater	Active	Drillhole Water Quality Retrofit
KI-101	Drillhole Decommissioning Location – Priority Rank 1	Water Quality-Groundwater	Active	Drillhole Water Quality Retrofit
KI-102	Drillhole Decommissioning Location – Priority Rank 1	Water Quality-Groundwater	Active	Drillhole Water Quality Retrofit
KI-103	Drillhole Decommissioning Location – Priority Rank 1	Water Quality-Groundwater	Active	Drillhole Water Quality Retrofit
KI-104	Drillhole Decommissioning Location – Priority Rank 1	Water Quality-Groundwater	Active	Drillhole Water Quality Retrofit
KI-105	Stormwater Flooding Report NW Albany Ave & NW Allen Rd	Drainage	Active	Major Maintenance
KI-106	Stormwater Flooding Report NW 8th St & NW Trenton Ave	Erosion	Active	Major Maintenance

3.4. Potential Projects

The next step for active known issues that have an individual CIP or a programmatic solution type is to develop a project concept and group the projects into programs. Two types of individual CIPs were developed, Drainage and Outfall Retrofit, as well as programmatic solutions for three groups of issues: major maintenance, failing UICs, and drillholes retrofits to protect groundwater quality.

CIP – Drainage

A stormwater CIP is a standalone project to manage runoff which may have a design requiring significant engineering and/or may have a higher construction cost estimate. A drainage project is designed to reduce the severity and frequency of flooding on streets and sidewalks after rainstorms. Flooding on private property due to uncontrolled runoff from City streets may also be addressed.

CIP – Outfall Retrofit

An outfall retrofit CIP project is designed to limit untreated stormwater from flowing into the Deschutes River from existing outfalls. These projects remove urban pollutants and reduce sediment in stormwater runoff before it reaches the river. These projects assist the City in complying with the NPDES MS4 permit from DEQ.

Major Maintenance Program

The purpose of this program is to apply more targeted maintenance, improve access to the existing stormwater system, or to manage a small drainage issue on a public street, sidewalk, or private property when caused by runoff from City infrastructure. Projects may repair, replace, or add a small number of less complex structures (e.g. new inlets). Construction costs are typically less than $1 million, however final costs may vary depending on implementation circumstances determined by City staff.

Failing UICs Drainage Improvements Program

This program is to reduce nuisance flooding on streets and sidewalks by replacing UICs that no longer function or adding new UICs to an underperforming system. Drywells or deep drywells may be used, depending on site conditions.

Drillhole Water Quality Retrofit Program

The program is to protect the quality of groundwater resources by adding pre-treatment to existing drillholes that may be at risk of discharging pollutants to the aquifer. The program prioritized 15 drillholes that are within the 2-year time of travel of wells that are used as public drinking water wells. Two-year time of travel is a measurement of how far groundwater, or in this case potential pollution or contaminants that have entered groundwater, travels to a specific point over a period of two years.

Potential project by program are listed in Table 7 and shown on Figure 13.

Table 7 Potential Projects by Program

Potential Project ID	Project Name	Program
PP-1	Dove Lane Drainage Improvement	CIP - Drainage
PP-14	NW Congress Drainage Improvement	CIP - Drainage
PP-16	Campbell Rd Drainage Improvement	CIP - Drainage
PP-42	Downtown Pedestrian Safety Drainage Improvements Program	CIP - Drainage
PP-46	Vicksburg Ave Drainage Improvement	CIP - Drainage
PP-12	Columbia Park Outfall 024 Retrofit	CIP - Outfall Retrofit
PP-35	Riverfront St Stormwater Improvements	CIP - Outfall Retrofit
PP-43	Saginaw Ave Stormwater Quality Improvement	CIP - Outfall Retrofit
PP-44	Drake Park Stormwater Improvements	CIP - Outfall Retrofit
PP-47	Galveston Ave Stormwater Quality Improvement	CIP - Outfall Retrofit
PP-48	Fresno Ave Drainage Improvement	CIP - Outfall Retrofit
PP-45	12th St Stormwater Quality Improvement	CIP - Outfall Retrofit
PP-62	Drillhole Retrofit (DDH009510)	Drillhole Water Quality Retrofit
PP-63	Drillhole Retrofit (DDH009513)	Drillhole Water Quality Retrofit
PP-64	Drillhole Retrofit (DDH009514)	Drillhole Water Quality Retrofit
PP-66	Drillhole Retrofit (DDH009727)	Drillhole Water Quality Retrofit
PP-67	Drillhole Retrofit (DDH009728)	Drillhole Water Quality Retrofit
PP-68	Drillhole Retrofit (DDH009766)	Drillhole Water Quality Retrofit
PP-71	Drillhole Retrofit (DDH009875)	Drillhole Water Quality Retrofit
PP-72	Drillhole Retrofit (DDH009932)	Drillhole Water Quality Retrofit
PP-70	Drillhole Retrofit (DDH009485)	Drillhole Water Quality Retrofit
PP-74	Drillhole Retrofit (DDH002049)	Drillhole Water Quality Retrofit
PP-75	Drillhole Retrofit (DDH009482)	Drillhole Water Quality Retrofit
PP-76	Drillhole Retrofit (DDH009446)	Drillhole Water Quality Retrofit
PP-77	Drillhole Retrofit (DDH009447)	Drillhole Water Quality Retrofit
PP-78	Drillhole Retrofit (DDH010013)	Drillhole Water Quality Retrofit
PP-79	Drillhole Retrofit (DDH009381)	Drillhole Water Quality Retrofit
PP-8	NW Georgia Avenue Drainage Improvement	Failing UICs Drainage Improvement
PP-9	NE Shephard Road Drainage Improvement	Failing UICs Drainage Improvement
PP-15	NE Eastwood Drainage Improvement	Failing UICs Drainage Improvement

Table 7 Potential Projects by Program

Potential Project ID	Project Name	Program
PP-17	NW Clearwater Dr Drainage Improvement	Failing UICs Drainage Improvement
PP-20	NW Summit Dr Drainage Improvement	Failing UICs Drainage Improvement
PP-22	NW Wall Street Drainage Improvement	Failing UICs Drainage Improvement
PP-23	NE Hawthorne Ave Drainage Improvement	Failing UICs Drainage Improvement
PP-24	NE 9th Street and Penn Drainage Improvement	Failing UICs Drainage Improvement
PP-25	SE 15th Street Drainage Improvement	Failing UICs Drainage Improvement
PP-26	SW Shevlin Hixon Dr Drainage Improvement	Failing UICs Drainage Improvement
PP-27	SW Simpson Ave Drainage Improvement (2014 SMP)	Failing UICs Drainage Improvement
PP-28	SW Forest Ridge Ave Drainage Improvement	Failing UICs Drainage Improvement
PP-29	McMullin Dr Drainage Improvement	Failing UICs Drainage Improvement
PP-30	SW Westridge Ave Drainage Improvement	Failing UICs Drainage Improvement
PP-31	NE Morningstar Dr Drainage Improvement	Failing UICs Drainage Improvement
PP-32	SW Chandler Ave Drainage Improvement	Failing UICs Drainage Improvement
PP-33	NE 2nd St Drainage Improvement	Failing UICs Drainage Improvement
PP-34	NE Revere Ave Drainage Improvement	Failing UICs Drainage Improvement
PP-36	NE Ross Rd Drainage Improvement	Failing UICs Drainage Improvement
PP-38	NW Sean Ct Drainage Improvement	Failing UICs Drainage Improvement
PP-41	NW Olney Ave Drainage Improvement	Failing UICs Drainage Improvement
PP-10	Wagontire Way Drainage Improvement	Major Maintenance
PP-11	Overturf Ct. Cul-de-sac Drainage Improvement	Major Maintenance
PP-13	NW Mueller Avenue Alley Drainage Improvement	Major Maintenance
PP-18	NE Nels Anderson Rd Drainage Improvement	Major Maintenance
PP-19	Poplar Street Drainage Improvement	Major Maintenance
PP-21	SE Waco Dr Drainage Improvement	Major Maintenance
PP-37	China Hat Rd Drainage Improvement	Major Maintenance
PP-40	SW Hayes Ave Drainage Improvement	Major Maintenance
PP-49	SE 3rd Street South of Brosterhous	Major Maintenance
PP-50	NW McKay Ave Pipe Repair	Major Maintenance
PP-55	SW Alderwood Cir Drainage Improvement	Major Maintenance
PP-56	NW Columbia St Drainage Improvement	Major Maintenance
PP-57	Newport Outfall Maintenance	Major Maintenance
PP-58	NW Tumalo at Drake Park Pipe Repair	Major Maintenance
PP-59	NW Baltimore Pipe Repair	Major Maintenance
PP-60	SE Ferguson Rd Drainage Improvement	Major Maintenance
PP-61	SE Gardenia Ave Drainage Improvement	Major Maintenance
PP-73	NE Olney Ave Drainage Improvement	Major Maintenance
PP-80	NE Penn/NE Neff Drainage Improvement	Major Maintenance

Table 7 Potential Projects by Program

Potential Project ID	Project Name	Program
PP-81	NW Trenton Ave Drainage Improvement	Major Maintenance
PP-82	NW Allen Rd Drainage Improvement	Major Maintenance

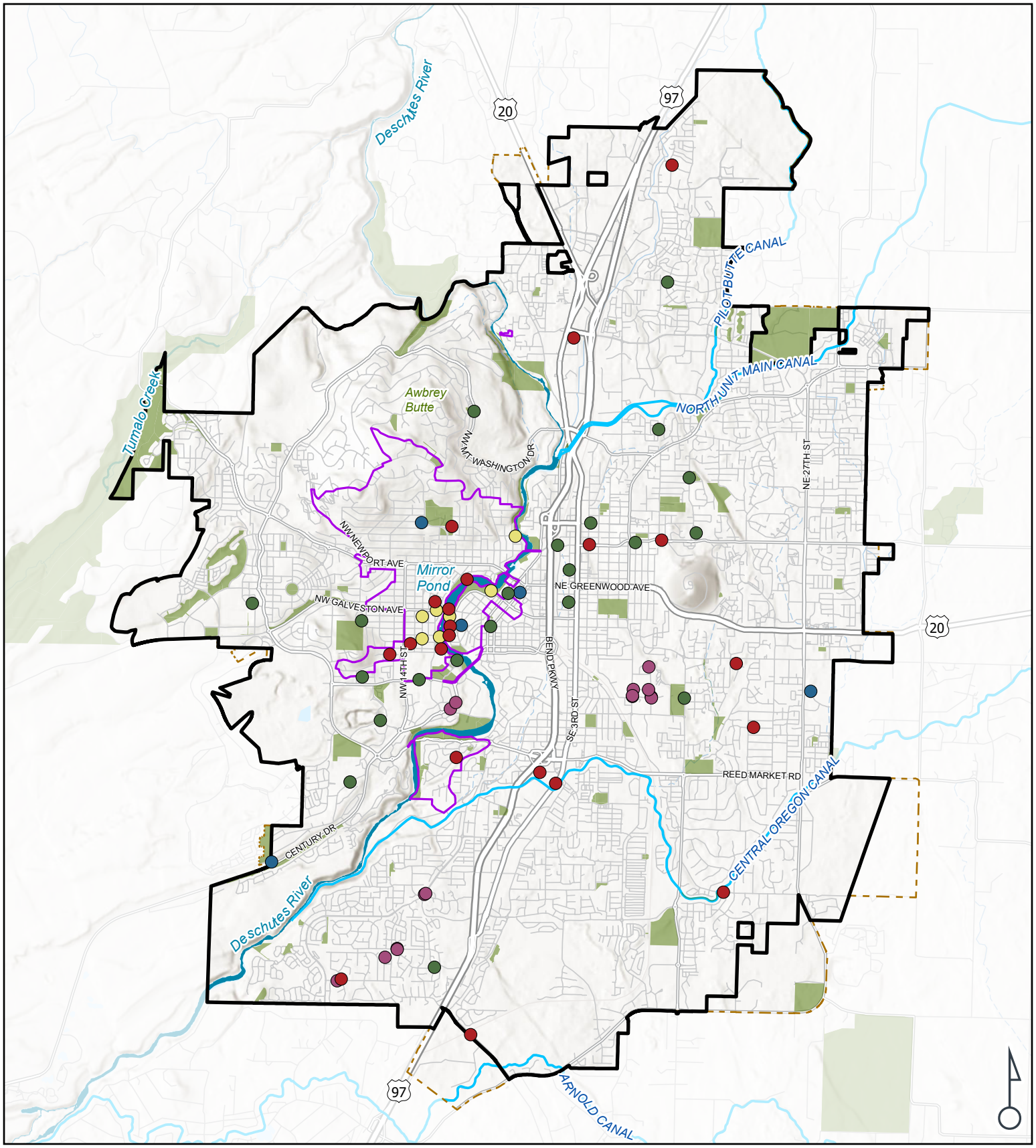

FIGURE 13
POTENTIAL PROJECTS
BEND STORMWATER MASTER PLAN
BEND, OREGON

LEGEND

- Bend City Limits
- Urban Growth Boundary
- MS4 Basin Delineation
- Parks
- Streams
- Canals

Program

- CIP - Drainage
- CIP - Outfall Retrofit
- Drillhole Water Quality Retrofit
- Failing UICs Drainage Improvement
- Major Maintenance

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Data Sources: City of Bend, USGS, Google Maps.
Date: 10/28/2025
Disclaimer: This data is not to survey accuracy and is meant for planning purposes only.

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3.5. Relationship to Other Planning Efforts and City Programs

In addition to the regulatory requirements for stormwater management discussed in Section 1.3, the City of Bend has several current planning efforts, programs, and projects that align with the goals of this SMP and were considered in the planning process and solution development.

3.5.1. Capital Projects and Planning

There are several planned capital projects in Bend that have stormwater components or opportunities for synergistic stormwater projects. The 2020 Transportation System Plan identified 46 near-term transportation projects. Where possible, including stormwater projects would help address known issues included in this plan. The following current projects overlap with several potential projects.

- **Galveston Corridor**: This transportation project aims to improve multi-modal mobility on Galveston Avenue. Initial design included improved stormwater infrastructure, but the project was scaled back in 2025 to focus on pedestrian crossing and sidewalk improvements.
- **Riverfront Street Redesign**: This transportation project aims to improve the road conditions on Riverfront Street and connect pieces of the Deschutes River Trail by constructing pedestrian and bicycle infrastructure. Upgrades to the existing stormwater system are intended to accompany the street redesign.
- **Midtown Crossing**: This transportation project aims to improve east-west travel on Greenwood Avenue, Hawthorne Avenue, Franklin Avenue, and 2nd Street. The proposed improvement includes an overcrossing at Hawthorne Ave, improvements to the undercrossings at Franklin and Greenwood and modernization of 2nd Street. The 2nd Street modernization was completed in June of 2025, and included stormwater improvements. The undercrossing projects were each identified as projects in the 2014 SMP are a currently being implemented by the City as a stormwater CIP.

