MS4 - Individual Permit Annual Report

RID 77211

Submitter

Michael Buettner

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City of Bend

PO Box 1458, Bend, OR 97703

Certification and Signature

Permit Registrant(s)	Legally Authorized Representative	Title
City of Bend	Mike Buettner	Public Works Director

Phone	Email
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Registrant Information

Permit Registrant(s)

Name	Site ID
BEND MUNICIPAL STORMWATER, MS4	312306

Physical Location

MUNICIPAL STORMWATER AREA, BEND, OR 97701 (44.0606,-121.319)

Type(s)	City
Registrant Type	Existing Registrant
Community Type	Small Community

DEQ Permit No	EPA File No
102901	113602

Point of Contact

Elisabeth O'Keefe

City of Bend

Program Manager

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541-317-3018

541-233-6964

Mailing Address

21051 NE Talus Place, Bend, OR 97701

Municipal Separate Storm Sewer System (MS4) Information

Estimate the area in square mileage served by the MS4: **2.18** square miles

Estimate the population served by the MS4: **5259**

MS4 Stormwater Discharge Information

	Receiving Waterbody	# of Outfalls	Impaired waterbody 303d listed	Impaired waterbody TMDL issued	Impairments
1	Deschutes River	36	Yes	No	temperatuer, pH, turbidity, sedimentation

Coordination Among Registrants and Joint Agreements

Is there a joint agreement in place for the implementation of one or more stormwater management program control measures?

No

If yes, has there been any change to the joint agreement(s) submitted previously?

Stormwater Management Program Information

Discuss the status and overall progress of establishing legal authority to control pollutant discharges into and discharges from the MS4 and to implement and enforce the conditions of this permit

The City's legal authority for stormwater quality rests in Bend Code Title 16, and the Standards and Specifications, both of which refer to the Central Oregon Stormwater Manual.

Is an updated SWMP Document attached?

No

Identify the publicly accessible website where the SWMP Document is posted?

Yes

Website Address

https://www.bendoregon.gov/government/departments/utilities/stormwater-reports-regulations

Does the SWMP Document include an implementation schedule for control measures that have yet to be or are partially implemented?

Yes

Describe the method used to gather, track, and use SWMP information to set priorities or assess compliance

The City uses several methods to track and document activities, as required in the ISWMP. The CityView application is used to track IDDE complaints, enforcement, plan review, permitting and erosion control inspections. The INFOR asset management system tracks stormwater maintenance, street sweeping & winter road care activities. Relevant public outreach information, performance standards and metrics, are summarized in each Annual Report, and are used to set priorities and assess compliance.

Have adequate finances, staff, equipment and other support capabilities been provided to implement the permit?

Yes

During this monitoring year was compliance with the requirements of this permit evaluated?

Yes

During this monitoring year was it determined or reported that discharge from the MS4 caused or contributed to an exceedance of an applicable water quality standard?

No

Public Education and Outreach

Provide a brief summary of the ongoing public education and outreach program

The City's public education and outreach program activities are implemented by utility stormwater staff. The program is designed to educate the public about the impacts of stormwater discharges on surface and groundwaters and the steps they can take to reduce pollutants. This year the staff continued to implement the One Water Student Video Contest, partnering with BendFilm and Central Oregon Daily. This 2025 theme of the contest was "Make a Choice be a Voice for Our Water!" that included a focus on illicit discharges. The PSA`s from the previous year's contest were aired on local TV and radio stations. The City also continues to sponsor and participate in the annual Deschutes River Cleanup Event with the Upper Deschutes Watershed Council and maintains a variety of educational resources and volunteer opportunities on it's website. In June of 2025, volunteers—including City staff—helped remove approximately 1,500 pounds of trash and invasive weeds from six sites along the river, including Farewell Bend Park and Tumalo State Park as part of the Deschutes River Cleanup. In September of 2024, the City completed a series of erosion control BMP installation and maintenance videos to educate the local homebuilding community. The videos can be viewed here: https://www.bendoregon.gov/government/departments/water-services/protecting-our-water/erosion-control

Were the required components in place by the implementation date?

Yes

> Provide the number of education and outreach activities conducted

During this reporting year

4

During the permit term

42

Explanation

During FY24-25 the Stormwater Program hosted outreach booths at four events including City Fest, Earth Day, and the Deschutes River Cleanup in July of 2024 and June of 2025.

Indicate target audiences addressed during this reporting year

- [x] General public, homeowners, homeowner association, school children, and businesses
- [x] Local elected officials, land use planners and engineers
- [x] Construction site operators

- [ ] Other

Have each target audience been addressed during the permit term?

Yes

Indicate target topics addressed during this reporting year

- [x] Impacts of illicit discharges on receiving waters and how to report them
- [x] Impacts from impervious surfaces and appropriate techniques to avoid adverse impacts
- [x] BMPs for proper use, application and storage of pesticides and fertilizer
- [x] BMPs for litter and trash control
- [ ] BMPs for recycling programs
- [x] BMPs for power washing, carpet cleaning and auto repair and maintenance
- [x] Low impact development/green infrastructure
- [ ] Information pertaining to maintenance of septic systems
- [x] Watershed awareness and how storm drains lead to local creeks and rivers, and potential impacts to fish and other wildlife
- [ ] Other

Describe the types of educational messages or activities distributed and/or offered during this reporting year

During FY24-25, staff attended the Earth Day public event (April 2025) and Cityfest public event (August 2024) where educational materials were available and/or stormwater topics were discussed or presented. The City also continues to implement the outreach program with EcoBiz for eco friendly business certifications. As part of the Ecobiz program, the City sent mailers to 347 landscaping and automotive businessses on June 14, 2024. Between April 2024 and March 2025, the Ecobiz program directly contacted and offered technical assistance to 167 businesses via email, 18 businesses via phone, and 24 businesses in person that included distribution of spill kits. Additionally, the program targeted 11 restaurants downtown providing in-person FOG (Fats Oils and Grease) handouts and education.The City also posted 10 stormwater outreach messages on social media platforms, and aired additional stormwater messages on the radio and local television channels. The City also maintains a stormwater public website that hosts multiple educational resources for target audiences listed under Schedule A.3.a.iii. During FY24-25, the City's public stormwater webpages received 4,645 views across 1,634 users. The City's One Water school education program with the Upper Deschutes Watershed Council provided storm, water conservation, and water reclamation education to 119 high school students and 80 elementrary school students over FY 24-25.

Was outreach to construction site operators working within your community offered during this reporting year?

Yes

Total number during the permit term

558

Identify and describe the assessment/evaluation of, at least, one education and outreach activity that occurred during this reporting year. Include the assessment process or metric for evaluation, and why this activity was considered successful

In FY24–25, the City of Bend hosted a One Water Student Video Contest aimed at increasing public awareness of stormwater pollution prevention through youth-led storytelling. The contest invited

high school and middle school students to submit short films focused on stormwater topics. The theme for this year was to create a video to spread the word about the impacts of illicit discharges and water waste and how to report them. Of the many submissions received, one student video stood out for its compelling message on Illicit Discharge Prevention and Keeping Storm Drains Clean. The winning concept was professionally produced into a short film.

Contest entries were evaluated based on several criteria including illicit discharge message clarity, community engagement, creativity, and cinematography. Evaluation feedback from staff and local partners during the contest judging process indicated the contest was highly successful in raising awareness and inspiring action for students. Staff noted that students demonstrated a strong understanding of stormwater systems and pollution prevention strategies through messaging included in their video submissions. The winning film will also be used as a PSA that airs on television in September and October of 2025, encouraging the public to learn more about how everyday behaviors affect stormwater and water quality.

Digital access to the winning video and additional stormwater education resources are available on the City's website at https://www.bendoregon.gov/government/departments/water-services/education-tours/one-water-student-video-contest

Will the assessment be used to inform future stormwater education and outreach efforts?

Yes

Explanation

Insights gained from the One Water Student Video Contest will help shape future stormwater education initiatives by highlighting the effectiveness of youth-led messaging in engaging the community. The contest revealed key themes and communication strategies that resonate with younger audiences and the broader public, which will be incorporated into future outreach campaigns. Feedback from judges and partners will guide the development of educational materials that emphasize clarity, creativity, and community relevance. Additionally, the winning video will serve as a model for future public service announcements and digital content aimed at promoting stormwater pollution prevention.

Public Involvement and Participation

Provide a brief summary of the overall progress towards implementation of this control measure

During FY 24-25 the City continued to host Water Advisory Group (WAG) meetings (formerlly known as Utilities Public Advisory Group UPAG). FY24-25 WAG topics focused on water conservation, water rates, Stormwater Master Plan development, and drainage and density. In June 2025, the WAG group toured a City owned water site and public park- Overturf Butte Park to discuss fire mitigation and management. Fire mitigation and vegetation management discussion overlapped with certain stormwater topics including erosion control and drainage. A link to the WAG webpage with agendas and meeting recordings is available here: https://www.bendoregon.gov/government/departments/water-services/water-advisory-group-wag. The City also continued to host the One Water Student Video contest with a theme focused on illicit discharges to the storm system.

Were the required components in place by the implementation date?

Yes

Is the SWMP Document posted on a publicly accessible website?

Yes

Web Address

https://www.bendoregon.gov/government/departments/water-services/integrated-sw-mgmt-plan

Was the publicly accessible website updated during this reporting year?

Yes

Does the publicly accessible website include illicit discharge complaint/reporting information or procedures?

Yes

Does the publicly accessible website include draft documents issued for public comment, final reports, plans and other official SWMP policy documents?

Yes

Does the publicly accessible website include links to all ordinances, policies and/or guidance documents related to the construction and post-construction stormwater management control programs, including education, training, licensing, and permitting?

Yes

Does the publicly accessible website include contact information for relevant staff, including phone numbers, mailing addresses and email addresses?

Yes

During this reporting year, was a stewardship opportunity created or partnered with another entity?

Yes

Explanation

The City's website underwent a partial redesign by the communications department that included condensing, rewording, and reformatting all stormwater pages with the goal to improve access and readability.

Illicit Discharge Detection and Elimination

Provide a brief summary of the overall progress towards implementation of this control measure

In FY24–25, staff improved data tracking and reporting settings in Cityview to enhance efficiency and monitor illicit discharge response. The most frequent IDDE cases involved sediment, washwater, and oil/gas/hydraulic fluid. In August 2024, staff completed an outfall analysis to identify priority locations for future monitoring.

Were the required components in place by the implementation date?

Yes

Is the MS4 map(s) current?

Yes

Describe the MS4 map(s) format(s)

The City uses a digital MS4 mapping system through Esri GIS and AutoCAD formats. Mapping accuracy and processes are consistent with industry standards. Portions of the map and digital inventory may be viewed on the City's public website through Bend Data Viewer or downloaded under the data catalog tab, at: https://data.bendoregon.gov/pages/interactive-maps The complete digital inventory can be made available to DEQ or the public upon request.

Is the MS4 map(s) included as attachment?

No

Or are the digital shapefiles available for electronic submittal?

Yes

Explanation

The map is available on the public website at https://experience.arcgis.com/experience/34a4bc300bfe4f028929b2c708b8e175

Is the digital inventory of all known outfalls, with the associated receiving waterbody current?

Yes

Indicate if the following features are included on your MS4 map

- [x] Location of all known outfalls
- [x] Stormwater collection and conveyance system
- [x] Stormwater structural controls
- [ ] Location of known chronic discharges

Explanation

Chronic discharges are not shown on the public map, but the City has data and location of all illicit discharge cases for code enforcement.

Have non-stormwater discharges into the MS4 been prohibited through enforcement of an ordinance or other regulatory mechanism?

Yes

Explanation

Illicit Discharges are prohibited through Bend Municipal Code Title 16 and enforced through code enforcement by the City.

Indicate which of the following have an ordinance or other regulatory mechanism to prohibit discharge to the MS4

- [x] Septic, sewage, and dumping or disposal of liquids or materials other than stormwater into the MS4
- [x] Discharges of washwater resulting from the hosing or cleaning of gas stations, auto repair garages, or other types of automotive services facilities
- [x] Discharges resulting from the cleaning, repair, or maintenance of any type of equipment, machinery, or facility, including motor vehicles, cement-related equipment, and port-a-potty servicing, etc.
- [x] Discharges of washwater from mobile operations, such as mobile automobile or truck washing, steam cleaning, power washing, and carpet cleaning, etc.
- [x] Discharges of washwater from the cleaning or hosing of impervious surfaces in municipal, industrial, commercial, or residential areas (including parking lots, streets, sidewalks, driveways, patios, plazas, work yards and outdoor eating or drinking areas, etc.) where detergents are used and spills or leaks of toxic or hazardous materials have occurred (unless all spilled material has been removed)
- [x] Discharges of runoff from material storage areas, which contain chemicals, fuels, grease, oil, or other hazardous materials from material storage areas
- [x] Discharges of pool or fountain water containing chlorine, biocides, or other chemicals; discharges of pool or fountain filter backwash water
- [x] Discharges of sediment, unhardened concrete, pet waste, vegetation clippings, or other landscape or construction related wastes
- [x] Discharges of trash, paints, stains, resins, or other household hazardous wastes
- [x] Discharges of food-related wastes (grease, restaurant kitchen mat and trash bin washwater, etc.)

The written escalating enforcement and response procedure can be found in the FY22-23 annual report attachments. This is available online: https://www.bendoregon.gov/government/departments/water-services/stormwater/stormwater-reports-regulations

Is the written escalating enforcement and response procedure included as an attachment?

No

Indicate which of the following are included in the complaints or reports tracking documentation

- [x] Phone number(s)
- [x] Webpage(s)
- [x] Other communication channels

Explanation

Provide the number of complaints received during this reporting year

73

On average, how long did it take to respond to complaints? Schedule A.3.c.v.B In days

0.13

Provide the number of complaints that included notification of the Oregon Emergency Response System during this reporting year

0

Provide the number of complaints where staff performed an investigation during this reporting year

73

On average, how long did it take to conduct an initial investigation in days

0.1

Provide the number of illicit discharges discovered and eliminated during this reporting year

73

On average, how long did it take to eliminate an illicit discharge

8

Provide the number times escalating enforcement procedure was used to eliminate illicit discharge during this reporting year

36

Do any of the illicit discharges involve the repair or replacement of the wastewater and/or storm sewer conveyance systems?

No

Provide the number of illicit discharges that were referred to another entity during this reporting year

0

On average, how long did it take to notify the entity(s)

n/a

Explanation

Indicate which of the following are included in the complaints or reports tracking documentation

- [x] Date the complaint was received and, if available, the complainant's name and contact information
- [x] Name of staff responding to the complaint
- [x] Date the investigation was initiated
- [x] The outcome of the staff investigation
- [x] Corrective action(s) taken to eliminate the illicit discharge
- [x] The responsible party for the corrective action(s)

- [x] The status of enforcement procedure(s), when necessary
- [x] The date the corrective action(s) was completed and staff who evaluated final compliance

Explanation

Provide percentage of outfalls inspected

100

Known outfalls screened this reporting year

100

Known outfalls screened during the permit term

100

Explanation

Provide percentage of outfalls inspected as part of field screening of priority location

100

Priority location outfalls screened this reporting year

36

Priority location outfalls screened during the permit term

36

Explanation

All 36 outfalls were screened in June 2025, including all high, moderate, low, and unranked outfalls. In August 2024, the City of Bend conducted an analysis to determine priority outfalls based on the following contributing factors of outfall drainage basins: soil infiltration rate, soil erodibility, slope, land cover, road area, drainage basin area, zoning, length of contributing storm main pipe, number of active storm drains in each drainage, and the number of IDDE cases in each drainage. Traffic counts and population density were omitted from the total weighting due to incomplete data. Major roads were defined as highways, arterials, or corridors and assigned a 40ft width to calculate road area for each outfall drainage. Of the 36 outfalls, there are 2 with very high priority, 3 with high priority, 6 with moderate priority, 15 with low priority, and 8 with very low priority. 2 of the 36 outfalls could not be ranked because they were newly discovered in August 2024.

Indicate which of the following dry-weather field screening activities have been performed in the last year

- [x] General observation
- [x] Field Screening and Analysis
- [ ] Pollutant Parameter Action Levels
- [ ] Laboratory Analysis

Explanation

If flow is observed and the source is unknown, provide a brief description of the field investigation and analysis process

Field evaluation of upstream drainage area supplemented by the use GIS data (land use, tax lots, stormwater system). Upstream points such as hard surfaces, manholes and catch basins are observed manually for flow/associated discharge. The system is investigated upstream until flow is no longer observed and/or no probable source is identified. If the source cannot be identified by visual observations during the field investigation, field sampling with Pollutant Parameter Action levels will be conducted. If neither the field investigation or field sampling result in source identification a grab sample will be collected and sent to a laboratory for further analysis.

Have pollutant parameter action levels been established and are they included as an attachment?

No

Are all persons responsible for investigating and eliminating illicit discharges and illicit connections into the MS4 appropriately trained to conduct such activities?

Yes

Explanation

Pollutant parameter action levels are established but not included as an attachment. They can be found in the FY22-23 annual report attachments at: https://www.bendoregon.gov/government/departments/water-services/stormwater/stormwater-reports-regulations

Are all new staff working to implement the IDDE program trained within 30 days of their assignment to this program?

Yes

Explanation

Construction Site Runoff Control

Provide a brief summary of the overall progress towards implementation of this control measure

The City of Bend has fully implemented its updated construction site runoff control measures, meeting the November 1, 2024 deadline. Key improvements included enhanced erosion control management and enforcement protocols.
In August 2024, the City revised its municipal code to expand inspection and enforcement to all construction projects disturbing 5,000 square feet or more, eliminating previous exemptions for smaller developments. Updates to the Cityview tracking system now allow for better oversight of smaller sites through the building permit process. Enhancements include a standardized erosion control template plan, photo documentation of installed BMPs, and inspection tracking. Resources for small site erosion control are available online at https://www.bendoregon.gov/government/departments/water-services/protecting-our-water/erosion-control/small-site-erosion-control-instructions. The City also finalized updates to standard drawings for erosion control BMPs and revised capital project specifications to clarify installation and maintenance requirements. After DEQ feedback recieved in 2024 from an inspection conducted in July of 2023, the City made some revisions to capital project erosion control. To provide more City oversight on capital projects, the stormwater program began requiring monthly inspection forms completed by the engineering department in November 2024. The stormwater program continues to coordinate with the Engineering department on consistent implementation of the monthly inspections by engineering staff and plans to add the monthly inspection form in the new Neogov training platform for all capital project managers in 2026.

Were the required components in place by the implementation date?

Yes

Do ordinances or other regulatory mechanisms require erosion controls, sediment controls, and waste materials management controls to be used and maintained at all qualifying construction projects?

Yes

Explanation

Yes, please see updates under Bend Municipal Code Chapter 16.35 Erosion Control Requirements at https://bend.municipal.codes/BC/16.35

Indicate the minimum land disturbance where construction site operators are required to complete and implement an Erosion and Sediment Control Plan (ESCP) for construction project sites

5000 square feet

For construction projects that disturb one or more acres (or that disturb less than one acre, if it is part of a "common plan of development or sale" disturbing one or more acres), provide a brief description how these projects are referred to DEQ or the appropriate DEQ agent, to obtain a NPDES Construction Stormwater General Permit

The requirement for developers to check with DEQ for 1200c permit requirement is listed as one of the permit conditions on all City-issued development permits and also referenced in Bend Municipal Code Title 16.

Provide the written specifications that address the proper installation and maintenance of such controls during all phases of construction activity as an attachment?

No

Provide the Erosion and Sediment Control Plan template as an attachment?

No

Indicate which of the following are required for qualifying construction projects

- [x] Site operator required to complete a ESCP template prior to beginning construction/land disturbance
- [x] Site operator required to keep the ESCP on site
- [x] Site operator required maintain and update the ESCP as site conditions change, or as needed
- [x] Site operator required to provide the ESCP to the permit registrant, DEQ, or another administrating entity

Explanation

Access them online at: Central Oregon Stormwater Manual: https://www.coic.org/stormwater/ City Design Standards: Section 7 Grading and Erosion Control, City Standard Drawings Erosion (E), and Special Provision to the 2021 OSS Section 00280 Erosion and Sediment Control: https://www.bendoregon.gov/government/departments/engineering/standards-and-specifications

ESCP templates from construction projects that will result in land disturbance of one or more acres (or that disturb less than one acre, if it is part of a "common plan of development or sale" disturbing one or more acres) are reviewed using a checklist or similar document to determine compliance?

Yes

Provide the ESCP review template as an attachment?

No

Indicate the minimum land disturbance where you require the ESCP to be reviewed, if different than one acre

5000 **ft2**

Explanation

See the FY23-24 report for the ESCP review template. https://www.bendoregon.gov/government/departments/water-services/stormwater/stormwater-reports-regulations

All construction projects [that will result in land disturbance of one or more acres (or that disturb less than one acre, if it is part of a "common plan of development or sale" disturbing one or more acres)] are expected or scheduled to be inspected at least once per permit term

Number of inspections completed to comply with this requirement during the permit term

2574

Indicate the number of inspections completed to comply with this requirement during this reporting year

811

Explanation

The land disturbance for the City of Bend permit is 5,000 square feet not 1 acre.

Are construction projects with visible sediment in stormwater/dewatering discharge or when a complaint is received inspected?

Yes

Indicate number of projects that were inspected based on this inspection trigger

21

Explanation

Indicate the total number of construction projects that were inspected this monitoring year

221

Indicate the total number of construction projects that were inspected during the permit term

626

Indicate which of the following are documented during an inspection

- [x] That the ESCP is reviewed to determine if the described
- [x] Control measures were installed, implemented, and maintained appropriately
- [x] Assessment of the site's compliance with the ordinances or requirements
- [x] Visual observation of any existing or potential non-stormwater discharges, illicit connections, and/or discharge of pollutants from the site
- [x] Recommendations to the construction site operator for follow-up
- [x] Education or instruction provided to the site operator related to stormwater pollution prevention practices

Explanation

If available, provide a copy of the written or electronic inspection report form?

Yes

Explanation

Please refer to the FY21-22 annual report for a copy of the general private development electronic inspection report forms. https://www.bendoregon.gov/government/departments/water-services/stormwater/stormwater-reports-regulations. A copy of the capital project inspection form is attached.

Provide the written escalating enforcement and response procedure as an attachment?

No

Explanation

Was the escalating enforcement procedure used to achieve compliance at any construction projects?

Yes

Indicate number of times during this reporting year

337

Indicate number of times during the permit term

1052

Explanation

The permit term number is based on the entire permit term up to 9/25/2025

Were all persons responsible for ESCP reviews, site inspections, and enforcement appropriately trained to conduct such activities?

Yes

Explanation

Were all new staff working to implement the construction site runoff control program appropriately trained within 30 days of their assignment to this program?

Yes

Post-Construction Site Runoff for New Development and Redevelopment

Provide a brief summary of the overall progress towards implementation of this control measure

The City of Bend continues to carry out post-construction stormwater requirements as outlined in Bend Code Title 16. These efforts include reviewing development plans, issuing private stormwater maintenance agreements, inspecting and maintaining publicly owned water quality facilities, and updating digital inventory records. In September 2025, City Council adopted amendments to Title 16 of the Bend Municipal Code to strengthen the legal authority needed to meet permit post-construction requirements.
To support residential subdivisions with privately owned stormwater facilities, the City is revising its maintenance agreement templates to include general agreements applicable to each lot within the entire subdivision and will be implemented for subdivision landuse applications submitted on or after 11/1/25. As part of this implementation, small residential building permit applications must include a post-construction stormwater plan template that identifies the facility type and sizing calculations for the individual lot. The City is also implementing an enforcement strategy to ensure compliance with private individual stormwater maintenance agreements by the November 1, 2025 deadline. This includes launching the CityView permit portal for annual inspection report submissions and establishing enforcement measures for late reports. For larger subdivisions with general maintenance agreements, individual lots will not be required to submit inspection reports; instead, City staff will inspect a sample of facilities within the subdivision each year. In 2026, the City also plans to inspect a portion of privately owned facilities with individual stormwater maintenance agreements that do require annual report submissions.
To assist property owners with individual agreements, the City has created a dedicated webpage with guidance on the new reporting and inspection process: https://www.bendoregon.gov/government/departments/water-services/stormwater/stormwater-maintenance-agreements-annual-reporting
Additional post-construction requirements, including the implementation of a Numeric Stormwater Retention Requirement (NSRR), is described in the new Stormwater Master Plan (see attached memo). The Master Plan is on track for completion and adoption by City Council in January 2026. As part of the plan's recommendations, updates to the Central Oregon Stormwater Manual are tentatively scheduled to begin in summer of 2026.

Were the required components in place by the implementation date?

Yes

For projects creating or replacing impervious area, indicate the area (or threshold) where the site is required to implement the post-construction site runoff program requirements

In square feet **5000** ft2

Explanation

Indicate which of the following are required at qualifying sites

- [x] The use of stormwater controls
- [x] A site-specific stormwater management approach that targets natural surface or predevelopment hydrological function through the installation and long-term operation and maintenance of stormwater controls
- [x] Long-term O&M of stormwater controls at project sites that are under the ownership of a private entity

Explanation

Were ordinance(s), code(s) and development standards reviewed to identify, minimize or eliminate barriers that inhibit design and implementation techniques intended to minimize impervious surfaces and reduce stormwater runoff?

Yes

If barriers were identified or if necessary, provide an explanation

Provide an explanation of the timeline for removal of barriers or if removal is outside your authority

In August of 2023, the City reviewed codes and standards for barriers that may inhibit implementation of low impact development techniques. No barriers were identified as a result of this review, as the City currently allows the use of LID techniques to manage stormwater onsite through development code. While conducting the barrier review, the City identified topics in development code such as walkway surfaces, street trees, and parking surfaces that can be further evaluated and encouraged as LID options. Furthermore, in conducting this review, the City identified areas of development code for the stormwater program to be aware of and involved with for any future code updates as they have a connection to stormwater (i.e. landscaping, tree code, and pavement requirements).

Indicate which of the following technical standards are used to determine the retention requirement

- [x] Volume-based method
- [ ] Storm event percentile-based method
- [ ] Annual average runoff-based method

Explanation

For projects that are unable to meet the retention requirement, is the remainder of the rainfall/runoff treated prior to discharge with a structural stormwater control?

Yes

Was the stormwater structural control designed to remove, at minimum, 80 percent of the total suspended solids?

Yes

Are the allowable structural stormwater controls and specifications available for review?

Yes

Indicate if they are attached or the location where they can be viewed

- [ ] Attached

Location

Structural stormwater control design requirements can be found under section 6.2 Treatment Goals for 80% total suspended solids removal for typical concentrations ranging from 30mg/l to 100mg/l in the Central Oregon Stormwater Manual https://www.coic.org/stormwater/

Have alternatives for projects complying with the retention requirement been approved?

No

Provide a brief description of the factors of technical infeasibility or site constraints that prevented the on-site management of the runoff amount stipulated in the stormwater retention requirement or a portion thereof

n/a

Before the allowance of alternative compliance, were mitigation options established?

No

If applicable, indicate which of the following mitigation options have been used and provide a narrative description of the implementation of the mitigation option

- [x] Off-Site Mitigation
- [ ] Groundwater Replenishment Projects
- [ ] Treatment Equivalent to the Retention Requirement

Explanation

not applicable- was required to select one of the boxes to submit form

Was a procedure developed for the review and approval of structural stormwater control plans for new development and redevelopment projects?

Yes

Explanation

Indicate the minimum land disturbance or creation of new impervious area where plans are required to be reviewed

5000

Are all sites that use alternative compliance to meet the retention requirement reviewed?

Yes

Explanation

NA - Alternative compliance has not been developed

Indicate if an inventory and implementation strategy is used to ensure that all stormwater controls are operated and maintained to meet the site performance standard in Schedule A.3.e.iv of the permit?

Yes

Explanation

Indicate which of the following strategies have been developed to ensure that all stormwater controls are operated and maintained to meet the site performance standard

- [x] Legal authority to inspect and require effective operation and maintenance of privately owned and operated stormwater controls
- [x] Inspection procedures and an inspection schedule to ensure compliance with the O&M requirements of each stormwater control operated by the permit registrant and by other private entities
- [x] A tracking mechanism for documenting inspections and the O&M requirements for each stormwater control
- [x] Reporting requirements for privately owned and operated stormwater controls that document compliance with the O&M requirement

Explanation

The City is updating tracking mechanisms including enforcement actions and compliance for private facilities including moving all tracking, reporting, and enforcement to the digital Cityview platform. Reporting requirements are currently required for individual stormwater maintenance agreement owners. Residential subdivision level agreements (general agreements) do not currently require reporting however the City plans to inspect a portion of individual lots on each subdivision annually.

Are the location of all public and private stormwater controls installed during this permit term documented on the MS4 Map?

Yes

Explanation

Currently, all city owned stormwater controls are mapped as well as newly constructed private facilities that are part of large subdivision developments with comingled drainage in the right of way. The City has developed an initial inventory of remaining known private stormwater controls and is in the process of verifying those to incorporate into the City's GIS.

Were all persons responsible for performing post-construction runoff site plan reviews, administrating the alternative compliance program, or performing O&M practices or evaluating compliance with long-term O&M requirements appropriately trained to conduct such activities?

Yes

Explanation

Were all new staff working to implement the post-construction site runoff for new development and redevelopment program appropriately trained within 30 days of their assignment to this program?

Yes

Explanation

Pollution Prevention and Good Housekeeping for Municipal Operations

Provide a brief summary of the overall progress towards implementation of this control measure

The City has an established O&M program that is responsible for ongoing inspection, maintenance and repair of the publicly managed storm drain system. This includes catch basins, structural controls, water quality facilities and all other associated infrastructure. The City also manages a street sweeping program to reduce pollutant loading from hard surfaces and this program sweeps the MS4 area 4 times per year. During FY24-25 the City began a performance management project to improve street sweeping and winter operations data tracking, mapping, and reporting. This project is anticipated to be complete in 2026. In addition, the City has developed performance standards trainings for municipal maintenance activities that are used to guide programs associated with street sweeping, winter road care, fleet repair/washing, storm drain O&M, litter control, corporation yard management as well as road repair/maintenance. In FY24-25 the City began migrating all trainings to a new digital platform called Neogov that will improve tracking and assignment of training to staff starting in 2026.

Were the required components in place by the implementation date?

Yes

Were O&M strategies for existing controls developed for both permit registrant-owned controls and controls owned and operated by another entity discharging to the MS4?

Yes

Explanation

Indicate the percentage of catch basins inspected/cleaned

Percentage inspected this reporting year	Percentage cleaned	
83	**83**	
If known, estimate of material removed	**946**	Units

Percentage inspected during the permit term

397

Percentage cleaned

371

If known, estimate of material removed

4519.75 cubic yards units

Explanation

Indicate if a catch basin inspection prioritization system and/or an alternate inspection frequency has been established?

Yes

Explanation

The City's current Operation and Maintenance SOP has a goal of a 2-year inspection interval for catch basins, while the MS4 permit requires a minimum of once every 5 years.

During the permit term were existing procedures for inspection and maintenance schedules reviewed/updated to ensure pollution prevention and good housekeeping practices were conducted for the following activities?

- [x] Pipe cleaning for stormwater and wastewater conveyance systems
- [x] Cleaning of culverts conveying stormwater in roadside ditches
- [ ] Ditch maintenance
- [ ] Road and bridge maintenance
- [ ] Road repair and resurfacing including pavement grinding
- [ ] Dust control for roads and municipal construction sites
- [x] Winter road maintenance, including salt or de-icing storage areas
- [ ] Fleet maintenance and vehicle washing
- [ ] Building and sidewalk maintenance including washing
- [ ] Solid waste transfer and disposal areas
- [x] Municipal landscape maintenance
- [x] Legal authority to inspect and require effective operation and maintenance of privately owned and operated stormwater controls
- [ ] Fire fighting training activities
- [ ] Maintenance of municipal facilities including public parks and open space, golf courses, airports, parking lots, swimming pools, marinas, etc.

Explanation

Do any permit registrant-owned facilities have coverage under DEQ's 1200-Z Industrial Stormwater Discharge Permit?

No

Are practices in place to reduce the discharge of pollutants to the MS4 associated with the application and storage of pesticides and fertilizers?

Yes

Explanation

Are methods/practices in place to reduce the discharge of litter within the jurisdiction?

Yes

Explanation

Are practices in place to ensure that collected material or pollutants removed in the course of maintenance are managed and disposed of in a manner such as to prevent such pollutants from entering the waters of the state in accordance with state and federal rules?

Yes

Explanation

Were all persons responsible for evaluating O&M practices, evaluating compliance with long-term O&M requirements or ensuring pollution prevention at facilities and during operations appropriately trained to conduct such activities?

Yes

Explanation

Were all new staff working to implement the pollution prevention and good housekeeping for municipal operations program appropriately trained within 30 days of their assignment to this program?

Yes

Explanation

Winter Maintenance

Is the Winter Maintenance Strategy complete?

Yes

Is the Winter Maintenance Strategy attached?

No

Is the Winter Maintenance Report attached?

No

Is the Winter Operations and Maintenance Staff Training complete?

Yes

Explanation

The City maintains a Winter Street Operations plan for managing right of way that is available online and referenced in the SWMP. https://www.bendoregon.gov/government/departments/streets/street-operations/winter#Resources

Industrial and Commercial Facilities

Was screening for existing and new industrial facilities completed during the reporting year?

N/A

How many industrial facilities were referred to DEQ for potential 1200-Z coverage?

N/A

Did DEQ respond to your industrial facility referrals?

N/A

An updated industrial/commercial facilities strategy is attached?

N/A

Staff responsible for inspecting and evaluating commercial and industrial facilities are appropriately trained per SWMP requirements to conduct activities?

N/A

A list of entities referred to DEQ, a list of categories of facilities inspected, and an overview of the inspection results are attached?

N/A

Stormwater Retrofit Strategy

Is the Stormwater retrofit strategy document complete?

Yes

Is the Stormwater retrofit strategy document attached?

Yes

Monitoring

Was municipal stormwater monitoring performed at outfall locations, in the receiving waterbody, or to demonstrate compliance with this permit?

No

Is Monitoring Data attached?

No

Water Quality Standards

During this monitoring year was it determined or reported that the MS4 discharge caused or contributed to an exceedance of an applicable water quality standard?

No

How and when did the exceedance of an applicable water quality standard occur?

n/a

Was the exceedance self-reported or did DEQ send written notification?

Within 48 hours was an investigation started into the cause of the water quality exceedance?

Within 30 days of becoming aware of the exceedance, was DEQ notified in writing, if self-reporting?

Within 60 days of becoming aware of or being notified of the exceedance, was a report submitted to DEQ that documents the following

- ☐ The results of the investigation, including the date the exceedance was discovered
- ☐ A brief description of the conditions that triggered the violation or the cause
- ☐ Corrective actions taken or planned, including the date corrective action was completed or is expected to be completed

Were the corrective actions implemented in accordance with the schedule approved by DEQ?

Provide any additional comments or narrative description

n/a

Technical Memorandum

To: Elisabeth O'Keefe and Lori Faha (City of Bend)

From: Trista Kobluskie, Rose Horton, PE, Tim Seed, Roger Tiffany, PE (Otak)

Copies: file

Date: June 30, 2025

Subject: NPDES Post-Construction Numeric Stormwater Retention Requirement (NSRR) Technical Memorandum

Project No.: 22124

Introduction and Summary

The City of Bend (City) is complying with its Phase II NPDES municipal stormwater permit (MS4 Permit) and needs to update stormwater post-construction codes and standards by November 1, 2025. The City wishes to confirm that its current stormwater standards meet the definition of a numeric stormwater retention requirement (NSRR), as required by MS4 Permit Schedule A.3.e.iii.(A). The City wishes to explore adopting standards which would allow, when the NSRR cannot be met, either the discharge of treated stormwater runoff from a development site or off-site mitigation, per MS4 Permit Schedule A.3.e.iii.(B), (C), and (D). This memorandum compares the City's standards to the required NSRR and provides recommendations for exploring a treated discharge standard and off-site mitigation options. Table 1 summarizes the observations and conclusions documented in the memorandum for reference.

Table 1. Summary of Post-Construction Stormwater Management Requirements (A.3.e.iii)

Permit Schedule	Topic	Observations and Conclusions
A.3.e.iii.(A)	Site Performance Standard	▪ NSRR is not identified by name, but the City effectively uses one by requiring all development sites to manage the NRCS Type I, 25-year, 24-hour design storm, which corresponds to 2.5 inches of rainfall, on site and by requiring runoff to remain on the lot of origin.
A.3.e.iii.(B)	1. Treatment Standard 2. Structural Stormwater Control Design and Specification	▪ The City does have an exception process, but it does not establish specific criteria for demonstrating that on-site infiltration is either technically infeasible and/or constrained by site conditions. ▪ In order to implement a permit-compliant treated discharge standard, the City would need to adopt technical infeasibility criteria and justifiable site constraints for on-site infiltration and require a treated discharge volume based on 2.5 inches of rainfall.

Permit Schedule	Topic	Observations and Conclusions
A.3.e.iii.(C)	Off-site Mitigation Alternative Compliance	▪ The City does have an exception process, but it does not establish specific criteria for demonstrating that either on-site infiltration or treatment of the NSRR volume are technically infeasible and/or constrained by site conditions.
A.3.e.iii.(D)	Off-site Mitigation Options	▪ In order to implement a permit-compliant off-site mitigation option, the City would need to: □ Adopt technical infeasibility criteria and justifiable site constraints for on-site infiltration and on-site treatment of the NSRR volume. □ Develop off-site mitigation options such as fee-in-lieu, regional stormwater facilities, or others.

Discussion of the NSRR Requirement

A 2022 report by Brown and Caldwell, *Summary of Supporting Information for the City of Bend Stormwater Design Standards Update*, identified a gap in the City's municipal code and the Central Oregon Stormwater Manual (COSM) in requiring development sites to use an NSRR as required by its MS4 Permit (see Appendix A). To examine this gap, Otak conducted a thorough review of the City's existing stormwater regulations and how they have been applied to a selection of recent new development plans in the City.

The City of Bend Municipal Code (BMC) Title 16 requires developed stormwater flows in excess of the predevelopment rate to be retained on the lot of origin (BMC 16.15.040.A.4). The Bend Design Standards define the flow-control event of interest as the NRCS Type I, 25-year, 24-hour design storm, which corresponds to 2.5 inches of rainfall.

Title 16 defines *site* as "any lot or parcel of land, or a contiguous combination of lots, parcels and/or easements under the same ownership or unified control" (BMC 16.05.060). *Lot of origin* is not defined.

Otak reviewed a selection of stormwater drainage reports submitted to the City for development between 2020 and 2025 to establish an understanding of whether proposed developments were able to retain stormwater on the lot of origin and the amount of infiltration (Table 2). We selected projects in each of the areas with varying infiltration capabilities that had been identified in the 2014 Stormwater Master Plan (Figure 1).

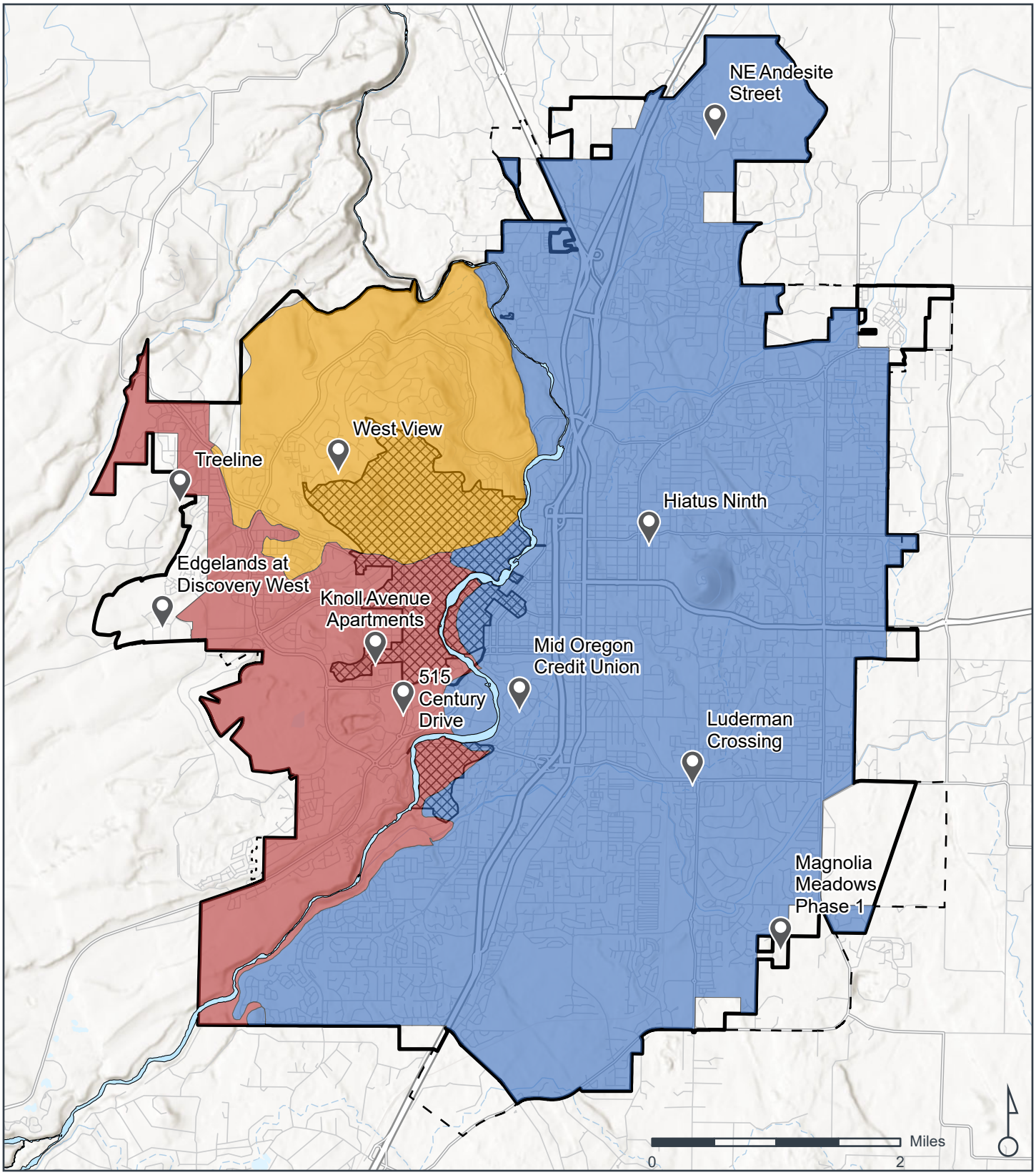


FIGURE 1

REVIEWED STORMWATER SYSTEMS IN BEND'S DRAINAGE AREAS

BEND NPDES | 22142

BEND, OREGON

Data Sources:
Date: 4/17/2025
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
- MS4 Area
- Best Infiltration
- Moderate Infiltration
- Poor Infiltration

Otak

Table 2 Stormwater Reports and Site Plans Reviewed

Project Name	Project Type	Size of Dev. (ac.)	Uses Retention	Retention Amount (in.)	Infiltration Zone (see Fig. 1)
NE Andesite Street	ROW	1.48	Y	3.0	Best
Magnolia Meadows Phase 1	Residential Subdivision	3.65	Y	2.5	Best
Hiatus Ninth	Residential Subdivision	0.54	Y	2.5	Best
Mid Oregon Credit Union	Commercial	0.89	Y	2.5	Best
Luderman Crossing Phase 2	Residential Subdivision	16.5	Y	3.0	Best
West View	ROW	1.85	Y	2.5	Moderate
Treeline	Residential Subdivision	24.98	Y	3.0	Poor
Edgelands at Discovery West	Residential Subdivision	5.16	Y	2.5	Poor
515 Century Drive	Mixed Use Multi-Family	2.20	Y	3.0	Poor
Knoll Avenue Apartments	Residential Townhome	0.28	Y	2.5	Poor

**Values represent the total 24-hour precipitation depth retained*

Summary of Findings

Title 16 requires developed stormwater flows in excess of the predevelopment rate to be retained on the lot of origin (BMC 16.15.040.A.4). The Bend Design Standards Part II and COSM define the flow-control event of interest as the NRCS Type I, 25-year, 24-hour design storm, which corresponds to 2.5 inches of rainfall. A review of recently approved stormwater reports for development in the City shows that projects typically meet the flow-control requirement by retaining the 25-year, 24-hour event on the lot of origin using infiltration facilities.