3.5.2. Tree Preservation

Preserving and protecting trees during development is an important facet of urban stormwater management. Trees help absorb rainwater, slow the flow of runoff, and provide a host of other ecosystem services. Bend's tree preservation program on parcels is formalized through its municipal and development codes. Planter strip landscaping in the right-of-way is regulated by the Bend Development Code and the City's Standards and Specifications. The Stormwater Tool Kit developed for this plan introduces a Stormwater Tree (See Appendix B) as a potential stormwater facility to implement in Bend. This facility is designed to improve the water quality of runoff while providing the other benefits of urban trees. Development or redevelopment projects may need to meet certain landscaping or street tree requirements, and the City should consider specifically allowing Stormwater Trees as an acceptable alternative in its development code.

3.5.3. Core Area Redevelopment Programs and Plans

Bend has identified three areas where tax increment financing may be used to reinvest or rebuild parts of the City that have infrastructure and structures in deteriorated conditions and decreasing property values due to blight and disinvestment: Core Area, Juniper Ridge, and Murphy Crossing. The City plans for much of its future housing and employment growth to be contained within the Core Area. Several infrastructure improvement projects are planned for the Core Area to improve utility services, public safety, and connections to downtown Bend. The City plans to partner with and offer support to private and non-profit entities to improve both housing and business development opportunities in the Core Area. Support options identified in the Tax Increment Finance Plan include, but are not limited to, off-site infrastructure improvements which could involve stormwater drainage and facilities (Ordinance No. 2379, 2020).

The Guiding Principles of the Core Area are:

- Create a place where you can live, work, and play.
- This is a walkable area with a balanced transportation system.
- This area removes barriers and connects the East and West sides of Bend.
- This plan leads to direct outcomes, if it is implemented.
- Affordability is preserved.
- Public investments incentivize and catalyze private development.
- The planning process is transparent and open to ensure that those affected by the decisions are involved in the process.
- This area incorporates sustainable and low impact development principles and practice.

Densities allowed in the Core Area could impact space available for stormwater management on development sites, which is a topic of concern addressed in this SMP and described in greater detail in the white paper Drainage and Density: Stormwater Management Options for Increasingly Dense Development (Appendix D). Some of the Core Area will have small setbacks for redevelopment. Similarly, the City's designated Climate Friendly Areas may have some of the setback or density issues that the Core Area may experience. Investing in regional stormwater facilities may spur private development by reducing the need for and cost of individual stormwater infrastructure on the site of development, which may have limited space for stormwater facilities due to allowable small setbacks. If the City chooses to pursue a regional approach to stormwater management in this area, then a separate stormwater plan should be developed for the Core Area.

Section 4. Stormwater Capital Improvement Projects

This section describes the evaluation and analysis done to develop a prioritized CIP project list that is expected to be achievable over a 20-year timeframe. Rated projects include both drainage CIPs and outfall retrofit CIPs.

4.1. Rating Criteria and Ranking Process

4.1.1. Develop Rating Criteria

During a series of workshops and meetings starting in the summer of 2024, City staff and stakeholders from the Water Advisory Group (WAG, then known as Utilities Public Advisory Group (UPAG)) explored the drivers and goals of the SMP.

Five project scoring categories were developed, each having a set of weighted criteria with scores from 0 through 5 based on defined values (see Table 8 for the scoring categories). The final project rating criteria reflect comments from both staff and WAG. The full rating criteria are provided in Appendix E.

Table 8 CIP Project Rating Criteria

Categories	Criteria	Weight	Scoring Concept
Conveyance & Flooding Improvements	Frequency of Flooding	2	Projects that address more frequent storm system-related flooding receive more points.
	Flooding Severity / Risk Avoidance	2	Projects that address flooding that damages private property or have serious traffic impacts or impact pedestrian safety receive more points.
Water Quality Improvements	River & Groundwater Protection	3	Projects that address water quality for already prioritized drillholes and outfalls receive more points.
	Permit Compliance	1	Projects that assist in meeting WPCF or MS4 Permit requirements receive more points.
Multiple Benefits	Increases Equitable Distribution of Public Stormwater Assets	1	Projects that are located where City storm system is not present and that will serve populations living below the federal poverty level (by Census Block Group) or have a relatively high minority populations receive more points.
	Supports Housing or Economic Development	1	Projects receive more points if they are located at the intersection of more City focus areas such as: - Urban Renewal District - Economic Improvement District - Enterprise Zone - Opportunity Area - Potential Climate Friendly Area

Table 8 CIP Project Rating Criteria

Categories	Criteria	Weight	Scoring Concept
	Maintenance Safety / Access	0.5	Projects receive maximum points if maintenance access/safety is improved, or drainage complaints requiring urgent response (callouts) will be reduced.
	Green Infrastructure / Ecosystem Services	0.5	Projects that are likely to include an above-ground component that is vegetated, such as swales, stormwater trees, and others receive maximum points.
	System Longevity	0.5	Projects receive maximum points if they rehabilitate or increase longevity of an existing asset.
	Community Partnerships	0.5	Projects receive maximum points if they are developed in partnership with another agency or organization such as Bend Park and Recreation District or Deschutes Watershed Council.
Recognized Priority Projects	Staff Priority	2	Projects solving issues identified as highest priority by Water Services Operations staff receive maximum points, and projects addressing issues identified as a priority by Water Services Compliance staff receive fewer points.
Feasibility & Cost	Complexity / Site Constraints	1	Projects receive more points when they have less complex site conditions.
	Low Cost[1]	1	Projects with low initial capital costs and low ongoing maintenance costs receive maximum points. Points reduce with higher capital cost and higher ongoing maintenance cost.

Note 1. Project scoring was completed during the initial concept stage of project development. Some project concepts altered with further project development, changing the relative costs, but projects were not scored again.

4.1.2. Scoring

All locations (24) that were initially deemed eligible for potential project concept development were scored. After further evaluation, about half were reclassified into the Major Maintenance program or other programs and removed from the CIP project list. Twelve CIPs were ultimately scored and ranked (Table 9). After final ranking, a project in Columbia Park was deemed infeasible and removed.

Table 9 Project Scores and Ranks

Rank	Project ID	Name	Score
1	PP-35	Riverfront Street Stormwater Improvements	51.0
2	PP-42	Downtown Pedestrian Safety Drainage Improvements	45.5
3	PP-44	Drake Park Stormwater Quality Improvements	36.0
4	PP-14	Congress Street Drainage Improvements	34.0
4	PP-46	Vicksburg Street Drainage Improvements	34.0
6	PP-47	Galveston Avenue Stormwater Quality Improvements	33.0
7	PP-48	Fresno Avenue Stormwater Improvements	32.5
8	PP-12*	Columbia Park Stormwater Outfall 024 Retrofit	29.5
9	PP-45	12th Street Stormwater Quality Improvements	28.5
10	PP-1	Dove Lane Drainage Improvements	27.5
11	PP-43	Saginaw Avenue Stormwater Quality Improvements	26.0
12	PP-16	Campbell Road Drainage Improvements	23.0

** PP-12, Columbia Park Stormwater Outfall 024 Retrofit project was later removed because it is infeasible.*

4.2. Stormwater CIP Project List

The Stormwater CIP project list consists of the new ranked projects in this plan and other stormwater projects that the City is in the process of implementing or has budgeted for beginning in Fiscal Year (FY) 2026 (Table 10).

The final project list reflects the City's priorities of ensuring adequate drainage on streets and in the storm sewer system as well as improving the water quality of runoff discharged from outfalls to the Deschutes River or through UICs to the ground. A map of the Stormwater CIP projects is presented in Figure 14, Stormwater Capital Improvement Projects.

Table 10 Stormwater CIP Projects

Project ID	Rank*	Project Name	Score	Primary Project Benefit	Cost (2025)†
Existing CIP					
1RSAB	1A	South Awbrey Butte Drainage	-	Drainage	$15,450,000
1RFGU	1A	Franklin Underpass, Phase 1	-	Drainage	$1,216,000
1RFGU	1A	Greenwood Underpass, Phase 1	-	Drainage	$1,824,000
1SSW3	1A	SW Sewer Basin Improvements, Phase 3‡	-	Drainage	$500,000
Planned CIP					
1RFGU	1B	Franklin Underpass, Phase 2	-	Drainage	§
1RFGU	1B	Greenwood Underpass, Phase 2	-	Drainage	§
PP-35	1	Riverfront Street Stormwater Improvements	51.0	Water Quality	$880,000
PP-42	2	Downtown Pedestrian Safety Drainage Improvements	45.5	Drainage	$770,000
PP-44	3	Drake Park Stormwater Quality Improvements	36.0	Water Quality	$4,140,000
PP-14	4	Congress Street Drainage Improvements	34.0	Drainage	$1,320,000
PP-46	4	Vicksburg Avenue Drainage Improvements	34.0	Drainage	$490,000
PP-47	6	Galveston Avenue Stormwater Quality Improvements	33.0	Water Quality	$5,820,000
PP-48	7	Fresno Avenue Stormwater Improvements	32.5	Water Quality	$4,230,000
PP-45	9	12th Street Stormwater Quality Improvements	28.5	Water Quality	$1,040,000
PP-1	10	Dove Lane Drainage Improvements	27.5	Drainage	$390,000
PP-43	11	Saginaw Avenue Stormwater Quality Improvements	26.0	Drainage	$2,620,000
PP-16	12	Campbell Rd Drainage Improvements	23.0	Drainage	$130,000

** Ranks 1A and 1B are given to projects that were not ranked by the SMP project team but are considered high priority because they are either ongoing or budgeted capital improvements (1A) or contained in an existing master plan or infrastructure improvement plan that is being implemented by the City (1B)*
† Costs are in 2025 dollars and should be escalated when a project is programmed for design and construction
‡ Stormwater portion of a sanitary sewer capital project
§ Preferred Phase 2 improvements may be addressed through a City-funded CIP or through private development

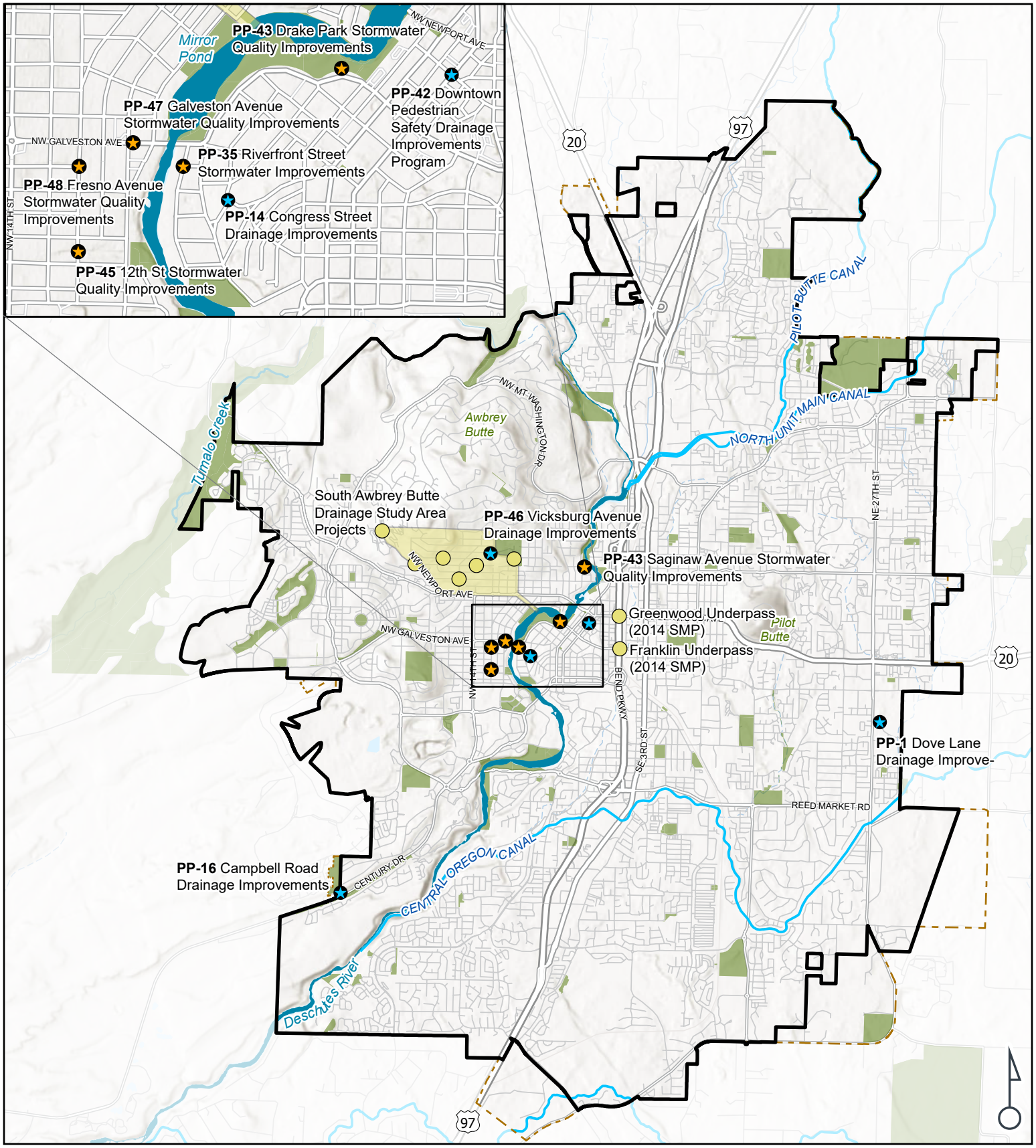

FIGURE 14
STORMWATER CAPITAL IMPROVEMENT PROJECTS
BEND STORMWATER MASTER PLAN
BEND, OREGON

Data Sources: City of Bend, Deschutes County, USGS, Google Maps.
Date: 10/28/2025
Disclaimer: This data is not to survey accuracy and is meant for planning purposes only.

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LEGEND

- Bend City Limits
- Urban Growth Boundary
- Streams
- Canals

Program

- CIP - Drainage
- CIP - Outfall Retrofit
- CIP In Progress

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4.3. Project Development and Descriptions

A planning-level design was prepared for each new stormwater CIP and benefits, design and implementation considerations, and costs were documented. Each project is summarized below. Stormwater CIP Project Fact Sheets are included in Appendix B. New CIPs are listed in order of priority ranking, followed by CIPs that are still active from the prior SMP.

PP-35: Riverfront Street Stormwater Improvements

This project seeks to improve stormwater quality discharging to the Deschutes River from Outfall 128 and improve neighborhood drainage.

PP-42: Downtown Pedestrian Safety Drainage Improvements

This project seeks to improve a series of drainage problems within a study area in downtown Bend. There are several intersections that, during moderate rain events, do not drain properly and block access to the curb's ADA ramps. In cold weather, this freezes over, causing hazardous pedestrian conditions. Project benefits include increased flood mitigation, pedestrian safety, and road safety.