We conclude that the City of Bend effectively has an NSRR employing a volume-based method requiring retention of 2.5 inches of rainfall. No updates to the City's code or COSM are required for compliance with Schedule A.3.e.iii.(A) of the Permit.

Recommended Actions

Update Intent of "On-Site"

It is recommended that the City update the intent of the present language that requires stormwater to be kept on the lot of origin to better align with regulatory expectations and local development practices seen elsewhere in Oregon. During a meeting of the City's Water Advisory Group, Pablo Martos of the Oregon Department of Environmental Quality (DEQ) explained that DEQ is planning to interpret "on-site stormwater management" more broadly to include the greater development site or subdivision (personal communication, January 8, 2025). This interpretation is in line with the Permit's definition of *common plan of development*, a contiguous construction project or projects where multiple separate and distinct

construction activities may be taking place at different times on different schedules but under one plan. To reduce potential barriers during project review and ensure consistent application of stormwater standards, the City could update BMC 16.05.060 with a definition of *lot of origin* which matches the definition of *site*. This alignment better reflects DEQ's definition of *common plan of development* and interpretation of on-site stormwater management. Alternatively, *lot of origin* could be replaced with *site* throughout Title 16 to simplify interpretation and improve consistency. This update will allow for more flexibility for stormwater compliance in the near-term. This would not impact the City's compliance with Schedule A.3.e.iii.(A) of the MS4 Permit because the NSRR volume would still be required to be retained on site.

Discussion of the Treated Discharge Option

MS4 Permit Schedule A.3.e.iii.(A) gives the City an option to develop an exception process for sites that cannot retain 100 percent of the NSRR volume on site. Exceptions must demonstrate technical infeasibility and/or site constraints, which are to be developed and defined by the permittee. An Alternative Compliance procedure is outlined in subsequent sections of the Permit.

The City may allow projects that cannot meet the NSRR requirement to treat the remainder of the NSRR volume not retained on site and then release it with a structural stormwater control under section A.3.e.iii.(B) of the Permit (see Appendix B and C).

The Permit requires that:

> *For projects that are unable to fully meet the NSRR, the remainder of the rainfall/runoff associated with this retention requirement must be treated prior to discharge with a structural stormwater control. This stormwater structural control must be designed to remove a defined percentage of total suspended solids and may include an upper and lower bound to their treatment requirement that reflect the practical limitation of an engineered control (e.g., 80 percent removal of TSS for typical influent concentrations ranging from 100mg/L to 200 mg/L). Stormwater discharged offsite must target natural surface or predevelopment hydrology (as measured by rate, duration, and volume of discharge) to minimize the potential for hydromodification impacts, except in circumstances where the permittee can demonstrate that the risk of hydromodification impacts are negligible, (e.g., large tidally influenced waterways or flow-managed waterways).* (A.3.e.iii.(B)1)

> *For sites that utilize the treatment option to satisfy the NSRR, the permittee must provide a description of all allowable structural stormwater controls including site-specific design requirements, design requirements that do not inhibit maintenance, conditions where each control applies, and operation and maintenance standards for each control. The permittee must identify conditions where the implementation of green infrastructure or equivalent approaches may be impracticable.* (A.3.e.iii(B)2)

The key requirements of the treated discharge option are:

- To use this option, applicants must demonstrate infeasibility of on-site retention or site constraints.
- The NSRR volume not retained must be treated in a structural stormwater control.
- Structural stormwater controls must be designed to remove a defined percentage of total suspended solids (TSS).
- Discharges must target natural surface or predevelopment hydrology unless hydromodification impacts are negligible.
- Bend must provide guidance for allowable structural controls and design requirements.

Inability to Use On-site Retention

To use the treated discharge option, inability to use on-site retention due to technical infeasibility and/or site constraints must be demonstrated. Feasibility or site constraint factors may include, but are not limited to, shallow bedrock, high groundwater, groundwater contamination, soil instability, or land use that is inconsistent with infiltration of stormwater.

Under the City's current standards, there are no specific criteria for determining infeasibility of infiltration on a site. City staff did not locate any recent examples of exemptions or waivers provided for use of on-site infiltration.

Bend Development Code's (BDC) Waiver and Modification of Public Improvement Standards (BDC 3.4.150) allows a pathway for development projects to request changes or exceptions to improvement standards for public and private infrastructure, such as transportation facilities; sewer, water, and other utilities; and drainage features and activities. In BDC 3.4.150, an applicant for a waiver from storm drainage improvements must demonstrate one of the following:

- The modification or waiver is necessary to eliminate or reduce impacts on existing drainage patterns or natural features such as riparian areas, significant trees, or steep slopes;
- Building on an existing lot would be infeasible without the modification or waiver; and
- Installation of required improvements would cause unacceptable significant adverse environmental impacts.

Under BDC 3.4.150, the City Engineer must issue a recommendation to waive or modify public improvement standards to the Review Authority for a specific development after reviewing the justifications provided. The chapter does not specify criteria for demonstrating infeasibility of infiltration.

BMC 16.15.020(B) offers exceptions for stormwater design elements that do not conform to COSM. BMC 16.15.040, Post-Construction Performance Standards for Stormwater Management, allows exceptions for retaining stormwater on the lot of origin if the City determines that retaining the design storm would pose a threat to public safety or adjacent properties (16.15.040(A)4); in these cases, flows may be directed to an off-site drainage facility approved by the City.

Neither of these sections offer criteria for demonstrating infeasibility of on-site infiltration.

Appendix 2B in COSM includes tables of potential BMPs to consider using on challenging sites but does not establish criteria for disallowing on-site infiltration. Challenging sites listed in COSM include:

- High groundwater areas
- Steep slopes
- Areas of natural impermeability
- Areas of fractured rock or minimal soil coverage

By contrast, the *Rogue Valley Stormwater Quality Design Manual* (2024) used by the cities of Central Point, Medford, and Ashland includes the following definitions of infeasibility for use of infiltration:

- Separation Distance from Seasonal High Groundwater and Bedrock: less than 3 feet for UICs and permeable pavement (without run-on); less than 5 feet for facilities with no soil growth media and permeable pavement (with run-on).
- Steep Slopes: 15 percent slope or greater average across the project site, or a certified professional recommends avoiding infiltration due to instability.
- Separation Distance to Drinking Water Wells: Defers to DEQ regulations; less than 500 feet of separation from a UIC to a drinking well, or less than 50 feet of separation between a stormwater facility and a drinking water well.
- Land Use Planning: Incompatible land use
- Transportation: If purchase of ROW is needed for a retention facility
- Infiltration Rate: Less than 1.5 inches per hour
- Contaminated Soils: Defers to DEQ classification
- Other: Any other criteria determined by the local jurisdiction

The City has standards which may serve as an exception process for the NSRR, although the standards lack specific criteria for a finding of infeasibility or site constraints preventing use of infiltration.

Treatment Volume Requirements

To use the treated discharge option, the portion of the NSRR volume not retained must be treated in a structural stormwater control. The structural stormwater solution would need to treat up to the NSRR volume, or 2.5-inch rainfall depth. City of Bend Design Standards Part II and COSM establish the required treatment volume for development sites. In Bend, water quality facilities currently must be designed to treat the 6-month NRCS Type I, 24-hour storm (Design Standards 6.1.2, COSM 6.4.1), which is a 1-inch rainfall depth in Bend (COSM Table 5-5).

The treatment volume specified in the Bend Design Standards Part II and COSM would not meet the MS4 Permit requirement for this option. The treatment volume could be amended with updates to Bend Design Standards Part II, Section 6.1.2, and be written to override the treatment volume specified in COSM.

In considering whether to provide a treated discharge option to meet the NSRR, the City may wish to consider evaluating the size and cost of a facility that could treat 2.5-inch rainfall depth. Otak sized two theoretical treatment facilities to meet this hypothetical requirement. An existing 4.61-acre affordable housing development called College View Apartments was chosen as a test site. Two facilities, a Contech StormFilter® vault and a water quality swale, were sized using runoff flows calculated in HydroCAD Version 10.0. The design runoff volume was derived from the 2.5-inch rainfall depth and design requirements outlined in Section 6.3 in the City of Bend Design Standards Part II. Table 3 shows the results of the modeling exercise.

Table 3. Treated Discharge Facility Sizing and Cost Evaluation

	StormFilter® Vault	Water Quality Swale
Site Area (ac)	4.61	4.61
Impervious area (ac)	2.12	2.12
Runoff (cfs)	3.4	3.4

	StormFilter® Vault	Water Quality Swale
Facility Requirements	▪ 104 18-inch StormFilter® cartridges (15-gal/min flow rate) ▪ four 8 x 12 vaults	▪ 309 feet in length ▪ 2-foot bottom width, 1.5 feet of depth, and 3:1 side slopes
Facility Footprint (sf)	384 (facility is underground)	3,550 (assuming optimal site conditions)
Impact on Site	Requires approximately 400 sf of surface under which vaults can be located, which could include parking and landscaping	Swale footprint occupies approximately two percent of the site, not including setback requirements or access
Planning Level Cost – based on Bend Stormwater Master Plan Stormwater CIP Tool Kit	Proprietary Filter Vault 8 x 12 vault with 28 filters $100,500 each x 4 = $402,000	Swale/Infiltration Swale $60/sf x 3,550 = $213,000

This rudimentary analysis suggests that structural stormwater controls designed to treat the volume from a 2.5-inch rainfall depth could be prohibitive in terms of size and cost.

Treatment Facility Removal Rates

To use the treated discharge option, structural controls must be designed to remove a defined percentage of TSS. The permit specifically prohibits detention ponds to serve as a treatment option to meet this requirement.

The COSM design criteria for water quality treatment facilities meet the Permit's requirements for TSS removal rates. The structural BMPs in Chapter 6, Water Quality Treatment, are designed to remove 80 percent of TSS for typical influent concentrations ranging from 30mg/L to 100 mg/L when the ultimate destination of the discharged stormwater is surface water (6.2.1). COSM does not allow detention ponds to be used as a water quality treatment BMP.

Existing treatment removal rates are sufficient for use with the treated discharge option.

Discharge Rates, Volumes, Durations

To use the treated discharge option, discharges must target natural surface or predevelopment hydrology unless hydromodification impacts are negligible. In addition to treatment, development sites would also need to use a flow-control facility.

COSM requires flow control (Basic Requirement #4) for all projects that add or replace 5,000 square feet of impervious surface unless discharging to a flow-managed water body such as the Deschutes River. Development sites utilizing treated discharge to the Deschutes River would require a downstream analysis to assure that the existing downstream conveyance system can accommodate the full uncontrolled discharge of the 25-year storm event in addition to existing conveyance.

In considering whether to provide a treated discharge option to the NSRR, the City may wish to consider evaluating the size and cost of a flow-control facility that could also treat 2.5-inch rainfall depth. Using the same site described above, Otak sized a theoretical extended detention dry pond to meet this hypothetical requirement. To provide comparison, we also sized an extended detention dry pond to

provide flow control and treat a 1-inch rainfall depth. The facilities were sized using the City's definition of pre-development—the natural condition before any type of development (BMC 16.05.060), and to match peak discharges per COSM Table 2-1. Table 4 shows the results of the modeling exercise.

Table 4. Extended Detention Dry Pond Sizing and Cost Comparison

	Extended Dry Detention Pond Sizing Using Current Standards	Extended Dry Detention Pond Sizing Using NSRR Volume
Site Area (ac)	4.61	4.61
Pre-development land cover	Woods, good condition	Woods, good condition
Pre-development Hydrologic Soil Group*	Type D	Type D
Impervious area (ac)	2.12	2.12
Water Quality Flow (cfs)	1.23	3.4
Facility Requirements	▪ 26.5L x 26.5W bottom dimensions ▪ 3:1 side slopes ▪ 7 feet of depth	▪ 53.7L x 53.5W bottom dimensions ▪ 3:1 side slopes ▪ 4 feet of depth
Facility Footprint (sf)	4,665	6,029
Facility Storage Volume (cf)	16,684	17,424
Impact on Site	Pond footprint occupies approximately 2.3 percent of the site, not including setback requirements or access	Pond footprint occupies approximately 3.0 percent of the site, not including setback requirements or access
Planning Level Cost – based on Bend Stormwater Master Plan Stormwater CIP Tool Kit	$116,785	$121,970

**For the purpose of this exercise, soils were set to Type D because this option would likely only be used if infiltration could not be accomplished on the site. We used Type D soils in this analysis although the actual site is approximately 50 percent Type A and 50 percent Type D.*

If discharging to the Deschutes River, there is negligible potential for hydromodification from stormwater discharged into the Deschutes River. The Upper Basin of the Deschutes River drains an area of Deschutes County, approximately between the Wickiup Reservoir to the northern border of the county, which includes the City of Bend. This portion of the river is a highly regulated and managed waterway. Its flow is largely determined by the operation of upstream storage infrastructure, which controls seasonal water releases to meet irrigation demands. During the irrigation season, flows are released through the dams to meet downstream demands. During the non-irrigation season, natural flows are stored behind dams in reservoirs. Within the City of Bend, there are multiple points of diversion to canals operated by irrigation districts, and one hydroelectric dam which regulates natural flow (Figure 2). The Deschutes River appears to meet a classification of a flow-managed waterway. The COSM affirms this position; it exempts projects from flow-control requirements that discharge directly to the Deschutes River (COSM, p. 2-12).

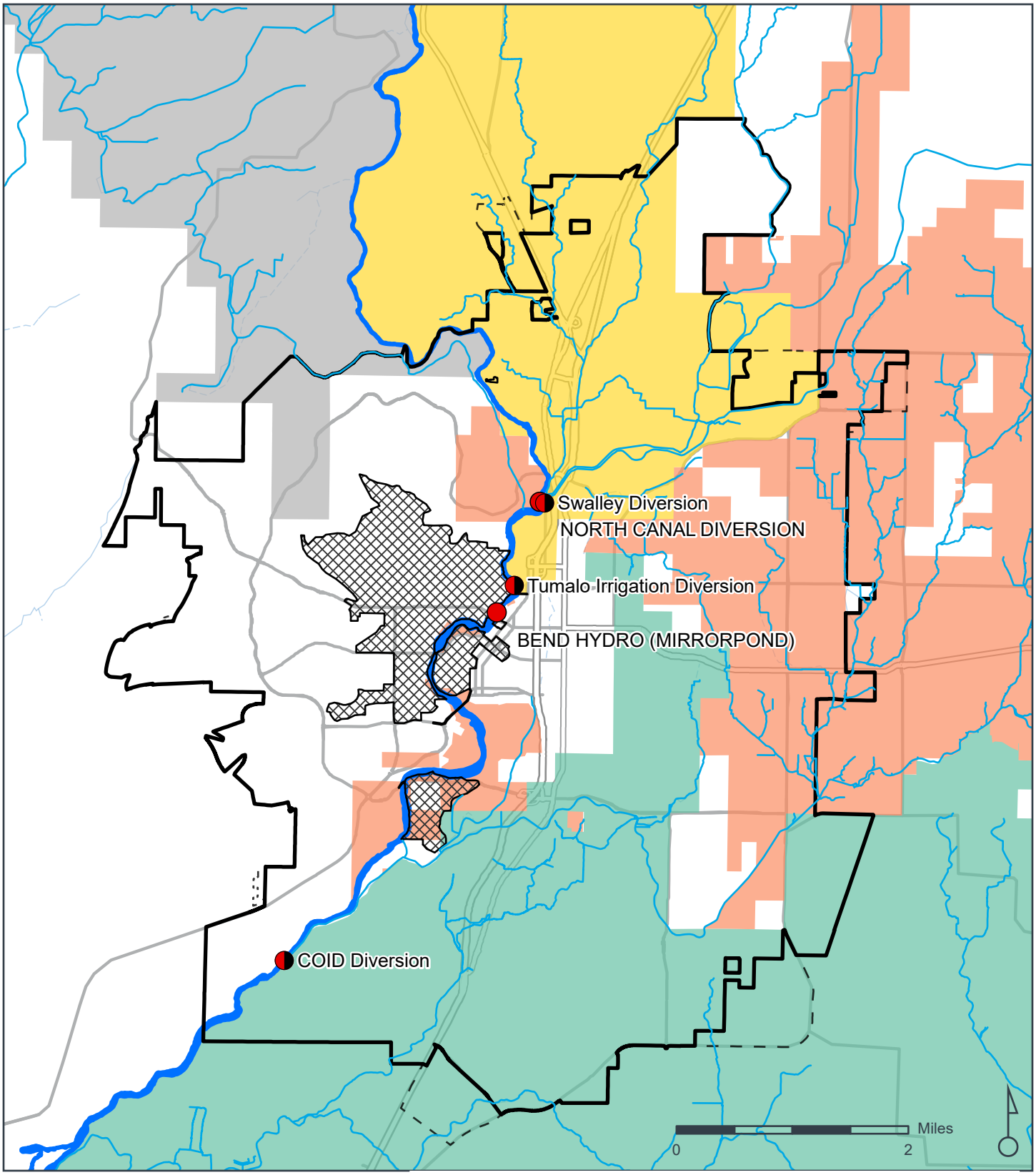


FIGURE 2

CONTROLS ON THE DESCHUTES RIVER WITHIN BEND

BEND NPDES | 22124

BEND, OREGON

Data Sources:
Date: 4/17/2025
Disclaimer: This data is not to survey accuracy and is meant for planning purposes only.

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- Bend City Limits
- Urban Growth Boundary
- MS4 Area
- DAM FACILITY
- Irrigation Diversion
- Arnold Irrigation District
- Central Oregon Irrigation District (COID)
- Swalley Irrigation District
- Tumalo Irrigation District
- Deschutes River
- Canal

Otak

Guidance for Allowable Structural Controls and Design Requirements

To use the treated discharge option, the City must provide guidance for allowable structural controls and design requirements.

Chapters 6 and 7 in COSM, Water Quality Treatment and Flow Control Design, respectively, provide the needed guidance and design requirements. Each facility type includes site-specific design requirements, design requirements for not inhibiting maintenance, conditions where each control applies, and operation and maintenance (O&M) standards.

Existing design guidance is sufficient for use with the treated discharge option, with the caveat that Bend would need to require treatment of a volume derived from 2.5 inches instead of 1 inch of rainfall. This could be accomplished through updates to Bend Design Standards Part II, Section 6.1.2.

Other Discussion

The increases in facility sizes that may result if the City offers a treated discharge option could pose a barrier to both its use as an option and to development, if implemented. One strategy to incorporate stormwater infrastructure is to co-locate the facilities in required open space, parking, or landscaping for new development or redevelopment. The Permit requires preference for green infrastructure: *"The permittee should encourage the use of treatment trains of structural post-construction stormwater controls and must give priority to implementing green infrastructure before considering hardscaped structural stormwater controls for stormwater treatment"* (A.3.e.iii.(B)1.).

According to the Bend Development Code, stormwater facilities may be co-located in the required open space for development. The area of the facilities may contribute to open space requirements provided the space is usable. The required amount of open space varies by zoning and land use. For example: cluster housing (zoned RM) has specific standards that require centrally located public open space that is at least 400 square feet per cottage (BDC 3.8.500(H)), and multi-unit residential developments (zoned RM or RH) with 20 or more units require a minimum 10 percent open space area (BDC 2.1.1000(B)(1)). Open space requirements are separate requirements from required landscaped area.

The City currently requires 15 percent landscaped areas for new development and redevelopment of residential (single-room occupancies with more than six units, micro-units, and multiple-units), commercial, industrial, mixed use, public, and institutional land uses (BDC 3.2.300.C). There may be other landscape standards outlined for Special Planned Districts. Landscaped stormwater facilities such as swales, stormwater planters, and stormwater trees may be counted toward landscaped area percentages, which includes parking areas and buffers or screens (BDC 3.2.300.D.8 & E).

In BDC 2.7.3270, Low Impact Stormwater Management, the City promotes the use of low-impact development (LID) techniques to manage stormwater on site. This section promotes shared stormwater facilities between properties and raingardens/bioretention areas to filter stormwater.

Treated Discharge Recommendation

Per section A.3.e.iii.(A) in the Permit, it is not compulsory that the City offer a treated discharge option for meeting the NSRR. If Bend wishes to allow a treated discharge option, it will need to establish infeasibility criteria for infiltration and update the treatment volume required when this option is selected.

The City should evaluate whether it is reasonable based on a range of factors: potentially large sizes of the required water quality facilities, whether stormwater infrastructure will significantly reduce a site's developable area, and how the City will define infeasibility of infiltration.

The following recommendations assume the City decides to implement a permit-compliant treated discharge option outlined in Schedule A.3.e.iii.(B).

Waivers and Modifications

Provide more detailed language within BDC 3.4.150, Waivers and Modifications, to ensure that applicants satisfy the need to demonstrate technical infeasibility or site constraints preventing retention of the NSRR on site before being approved to use the treated release alternative.

Infeasibility Criteria

Adding specific infeasibility criteria for infiltration is recommended. This could be accomplished by adding infeasibility criteria to Title 16 and deeming use of infiltration in these situations to cause "adverse impact to existing drainage patterns or steep slopes" and/or to cause "unacceptable significant adverse environmental impacts," which would give the appropriate justification for waiver under BMC 3.4.150.

Conditions specific to the City may include the following adjustments to the suggested criteria in COSM:

- High groundwater areas: Minimum separation distance between seasonal high ground water and the bottom of infiltration facilities
- Steep slopes: Maximum percentage grade for use of infiltration on steep slopes
- Areas of natural impermeability: Minimum infiltration rate; flexibility in areas of the City with known areas of impermeable welded tuff
- Areas of fractured rock or minimal soil coverage: Minimum infiltration rate

Suggested criteria from the Permit Schedule A.3.e.iii.(A):

- Shallow bedrock: Minimum separation distance from bedrock
- Groundwater Contamination: Minimum horizontal separation from drinking wells in line with DEQ regulations
- Incompatible land use: To be determined by the City, but may include land uses with high risk of contaminating stormwater, dense small-lot development, or other land uses

A detailed policy analysis and recommendations from a geotechnical engineer are recommended before adopting infeasibility criteria into code.

Treatment Volume

City of Bend Design Standards Part II, Section 6.1.2, would require updating to define a treatment volume based on 2.5 inches of precipitation when on-site infiltration is not feasible.

Landscaping Requirements

The landscaping requirements in Bend's Development Code appear to allow flexibility for placing stormwater facilities into required open space and landscaping. To include a greater set of stormwater facilities in landscaped areas, buffers, and parking lots, it is recommended that BDC 3.2.300.D.8 replace "bio-swales" with "above-ground stormwater BMPs."

Discussion of Off-site Mitigation Option

The City of Bend does not currently have an established off-site mitigation program for stormwater. All stormwater must be retained on the lot of origin. Off-site mitigation is an optional program that the City is permitted to implement. Permit sections A.3.e.iii.(C) and A.3.e.iii.(D) outline off-site mitigation alternative compliance and off-site mitigation options, respectively, to meet unmet NSRR infiltration volume and/or water quality goals (see Appendix D and E).

In order to allow development sites to use an off-site mitigation option, the Permit requires that:

> *For projects unable to fully meet the NSRR and/or treatment standard alternative, the permittee may choose to allow offsite alternatives for projects based on factors of technical infeasibility or site constraints. The determination that the NSRR and/or treatment standards cannot be achieved at the project site must be based on review criteria and cannot be based solely on increased cost. The offsite alternatives must account for retention or treatment at least equal to the NSRR volume not met onsite.*
>
> *For project sites requesting alternative compliance, the permittee must require and subsequently evaluate the written technical justification documenting the infeasibility or site constraints, which prevent the onsite management of the runoff amount stipulated in the NSRR. The written technical justification must be in the form of a site-specific hydrologic or design analysis conducted and endorsed by an Oregon registered Professional Engineer or Oregon Certified Engineering Geologist.*
>
> *If the permittee agrees that alternative compliance with the retention requirement is necessary, meaning retention of or treatment up to the NSRR volume is not feasible, the permittee must require that the site operator use one or more of the stormwater mitigation options outlined in the Offsite Stormwater Mitigation Options below for any portion of the NSRR not retained or treated.* (A.3.e.iii.(C))

The key requirements to allow use of an off-site mitigation option are:

- Applicant must demonstrate technical infeasibility or site constraints that limit use of on-site stormwater management to meet the NSRR and/or the treated discharge requirement using site-specific hydrologic or design analysis conducted by a certified professional, which may not be based solely on cost.
- Bend must evaluate the written justification and agree with it to proceed.

Before allowing off-site mitigation, the City must establish the mitigation options that are available to applicants. No one strategy is mandated by the Permit. Options for alternative compliance must include institutional standards and management systems to value, estimate, and account for how mitigation projects address unmet NSRR volume. Mitigation options must achieve at least one of the following:

> *Offsite Mitigation: General offsite mitigation options may include meeting the retention requirement at another location, the use of a stormwater mitigation bank program, the use of stormwater payment-in-lieu program, or offsite treatment up to the NSRR.* (A.3.e.iii.(D)1.)
>
> *Offsite Groundwater Replenishment Projects: Groundwater replenishment projects include implementing a project that the permittee has determined to provide an opportunity to replenish regional groundwater supplies*. (A.3.e.iii.(D)2.)

An off-site mitigation program can offer several benefits when fully implemented. This program provides an option to maximize land use efficiency while also meeting stormwater regulations and requirements. Regional facilities can increase flexibility for projects and support stormwater management planning. The 2025 update to Bend's *Stormwater Master Plan* will explore policies for regional stormwater facilities.

Off-site Mitigation Recommendation

Implementing an off-site mitigation program will take considerable planning efforts from the City. There are no off-site mitigation programs currently in place. Modifications to Bend's Development Code, Municipal Code, and Standards and Specifications would be required, and internal standards and procedures for processing applications and tracking off-site mitigation would need to be developed.

Due to the limited amount of available space within the City, an off-site mitigation program may be best suited for special districts, planned expansions into the urban growth area where no stormwater facilities exist, or redevelopment of dense or highly impervious areas. A geographic limitation of off-site mitigation is that off-site mitigation sites must be within the same subwatershed (HUC-12) as the development seeking the off-site mitigation option. The City has five subwatersheds within its UGB (Figure 3). An analysis to prioritize subwatershed basins and identify potential sites for off-site mitigation should be conducted prior to implementation.

Conclusion

The City of Bend effectively has an NSRR established in current codes and stormwater regulations.

Through analysis of new development applications in the past five years, despite differences in infiltration capacity in different areas of the City, all developments reviewed indicate that stormwater infiltrated on the lot of origin. The City's requirement for stormwater to be kept on the "lot of origin" is more restrictive than the intent of on-site stormwater management requirements, including the NSRR, provided by DEQ. It is recommended that the City adopt a broader definition of "lot of origin" or change the standard to "on-site" wherever "lot of origin" is written in relationship to stormwater in Title 16 and BDC.

Allowance of treated discharges and off-site mitigation options would require the City to take additional steps such as updating engineering standards.

Next Steps

The City can take steps in the near and long term to update its post-construction standards to align with Permit requirements. In the near-term, the City may develop specific criteria for on-site infiltration infeasibility that are best for the City's unique geology, and consider providing the treated release option to the NSRR. On a longer time horizon, the City may consider the desired structure for an off-site stormwater mitigation program.

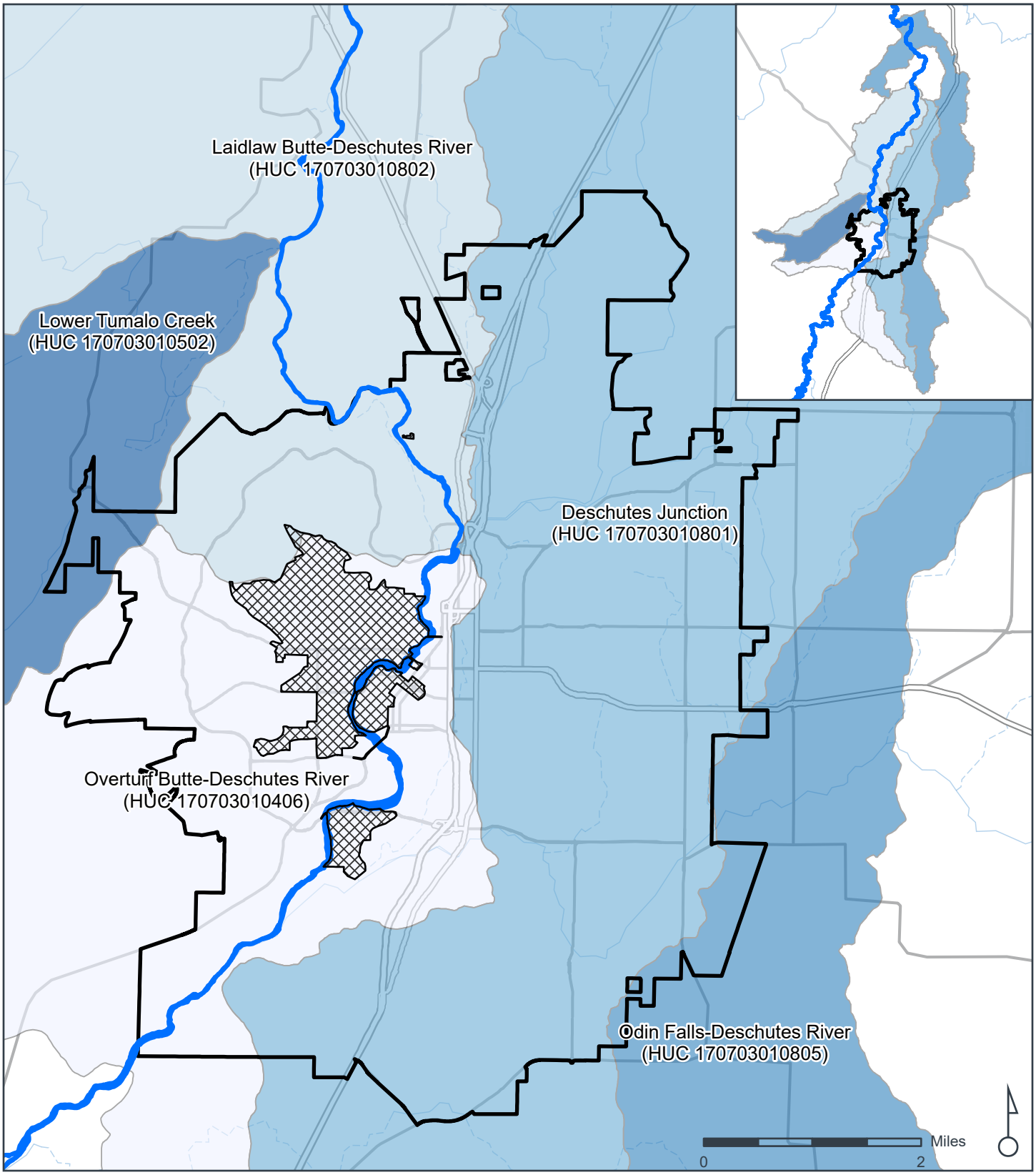


FIGURE 3

SUB-WATERSHED BASINS WITHIN THE CITY OF BEND

BEND NPDES | PROJECT 22124

BEND, OREGON

Bend City Limits
Urban Growth Boundary
MS4 Area
Deschutes River

Sub-watershed (HUC 12)
Overturf Butte-Deschutes River
Laidlaw Butte-Deschutes River
Deschutes Junction
Odin Falls-Deschutes River
Lower Tumalo Creek

Data Sources:
Date: 6/9/2025
Disclaimer: This data is not to survey accuracy and is meant for planning purposes only.

O:\PROJECT\22100\22124\04 CAD\GIS\Bend NPDES\Bend_NPDES.aprx

Otak

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Appendices

Appendix A. Permit Requirement: Establishing NSRR

Appendix B. Permit Requirement: Treatment Standard

Appendix C. Permit Requirement: Structural Stormwater Control Design and Specifications

Appendix D. Permit Requirement: Off-site Mitigation Compliance

Appendix E. Permit Requirement: Off-site Stormwater Mitigation Options

Appendix A. Permit Requirement: Establishing NSRR

Permit Section Reference	A.3.e.iii.(A) *Site Performance Standard*
Permit Text	The permittee must establish a site performance standard with a Numeric Stormwater Retention Requirement (NSRR) to target natural surface or predevelopment hydrologic function to retain stormwater on site and minimize the off-site discharge of pollutants in runoff utilizing structural stormwater controls that infiltrate, capture, and/or evapotranspirate stormwater. This NSRR volume must be determined by the use of one of the following: 1. Volume-based method (for example, the first inch of each storm event) 2. Storm-event percentile-based method (for example, the 95th percentile storm event – 95 percent of the time the data is below this value) 3. Annual runoff-based method (for example 80 percent of annual average runoff) The site performance standard is met when 100 percent of the NSRR volume (determined by the method chosen above) from the project site is routed to one or more structural stormwater controls with sufficient capacity to accommodate this stormwater runoff and will fully infiltrate (after any necessary treatment), evapotranspirate, and/or be reused on site without stormwater runoff discharging from the site. Evapotranspiration and reuse can be used to meet the retention requirements but are not required prior to pursuing treatment or alternative compliance options discussed below. At sites where 100 percent of the NSRR volume cannot be retained due to technical infeasibility and/or site constraints, the permittee may develop an exception process for the retention in the site performance standard by following the Step-Wise Alternative Compliance procedure outlined below (see Schedule A.3.e.iii.B and C). Such feasibility or site constraint factors may include, but are not limited to, shallow bedrock, high groundwater, groundwater contamination, soil instability as documented by geotechnical analysis, or a land use that is inconsistent with capture and infiltration of stormwater.
Current Standards	The City of Bend Municipal Code Title 16 requires developed stormwater flows in excess of the predevelopment rate to be retained on the lot of origin and not trespass onto the public right-of-way or private property. Both the Bend Design Standards and Central Oregon Stormwater Manual (COSM) define the flow-control event of interest as the NRCS Type I, 25-year, 24-hour design storm, which corresponds to 2.5 inches of rainfall.

Manual, Code, and/or Design Standards Reference	▪ BC 16.15.040.4 ▪ City of Bend Design Standards Part II, 6.2.1 ▪ COSM, 2.2.4 ▪ COSM Appendix 2B
Findings	▪ NSRR is not identified by name, but the City effectively uses one. ▪ Standards require retention of a volume based on 2.5 inches of rainfall on sites (lots of origin) We did not find examples of the City granting exceptions to the requirement to retain stormwater on site for sites that met the threshold for requiring stormwater management. COSM Appendix 2B offers suggestions for BMPs to use on sites with challenging conditions but does not establish criteria for determining that the flow-control volume cannot be retained on site.

Adjunct B. Permit Requirement: Treatment Standard (Treated Discharge)

Permit Section Reference	*A. 3.e.iii.(B)1. Treatment Standard*
Permit Text	For projects that are unable to fully meet the NSRR, the remainder of the rainfall/runoff associated with this retention requirement must be treated prior to discharge with a structural stormwater control. This stormwater structural control must be designed to remove a defined percentage of total suspended solids (TSS) and may include an upper and lower bound to their treatment requirement that reflect the practical limitation of an engineered control (e.g., 80 percent removal of TSS for typical influent concentrations ranging from 100mg/L to 200 mg/L). Stormwater discharged off site must target natural surface or predevelopment hydrology (as measured by rate, duration, and volume of discharge) to minimize the potential for hydromodification impacts, except in circumstances where the permittee can demonstrate that the risk of hydromodification impacts are negligible, (e.g., large, tidally influenced waterways, or flow-managed waterways). The permittee should establish treatment requirements that target the equivalent water quality benefits as on-site retention of stormwater from new development or redevelopment sites using a model, such as a continuous simulation model or other evaluation tool. The permittee should encourage the use of treatment trains of structural post-construction stormwater controls and must give priority to implementing green infrastructure before considering hardscaped structural stormwater controls for stormwater treatment. Detention ponds are not a sufficient stand-alone treatment method and must be combined with other structural stormwater controls. Treating the volume of water that would otherwise be retained under the NSRR satisfies the retention requirement.
Current Standards	The City requires all developments to retain 100 percent of a volume based on 2.5 inches of rainfall on the site of origin. The City does not have a standard approach for alternatives if infiltration is determined to be infeasible. The current treatment standard in COSM requires treatment in Bend of a volume or flow based on 1 inch of rainfall. Following the flow-control standard for site discharges in COSM, detention facilities must detain runoff such that the release rate does not exceed the pre-developed conditions for multiple storm events, including the 2-year and 25-year. COSM exempts projects that discharge directly to the Deschutes River from flow-control requirements.

Manual Code and/or Design Standards Reference	▪ BC 16.15.040.A.4. ▪ BDC 3.4.150 ▪ COSM 5.1 ▪ COSM 6.2.1 ▪ COSM 6.5 ▪ COSM 2.2
Findings	▪ This part of the Permit is optional. No gap identified to meet requirements for post-construction site runoff for new development and redevelopment by November 2025. ▪ If the City were to allow exceptions to on-site retention by meeting a treatment option, the following findings would apply: □ The current treatment standard in COSM (1 inch) would not meet the requirement to treat the current NSRR volume in Bend (2.5 inches). The current flow-control standard in COSM would meet the requirement for discharges to target natural surface or predevelopment hydrology (as measured by rate, duration, and volume of discharge).

Appendix C. Permit Requirement: Structural Stormwater Control Design and Specifications

Permit Section Reference	A.3.e.iii.(B)2. *Structural Stormwater Control Design and Specifications*
Permit Text	For sites that utilize the treatment option to satisfy the NSRR, the permittee must provide a description of all allowable structural stormwater controls including site-specific design requirements, design requirements that do not inhibit maintenance, conditions where each control applies, and operation and maintenance (O&M) standards for each control. The permittee must identify conditions where the implementation of green infrastructure or equivalent approaches may be impracticable. A permittee may adopt specifications created by another entity that complies with this requirement.
Current Standards	COSM describes allowable structural stormwater controls to meet the treatment standard, including design requirements, maintenance access requirements, conditions for use, and maintenance criteria. COSM offers a chapter on site design and low impact development. City of Bend Design Standards Part II describes preferred stormwater strategies by area (defined by site drainage characteristics) and by pollutant of concern. City of Bend Standard Drawings includes standard details and drawing for structural stormwater controls and their components for use in Bend. COSM Appendix 2-B identifies appropriate BMPs for challenging sites, which includes a discussion of when some green infrastructure facilities may not be appropriate.
Manual, Code, and/or Design Standards Reference	▪ COSM 6, 7, 8, 11, 12, Appendices 2-B and 12-B ▪ City of Bend Standard Drawings ▪ City of Bend Design Standards Part II 6.3
Identified Gaps	▪ This part of the Permit is optional. No gap identified. ▪ If the City were to allow exceptions to on-site retention by meeting a treatment option, the following findings would apply: □ The current discussion of structural stormwater controls and green infrastructure in COSM would be sufficient to meet the requirement.

Appendix D. Permit Requirement: Off-site Mitigation Compliance

Permit Section Reference	A.3.e.iii.(C) *Offsite Mitigation Compliance*
Permit Text	For projects unable to fully meet the NSRR and/or treatment standard alternative, the permittee may choose to allow off-site alternatives for projects based on factors of technical infeasibility or site constraints. The determination that the NSRR and/or treatment standards cannot be achieved at the project site must be based on review criteria and cannot be based solely on increased cost. The off-site alternatives must account for retention or treatment at least equal to the NSRR volume not met on site. For project sites requesting alternative compliance, the permittee must require and subsequently evaluate the written technical justification documenting the infeasibility or site constraints, which prevent the on-site management of the runoff amount stipulated in the NSRR. The written technical justification must be in the form of a site-specific hydrologic or design analysis conducted and endorsed by an Oregon registered Professional Engineer or Oregon Certified Engineering Geologist. If the permittee agrees that alternative compliance with the retention requirement is necessary, meaning retention of, or treatment up to, the NSRR volume is not feasible, the permittee must require that the site operator use one or more of the stormwater mitigation options outlined in the Offsite Stormwater Mitigation Options below for any portion of the NSRR not retained or treated.
Current Standards	BMC Title 16 requires that water in excess of the predevelopment flow rate be contained on the lot of origin. If this is not possible, then runoff can be directed to an off-site drainage facility as approved by the City. If the off-site retention/treatment is directed to city-owned property, the owner of the lot(s) of origin are required to compensate the City for construction and O&M costs related to the increased stormwater drainage and treatment capacity. The City has neither adopted approval criteria for using off-site stormwater control nor published submittal procedures for technical justification.
Manual, Code, and/or Design Standards Reference	▪ BMC 16.15.040 A.4
Findings	▪ Although allowable under code, the City does not have a process, procedure, guidelines, or criteria for approval of off-site stormwater management.

Appendix E. Permit Requirement: Off-site Stormwater Mitigation Options

Permit Section Reference	A.3.e.iii.(D) *Offsite Stormwater Mitigation Options*
Permit Text	If the permittee chooses to develop mitigation options for alternative compliance, such options may include, but are not limited to, a payment-in-lieu program or other option that matches the water quality goal of the NSRR at any given site. Before allowing off-site alternative compliance with the NSRR, the permittee must establish stormwater mitigation options for alternative compliance, including institutional standards and management systems to value, estimate, and account for how these mitigation projects address the unmet volume of the stormwater specified in this retention requirement. The mitigation project or site must be within the same subwatershed as the site undergoing development. Stormwater mitigation options must include one or more of the following for alternative compliance: 1. Off-site Mitigation General off-site mitigation options may include meeting the retention requirement at another location, the use of a stormwater mitigation bank program, the use of stormwater payment-in-lieu program, or off-site treatment up to the NSRR. 2. Off-site Groundwater Replenishment Projects Groundwater replenishment projects include implementing a project that the permittee has determined to provide an opportunity to replenish regional groundwater supplies.
Current Standards	The City does not have an off-site mitigation program nor the required components such as off-site facilities, payment-in-lieu options, or institutional standards to value, estimate, and account for retention volumes not contained on site.
Manual, Code, and/or Design Standards Reference	▪ None
Findings	▪ There are no current off-site stormwater mitigation options in Bend.

Memorandum

To:	Austin Somhegyi, City of Bend
From:	Trista Kobluskie, Philip Kenyon, PE
Copies:	Lori Faha, Elisabeth O'Keefe, File
Date:	August 27, 2024
Subject:	Outfall Retrofit Needs Assessment
Project No.:	20359

Introduction

The City of Bend is updating its Stormwater Master Plan (SMP) and is reviewing its existing stormwater outfalls to identify retrofit needs and opportunities. Stormwater in the City of Bend discharges predominantly into underground injection controls (UICs). However, the area around the Deschutes River north of Farewell Bend Park discharges to the river itself. Geographic Information System (GIS) records indicate that there are 31 outfalls owned by the City of Bend. An outfall is a point discharge from the City's Municipal Separate Storm Sewer System (MS4) into the river. A majority of these outfalls are not located on City-owned property and are located either on Bend Park and Recreation Department (BRPD) properties or located on other private properties. This Outfall Retrofit Needs Assessment studies the characteristics of each outfall's contributing basin with respect to its pollution source potential and incorporates information about the condition and accessibility of the stormwater pipes and outfalls.

Purpose

The purpose of this Outfall Retrofit Needs Assessment is to document the City's stormwater quality retrofit objectives and to identify the outfalls most in need of retrofit when considering the objectives. Subsequent analyses will identify potential projects to retrofit the highest priority outfalls. The City's MS4 permit requires the following: "The permittee must develop a Stormwater Quality Retrofit Strategy that addresses areas identified by the permittee as having an impact on water quality, and that are underserved, difficult to maintain in its current design, or lacking stormwater quality controls.

A. The stormwater retrofit strategy must be based on a permittee-defined set of stormwater quality retrofit objectives and a comprehensive evaluation of a range of retrofit control measures and its appropriate use. The permittee-defined objectives must prioritize progress toward improving water quality.

B. The permittee must submit a stormwater retrofit strategy document with permittee-defined objectives with the fourth annual report, due to the Oregon Department of Environmental Quality by November 1, 2025.

Stormwater Quality Retrofit Objectives

The City has identified the protection of the public, natural resources, water quality, and the preservation of existing City infrastructure as primary goals for their Master Plan. The stormwater quality retrofit objectives described below will support these goals.

Urban stormwater runoff is known to carry a variety of pollutants, including metals, oils, chemicals, bacteria, and nutrients. An emerging group of dissolved contaminants of concern are per- and-polyfluoroalky substances (PFAS). The City of Bend utilizes Magnesium Chloride (MgCl) for deicing operations during the winter months. The Deschutes River from Spring River to North Unit Diversion Dam (AU_ID = OR_SR_1707030104_05_102628) is listed as Category 5 Impaired for sedimentation, temperature (year round), turbidity, and pH, and is listed as Category 4 Impaired for flow modification and habitat modification. Sedimentation, turbidity and pH can all be influenced by urban stormwater.

The City staff has documented numerous instances of inlet clogging and movement of particulate material around and through the stormwater system in undesirable/unintended ways. These challenges can be referred as pretreatment challenges. Lack of pretreatment contributes to stormwater pollution in a couple of ways. First, when inlets are clogged with sediments, inlet capacity is reduced, leading to runoff flowing for longer distances over impervious surfaces and picking up more pollutants. Second, some sediments are conveyed through the piped system and discharged to the river along with pollutants that may adsorb to the particles. Typical pretreatment systems provide capture/removal of particulate matter and floatable materials.

The City staff has also documented both poor condition and maintenance access issues through camera inspection and maintenance records. Where condition or access issues have been documented, the need for retrofit is coupled with a need for repair or redesign of the pipe system.

The stormwater quality retrofit objectives are:

1. Reduce polluted discharges from largest contributing areas that do not already have treatment.
2. Prioritize removal of typical urban stormwater pollutants from higher intensity land uses.
3. Prioritize protecting the capacity and function of existing stormwater conveyance, treatment and infiltration facilities.
4. Prioritize retrofits for outfalls where repairs, rehabilitation, or realignment of pipes and structures is necessary to correct poor condition and/or lack of access to public infrastructure.

Needs Analysis

Otak has developed a framework for prioritizing outfall basins for retrofit in collaboration with the City of Bend by calculating a score identifying need for retrofit for each outfall basin. The score is calculated based on the following criteria: untreated area, pollutant load, sediment load, and maintenance access/pipe condition. Scoring for each criterion is explored below.

Untreated Areas

Reducing polluted discharges from the largest contributing areas that do not already have treatment has been identified as a water quality objective. There are 32 outfall drainage basins as shown in Figure 1. Three basins have multiple outfalls and are identified as such. One basin (labeled “TBD”) is delineated in the City’s stormwater inventory but has no associated point outfall identified with it in the inventory. The

City identified one very large basin draining to the Newport outfalls. Based on conversations with the City about the recent improvements along Newport Avenue, this large basin has been divided into two smaller basin polygons for the purposes of this assessment. The basins range in size from 0.2 acres to 497.4 acres. For the purposes of this assessment, areas within the MS4 basins draining to runoff treatment facilities or UICs are considered treated areas that are not in need of retrofit. Approximate treated areas are represented visually on Figure 1 and have been tabulated in Table 7.

Treated areas have been estimated at a planning level as follows:

- UICs: approximately 150 UICs have been identified within the boundaries of the outfall drainage basins. Each UIC is assumed to have 12,500 square feet of area draining to it based on a GIS analysis conducted by the City (City of Bend, 2024). Private stormwater swales: private stormwater swales are assumed to provide runoff treatment for the tax lots on which they are located.
- Public stormwater swales: public stormwater swales are assumed to have been sized using a 6% sizing factor, i.e., the swale area is 6% of the area that drains to it. While this rationale is not included in the COSM, it is a simplified approach used in low-infiltration (2 in/hr or less) areas in parts of north-western Oregon. Clean Water Services utilizes a 6% sizing factor (CWS, 2019).
- Contech StormFilter© cartridge vaults and catch basins: we collected drainage basin size for each StormFilter© vault by reviewing the drainage report.

After calculating treated area within a basin, the remaining basin area is considered untreated.

Untreated Area Scores

Outfall basins are scored from 0 to 3 according to the acreage of untreated area as shown in Table 1.

Table 1 Untreated Areas Scoring

Untreated Area (ac)	Score	Basins in this Category (each)
0-10	0	17
10-50	1	8
50-150	2	4
150+	3	2

Pollutant Load

Removal of typical urban stormwater pollutants has been identified as a water quality objective. Pollutant loads can be correlated to land uses and high-traffic roadways. A desktop GIS review of roadway classifications revealed that only moderate variation of roadway types is present within the outfalls study area, with the highest polluting roadways in the City (highways, etc.) being located outside of the area. However, roadways are spatially correlated with land uses such that higher-traffic count roads are adjacent to more intense land uses. Therefore, for this assessment both land use and roadway pollutant intensity are represented by the City's established zoning. Otak classified zoning into three intensities of pollutant generation, as follows:

- Low pollutant generating land uses include residential, urban reserve, professional offices, and most public facilities such as parks and schools (those with less than 80% impervious area). Zoning codes included in this category are RL, RS, RM, RM-10, RH, UAR, PO, and PF.

- Moderate pollutant generating land uses include mixed uses and commercial uses, as well as public facilities with more than 80% impervious area. A visual inspection of the public facilities within the outfall drainage basins shows two bridge areas as being more than 80% impervious. Zoning codes included in this category are ME, MR, MN, MU, CB, CC, CL, CG, and CN.
- High pollutant generating land uses include industrial and special planned districts. Zoning codes included in this category are IG, IL, and SM.

Pollutant Load Scores

Outfalls are scored from 0 to 3 for pollutant load based on the relative amounts of area in each land use category. Table 2 summarizes the scoring for this factor. The scoring is additive; an outfall basin is awarded a point for each criterion it meets.

Table 2 Pollutant Load Scoring

Description	Add Score	Basins Eligible for this Point (each)
Only "Low" Loading	0	20
Any amount of "High" Loading	Add 1	1
At least 1 acre of "Moderate" Loading	Add 1	10
More than 10 acres of "Moderate" Loading	Add 1	4
Maximum Score is 3		

The counts of basins by total score are listed below:

- Score 0: 20 basins
- Score 1: 7 basins
- Score 2: 4 basins
- Score 3: 0 basins

Sediment Load

Protecting the capacity and function of existing stormwater treatment and infiltration facilities has been identified as a water quality objective. Under existing conditions, the City has collected evidence through tracking drainage complaints and maintenance service calls that sediment in the collection and conveyance system from erosion and winter street maintenance threatens the capacity, function, and longevity of collection, conveyance, and runoff treatment systems within the outfalls basins.

Within the MS4 area, Awbrey Butte has slopes greater than 15%, which then flatten out as it approaches the river (slopes less than 5% slope). Although portions of Awbrey Butte have been developed under more recent and more protective stormwater standards, sediment is still deposited and transported to storm systems on the roads due to runoff flowing over bare or erodible soils and landscaping and sanding for winter traction (HDR, 2017). City staff reported that some of the main roads that lead up or down from Awbrey Butte transport significant sediment.

The City of Bend has soils that are predominantly friable and non-cohesive (GSI, 2020). Older parts of the City are lacking curb and gutter infrastructure. In some cases, low exposure curbs approximately three inches tall are present. In these locations, loose sediment readily moves across roadways, alleys,

sidewalks, driveways, paths, etc. during storms. The City applies sand during the winter to provide traction during icy conditions. The steepest roads in the City receive the most sand.

The City's staff reported that most of their catch basins have sumps, but the depth of these sumps may vary. The City has also identified that some of the filter media cartridge treatment vaults lack pretreatment structures that would extend the service life of the cartridges by capturing trash and larger sediment particles prior to runoff entering the filter vault. Implementation of pretreatment vaults would lessen frequency of clogging of filters and bypassing of flows during storm events.

For the purposes of this assessment, site topography has been identified as an indicator of higher sediment loads.

Slopes have been separated into three categories: "Flat," "Moderate," and "Steep." Flat slopes are defined as less than 5% slopes, Moderate slopes are greater than or equal to 5% and less than or equal to 15% slopes, and Steep slopes are defined as greater than 15% slopes.

Sediment Load Scores

We calculated a "slope factor" in Excel for each outfall basin derived from the inverse of the relative proportions of each slope category normalized against basin size. Then we calculated a score for slope from the slope factor, where higher slope factors are associated with higher scores. Larger slope factors correspond to higher scores (Table 3).

Table 3 Sediment Load Scoring

Slope Factor	Score	Basins in this Category
0.00-0.25	0	7
0.25-0.40	1	15
0.40-0.55	2	4
0.55-1.00	3	5

Related Known Issues

The preliminary planning steps for the Stormwater Master Plan have identified numerous known issues within the outfall basins. Additional emphasis is given in this assessment where there are documented pipes or structures in poor condition based on closed-circuit television (CCTV) investigation, documented maintenance access issues, drainage issues, or documented sedimentation issues. See related known issues descriptions in the notes on Table 7.

Related Known Issues Scoring

The City has provided a list of drainage known issues with priority scores attached to them. A score of 3 (the highest score) is given to outfall identified by the City's maintenance team as being "Priority 1" or highest priority known issue. Of the remaining known issues within the MS4 permit area, the only "Priority 2" known issue was in the same basin as a "Priority 1" known issue and the only "Priority 3" known issue was listed as being already resolved as of July 2024. After review of each of the specific known issues in each basin, a score of 0, 1, or 2 was applied based on engineering judgement of severity of the known issues. A total of 8 outfall basins have related active known issues.

Scoring Input

The scoring input values were geo-processed and mapped for visualization (Figure 2, Figures attached).

Results

The outfalls are scored from 0 to 9 by adding scores for each of the four factors above. Increasing score corresponds to increasing need for retrofit.

The average score of the outfall basins using the above scoring criteria is a score of 3. The top seven highest scoring basins have scores of 4-9. At the low end of scoring, three basins received scores of 0. Figure 1 below provides a histogram of the outfall scoring.

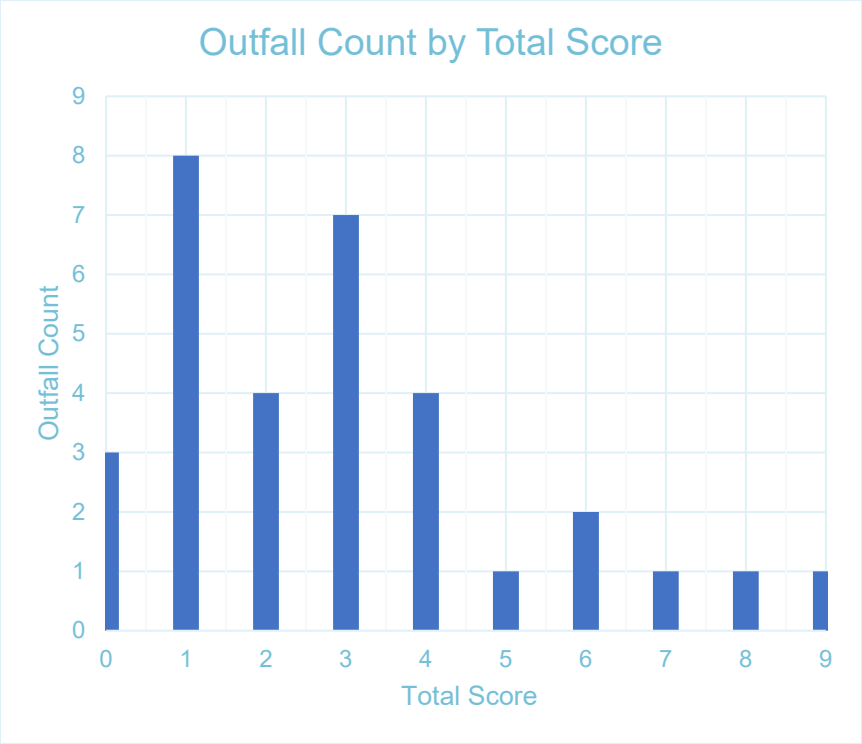


Figure 1 Outfall Retrofit Needs Score Distribution Chart

We ranked basins based on score. See Table 4 below for the outfalls in alphanumeric order, with high score / low rank denoting greatest need. There are many “tie” scores between outfalls. See Conclusions for recommendations to proceed.

Table 4 Outfall Basins' Scores and Ranks

Outfall ID	Untreated Score	Slope Score	Zoning Score	Known Issue Score	Total Score	Rank
DOF000012	0	1	0	0	1	22
DOF000013	3	3	0	0	6	4
DOF000016	0	0	0	0	0	30
DOF000017	1	0	0	0	1	22
DOF000018	1	0	2	3	6	4
DOF000019	1	1	0	2	4	7
DOF000020	2	1	2	2	7	3
DOF000022	1	1	0	1	3	11
DOF000024	2	3	1	2	8	2
DOF000034	0	1	0	0	1	22
DOF000039	2	2	0	0	4	7
DOF000040	0	1	0	0	1	22
DOF000065	0	0	1	0	1	22
DOF000066	0	1	1	0	2	18
DOF000070	0	0	0	0	0	30
DOF000108	0	1	0	0	1	22
DOF000109	0	0	0	0	0	30
DOF000110	0	1	0	0	1	22
DOF000125	0	2	1	0	3	11
DOF000127	1	1	2	0	4	7
DOF000128	1	1	0	3	5	6
DOF000130	1	1	0	0	2	18
DOF000131	2	1	1	0	4	7
DOF000192	0	2	0	0	2	18
DOF000193	0	1	0	2	3	11
DOF000200 & DOF000222 & DOF000223	0	0	1	0	1	22
DOF000207	0	3	0	0	3	11
DOF000220	0	3	0	0	3	11
DOF000221	0	2	1	0	3	11
DOF000266 & DOF000014S	2	1	0	0	3	11
DOF000266 & DOF000014N	3	3	0	3	9	1
TBD	1	1	0	0	2	18

Conclusions

Otak recommends that the highest six ranked basins be considered in the next stage of the master plan. The highest-ranking basin is very large (nearly 500 acres) and has numerous opportunities for potential retrofits. The basins recommended for further consideration are listed as ranked in Table 5.

Table 5 Priority Outfalls for Further Consideration

Outfall ID	Total Score	Rank
DOF000266 & DOF000014N	9	1
DOF000024	8	2
DOF000020	7	3
DOF000013	6	4
DOF000018	6	4
DOF000128	5	6

There is a four-way tie for the seventh-ranked outfalls, which the City could consider in an additional phase of outfall retrofits, as listed in Table 6.

Table 6 Secondary Outfalls for Further Consideration

Outfall ID	Total Score	Rank
DOF000019	4	7
DOF000039	4	7
DOF000127	4	7
DOF000131	4	7

Figure 3 (Figures attached) shows that the outfall basins ranking highest in need are mostly located west of the Deschutes river and tend to be larger basins. Large basins offer opportunities for larger “regional” facilities that simplify maintenance by centralizing captured pollutants. The “DFO000266 & DOF000014” basin has been split into north (N) and south (S) subbasins for this purpose. Even though these two subbasins outfall to the same location, there have been significant improvements to the south subbasin along Newport Avenue. There remain many opportunities in the South Awbrey Butte area to the north. The rating and ranking classified the large north basin as the highest priority basin. A challenge with regional facilities is often the space that they require (whether vegetated or underground), which can be prohibitively expensive where valuable real estate / easements must be purchased. Regional vegetated/above-ground facilities may be difficult to locate due to the land uses in the most highly ranked basins. However, stormwater pretreatment systems such as hydrodynamic separators may centralize pollutants for easier maintenance if they can be located within the existing right-of-way.

Table 7 Outfall Rating and Ranking

		Untreated Area			Slopes								Zoning							Related Known Issues		Total Score and Rank	
Outfall ID	Basin Area	Untreated Area (acres)	Untreated Percentage	Untreated Score	Steep (acres)	Steep (percentage)	Moderate (acres)	Moderate (percentage)	Flat (acres)	Flat (percentage)	Slope Factor	Slope Score	High Load (acres)	High Load (percentage)	Medium Load (acres)	Medium Load (percentage)	Low Load (acres)	Low Load (percentage)	Zoning Score (See Notes Table)	Known Issues (See Notes Table)	Issues Score	Total Score	Rank
DOF000012	3.7	3.7	100%	0	0.1	4%	0.7	18%	2.9	78%	0.36	1	0	0%	0.0	0%	3.7	100%	0		0	1	**22**
DOF000013	170.4	160.3	94%	3	16.9	10%	75.4	44%	78.1	46%	0.58	3	0	0%	0.0	0%	170.5	100%	0		0	6	**4**
DOF000016	7.9	7.9	100%	0	0.0	0%	0.7	8%	7.2	91%	0.16	0	0	0%	0.0	0%	7.9	100%	0		0	0	**30**
DOF000017	11.2	11.0	98%	1	0.0	0%	1.3	11%	9.9	88%	0.20	0	0	0%	0.0	0%	11.2	100%	0		0	1	**22**
DOF000018	24.2	20.5	85%	1	0.2	1%	2.4	10%	21.5	89%	0.20	0	0	0%	19.0	79%	5.2	21%	2	Yes	3	6	**4**
DOF000019	11.3	11.1	98%	1	0.1	1%	1.8	16%	9.3	83%	0.29	1	0	0%	0.0	0%	11.3	100%	0	Yes	2	4	**7**
DOF000020	56.0	52.7	94%	2	0.6	1%	9.6	17%	45.8	82%	0.30	1	0	0%	11.0	20%	45.0	80%	2	Yes	2	7	**3**
DOF000022	21.4	21.0	98%	1	0.3	2%	4.2	20%	16.8	79%	0.34	1	0	0%	0.0	0%	21.3	100%	0	Yes	1	3	**11**
DOF000024	70.4	65.9	94%	2	10.7	15%	21.7	31%	37.9	54%	0.59	3	0	0%	4.6	6%	65.9	94%	1	Yes	2	8	**2**
DOF000034	0.7	0.6	75%	0	0.0	0%	0.2	22%	0.6	77%	0.36	1	0	0%	0.0	0%	0.7	100%	0		0	1	**22**
DOF000039	97.1	91.7	94%	2	10.2	11%	18.0	19%	68.9	71%	0.45	2	0	0%	0.7	1%	96.4	99%	0		0	4	**7**
DOF000040	14.4	9.4	65%	0	0.3	2%	2.9	20%	11.2	78%	0.35	1	0	0%	0.0	0%	14.4	100%	0		0	1	**22**
DOF000065	9.2	8.9	97%	0	0.2	2%	1.0	11%	8.0	87%	0.24	0	0	0%	1.0	11%	8.2	89%	1		0	1	**22**
DOF000066	1.3	1.1	89%	0	0.1	5%	0.2	17%	1.0	77%	0.37	1	0	0%	1.3	100%	0.0	0%	1		0	2	**18**
DOF000070	1.4	1.4	100%	0	0.0	0%	0.1	6%	1.3	94%	0.12	0	0	0%	0.0	0%	1.4	100%	0		0	0	**30**
DOF000108	0.3	0.3	100%	0	0.0	11%	0.0	4%	0.3	82%	0.31	1	0	0%	0.1	43%	0.2	57%	0		0	1	**22**
DOF000109	0.4	0.4	100%	0	0.0	0%	0.0	6%	0.3	93%	0.14	0	0	0%	0.4	100%	0.0	0%	0		0	0	**30**
DOF000110	4.2	4.2	100%	0	0.1	2%	0.7	17%	3.4	81%	0.31	1	0	0%	0.0	0%	4.2	100%	0		0	1	**22**
DOF000125	0.8	0.6	79%	0	0.1	8%	0.2	27%	0.5	64%	0.51	2	0.3	34%	0.0	6%	0.4	59%	1		0	3	**11**
DOF000127	52.7	32.6	62%	1	1.7	3%	6.6	13%	44.5	84%	0.27	1	0	0%	45.5	86%	7.2	14%	2		0	4	**7**
DOF000128	12.7	12.7	100%	1	0.1	1%	2.0	16%	10.6	83%	0.28	1	0	0%	0.0	0%	12.7	100%	0	Yes	3	5	**6**
DOF000130	20.0	19.5	98%	1	0.6	3%	3.8	19%	15.6	78%	0.35	1	0	0%	0.0	0%	20.0	100%	0		0	2	**18**
DOF000131	67.4	63.6	94%	2	0.3	0%	10.2	15%	56.9	84%	0.26	1	0	0%	2.6	4%	64.8	96%	1		0	4	**7**
DOF000192	7.8	6.8	87%	0	0.9	11%	1.6	21%	5.3	68%	0.48	2	0	0%	0.0	0%	7.8	100%	0		0	2	**18**
DOF000193	7.8	7.5	96%	0	0.5	6%	1.3	16%	6.1	77%	0.37	1	0	0%	0.0	0%	7.8	100%	0	Yes	2	3	**11**
DOF000200 & DOF000222 & DOF000223	1.1	1.0	88%	0	0.0	0%	0.1	8%	1.0	91%	0.17	0	0	0%	1.0	89%	0.1	11%	1		0	1	**22**
DOF000207	0.2	0.2	100%	0	0.1	31%	0.0	29%	0.1	39%	0.67	3	0	0%	0.2	100%	0.0	0%	0		0	3	**11**
DOF000220	3.7	3.4	92%	0	0.3	7%	1.6	44%	1.8	48%	0.56	3	0	0%	0.0	0%	3.7	100%	0		0	3	**11**
DOF000221	1.6	1.3	85%	0	0.1	5%	0.4	24%	1.1	70%	0.45	2	0	0%	1.6	100%	0.0	0%	1		0	3	**11**
DOF000266 & DOF000014S	95.3	55.1	58%	2	2.1	2%	17.5	18%	75.8	79%	0.33	1	0	0%	16.1	17%	79.2	83%	0		0	3	**11**
DOF000266 & DOF000014N	497.4	486.5	98%	3	73.5	15%	278.6	56%	145.2	29%	0.58	3	0	0%	0.6	0%	496.9	100%	0	Yes	3	9	**1**
TBD	11.5	10.6	93%	1	0.3	3%	2.3	20%	8.9	77%	0.36	1	0	0%	0.0	0%	11.5	100%	0		0	2	**18**

Updated 8/27/2024

Related Known Issues Notes

Outfall ID	Description
DOF000018	Rationale: Score this as 3, City identified two "Priority 1" issues in the basin related to long pipe runs with limited access for maintenance.
DOF000019	Rationale: Score this as 2, City reported that this issue occurred at multiple places in the neighborhood, and this was concern for private property.
DOF000020	Rationale: Score this as 2, Tear in the pipe represents potential sinkhole concern.
DOF000022	Rationale: Score this as 1, CCTV shows root intrusion and a void but no outward indicators of an issue.
DOF000024	Rationale: Score this as 2, damage to pipe is a potential safety concern (though it is on private property), there are reported inlet clogging problems, and some flooding.
DOF000128	Rationale: Score as 3, there are multiple "Priority 1" issues identified by the City staff in this basin.
DOF000193	Rationale: Score as 2, gas line through a pipe with a "huge void" is a safety and utility concern.
DOF000266 & DOF000014 N	Rationale: Score as 3, Awbrey Butte is one of the highest priority stormwater issue locations in the City.

Zoning Notes

Outfall ID	Description
DOF000266 & DOF000014 S	Rationale: This basin ranks highly based on land use zone, however Newport Ave has had significant improvements to treat runoff, substantially attenuating the impact of the land use zoning. This basin has been scored "zero" for zoning.

References

GSI, 2020. *Stormwater Infiltration Evaluation Update*. October 2020. GSI Water Solutions, Inc.

HDR, 2017 *South Awbrey Butte Drainage Study Final Improvement Plan.* October 17, 2017. HDR Engineering, Inc.

Central Oregon Intergovernmental Council, 2010. *Central Oregon Stormwater Manual.* Update August 2010.

CWS, 2019. *Design and Construction Standards, Chapter 4.* Clean Water Services. November 12, 2019.

City of Bend, 2024. *Groundwater Protectiveness Demonstration Update for Per- and Polyfluoralkyl Substances (PFAS), City of Bend, Oregon.* April 14, 2024.

Figures

FIGURE 2

STORMWATER OUTFALL NEEDS ASSESSMENT INPUTS

BEND STORMWATER MASTER PLAN

BEND, OREGON

LEGEND

- Outfalls
- Storm Main
- Outfall Basin Delineation
- Representative Treated Areas
- Contours (10')

Zoning Type Pollutant Load

- High
- Moderate
- Low

CITY OF BEND LIMITS

LOCATOR MAP

0 1,000 2,000 ft

0 1,500 3,000 ft

Data Sources: City of Bend, USGS, Google Maps.
Date: 8/20/2024
Disclaimer: This data is not to survey accuracy and is meant for planning purposes only.

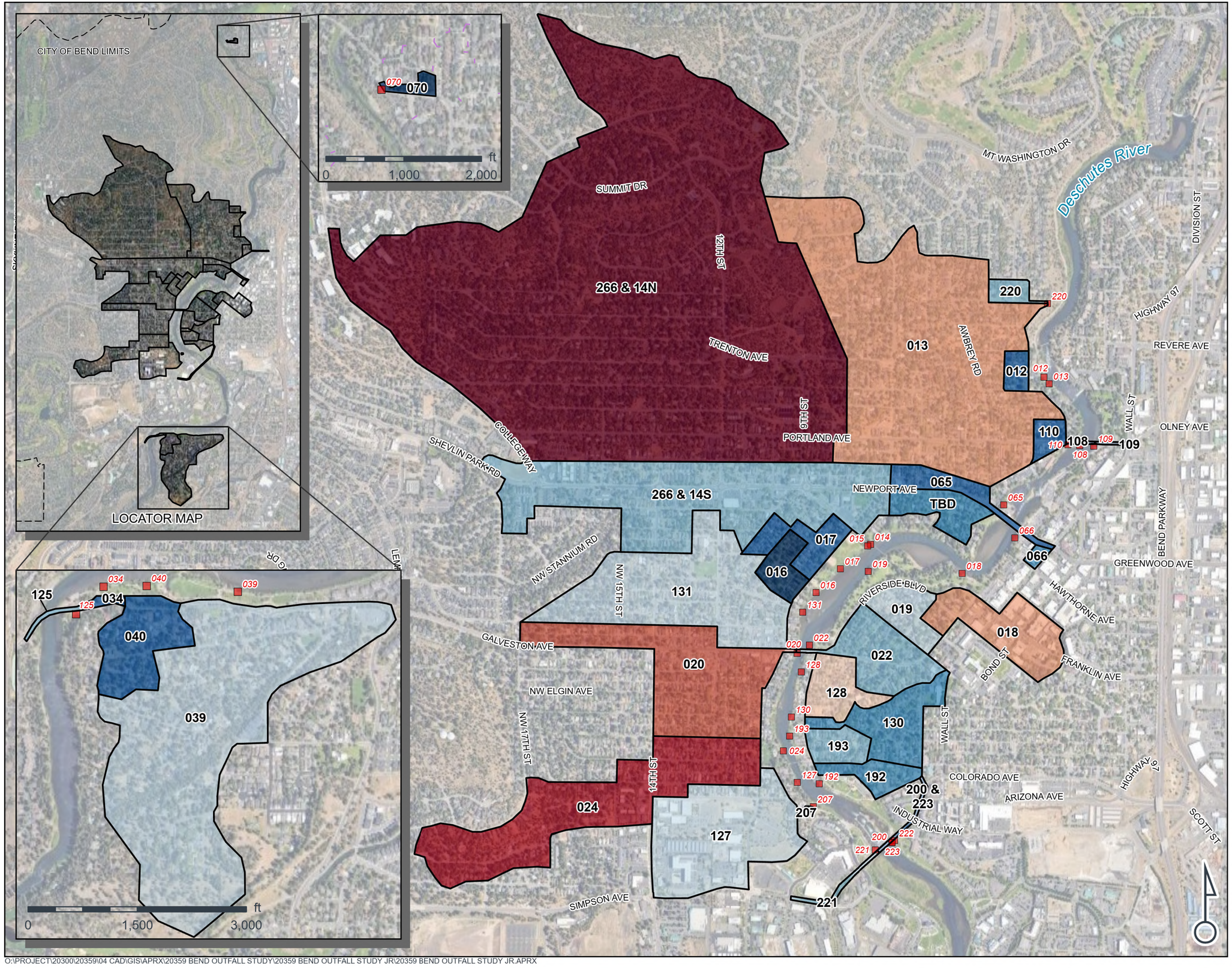
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FIGURE 3

STORMWATER OUTFALL BASIN RANKING

BEND STORMWATER MASTER PLAN

BEND, OREGON



LEGEND

- Outfall Basin Delineation
- Outfalls

Outfall Basin Ranking

Rank

- 1
- 2
- 3
- 4
- 6
- 7
- 11
- 18
- 22
- 30

ft
0
1,500
3,000

Data Sources: City of Bend, USGS, Google Maps.
Date: 8/27/2024
Disclaimer: This data is not to survey accuracy and is meant for planning purposes only.

Otak

BEND

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FINAL TECHNICAL MEMORANDUM

Modified Drywell Siting Criteria and Drillhole Decommissioning Framework, City of Bend, Oregon

To: Trista Kobluskie, PE / Otak, Inc.

From: Matt Kohlbecker, RG / GSI Water Solutions, Inc.
Casey McGuire / GSI Water Solutions, Inc.

CC: Elisabeth O'Keefe / City of Bend
Lori Faha, PE / City of Bend

Date: August 14, 2025

Attachments

Figure 1 - Deep Drywell Design for Overflow at Awbrey Reservoir

Figure 2 - Areas that Meet Siting Criteria

Figure 3 - Land Use

Figure 4 - Traffic Volume

Figure 5a - Risk Assigned to Water Well Locations – Distance from Water Wells

Figure 5b: Risk Assigned to Water Well Locations – Risk to Public Water Wells

Figure 5c - Risk Assigned to Water Well Locations - Perched Groundwater within the "North Bend Perched Area" or the "Old Mill District Perched Area

Figure 6 - Current Drill Hole Conditions

Figure 7 - Priority Ranking

Appendix A – Drillhole Flooding Reports: Priority 1, Priority 2, and Priority 3 Locations

Appendix B – Drillhole Prioritizations

1. Introduction

This technical memorandum (TM), prepared by GSI Water Solutions, Inc. (GSI) for Otak, Inc. (Otak), presents an evaluation of modified drywell suitability and a drillhole replacement prioritization to inform the City of Bend's (City) updated Stormwater Master Plan. The following sections provide an overview of Underground Injection Control (UIC) configurations, the purpose and objectives of this TM (Section 1.2), and the organization of this TM (Section 1.3).

1.1 Underground Injection Control Types and Configuration

The City uses about 6,500 UICs to manage stormwater runoff from public rights-of-way (GSI, 2023). According to the Oregon Administrative Rules, a UIC is a well, improved sinkhole, or other subsurface fluid

distribution system that is used for the subsurface emplacement or discharge of fluids[1]. About 5,500 of the City's UICs are drywells, and about 1,000 of the City's UICs are drillholes. Drywells are typically 10 to 20 feet deep cylindrical structures constructed of 4-foot diameter concrete rings with weep holes. Drillholes are typically 6-inch diameter open boreholes completed with a steel surface casing (generally 10 to 20 feet) (GSI, 2023) that may be up to 100 feet deep (the maximum UIC depth allowable by state law for rule authorized UICs[2]). Recently, new construction techniques have been introduced in Oregon that allow for installation of drywells to up to 100 feet deep (modified drywells).

Drillholes are more common west of the Deschutes River where low-permeability volcanic ash layers are prevalent, and in older parts of the City. New drillholes have not been permitted in the City standards for several years due to maintenance issues, the lack of pretreatment, and due to the difficulty and expense of retrofitting.

1.2 Purpose and Objectives

The purpose of this TM is to provide the City with information about new-to-Oregon stormwater infiltration devices (i.e., modified drywells) and a prioritization framework for decommissioning of old stormwater infiltration devices (i.e., drillholes) to inform the City's 2024 Stormwater Master Plan update. The objectives of the TM are:

- Provide an overview of modified drywells, including advantages and disadvantages.
- Develop criteria for minimizing the risk of environmental contamination from modified drywells.
- Develop a prioritization framework for decommissioning drillholes.

1.3 Technical Memorandum Organization

The remainder of this TM is organized as follows:

- Section 2: Provides criteria for siting modified drywells
- Section 3: Outlines drillhole replacement and upgrade prioritization

2. Modified Drywell Siting Criteria

Conventional drywells, which comprise the City's approximately 5,500 drywells, are 4-foot diameter structures typically excavated with a hydraulic clam shell that have a maximum depth of approximately 40 feet in Oregon. Modified drywells have a similar diameter as conventional drywells but are excavated with large-diameter augers. Modified drywells are deeper than conventional drywells, generally up to 100 feet deep depending on local geology. The City's Stormwater Sedimentation Manhole, with proposed modifications for drywell design is shown in Figure 1. This design includes 150 gallons of spill control containment capacity.

Modified drywells have been used in the desert southwest since the 1970s; they have been installed at significant depths to bypass shallow, low-permeability caliche layers and rock. Recently, the City of Gresham, Oregon, constructed a modified drywell to bypass a shallow perched aquifer, and King County has managed stormwater runoff in dense residential neighborhoods by drilling 50 to 100 feet deep drywells to bypass shallow, low permeability glacial till and infiltrate stormwater into the underlying sands (Radford, 2016). The City of Bend has been receiving increased requests from developers to construct modified drywells.

[1] OAR 340-044-0005(24)
[2] OAR 340-044-0018(3)(a)(G)

This section summarizes the advantages of modified drywells (Section 2.1), the disadvantages of modified drywells (Section 2.2), criteria for siting modified drywells to minimize the risk of environmental contamination (Section 2.3), and conclusions (Section 2.4).

2.1 Advantages of Modified Drywells

Advantages of modified drywells (when compared to drillholes or traditional drywells) include the following:

- **Footprint.** Modified drywells have a small footprint because the pretreatment device is installed within the same borehole as the drywell, making modified drywells a good option in urban areas where space is limited.
- **Bypass shallow, low-permeability soil layers**. Modified drywells can bypass shallow soils characterized by low infiltration rates (e.g., silt, clay, or volcanic ash), targeting deeper soils and sediments have higher infiltration rates.
- **Larger storage volume and improved treatment compared to a drillholes.** Because of their large-diameter, modified drywells can store a larger volume of water than a drillhole, thereby allowing the water to slowly exfiltrate from the drywell in low-permeability soil environments. In addition, unlike drillholes, proprietary modified drywells are equipped with pretreatment devices like a sedimentation manhole to allow for settling of stormwater solids, hydrocarbon-absorbent pillows, and intake screens/debris shields.
- **More head during infiltration.** Higher infiltration rates can be achieved at modified drywells because the drywell can accommodate additional mounding (i.e., head) during infiltration.

2.2 Disadvantages of Modified Drywells

Disadvantages of modified drywells (when compared to drillholes or traditional drywells) include the following:

- **Higher risk of causing groundwater contamination.** The highest risk to groundwater is from contaminants in stormwater that are toxic, common, mobile, and persistent (GSI, 2013). Pollutant fate and transport modeling by GSI (2011) showed that most common stormwater pollutants do not reach groundwater as long as there are five feet of vertical separation between the bottom of the drywell and groundwater. However, recent modeling by GSI (2024) showed that significantly larger vertical separation distances are needed to protect groundwater from emerging pollutants [i.e., per- and polyfluoroalky substances (PFAS) and simazine will reach groundwater unless there are about 53 feet and 37 feet of vertical separation, respectively]. Because modified drywells are deeper than conventional UICs, they minimize vertical separation distance and, therefore, increase the risk of groundwater pollution.
- **Difficult and expensive to clean in the case of a spill of hazardous material.** Traditionally, drywells are cleaned via pressure washing, scraping of the interior walls, and/or vacuuming with a vactor truck if a spill occurs. However, because vactor trucks are not effective on drywells that are more than 40 feet deep, removal of a spill of hazardous materials from a modified drywell cannot not be performed using traditional techniques. Options are drill or pump rigs and bailers to remove spilled material from deep drywells, which would significantly increase the cost of cleanup. In addition, remediation of spilled material that has infiltrated into soils surrounding the drywell would be significantly more expensive due to the increased depth.
- **Novelty and lack of performance data.** There is limited research on modified drywell performance in Oregon over time due to the relative newness in the Pacific Northwest. Geosyntec (2020) noted data gaps including Infiltration testing guidance prior to UIC citing and drywell lifecycle research, both of

which would be beneficial when planning a new UIC. However, it should be noted the City of Gresham's modified drywell has experienced no performance declines since it was constructed in the Spring of 2022.

- Often more expensive than traditional UICs.

2.3 Criteria to Minimize Risk of Environmental Contamination from Modified Drywells

This section provides criteria to minimize the risk of environmental contamination from modified drywells, including siting criteria (Section 2.2.1), construction practices (Section 2.2.2), spill mitigation (Section 2.2.3), pretreatment (Section 2.2.4), and operations and maintenance (Section 2.2.5).

2.3.1 Siting Criteria

Proper drywell siting minimizes the risk that a drywell will contaminate groundwater, and is especially important for modified drywells because groundwater contamination is significantly more expensive to clean up. As long as a 53-foot vertical separation distance between the base of the UIC and the seasonal high of groundwater are adhered to (based on the findings of GSI's 2024 Groundwater Protectiveness Demonstration Update), groundwater contamination from common stormwater pollutants should not be of concern. Contamination caused by spills of hazardous material poses the highest risk of groundwater contamination.

Drywell siting criteria are covered in Bend's standards (2023). Drywell siting should consider the local factors such as land use (which will affect the quality of the water discharging to the drywell), traffic volume, water well locations, groundwater depth, and geology. See Section 3 prioritization criteria for further information on these topics. There is a low risk that drywells meeting all of the following criteria will be impacted by a spill. Therefore, modified drywells may be sited in drainage basins that meet these criteria (see green-light areas in Figure 2):

- Residential land use
- Local, collector, minor arterial, resource, or service road street classifications,
- Outside of two-year time-of-travel zones from municipal supply wells and >500 feet from water wells, and
- Outside of areas with perched groundwater (i.e., the Old Mill District Perched Area and North Bend Perched Area).

Developers may request that modified drywells be used in areas that do not meet all these criteria. The City may consider approving modified drywell use in yellow-light areas identified in Figure 2, such areas as long as additional protective measures are incorporated into the drywell design (as shown in Figure 1). In no case should modified drywells be constructed within 500 feet of a water well or within the two-year time-of-travel zone of a municipal supply well.

The City of Gresham does not have formal siting criteria; however, the one modified drywell that has been installed so far was installed to meet the following protectiveness:

- Residential streets (< 1,000 trips per day),
- Outside of two-year time-of-travel zones from municipal supply wells, and
- Must have a shut off valve.

2.3.2 Construction

The following construction methods mitigate groundwater contamination, and should be common practice at a site where a modified drywell is being constructed:

- Drywell inlets should be sealed with two layers of UV protected geotextile material until nearby construction is complete, to prevent sediment ingress (ADEQ, 2018).
- Drywells should be covered by a solid manhole so that flow into the drywell is solely through the interceptor inlet, and the manhole should be bolted and labelled 'stormwater only' to prevent tampering (ADEQ, 2018).
- Manholes installed at modified drywells should be modeled on the Figure 1 to provide some level of additional spill protection.

2.3.3 Spill Mitigation

To mitigate the effect of spills, GSI recommends that Bend (similarly to what GSI previously recommended to the City of Gresham) have a spill response plan in place and automatic shut-off-valves that close when spills are detected. In addition, if the modified drywell is constructed of an infiltration pipe that runs inside the annular space between the sedimentation manhole and borehole wall, and then curves underneath the bottom of the sedimentation manhole, GSI recommends a cleanout be installed so that the infiltration pipe below the sedimentation manhole can be accessed by a bailer to clean material out of the drywell, or a brush to clean the drywell.

2.3.4 Pretreatment

Pretreatment options for stormwater discharges are described in DEQ's Industrial Stormwater Best Management Practices Manual (Jurries and Ratliff, 2013).

Pretreatment recommendations for drywell type are described in Table 1, and should be considered for modified drywells. The best pretreatment option for a site will be determined by site characteristics and known potential pollutants at a site.

Table 1. Pretreatment Recommendations for Drywell Type.

Drywell Type	Pretreatment Goals	Types of BMPs Recommended	Additional Spill Control and Outreach Recommendations
Conventional	Manage rate of clogging[1], oil control, metals treatment	From Central Oregon Stormwater Manual (2010): ▪ Low impact development ▪ Infiltration swale ▪ Vegetated filter strips ▪ Oil/water separator ▪ Wetponds ▪ Extended detention dry ponds ▪ Evaporation ponds ▪ Grassy swales ▪ Sedimentation manholes ▪ Emerging technologies ▪ Treatment trains	N/A

Modified	"Conventional" goals, plus: ▪ Isolate and contain spills, and ▪ Capture trash ▪ Provide treatment of particulate-bound pollutants	From Geosyntec (2020): ▪ Oil absorbent pillows ▪ Debris screen ▪ Hydrodynamic separator ▪ TAPE Pretreatment GULD[2] Bioretention ▪ Media filter ▪ TAPE Basic GULD[3] (with sump element) ▪ Alternative pretreatment BMP selected based on clogging and water quality considerations (Subject to LEA approval)	From Geosyntec (2020): ▪ Conduct source control investigation and outreach for potential sources of human waste ▪ Closed bottom sump with elevated outlet, documentation of a spill response plan and adequately trained spill response team, or demonstration of low risk of spills in the drainage area ▪ Include an automatic shutoff valve

Notes

[1]Clogging is not a groundwater quality risk, however it affects the necessary maintenance intervals and lifecycle cost of a drywell and needs to be considered in selection of pretreatment BMPs.

[2]TAPE Pretreatment General Use Level Designation (GULD) BMPs are BMPs that meet 50% removal of TSS, when influent is between 100 and 200 mg/L.

[3]TAPE Basic GULD BMPs are BMPs that meet 80% removal of TSS when influent is between 100 and 200 mg/L.

2.3.5 Operations and Maintenance

Inspection and maintenance recommendations for modified drywells are outlined below. Records should be kept of all inspections, problems, and actions taken.

Inspections

Inspections should be conducted according to a schedule, ideally at least annually. The inspection should include but not be limited to the following (ADEQ, 2018):

- Ensure that no hazardous materials are being used or stored in the area.
- Check for staining, discoloration, or residue on the surrounding the area (i.e. oil stains on pavement), or odors, all of which could indicate potentially contaminating materials.
- Check settling chambers and interceptor compartments for debris and sediment (which should be removed under maintenance).
- Check chemical absorbents (where present) and replace if discolored and/or below the water surface.
- Track performance, ranging from documenting failure (e.g., performance) to testing modified drywells and comparing performance over time.

Maintenance

Maintenance of drywells should include cleaning filters and screens, replacement of chemical absorbents, and removal of sediment, debris, and trash:

- ADEQ (2018) recommends that debris and silt be removed at regularly scheduled times, i.e. at least annually, or at a minimum at the following times:
  - "In paved areas when the sediment level fills 10 percent of the effective settling capacity.
  - In landscaped areas when the sediment level fills 25 percent of the effective settling capacity.