PP-44: Drake Park Stormwater Quality Improvements

This project seeks to improve stormwater quality discharging to the Deschutes River from Outfall 018 and improve conveyance of runoff in parts of Old Bend near Drake Park. Project benefits include increased surface water quality, local infiltration, and a better understanding of the area's existing stormwater system.

PP-14: Congress Street Drainage Improvements

This project seeks to improve drainage in an area of Old Bend that does not have sufficient existing infrastructure. During rain events, stormwater in this area exceeds the curb height of the ROW and floods causes undesirable overland flow. Project benefits include increased flood mitigation and road safety.

PP-46: Vicksburg Avenue Drainage Improvements

This project seeks to improve drainage in the Awbrey Butte area that does not have sufficient existing infrastructure. During rain events, runoff from the ROW causes undesirable overland flow. Mitigation strategies have only pushed the problem to different properties, and flooding remains a problem during large rain events. Project benefits include increased flood mitigation and road safety.

PP-47: Galveston Avenue Stormwater Quality Improvements

This project seeks to improve stormwater quality discharging to the Deschutes River from Outfall 020. A combination of solutions will treat the runoff from an estimated 18.56 acres of impervious surface. Project benefits include increased surface water quality and integration of innovative green solutions.

PP-48: Fresno Avenue Stormwater Improvements

This project seeks to improve stormwater quality discharging to the Deschutes River from Outfall 020. This will be achieved by improving infiltration in the neighborhood and repairing damaged infrastructure. Project benefits include increased surface and ground water quality, flood mitigation, and road safety.

PP-45: 12th Street Stormwater Quality Improvements

This project seeks to improve stormwater quality discharging to the Deschutes River from Outfall 024. This project will treat an estimated 3 acres of impervious surface. Project benefits include increased surface water quality.

PP-1: Dove Lane Drainage Improvements
Formerly unincorporated Deschutes County land, this location does not have stormwater infrastructure. During rain events, runoff from the ROW flows overland. Mitigation strategies have not been successful, and overland flow remains a problem during large rain events. This project will install stormwater infrastructure to manage runoff from approximately 2.25 acres of contributing area. Project benefits include increased flood mitigation and road safety.

PP-43: Saginaw Avenue Stormwater Quality Improvements
This project seeks to improve stormwater quality discharging to the Deschutes River from Outfall 012. This will be achieved through installation of "stormwater trees," which are tree planter inlet and pass-through vault structures which use biofiltration as well as plant transpiration to reduce pollutants and runoff volume on neighborhood streets, and underground treatment facilities that will filter out sediments and pollutants. Project benefits include increased surface water quality, increased tree canopy, and improved stormwater conveyance.

PP-16: Campbell Rd Drainage Improvements
This project seeks to improve drainage on W Campbell Ave to prevent downstream impacts on SW Century Drive. Stormwater runoff from the ROW and unimproved land flows overland, depositing debris and causing localized flooding. Ponding on SW Century Drive impacts road safety. Project benefits include reduced maintenance needs and increased flood mitigation and road safety.

1RSAB: South Awbrey Butte Drainage Improvements – In Progress
This project is an in-progress project from the 2014 SMP. Drainage issues in the area have persisted for decades due to limited piped infrastructure and somewhat poor natural infiltration. Seven potential improvement areas (PIAs) were identified within South Awbrey Butte that will be completed over the next several years. To date, one PIA-1, Newport Ave, has been completed.

1RFGU: Franklin & Greenwood Underpasses – In Progress
The underpasses at Franklin Avenue and Greenwood Avenue beneath the BNSF tracks were identified as potential projects in the 2014 SMP. During moderate to heavy rain events, the existing drywells are insufficient and the roadway floods, causing closure to traffic and disrupting east-west travel. Both underpass projects are in progress under the same project ID. This project will mitigate flooding impacts at the two underpasses by treating and infiltrating excess stormwater with improved standard drywells. Pumping excess stormwater to the Deschutes River was proposed in the 2014 SMP and is no longer a preferred alternative by the City.

As described in the Midtown Crossing Stormwater Report, there are two phases to each underpass project. Phase 1 addresses drainage problems in the contributing basins at each Undercrossing Improvement area. Phase 2 aims to maximize collection, treatment, and disposal of stormwater in the associated Upper Basin Improvement areas.

4.4. Cost Estimating Procedure

Based on the planning-level design of each CIP, Class 5 cost estimates, as established by Association for the Advancement of Cost Engineering (AACE), were prepared using the methods detailed below. Costs are presented in 2025 dollars.

4.4.1. Stormwater Tool Kit

Project costs were developed based on a simplified Stormwater Tool Kit (Table 11). A single price was established for the construction of each tool in the kit. This tool price list was then used to establish the base construction cost for each project. See Appendix B for stormwater tool kit fact sheets.

Table 11 Stormwater Tool Kit Details and Estimated Costs

	Tool Name	Tool Detail	Unit	Cost Per Unit*
1	Stormwater Pond	-	CF	$7
2	Outfall Scour Protection	for pipe less than 30-in diameter	EA	$2,050
		for pipe 30-in to 48-in diameter	EA	$7,000
3	Infiltration Trench	-	SF	$30
4	Pre-Treatment	for small drainage basin (less than 1 acre)	EA	$12,000
		for medium drainage basin (1-5 acre)	EA	$18,000
		for large drainage basin (5-15 acre)	EA	$43,500
5	Storm Sewer Pipe	12-inch diameter	LF	$180
		18-inch diameter	LF	$220
		24-inch diameter	LF	$280
6	Underground Storage	-	CF	$18
7	Permanent Stabilization	-	SF	$6
8	Drywell	-	EA	$32,000
9	Stormwater Planter	-	SF	$170
10	Deep Drywell	-	EA	$78,500
11	Stormwater Trees	-	EA	$5,400
12	Proprietary Filter System	Catch Basin-style	EA	$11,500
		Manhole-style	EA	$44,500
		Vault-style	EA	$100,500
13	Swale/Infiltration Swale	-	SF	$60

**Tool kit cost estimates are in 2025 dollars*

Unit costs for construction and materials were drawn from a variety of sources, including bid tabulations from recent water quality facility rehabilitation projects within the City of Hillsboro and City of Tigard in Oregon, bid tabulations provided by the City of Bend, and average 2024 Oregon Department of Transportation (ODOT) bid tabulations. The ODOT 2024 bid tabulations were the latest available at the time the cost estimates were developed. From the available data, the consultant's engineers used professional judgement to estimate unit prices for each tool.

Detailed descriptions of the stormwater tool kit tools containing uses, benefits, and cost assumptions are included with this plan in Appendix B.

4.4.2. Other Construction Costs

Other typical construction costs were estimated by percentage.

Table 12 Construction Costs by Line Item

Project Unit Costs	Calculation Method
Construction Mobilization	10% of total Construction Costs
Erosion and Sediment Control	2% of total Construction Costs
Traffic Control	4% of total Construction Costs
Construction Contingency	Three tiers were established using an inverse correlation. A 30% contingency was applied when total construction costs exceeded $1 million,40% when total construction costs were between $400,000 and $1 million, and 50% was applied when it was less. In some cases, engineering judgement was used to apply an additional 15% contingency. This was applied to projects which are anticipated to encounter significant utility conflicts.

4.4.3. Other Costs

Costs were estimated for engineering, administration, easement acquisition, and permitting.

Engineering

Engineering costs cover technical activities such as design, drafting, feasibility studies, specifications, field inspections, and quality control. This cost was calculated as 20% of the construction subtotal.

Administration

Administration costs cover project management, contract administration, scheduling, compliance, and general office support. This cost was calculated as 10% of the construction subtotal.

Easement Acquisition

Acquisition of permanent easements was estimated at $9.00 per square foot.

Permitting

Permitting costs depended on the permitting requirements. All projects were assumed to require a basic level of permitting, which was valued at $3,000. Projects which include any portion of the project located in the WOZ were assumed to require an additional $3,000 permitting cost.

Section 5. Programmatic Solutions

Known issues that were similar in scope and approach were grouped into programmatic improvements for resolution. Programs are groups of similar small and medium projects that are addressed systematically over time and sometimes have fixed yearly funding allocated to the effort. Each of the programs is summarized below and in the programmatic fact sheets included in Appendix C.

5.1. UIC Priorities

The City owns and operates approximately 7,000 UICs, about 6,000 of which are drywells and 1,000 of which are drillholes. A drywell is an underground structure designed to temporarily hold and slowly infiltrate stormwater. A drillhole is a borehole that is drilled through impermeable geologic layers and is also designed to infiltrate stormwater.

Drywells can fail to provide appropriate drainage when they become clogged with sediment, surrounding soil becomes compacted, suffer from poor design and siting, or suffer from structural failure. Drywells and pretreatment devices need to be protected from the high sediment loads from unpaved streets, erosion, and road traction material by an efficient upstream sediment removal device or effective operational controls.

In Bend, drillholes were used for disposal of stormwater in areas where drywells do not function. Many of the existing drillholes were installed earlier in the City's history before drywells became common practice. Drillholes are typically 6 to 8 inches in diameter and extend deep into the ground. Because of their depth, drillholes pose a potential threat to groundwater and DEQ does not allow them to exceed 100 feet in depth unless they are covered under a UIC WPCF Permit and meet requirements for groundwater protection. Due to sizing, maintenance challenges, and spill risks associated with their deeper depths, the City no longer allows drillholes to be used for public infrastructure. As existing drillholes come to the end of their functional life, they should be replaced by more reliable facilities.

Two programmatic solutions focus on Bend's UICs: the Failing UIC Drainage Improvement Program and the Drillhole Water Quality Retrofit Program (Figure 15).

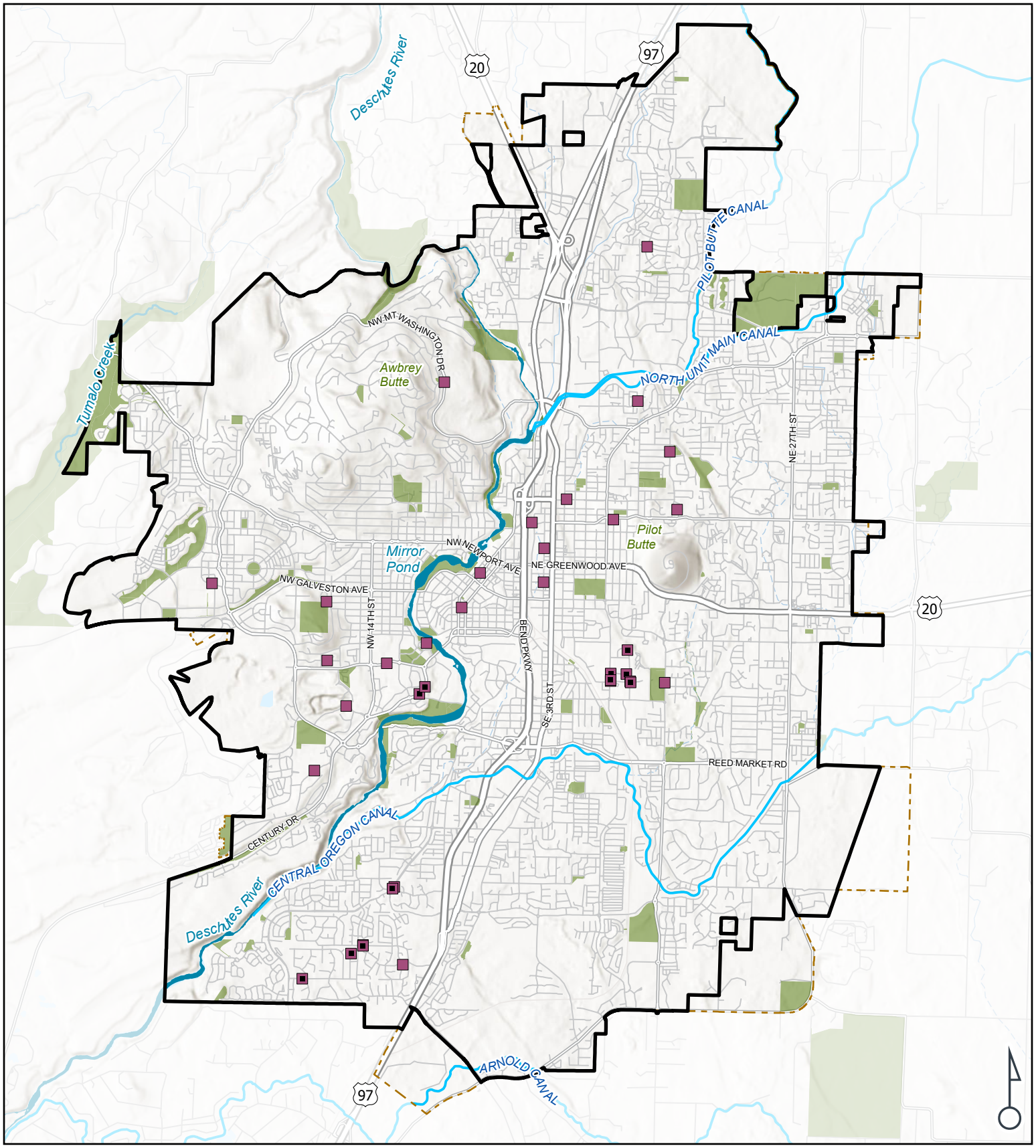

FIGURE 15
UIC PRIORITY PROGRAMS
BEND STORMWATER MASTER PLAN
BEND, OREGON

LEGEND

- Bend City Limits
- Urban Growth Boundary
- Parks
- Streams
- Canals
- Failing UIC Drainage Improvements Program
- Drillhole Water Quality Retrofit Program

Data Sources: City of Bend, Deschutes County, USGS, Google Maps.
Date: 10/28/2025
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5.1.1. Failing UIC Drainage Improvement Program

The Failing UIC Drainage Improvement Program intends to either replace UICs that no longer function with drywells or deep drywells, or to add capacity to an existing drillhole or drywell that does not have capacity for the runoff it receives. The failing UICs in this program tend to have less complex solutions that can sometimes be implemented in-house by City personnel. The span of time for implementing the program is 10 years. With 21 identified locations of failing UICs (Table 13), the total cost of this program is estimated to be $5,340,000. This program will implement one to two projects per year. It is recommended that Potential Projects in this program that have water quality as a secondary issue be prioritized for implementation.

Table 13 Potential Projects in the Failing UIC Drainage Improvement Program

Potential Project ID	Project Name
PP-8	NW Georgia Avenue Drainage Improvement
PP-9	NE Shephard Road Drainage Improvement
PP-15	NE Revere Ave Drainage Improvement
PP-17	NW Clearwater Dr Drainage Improvement
PP-20	NW Summit Dr Drainage Improvement
PP-22	NW Wall Street Drainage Improvement
PP-23	NE Hawthorne Ave Drainage Improvement
PP-24	NE 9th Street and Penn Drainage Improvement
PP-25	SE 15th Street Drainage Improvement
PP-26	SW Shevlin Hixon Dr Drainage Improvement
PP-27	SW Simpson Ave Drainage Improvement (2014 SMP)
PP-28	SW Forest Ridge Ave Drainage Improvement
PP-29	McMullin Dr Drainage Improvement
PP-30	SW Westridge Ave Drainage Improvement
PP-31	NE Morningstar Dr Drainage Improvement
PP-32	SW Chandler Ave Drainage Improvement
PP-33	NE 2nd St Drainage Improvement
PP-34	NE Eastwood Drainage Improvement
PP-36	NE Ross Rd Drainage Improvement
PP-38	NW Sean Ct Drainage Improvement
PP-41	NW Olney Ave Drainage Improvement

The City may continue to add to this list over time in response to new drainage complaints related to failing UICs. It can be noted that some drainage issues associated with failing UICs have been grouped instead into the Major Maintenance Program, described later; these tend to be the higher priority or more complex failing UICs (Table 15).

5.1.2. Drillhole Water Quality Retrofit Program

This program focuses on protecting groundwater quality by either decommissioning or retrofitting existing drillholes. Decommissioned drillholes will be replaced by a new infiltration facility (a drywell or deep drywell) and appropriate pre-treatment outside the two-year time of travel of zone for municipal and quasi-

municipal drinking water wells. Retrofitted drillholes will remain, be re-drilled if necessary, and preceded by an appropriate pre-treatment facility. A 2025 technical memorandum prepared by GSI Water Solutions, Inc. (Appendix A), developed a framework to prioritize the decommissioning of drillholes in Bend. This framework calculated a risk score for each drillhole based on land use, traffic volume, risk to drinking water quality, groundwater depth, and current condition.

Based on this assessment, 23 drillholes were categorized as Priority 1. These are located within the 2-year time of travel zone of municipal and quasi-municipal drinking water wells. Two drillholes are Priority 2, and 85 drillholes are Priority 3.

Of the 23 drillholes that are the high priority for a retrofit, ten were retrofitted with a sedimentation manhole for pretreatment during the writing of this plan. The remaining Priority 1 and Priority 2 drillholes, 15 in total, will be retrofitted in the manner described by this program over the course of five years (Table 14). The City may continue retrofitting drillholes ranked Priority 3 through 5 as resources allow.

Table 14 Priority 1 and Priority 2 Drillholes

Priority	Potential Project ID	Drillhole ID	Year Completed
1	-	DDH009763	FY 2023-24
1	-	DDH009764	FY 2023-24
1	-	DDH009765	FY 2023-24
1	-	DDH009498	FY 2024-25
1	-	DDH009520	FY 2024-25
1	-	DDH009550	FY 2024-25
1	-	DDH009625	FY 2024-25
1	-	DDH009841	FY 2024-25
1	PP-65	DDH009624	FY 2025-26
1	PP-69	DDH009767	FY 2025-26
1	PP-62	DDH009510	-
1	PP-63	DDH009513	-
1	PP-64	DDH009514	-
1	PP-66	DDH009727	-
1	PP-67	DDH009728	-
1	PP-68	DDH009766	-
1	PP-70	DDH009485	-
1	PP-74	DDH002049	-
1	PP-79	DDH009381	-
1	PP-76	DDH009466	-
1	PP-77	DDH009477	-
1	PP-75	DDH009482	-
1	PP-78	DDH010013	-
2	PP-71	DDH009875	-
2	PP-72	DDH009932	-

A high and low cost estimate was developed for this program, based on addressing the 15 remaining high-priority drillholes. The higher cost option decommissions the drillholes and replaces the facilities with drywells outside of the two-year time of travel zone of municipal water wells. The lower cost option includes redrilling the drillhole to improve infiltration capacity and installing a connecting catch basin and water quality manhole to control sediment, oils, and trash. The total cost of this program is between $1,690,000 and $3,970,000, depending on the solution used.

5.2. Major Maintenance Program

The Major Maintenance Program is an existing program, currently known as the Stormwater Capital Repair and Replacement Program, within the Water Services Department and the Engineering Department and is currently budgeted as 1RCAP in the stormwater fund Biennial Budget. Projects in this program are intended to be completed as resources or synergy opportunities become available.

Potential Projects marked for the Major Maintenance Program are moderately complex repair, replacement, or drainage projects to maintain functional condition, improve access, or manage small drainage issues (Figure 16). These projects may be designed by in-house personnel or consultants. The program is assumed to be implemented indefinitely because repair, replacement, synergy opportunities, and small drainage projects will continue to arise over time, especially if the City were to implement a systematic inspection program for its stormwater pipe system.

The City plans to conduct an in-house prioritization of the identified Major Maintenance projects in this SMP (Table 15) and will re-prioritize as other project needs are identified in the future. Several Major Maintenance projects are prioritized as ‘High’ in this plan because the City intends to resolve these issues in the near-term based on recent significant stormwater runoff impacts.

Table 15 Potential Projects in the Major Maintenance Program

Potential Project ID	Project Name	Priority
PP-13	NW Mueller Avenue Alley Drainage Improvement	High
PP-80	NE Penn Ave/NE Neff Rd Drainage Improvement	High
PP-81	NW Trenton Drainage Improvement	High
PP-10	Wagontire Way Drainage Improvement	TBD
PP-11	Overturf Ct Cul-de-sac Drainage Improvement	TBD
PP-18	NE Nels Anderson Rd Drainage Improvement	TBD
PP-19	Poplar Street Drainage Improvement	TBD
PP-21	SE Waco Dr Drainage Improvement	TBD
PP-37	China Hat Rd Drainage Improvement	TBD
PP-40	SW Hayes Ave Drainage Improvement	TBD
PP-49	SE 3rd Street South of Brosterhous	TBD
PP-50	NW McKay Ave Pipe Repair	TBD
PP-55	SW Alderwood Cir Drainage Improvement	TBD
PP-56	NW Clearwater Dr Drainage Improvement	TBD
PP-57	Newport Outfall Maintenance	TBD
PP-58	NW Tumalo at Drake Park Pipe Repair	TBD
PP-59	NW Baltimore Pipe Repair	TBD

Table 15 Potential Projects in the Major Maintenance Program

Potential Project ID	Project Name	Priority
PP-60	SE Ferguson Rd Drainage Improvement	TBD
PP-61	SE Gardenia Ave Drainage Improvement	TBD
PP-73	NE Olney Ave Drainage Improvement	TBD
PP-82	NW Allen Drainage Improvement	TBD

The City will continue to add to the Major Maintenance list over time in response to new inspection results of individual public facilities, drainage complaints, and condition assessments of pipes.

5.3. Programmatic Solution Cost Summary

Program-level costs were developed using the stormwater toolkit and construction assumptions developed for this plan for the identified issues or projects in each programmatic solution. A recommended implementation timeframe is noted. The Drillhole Water Quality Retrofit Program has up to116 project locations (Priority Ranks 1-5) and may end after all drillholes that may impact groundwater quality have been retrofitted. The Failing UIC Drainage Improvement Program and the Stormwater Major Maintenance Improvement Program likely will need to continue indefinitely after the identified projects have been addressed.

Table 16 Programmatic Solution Cost Summary

ID	Program Name	Cost (2025 $)	Notes
1RDHD	Drillhole Water Quality Retrofit Program	$5,700,000	Total costs include the priority locations documented in the fact sheet for a five-year implementation schedule ($3,970,000) and subsequent lower-priority projects implemented at a slower pace in future years ($1,730,000); Currently "Drillhole Decommissioning" (1RDHD) in 2025-27 Biennial Budget.
TBD	Failing UIC Drainage Improvement Program	$5,340,000	The cost is to address the identified known issues in this plan over a 10-year implementation schedule to begin after completion of the high priority projects in the Drillhole Water Quality Retrofit Program, above. Program will likely need to continue indefinitely or be rolled into Stormwater Major Maintenance after the issues identified in this SMP have been addressed.
1RCAP	Stormwater Major Maintenance Program	$7,500,000	The cost is for five years of this program using a variable annual budget allocation. Currently "Stormwater Capital Repair and Replacement" (1RCAP) in 2025-27 Proposed Biennial Budget. Assume continuation of this program at a set annual level of $1.5 million from years 6 to 20 (cost not included in this table).
	Total	**$18,540,000**	

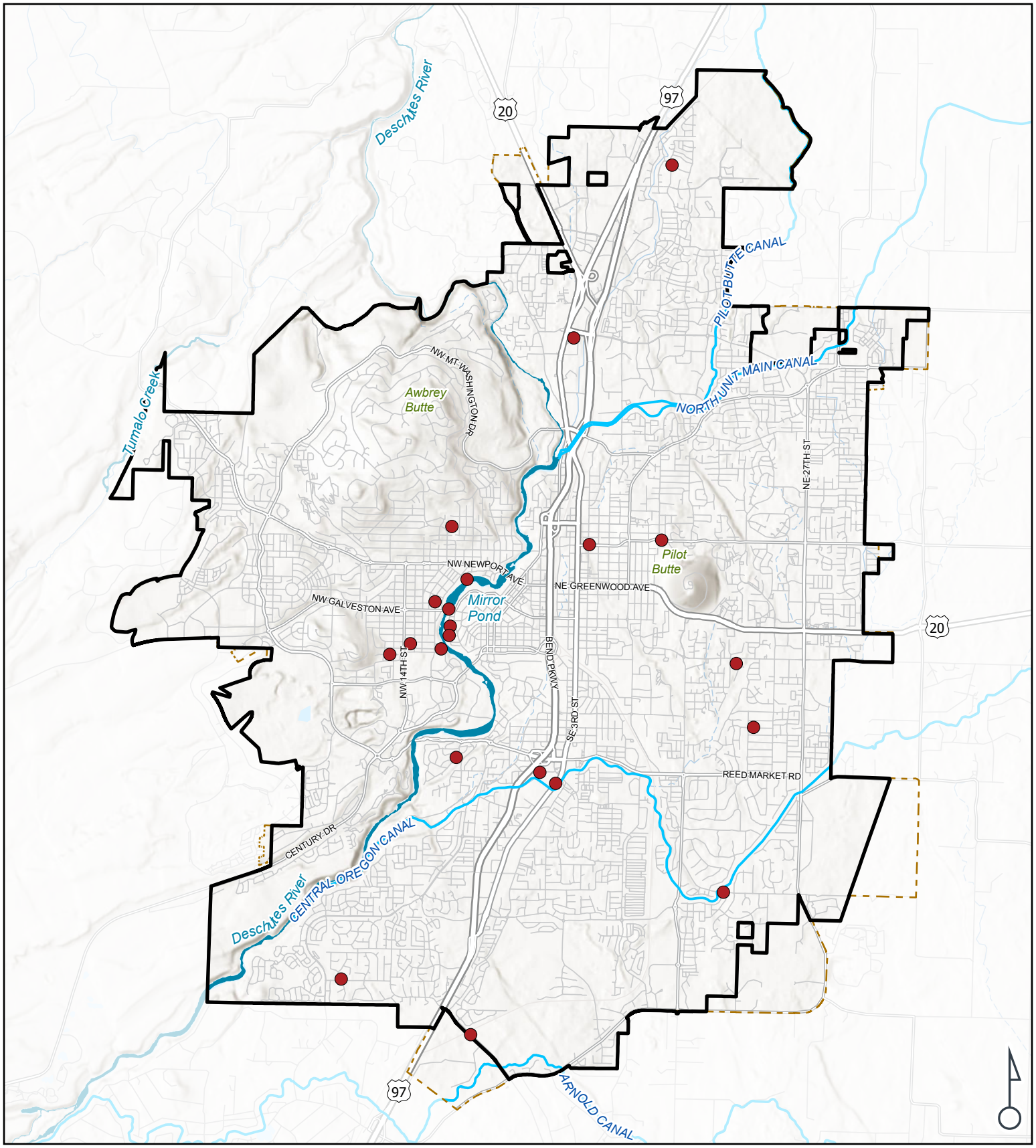

FIGURE 16
MAJOR MAINTENANCE PROGRAM
BEND STORMWATER MASTER PLAN
BEND, OREGON

LEGEND

- Bend City Limits
- Urban Growth Boundary
- Streams
- Canals
- Major Maintenance Program

Data Sources: City of Bend, USGS, Google Maps.
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Section 6. Policy Discussion

Two white papers were developed for this SMP to advance policy development or strategic planning around issues and challenges facing stormwater management in Bend. Drainage and density, level of service, climate change, and new stormwater management techniques were selected as topics of interest. Each issue is summarized below, and supporting materials are provided in Appendix D.

6.1. Drainage and Density

Bend's 2016 Comprehensive Plan identified the need for 17,234 new housing units and the City is also planning for over 60,000 new jobs by 2028. Various recent state laws direct cities to allow more types of housing. To accommodate this growth, the City has enacted policies to create a diversity of housing options and to identify land to support economic development. With rapid growth, the City is densifying. Increasingly, lots are smaller, leaving little room for construction of stormwater management facilities. An increasing number of lots with geology and site conditions that are not conducive to stormwater management are being developed. Therefore, City staff and developers are calling for more options to manage stormwater both on-site and in a more centralized or regional fashion. A white paper explores some of the opportunities and limitations of Bend's existing policies and approaches to managing stormwater, and it contemplates additional options.

6.1.1. Stormwater Policy for Development

Bend's default and most common pattern for stormwater system development is decentralized and privatized. Unless alternate allowable arrangements are made, stormwater runoff must be kept on the lot of origin and managed by the property owner. This document refers to this method of managing stormwater on individual lots as "lot-scale stormwater management." Lot-scale stormwater management is described in the following codes and standards:

- Bend Municipal Code (BMC) Title 16 – Grading, Erosion Control, Stormwater, Illicit Discharge, Tree Protection, and Wells
- Bend Design Standards and Specifications, Part II, Chapter 6, Stormwater
- Central Oregon Stormwater Manual (COSM)
- Bend Development Code (BDC) Title 2, Land Use Districts
- BDC Title 3, Design Standards
- BDC Title 4, Applications and Review Procedures

To comply with the MS4 Permit, Bend is updating its stormwater development procedures in 2025 to seek more consistent enforcement of stormwater standards and more effective facility design and construction on residential lots for subdivision and short plat applications.

While the lot-scale pattern described in these codes and standards relieves the City of providing an all-inclusive public stormwater system, it has drawbacks. Disadvantages include the following:

- Crowding out owner-preferred elements of residential landscaping/hardscaping such as lawns, planting beds, or patios on small lots.
- Assuming that individual lots have capacity to manage urban stormwater runoff, including appropriate geology, and space to place facilities outside of setbacks to other properties, streets, and hazardous features such as steep slopes.