- When ownership of the property changes.
- When material not resulting from storm water or urban surface runoff enters the drainage system interceptor or drywell settling chamber."

Regular street cleaning should also be conducted to reduce debris sources that could be mobilized by runoff to enter the UICs.

2.4 Advantages, Disadvantages, and Risk Minimization Conclusions

Table 2 below summarizes the modified drywell disadvantages (i.e., higher risk of causing groundwater contamination, difficult to clean, and lack of performance data) and options for minimizing the risk associated with each disadvantage.

Table 2. Modified Drywell Disadvantages and Mitigation Options.

Disadvantage	Risk Minimization Option		Option Details
Groundwater contamination	Siting		Establish siting criteria based on land use, perched groundwater areas, setbacks from water wells, and traffic volume
	Construction		Seal drywell inlets, secure manhole cover, sump
	Spill mitigation		Spill response plan, shut off valve
	Pretreatment		Require enhanced pretreatment (e.g., spill control manholes)
	Operations and Maintenance		Inspections at least annually, regular cleaning of drywell and street
Difficult/expensive to clean	Preventative measures (so cleaning not required)	Siting	Setbacks from potential sources of large sediment load associated with construction sites, or implement other best management practices
		Construction	Seal drywell inlets, secure manhole cover, sump
		Spill mitigation	Spill response plan, automatic shut off valve, install cleanout to access infiltration pipe
		Pretreatment	Require enhanced pretreatment (e.g., engineered media filters, vegetated strips, manufactured devices, and detention basins)
	Operations and Maintenance		Inspections at least annually, regular cleaning of drywell and street
Novelty and lack of performance data	Operations and Maintenance		Track and compile records of drywell failure and performance testing

3. Prioritization Framework for Drillhole Decommissioning

A drillhole is a 6" diameter open hole, typically completed with 20 feet of surface casing, that varies in depth from 10 feet to over 100 feet deep (City of Bend, 2012). Drillholes have not been allowed in the City's Standards and Specifications for several years, in part because they require frequent maintenance, are characterized by a lack of pretreatment, and they can be difficult and expensive to retrofit. This section provides a framework for prioritizing drillhole retrofits and/or replacements to meet the City's goal of efficiently managing stormwater by infiltration in a manner that is protective of groundwater quality.

3.1 Methods for Developing Framework to Prioritize Drillhole Decommissioning

GSI developed a framework for prioritizing drillhole decommissioning, in collaboration with the City of Bend, by calculating a risk score for each drillhole. The risk score was calculated for each drillhole location based on the following criteria: land use (Section 3.1.1), traffic volume (Section 3.1.2), risk to drinking water quality (Section 3.1.3), and current drillhole condition (Section 3.1.4). Each criterion was divided into different risk categories (e.g., high, medium or low), a score was assigned to each category, and a weighting was assigned to each score. Weighting was either applied as an "additive" (meaning the total risk score for a given drillhole is determined by summing the score for the criterion) or a "multiplier" (meaning the total risk score for a given drillhole is determined by multiplying the score for the criterion).

3.1.1 Land Use

Land use is correlated with pollutant load and likelihood of a hazardous material spill. Drillholes located in land use categories associated with higher pollutant loads and spill potential were prioritized for retrofit or replacement. Land use categories are shown in Table 3, and are classified into "high risk," "moderate risk," and "low risk" categories such that the highest risk is associated with the highest pollutant load and spill likelihood. The land use dataset is from the City of Bend Zoning Designations. Risk assigned to Land Use categories are shown on Figure 3.

Table 3. Risk Assigned to Land Use (City of North Bend, 2015; City of Bend, 2024).

Risk Category	City of Bend Zoning Designation	Definition	Score Assigned	Multiplier or Additive
High Risk	Industrial	Manufacturing and Production, industrial service, warehouse, transportation, freight, and distribution	3	Additive
Moderate Risk	Commercial	Retail, services, and offices	2	Additive
	Mixed-Use	Residential land use with retail/commercial/office and/or service uses in the same building or on the same site.		
	Public Facility (AND >50% impervious[1])	Public facilities, including Town Hall, recycling center, Community parks, sports complexes (and other outdoor recreation)		
	Urban Area	Urban Growth Area, i.e. area that may be developed in the future but not yet determined what land use it will be developed to.		
Low Risk	Public Facility (AND <50% impervious[1])	<80% developed to just capture community parks, sports complexes (and other outdoor recreation)	1	Additive
	Professional Office	"The Professional Office zone is intended to provide for professional offices in locations near arterial or collector streets and to provide a transition of uses between residential areas and other more intensive zones. Through design standards, the Professional Office zone is intended to create a mix of high density residential housing, office and service commercial developments that are pedestrian oriented and provide a positive contribution to the streetscape."		
	Residential	Low to high-density housing		

Note:
[1]The 50% impervious threshold was used to ensure the Deschutes Recycling center was captured. This site is within the 'public facilities' layer but is a higher risk than other facilities including parks that predominantly made up this layer so this impervious threshold was added to weed out this and other potentially contaminating sites.

3.1.2 Traffic Volume

Traffic volumes are correlated with pollutant load to a UIC, such that local streets are expected to have a lower number of trips per day and therefore a lower pollutant load than for example highways, which would have a higher pollutant load due to higher brake pad wear, deposition of hydrocarbon combustion byproducts, etc.

Drillholes located on highways, major arterials, and ramps were prioritized for retrofit or replacement. Data for this category came directly from the City, in a shapefile titled 'Road_Centerlines.' Risk categories that were assigned to Traffic Volume are outlined in Table 4 and displayed on Figure 4.

Table 4. Risk Assigned to Street Classifications and Associated Traffic Volumes.

Risk Category	Road classes within this category	Score Assigned	Multiplier or Additive
High Risk	Highways; Major Arterials; Ramps	3	Additive
Low – Moderate Risk	Local; Collector; Minor Arterial; Resource; Service	1	Additive

3.1.3 Risk to Drinking Water Quality

This risk posed by drillholes to drinking water quality was assessed by considering the distance between the drillhole and the nearest water well (i.e., whether a drillhole is located within the two-year time-of-travel zone or 500 feet of a water well) and the depth to groundwater. A time-of-travel zone is the volumetric extent of groundwater that is pumped by a drinking water well over a given time period. For example, the two-year time-of-travel zone represents the groundwater that is pumped by a drinking water well over two years. DEQ rules discourage construction of UICs within the two-year time-of-travel zone to minimize risk to groundwater quality. If a two-year time-of-travel zone has not been delineated for a well, then DEQ rules discourage construction of UICs within 500 feet of a water well. In addition to location relative to a water well, UICs pose a higher risk to drinking water quality in areas of shallow groundwater because there is not as much unsaturated soil to filter and remove pollutants from stormwater. Two areas of shallow groundwater have been identified in the City.

Water Well Locations

Drillholes that are located within a two-year time-of-travel zone or 500 feet of a water well were prioritized for retrofit or replacement. Water wells included in this category were municipal supply wells, irrigation wells, and domestic supply wells (GSI, 2022). Risk categories that were assigned are outlined in Table 5a and shown on Figure 5a. An extra high risk category was added with a large multiplier to ensure that any drillholes within 100 feet of a water well rose to the top of the prioritization list.

Table 5a. Risk Assigned to Water Well Locations.

Risk Category	Well Location	Score Assigned	Multiplier or Additive
Extra High Risk	<100 ft from water well	10	Multiplier
High Risk	<500 ft from water well	3	Additive
Low Risk	>500 ft from water well	1	Additive

An additional extra high risk category was added (Table 5b) with a large multiplier to ensure that any drillholes within Two-year time-of-travel of a public water well zones rose to the top of the prioritization list. This extra high risk category is shown in Figure 5b. There would be a very high impact if a public water well were to become contaminated due to the large population served.

Table 5b. Risk Assigned to Water Well Locations.

Risk Category	Well Location	Score Assigned	Multiplier or Additive
Extra High Risk	Two-year time-of-travel of a public water well zones	20	Multiplier

Groundwater depth

The depth to the regional groundwater table in Bend ranges from 300-750 feet bgs; however, areas of perched groundwater with groundwater depths of a few feet to 200 feet bgs have been identified within the City (GSI, 2024). These perched groundwater areas are primarily within two regions: the Old Mill District Perched Area and the North Bend Perched Area (Figure 5c). Based on the findings of GSI's 2024 Groundwater Protectiveness Demonstration Update, 53 ft vertical separation between the base of the UIC and the seasonal high of groundwater is required to protect groundwater from PFAS in stormwater (GSI, 2024). Because drillholes can be constructed to 100 feet deep, PFAS in stormwater discharges from drillholes has the potential to reach groundwater in these perched areas.

Drillholes located in areas of perched groundwater were prioritized for retrofit and/or replacement. These locations are shown in Figure 5c. Perched groundwater within the "North Bend Perched Area" or the "Old Mill

District Perched Area" has been applied as a multiplier due to the significant risk of introducing contamination to shallow groundwater posed by drillholes within these areas. Risk categories that were assigned to perched groundwater areas are shown in Table 6 and on Figure 5c.

Table 6. Perched Groundwater within the "North Bend Perched Area" or the "Old Mill District Perched Area."

Risk Category	Vertical Separation from Groundwater/Perched Groundwater	Score Assigned	Multiplier or Additive
Extra High Risk	Areas of perched groundwater **AND** <53 ft vertical separation from groundwater	2	Multiplier
High Risk	Areas of perched groundwater	1.5	
Low Risk	Outside of a perched groundwater area	1	

3.1.4 Current Drillhole Condition

For this section, GSI reviewed the 'Stormwater Master Plan Flooding Locations' spreadsheet as well as the 'Stormwater Flooding Report' for City-owned drillholes, provided by Travis Somers of the City of Bend Stormwater Utility Department via email in April 2024. The 'Stormwater Master Plan Flooding Locations' spreadsheet identified UICs (both drywells and drillholes) with known flooding issues that the City is aware of. These were organized by the City by order of priority to replace or repair, with Priority 1 being the highest priority to address. The Stormwater Flooding Reports detailed known information about each site, along with photos. These are included in Appendix A and locations are shown on Figure 6. Risk categories that were assigned to current drillhole conditions are shown in Table 7. A multiplier was applied to drillhole conditions to ensure drillholes that have been pre-prioritized for replacement would float to the top of this prioritization list.

Table 7. Risk assigned to Current Drillhole Conditions.

Risk Assigned	Category	Definition[3]	Score Assigned	Multiplier or Additive
High Risk	Level 1 Priority	Stormwater causes or is at risk of causing safety concerns. Stormwater causes property damage or has the risk of causing property damage. Frequent responses from the City are required.	3	Multiplier
Moderate Risk	Level 2 Priority	Stormwater infrastructure may be undersized or failing. Less frequent responses from the City are required, often after a more sustained rain event	2	
Low Risk	Level 3 Priority	Low priority locations. Some improvements completed at most of these sites to improve/control runoff. These locations should be evaluated overtime to decide if existing infrastructure is adequate, needs to be replaced, or additional controls are needed to increase capacity.	1	

3.2 Drillhole Decommissioning Prioritization Results

A score was assigned to each drillhole at the end of this scoring exercise. The results of the drillhole prioritization scoring assessment are shown on Figure 7. On this figure, drillhole rankings from 1 to 10 and >10 are displayed, with the drillhole ranked as number one being the drillhole that has the highest priority for replacement. The top five ranked drillhole prioritization results are shown in Table 8. The full drillhole scoring is shown in Appendix B.

[3] Provided by Travis Somers at the City of Bend via email on March 21, 2024

Table 8. Drillhole Decommissioning Prioritization Results.

Priority Rank	Drillhole ID(s)
1	DDH009510, DDH009485, DDH009498, DDH009625, DDH009624, DDH009514, DDH009513, DDH009550, DDH009520, DDH009841, DDH009727, DDH009728, DDH009767, DDH009766, DDH009764, DDH009765, DDH009763, DDH002049, DDH009381, DDH009446, DDH009447, DDH009482, DDH010013
2	DDH009875, DDH009932
3	DDH009573, DDH009572, DDH009571, DDH009396, DDH009397, DDH009394, DDH009444, DDH009431, DDH002022, DDH009122, DDH009129, DDH009130, DDH009586, DDH009585, DDH009583, DDH009438, DDH009419, DDH009420, DDH009403, DDH009425, DDH002020, DDH009407, DDH009406, DDH009405, DDH009404, DDH009416, DDH009426, DDH009423, DDH009424, DDH009440, DDH009441, DDH009436, DDH009437, DDH009417, DDH009418, DDH009392, DDH009386, DDH001022, DDH001023, DDH001013, DDH001012, DDH009398, DDH009439, DDH009395, DDH009421, DDH009422, DDH009443, DDH009384, DDH009380, DDH009385, DDH001015, DDH001014, DDH009399, DDH009415, DDH009412, DDH009413, DDH009628, DDH009629, DDH009632, DDH009604, DDH002018, DDH002019, DDH009445, DDH009387, DDH009388, DDH009389, DDH009390, DDH009391, DDH009393, DDH009402, DDH009401, DDH009400, DDH009429, DDH009430, DDH009435, DDH009434, DDH009433, DDH002023, DDH009428, DDH009631, DDH009630, DDH009605, DDH009603, DDH009609, DDH009606
4	DDH001019, DDH009454
5	DDH009863, DDH009902, DDH010018, DDH010019

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Figures

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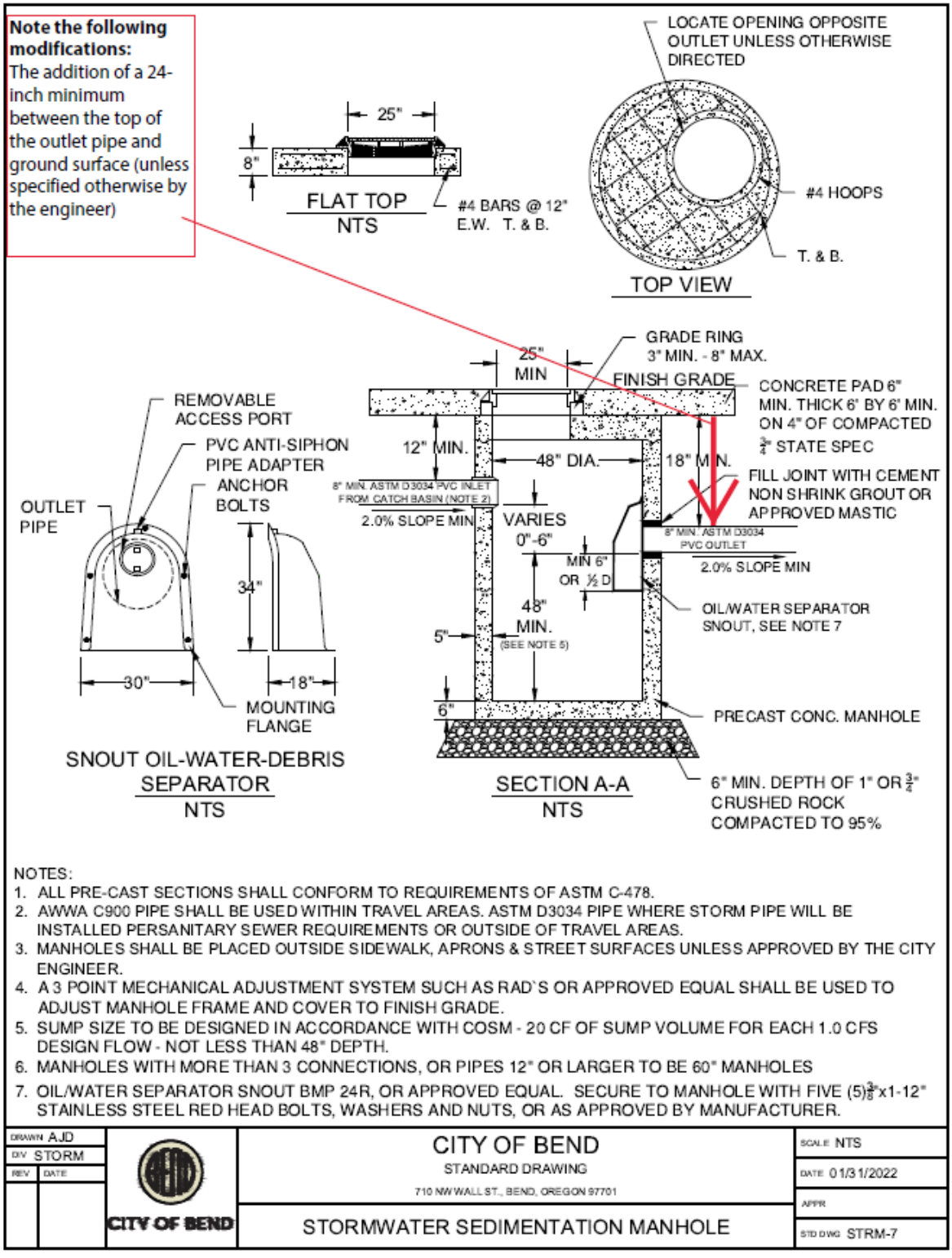
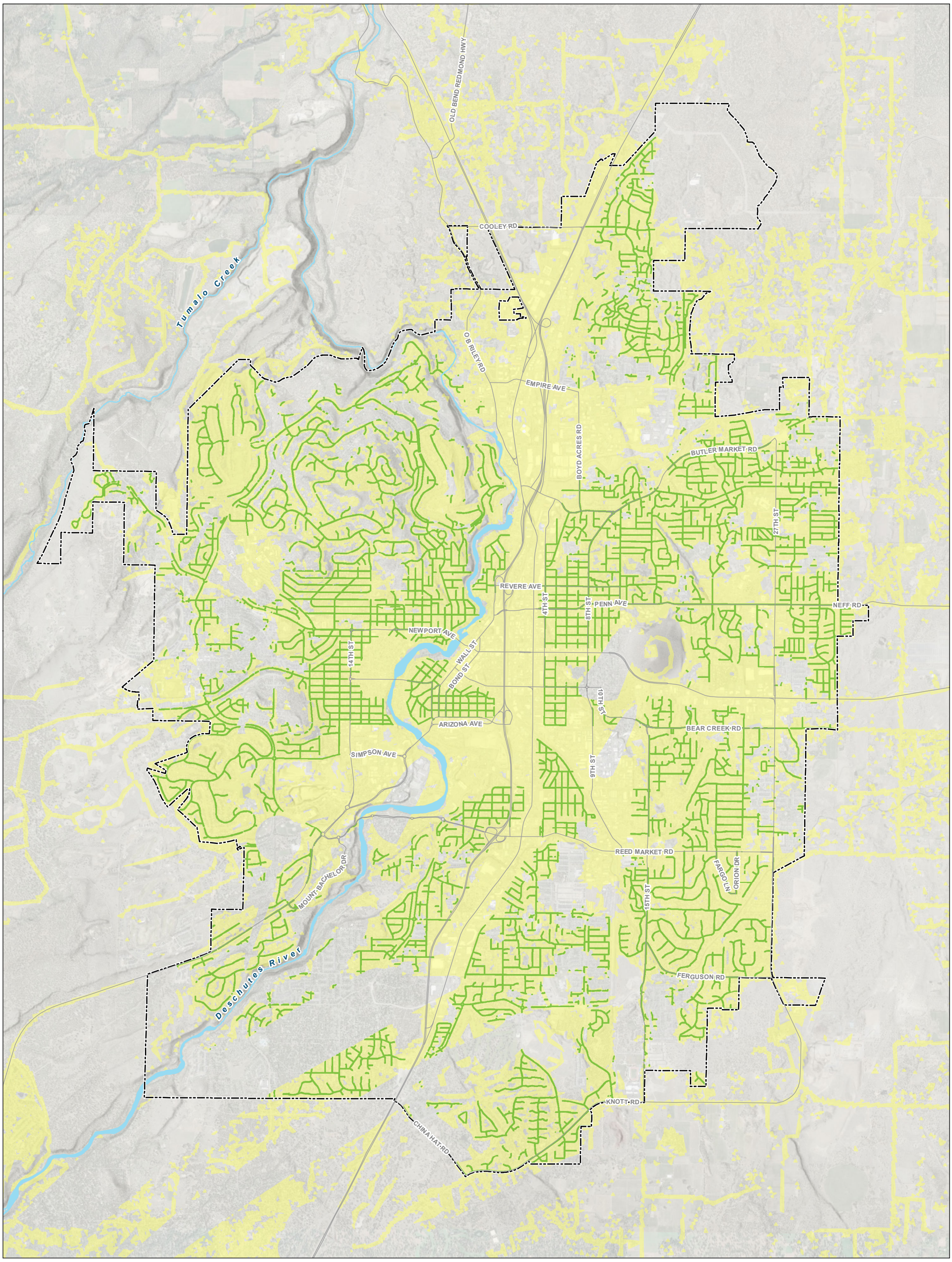


FIGURE 1

Modified Bend Stormwater Sedimentation Manhole

City of Bend Modified Drywell Siting Criteria and Drillhole Decommissioning Framework

GSI Water Solutions, Inc.



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 2

Areas that Meet Siting Criteria

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

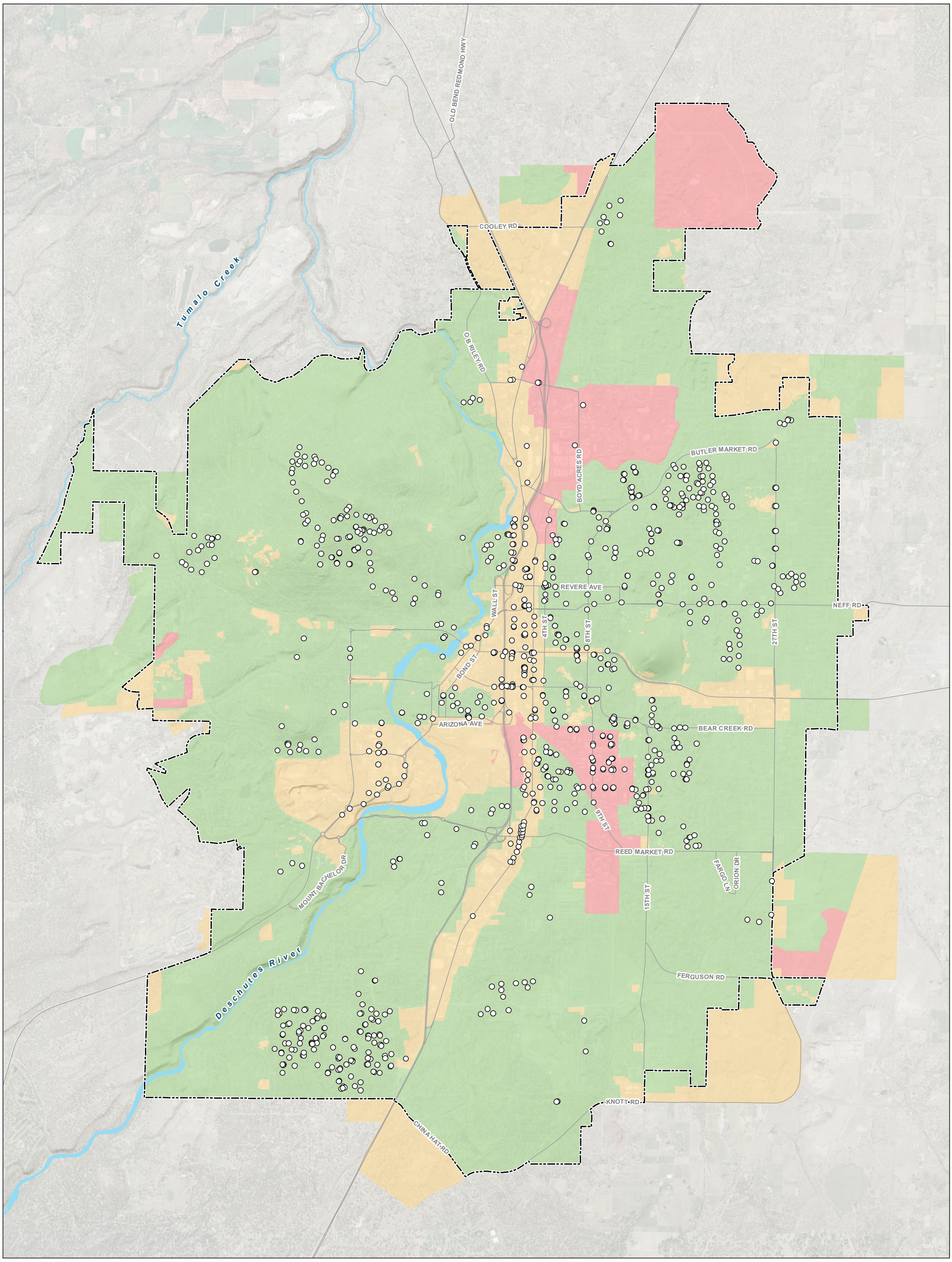
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GSI Water Solutions, Inc.

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LEGEND

- Drillhole

Land Use Risk

- High Risk: Industrial
- Moderate Risk: Commercial, Mixed-Use, Public Facility (AND >50% Impervious), Urban Area
- Low Risk: Public Facility (AND <50% impervious), Professional Office, Residential

All Other Features

- City Boundary
- Major Road
- Watercourse
- Waterbody

FIGURE 3

Land Use

City of Bend Modified Drywell Siting Criteria and Drillhole Decommissioning Framework

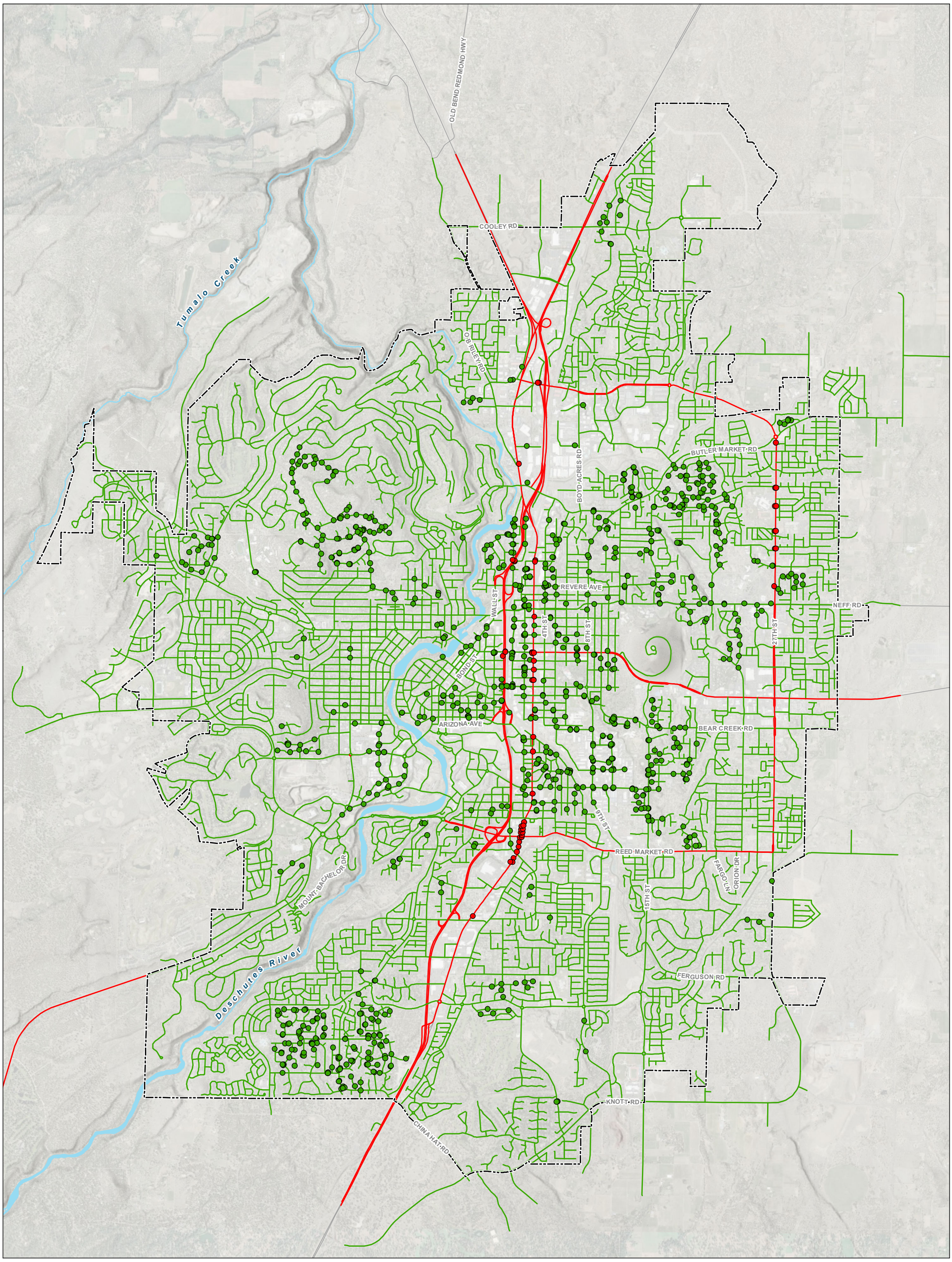
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LEGEND

Drillhole

- High Risk
- Low-Moderate Risk

Traffic Volume Risk

- High Risk: Highways, Major Arterials, Ramps
- Low-Moderate Risk: Local, Collector, Minor Arterial, Resource, Service Roads

All Other Features

- City Boundary
- Major Road
- Watercourse
- Waterbody

FIGURE 4

Traffic Volume

City of Bend Modified Drywell Siting Criteria and Drillhole Decommissioning Framework

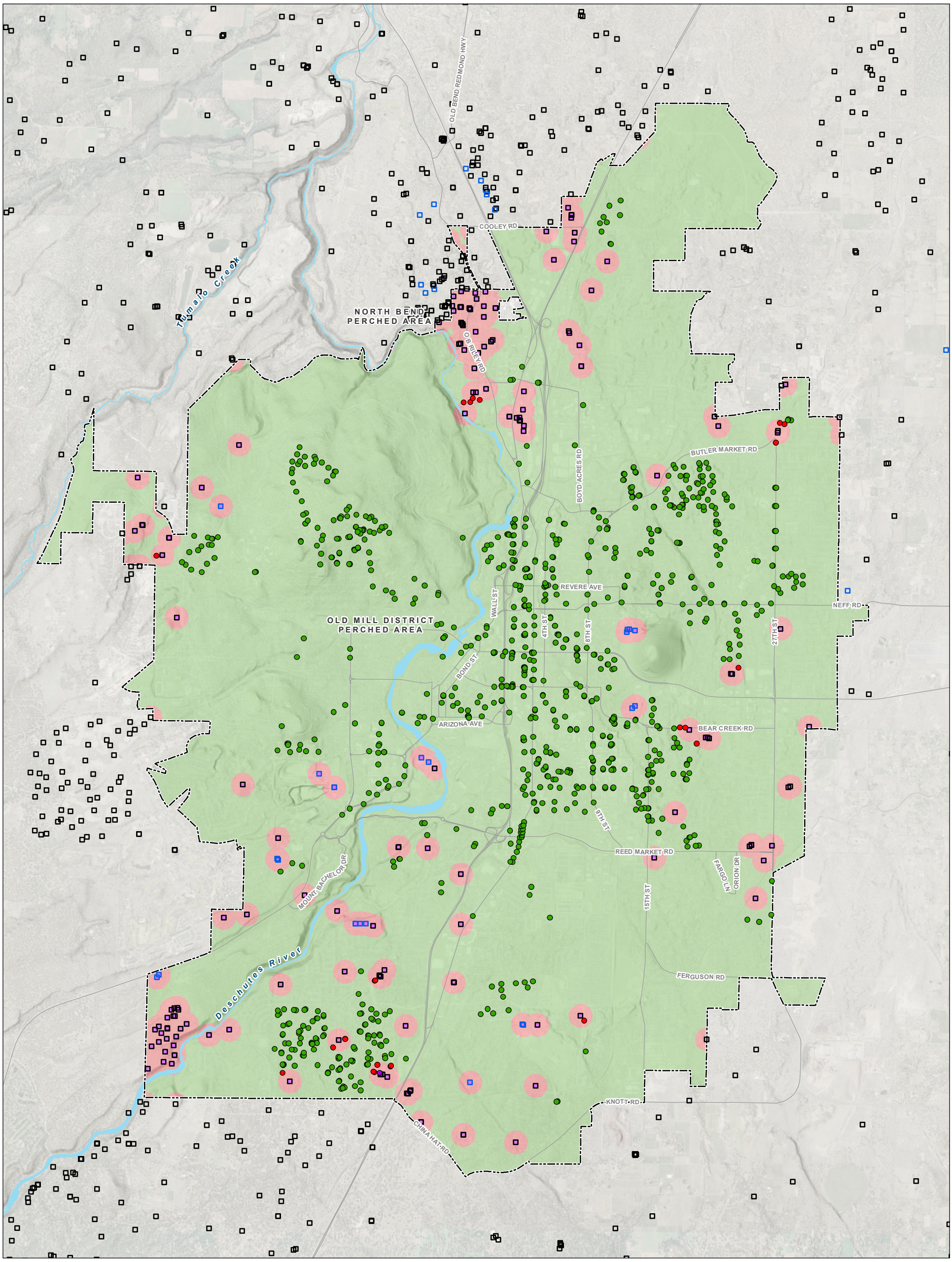
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GSI Water Solutions, Inc.

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LEGEND

- Drillhole
- Private Water Well
- Public Water Well

Risk Assigned to Water Well Locations

- Extra High Risk: <100 ft from Water Well
- High Risk: <500 ft from Water Well
- Low Risk: >500 ft from Water Well

All Other Features

- City Boundary
- Major Road
- Watercourse
- Waterbody

FIGURE 5a

Risk Assigned to Water Well Locations – Distance from Water Wells

City of Bend Modified Drywell Siting Criteria and Drillhole Decommissioning Framework

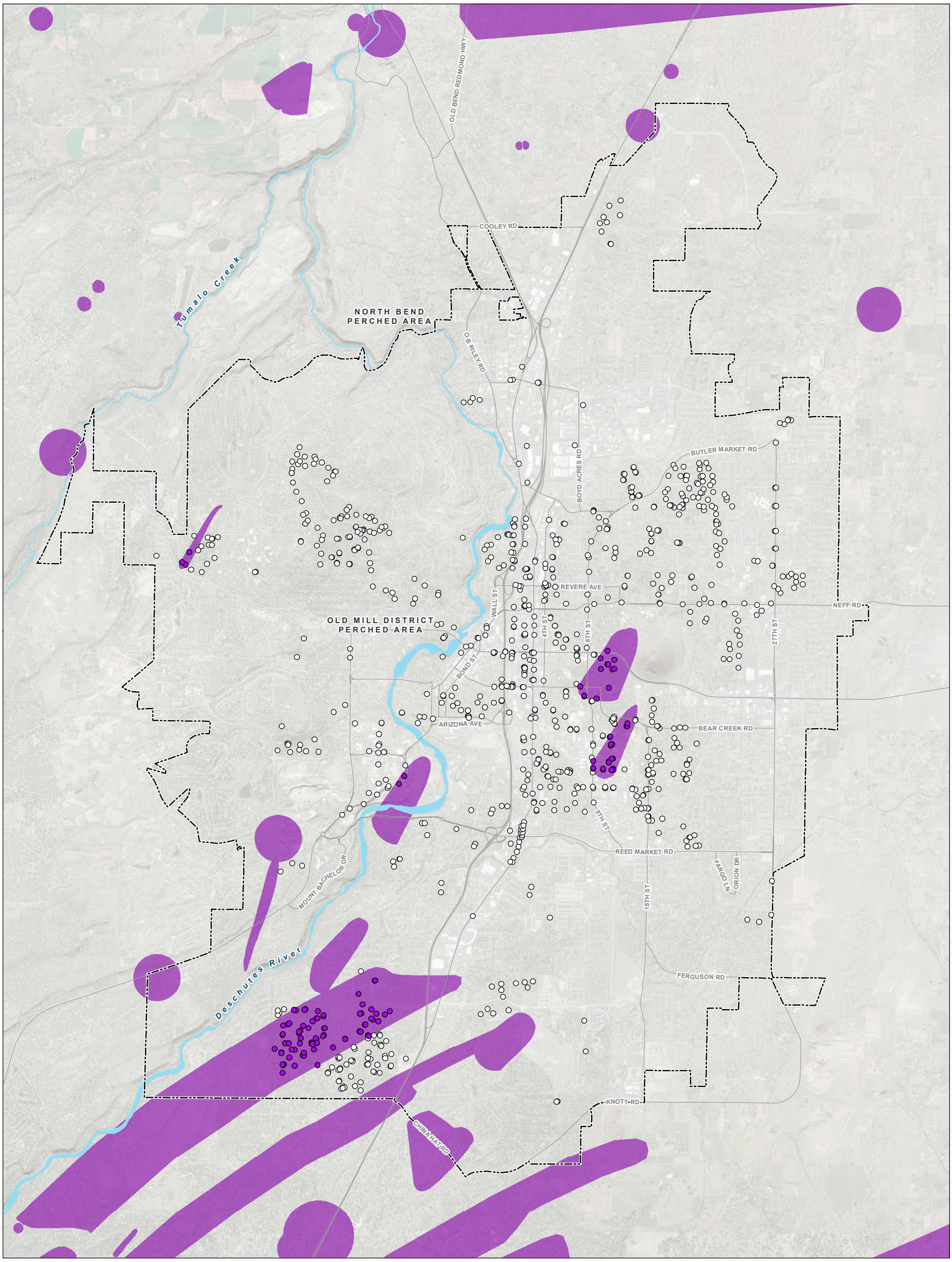
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LEGEND

- Drillhole
- Extra High Risk: Two-year time-of-travel of a public water well zones

All Other Features

- City Boundary
- Major Road
- Watercourse
- Waterbody

FIGURE 5b

Risk Assigned to Water Well Locations – Risk to Public Water Wells

City of Bend Modified Drywell Siting Criteria and Drillhole Decommissioning Framework

Date: July 3, 2024

Data Sources: City of Bend, ESRI, ODOT, USGS, Aerial Photo 2022

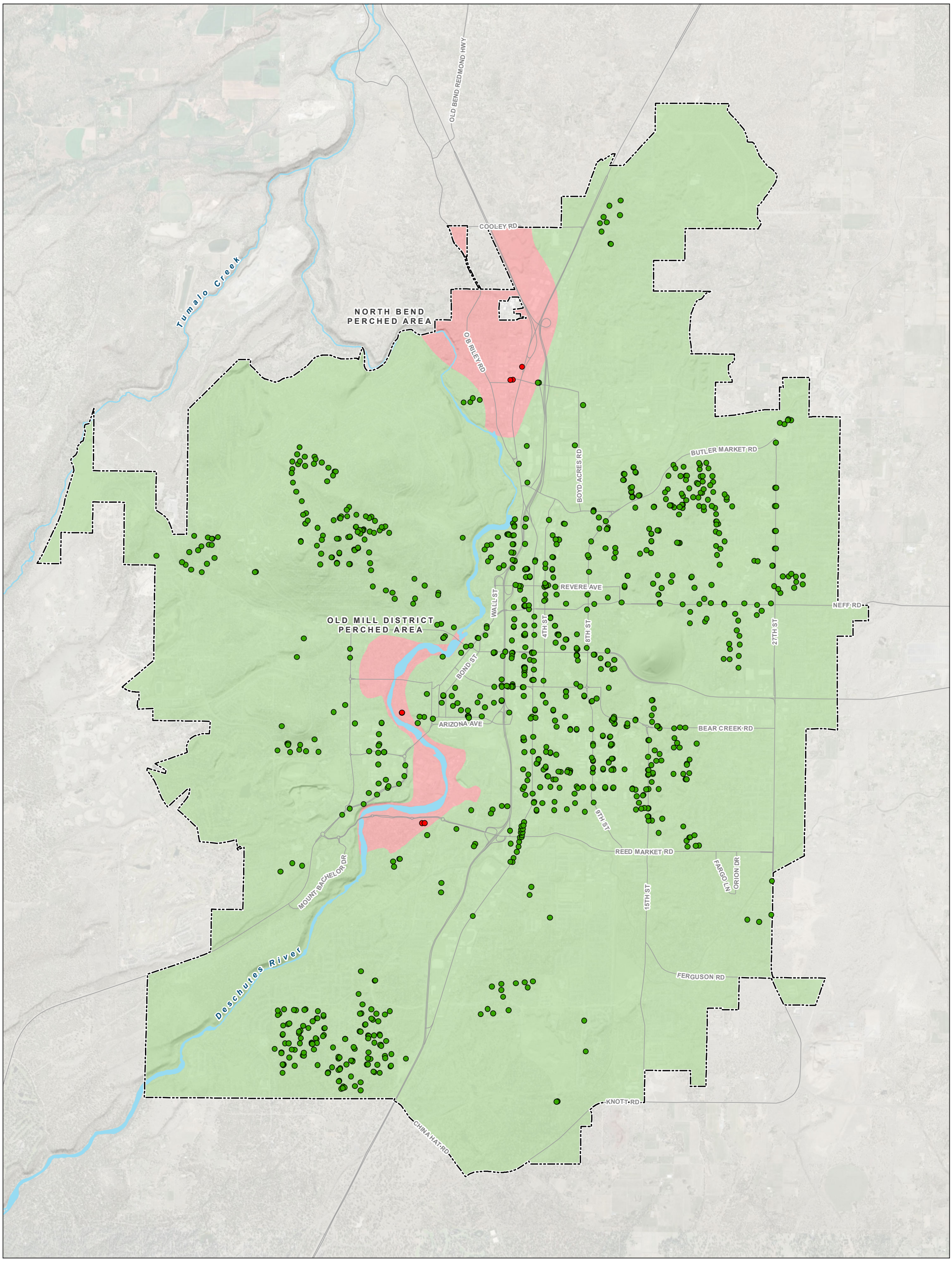
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GSI Water Solutions, Inc.

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LEGEND

- Drillhole

Risk Assigned to Water Well Locations

- Low Risk: Outside of a perched groundwater area
- High Risk: Areas of perched groundwater
- Extra High Risk: Areas of perched groundwater AND <53 ft vertical separation from groundwater

All Other Features

- City Boundary
- Major Road
- Watercourse
- Waterbody

FIGURE 5c

Risk Assigned to Water Well Locations - Perched Groundwater within the "North Bend Perched Area" or the "Old Mill District Perched Area"

City of Bend Modified Drywell Siting Criteria and Drillhole Decommissioning Framework

Date: July 3, 2024

Data Sources: City of Bend, ESRI, ODOT, USGS, Aerial Photo 2022

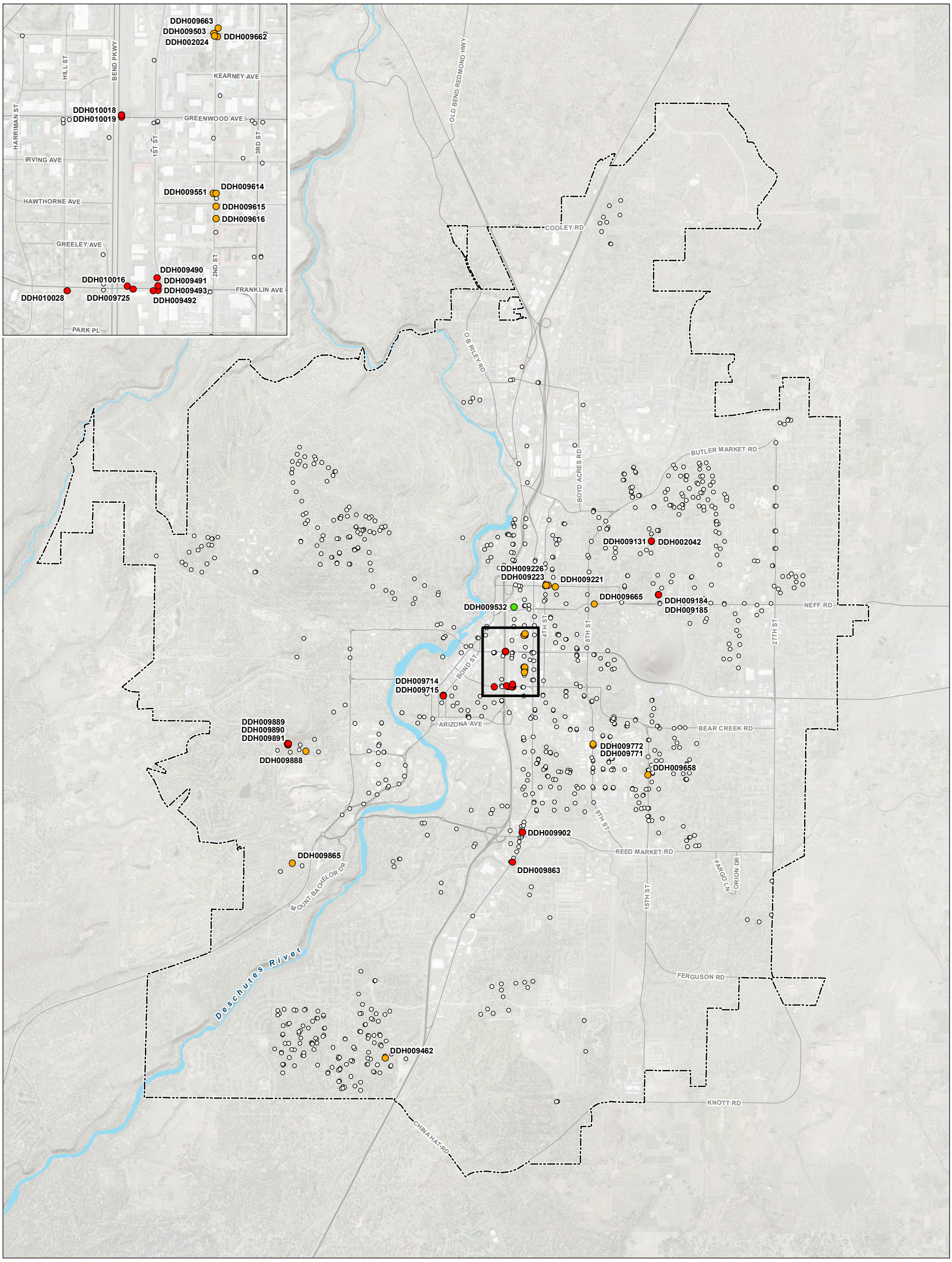
N

0 2,000 4,000 6,000

Feet

GSI Water Solutions, Inc.

Document Path: Y:\0655_Otak\Source_Figures\004_Bend_SW_Master_Plan\Modified_Drywell_Siting\Figure5c_Perched_GW.mxd, npalmer



LEGEND

- Drillhole

Risk Level Priority

- High Risk: Level 1
- Moderate Risk: Level 2
- Low Risk: Level 3

All Other Features

- City Boundary
- Major Road
- Watercourse
- Waterbody

FIGURE 6

Current Drill Hole Conditions

City of Bend Modified Drywell Siting Criteria and Drillhole Decommissioning Framework

Date: November 11, 2024

Data Sources: City of Bend, ESRI, ODOT, USGS, Aerial Photo 2022

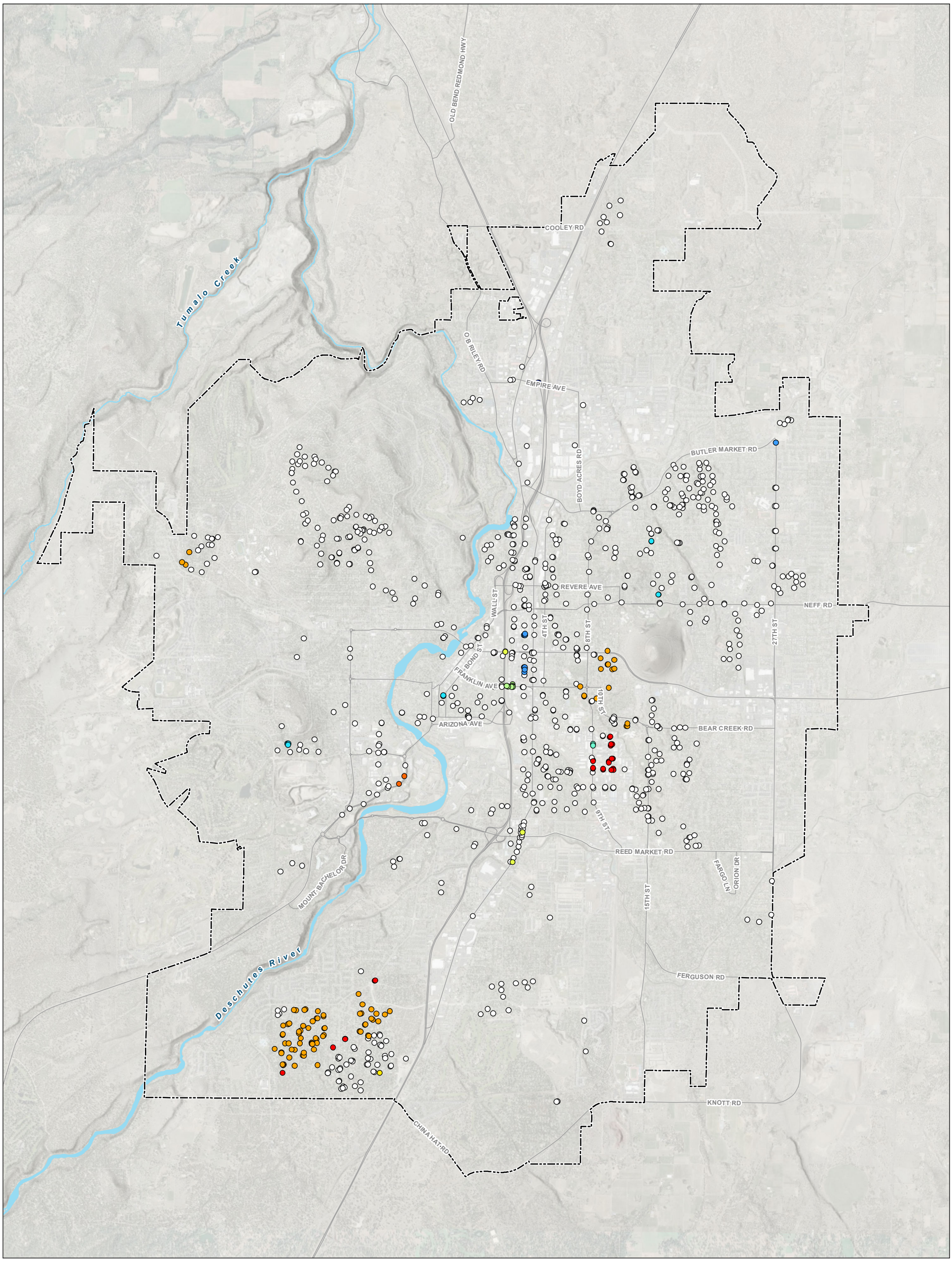
N

0 2,000 4,000 6,000

Feet

GSI Water Solutions, Inc.

Document Path: Y:\0655_Otak\Source_Figures\004_Bend_SW_Master_Plan\Modified_Drywell_Siting\Figure6_Current_Drill_Hole.mxd, bramos



LEGEND

Drillhole Priority Rank (Quantity)

- 1 (23)
- 2 (2)
- 3 (85)
- 4 (1)
- 5 (4)
- 6 (7)
- 7 (2)
- 8 (9)
- 9 (9)
- 10 (2)
- >10 (816)

All Other Features

- City Boundary
- Major Road
- Watercourse
- Waterbody

FIGURE 7

Priority Ranking

City of Bend Modified Drywell Siting Criteria and Drillhole Decommissioning Framework

Date: August 14, 2025

Data Sources: City of Bend, ESRI, ODOT, USGS, Aerial Photo 2022

N

0 2,000 4,000 6,000

Feet

GSI Water Solutions, Inc.

Document Path: Y:\0655_Otak\Source_Figures\004_Bend_SW_Master_Plan\Modified_Drywell_Siting\Figure7_Priority_Ranking.mxd, npalmer

APPENDIX A

Drillhole Flooding Reports: Priority 1, Priority 2, and Priority 3 Locations

Priority 1 Locations

Stormwater Flooding Report

UTILITY DEPARTMENT

Work Order #	1415715
Nearest Address	1515 NE 2nd St
Asset Number	DDW002067 [Long]
Date Reported:	4/1/2022 12:00:00 AM

Flooding Information	
Flooding Severity:	Right-of-Way (Moderate Traffic Impacts)
Triggering Rain Event Size (In):	[Rain Event (In):]
Problem Code	Failing Drywell

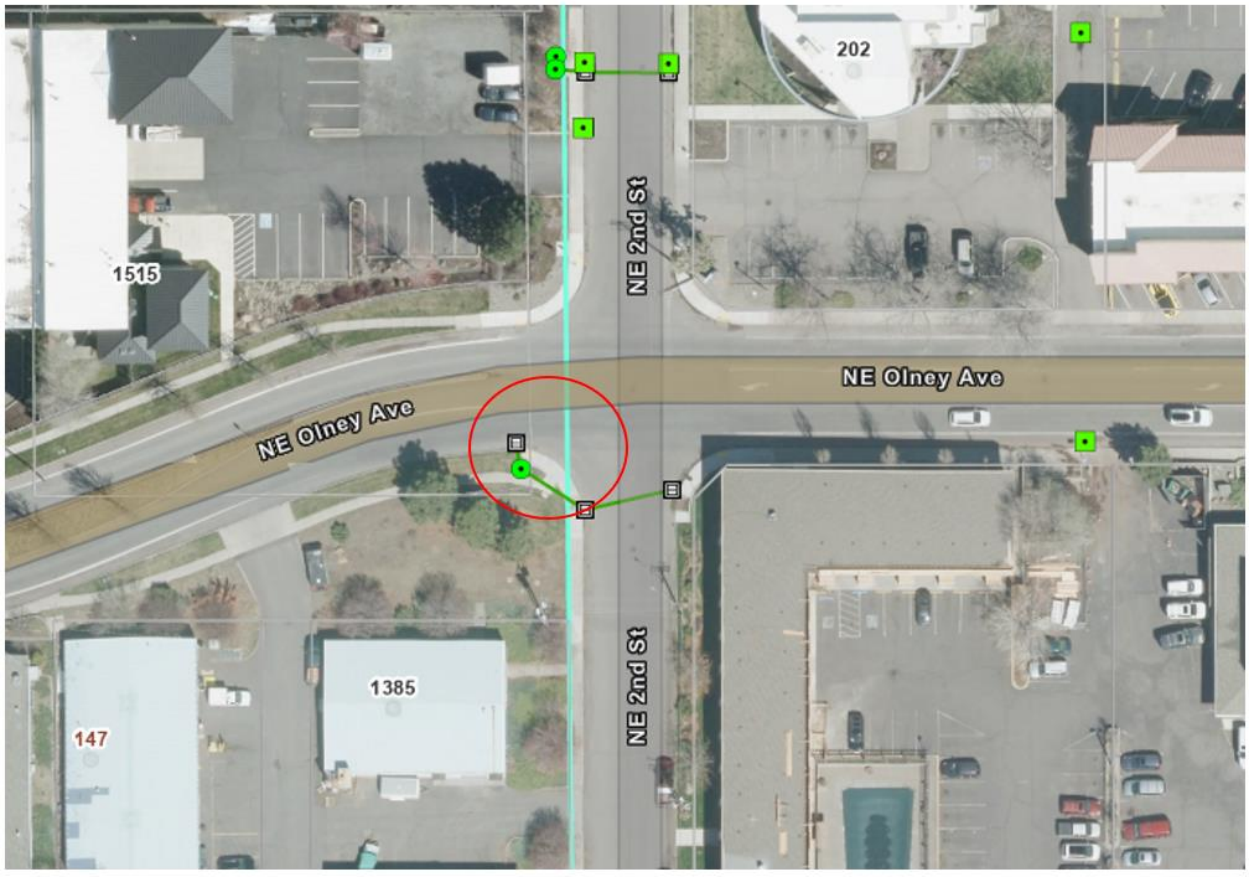
Flooding Description:

Drywell has completely failed causing water to puddle in roadway even with minimal precipitation.

Proposed Solution:

Install additional UIC's or maybe a regional pond in ROW.

Map:



Images:







Completed by ACE/SW Management Team	
Project Name:	2nd Street Drainage Improvements
Estimated Drainage Basin Size (Acres):	15
Priority Ranking:	14
Project Category:	Under Review
Estimated Budget:	[Estimated Budget:]
Project Funding Year:	[Project Funding Year:]
Project Status:	Open

UTILITY DEPARTMENT

Stormwater Project Request

Work Order #	1261386
Nearest Address	1080 SE 3rd St
Asset Number	DDH009902
Date Reported:	11/15/2020 12:00:00 AM

Flooding Information	
Flooding Severity:	Right-of-Way (Serious Traffic Impacts)
Triggering Rain Event Size (In):	[Rain Event (In):]
Problem Code	Failing Drill Hole

Flooding Description:

Large puddle form along shoulder and into the 2nd northbound travel lane

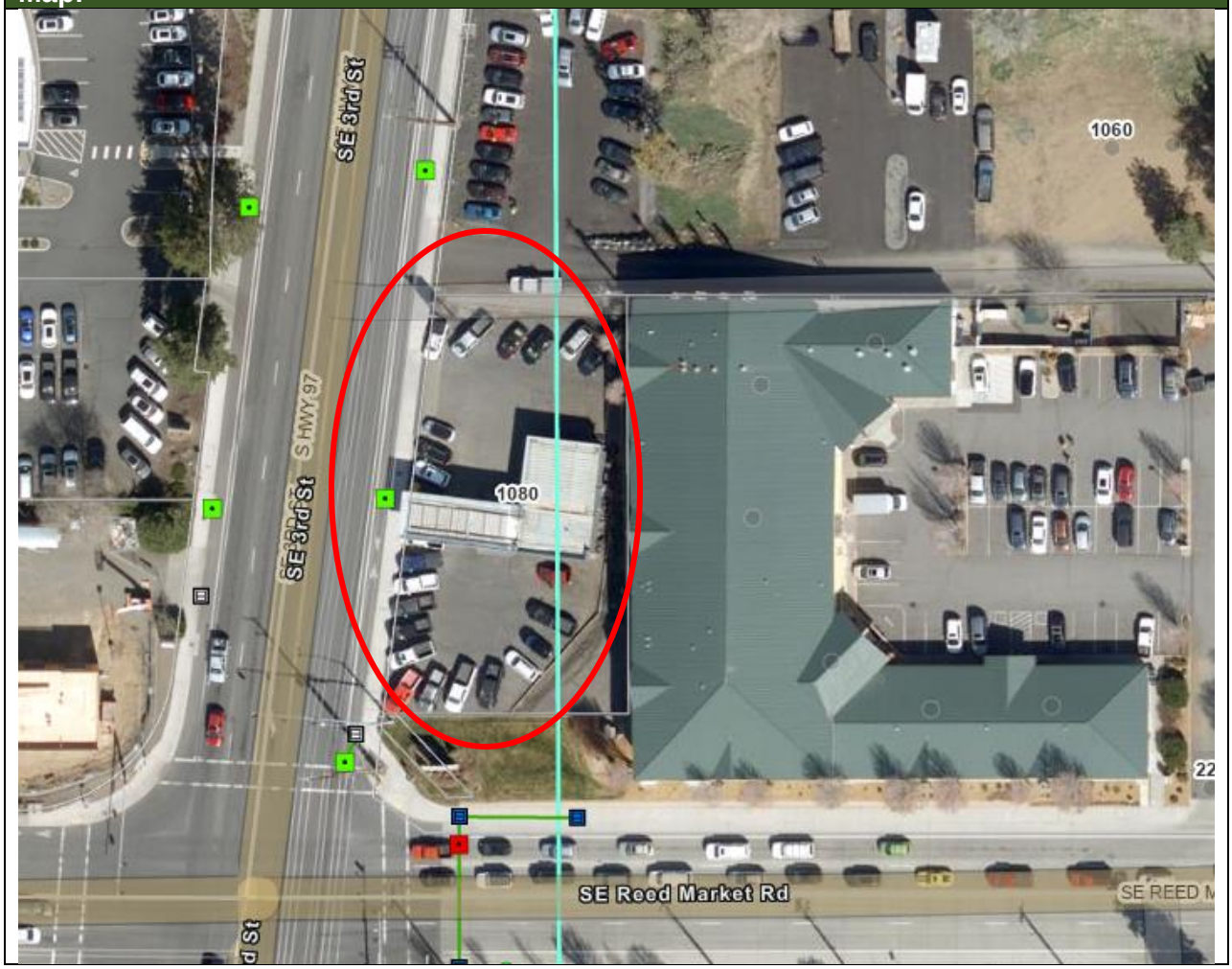
Proposed Solution:

Install additional catch basins and UIC's

Additional Information:

This location floods more frequently in the wintertime due to snowplows blocking the storm drain. The drillhole does infiltrate slowly but becomes overwhelmed easily. When the system is overwhelmed water puddles in the road and in the business parking lot causing additional property damage.

Map:



Images:







Completed by ACE/SW Management Team	
Project Name:	[Project Name]
Estimated Drainage Basin Size (Acres):	[Drainage Basin Size]
Priority Ranking:	[Priority Ranking]
Project Category:	Under Review
Estimated Budget:	[Estimated Budget:]
Project Funding Year:	[Project Funding Year:]
Project Status:	Open

UTILITY DEPARTMENT

Stormwater Flooding Report

Work Order #	1448569
Nearest Address	1901 SW KNOLL AVE
Asset Numbers	DDH009891 DDH009889 DDH009890
Date Reported:	11/4/2022 12:00:00 AM

Flooding Information	
Flooding Severity:	Property Damage (Exterior)
Triggering Rain Event Size (In):	[Rain Event (In):]
Problem Code	Under Sized System

Flooding Description:

Inadequate drainage on SW Gleneagles Way, SW Troon, SW 19th and Knoll to handle the larger rain events. Stormwater flows onto private property causing damage.

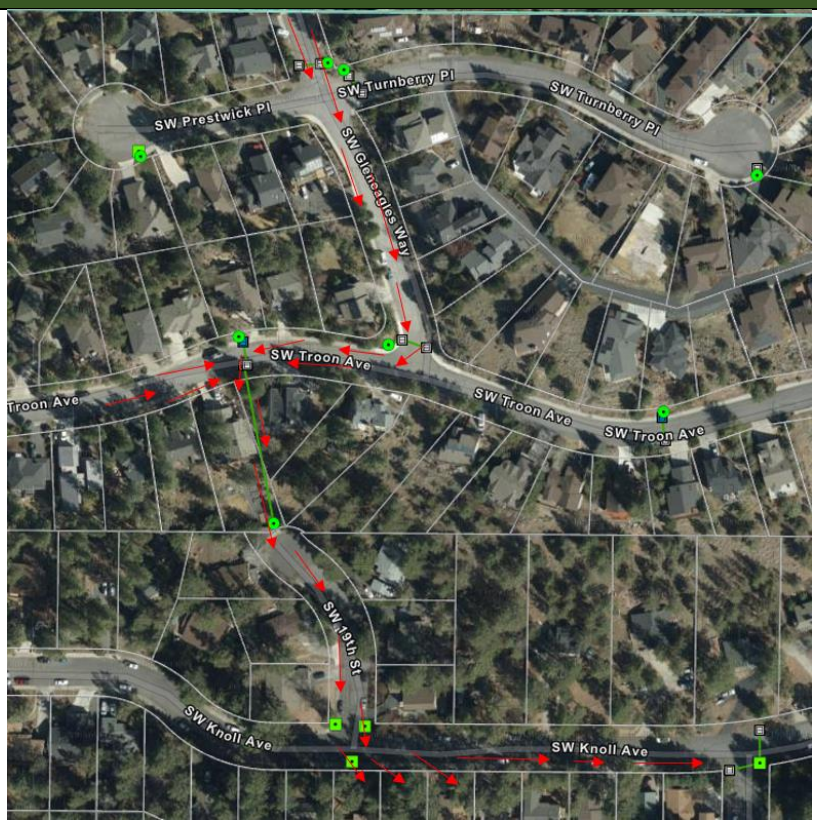
Proposed Solution:

Install additional UIC's,

Additional Information:

There has been some swale work at the top of Gleneagles Way to capture some of the runoff from Overturf Butte but ultimately it becomes overwhelmed and flows down the hill. There has also been some concrete driveway work on Knoll Ave to try and keep stormwater in the right of way. UIC's in the area do not infiltrate well and are easily overwhelmed.

Map:


SW Turnberry Pl
SW Turnberry Pl
SW Prestwick Pl
SW Gleneagles Way
SW Troon Ave
SW Troon Ave
Troon Ave
SW Troon Ave
SW 19th St
SW Knoll Ave
SW Knoll Ave

Images:







Completed by ACE/SW Management Team	
Project Name:	Overturf Butte Sub. Drainage Improvements
Estimated Drainage Basin Size (Acres):	55
Priority Ranking:	3
Project Category:	Under Review
Estimated Budget:	[Estimated Budget:]
Project Funding Year:	[Project Funding Year:]
Project Status:	Open

UTILITY DEPARTMENT

Stormwater Project Request

Work Order #	1433112
Nearest Address	717 NW Georgia Ave
Asset Number	DDH009715 DDH009714 DDW001987
Date Reported:	11/13/2020 12:00:00 AM

Flooding Information	
Flooding Severity:	Property Damage (Exterior)
Triggering Rain Event Size (In):	[Rain Event (In):]
Problem Code	Failing Drill Hole

Flooding Description:

During large rain events water from Bond and Wall converge and overwhelm the drillholes and flood on private property.

Proposed Solution:

Install new drainage/UIC's

Additional Information:

Performed infiltration test on all three drillholes and none of them work very well.

Map:


406
730
728
734
732
720
Unit 2
716
Unit 1
704
402
NW Wall St
NW Bond St
NW GEORGIA AVE
NW Georgia Ave
NW Georgia Ave
NW WALL ST
NW BOND ST
344
733
727
Unit A
717
711
338
Unit C
Unit B
329
Suite 200

Images:

Completed by ACE/SW Management Team	
Project Name:	[Project Name]
Estimated Drainage Basin Size (Acres):	[Drainage Basin Size]
Priority Ranking:	[Priority Ranking]
Project Category:	Under Review
Estimated Budget:	[Estimated Budget:]
Project Funding Year:	[Project Funding Year:]
Project Status:	Open

UTILITY DEPARTMENT

Stormwater Project Request

Work Order #	1261038
Nearest Address	1300 SE 3rd St.
Asset Number	DDH009863
Date Reported:	11/13/2020 12:00:00 AM

Flooding Information	
Flooding Severity:	Property Damage (Exterior)
Triggering Rain Event Size (In):	[Rain Event (In):]
Problem Code	Under Sized System

Flooding Description:

Water puddles on road and flows down into parking lot and main lobby of the Budget Inn causing property damage during larger rain events.

Proposed Solution:

Install additional drainage, UIC's

Additional Information:

We have installed water-bars and lowered the asphalt level to keep water in the right of way going to the drillhole, but it still floods during the larger events. There may be legal issues with this location.

Map:


Cynthia's Sewing Center
1275
1245
Super 8
SE 3rd St
Brosterhous Rd
Central Oregon Canal
61555
AutoZone
1325
1300
SE 3RD ST
S HWY 97
61545
61543
Parrell Rd
S Highway 97
61541
61533

Images:

Completed by ACE/SW Management Team	
Project Name:	[Project Name]
Estimated Drainage Basin Size (Acres):	[Drainage Basin Size]
Priority Ranking:	[Priority Ranking]
Project Category:	Under Review
Estimated Budget:	[Estimated Budget:]
Project Funding Year:	[Project Funding Year:]
Project Status:	Open

UTILITY DEPARTMENT

Stormwater Project Request

Work Order #	479871
Nearest Address	1648 NE Eastwood Dr
Asset Number	DDH009185 DDH009184
Date Reported:	9/10/13

Flooding Information	
Flooding Severity:	Property Damage (Exterior)
Triggering Rain Event Size (In):	[Rain Event (In):]
Problem Code	Under Sized System

Flooding Description:

Inadequate drainage to handle runoff. 1648 NE Eastwood is located at the low point in this basin. Water overwhelms the drill holes and floods onto property.

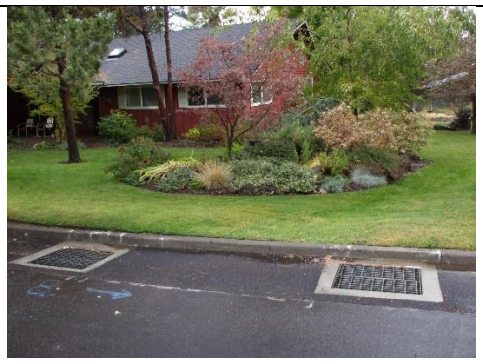
Proposed Solution:

Additional Information:

Map:


NE Shepard Rd
NE EASTWOOD DR
NE Eastwood Dr
NE SHEPARD RD
NE Neff Rd

Images:





Completed by ACE/SW Management Team	
Project Name:	[Project Name]
Estimated Drainage Basin Size (Acres):	[Drainage Basin Size]
Priority Ranking:	[Priority Ranking]
Project Category:	Under Review
Estimated Budget:	[Estimated Budget:]
Project Funding Year:	[Project Funding Year:]
Project Status:	Open

UTILITY DEPARTMENT

Stormwater Project Request

Work Order #	1213903
Nearest Address	2310 NE Shepard Rd
Asset Numbers	DDH002042 DDH009131
Date Reported:	6/1/2020 12:00:00 AM

Flooding Information	
Flooding Severity:	Structure Damage (Interior)
Triggering Rain Event Size (In):	[Rain Event (In):]
Problem Code	Under Sized System

Flooding Description:

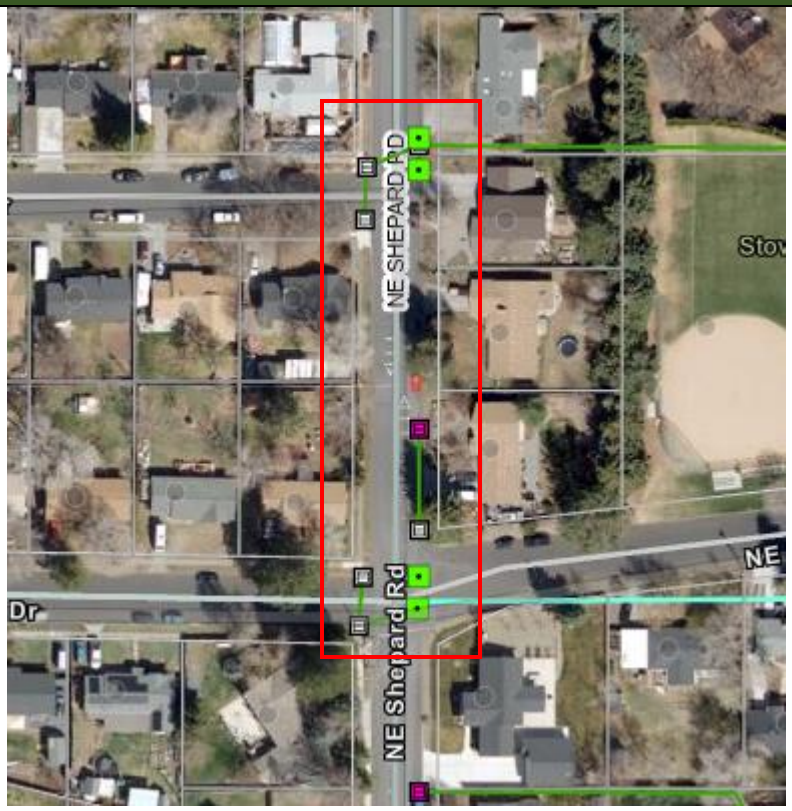
Stormwater overwhelms existing system. During large rain events the water has flowed onto private property causing damage.

Proposed Solution:

Remove and replace existing drainage with City standard storm drains, sedimentation manholes and drywells. Connect all the drainage from NE Watson Dr on Shepard to NE Dempsey. Bypass/Overflow out existing storm line to the east at 2342 NE Shepard.

Additional Information:

Map:



Images:





Completed by ACE/SW Management Team	
Project Name:	[Project Name]
Estimated Drainage Basin Size (Acres):	[Drainage Basin Size]
Priority Ranking:	[Priority Ranking]
Project Category:	Under Review
Estimated Budget:	[Estimated Budget:]
Project Funding Year:	[Project Funding Year:]
Project Status:	Open

UTILITY DEPARTMENT

Stormwater Project Request

Work Order #	141965
Nearest Address	19410 Century Dr
Asset Number	DDW001276
Date Reported:	6/3/2022 12:00:00 AM

Flooding Information	
Flooding Severity:	Property Damage (Exterior)
Triggering Rain Event Size (In):	[Rain Event (In):]
Problem Code	Under Sized System

Flooding Description:

During large rain events water flows from West Campbell Rd and Tetherow overland through several properties and into the right of way

Proposed Solution:

Install UIC's, install regional swale, install erosion control measures

Additional Information:

There are several homes that were built in the natural drainage and there is no stormwater infrastructure in the area. West Campbell Rd was re-graded to try and shed water to the opposite side, but water still flows through the properties.

Map:


SWARENS AV
W Campbell Rd
W Campbell Rd
W Campbell RdPBELL RD
SW Century Dr
SW Century Dr

Images:









Completed by ACE/SW Management Team	
Project Name:	[Project Name]
Estimated Drainage Basin Size (Acres):	[Drainage Basin Size]
Priority Ranking:	[Priority Ranking]
Project Category:	Under Review
Estimated Budget:	[Estimated Budget:]
Project Funding Year:	[Project Funding Year:]
Project Status:	Open

UTILITY DEPARTMENT

Stormwater Project Request

Work Order #	878656	
Nearest Address	633 NW York Dr	
Asset Number	DDW008446	DDW008445
	DDW008444	
Date Reported:	2/8/2017 12:00:00 AM	

Flooding Information	
Flooding Severity:	Right-of-Way (Serious Traffic Impacts)
Triggering Rain Event Size (In):	[Rain Event (In):]
Problem Code	Failing Drywell

Flooding Description:

Large puddle forms in the right of way and up over the curb during large rain/snow events.

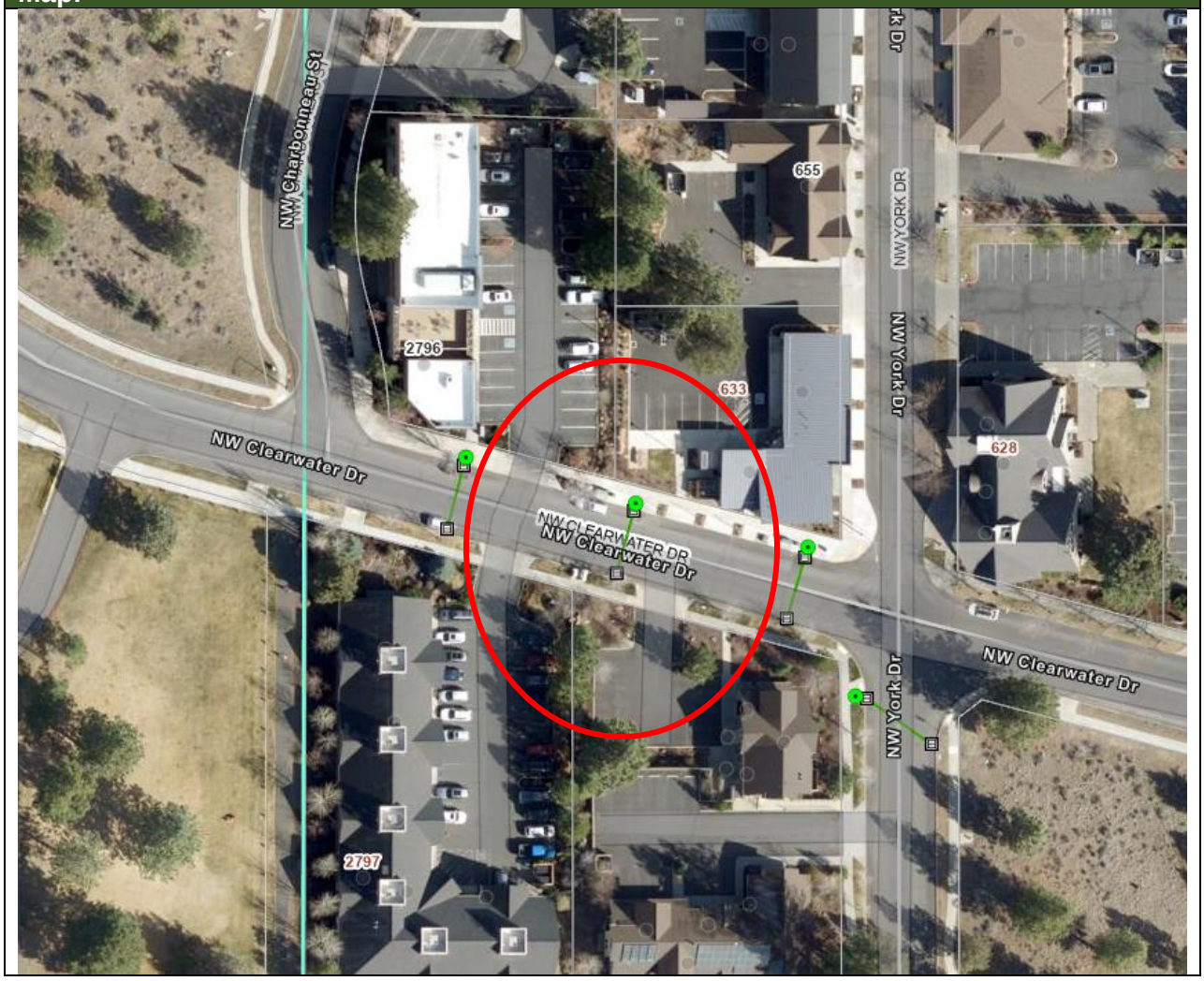
Proposed Solution:

Install additional UIC's, install regional swale

Additional Information:

This location typically only floods during the winter months when the ground is frozen

Map:


NW Charbonneau St
655
NW YORK DR
NW York Dr
2796
633
628
NW Clearwater Dr
NW CLEARWATER DR
NW Clearwater Dr
NW Clearwater Dr
NW York Dr
2797

Images:

Completed by ACE/SW Management Team	
Project Name:	[Project Name]
Estimated Drainage Basin Size (Acres):	[Drainage Basin Size]
Priority Ranking:	[Priority Ranking]
Project Category:	Under Review
Estimated Budget:	[Estimated Budget:]
Project Funding Year:	[Project Funding Year:]
Project Status:	Open

UTILITY DEPARTMENT

Stormwater Flooding Report

Work Order #	1483259
Nearest Address	125 NE Franklin Ave
Asset Numbers	DDH009725 DDH010016 DDH009492 DDH009493 DDH009491 DDH010028 DDH010018 DDH009490 DDH010019
Date Reported:	12/26/2022 12:00:00 AM

Flooding Information	
Flooding Severity:	Right-of-Way (Serious Traffic Impacts)
Triggering Rain Event Size (In):	[Rain Event (In):]
Problem Code	Failing Drill Hole

Flooding Description:

There is 1 working drill hole servicing the underpass runoff and it is failing. Storm water puddles in roadway requiring underpass to be closed. The other assets listed are part of the underpass drainage basin.

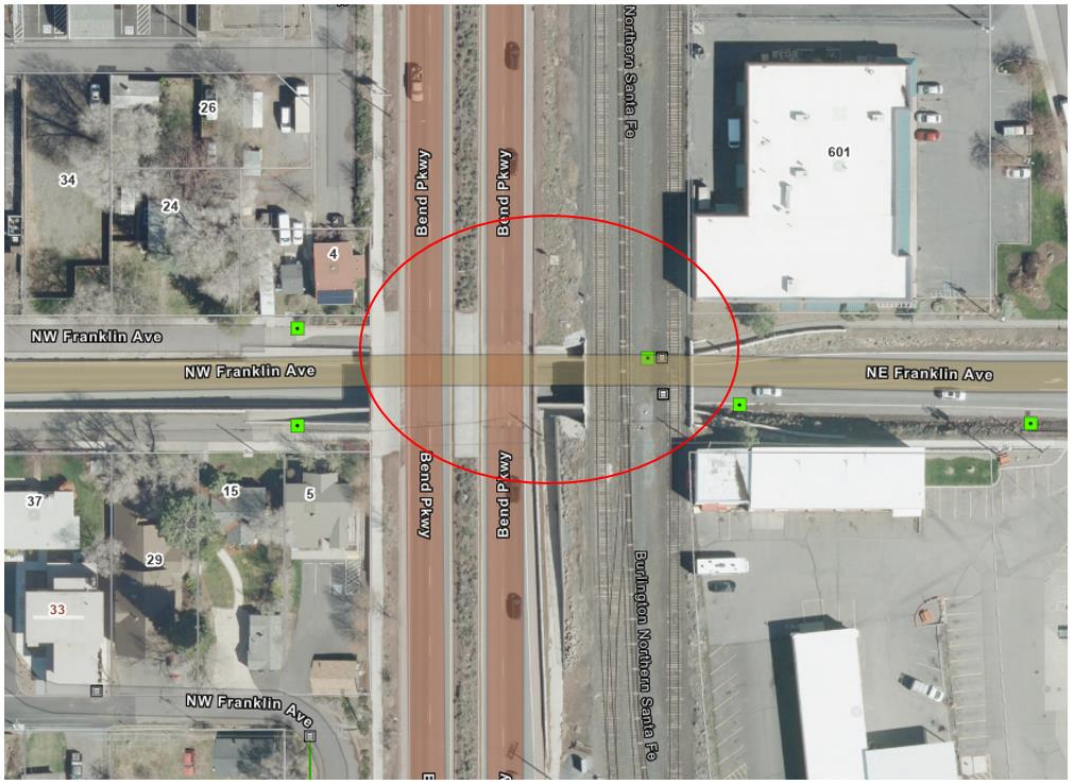
Proposed Solution:

Install a storm system sed. manhole, storm drains, drywells or pump station.

Additional Information:

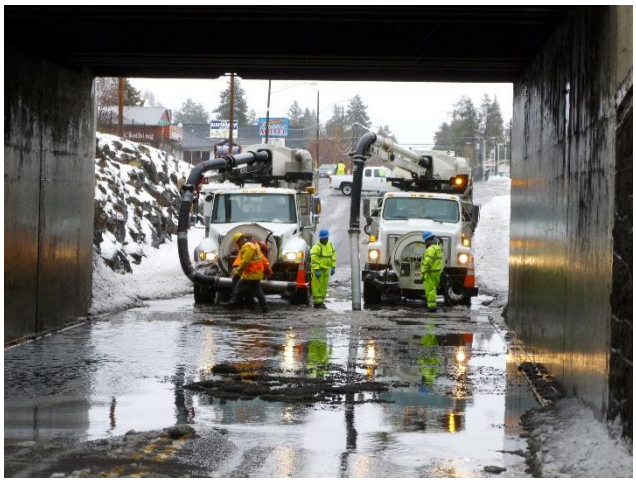
There is a large amount of sediment erosion along the road and sidewalk that are contributing to the expedited failure of the drillhole (DDH010016).

Map:


NW Franklin Ave
NW Franklin Ave
NE Franklin Ave
NW Franklin Ave
Bend Pkwy
Bend Pkwy
Bend Pkwy
Bend Pkwy
Northern Santa Fe
Burlington Northern Santa Fe
601
26
34
24
4
37
15
5
29
33

Images:









Completed by ACE/SW Management Team	
Project Name:	Franklin Underpass Drainage Improvements
Estimated Drainage Basin Size (Acres):	[Drainage Basin Size]
Priority Ranking:	1

Project Category:	Master Plan
Estimated Budget:	[Estimated Budget:]
Project Funding Year:	[Project Funding Year:]
Project Status:	Open

UTILITY DEPARTMENT

Stormwater Flooding Report

Work Order #	1483284
Nearest Address	5 NW Greenwood Ave
Asset Numbers	DDH010018 DDH010019
Date Reported:	12/26/2022 12:00:00 AM

Flooding Information	
Flooding Severity:	Right-of-Way (Serious Traffic Impacts)
Triggering Rain Event Size (In):	[Rain Event (In):]
Problem Code	Failing Drill Hole

Flooding Description:

There are 2 drill holes servicing the underpass runoff and they are inadequate in large rain events. Storm water puddles in roadway requiring underpass to be closed.

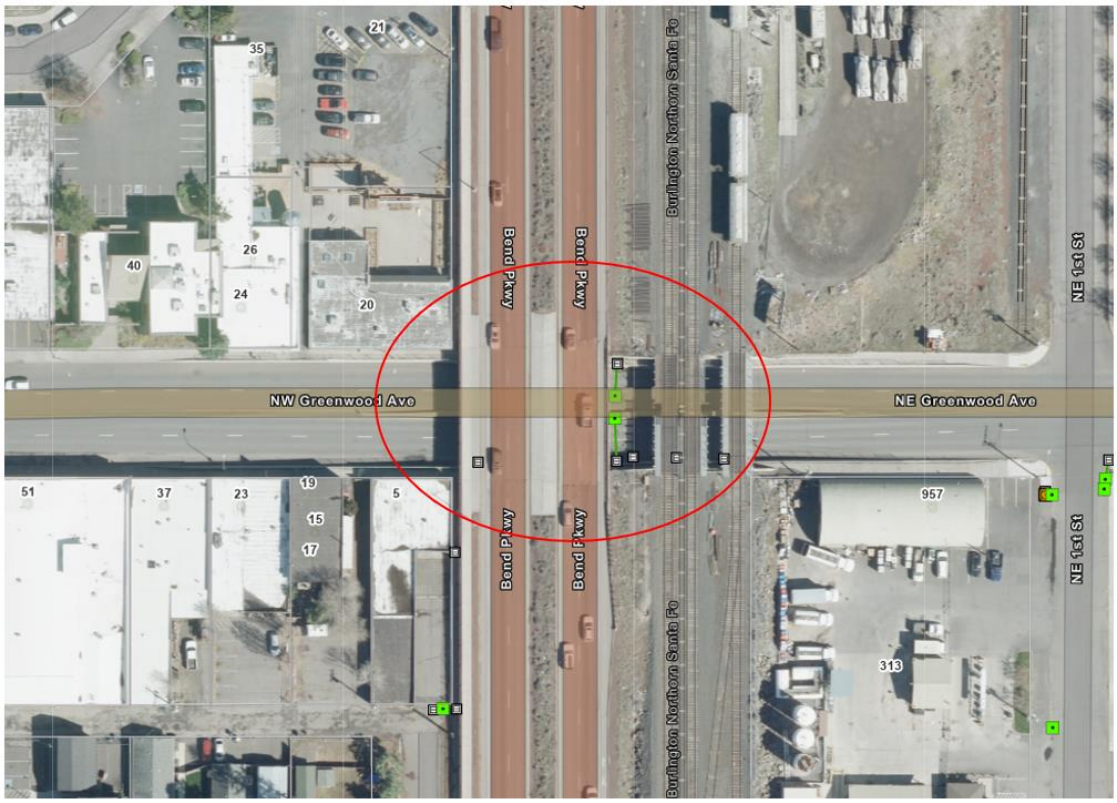
Proposed Solution:

Install a storm system sed. manhole, storm drains, drywells, or pump station.

Additional Information:

Drillhole (DDH010018) in west bound lane was recently re-drilled to 100ft. Both drillholes still infiltrate poorly and ultimately all drainage needs to be upgraded.