- Entrusting individual property owners or HOAs with responsibility for systems that can be difficult to inspect, operate, and maintain.
- The frequently long time period between land disturbance on individual lots (grubbing, rough grading) and provision of stormwater facilities during development of some large subdivisions can mean that stormwater facilities in the streets are exposed to more sediment running off of lots that have not been stabilized.

The review of the existing codes and standards revealed that alternate stormwater system development options are allowable but face administrative barriers, are not widely known or understood, and are infrequently used.

6.1.2. Alternatives to Lot-Scale Stormwater Management

To mitigate some of the disadvantages of lot-scale stormwater management, the white paper explores alternatives the City could allow or promote. The options include techniques other than lot-scale stormwater management that are allowed but infrequently used as well as techniques that may not currently be allowed in Bend.

Centralized On-site Stormwater Management

One option is centralized on-site stormwater management, defined as the provision of a unified stormwater conveyance network and centralized stormwater treatment facilities which may manage runoff from both private lots and public streets. Centralized on-site stormwater management is allowed in Bend through a master planned development and may also be allowed in other circumstances. However, it is rarely used. The review of governing policies found that:

- The drainage submittal requirements in BMC 16.15.010.B allow for residential, commercial, institutional, or industrial development to apply stormwater management standards to the common land development plan, rather than lot by lot, if the development has a master plan that includes formal arrangements for stormwater drainage across multiple properties. However, Specification 6.4.1 allows only residential developments to pipe runoff to the ROW. City staff have indicated that no commercial or industrial projects have been permitted to comingle runoff with public runoff in the ROW.
- BMC 16.15.040.A.4 requires stormwater drainage in excess of the predevelopment rates or volumes to be retained on the lot of origin and not trespass onto the public right-of-way or private property except: a) if City determines retaining would pose a threat to public safety or adjacent properties, b) when the owners of the lots of origin compensate the City for the cost of constructing, operating, and maintaining additional stormwater drainage and treatment capacity, c) access is provided to on-site stormwater facilities, or d) if the development has a master plan that includes formal arrangements for stormwater drainage across multiple properties
- BMC 16.15.040.A.6 allows stormwater facilities within residential subdivisions to serve multiple lots and/or combination of lots and roadways if stormwater facilities are located on a lot owned and maintained by an HOA.

The white paper explores how centralized on-site stormwater management has been used successfully for residential subdivisions and non-residential site development in Bend and other Oregon communities. It identifies infill as a type of development that could benefit from more investigation into the barriers to and opportunities for centralizing stormwater management systems. See Table 17.

Table 17 Summary of Centralized On-Site Stormwater Management Options

Development Type	Location of Stormwater Facility	Who is Draining	Facility Owner Existing Options [Recommended Options]	Approval Process
Residential Subdivision, streets and lots managed together	Street, tract, or individual lot, or combination	Lots and Street	Varies, HOA or City [HOA on tract; City in ROW]	Typically Type II*
Non-Residential Site Development	Lot	Lot	Commercial/Multifamily property owner [Commercial/Multifamily property owner]	Typically Type II*
Infill	Private property within easement or street, in limited cases	Private	Private, could be HOA or individual owners	Minimum Development Standards (MDS) Review**

** Type II decisions are made by the Community and Economic Development Director following public notice and an opportunity for parties to comment but without a public hearing. (BDC 4.1.415)*
*** MDS Applications are generally reviewed under the Type I process, which may be handled administratively by the Community and Economic Development Director without public notice or hearing because this is neither a land use decision nor a limited land use decision (BDC 4.1.310). MDS are defined within BDC 4.2.*

The white paper explores the barriers to centralized on-site stormwater management, which include current code, standards, procedures, and public funding.

ROW Comingled Stormwater Management Options

Another alternative for stormwater management is to allow private or comingled public/private stormwater facilities in the City's ROW. Managing lot runoff in the ROW could be accomplished either by allowing a development such as infill to drain to existing public conveyances and facilities or allowing a development to construct a system in the ROW. Managing lot runoff in the ROW would be a bigger departure from current practice than centralized on-site stormwater management. ROW stormwater management options may be most needed for infill that does not have adequate space for functional on-lot or multi-lot facilities.

The review of governing policies found that BMC 16.15.040.A.4 allows drainage from private property to enter the ROW when the owners of the lots of origin compensate the City for the cost of constructing, operating, and maintaining additional stormwater drainage and treatment capacity. This option is not approvable because the City has established neither a mechanism for calculating, charging, collecting, and using such a fee nor standards for demonstrating that an existing public system has adequate capacity. In addition, developments that might benefit from this option (infill) typically go through the MDS Review instead of full land use review, and the purpose of the MDS Review is to streamline and simplify approvals for development. If this option were approvable, then the applicant could connect to or construct a stormwater facility in the ROW as part of an infill land division. Facilities would require a ROW permit and would be built to public improvement standards. The City would need to establish a mechanism and determine if the applicant would reimburse the City for future operation and maintenance, and the City would then own and operate the facilities.

The white paper explores the barriers to ROW comingled stormwater management, which include the MDS Review process, lack of funding for maintenance of more public stormwater facilities, and perception of fairness when using public assets to provide a service that is typically provided by private parties.

Regional Facilities or Regional Stormwater Strategies

The City of Bend is investing in several locations such as Central Core/Midtown with the multiple aims of supporting economic development, improving public safety, providing adequate housing inventory, improving circulation, and beautification. Creation of regional stormwater strategies and/or regional stormwater facilities can support these aims by planning for or providing required infrastructure in advance of redevelopment, which could reduce costs and streamline permitting. A regional stormwater strategy addresses conveyance, water quantity control, and water quality treatment through a planned set of public, private, and/or public and private stormwater infrastructure. A regional stormwater strategy could include several types of solutions to manage runoff in a coordinated manner. A regional stormwater facility is typically described as a large stormwater management solution strategically situated and designed to serve multiple properties, which often are under varied ownership and span a large area, to optimize stormwater management as part of a development project or to facilitate redevelopment.

Regional stormwater planning requires significant investment from the City, starting with commitment to exploring opportunities and then coordinating with community stakeholders, identifying or developing a funding mechanism, and permitting implementation by updating policies and codes. The white paper explores these steps in greater detail and provides numerous successful examples from the Pacific Northwest.

6.1.3. Recommendations and Next Steps

The recommendation is for Bend to provide more flexible options for managing stormwater on development and redevelopment sites. Bend must also maintain compliance with NPDES and WPCF permits from the state and protect public safety by regulating conveyance capacity, downstream impacts, and technical feasibility of stormwater facilities based on site conditions. City staff have articulated the following overarching tenets for guiding further investigation or implementation of changes to stormwater management policies:

- Public stormwater facilities should be constructed to public improvement standards and provide adequate access for maintenance.
- Stormwater facilities in the ROW should be owned and operated by the City.
- The City should identify adequate resources to maintain a larger inventory of public facilities if any recommendations to allow more public facilities are pursued and implemented.
- The City should establish an internal committee to determine the steps necessary to implement recommendations in this SMP, including code/standards updates, development permitting processes, fees/funding adjustments if needed, and stakeholder involvement.
- The City should evaluate the budget and planning resources necessary to develop a specific stormwater master plan for the Central Core/Mid Town area that evaluates and recommends district-specific public-private stormwater management.

The white paper lists specific policies and technical standards which the City may explore updating.

6.2. Stormwater Operations Level of Service

The City hopes to establish a target Level of Service (LOS) for key aspects of the stormwater utility because identifying a baseline and target LOS are foundational steps in asset management. The SMP begins the LOS analysis and recommends next steps.

Defining LOS targets helps guide investment decisions, optimize operations, communicate service expectations, and manage performance trade-offs. These targets can range from broad, strategic goals at the agency level to specific performance standards for individual assets or components. LOS is not static and may evolve according to changes in customer demands, regulatory requirements, system condition, and fiscal constraints. A well-structured LOS framework will enable Bend's stormwater utility to balance service delivery, affordability, and long-term sustainability, ensuring that the right level of service is delivered at the right cost with an acceptable level of risk.

Eleven categories of service were explored through workshops and conversations with City staff. The LOS for each category was subjectively assessed on a scale of low, moderate, and high (Table 18). A "low" LOS indicates a reactive service with limited investment or capacity. "Moderate" indicates a balanced service with funding that meets permit requirements or performance goals. "High" indicates proactive or preventative services with increased investment that does or may exceed regulatory mandates. Implementing a recommendation to increase LOS may incur additional costs for staff or equipment that have not been quantified for this assessment.

Table 18 Recommended LOS Strategies and Goals

Category	Current LOS	Target	Regulatory Requirements	Recommendations
A. Drainage Complaint Immediate Response	High	Respond to drainage complaints within 72 hours.	N/A	▪ Maintain LOS ▪ Continue current activities ▪ Explore process improvements including a decision tree to clarify internal and cross-department responsibilities for various types of complaints
B. Inspection & Maintenance of Underground Facilities	High	Inspect underground facilities (excluding pipes) once per year	MS4 Permit (A.3.f.ii.) ISWMP BMP OM-2	▪ Maintain LOS ▪ Continue current activities ▪ Implement process improvements
C. Inspection of Storm Pipes	Low	Inspect the entirety of the City's storm pipe system and establish a frequency for re-inspection	MS4 Permit (A.3.f.ii.) ISWMP BMP OM-2	▪ Increase LOS to ensure system condition is known and kept up to date Establish a percentage of storm pipe system to be inspected per year ▪ Pursue implementation planning for pipe inspections

Table 18 Recommended LOS Strategies and Goals

Category	Current LOS	Target	Regulatory Requirements	Recommendations
D. Inspection of Aboveground Water Quality Facilities	High	Inspect water quality facilities at least once per year	MS4 Permit (A.3.e.) ISWMP BMP PC-3	▪ Maintain LOS ▪ Continue current activities ▪ Explore process improvements for efficiency
E. Maintenance of Aboveground Water Quality Facilities	Low	Maintain water quality facilities to ensure function, including water quality and aesthetics (trash and weed management)	MS4 Permit (A.3.e.) ISWMP BMP PC-3	▪ Increase LOS to ensure regular and ongoing proper functioning of facilities ▪ Improve capacity for in-house and/or contracted vegetation management for ROW facilities to improve frequency of maintenance and recognize increasing inventory ▪ Establish a maintenance checklist that addresses vegetation management, sedimentation buildup, irrigation performance, and effects of roadway applications such as deicers and cinders
F. Ground Water Quality Protection Retrofit Projects	Low	Yearly progress in completing UIC retrofits	WPCF Permit ISWMP BMP PL-2	▪ Increase LOS to be able to implement recommended list of projects ▪ Implement drillhole retrofit strategy ▪ Complete priority drillhole retrofits
G. Capital Project Implementation	Moderate	Plan, fund, and construct stormwater capital improvements, which include drainage and surface water quality retrofit projects, as identified in the CIP.	MS4 Permit (A.3.f.x.)	▪ Maintain LOS ▪ Maintain or increase pace of project implementation based on prioritized list in 2025 SMP; Improve synergy with other City departments. ▪ Ensure surface water quality retrofit projects are implemented per MS4 Permit requirements
H Major Maintenance Program Implementation	Low	Prioritize, fund, and complete major maintenance projects.	N/A	▪ Increase LOS ▪ Monitor utilization of increased budget on identified major maintenance and synergy projects ▪ Prioritize major maintenance projects recommended in the 2025 SMP

Table 18 Recommended LOS Strategies and Goals

Category	Current LOS	Target	Regulatory Requirements	Recommendations
I. Street Sweeping	Moderate	Sweep streets within the MS4 area once per quarter.	MS4 Permit (A.3.f.iii.) ISWMP BMP OM-3	▪ Maintain LOS ▪ Update collection and management of sweeping data within the MS4 area ▪ Use data to optimize sweeping routes and notify the public during MS4 sweeping efforts.
J. Development Regulations for Private Stormwater Infrastructure & Inspections	Moderate	Establish an internal system that identifies and catalogues private stormwater systems and inspection schedules.	MS4 Permit (A.3.e.v.) ISWMP BMP PC-4	▪ Identify and create a plan to provide appropriate LOS necessary to meet permit compliance ▪ Monitor and evaluate implementation of emergent activities ▪
K. Other MS4 Compliance	Moderate	Maintain compliance with all aspects of the MS4 Permit.	MS4 Permit	▪ Maintain LOS ▪ Monitor effectiveness of current compliance activities ▪ Evaluate needs under new Permit in 2026

Several categories will experience an increase in inventory as the City's stormwater system expands. The future workload is therefore also expected to increase corresponding to inventory growth. Current LOS may trend up or down as inventories increase and can be mitigated by additional full-time equivalent (FTE) for the stormwater utility and/or introducing processes that prioritize efficiency.

Categories not classified as having a high LOS currently have the potential for more proactive activities and practices. In several of the categories, the City wishes to improve upon the current LOS. Increasing LOS can be measured through introducing new actions or improving upon key performance metrics, often the frequency of actions specific to each category.

The City's stormwater infrastructure inventory is projected to grow, and regulatory requirements are also expected to increase. Under these conditions, the utility's financial and staffing capacity will directly impact levels of service for all categories. There are four recommended next steps following the LOS analysis:

- **Adopt the 2025 Stormwater Master Plan.** The SMP will guide future capital investments and policy decisions and should be considered when setting LOS goals.
- **Establish LOS goals and related resource needs and cost of service.** Using the analysis and recommendations in the white paper, summarized in Table 18, the City should establish LOS benchmarks for its service categories.
- **Engage internal stakeholders in budget planning.** Conversations with internal stakeholders (field staff and managers of the stormwater utility and departments that interface with the stormwater system) are needed to assess current and future budgetary needs.

- **Conduct a stormwater utility rate analysis**. A rate analysis is needed to determine the resources needed to achieve target levels of service and implement the capital projects.

6.3. Climate Change

To begin to address the question about whether the City should update its stormwater technical standards or policies to adjust to changes in precipitation patterns, the firm Haley & Aldrich developed a presentation for City staff based on local and national climate research. (Appendix A).

Research indicates that the following impacts due to climate change may be expected in Bend:

- Increased overall annual precipitation by 2100 (6% greater)
- Increased severity and intensity of storm events
- Decline in winter snowpack, reducing the amount of stored water during the melt season
- Increased severity and duration of drought, measured by decreased frequency of seasonal precipitation

6.3.1. Current Precipitation Depths

Bend uses the COSM for stormwater standards. The water quality design storm is the 6-month 24-hour storm, and the flow control storm is the 25-year 24-hour storm.

The design storm precipitation depths are based on NOAA Atlas 2, which was last updated in 1973 based on data from the 1960s. The use of outdated precipitation depths could lead to stormwater system designs that provide a lower level of service than intended and may play a role in the City's numerous local or nuisance flooding issues, identified in Section 3 of this plan.