Map:


NW Greenwood Ave
NE Greenwood Ave
Bond Pkwy
Bond Pkwy
Bond Pkwy
Bond Pkwy
Burlington Northern Santa Fe
Burlington Northern Santa Fe
NE 1st St
NE 1st St
21
35
40
26
24
20
51
37
23
19
15
17
5
957
313

Images:









Completed by ACE/SW Management Team	
Project Name:	Greenwood Underpass Drainage Improvements
Estimated Drainage Basin Size (Acres):	[Drainage Basin Size]
Priority Ranking:	2
Project Category:	Master Plan
Estimated Budget:	[Estimated Budget:]
Project Funding Year:	[Project Funding Year:]
Project Status:	Open

UTILITY DEPARTMENT

Stormwater Project Request

Work Order #	1219584
Nearest Address	NW Summit/NW Mt. Washington
Asset Number	DDW007037
Date Reported:	2/13/2024 12:00:00 AM

Flooding Information	
Flooding Severity:	Right-of-Way (Serious Traffic Impacts)
Triggering Rain Event Size (In):	[Rain Event (In):]
Problem Code	Failing Drywell

Flooding Description:

Water from NW Summit Dr flows down hill and overwhelms drywell on SW corner. Very slow draining drywell.

Proposed Solution:

Install additional drainage/UIC's on Summit, rehab/replace existing drywell, install drillhole in existing drywell, swale

Additional Information:

This large drainage area has become a stormwater hotspot for flooding. Drywell has completely failed and water either builds up enough to flow across the intersection and down to the next drainage area or it evaporates.

Map:


3020
NW Merchant Way
NW Summit Dr
NW SUMMIT DR
NW MT WASHINGTON DR
NW Mount Washington Dr
3037
3025
3000
NW Lucus Ct
NW Lucus Ct
2990

Images:







Completed by ACE/SW Management Team	
Project Name:	[Project Name]
Estimated Drainage Basin Size (Acres):	[Drainage Basin Size]
Priority Ranking:	[Priority Ranking]
Project Category:	Under Review
Estimated Budget:	[Estimated Budget:]
Project Funding Year:	[Project Funding Year:]
Project Status:	Open

UTILITY DEPARTMENT

Stormwater Project Request

Work Order #	779132
Nearest Address	858 NW Wall St.
Asset Numbers	DDW007557 DDW007558
Date Reported:	6/8/2016 12:00:00 AM

Flooding Information	
Flooding Severity:	Property Damage (Exterior)
Triggering Rain Event Size (In):	[Rain Event (In):]
Problem Code	Failing Drywell

Flooding Description:

The drywells in this area have completely failed and sit full of water year-round. Water builds up and floods into several businesses before it can flow south to the mainline to the river.

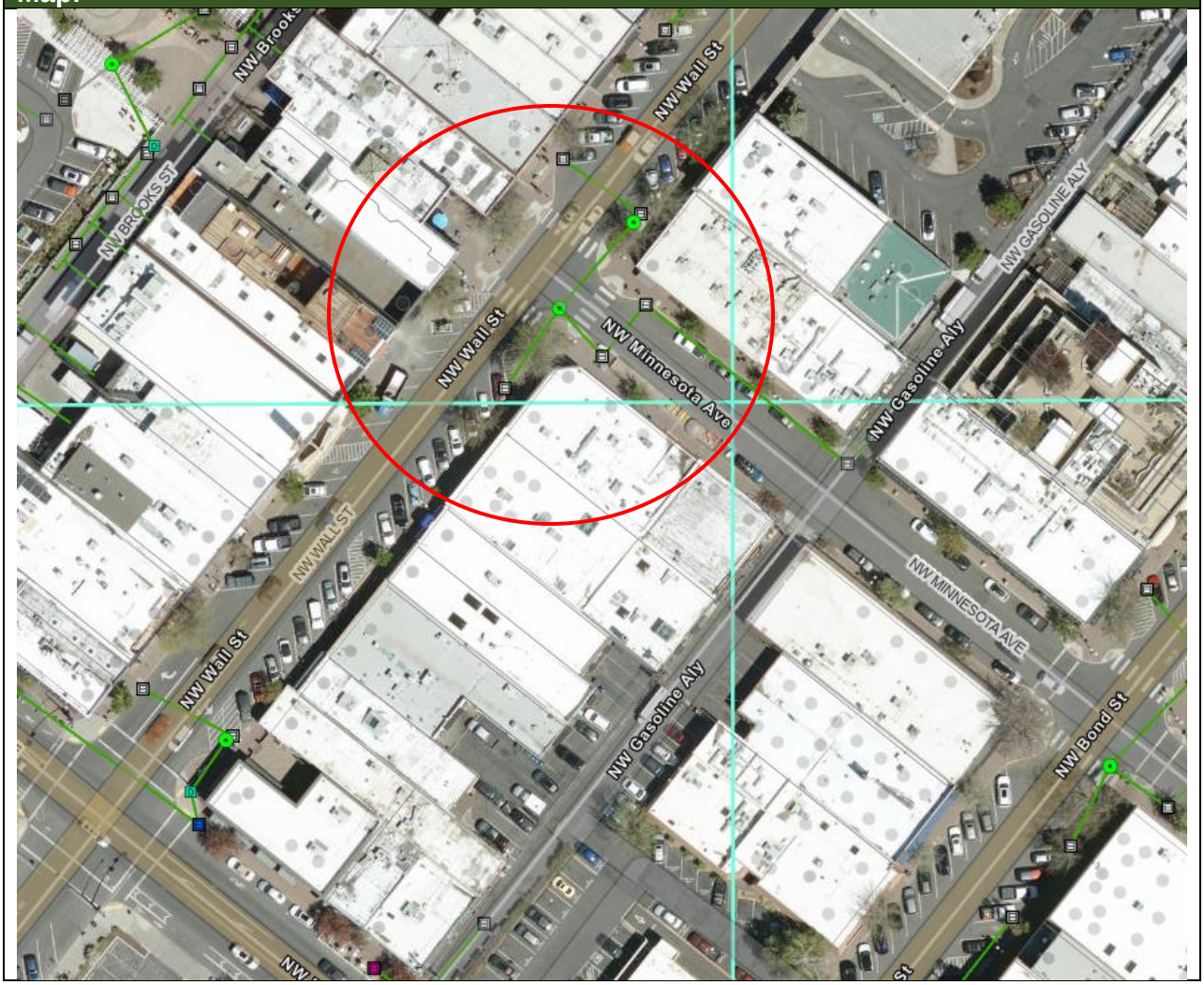
Proposed Solution:

Install new UIC's, extend pipeline to the river, install pre-treatment

Additional Information:

All downtown drainage is aging and needs to be addressed. This location floods more frequently than any other downtown location.

Map:


NW Brooks St
NW Wall St
NW BROOKS ST
NW Wall St
NW Minnesota Ave
NW Gasoline Aly
NW GASOLINE ALY
NW WALL ST
NW Wall St
NW MINNESOTA AVE
NW Gasoline Aly
NW Bond St

Images:









Completed by ACE/SW Management Team	
Project Name:	[Project Name]
Estimated Drainage Basin Size (Acres):	[Drainage Basin Size]
Priority Ranking:	[Priority Ranking]
Project Category:	Under Review
Estimated Budget:	[Estimated Budget:]
Project Funding Year:	[Project Funding Year:]
Project Status:	Open

Priority 2 Locations

UTILITY DEPARTMENT

Stormwater Project Request

Work Order #	715133
Nearest Address	151 SW Shevlin LN
Asset Number	DDW003166
Date Reported:	5/21/2015 12:00:00 AM

Flooding Information	
Flooding Severity:	Right-of-Way (Serious Traffic Impacts)
Triggering Rain Event Size (In):	[Rain Event (In):]
Problem Code	Failing Drywell

Flooding Description:

Drywells at this location have wet feet. Floods across entire width of roadway.

Proposed Solution:

Install pretreatment and discharge to river.

Additional Information:

Map:


SW SHEVLIN HIXON DR
SW Shevlin Hixon Dr
143
147
151
155
166
120
132
144
159
SW CROWELL WAY
Hixon Park Block
SW BRADBURY WAY
SW Bradbury Way
SW Allen Rd
SW Shevlin Hixon Dr

Images:

Completed by ACE/SW Management Team	
Project Name:	[Project Name]
Estimated Drainage Basin Size (Acres):	[Drainage Basin Size]
Priority Ranking:	[Priority Ranking]
Project Category:	Under Review
Estimated Budget:	[Estimated Budget:]
Project Funding Year:	[Project Funding Year:]
Project Status:	Open

UTILITY DEPARTMENT

Stormwater Project Request

Work Order #	694128
Nearest Address	330 SE 15th St.
Asset Number	DDH009658
Date Reported:	[Date Added]

Flooding Information	
Flooding Severity:	Right-of-Way (Moderate Traffic Impacts)
Triggering Rain Event Size (In):	[Rain Event (In):]
Problem Code	Failing Drill Hole

Flooding Description:

Water puddles in bike lane and road causing traffic to drive into on-coming lane.

Proposed Solution:

Install UIC, connect to drill hole on east side of the road

Additional Information:

This drillhole is easily overwhelmed, but it does catch up it just takes a while. It cannot be re-drilled due to overhead powerlines.

Map:



Images:





Completed by ACE/SW Management Team	
Project Name:	[Project Name]
Estimated Drainage Basin Size (Acres):	[Drainage Basin Size]
Priority Ranking:	[Priority Ranking]
Project Category:	Under Review
Estimated Budget:	[Estimated Budget:]
Project Funding Year:	[Project Funding Year:]
Project Status:	Open

UTILITY DEPARTMENT

Stormwater Project Request

Work Order #	1024531
Nearest Address	510 NW Sean Ct.
Asset Numbers	DDW007204 DDW007205
Date Reported:	5/24/2018 12:00:00 AM

Flooding Information	
Flooding Severity:	Property Damage (Exterior)
Triggering Rain Event Size (In):	[Rain Event (In):]
Problem Code	Failing Drywell

Flooding Description:

Runoff from Overturf Butte runs downhill onto private property and overwhelms the catch basin and drywell. The drywell does infiltrate slowly but is undersized for the area.

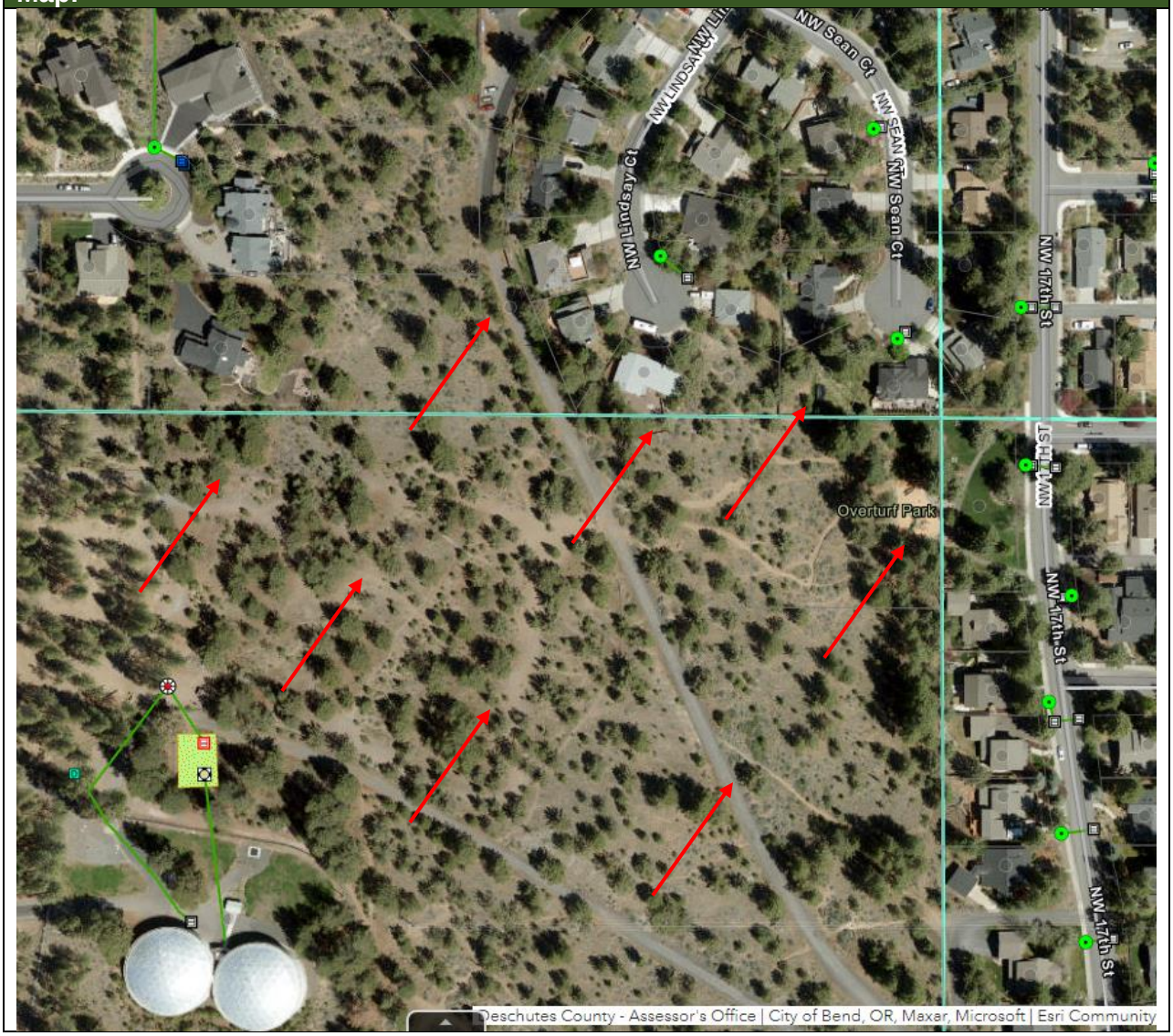
Proposed Solution:

Install additional UIC's, better control of runoff on Overturf Butte

Additional Information:

The stormwater maintenance crew installed several erosion control measures on Overturf Butte including: straw wattles, check dams, and re-vegetation. This did help, but the larger storms still cause problems.

Map:


NW Sean Ct
NW LINDSAY Ct
NW Lindsay Ct
NW SEAN
NW Sean Ct
NW 17th St
NW 17th St
Overturf Park
NW 17th St
NW 17th St
Deschutes County - Assessor's Office | City of Bend, OR, Maxar, Microsoft | Esri Community

Images:





Completed by ACE/SW Management Team	
Project Name:	[Project Name]
Estimated Drainage Basin Size (Acres):	[Drainage Basin Size]
Priority Ranking:	[Priority Ranking]
Project Category:	Under Review
Estimated Budget:	[Estimated Budget:]
Project Funding Year:	[Project Funding Year:]
Project Status:	Open

UTILITY DEPARTMENT

Stormwater Project Request

Work Order #	1082838	
Nearest Address	821 NE 2nd St	
Asset Numbers	DDH009551	DDH009614
	DDH011033	DDW0077539
	DDH009615	DDH009616
Date Reported:	12/18/2018 12:00:00 AM	

Flooding Information	
Flooding Severity:	Right-of-Way (Serious Traffic Impacts)
Triggering Rain Event Size (In):	[Rain Event (In):]
Problem Code	Failing Drill Hole

Flooding Description:

Water puddles in intersection during large rain events.

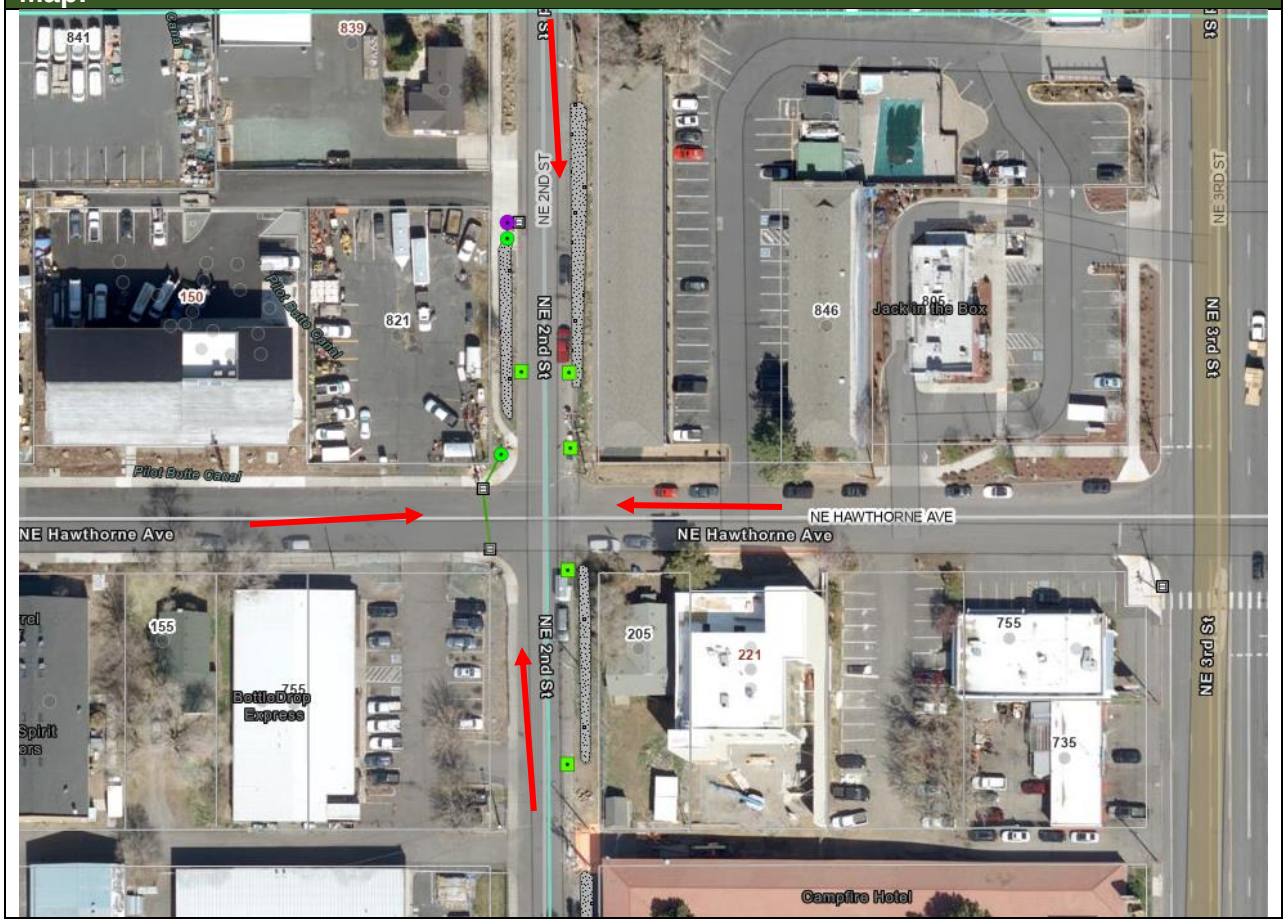
Proposed Solution:

Install additional UIC's, install regional swale

Additional Information:

Over the years this intersection has undergone several changes including the addition of swales and a new drywell system to try and help the failing drillholes. Still needs additional UIC's on South and East and West side.

Map:


841
839
NE 2ND ST
NE 3RD ST
150
821
846
Jack in the Box
Pilot Butte Canal
NE HAWTHORNE AVE
NE Hawthorne Ave
NE Hawthorne Ave
155
755
BottleDrop Express
205
221
755
735
NE 2nd St
NE 3rd St
Campfire Hotel

Images:









Completed by ACE/SW Management Team	
Project Name:	[Project Name]
Estimated Drainage Basin Size (Acres):	[Drainage Basin Size]
Priority Ranking:	[Priority Ranking]
Project Category:	Under Review
Estimated Budget:	[Estimated Budget:]
Project Funding Year:	[Project Funding Year:]
Project Status:	Open

UTILITY DEPARTMENT

Stormwater Project Request

Work Order #	1141148
Nearest Address	902 SE Textron
Asset Numbers	DDH009772 DDH009771
Date Reported:	[Date Added]

Flooding Information	
Flooding Severity:	Right-of-Way (Moderate Traffic Impacts)
Triggering Rain Event Size (In):	[Rain Event (In):]
Problem Code	Failing Drill Hole

Flooding Description:

Water puddles on SE corner, drillhole infiltrates very slowly

Proposed Solution:

Re-drill, install UIC's

Additional Information:

The drillhole on the NE corner has been re-drilled and works, but water still puddles on the SE side of the intersection. Southeast drill hole is scheduled to be reconditioned spring 2024.

Map:



Images:







Completed by ACE/SW Management Team	
Project Name:	[Project Name]
Estimated Drainage Basin Size (Acres):	[Drainage Basin Size]
Priority Ranking:	[Priority Ranking]
Project Category:	Under Review
Estimated Budget:	[Estimated Budget:]
Project Funding Year:	[Project Funding Year:]
Project Status:	Open

UTILITY DEPARTMENT

Stormwater Project Request

Work Order #	770608	
Nearest Address	1125 NE 2nd St	
Asset Number	DDH009662	DDH009503
	DDH002024	DDH009663
Date Reported:	4/15/2016	

Flooding Information	
Flooding Severity:	Right-of-Way (Moderate Traffic Impacts)
Triggering Rain Event Size (In):	[Rain Event (In):]
Problem Code	Failing Drill Hole

Flooding Description:

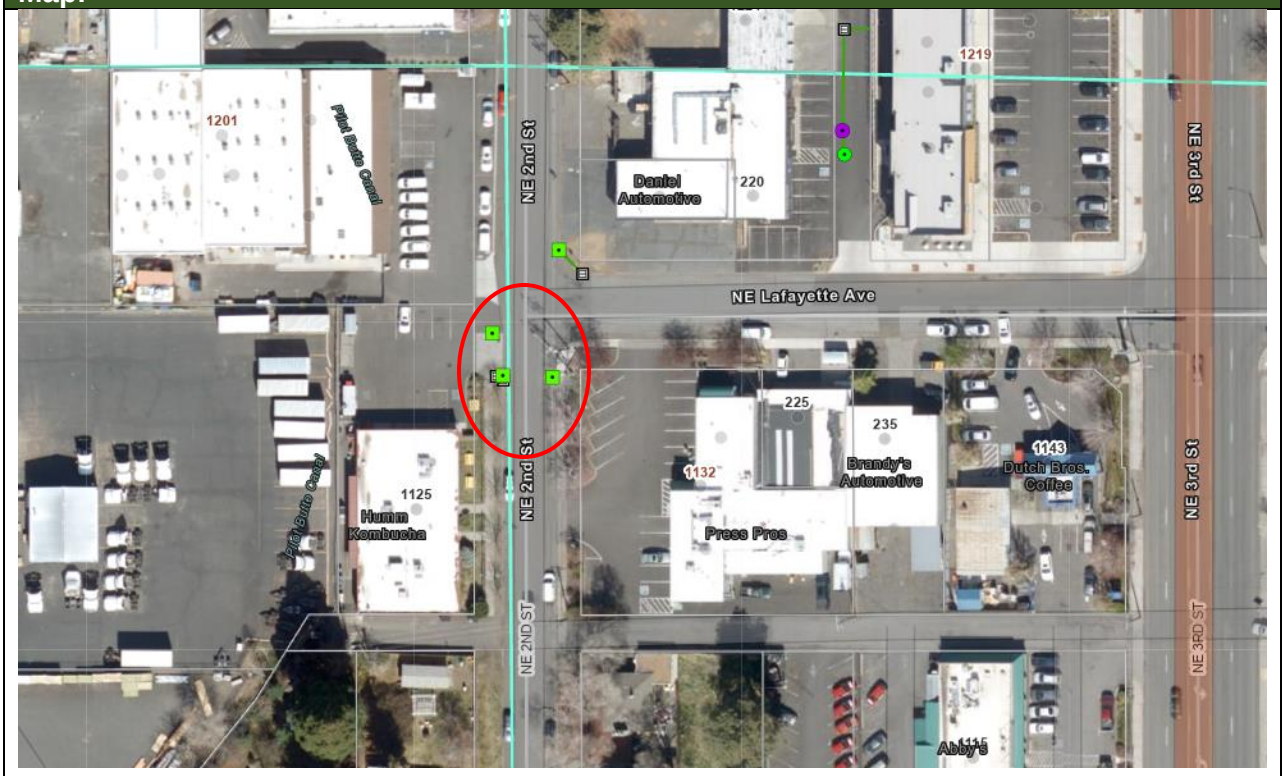
Old/minimal stormwater infrastructure. Some of the drill holes work, some do not. We have issues with the storm grates plugging at this location.

Proposed Solution:

Install additional upstream storm systems and expand or replace storm system at the intersection.

Additional Information:

Map:


1219
1201
Pilot Butte Canal
NE 2nd St
Daniel Automotive
220
NE 3rd St
NE Lafayette Ave
225
235
1143
Dutch Bros. Coffee
1132
Brandy's Automotive
1125
Humm Kombucha
Press Pros
NE 2ND ST
NE 3RD ST
Abby's

Images:









Completed by ACE/SW Management Team	
Project Name:	[Project Name]
Estimated Drainage Basin Size (Acres):	[Drainage Basin Size]
Priority Ranking:	[Priority Ranking]
Project Category:	Under Review
Estimated Budget:	[Estimated Budget:]
Project Funding Year:	[Project Funding Year:]
Project Status:	Open

Stormwater Flooding Report

UTILITY DEPARTMENT

Work Order #	1483252
Nearest Address	1193 Ross Rd
Asset Number	DDW007179
Date Added:	4/12/2023 12:00:00 AM

Flooding Information	
Flooding Severity:	Right-of-Way (Serious Traffic Impacts)
Triggering Rain Event Size (In):	1.5
Problem Code:	Failing Drywell

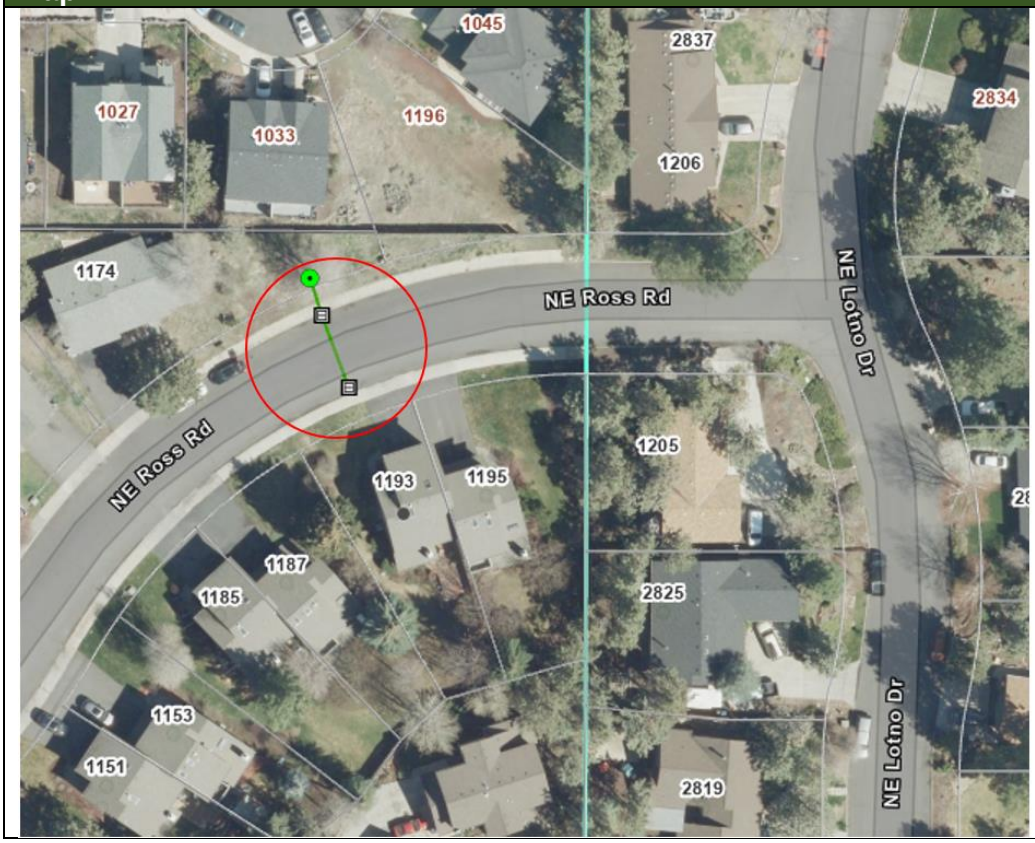
Flooding Description:

Drywell is failing and easily overwhelmed

Proposed Solution:

Install additional drainage, drywell or drill hole in drywell

Map:



Images:

Completed by ACE/SW Management Team	
Project Name:	Ross Rd Drainage Improvements
Estimated Drainage Basin Size (Acres):	1.5
Priority Ranking:	**3**
Project Category:	Under Review
Estimated Budget:	[Estimated Budget:]
Project Funding Year:	[Project Funding Year:]
Project Status:	Open

UTILITY DEPARTMENT

Stormwater Project Request

Work Order #	
Nearest Address	1212 SW Simpson Ave
Asset Numbers	DDW008127 DDW010340
Date Reported:	

Flooding Information	
Flooding Severity:	Right-of-Way (Serious Traffic Impacts)
Triggering Rain Event Size (In):	[Rain Event (In):]
Problem Code	Failing Drywell

Flooding Description:

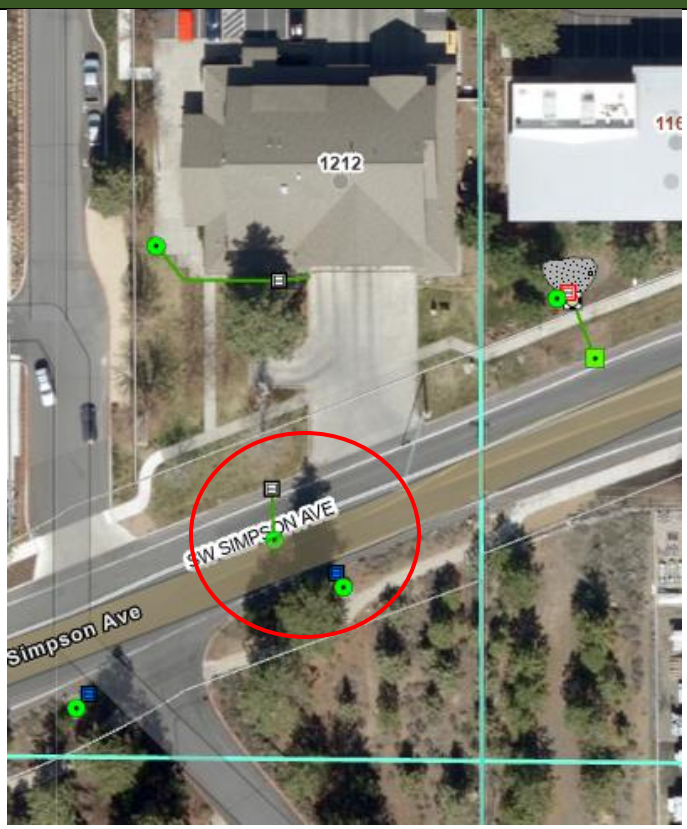
The two drywells at this location are failing. Stormwater floods across the entire roadway.

Proposed Solution:

Replace old storm system.

Additional Information:

Map:



Images:







Completed by ACE/SW Management Team	
Project Name:	[Project Name]
Estimated Drainage Basin Size (Acres):	[Drainage Basin Size]
Priority Ranking:	[Priority Ranking]
Project Category:	Under Review
Estimated Budget:	[Estimated Budget:]
Project Funding Year:	[Project Funding Year:]
Project Status:	Open

UTILITY DEPARTMENT

Stormwater Project Request

Work Order #	1420496
Nearest Address	1501 NE Neff Rd
Asset Number	DDH009221
Date Reported:	6/28/2022 12:00:00 AM

Flooding Information	
Flooding Severity:	Right-of-Way (Serious Traffic Impacts)
Triggering Rain Event Size (In):	[Rain Event (In):]
Problem Code	Failing Drill Hole

Flooding Description:

This one drillhole serves a very large drainage basin and can be overwhelmed easily. During large rain events, erosion from Pilot Butte contributes a large amount of sediment.

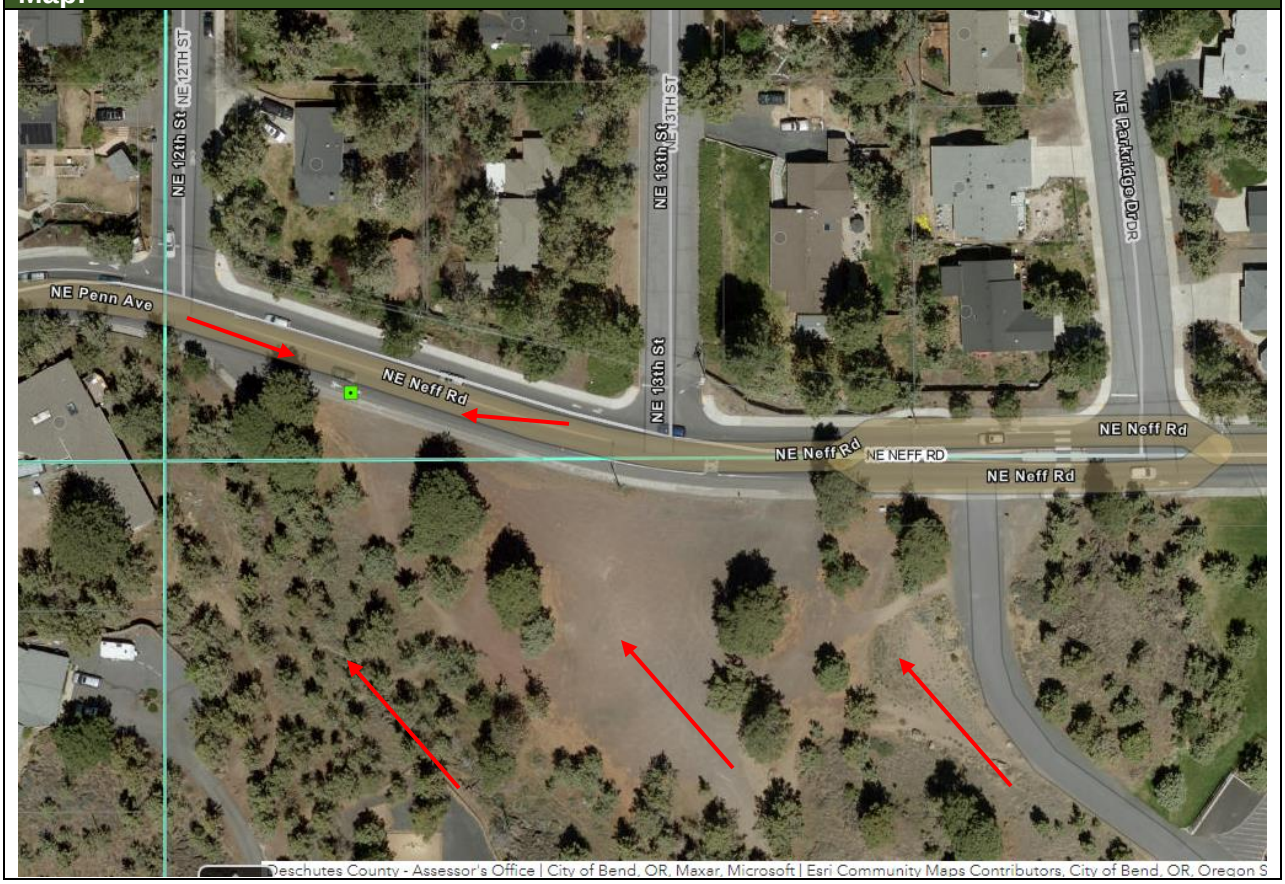
Proposed Solution:

Install flanking catch basins to protect drillhole, install additional UIC's, install regional swale, install erosion control measures on Pilot Butte and vacant lot

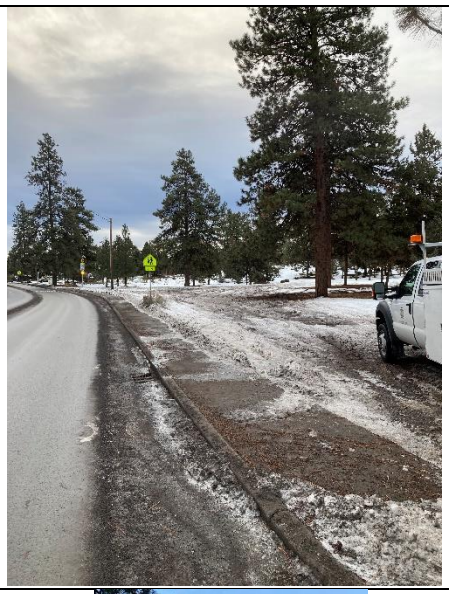
Additional Information:

This drillhole has been re-drilled to 95ft and does infiltrate well now. The entire Penn/Neff corridor from 8th St. to NE Cliff Dr. needs additional stormwater infrastructure. This has been a known flooding area for years and was also previously identified in the 2014 masterplan.

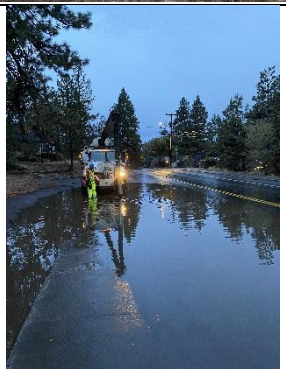
Map:


NE 12th St
NE 12TH ST
NE 13th St
NE 13TH ST
NE Parkridge Dr
NE Penn Ave
NE Neff Rd
NE Neff Rd
NE NEFF RD
NE Neff Rd
Deschutes County - Assessor's Office | City of Bend, OR, Maxar, Microsoft | Esri Community Maps Contributors, City of Bend, OR, Oregon S

Images:









Completed by ACE/SW Management Team	
Project Name:	[Project Name]
Estimated Drainage Basin Size (Acres):	[Drainage Basin Size]
Priority Ranking:	[Priority Ranking]
Project Category:	Under Review
Estimated Budget:	[Estimated Budget:]
Project Funding Year:	[Project Funding Year:]
Project Status:	Open

UTILITY DEPARTMENT

Stormwater Project Request

Work Order #	1087831
Nearest Address	1532 NE 9th St
Asset Number	DDH009665
Date Reported:	1/29/2019 12:00:00 AM

Flooding Information	
Flooding Severity:	Property Damage (Exterior)
Triggering Rain Event Size (In):	[Rain Event (In):]
Problem Code	Failing Drill Hole

Flooding Description:

Runoff from Pilot Butte all drains downhill to this location. There is no drainage infrastructure between 9th and 13th on Penn.

Proposed Solution:

Install additional UIC's on Penn, re-drill drillhole, install pre-treatment, connect drainage to swale on 8th and Penn

Additional Information:

There was some swale work done on the shoulder at this intersection, but it still floods and runs down onto private property

Map:


NE Penn Ave
NE Penn Ave
NE Penn Ave
NE PENN AVE
NE 9th St
NE 9TH ST
NE 9th St

Images:









Completed by ACE/SW Management Team	
Project Name:	[Project Name]
Estimated Drainage Basin Size (Acres):	[Drainage Basin Size]
Priority Ranking:	[Priority Ranking]
Project Category:	Under Review
Estimated Budget:	[Estimated Budget:]
Project Funding Year:	[Project Funding Year:]
Project Status:	Open

UTILITY DEPARTMENT

Stormwater Project Request

Work Order #	1419415
Nearest Address	1567 SW Chandler Ave
Asset Numbers	DDW008597 DDW008596 DDW008595
Date Reported:	6/1/2022 12:00:00 AM

Flooding Information	
Flooding Severity:	Right-of-Way (Moderate Traffic Impacts)
Triggering Rain Event Size (In):	[Rain Event (In):]
Problem Code	Failing Drywell

Flooding Description:

Water puddles across the road during large rain events

Proposed Solution:

Install additional UIC's, Install regional swale

Additional Information:

There are several drywells in this area that do infiltrate, but become overwhelmed during large rain events. There is a lot of pumice soil in the area that does not drain well.

Map:


Tykeson Hall
Bend Science Station
Obsidian Hall
SW Chandler Ave
SW Chandler Ave
Yates Dr

Images:

Completed by ACE/SW Management Team	
Project Name:	[Project Name]
Estimated Drainage Basin Size (Acres):	[Drainage Basin Size]
Priority Ranking:	[Priority Ranking]
Project Category:	Under Review
Estimated Budget:	[Estimated Budget:]
Project Funding Year:	[Project Funding Year:]
Project Status:	Open

UTILITY DEPARTMENT

Stormwater Project Request

Work Order #	1225892
Nearest Address	1757 Forest Ridge Ave
Asset Number	DDH009888
Date Reported:	7/21/2020 12:00:00 AM

Flooding Information	
Flooding Severity:	Property Damage (Exterior)
Triggering Rain Event Size (In):	[Rain Event (In):]
Problem Code	Failing Drill Hole

Flooding Description:

During large rain events water from both sides of Forest Ridge overwhelm the drillhole and flood on private property.

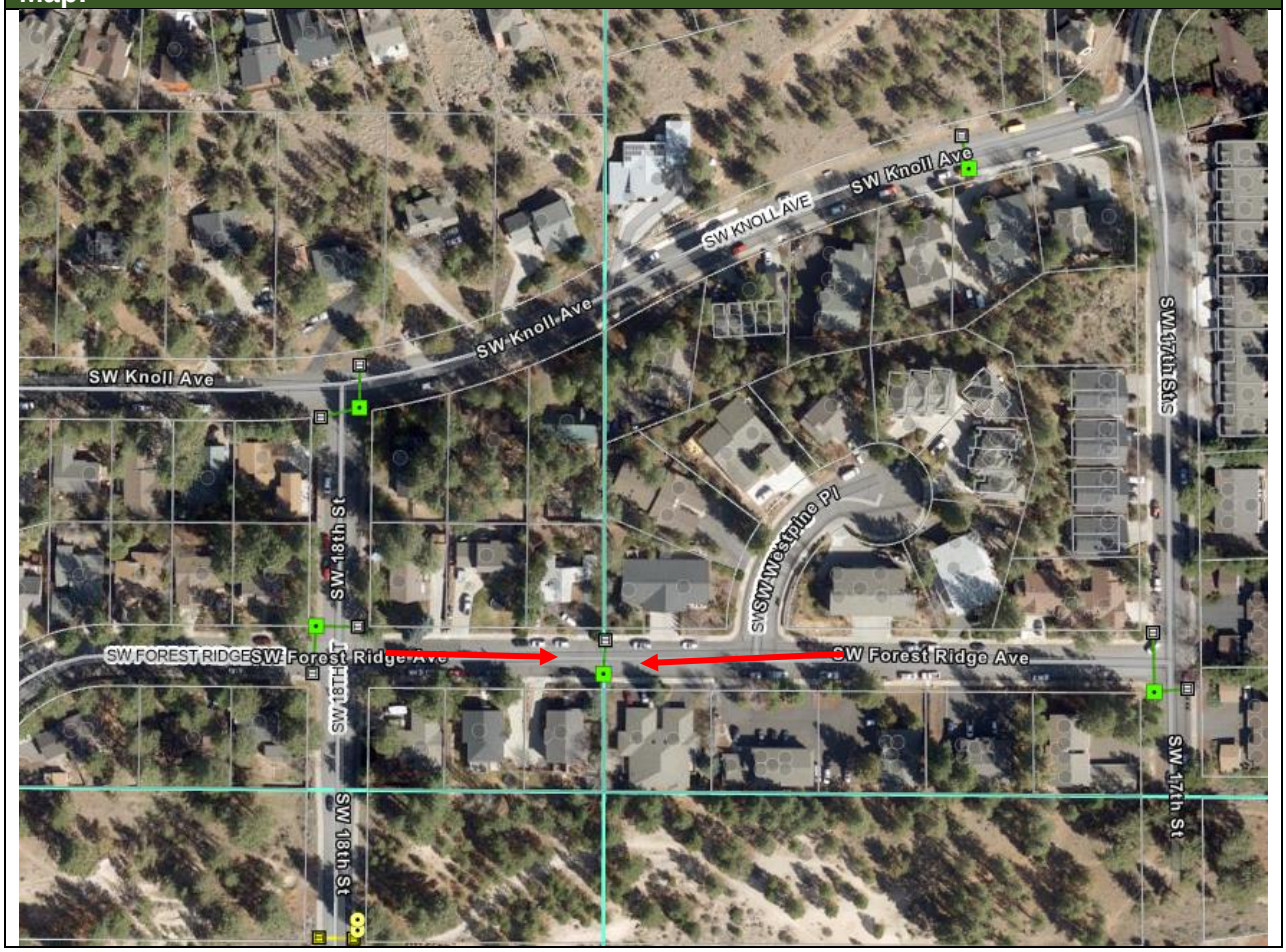
Proposed Solution:

Install new drainage/UIC's

Additional Information:

This drillhole was re-drilled in 2015 to 87ft but still only takes 44 gpm. This drillhole has since filled in due to loose pumice-soil.

Map:


SW Knoll Ave
SW KNOLL AVE
SW Knoll Ave
SW Knoll Ave
SW 17th St
SW 18th St
SW Westpine Pl
SW FOREST RIDGE
SW Forest Ridge Ave
SW Forest Ridge Ave
SW 18TH
SW 18th St
SW 17th St

Images:

Completed by ACE/SW Management Team	
Project Name:	[Project Name]
Estimated Drainage Basin Size (Acres):	[Drainage Basin Size]
Priority Ranking:	[Priority Ranking]
Project Category:	Under Review
Estimated Budget:	[Estimated Budget:]
Project Funding Year:	[Project Funding Year:]
Project Status:	Open

UTILITY DEPARTMENT

Stormwater Project Request

Work Order #	[Work Order #]
Nearest Address	60924 SW McMullin
Asset Number	DDH009462
Date Reported:	[Date Added]

Flooding Information	
Flooding Severity:	Property Damage (Exterior)
Triggering Rain Event Size (In):	[Rain Event (In):]
Problem Code	Failing Drill Hole

Flooding Description:

Failed drill hole causing water to puddle in the roadway and flow onto private property.

Proposed Solution:

Install new storm system or connect to new storm system located 100’ to the north.

Additional Information:

Map:


60945
60939
946
McMullin Dr
Cinder
60932
CINDER LN
Cinder Ln
60929
60924
19949
60921
19945
McMULLIN DR

Images:



Completed by ACE/SW Management Team	
Project Name:	[Project Name]
Estimated Drainage Basin Size (Acres):	[Drainage Basin Size]
Priority Ranking:	[Priority Ranking]
Project Category:	Under Review
Estimated Budget:	[Estimated Budget:]
Project Funding Year:	[Project Funding Year:]
Project Status:	Open

UTILITY DEPARTMENT

Stormwater Project Request

Work Order #	780398
Nearest Address	61553 Westridge Ave
Asset Number	DDH009865
Date Reported:	6/20/2016

Flooding Information	
Flooding Severity:	Property Damage (Exterior)
Triggering Rain Event Size (In):	[Rain Event (In):]
Problem Code	Failing Drill Hole

Flooding Description:

Drill hole has failed. Stormwater builds up and flows over driveway approach onto property causing erosion.

Proposed Solution:

Install new storm system

Additional Information:

Map:


61553
SW Westridge Ave
WEST RIDGE AVE
SW Westridge Ave
61552
SW Westridge Ave

Images:







Completed by ACE/SW Management Team	
Project Name:	[Project Name]
Estimated Drainage Basin Size (Acres):	[Drainage Basin Size]
Priority Ranking:	[Priority Ranking]
Project Category:	Under Review
Estimated Budget:	[Estimated Budget:]
Project Funding Year:	[Project Funding Year:]
Project Status:	Open

UTILITY DEPARTMENT

Stormwater Project Request

Work Order #	1310021
Nearest Address	63275 Wishing Well Ln.
Asset Numbers	DDW007000 DDW009788 DDW010035
Date Reported:	6/24/2021 12:00:00 AM

Flooding Information	
Flooding Severity:	Property Damage (Exterior)
Triggering Rain Event Size (In):	[Rain Event (In):]
Problem Code	Failing Drywell

Flooding Description:

During large rain events the entire intersection floods over the curb onto private property.

Proposed Solution:

Install additional drainage/UIC's, install regional swale

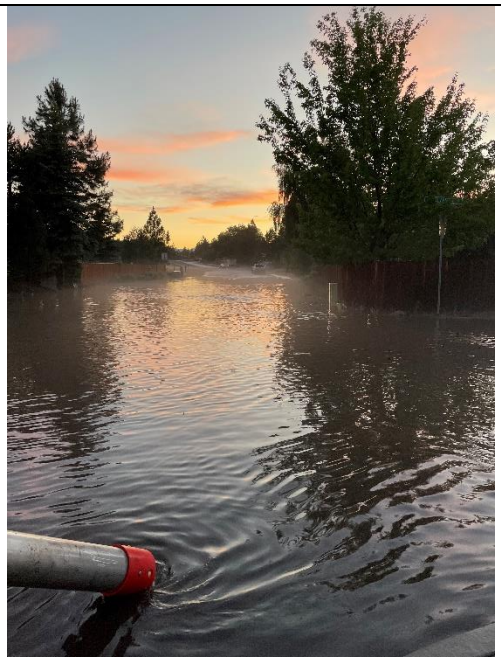
Additional Information:

On 6/24/2021 we removed approximately 24 Vactor loads of water from this intersection. The drywells in this area do infiltrate but can be overwhelmed during large events.

Map:


BOYD ACRES RD
Carly Ln
Ridgefield DR
NE Morningstar Dr
PEALE ST
AMBER CT
NE Amber Way
NE Morningstar Dr
NE Morningstar Dr
MORNINGSTAR DR
WISHING WELL LN
NE Gallop Ct
GALLOP RD
Gallop Rd

Images:

Completed by ACE/SW Management Team	
Project Name:	[Project Name]
Estimated Drainage Basin Size (Acres):	[Drainage Basin Size]
Priority Ranking:	[Priority Ranking]
Project Category:	Under Review
Estimated Budget:	[Estimated Budget:]
Project Funding Year:	[Project Funding Year:]
Project Status:	Open

UTILITY DEPARTMENT

Stormwater Project Request

Work Order #	1082854
Nearest Address	NE 4th St/NE Revere Ave
Asset Number	DDH009226 DDH009225 DDH009223
Date Reported:	12/18/2018 12:00:00 AM

Flooding Information	
Flooding Severity:	Right-of-Way (Moderate Traffic Impacts)
Triggering Rain Event Size (In):	[Rain Event (In):]
Problem Code	Under Sized System

Flooding Description:

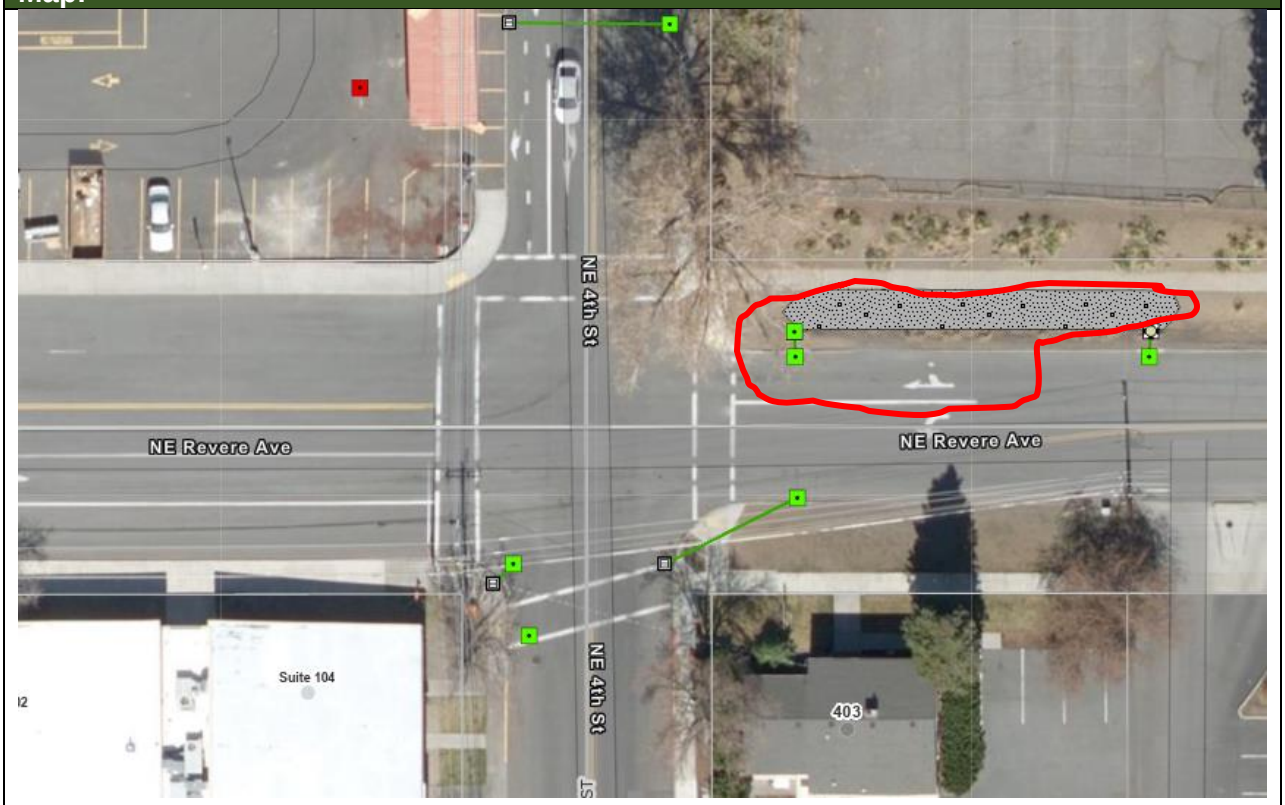
Stormwater runoff overwhelms drill holes and the swale causing water puddle in the roadway.

Proposed Solution:

Install additional UIC's with pretreatment to handle runoff.

Additional Information:

Map:



Images:





Completed by ACE/SW Management Team	
Project Name:	[Project Name]
Estimated Drainage Basin Size (Acres):	[Drainage Basin Size]
Priority Ranking:	[Priority Ranking]
Project Category:	Under Review
Estimated Budget:	[Estimated Budget:]
Project Funding Year:	[Project Funding Year:]
Project Status:	Open

UTILITY DEPARTMENT

Stormwater Project Request

Work Order #	715134
Nearest Address	NE 4th at NE Onley Ave
Asset Number	DDW003050
Date Reported:	5/21/2015 12:00:00 AM

Flooding Information	
Flooding Severity:	Select Option
Triggering Rain Event Size (In):	[Rain Event (In):]
Problem Code	[Problem Code]

Flooding Description:

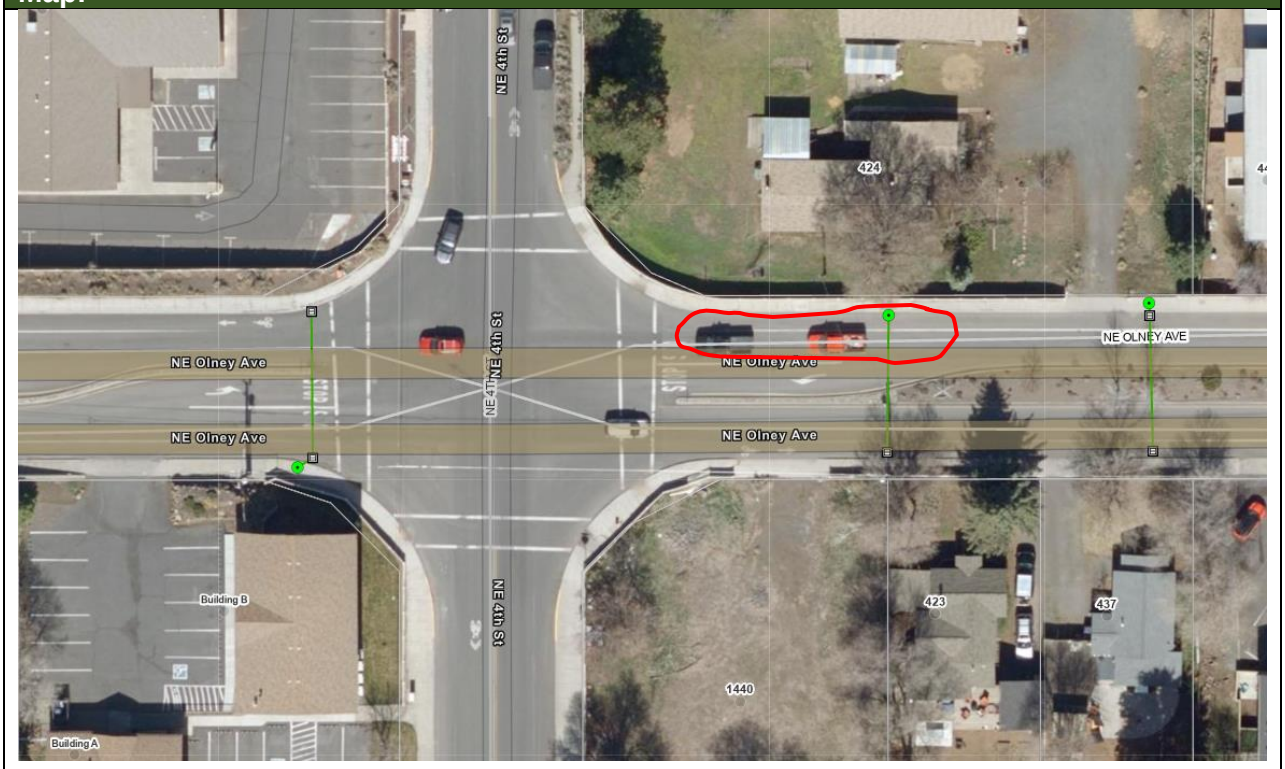
There is a failing drywell at this location that becomes overwhelmed during rain events. We have responded to this location for more than 20 years. New drainage has been added uphill of this intersection over the years which has reduced the amount of water this UIC'c receives. Response to this location is now less frequent.

Proposed Solution:

Add an additional UIC or connected drywell to the drywell that works 85' to the east.

Additional Information:

Map:


NE 4th St
424
NE Olney Ave
NE 4th St
NE Olney Ave
NE OLNEY AVE
NE Olney Ave
NE Olney Ave
Building B
NE 4th St
423
437
1440
Building A

Images:





Completed by ACE/SW Management Team	
Project Name:	[Project Name]
Estimated Drainage Basin Size (Acres):	[Drainage Basin Size]
Priority Ranking:	[Priority Ranking]
Project Category:	Under Review
Estimated Budget:	[Estimated Budget:]
Project Funding Year:	[Project Funding Year:]
Project Status:	Open

Priority 3 Locations

Stormwater Project Request

UTILITY DEPARTMENT

Work Order #	N/A
Nearest Address	59 SW Hayes Ave
Asset Number	DDW008118
Date Reported:	3/1/2024 12:00:00 AM

Flooding Information	
Flooding Severity:	Right-of-Way (Moderate Traffic Impacts)
Triggering Rain Event Size (In):	[Rain Event (In):]
Problem Code	No Drainage Systems

Flooding Description:

Historic flooding location, water puddles in road before it can flow east to the catch basin and drywell

Proposed Solution:

Install additional catch basins and connect to drywell, install additional UIC's, install regional swale

Additional Information:

Mike's Fence Center did some work on their property to control stormwater which helps, but water still puddles in the driveway to the food bank

Map:


7-Eleven
SW Hayes Ave
SE Division St
SE 3RD St
Cynthia's
Sewing Center
Super 8
SE 3rd St

Images:

Completed by ACE/SW Management Team	
Project Name:	[Project Name]
Estimated Drainage Basin Size (Acres):	[Drainage Basin Size]
Priority Ranking:	[Priority Ranking]
Project Category:	Under Review
Estimated Budget:	[Estimated Budget:]
Project Funding Year:	[Project Funding Year:]
Project Status:	Open

UTILITY DEPARTMENT

Stormwater Project Request

Work Order #	1419952
Nearest Address	576 NW Lindsay Ct.
Asset Number	DDW007203
Date Reported:	6/6/2022 12:00:00 AM

Flooding Information	
Flooding Severity:	Property Damage (Exterior)
Triggering Rain Event Size (In):	[Rain Event (In):]
Problem Code	Failing Drywell

Flooding Description:

Runoff from Overturf Butte runs downhill onto private property and overwhelms the catch basin and drywell. The drywell does infiltrate slowly but is undersized for the area.

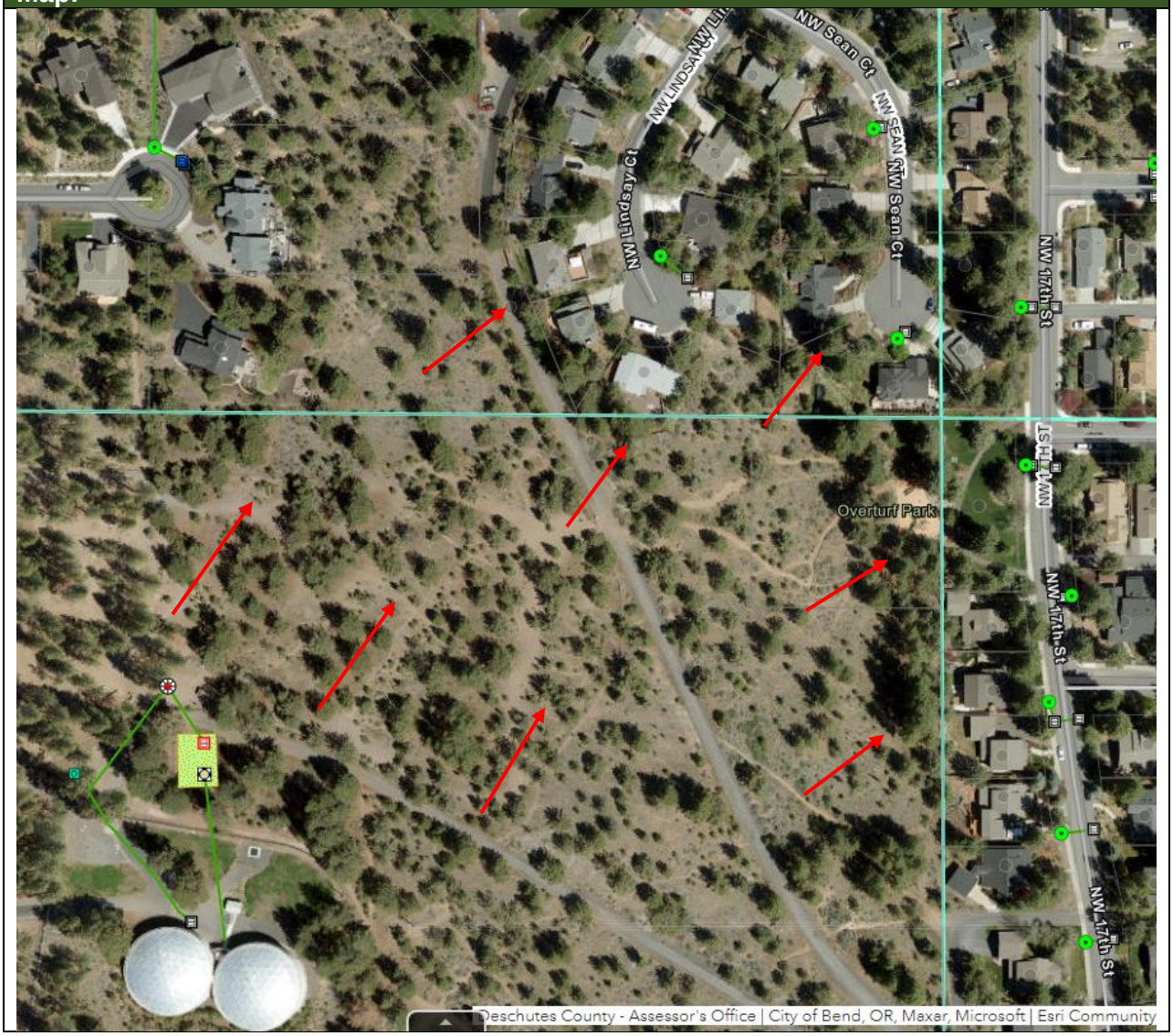
Proposed Solution:

Install additional UIC's, better control of runoff on Overturf Butte

Additional Information:

The stormwater maintenance crew installed several erosion control measures on Overturf Butte including: straw wattles, check dams, and re-vegetation. This did help, but the larger storms still cause problems.

Map:


NW Sean Ct
NW Lindsay Ct
NW 17th St
Overturf Park
Deschutes County - Assessor's Office | City of Bend, OR, Maxar, Microsoft | Esri Community

Images:

Completed by ACE/SW Management Team	
Project Name:	[Project Name]
Estimated Drainage Basin Size (Acres):	[Drainage Basin Size]
Priority Ranking:	[Priority Ranking]
Project Category:	Under Review
Estimated Budget:	[Estimated Budget:]
Project Funding Year:	[Project Funding Year:]
Project Status:	Open

UTILITY DEPARTMENT

Stormwater Project Request

Work Order #	N/A
Nearest Address	1507 NE 1st St.
Asset Number	DDH009532
Date Reported:	3/1/2024 12:00:00 AM

Flooding Information	
Flooding Severity:	Property Damage (Exterior)
Triggering Rain Event Size (In):	[Rain Event (In):]
Problem Code	Failing Drill Hole

Flooding Description:

Historic flooding location, water from Olney and 1st converge causing flooding on private property

Proposed Solution:

Install additional UIC's, install regional swale

Additional Information:

There is one drillhole in the are that does infiltrate, but can become overwhelmed during larger rain events. Water puddles on the north and south side of the intersection.

Map:


1507
1506
NE 1st Ave
1515
NW Olney Ave
NE Olney Ave
1470
21
147
Burlington Northern Santa Fe
NE 1st St

Images:





Completed by ACE/SW Management Team	
Project Name:	[Project Name]
Estimated Drainage Basin Size (Acres):	[Drainage Basin Size]
Priority Ranking:	[Priority Ranking]
Project Category:	Under Review
Estimated Budget:	[Estimated Budget:]
Project Funding Year:	[Project Funding Year:]
Project Status:	Open

APPENDIX B

Drillhole Prioritizations

Appendix B. Score Assigned to Drill Holes

Drill Hole ID	Land Use Risk	Traffic Volume Risk	Water Well Locations Risk	TOT Zones Risk	Perched GW Risk	Current Drill Hole Condition Risk	Total Score (Formula)	Total Score	Priority Ranking
DDH002049	1	1	3	20	1		=(C3+D3+E3)*F3*G3	100	1
DDH009381	1	1	3	20	1		=(C4+D4+E4)*F4*G4	100	1
DDH009446	1	1	3	20	1		=(C5+D5+E5)*F5*G5	100	1
DDH009447	1	1	3	20	1		=(C6+D6+E6)*F6*G6	100	1
DDH009482	1	1	3	20	1		=(C7+D7+E7)*F7*G7	100	1
DDH009485	3	1	1	20	1		=(C8+D8+E8)*F8*G8	100	1
DDH009498	3	1	1	20	1		=(C9+D9+E9)*F9*G9	100	1
DDH009510	3	1	1	20	1		=(C10+D10+E10)*F10*G10	100	1
DDH009513	3	1	1	20	1		=(C11+D11+E11)*F11*G11	100	1
DDH009514	3	1	1	20	1		=(C12+D12+E12)*F12*G12	100	1
DDH009520	3	1	1	20	1		=(C13+D13+E13)*F13*G13	100	1
DDH009550	3	1	1	20	1		=(C14+D14+E14)*F14*G14	100	1
DDH009624	3	1	1	20	1		=(C15+D15+E15)*F15*G15	100	1
DDH009625	3	1	1	20	1		=(C16+D16+E16)*F16*G16	100	1
DDH009727	3	1	1	20	1		=(C17+D17+E17)*F17*G17	100	1
DDH009728	3	1	1	20	1		=(C18+D18+E18)*F18*G18	100	1
DDH009763	3	1	1	20	1		=(C19+D19+E19)*F19*G19	100	1
DDH009764	3	1	1	20	1		=(C20+D20+E20)*F20*G20	100	1
DDH009765	3	1	1	20	1		=(C21+D21+E21)*F21*G21	100	1
DDH009766	3	1	1	20	1		=(C22+D22+E22)*F22*G22	100	1
DDH009767	3	1	1	20	1		=(C23+D23+E23)*F23*G23	100	1
DDH009841	3	1	1	20	1		=(C24+D24+E24)*F24*G24	100	1
DDH010013	1	1	3	20	1		=(C25+D25+E25)*F25*G25	100	1
DDH009875	2	1	1	20	1		=(C26+D26+E26)*F26*G26	80	2
DDH009932	2	1	1	20	1		=(C27+D27+E27)*F27*G27	80	2
DDH001012	1	1	1	20	1		=(C28+D28+E28)*F28*G28	60	3
DDH001013	1	1	1	20	1		=(C29+D29+E29)*F29*G29	60	3
DDH001014	1	1	1	20	1		=(C30+D30+E30)*F30*G30	60	3
DDH001015	1	1	1	20	1		=(C31+D31+E31)*F31*G31	60	3

Appendix B. Score Assigned to Drill Holes

DDH001022	1	1	1	20	1	=(C32+D32+E32)*F32*G32	60	3
DDH001023	1	1	1	20	1	=(C33+D33+E33)*F33*G33	60	3
DDH002018	1	1	1	20	1	=(C34+D34+E34)*F34*G34	60	3
DDH002019	1	1	1	20	1	=(C35+D35+E35)*F35*G35	60	3
DDH002020	1	1	1	20	1	=(C36+D36+E36)*F36*G36	60	3
DDH002022	1	1	1	20	1	=(C37+D37+E37)*F37*G37	60	3
DDH002023	1	1	1	20	1	=(C38+D38+E38)*F38*G38	60	3
DDH009122	1	1	1	20	1	=(C39+D39+E39)*F39*G39	60	3
DDH009129	1	1	1	20	1	=(C40+D40+E40)*F40*G40	60	3
DDH009130	1	1	1	20	1	=(C41+D41+E41)*F41*G41	60	3
DDH009380	1	1	1	20	1	=(C42+D42+E42)*F42*G42	60	3
DDH009384	1	1	1	20	1	=(C43+D43+E43)*F43*G43	60	3
DDH009385	1	1	1	20	1	=(C44+D44+E44)*F44*G44	60	3
DDH009386	1	1	1	20	1	=(C45+D45+E45)*F45*G45	60	3
DDH009387	1	1	1	20	1	=(C46+D46+E46)*F46*G46	60	3
DDH009388	1	1	1	20	1	=(C47+D47+E47)*F47*G47	60	3
DDH009389	1	1	1	20	1	=(C48+D48+E48)*F48*G48	60	3
DDH009390	1	1	1	20	1	=(C49+D49+E49)*F49*G49	60	3
DDH009391	1	1	1	20	1	=(C50+D50+E50)*F50*G50	60	3
DDH009392	1	1	1	20	1	=(C51+D51+E51)*F51*G51	60	3
DDH009393	1	1	1	20	1	=(C52+D52+E52)*F52*G52	60	3
DDH009394	1	1	1	20	1	=(C53+D53+E53)*F53*G53	60	3
DDH009395	1	1	1	20	1	=(C54+D54+E54)*F54*G54	60	3
DDH009396	1	1	1	20	1	=(C55+D55+E55)*F55*G55	60	3
DDH009397	1	1	1	20	1	=(C56+D56+E56)*F56*G56	60	3
DDH009398	1	1	1	20	1	=(C57+D57+E57)*F57*G57	60	3
DDH009399	1	1	1	20	1	=(C58+D58+E58)*F58*G58	60	3
DDH009400	1	1	1	20	1	=(C59+D59+E59)*F59*G59	60	3
DDH009401	1	1	1	20	1	=(C60+D60+E60)*F60*G60	60	3
DDH009402	1	1	1	20	1	=(C61+D61+E61)*F61*G61	60	3
DDH009403	1	1	1	20	1	=(C62+D62+E62)*F62*G62	60	3
DDH009404	1	1	1	20	1	=(C63+D63+E63)*F63*G63	60	3
DDH009405	1	1	1	20	1	=(C64+D64+E64)*F64*G64	60	3

Appendix B. Score Assigned to Drill Holes

DDH009406	1	1	1	20	1	=(C65+D65+E65)*F65*G65	60	3
DDH009407	1	1	1	20	1	=(C66+D66+E66)*F66*G66	60	3
DDH009412	1	1	1	20	1	=(C67+D67+E67)*F67*G67	60	3
DDH009413	1	1	1	20	1	=(C68+D68+E68)*F68*G68	60	3
DDH009415	1	1	1	20	1	=(C69+D69+E69)*F69*G69	60	3
DDH009416	1	1	1	20	1	=(C70+D70+E70)*F70*G70	60	3
DDH009417	1	1	1	20	1	=(C71+D71+E71)*F71*G71	60	3
DDH009418	1	1	1	20	1	=(C72+D72+E72)*F72*G72	60	3
DDH009419	1	1	1	20	1	=(C73+D73+E73)*F73*G73	60	3
DDH009420	1	1	1	20	1	=(C74+D74+E74)*F74*G74	60	3
DDH009421	1	1	1	20	1	=(C75+D75+E75)*F75*G75	60	3
DDH009422	1	1	1	20	1	=(C76+D76+E76)*F76*G76	60	3
DDH009423	1	1	1	20	1	=(C77+D77+E77)*F77*G77	60	3
DDH009424	1	1	1	20	1	=(C78+D78+E78)*F78*G78	60	3
DDH009425	1	1	1	20	1	=(C79+D79+E79)*F79*G79	60	3
DDH009426	1	1	1	20	1	=(C80+D80+E80)*F80*G80	60	3
DDH009428	1	1	1	20	1	=(C81+D81+E81)*F81*G81	60	3
DDH009429	1	1	1	20	1	=(C82+D82+E82)*F82*G82	60	3
DDH009430	1	1	1	20	1	=(C83+D83+E83)*F83*G83	60	3
DDH009431	1	1	1	20	1	=(C84+D84+E84)*F84*G84	60	3
DDH009433	1	1	1	20	1	=(C85+D85+E85)*F85*G85	60	3
DDH009434	1	1	1	20	1	=(C86+D86+E86)*F86*G86	60	3
DDH009435	1	1	1	20	1	=(C87+D87+E87)*F87*G87	60	3
DDH009436	1	1	1	20	1	=(C88+D88+E88)*F88*G88	60	3
DDH009437	1	1	1	20	1	=(C89+D89+E89)*F89*G89	60	3
DDH009438	1	1	1	20	1	=(C90+D90+E90)*F90*G90	60	3
DDH009439	1	1	1	20	1	=(C91+D91+E91)*F91*G91	60	3
DDH009440	1	1	1	20	1	=(C92+D92+E92)*F92*G92	60	3
DDH009441	1	1	1	20	1	=(C93+D93+E93)*F93*G93	60	3
DDH009443	1	1	1	20	1	=(C94+D94+E94)*F94*G94	60	3
DDH009444	1	1	1	20	1	=(C95+D95+E95)*F95*G95	60	3
DDH009445	1	1	1	20	1	=(C96+D96+E96)*F96*G96	60	3
DDH009571	1	1	1	20	1	=(C97+D97+E97)*F97*G97	60	3

Appendix B. Score Assigned to Drill Holes

DDH009572	1	1	1	20	1		=(C98+D98+E98)*F98*G98	60	3
DDH009573	1	1	1	20	1		=(C99+D99+E99)*F99*G99	60	3
DDH009583	1	1	1	20	1		=(C100+D100+E100)*F100*G100	60	3
DDH009585	1	1	1	20	1		=(C101+D101+E101)*F101*G101	60	3
DDH009586	1	1	1	20	1		=(C102+D102+E102)*F102*G102	60	3
DDH009603	1	1	1	20	1		=(C103+D103+E103)*F103*G103	60	3
DDH009604	1	1	1	20	1		=(C104+D104+E104)*F104*G104	60	3
DDH009605	1	1	1	20	1		=(C105+D105+E105)*F105*G105	60	3
DDH009606	1	1	1	20	1		=(C106+D106+E106)*F106*G106	60	3
DDH009609	1	1	1	20	1		=(C107+D107+E107)*F107*G107	60	3
DDH009628	1	1	1	20	1		=(C108+D108+E108)*F108*G108	60	3
DDH009629	1	1	1	20	1		=(C109+D109+E109)*F109*G109	60	3
DDH009630	1	1	1	20	1		=(C110+D110+E110)*F110*G110	60	3
DDH009631	1	1	1	20	1		=(C111+D111+E111)*F111*G111	60	3
DDH009632	1	1	1	20	1		=(C112+D112+E112)*F112*G112	60	3
DDH001019	1	1	10	1	1		=(C113+D113)*E113*F113*G113	20	4
DDH009454	1	1	10	1	1		=(C114+D114)*E114*F114*G114	20	4
DDH009863	2	3	1	1	1	3	=(C115+D115+E115)*F115*G115*H115	18	5
DDH009902	2	3	1	1	1	3	=(C116+D116+E116)*F116*G116*H116	18	5
DDH010018	2	3	1	1	1	3	=(C117+D117+E117)*F117*G117*H117	18	5
DDH010019	2	3	1	1	1	3	=(C118+D118+E118)*F118*G118*H118	18	5
DDH009490	2	1	1	1	1	3	=(C119+D119+E119)*F119*G119*H119	12	6
DDH009491	2	1	1	1	1	3	=(C120+D120+E120)*F120*G120*H120	12	6
DDH009492	2	1	1	1	1	3	=(C121+D121+E121)*F121*G121*H121	12	6
DDH009493	2	1	1	1	1	3	=(C122+D122+E122)*F122*G122*H122	12	6
DDH009725	2	1	1	1	1	3	=(C123+D123+E123)*F123*G123*H123	12	6
DDH010016	2	1	1	1	1	3	=(C124+D124+E124)*F124*G124*H124	12	6
DDH010028	2	1	1	1	1	3	=(C125+D125+E125)*F125*G125*H125	12	6
DDH009771	3	1	1	1	1	2	=(C126+D126+E126)*F126*G126*H126	10	7
DDH009772	3	1	1	1	1	2	=(C127+D127+E127)*F127*G127*H127	10	7
DDH002042	1	1	1	1	1	3	=(C128+D128+E128)*F128*G128*H128	9	8
DDH009131	1	1	1	1	1	3	=(C129+D129+E129)*F129*G129*H129	9	8
DDH009184	1	1	1	1	1	3	=(C130+D130+E130)*F130*G130*H130	9	8

Appendix B. Score Assigned to Drill Holes

DDH009185	1	1	1	1	1	3	=(C131+D131+E131)*F131*G131*H131	9	8
DDH009714	1	1	1	1	1	3	=(C132+D132+E132)*F132*G132*H132	9	8
DDH009715	1	1	1	1	1	3	=(C133+D133+E133)*F133*G133*H133	9	8
DDH009889	1	1	1	1	1	3	=(C134+D134+E134)*F134*G134*H134	9	8
DDH009890	1	1	1	1	1	3	=(C135+D135+E135)*F135*G135*H135	9	8
DDH009891	1	1	1	1	1	3	=(C136+D136+E136)*F136*G136*H136	9	8
DDH002024	2	1	1	1	1	2	=(C137+D137+E137)*F137*G137*H137	8	9
DDH009038	2	3	3	1	1		=(C138+D138+E138)*F138*G138	8	9
DDH009503	2	1	1	1	1	2	=(C139+D139+E139)*F139*G139*H139	8	9
DDH009551	2	1	1	1	1	2	=(C140+D140+E140)*F140*G140*H140	8	9
DDH009614	2	1	1	1	1	2	=(C141+D141+E141)*F141*G141*H141	8	9
DDH009615	2	1	1	1	1	2	=(C142+D142+E142)*F142*G142*H142	8	9
DDH009616	2	1	1	1	1	2	=(C143+D143+E143)*F143*G143*H143	8	9
DDH009662	2	1	1	1	1	2	=(C144+D144+E144)*F144*G144*H144	8	9
DDH009663	2	1	1	1	1	2	=(C145+D145+E145)*F145*G145*H145	8	9
DDH002048	3	3	1	1	1		=(C146+D146+E146)*F146*G146	7	10
DDH009024	3	3	1	1	1		=(C147+D147+E147)*F147*G147	7	10
DDH002025	2	3	1	1	1		=(C148+D148+E148)*F148*G148	6	11
DDH002036	2	3	1	1	1		=(C149+D149+E149)*F149*G149	6	11
DDH009016	2	1	1	1	1.5		=(C150+D150+E150)*F150*G150	6	11
DDH009017	2	1	1	1	1.5		=(C151+D151+E151)*F151*G151	6	11
DDH009018	2	1	1	1	1.5		=(C152+D152+E152)*F152*G152	6	11
DDH009032	2	3	1	1	1		=(C153+D153+E153)*F153*G153	6	11
DDH009221	1	1	1	1	1	2	=(C154+D154+E154)*F154*G154*H154	6	11
DDH009223	1	1	1	1	1	2	=(C155+D155+E155)*F155*G155*H155	6	11
DDH009225	1	1	1	1	1	2	=(C156+D156+E156)*F156*G156*H156	6	11
DDH009226	1	1	1	1	1	2	=(C157+D157+E157)*F157*G157*H157	6	11
DDH009245	2	3	1	1	1		=(C158+D158+E158)*F158*G158	6	11
DDH009246	2	3	1	1	1		=(C159+D159+E159)*F159*G159	6	11
DDH009345	2	3	1	1	1		=(C160+D160+E160)*F160*G160	6	11
DDH009346	2	3	1	1	1		=(C161+D161+E161)*F161*G161	6	11
DDH009347	2	3	1	1	1		=(C162+D162+E162)*F162*G162	6	11
DDH009462	1	1	1	1	1	2	=(C163+D163+E163)*F163*G163*H163	6	11

Appendix B. Score Assigned to Drill Holes

DDH009588	2	3	1	1	1		=(C164+D164+E164)*F164*G164	6	11
DDH009613	2	3	1	1	1		=(C165+D165+E165)*F165*G165	6	11
DDH009618	2	3	1	1	1		=(C166+D166+E166)*F166*G166	6	11
DDH009621	2	3	1	1	1		=(C167+D167+E167)*F167*G167	6	11
DDH009653	2	3	1	1	1		=(C168+D168+E168)*F168*G168	6	11
DDH009654	2	3	1	1	1		=(C169+D169+E169)*F169*G169	6	11
DDH009655	2	3	1	1	1		=(C170+D170+E170)*F170*G170	6	11
DDH009656	2	3	1	1	1		=(C171+D171+E171)*F171*G171	6	11
DDH009658	1	1	1	1	1	2	=(C172+D172+E172)*F172*G172*H172	6	11
DDH009665	1	1	1	1	1	2	=(C173+D173+E173)*F173*G173*H173	6	11
DDH009787	2	3	1	1	1		=(C174+D174+E174)*F174*G174	6	11
DDH009849	2	1	3	1	1		=(C175+D175+E175)*F175*G175	6	11
DDH009851	2	3	1	1	1		=(C176+D176+E176)*F176*G176	6	11
DDH009852	2	3	1	1	1		=(C177+D177+E177)*F177*G177	6	11
DDH009853	2	3	1	1	1		=(C178+D178+E178)*F178*G178	6	11
DDH009860	2	3	1	1	1		=(C179+D179+E179)*F179*G179	6	11
DDH009862	2	3	1	1	1		=(C180+D180+E180)*F180*G180	6	11
DDH009864	2	3	1	1	1		=(C181+D181+E181)*F181*G181	6	11
DDH009865	1	1	1	1	1	2	=(C182+D182+E182)*F182*G182*H182	6	11
DDH009888	1	1	1	1	1	2	=(C183+D183+E183)*F183*G183*H183	6	11
DDH009895	2	3	1	1	1		=(C184+D184+E184)*F184*G184	6	11
DDH009898	2	3	1	1	1		=(C185+D185+E185)*F185*G185	6	11
DDH009899	2	3	1	1	1		=(C186+D186+E186)*F186*G186	6	11
DDH009900	2	3	1	1	1		=(C187+D187+E187)*F187*G187	6	11
DDH009901	2	3	1	1	1		=(C188+D188+E188)*F188*G188	6	11
DDH009903	2	3	1	1	1		=(C189+D189+E189)*F189*G189	6	11
DDH009904	2	3	1	1	1		=(C190+D190+E190)*F190*G190	6	11
DDH009905	2	3	1	1	1		=(C191+D191+E191)*F191*G191	6	11
DDH009909	2	3	1	1	1		=(C192+D192+E192)*F192*G192	6	11
DDH009965	2	3	1	1	1		=(C193+D193+E193)*F193*G193	6	11
DDH010004	2	3	1	1	1		=(C194+D194+E194)*F194*G194	6	11
DDH010012	2	3	1	1	1		=(C195+D195+E195)*F195*G195	6	11
DDH001018	1	1	3	1	1		=(C196+D196+E196)*F196*G196	5	12

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DDH001020	1	1	3	1	1	=(C197+D197+E197)*F197*G197	5	12
DDH001021	1	1	3	1	1	=(C198+D198+E198)*F198*G198	5	12
DDH001024	1	1	3	1	1	=(C199+D199+E199)*F199*G199	5	12
DDH001028	1	3	1	1	1	=(C200+D200+E200)*F200*G200	5	12
DDH001029	1	3	1	1	1	=(C201+D201+E201)*F201*G201	5	12
DDH001030	1	3	1	1	1	=(C202+D202+E202)*F202*G202	5	12
DDH001031	1	3	1	1	1	=(C203+D203+E203)*F203*G203	5	12
DDH002046	1	3	1	1	1	=(C204+D204+E204)*F204*G204	5	12
DDH002047	1	3	1	1	1	=(C205+D205+E205)*F205*G205	5	12
DDH002050	3	1	1	1	1	=(C206+D206+E206)*F206*G206	5	12
DDH009019	1	1	3	1	1	=(C207+D207+E207)*F207*G207	5	12
DDH009020	1	1	3	1	1	=(C208+D208+E208)*F208*G208	5	12
DDH009021	1	1	3	1	1	=(C209+D209+E209)*F209*G209	5	12
DDH009022	1	1	3	1	1	=(C210+D210+E210)*F210*G210	5	12
DDH009050	1	1	3	1	1	=(C211+D211+E211)*F211*G211	5	12
DDH009051	1	1	3	1	1	=(C212+D212+E212)*F212*G212	5	12
DDH009113	1	3	1	1	1	=(C213+D213+E213)*F213*G213	5	12
DDH009116	1	3	1	1	1	=(C214+D214+E214)*F214*G214	5	12
DDH009160	3	1	1	1	1	=(C215+D215+E215)*F215*G215	5	12
DDH009161	3	1	1	1	1	=(C216+D216+E216)*F216*G216	5	12
DDH009163	3	1	1	1	1	=(C217+D217+E217)*F217*G217	5	12
DDH009175	1	3	1	1	1	=(C218+D218+E218)*F218*G218	5	12
DDH009455	1	1	3	1	1	=(C219+D219+E219)*F219*G219	5	12
DDH009456	1	1	3	1	1	=(C220+D220+E220)*F220*G220	5	12
DDH009476	1	1	3	1	1	=(C221+D221+E221)*F221*G221	5	12
DDH009477	1	1	3	1	1	=(C222+D222+E222)*F222*G222	5	12
DDH009478	1	1	3	1	1	=(C223+D223+E223)*F223*G223	5	12
DDH009511	3	1	1	1	1	=(C224+D224+E224)*F224*G224	5	12
DDH009512	3	1	1	1	1	=(C225+D225+E225)*F225*G225	5	12
DDH009641	1	1	3	1	1	=(C226+D226+E226)*F226*G226	5	12
DDH009648	3	1	1	1	1	=(C227+D227+E227)*F227*G227	5	12
DDH009690	3	1	1	1	1	=(C228+D228+E228)*F228*G228	5	12
DDH009729	3	1	1	1	1	=(C229+D229+E229)*F229*G229	5	12