In the absence of updated data over the past couple of decades, many municipalities in the northwest have updated design storms on their own using local data or other approaches. ODOT and City of Salem use data from ODOT, which updated NOAA Atlas 2 data for Oregon in 2008 based on historic rainfall. However, ODOT's data is already over 15 years old. City of Eugene uses locally collected data; its flood control design storms are based on different specific historical storms and vary by basin. Seattle developed design storms to replace Atlas 2 that were based on specific historical storms recorded by the City's large network of rain gauges.

In coordination with other agencies, Bend has access to data from three currently operational weather stations in Bend and one in Madras.

6.3.2. Historic Rainfall vs Projected Rainfall with Climate Change

Recent studies and climate models indicate storms are expected to become more severe in central Oregon. The University of Washington Climate Impacts Group has created a dynamic downscaled model of global climate change data. This model projects changes in extreme precipitation under different representative concentration pathways (RCP) or climate change scenarios. RCP 8.5 is considered the "business as usual" scenario in which the carbon emission patterns of today are continued into the future. A visualization of possible changes in extreme precipitation for Bend between the 2030s to the 2080s are shown in Figure 17 and Figure 18. In the charts, the blue dots represent the outputs of various climate models, and the red diamonds represent the average of the models.

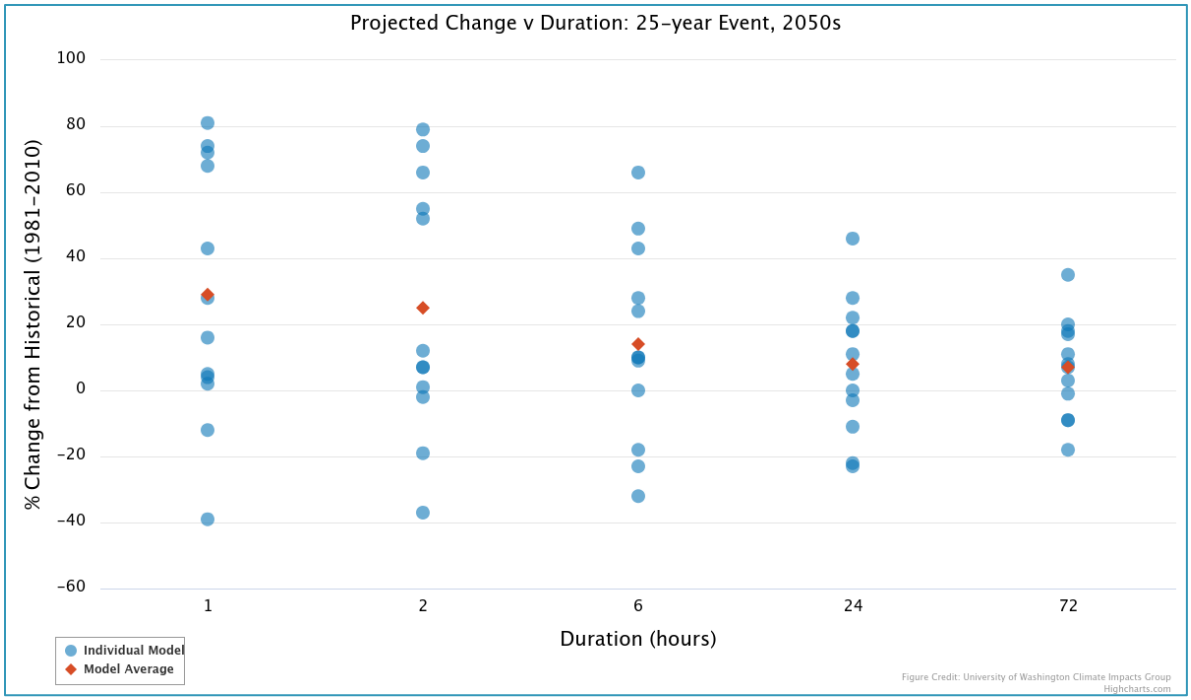


Figure 17 Projected Change in Precipitation for the 25-Year Event by Duration in Bend (Morgan, et. al, 2021)

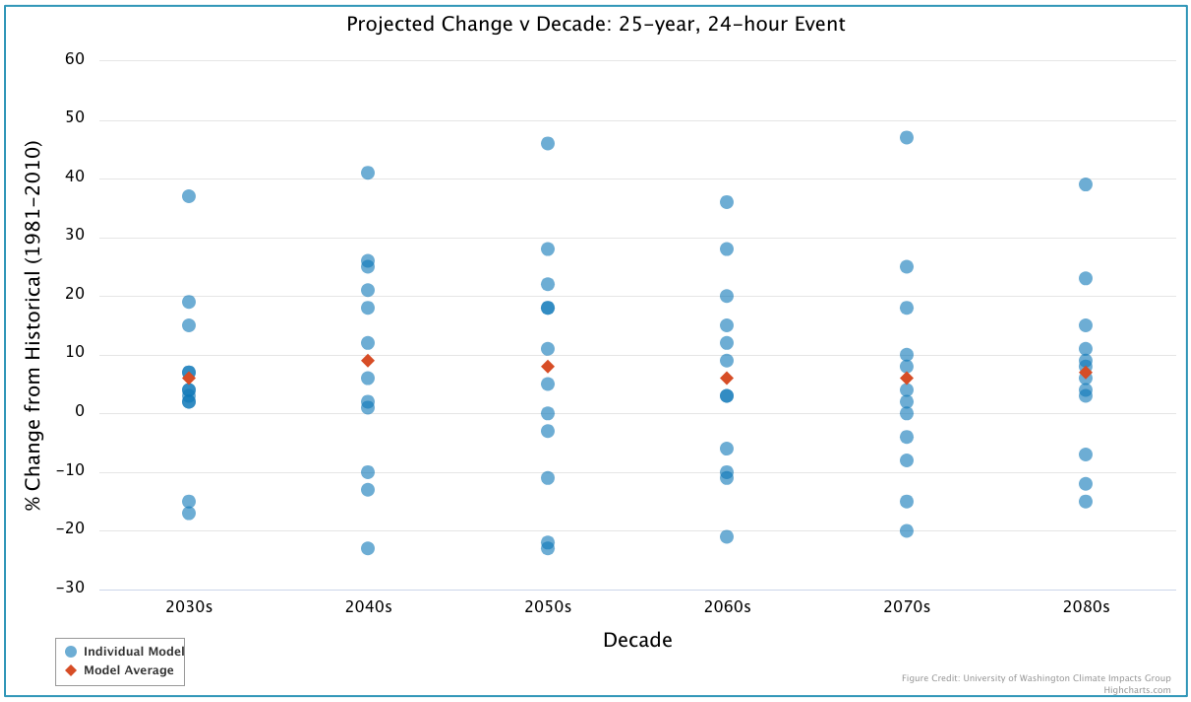


Figure 18 Projected Change in Precipitation for the 25-Year Event by Decade in Bend (Morgan, et. al, 2021)

6.3.3. Stormwater System Challenges

Shifting precipitation regimes due to climate change will impact Bend's stormwater system. Through discussion with stakeholders, two of six identified issues associated with precipitation were prioritized:

- Inappropriately sized design storms for existing conditions
- Increasing intensity and frequency of storm events

A lack of both updated national data and recent local precipitation data was identified as a gap hindering the City's ability to address these priorities. Fortunately, NOAA Atlas 15 is expected in 2027 and will provide an updated national dataset that covers Central Oregon. The first volume will be updated with historical and present-day data, covering the entirety of the United States. The second volume will build on that by generating adjustment factors for the present-day data based on climate models.

6.3.4. Recommendations

Primary recommendations include:

1. Developing a strong baseline of observed precipitation records by increasing weather data collection locations.
2. Adopt a watchful waiting stance for developing new design guidelines. Updating design guidelines based on the most updated data and climate projections requires time, expertise, and resources.
3. Change flow control facility requirements based on other factors when a complete update based on climate projections is not yet possible. Options include: upsizing flow control BMP volumes by a factor, scaling design storms by a factor, or designing BMPs for a larger storm event – like using the 50- or 100-year storm rather than the 25-year storm.
4. Help the community understand why they should care and how the parts of the community they love will be affected by a changing climate and increases in stormwater intensity (i.e. the river, their homes). Getting the community on board can help move processes along and hopefully make them more willing to put resources toward stormwater management and climate change.
5. Considering developing an internal policy for stormwater system design which encourages the Engineering Department to use conservative assumptions and calculations when sizing stormwater conveyance, treatment, and disposal systems, resulting in erring on the size of greater collection and conveyance capacity.

6.4. New Stormwater Management Techniques

In the 15 years since the COSM was last updated, stormwater management practices and techniques have evolved. Innovative proprietary and non-proprietary facilities that are easier to install in challenging locations or that improve pollutant removal capacity have been tested and used elsewhere in the Pacific Northwest. Of particular interest to Bend are stormwater management techniques that can introduce water quality protection in front of existing drillholes with minimal disturbance, provide multiple benefits such as greenery or aesthetics, or manage runoff in areas with welded tuff soils or shallow groundwater.

Use of new stormwater management techniques for City capital improvements and private development projects may be hindered by lack of familiarity among staff and the community, lack of provisions for their use in Title 16, Grading, Erosion Control, Stormwater, Illicit Discharge, Tree Protection, and Wells, lack of standards for selection, siting, design, performance, and maintenance in either the COSM or City of Bend Design Standards Part II, and absence of a standard drawing or standard detail approved by the City Engineer.

6.4.1. Specialized Water Quality Manhole

The Drillhole Water Quality Retrofit Program recommends the use of a specialized water quality manhole that uses both a snout and a baffle wall to improve pollutant removal. The design differs from the City's standard water quality manhole standard detail and the water quality manhole illustrated in the COSM. The specialized design is effective and inexpensive and may be a good option for introducing water quality treatment in front of drillholes with minimal disturbance. The design is non-proprietary. Adoption of this specialized manhole for use in front of existing drillholes should be vetted with the City's Engineering and Operations stakeholders. Because this structure is not being recommended for general use on new projects as a water quality manhole, it would not be necessary to update the Design Standards or Standard Drawings.

6.4.2. Stormwater Trees

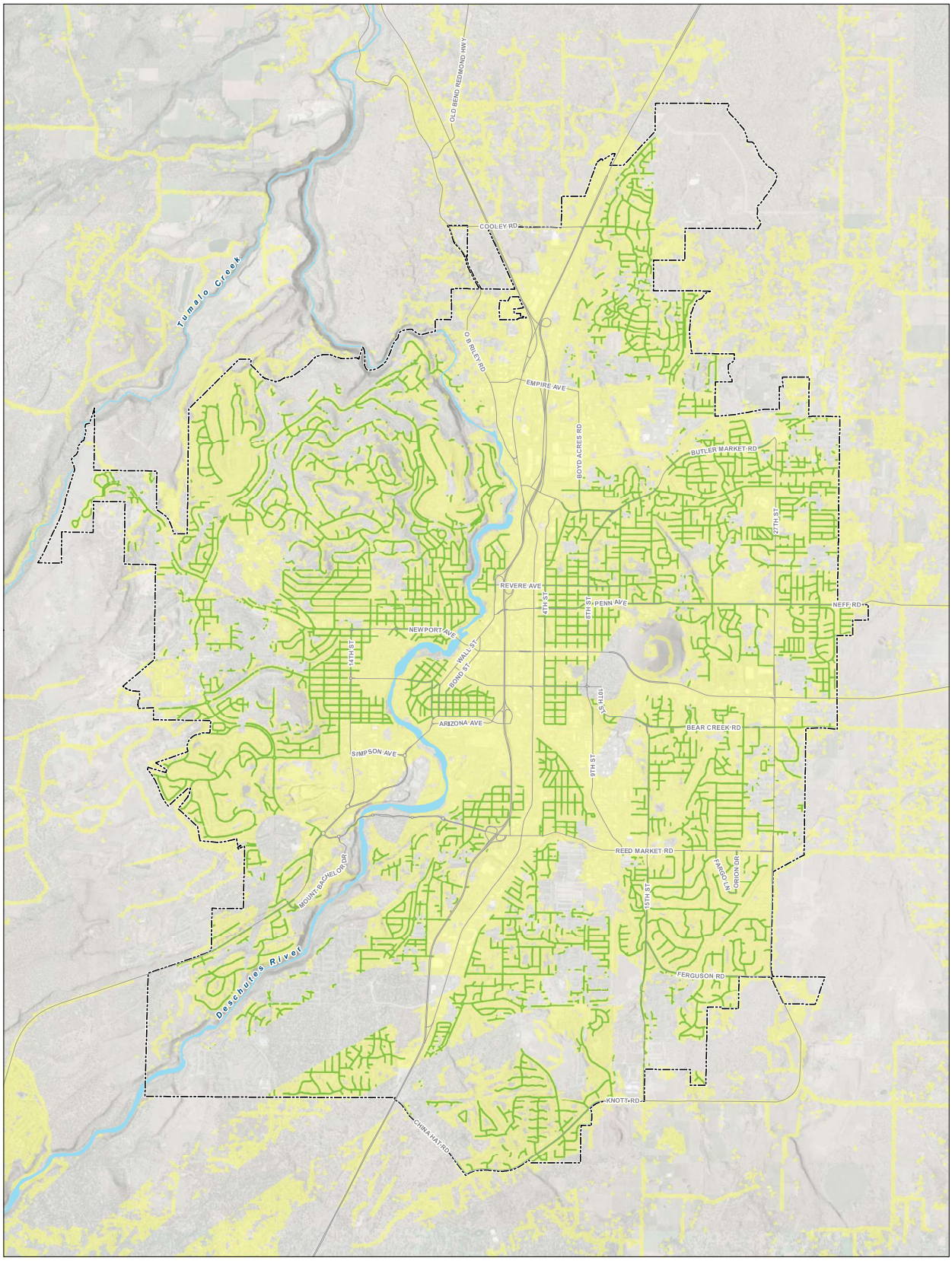
Gresham, Oregon and some cities in Europe have begun using versions of a stormwater tree to manage and treat runoff. Some CIP projects recommended in this plan assume the use of a non-proprietary stormwater tree practice to manage and mitigate stormwater runoff along public streets. The Stormwater Trees fact sheet (Appendix B) describes the technique. Stormwater trees are not currently included in the COSM or Bend's Standards and Specifications for stormwater control or treatment. Use on existing City streets to provide stormwater management where a stormwater system is currently lacking is the recommended use in the SMP. After the City gains experience siting, designing, constructing, and maintaining these facilities, the City may wish to consider adopting the stormwater tree as an approved stormwater facility for development sites by adding it to its Design Standards and Standard Drawings and/or by working with regional partners to update the COSM.

6.4.3. Deep Drywell Siting

Deep (or modified) drywells are an emerging stormwater management practice in the Pacific Northwest that may allow the use of infiltration where welded tuff near the surface typically prevents infiltration through drywells or surface infiltration facilities such as swales. Because deep drywells rely on drilled shafts of various depths, and Bend's aquifer varies in depth, the City should take additional precautions to protect groundwater resources when using or allowing their use. A preliminary analysis (Appendix A) has identified locations where deep drywells up to 100-foot may be sited with no additional investigation into water quality protection. Secondary locations, where these facilities are likely to be safe, but site-specific studies should be provided, are also identified (Figure 19). To allow and consistently regulate the use of deep drywells, the City should update its Standards and Specifications.

6.5. Required Regulatory Updates and Future Permits

The City should respond to new and additional requirements in the next NPDES Phase II Permit. The current permit was issued in 2021 and will expire in 2026. The extent of potential regulatory changes in the next permit is not known at this time. The City's WCFP Permit expired in 2013 and was reissued in July 2025 during preparation of this plan. The new permit did not include major changes from the previous one.



LEGEND

Green Light - Impervious surfaces, residential land use; local, collector, minor arterial, resource, and service roads; outside of two-year time-of-travel zones and >500 ft from water wells; and outside of areas with perched groundwater

Yellow Light - Impervious areas that are outside of the two-year ToT and greater than 100 feet from all water wells

All Other Features

- City Boundary
- Major Road
- Watercourse
- Waterbody

FIGURE 19

Deep Drywell Siting Criteria Map

City of Bend Modified Drywell Siting Criteria and Drillhole Decommissioning Framework

Date: July 24, 2025
Data Sources: City of Bend, ESRI, ODOT, USGS, Aerial Photo 2022

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GSI Water Solutions, Inc.

Document Path: Y:\0655_Otak\Source_Figures\004_Bend_SW_Master_Plan\Modified_Drywell_Siting\Figure2_Siting_Criteria.mxd, npalmer

Section 7. Outreach and Engagement

The Stormwater Master Plan update was managed by the Engineering Department and will be implemented primarily by the Water Services Department and the Engineering Department, with support from the Community Development Department related to new development standards and programs. Other departments or divisions are internal stakeholders, managing work that may be coordinated with implementation of the capital programs or policy recommendations. The project team consulted internal stakeholders for input and feedback on targeted issues and recommendations. External stakeholders were engaged throughout the plan development, and the general public was informed through the Stormwater Master Plan Update web page.

7.1. Internal Stakeholders

The project team met with the internal stakeholder to discuss a variety of topics as follows:

- Community Development Department, Growth Management Division to discuss the relationship of regional stormwater facilities to economic development in the Central Core and to address equity questions (December 2024)
- Community Development Department, Private Development Engineering Division and Building Safety Division to review on-site stormwater management issues in the field for the drainage and density policy review (May 2025)
- Enterprise Asset Data Division to discuss data requirements for stormwater capital improvement program GIS records (July 2025)

7.2. External Stakeholders and General Public

A variety of external stakeholders were invited to engage repeatedly throughout the plan development. They include Bend Park and Recreation District (BPRD), and the members of the Water Advisory Group (WAG). Additionally, the project team engaged with Central Oregon Builders Association (COBA), the City of Redmond, and local engineering firms on specific topics through round table discussions. BPRD is a recognized stakeholder because several of Bend's outfall pipes pass through parks adjacent to the Deschutes River and because the Engineering Department and BPRD are coordinating together on a project in Columbia Park which will improve access to the river and realign one of the City's stormwater outfalls. WAG, formerly Utilities Public Advisory Group (UPAG), is a group of community stakeholders invited by the Water Services Department to provide input to staff on programs and policies for stormwater management and other water system topics. It is made up of individuals who have experience or expertise, professional or lived, in areas that relate to the protection and management of water resources represent the following interests:

- Landscape design and construction
- Property development and consulting engineers
- Environmental community
- Citizens/neighborhood organizations
- Business/Chamber of Commerce
- State water/environmental regulator

Table 19 Stakeholder Involvement Dates and Topics

Date	Stakeholder	Topic
March 2024	UPAG	Introduction to Stormwater Master Plan update project
April 2024	BPRD	Meeting at Columbia Park to review project concept and existing stormwater infrastructure on site
May 2024	UPAG	Interactive workshop to discuss values and priorities for the SMP
August 2024	UPAG	Modified drywell siting, prioritization of existing drillholes for groundwater quality protection, concepts for capital project prioritization criteria
September 2024	UPAG	Follow-up to capital project prioritization criteria and introduction to the outfall retrofit needs assessment
October 2024	UPAG	Climate change and stormwater, follow-up from feedback on previous topics
January 2025	WAG	Introduction to the drainage and density policy topic
February 2025	WAG	Updates to rating criteria, results of CIP prioritization, discussion of other stormwater capital programs
March 2025	BPRD	Discuss possible synergy between stormwater projects and Parks
March 2025	Local Engineering Round Table	Discussion hosted by AKS Engineering including several local engineering firms to discuss drainage and density policy topic
April 2025	WAG	Follow-up to drainage and density policy topic
April 2025	COBA	Stormwater Master Plan overview and drainage and density policy topics
May 2025	City of Redmond	Overview of City of Redmond's approach to stormwater management focused on private development
May 2025	WAG	Recap, review final CIP recommendations, and introduce policy recommendations
September 2025	WAG	Recap and presentation of DRAFT Stormwater Master Plan

The general public has had the opportunity to be informed via the Stormwater Master Plan Update web page, which includes the project purpose, schedule, and background, as well links to the draft CIP map with ranks and the DRAFT Stormwater Master Plan.

Materials used for outreach to external stakeholders and the public are collected in Appendix F.

Section 8. Implementation Plan

The SMP proposes a balance between addressing immediate concerns and preparing for the future. This implementation plan will help the City sequence its efforts over the next 20 years and adapt to changing circumstances and priorities.

8.1. Stormwater Program Goals

Completion of infrastructure master plans, including this update to the SMP, is a stated goal of City Council for 2025 to 2027. Implementation of the SMP will help Bend address public concerns with drainage, stakeholder priorities for public safety and environmental stewardship, and City Council's goals.

8.1.1. Public Drainage Concerns

Several intense rainstorms with severe localized flooding have occurred in the last decade, drawing increasing public attention to private property damage and traffic safety resulting from lack of collection and/or conveyance capacity in the City's storm systems. These intense storms include, but are not limited to, two over Pilot Butte in August 2025 as this plan was reaching its conclusion. Addressing severe localized flooding is a priority for staff and affected members of the public and could serve to reduce the City's liability.

8.1.2. Staff and Stakeholder Goals

Both City staff and stakeholders have emphasized public safety as a priority that can be served by attending equally to both drainage problems that impact pedestrians or traffic safety or private property and to water quality protection.

Stakeholders have emphasized environmental stewardship and projects that serve multiple purposes.

Compliance with the City's two stormwater permits is a priority for staff and stakeholders and is the driver of several of the recommendations.

8.1.3. City Council Goals

The following elements of the 2025-2027 City Council Work Plan are pertinent to the SMP:

- Prioritizing policies that support affordable, attainable housing, and livability contribute to Council's "Safety + Belonging" principle.
- Prioritizing environmental resilience to ensure a thriving and livable Bend contributes to Council's "Environment and Climate" guiding principle and honors the original stewards of the land.
- Adopting development code and entitlement process improvements that remove barriers and speed up missing middle-income, affordable housing, and infill development serve Council's Housing objectives.
- Several objectives of the Transportation & Infrastructure goal are pertinent:
  - Enhancing safety for all modes of travel.
  - Developing projects and funding solutions to improve safety, reliability, maintenance, and capital needs, aligning revenue options with planning and performance metrics and goals.
  - Ensuring stormwater systems are aligned with the needs of a growing city and understanding capacity for growth.
  - Finishing the Stormwater Master Plan, prioritizing infill development.

- Leveraging public-private partnerships that catalyze investment in the Bend Central District.
- Improving permitting processes and reducing review times to support housing and economic development.

The SMP addresses each of these principles or goals through capital improvements and policy recommendations. See Table 21 (on page 79) for the recommended stormwater program priorities and their relationship to City Council's goals.

8.2. Summary of Recommended Solutions and Costs

The SMP recommends implementation of stormwater capital improvements that have been planned, designed, or started construction since the 2014 SMP. Most of these projects address drainage issues. It recommends planning for 11 new stormwater capital improvement projects (CIPs) to address larger-scale drainage and water quality issues and three programmatic solutions to systematically address smaller-scale water quality and storm system condition issues over time (Figure 20).

The SMP estimates the cost of capital improvements in 2025 dollars. The planning-level estimates include the full cost of implementing each individual CIP, from design through construction, as well as approximate costs for implementing programmatic solutions.

The 20-year cost table (Table 20, on page 77 below) spreads the estimates over a 20-year horizon in phases correlating to the City's capital planning cycle: years one through five, years six through ten, and the remaining years 11 through 20. The 20-year cost table also includes stormwater CIPs that were in progress or planned for implementation prior to the completion of the SMP and that appear in the capital improvement budget or planning documents such as the Midtown Crossings Stormwater Report.

The SMP also recommends policy initiatives. To address drainage and density, the SMP explores how the City could enforce stormwater standards more rigorously while allowing greater flexibility for centralizing stormwater management facilities. To address the pressures on available staffing and equipment resources resulting from growing storm system inventory and increasing regulation, the SMP recommends establishing and communicating about levels of service for the various stormwater services provided by the City and recommends more uniform and rigorous tracking of service metrics. Over time, these service expectations and metrics will assist in evaluating the costs and benefits of different levels of staffing and revenues. Finally, the SMP recommends the City take a watchful waiting stance to address the uncertainties of climate change, while pursuing an update to the outdated national precipitation data used to size stormwater facilities.

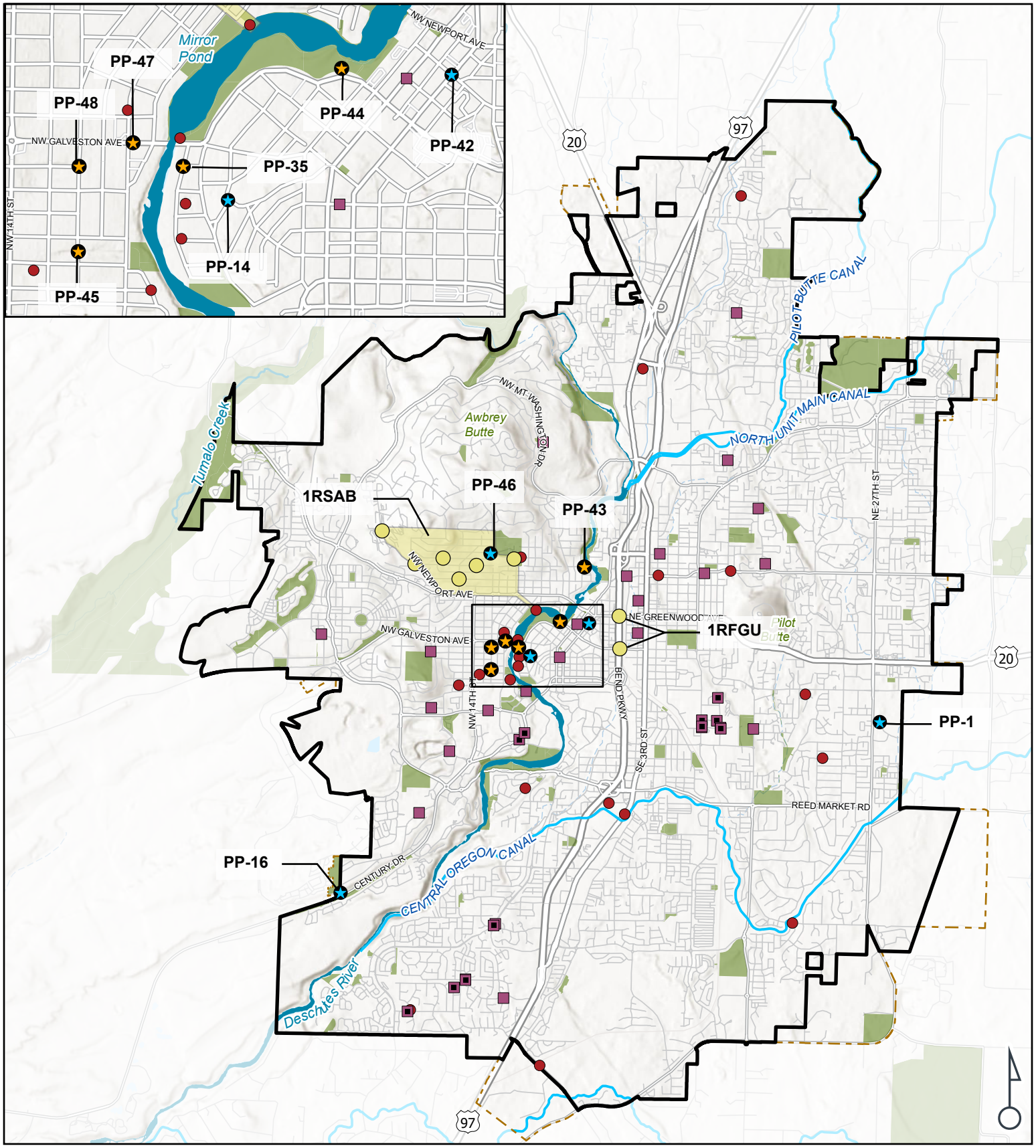

FIGURE 20
STORMWATER MASTER PLAN PROJECTS & PROGRAMS
BEND STORMWATER MASTER PLAN
BEND, OREGON

Data Sources: City of Bend, Deschutes County, USGS, Google Maps.
Date: 10/28/2025
Disclaimer: This data is not to survey accuracy and is meant for planning purposes only.

O:\PROJECT\20300\20359\04 CAD\GIS\APRX\20359 BEND MASTER PLAN MAPS JR.APRX

LEGEND

- Bend City Limits
- Urban Growth Boundary
- Streams
- Canals
- CIP - Drainage
- CIP - Outfall Retrofit
- CIP In Progress
- Major Maintenance Program
- Drillhole Water Quality Retrofit Program
- Failing UIC Drainage Improvements Program

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8.3. Recommended Stormwater Program Priorities

To address growing stormwater program demands amid stable funding, the SMP outlines strategic priorities that reflect City Council's goals and incorporate input from stakeholders gathered during the plan's development. Table 21 (on page 79 below) serves as a guiding framework for implementing these priorities.

Table 20 Recommended Stormwater Capital Improvements 20-Year Costs and Prioritization

Rank	ID	Project Name	Total Cost*	Information Source	Notes	Years 1-5†	Years 6-10	Years 11-20
Existing CIPs – Individual Projects								
1A‡	1SSW3	SW Sewer Basin Improvements Ph 3	$400,000	2025-27 Proposed Biennial Budget	Costs included in this table begin in 2026-27. Estimated completion in 2026-27.	$500,000		
1A	1RSAB	South Awbrey Butte Drainage Improvements	$12,500,000	2025-27 Proposed Biennial Budget	Costs included in this table begin in 2026-27. PP-2, PP-3, PP-4, PP-5, PP-6, PP-7 are all part of the drainage improvements; Estimated completion date of 2029	$15,450,000		
1A	1RFGU	Franklin Stormwater Improvements, Ph 1	$620,000	Midtown Crossing Stormwater Report	PP-51; Estimated completion date of 2026; Franklin is included in the budget with Greenwood, though they are separate project locations	$1,216,000		
1A	1RFGU	Greenwood Stormwater Improvements, Ph 1	$1,000,000	Midtown Crossing Stormwater Report	PP-39; Greenwood is included in the budget with Franklin, though they are separate project locations; Estimated completion date of 2026	$1,824,000		
					Existing CIPs Subtotal	*$18,990,000*	*$0*	*$0*
Planned CIPs – Individual Projects								
1B‡	1RFGU, Ph. 2	Franklin Stormwater Improvements, Ph 2	$850,000	Midtown Crossing Stormwater Report	Date of Implementation TBD; Franklin is included in the budget with Greenwood, though they are separate project locations		§	
1B	1RFGU, Ph. 2	Greenwood Stormwater Improvements, Ph 2	$3,800,000	Midtown Crossing Stormwater Report	Date of Implementation TBD; Greenwood is included in the budget with Franklin, though they are separate project locations		§	
1	PP-35	Riverfront Street Stormwater Improvements	$880,000	CIP Fact Sheet	Date of implementation TBD. Note that the 2025-27 Proposed Biennial Budget has a placeholder for Outfall Improvements (1ROTI) with expenditures beginning in 2028-29.		$880,000	
2	PP-42	Downtown Pedestrian Safety Drainage Improvements	$770,000	CIP Fact Sheet	Date of implementation TBD.		$385,000	$385,000
3	PP-44	Drake Park Stormwater Quality Improvements	$4,140,000	CIP Fact Sheet	Date of implementation TBD. Note that the 2025-27 Proposed Biennial Budget has a placeholder for Outfall Improvements (1ROTI) with expenditures beginning in 2028-29.		$2,070,000	$2,070,000
4	PP-14	Congress Street Drainage Improvements	$1,320,000	CIP Fact Sheet	Date of implementation TBD.			$1,320,000
5	PP-46	Vicksburg Avenue Drainage Improvements	$490,000	CIP Fact Sheet	Date of implementation TBD.		$490,000	
6	PP-47	Galveston Avenue Stormwater Quality Improvements	$5,820,000	CIP Fact Sheet	Date of implementation TBD. Note that the 2025-27 Proposed Biennial Budget has a placeholder for Outfall Improvements (1ROTI) with expenditures beginning in 2028-29.		$5,820,000	
7	PP-48	Fresno Avenue Stormwater Improvements	$4,230,000	CIP Fact Sheet	Date of implementation TBD. Note that the 2025-27 Proposed Biennial Budget has a placeholder for Outfall Improvements (1ROTI) with expenditures beginning in 2028-29.			$4,230,000
8	PP-45	12th Street Stormwater Quality Improvements	$1,040,000	CIP Fact Sheet	Date of implementation TBD. Note that the 2025-27 Proposed Biennial Budget has a placeholder for Outfall Improvements (1ROTI) with expenditures beginning in 2028-29.			$1,040,000
9	PP-1	Dove Lane Drainage Improvements	$390,000	CIP Fact Sheet	Date of implementation TBD.			$390,000
10	PP-43	Saginaw Avenue Stormwater Quality Improvements	$2,620,000	CIP Fact Sheet	Date of implementation TBD. Note that the 2025-27 Proposed Biennial Budget has a placeholder for Outfall Improvements (1ROTI) with expenditures beginning in 2028-29.			$2,620,000
11	PP-16	Campbell Rd Drainage Improvements	$130,000	CIP Fact Sheet	Date of implementation TBD.			$130,000
					Planned CIPs Subtotal	*$0*	*$9,645,000*	*$12,185,000*
					Individual CIPs Total	**$18,990,000**	**$9,645,000**	**$12,185,000**

Table 20 continues on next page

Table E-2 Recommended Stormwater Capital Improvements 20-Year Costs and Prioritization

Rank	ID	Project Name	Total Cost*	Information Source	Notes	Years 1-5†	Years 6-10	Years 11-20
Programmatic Solutions								
n/a	1RDHD	Drillhole Water Quality Retrofit Program	$5,700,000	Program Fact Sheet and 2025-27 Biennial Budget	Total costs include the priority locations documented in the fact sheet for a five-year implementation schedule and subsequent lower-priority projects implemented at a slower pace in future years.	$750,000	$3,375,000	$ 1,575,000
n/a	TBD	Failing UIC Drainage Improvement Program	$5,340,000	Program Fact Sheet	10-year implementation schedule to begin after completion of the high priority projects in the 1RDHD program. This program will be rolled into Stormwater Major Maintenance after the priority issues completed.		$2,670,000	$2,670,000
n/a	1RCAP	Stormwater Major Maintenance Program	Annual allocation	Annual allocation	Currently "Stormwater Capital Repair and Replacement" (1RCAP) in 2025-27 Proposed Biennial Budget. Assume continuation of this program at a set annual level of $1.5 million from years 6 to 20.	$6,620,000	$4,830,000	$13,155,000
					Programmatic Solutions Total	**$7,370,000**	**$10,875,000**	**$17,400,000**
					Total by Planning Horizon	**$26,360,000**	**$20,520,000**	**$29,585,000**
					Grand Total	**$76,465,000**		

** All costs are in 2025 dollars*
† Year 1 is the fiscal year 2025-2026
‡ Ranks 1A and 1B are given to projects that were not ranked by the SMP project team but are considered high-priority because they are either ongoing or budgeted capital improvements (1A) or contained in an existing master plan or infrastructure improvement plan that is being implemented by the City (1B)
§ City of Bend is determining if this work will be addressed through a City-funded CIP or through private development

Table 21 Recommended Stormwater Program Priorities

Program or Policy Recommendation	Description		Priority	Driver	Goal(s) Served
Implement the CIP Program – Drainage Projects	A stormwater capital improvement project is a standalone project to manage runoff which may have a design requiring complicated engineering, or creates a storm system where one does not exist, or has a high construction cost estimate.	A drainage project is designed to reduce the severity and frequency of flooding on streets and sidewalks after rain. Flooding on private property due to uncontrolled runoff from City streets may also be addressed.	High*	Service	▪ Enhance safety for all modes of travel ▪ Ensure stormwater systems are aligned with the needs of a growing city and understand capacity for growth ▪ Improve safety, reliability, maintenance, and capital needs
Implement the CIP Program – Outfall Retrofit Projects		An outfall retrofit project is designed to protect water quality by preventing untreated stormwater from flowing into the Deschutes River from existing outfalls. These projects remove urban pollutants and reduce sediment in runoff before it reaches the river.	High*	Service and Compliance	▪ Protecting and sustaining the environment ▪ Meets requirements of the City's National Pollutant Discharge Elimination System (NPDES) municipal stormwater permit issued by the State of Oregon under the federal Clean Water Act
Implement the Drillhole Water Quality Retrofit Program	The program is to protect the quality of groundwater resources by adding pre-treatment to existing drillholes that may be at risk of discharging pollutants to the aquifer. The program prioritizes drillholes that are within the 2-year time of travel of wells that are used as public drinking water wells.		High	Compliance	▪ Protecting and sustaining the environment ▪ Meets requirements of the WPCF Permit
Implement the Failing Underground Injection Control (UIC) Drainage Improvements Program	The program is to reduce nuisance flooding on streets and sidewalks by replacing UICs – drywells and drillholes – that no longer function or by adding new UICs to an underperforming system. Drywells or deep drywells may be used, depending on site conditions.		Medium	Service	▪ Enhance safety for all modes of travel ▪ Ensure stormwater systems are aligned with the needs of a growing city and understand capacity for growth ▪ Improve safety, reliability, maintenance, and capital needs
Implement the Major Maintenance Program	The program is to maintain condition or improve access to the existing stormwater system, or to manage small drainage issues on a public street, sidewalk, or private property when caused by runoff from a City street. Projects may repair, replace or add a small number or less complex structures (e.g. new inlets). Construction costs are estimated to be less than $1 million.		Medium	Service	▪ Enhance safety for all modes of travel ▪ Improve safety, reliability, maintenance, and capital needs
Drainage and Density policy: Advertise existing options for alternative stormwater management tools in development	The Drainage and Density white paper explores how Bend can better serve development by improving processes, increasing tools available, and exploring policy changes related to managing stormwater on development sites.	This is a short-term recommendation of the Drainage and Density white paper which will make permitting stormwater systems on some private development sites easier and more effective.	High	Service	▪ Improve permitting processes and reduce review times to support housing and economic development ▪ Prioritize policies that support affordable, attainable housing, and livability ▪ Adopt development code and entitlement process improvements that remove barriers and speed up missing middle-income, affordable housing and infill development.
Drainage and Density policy: Study and offer new options for alternative stormwater management tools in development, particularly for infill development		This is a long-term recommendation of the Drainage and Density white paper which will make permitting stormwater systems on some private development sites easier and more effective.	Medium	Service	▪ Improve permitting processes and reduce review times to support housing and economic development ▪ Finish the Stormwater Master Plan, prioritizing infill development ▪ Prioritize policies that support affordable, attainable housing, and livability ▪ Adopt development code and entitlement process improvements that remove barriers and speed up missing middle-income, affordable housing and infill development.
Drainage and Density policy: Prepare a separate regional stormwater plan to serve the Central Core District		This is a short-term recommendation of the Drainage and Density white paper which would remove barriers to redevelopment in the Bend Central Core.	TBD by City	Service	▪ Leverage public-private partnerships that catalyze investment in the Bend Central District ▪ Prioritize policies that support affordable, attainable housing, and livability

Table 21 continues on next page

Table 21 Recommended Stormwater Program Priorities

Program or Policy Recommendation	Description		Priority	Driver	Goal(s) Served
Level of Service (LOS) policy: Establish stormwater operations LOS goals and metrics	The LOS white paper explores Bend's policies, or lack thereof, for setting stormwater system LOS.	This is a short-term recommendation of the LOS white paper which would support a long-term goal of tracking metrics for stormwater operations, regulation, and capital improvements.	Medium	Service and Compliance	▪ Ensure stormwater system is aligned with the needs of a growing city and understand capacity for growth
LOS policy: Update stormwater tracking to address LOS metrics		This is a long-term recommendation of the LOS white paper which would provide standardized feedback on stormwater program achievement to support adapting policies, processes, and resource allocations to growth.	Low	Service and Compliance	▪ Ensure stormwater system is aligned with the needs of a growing city and understand capacity for growth
Climate change policy: Collect more precipitation and flow data to support assessment of design standards	The Climate Change presentation reviews data underpinning Bend's stormwater design standards and reviews the current state of the practice for predicting future precipitation patterns in central Oregon.	This is a long-term recommendation which would provide local data to supplement global and regionally downscaled climate model predictions when assessing design standards for stormwater control.	Medium	Service	▪ Ensure stormwater system is aligned with the needs of a growing city and understand capacity for growth ▪ Prioritizing environmental resilience
Climate change policy: Develop a watchful waiting approach to incorporating climate change projections into design standards for private development.		This is a long-term recommendation following the climate change literature review which would allow the City to target the long-term goal of ensuring capacity for growth while addressing more emergent drainage and water quality issues in the meantime.	Low	Service	▪ Ensure stormwater system is aligned with the needs of a growing city and understand capacity for growth ▪ Prioritizing environmental resilience
Climate change policy: Develop an internal policy for stormwater system design which encourages Engineering to use conservative assumptions and calculations when sizing stormwater conveyance, treatment, and disposal systems, to err on the size of providing greater collection and conveyance capacity.		This is a long-term recommendation following the climate change literature review which would allow the City to target the long-term goal of ensuring capacity for growth while addressing more emergent drainage and water quality issues in the meantime.	Low	Service	▪ Ensure stormwater system is aligned with the needs of a growing city and understand capacity for growth ▪ Prioritizing environmental resilience

** High priority describes overall priority for the Stormwater Capital Improvement Program. On the other hand, individual CIPs have been ranked so that each has a unique priority when compared to other CIPs (see Table 20).*

8.4. Funding

The stormwater utility receives its funding from the Stormwater Fund, which collects revenue from the stormwater utility fee paid by property owners. The stormwater utility issued long-term debt for the first time in FY 2021 for capital projects. The SMP recommends capital investment of more than $76 million over the next 20 years to address drainage issues, protect groundwater and surface water quality, and meet permit requirements for operating storm sewers and UICs. The costs of day-to-day stormwater operations and regulation of stormwater systems on private property have not been estimated in this plan; however, budgets for system operations, maintenance, and regulation can be expected to grow with increasing inventory of storm system assets, increasing growth in private development, and increasing regulation of the City.

Using cost inputs from the SMP, the City will study the cost of providing stormwater capital improvements and ongoing stormwater services to the community and assess how to align stormwater utility fees with City costs. See Appendix G for a preliminary financial analysis preceding the full study.

8.5. Adaptive Management

The SMP addresses numerous current stormwater issues and provides recommendations for some of the highest priority actions and policy considerations. During preparation of this plan, several questions and concerns arose which could not be addressed within the scope or schedule for preparing the plan. Some of the documented issues that have not been addressed in this plan include:

- Managing annexations from Deschutes County with no storm infrastructure. Deschutes County's stormwater regulations differ from Bend's. Urbanization on lands with little to no private or public storm infrastructure can lead to nuisance flooding and localized drainage concerns when properties annex to the city.
- Studying options for managing drainage, or lack thereof, in frozen conditions, or rain on ice conditions. Bend's climate produces frozen conditions that can block inlets to stormwater systems, leading to nuisance flooding and localized drainage concerns in the winter. There may be operational or design changes that could reduce flooding on streets related to frozen conditions.
- Managing the City's numerous outfalls that cross Bend Park and Recreation District (BPRD) property without easements for maintenance. Over the long term, the City needs to work with its partner, BPRD, to formalize permission to maintain outfall pipes that run under parks. Pipes need to be inspected, maintained, and improved to avoid surface impacts such as sink holes from breaks, to ensure capacity, and to improve quality of runoff discharging to the river.
- Assessing whether engineering design standards for low impact development stormwater facilities such as vegetated planters cause or contribute to maintainability issues that have been observed by staff.

The City should continue to adaptively manage its stormwater utility by periodically assessing the relative priority of this plan's recommendations, reviewing whether issues not addressed within this plan have increased in priority, collecting and prioritizing drainage complaints, and keeping abreast of changes to state and local priorities which may impact how the City plans for and manages stormwater.

Section 9. References

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APPENDICES

Provided Separately