Appendix B. Score Assigned to Drill Holes

DDH009730	3	1	1	1	1	=(C230+D230+E230)*F230*G230	5	12
DDH009731	3	1	1	1	1	=(C231+D231+E231)*F231*G231	5	12
DDH009732	3	1	1	1	1	=(C232+D232+E232)*F232*G232	5	12
DDH009733	3	1	1	1	1	=(C233+D233+E233)*F233*G233	5	12
DDH009734	3	1	1	1	1	=(C234+D234+E234)*F234*G234	5	12
DDH009735	3	1	1	1	1	=(C235+D235+E235)*F235*G235	5	12
DDH009768	3	1	1	1	1	=(C236+D236+E236)*F236*G236	5	12
DDH009769	3	1	1	1	1	=(C237+D237+E237)*F237*G237	5	12
DDH009770	3	1	1	1	1	=(C238+D238+E238)*F238*G238	5	12
DDH009773	3	1	1	1	1	=(C239+D239+E239)*F239*G239	5	12
DDH009774	3	1	1	1	1	=(C240+D240+E240)*F240*G240	5	12
DDH009775	3	1	1	1	1	=(C241+D241+E241)*F241*G241	5	12
DDH009776	3	1	1	1	1	=(C242+D242+E242)*F242*G242	5	12
DDH009777	3	1	1	1	1	=(C243+D243+E243)*F243*G243	5	12
DDH009778	3	1	1	1	1	=(C244+D244+E244)*F244*G244	5	12
DDH009815	1	1	3	1	1	=(C245+D245+E245)*F245*G245	5	12
DDH009846	1	1	3	1	1	=(C246+D246+E246)*F246*G246	5	12
DDH009938	3	1	1	1	1	=(C247+D247+E247)*F247*G247	5	12
DDH009955	3	1	1	1	1	=(C248+D248+E248)*F248*G248	5	12
DDH010015	3	1	1	1	1	=(C249+D249+E249)*F249*G249	5	12
DDH010031	3	1	1	1	1	=(C250+D250+E250)*F250*G250	5	12
DDH009722	1	1	1	1	1.5	=(C251+D251+E251)*F251*G251	4.5	13
DDH009723	1	1	1	1	1.5	=(C252+D252+E252)*F252*G252	4.5	13
DDH009914	1	1	1	1	1.5	=(C253+D253+E253)*F253*G253	4.5	13
DDH009916	1	1	1	1	1.5	=(C254+D254+E254)*F254*G254	4.5	13
DDH001032	2	1	1	1	1	=(C255+D255+E255)*F255*G255	4	14
DDH001033	2	1	1	1	1	=(C256+D256+E256)*F256*G256	4	14
DDH001034	2	1	1	1	1	=(C257+D257+E257)*F257*G257	4	14
DDH002006	2	1	1	1	1	=(C258+D258+E258)*F258*G258	4	14
DDH002007	2	1	1	1	1	=(C259+D259+E259)*F259*G259	4	14
DDH002035	2	1	1	1	1	=(C260+D260+E260)*F260*G260	4	14
DDH002059	2	1	1	1	1	=(C261+D261+E261)*F261*G261	4	14
DDH002061	2	1	1	1	1	=(C262+D262+E262)*F262*G262	4	14

DDH002067	2	1	1	1	1	=(C263+D263+E263)*F263*G263	4	14
DDH009139	2	1	1	1	1	=(C264+D264+E264)*F264*G264	4	14
DDH009159	2	1	1	1	1	=(C265+D265+E265)*F265*G265	4	14
DDH009231	2	1	1	1	1	=(C266+D266+E266)*F266*G266	4	14
DDH009232	2	1	1	1	1	=(C267+D267+E267)*F267*G267	4	14
DDH009233	2	1	1	1	1	=(C268+D268+E268)*F268*G268	4	14
DDH009249	2	1	1	1	1	=(C269+D269+E269)*F269*G269	4	14
DDH009258	2	1	1	1	1	=(C270+D270+E270)*F270*G270	4	14
DDH009259	2	1	1	1	1	=(C271+D271+E271)*F271*G271	4	14
DDH009333	2	1	1	1	1	=(C272+D272+E272)*F272*G272	4	14
DDH009334	2	1	1	1	1	=(C273+D273+E273)*F273*G273	4	14
DDH009335	2	1	1	1	1	=(C274+D274+E274)*F274*G274	4	14
DDH009342	2	1	1	1	1	=(C275+D275+E275)*F275*G275	4	14
DDH009348	2	1	1	1	1	=(C276+D276+E276)*F276*G276	4	14
DDH009349	2	1	1	1	1	=(C277+D277+E277)*F277*G277	4	14
DDH009350	2	1	1	1	1	=(C278+D278+E278)*F278*G278	4	14
DDH009351	2	1	1	1	1	=(C279+D279+E279)*F279*G279	4	14
DDH009352	2	1	1	1	1	=(C280+D280+E280)*F280*G280	4	14
DDH009362	2	1	1	1	1	=(C281+D281+E281)*F281*G281	4	14
DDH009363	2	1	1	1	1	=(C282+D282+E282)*F282*G282	4	14
DDH009364	2	1	1	1	1	=(C283+D283+E283)*F283*G283	4	14
DDH009365	2	1	1	1	1	=(C284+D284+E284)*F284*G284	4	14
DDH009366	2	1	1	1	1	=(C285+D285+E285)*F285*G285	4	14
DDH009367	2	1	1	1	1	=(C286+D286+E286)*F286*G286	4	14
DDH009368	2	1	1	1	1	=(C287+D287+E287)*F287*G287	4	14
DDH009374	2	1	1	1	1	=(C288+D288+E288)*F288*G288	4	14
DDH009442	2	1	1	1	1	=(C289+D289+E289)*F289*G289	4	14
DDH009488	2	1	1	1	1	=(C290+D290+E290)*F290*G290	4	14
DDH009489	2	1	1	1	1	=(C291+D291+E291)*F291*G291	4	14
DDH009494	2	1	1	1	1	=(C292+D292+E292)*F292*G292	4	14
DDH009495	2	1	1	1	1	=(C293+D293+E293)*F293*G293	4	14
DDH009501	2	1	1	1	1	=(C294+D294+E294)*F294*G294	4	14
DDH009502	2	1	1	1	1	=(C295+D295+E295)*F295*G295	4	14

DDH009504	2	1	1	1	1		=(C296+D296+E296)*F296*G296	4	14
DDH009505	2	1	1	1	1		=(C297+D297+E297)*F297*G297	4	14
DDH009506	2	1	1	1	1		=(C298+D298+E298)*F298*G298	4	14
DDH009507	2	1	1	1	1		=(C299+D299+E299)*F299*G299	4	14
DDH009508	2	1	1	1	1		=(C300+D300+E300)*F300*G300	4	14
DDH009509	2	1	1	1	1		=(C301+D301+E301)*F301*G301	4	14
DDH009516	2	1	1	1	1		=(C302+D302+E302)*F302*G302	4	14
DDH009517	2	1	1	1	1		=(C303+D303+E303)*F303*G303	4	14
DDH009518	2	1	1	1	1		=(C304+D304+E304)*F304*G304	4	14
DDH009521	2	1	1	1	1		=(C305+D305+E305)*F305*G305	4	14
DDH009522	2	1	1	1	1		=(C306+D306+E306)*F306*G306	4	14
DDH009523	2	1	1	1	1		=(C307+D307+E307)*F307*G307	4	14
DDH009530	2	1	1	1	1		=(C308+D308+E308)*F308*G308	4	14
DDH009531	2	1	1	1	1		=(C309+D309+E309)*F309*G309	4	14
DDH009532	2	1	1	1	1	1	=(C310+D310+E310)*F310*G310*H310	4	14
DDH009533	2	1	1	1	1		=(C311+D311+E311)*F311*G311	4	14
DDH009534	2	1	1	1	1		=(C312+D312+E312)*F312*G312	4	14
DDH009535	2	1	1	1	1		=(C313+D313+E313)*F313*G313	4	14
DDH009536	2	1	1	1	1		=(C314+D314+E314)*F314*G314	4	14
DDH009537	2	1	1	1	1		=(C315+D315+E315)*F315*G315	4	14
DDH009541	2	1	1	1	1		=(C316+D316+E316)*F316*G316	4	14
DDH009567	2	1	1	1	1		=(C317+D317+E317)*F317*G317	4	14
DDH009581	2	1	1	1	1		=(C318+D318+E318)*F318*G318	4	14
DDH009589	2	1	1	1	1		=(C319+D319+E319)*F319*G319	4	14
DDH009592	2	1	1	1	1		=(C320+D320+E320)*F320*G320	4	14
DDH009597	2	1	1	1	1		=(C321+D321+E321)*F321*G321	4	14
DDH009598	2	1	1	1	1		=(C322+D322+E322)*F322*G322	4	14
DDH009601	2	1	1	1	1		=(C323+D323+E323)*F323*G323	4	14
DDH009602	2	1	1	1	1		=(C324+D324+E324)*F324*G324	4	14
DDH009617	2	1	1	1	1		=(C325+D325+E325)*F325*G325	4	14
DDH009622	2	1	1	1	1		=(C326+D326+E326)*F326*G326	4	14
DDH009626	2	1	1	1	1		=(C327+D327+E327)*F327*G327	4	14
DDH009627	2	1	1	1	1		=(C328+D328+E328)*F328*G328	4	14

DDH009640	2	1	1	1	1	=(C329+D329+E329)*F329*G329	4	14
DDH009643	2	1	1	1	1	=(C330+D330+E330)*F330*G330	4	14
DDH009644	2	1	1	1	1	=(C331+D331+E331)*F331*G331	4	14
DDH009645	2	1	1	1	1	=(C332+D332+E332)*F332*G332	4	14
DDH009646	2	1	1	1	1	=(C333+D333+E333)*F333*G333	4	14
DDH009649	2	1	1	1	1	=(C334+D334+E334)*F334*G334	4	14
DDH009650	2	1	1	1	1	=(C335+D335+E335)*F335*G335	4	14
DDH009651	2	1	1	1	1	=(C336+D336+E336)*F336*G336	4	14
DDH009652	2	1	1	1	1	=(C337+D337+E337)*F337*G337	4	14
DDH009659	2	1	1	1	1	=(C338+D338+E338)*F338*G338	4	14
DDH009661	2	1	1	1	1	=(C339+D339+E339)*F339*G339	4	14
DDH009674	2	1	1	1	1	=(C340+D340+E340)*F340*G340	4	14
DDH009682	2	1	1	1	1	=(C341+D341+E341)*F341*G341	4	14
DDH009684	2	1	1	1	1	=(C342+D342+E342)*F342*G342	4	14
DDH009686	2	1	1	1	1	=(C343+D343+E343)*F343*G343	4	14
DDH009687	2	1	1	1	1	=(C344+D344+E344)*F344*G344	4	14
DDH009688	2	1	1	1	1	=(C345+D345+E345)*F345*G345	4	14
DDH009698	2	1	1	1	1	=(C346+D346+E346)*F346*G346	4	14
DDH009748	2	1	1	1	1	=(C347+D347+E347)*F347*G347	4	14
DDH009749	2	1	1	1	1	=(C348+D348+E348)*F348*G348	4	14
DDH009750	2	1	1	1	1	=(C349+D349+E349)*F349*G349	4	14
DDH009751	2	1	1	1	1	=(C350+D350+E350)*F350*G350	4	14
DDH009752	2	1	1	1	1	=(C351+D351+E351)*F351*G351	4	14
DDH009753	2	1	1	1	1	=(C352+D352+E352)*F352*G352	4	14
DDH009754	2	1	1	1	1	=(C353+D353+E353)*F353*G353	4	14
DDH009788	2	1	1	1	1	=(C354+D354+E354)*F354*G354	4	14
DDH009869	2	1	1	1	1	=(C355+D355+E355)*F355*G355	4	14
DDH009870	2	1	1	1	1	=(C356+D356+E356)*F356*G356	4	14
DDH009871	2	1	1	1	1	=(C357+D357+E357)*F357*G357	4	14
DDH009872	2	1	1	1	1	=(C358+D358+E358)*F358*G358	4	14
DDH009873	2	1	1	1	1	=(C359+D359+E359)*F359*G359	4	14
DDH009874	2	1	1	1	1	=(C360+D360+E360)*F360*G360	4	14
DDH009876	2	1	1	1	1	=(C361+D361+E361)*F361*G361	4	14

Appendix B. Score Assigned to Drill Holes

DDH009877	2	1	1	1	1	=(C362+D362+E362)*F362*G362	4	14
DDH009878	2	1	1	1	1	=(C363+D363+E363)*F363*G363	4	14
DDH009879	2	1	1	1	1	=(C364+D364+E364)*F364*G364	4	14
DDH009880	2	1	1	1	1	=(C365+D365+E365)*F365*G365	4	14
DDH009881	2	1	1	1	1	=(C366+D366+E366)*F366*G366	4	14
DDH009882	2	1	1	1	1	=(C367+D367+E367)*F367*G367	4	14
DDH009883	2	1	1	1	1	=(C368+D368+E368)*F368*G368	4	14
DDH009896	2	1	1	1	1	=(C369+D369+E369)*F369*G369	4	14
DDH009906	2	1	1	1	1	=(C370+D370+E370)*F370*G370	4	14
DDH009930	2	1	1	1	1	=(C371+D371+E371)*F371*G371	4	14
DDH009931	2	1	1	1	1	=(C372+D372+E372)*F372*G372	4	14
DDH009933	2	1	1	1	1	=(C373+D373+E373)*F373*G373	4	14
DDH009936	2	1	1	1	1	=(C374+D374+E374)*F374*G374	4	14
DDH009937	2	1	1	1	1	=(C375+D375+E375)*F375*G375	4	14
DDH009963	2	1	1	1	1	=(C376+D376+E376)*F376*G376	4	14
DDH009964	2	1	1	1	1	=(C377+D377+E377)*F377*G377	4	14
DDH009966	2	1	1	1	1	=(C378+D378+E378)*F378*G378	4	14
DDH009967	2	1	1	1	1	=(C379+D379+E379)*F379*G379	4	14
DDH009971	2	1	1	1	1	=(C380+D380+E380)*F380*G380	4	14
DDH009972	2	1	1	1	1	=(C381+D381+E381)*F381*G381	4	14
DDH010006	2	1	1	1	1	=(C382+D382+E382)*F382*G382	4	14
DDH010007	2	1	1	1	1	=(C383+D383+E383)*F383*G383	4	14
DDH010014	2	1	1	1	1	=(C384+D384+E384)*F384*G384	4	14
DDH010022	2	1	1	1	1	=(C385+D385+E385)*F385*G385	4	14
DDH010026	2	1	1	1	1	=(C386+D386+E386)*F386*G386	4	14
DDH010027	2	1	1	1	1	=(C387+D387+E387)*F387*G387	4	14
DDH010033	2	1	1	1	1	=(C388+D388+E388)*F388*G388	4	14
DDH010035	2	1	1	1	1	=(C389+D389+E389)*F389*G389	4	14
DDH010036	2	1	1	1	1	=(C390+D390+E390)*F390*G390	4	14
DDH001000	1	1	1	1	1	=(C391+D391+E391)*F391*G391	3	15
DDH001001	1	1	1	1	1	=(C392+D392+E392)*F392*G392	3	15
DDH001003	1	1	1	1	1	=(C393+D393+E393)*F393*G393	3	15
DDH001004	1	1	1	1	1	=(C394+D394+E394)*F394*G394	3	15

Appendix B. Score Assigned to Drill Holes

DDH001005	1	1	1	1	1	=(C395+D395+E395)*F395*G395	3	15
DDH001006	1	1	1	1	1	=(C396+D396+E396)*F396*G396	3	15
DDH001007	1	1	1	1	1	=(C397+D397+E397)*F397*G397	3	15
DDH001008	1	1	1	1	1	=(C398+D398+E398)*F398*G398	3	15
DDH001009	1	1	1	1	1	=(C399+D399+E399)*F399*G399	3	15
DDH001010	1	1	1	1	1	=(C400+D400+E400)*F400*G400	3	15
DDH001011	1	1	1	1	1	=(C401+D401+E401)*F401*G401	3	15
DDH001016	1	1	1	1	1	=(C402+D402+E402)*F402*G402	3	15
DDH001017	1	1	1	1	1	=(C403+D403+E403)*F403*G403	3	15
DDH001025	1	1	1	1	1	=(C404+D404+E404)*F404*G404	3	15
DDH001026	1	1	1	1	1	=(C405+D405+E405)*F405*G405	3	15
DDH001027	1	1	1	1	1	=(C406+D406+E406)*F406*G406	3	15
DDH001035	1	1	1	1	1	=(C407+D407+E407)*F407*G407	3	15
DDH001036	1	1	1	1	1	=(C408+D408+E408)*F408*G408	3	15
DDH002000	1	1	1	1	1	=(C409+D409+E409)*F409*G409	3	15
DDH002001	1	1	1	1	1	=(C410+D410+E410)*F410*G410	3	15
DDH002002	1	1	1	1	1	=(C411+D411+E411)*F411*G411	3	15
DDH002003	1	1	1	1	1	=(C412+D412+E412)*F412*G412	3	15
DDH002004	1	1	1	1	1	=(C413+D413+E413)*F413*G413	3	15
DDH002008	1	1	1	1	1	=(C414+D414+E414)*F414*G414	3	15
DDH002009	1	1	1	1	1	=(C415+D415+E415)*F415*G415	3	15
DDH002010	1	1	1	1	1	=(C416+D416+E416)*F416*G416	3	15
DDH002011	1	1	1	1	1	=(C417+D417+E417)*F417*G417	3	15
DDH002012	1	1	1	1	1	=(C418+D418+E418)*F418*G418	3	15
DDH002013	1	1	1	1	1	=(C419+D419+E419)*F419*G419	3	15
DDH002014	1	1	1	1	1	=(C420+D420+E420)*F420*G420	3	15
DDH002015	1	1	1	1	1	=(C421+D421+E421)*F421*G421	3	15
DDH002016	1	1	1	1	1	=(C422+D422+E422)*F422*G422	3	15
DDH002017	1	1	1	1	1	=(C423+D423+E423)*F423*G423	3	15
DDH002021	1	1	1	1	1	=(C424+D424+E424)*F424*G424	3	15
DDH002029	1	1	1	1	1	=(C425+D425+E425)*F425*G425	3	15
DDH002030	1	1	1	1	1	=(C426+D426+E426)*F426*G426	3	15
DDH002033	1	1	1	1	1	=(C427+D427+E427)*F427*G427	3	15

DDH002034	1	1	1	1	1	=(C428+D428+E428)*F428*G428	3	15
DDH002039	1	1	1	1	1	=(C429+D429+E429)*F429*G429	3	15
DDH002040	1	1	1	1	1	=(C430+D430+E430)*F430*G430	3	15
DDH002041	1	1	1	1	1	=(C431+D431+E431)*F431*G431	3	15
DDH002043	1	1	1	1	1	=(C432+D432+E432)*F432*G432	3	15
DDH002044	1	1	1	1	1	=(C433+D433+E433)*F433*G433	3	15
DDH002051	1	1	1	1	1	=(C434+D434+E434)*F434*G434	3	15
DDH002052	1	1	1	1	1	=(C435+D435+E435)*F435*G435	3	15
DDH002053	1	1	1	1	1	=(C436+D436+E436)*F436*G436	3	15
DDH002054	1	1	1	1	1	=(C437+D437+E437)*F437*G437	3	15
DDH002055	1	1	1	1	1	=(C438+D438+E438)*F438*G438	3	15
DDH002056	1	1	1	1	1	=(C439+D439+E439)*F439*G439	3	15
DDH002058	1	1	1	1	1	=(C440+D440+E440)*F440*G440	3	15
DDH002064	1	1	1	1	1	=(C441+D441+E441)*F441*G441	3	15
DDH002065	1	1	1	1	1	=(C442+D442+E442)*F442*G442	3	15
DDH002068	1	1	1	1	1	=(C443+D443+E443)*F443*G443	3	15
DDH002069	1	1	1	1	1	=(C444+D444+E444)*F444*G444	3	15
DDH002070	1	1	1	1	1	=(C445+D445+E445)*F445*G445	3	15
DDH009000	1	1	1	1	1	=(C446+D446+E446)*F446*G446	3	15
DDH009001	1	1	1	1	1	=(C447+D447+E447)*F447*G447	3	15
DDH009002	1	1	1	1	1	=(C448+D448+E448)*F448*G448	3	15
DDH009003	1	1	1	1	1	=(C449+D449+E449)*F449*G449	3	15
DDH009004	1	1	1	1	1	=(C450+D450+E450)*F450*G450	3	15
DDH009005	1	1	1	1	1	=(C451+D451+E451)*F451*G451	3	15
DDH009006	1	1	1	1	1	=(C452+D452+E452)*F452*G452	3	15
DDH009007	1	1	1	1	1	=(C453+D453+E453)*F453*G453	3	15
DDH009008	1	1	1	1	1	=(C454+D454+E454)*F454*G454	3	15
DDH009009	1	1	1	1	1	=(C455+D455+E455)*F455*G455	3	15
DDH009010	1	1	1	1	1	=(C456+D456+E456)*F456*G456	3	15
DDH009011	1	1	1	1	1	=(C457+D457+E457)*F457*G457	3	15
DDH009012	1	1	1	1	1	=(C458+D458+E458)*F458*G458	3	15
DDH009013	1	1	1	1	1	=(C459+D459+E459)*F459*G459	3	15
DDH009014	1	1	1	1	1	=(C460+D460+E460)*F460*G460	3	15

Appendix B. Score Assigned to Drill Holes

DDH009015	1	1	1	1	1	=(C461+D461+E461)*F461*G461	3	15
DDH009034	1	1	1	1	1	=(C462+D462+E462)*F462*G462	3	15
DDH009035	1	1	1	1	1	=(C463+D463+E463)*F463*G463	3	15
DDH009036	1	1	1	1	1	=(C464+D464+E464)*F464*G464	3	15
DDH009037	1	1	1	1	1	=(C465+D465+E465)*F465*G465	3	15
DDH009039	1	1	1	1	1	=(C466+D466+E466)*F466*G466	3	15
DDH009040	1	1	1	1	1	=(C467+D467+E467)*F467*G467	3	15
DDH009041	1	1	1	1	1	=(C468+D468+E468)*F468*G468	3	15
DDH009042	1	1	1	1	1	=(C469+D469+E469)*F469*G469	3	15
DDH009043	1	1	1	1	1	=(C470+D470+E470)*F470*G470	3	15
DDH009044	1	1	1	1	1	=(C471+D471+E471)*F471*G471	3	15
DDH009047	1	1	1	1	1	=(C472+D472+E472)*F472*G472	3	15
DDH009048	1	1	1	1	1	=(C473+D473+E473)*F473*G473	3	15
DDH009049	1	1	1	1	1	=(C474+D474+E474)*F474*G474	3	15
DDH009052	1	1	1	1	1	=(C475+D475+E475)*F475*G475	3	15
DDH009053	1	1	1	1	1	=(C476+D476+E476)*F476*G476	3	15
DDH009054	1	1	1	1	1	=(C477+D477+E477)*F477*G477	3	15
DDH009055	1	1	1	1	1	=(C478+D478+E478)*F478*G478	3	15
DDH009056	1	1	1	1	1	=(C479+D479+E479)*F479*G479	3	15
DDH009057	1	1	1	1	1	=(C480+D480+E480)*F480*G480	3	15
DDH009058	1	1	1	1	1	=(C481+D481+E481)*F481*G481	3	15
DDH009059	1	1	1	1	1	=(C482+D482+E482)*F482*G482	3	15
DDH009060	1	1	1	1	1	=(C483+D483+E483)*F483*G483	3	15
DDH009061	1	1	1	1	1	=(C484+D484+E484)*F484*G484	3	15
DDH009062	1	1	1	1	1	=(C485+D485+E485)*F485*G485	3	15
DDH009063	1	1	1	1	1	=(C486+D486+E486)*F486*G486	3	15
DDH009064	1	1	1	1	1	=(C487+D487+E487)*F487*G487	3	15
DDH009065	1	1	1	1	1	=(C488+D488+E488)*F488*G488	3	15
DDH009066	1	1	1	1	1	=(C489+D489+E489)*F489*G489	3	15
DDH009068	1	1	1	1	1	=(C490+D490+E490)*F490*G490	3	15
DDH009069	1	1	1	1	1	=(C491+D491+E491)*F491*G491	3	15
DDH009070	1	1	1	1	1	=(C492+D492+E492)*F492*G492	3	15
DDH009071	1	1	1	1	1	=(C493+D493+E493)*F493*G493	3	15

Appendix B. Score Assigned to Drill Holes

DDH009072	1	1	1	1	1	=(C494+D494+E494)*F494*G494	3	15
DDH009073	1	1	1	1	1	=(C495+D495+E495)*F495*G495	3	15
DDH009074	1	1	1	1	1	=(C496+D496+E496)*F496*G496	3	15
DDH009075	1	1	1	1	1	=(C497+D497+E497)*F497*G497	3	15
DDH009076	1	1	1	1	1	=(C498+D498+E498)*F498*G498	3	15
DDH009077	1	1	1	1	1	=(C499+D499+E499)*F499*G499	3	15
DDH009078	1	1	1	1	1	=(C500+D500+E500)*F500*G500	3	15
DDH009079	1	1	1	1	1	=(C501+D501+E501)*F501*G501	3	15
DDH009080	1	1	1	1	1	=(C502+D502+E502)*F502*G502	3	15
DDH009081	1	1	1	1	1	=(C503+D503+E503)*F503*G503	3	15
DDH009082	1	1	1	1	1	=(C504+D504+E504)*F504*G504	3	15
DDH009083	1	1	1	1	1	=(C505+D505+E505)*F505*G505	3	15
DDH009084	1	1	1	1	1	=(C506+D506+E506)*F506*G506	3	15
DDH009085	1	1	1	1	1	=(C507+D507+E507)*F507*G507	3	15
DDH009086	1	1	1	1	1	=(C508+D508+E508)*F508*G508	3	15
DDH009087	1	1	1	1	1	=(C509+D509+E509)*F509*G509	3	15
DDH009088	1	1	1	1	1	=(C510+D510+E510)*F510*G510	3	15
DDH009089	1	1	1	1	1	=(C511+D511+E511)*F511*G511	3	15
DDH009090	1	1	1	1	1	=(C512+D512+E512)*F512*G512	3	15
DDH009091	1	1	1	1	1	=(C513+D513+E513)*F513*G513	3	15
DDH009092	1	1	1	1	1	=(C514+D514+E514)*F514*G514	3	15
DDH009093	1	1	1	1	1	=(C515+D515+E515)*F515*G515	3	15
DDH009094	1	1	1	1	1	=(C516+D516+E516)*F516*G516	3	15
DDH009095	1	1	1	1	1	=(C517+D517+E517)*F517*G517	3	15
DDH009096	1	1	1	1	1	=(C518+D518+E518)*F518*G518	3	15
DDH009097	1	1	1	1	1	=(C519+D519+E519)*F519*G519	3	15
DDH009098	1	1	1	1	1	=(C520+D520+E520)*F520*G520	3	15
DDH009099	1	1	1	1	1	=(C521+D521+E521)*F521*G521	3	15
DDH009100	1	1	1	1	1	=(C522+D522+E522)*F522*G522	3	15
DDH009101	1	1	1	1	1	=(C523+D523+E523)*F523*G523	3	15
DDH009102	1	1	1	1	1	=(C524+D524+E524)*F524*G524	3	15
DDH009103	1	1	1	1	1	=(C525+D525+E525)*F525*G525	3	15
DDH009104	1	1	1	1	1	=(C526+D526+E526)*F526*G526	3	15

Appendix B. Score Assigned to Drill Holes

DDH009105	1	1	1	1	1	=(C527+D527+E527)*F527*G527	3	15
DDH009106	1	1	1	1	1	=(C528+D528+E528)*F528*G528	3	15
DDH009107	1	1	1	1	1	=(C529+D529+E529)*F529*G529	3	15
DDH009108	1	1	1	1	1	=(C530+D530+E530)*F530*G530	3	15
DDH009110	1	1	1	1	1	=(C531+D531+E531)*F531*G531	3	15
DDH009111	1	1	1	1	1	=(C532+D532+E532)*F532*G532	3	15
DDH009112	1	1	1	1	1	=(C533+D533+E533)*F533*G533	3	15
DDH009118	1	1	1	1	1	=(C534+D534+E534)*F534*G534	3	15
DDH009119	1	1	1	1	1	=(C535+D535+E535)*F535*G535	3	15
DDH009120	1	1	1	1	1	=(C536+D536+E536)*F536*G536	3	15
DDH009121	1	1	1	1	1	=(C537+D537+E537)*F537*G537	3	15
DDH009123	1	1	1	1	1	=(C538+D538+E538)*F538*G538	3	15
DDH009124	1	1	1	1	1	=(C539+D539+E539)*F539*G539	3	15
DDH009125	1	1	1	1	1	=(C540+D540+E540)*F540*G540	3	15
DDH009126	1	1	1	1	1	=(C541+D541+E541)*F541*G541	3	15
DDH009127	1	1	1	1	1	=(C542+D542+E542)*F542*G542	3	15
DDH009128	1	1	1	1	1	=(C543+D543+E543)*F543*G543	3	15
DDH009132	1	1	1	1	1	=(C544+D544+E544)*F544*G544	3	15
DDH009133	1	1	1	1	1	=(C545+D545+E545)*F545*G545	3	15
DDH009134	1	1	1	1	1	=(C546+D546+E546)*F546*G546	3	15
DDH009135	1	1	1	1	1	=(C547+D547+E547)*F547*G547	3	15
DDH009136	1	1	1	1	1	=(C548+D548+E548)*F548*G548	3	15
DDH009137	1	1	1	1	1	=(C549+D549+E549)*F549*G549	3	15
DDH009141	1	1	1	1	1	=(C550+D550+E550)*F550*G550	3	15
DDH009146	1	1	1	1	1	=(C551+D551+E551)*F551*G551	3	15
DDH009147	1	1	1	1	1	=(C552+D552+E552)*F552*G552	3	15
DDH009148	1	1	1	1	1	=(C553+D553+E553)*F553*G553	3	15
DDH009149	1	1	1	1	1	=(C554+D554+E554)*F554*G554	3	15
DDH009150	1	1	1	1	1	=(C555+D555+E555)*F555*G555	3	15
DDH009151	1	1	1	1	1	=(C556+D556+E556)*F556*G556	3	15
DDH009152	1	1	1	1	1	=(C557+D557+E557)*F557*G557	3	15
DDH009153	1	1	1	1	1	=(C558+D558+E558)*F558*G558	3	15
DDH009154	1	1	1	1	1	=(C559+D559+E559)*F559*G559	3	15

Appendix B. Score Assigned to Drill Holes

DDH009155	1	1	1	1	1	=(C560+D560+E560)*F560*G560	3	15
DDH009156	1	1	1	1	1	=(C561+D561+E561)*F561*G561	3	15
DDH009157	1	1	1	1	1	=(C562+D562+E562)*F562*G562	3	15
DDH009158	1	1	1	1	1	=(C563+D563+E563)*F563*G563	3	15
DDH009164	1	1	1	1	1	=(C564+D564+E564)*F564*G564	3	15
DDH009165	1	1	1	1	1	=(C565+D565+E565)*F565*G565	3	15
DDH009166	1	1	1	1	1	=(C566+D566+E566)*F566*G566	3	15
DDH009167	1	1	1	1	1	=(C567+D567+E567)*F567*G567	3	15
DDH009168	1	1	1	1	1	=(C568+D568+E568)*F568*G568	3	15
DDH009169	1	1	1	1	1	=(C569+D569+E569)*F569*G569	3	15
DDH009170	1	1	1	1	1	=(C570+D570+E570)*F570*G570	3	15
DDH009171	1	1	1	1	1	=(C571+D571+E571)*F571*G571	3	15
DDH009172	1	1	1	1	1	=(C572+D572+E572)*F572*G572	3	15
DDH009173	1	1	1	1	1	=(C573+D573+E573)*F573*G573	3	15
DDH009174	1	1	1	1	1	=(C574+D574+E574)*F574*G574	3	15
DDH009176	1	1	1	1	1	=(C575+D575+E575)*F575*G575	3	15
DDH009177	1	1	1	1	1	=(C576+D576+E576)*F576*G576	3	15
DDH009178	1	1	1	1	1	=(C577+D577+E577)*F577*G577	3	15
DDH009179	1	1	1	1	1	=(C578+D578+E578)*F578*G578	3	15
DDH009180	1	1	1	1	1	=(C579+D579+E579)*F579*G579	3	15
DDH009182	1	1	1	1	1	=(C580+D580+E580)*F580*G580	3	15
DDH009183	1	1	1	1	1	=(C581+D581+E581)*F581*G581	3	15
DDH009186	1	1	1	1	1	=(C582+D582+E582)*F582*G582	3	15
DDH009187	1	1	1	1	1	=(C583+D583+E583)*F583*G583	3	15
DDH009188	1	1	1	1	1	=(C584+D584+E584)*F584*G584	3	15
DDH009189	1	1	1	1	1	=(C585+D585+E585)*F585*G585	3	15
DDH009190	1	1	1	1	1	=(C586+D586+E586)*F586*G586	3	15
DDH009191	1	1	1	1	1	=(C587+D587+E587)*F587*G587	3	15
DDH009192	1	1	1	1	1	=(C588+D588+E588)*F588*G588	3	15
DDH009193	1	1	1	1	1	=(C589+D589+E589)*F589*G589	3	15
DDH009194	1	1	1	1	1	=(C590+D590+E590)*F590*G590	3	15
DDH009195	1	1	1	1	1	=(C591+D591+E591)*F591*G591	3	15
DDH009196	1	1	1	1	1	=(C592+D592+E592)*F592*G592	3	15

Appendix B. Score Assigned to Drill Holes

DDH009197	1	1	1	1	1	=(C593+D593+E593)*F593*G593	3	15
DDH009199	1	1	1	1	1	=(C594+D594+E594)*F594*G594	3	15
DDH009200	1	1	1	1	1	=(C595+D595+E595)*F595*G595	3	15
DDH009201	1	1	1	1	1	=(C596+D596+E596)*F596*G596	3	15
DDH009202	1	1	1	1	1	=(C597+D597+E597)*F597*G597	3	15
DDH009203	1	1	1	1	1	=(C598+D598+E598)*F598*G598	3	15
DDH009204	1	1	1	1	1	=(C599+D599+E599)*F599*G599	3	15
DDH009205	1	1	1	1	1	=(C600+D600+E600)*F600*G600	3	15
DDH009206	1	1	1	1	1	=(C601+D601+E601)*F601*G601	3	15
DDH009208	1	1	1	1	1	=(C602+D602+E602)*F602*G602	3	15
DDH009209	1	1	1	1	1	=(C603+D603+E603)*F603*G603	3	15
DDH009210	1	1	1	1	1	=(C604+D604+E604)*F604*G604	3	15
DDH009211	1	1	1	1	1	=(C605+D605+E605)*F605*G605	3	15
DDH009212	1	1	1	1	1	=(C606+D606+E606)*F606*G606	3	15
DDH009214	1	1	1	1	1	=(C607+D607+E607)*F607*G607	3	15
DDH009215	1	1	1	1	1	=(C608+D608+E608)*F608*G608	3	15
DDH009216	1	1	1	1	1	=(C609+D609+E609)*F609*G609	3	15
DDH009219	1	1	1	1	1	=(C610+D610+E610)*F610*G610	3	15
DDH009222	1	1	1	1	1	=(C611+D611+E611)*F611*G611	3	15
DDH009224	1	1	1	1	1	=(C612+D612+E612)*F612*G612	3	15
DDH009227	1	1	1	1	1	=(C613+D613+E613)*F613*G613	3	15
DDH009228	1	1	1	1	1	=(C614+D614+E614)*F614*G614	3	15
DDH009229	1	1	1	1	1	=(C615+D615+E615)*F615*G615	3	15
DDH009235	1	1	1	1	1	=(C616+D616+E616)*F616*G616	3	15
DDH009237	1	1	1	1	1	=(C617+D617+E617)*F617*G617	3	15
DDH009238	1	1	1	1	1	=(C618+D618+E618)*F618*G618	3	15
DDH009239	1	1	1	1	1	=(C619+D619+E619)*F619*G619	3	15
DDH009240	1	1	1	1	1	=(C620+D620+E620)*F620*G620	3	15
DDH009241	1	1	1	1	1	=(C621+D621+E621)*F621*G621	3	15
DDH009242	1	1	1	1	1	=(C622+D622+E622)*F622*G622	3	15
DDH009243	1	1	1	1	1	=(C623+D623+E623)*F623*G623	3	15
DDH009250	1	1	1	1	1	=(C624+D624+E624)*F624*G624	3	15
DDH009251	1	1	1	1	1	=(C625+D625+E625)*F625*G625	3	15

DDH009252	1	1	1	1	1	=(C626+D626+E626)*F626*G626	3	15
DDH009253	1	1	1	1	1	=(C627+D627+E627)*F627*G627	3	15
DDH009254	1	1	1	1	1	=(C628+D628+E628)*F628*G628	3	15
DDH009255	1	1	1	1	1	=(C629+D629+E629)*F629*G629	3	15
DDH009256	1	1	1	1	1	=(C630+D630+E630)*F630*G630	3	15
DDH009260	1	1	1	1	1	=(C631+D631+E631)*F631*G631	3	15
DDH009262	1	1	1	1	1	=(C632+D632+E632)*F632*G632	3	15
DDH009264	1	1	1	1	1	=(C633+D633+E633)*F633*G633	3	15
DDH009265	1	1	1	1	1	=(C634+D634+E634)*F634*G634	3	15
DDH009273	1	1	1	1	1	=(C635+D635+E635)*F635*G635	3	15
DDH009275	1	1	1	1	1	=(C636+D636+E636)*F636*G636	3	15
DDH009276	1	1	1	1	1	=(C637+D637+E637)*F637*G637	3	15
DDH009277	1	1	1	1	1	=(C638+D638+E638)*F638*G638	3	15
DDH009278	1	1	1	1	1	=(C639+D639+E639)*F639*G639	3	15
DDH009279	1	1	1	1	1	=(C640+D640+E640)*F640*G640	3	15
DDH009280	1	1	1	1	1	=(C641+D641+E641)*F641*G641	3	15
DDH009281	1	1	1	1	1	=(C642+D642+E642)*F642*G642	3	15
DDH009282	1	1	1	1	1	=(C643+D643+E643)*F643*G643	3	15
DDH009283	1	1	1	1	1	=(C644+D644+E644)*F644*G644	3	15
DDH009284	1	1	1	1	1	=(C645+D645+E645)*F645*G645	3	15
DDH009285	1	1	1	1	1	=(C646+D646+E646)*F646*G646	3	15
DDH009287	1	1	1	1	1	=(C647+D647+E647)*F647*G647	3	15
DDH009288	1	1	1	1	1	=(C648+D648+E648)*F648*G648	3	15
DDH009290	1	1	1	1	1	=(C649+D649+E649)*F649*G649	3	15
DDH009291	1	1	1	1	1	=(C650+D650+E650)*F650*G650	3	15
DDH009292	1	1	1	1	1	=(C651+D651+E651)*F651*G651	3	15
DDH009293	1	1	1	1	1	=(C652+D652+E652)*F652*G652	3	15
DDH009294	1	1	1	1	1	=(C653+D653+E653)*F653*G653	3	15
DDH009295	1	1	1	1	1	=(C654+D654+E654)*F654*G654	3	15
DDH009296	1	1	1	1	1	=(C655+D655+E655)*F655*G655	3	15
DDH009297	1	1	1	1	1	=(C656+D656+E656)*F656*G656	3	15
DDH009298	1	1	1	1	1	=(C657+D657+E657)*F657*G657	3	15
DDH009299	1	1	1	1	1	=(C658+D658+E658)*F658*G658	3	15

DDH009300	1	1	1	1	1	=(C659+D659+E659)*F659*G659	3	15
DDH009301	1	1	1	1	1	=(C660+D660+E660)*F660*G660	3	15
DDH009302	1	1	1	1	1	=(C661+D661+E661)*F661*G661	3	15
DDH009303	1	1	1	1	1	=(C662+D662+E662)*F662*G662	3	15
DDH009304	1	1	1	1	1	=(C663+D663+E663)*F663*G663	3	15
DDH009305	1	1	1	1	1	=(C664+D664+E664)*F664*G664	3	15
DDH009306	1	1	1	1	1	=(C665+D665+E665)*F665*G665	3	15
DDH009307	1	1	1	1	1	=(C666+D666+E666)*F666*G666	3	15
DDH009308	1	1	1	1	1	=(C667+D667+E667)*F667*G667	3	15
DDH009309	1	1	1	1	1	=(C668+D668+E668)*F668*G668	3	15
DDH009310	1	1	1	1	1	=(C669+D669+E669)*F669*G669	3	15
DDH009311	1	1	1	1	1	=(C670+D670+E670)*F670*G670	3	15
DDH009312	1	1	1	1	1	=(C671+D671+E671)*F671*G671	3	15
DDH009313	1	1	1	1	1	=(C672+D672+E672)*F672*G672	3	15
DDH009314	1	1	1	1	1	=(C673+D673+E673)*F673*G673	3	15
DDH009315	1	1	1	1	1	=(C674+D674+E674)*F674*G674	3	15
DDH009316	1	1	1	1	1	=(C675+D675+E675)*F675*G675	3	15
DDH009317	1	1	1	1	1	=(C676+D676+E676)*F676*G676	3	15
DDH009318	1	1	1	1	1	=(C677+D677+E677)*F677*G677	3	15
DDH009319	1	1	1	1	1	=(C678+D678+E678)*F678*G678	3	15
DDH009320	1	1	1	1	1	=(C679+D679+E679)*F679*G679	3	15
DDH009321	1	1	1	1	1	=(C680+D680+E680)*F680*G680	3	15
DDH009322	1	1	1	1	1	=(C681+D681+E681)*F681*G681	3	15
DDH009323	1	1	1	1	1	=(C682+D682+E682)*F682*G682	3	15
DDH009324	1	1	1	1	1	=(C683+D683+E683)*F683*G683	3	15
DDH009325	1	1	1	1	1	=(C684+D684+E684)*F684*G684	3	15
DDH009326	1	1	1	1	1	=(C685+D685+E685)*F685*G685	3	15
DDH009328	1	1	1	1	1	=(C686+D686+E686)*F686*G686	3	15
DDH009329	1	1	1	1	1	=(C687+D687+E687)*F687*G687	3	15
DDH009330	1	1	1	1	1	=(C688+D688+E688)*F688*G688	3	15
DDH009331	1	1	1	1	1	=(C689+D689+E689)*F689*G689	3	15
DDH009332	1	1	1	1	1	=(C690+D690+E690)*F690*G690	3	15
DDH009338	1	1	1	1	1	=(C691+D691+E691)*F691*G691	3	15

DDH009339	1	1	1	1	1	=(C692+D692+E692)*F692*G692	3	15
DDH009340	1	1	1	1	1	=(C693+D693+E693)*F693*G693	3	15
DDH009343	1	1	1	1	1	=(C694+D694+E694)*F694*G694	3	15
DDH009344	1	1	1	1	1	=(C695+D695+E695)*F695*G695	3	15
DDH009353	1	1	1	1	1	=(C696+D696+E696)*F696*G696	3	15
DDH009354	1	1	1	1	1	=(C697+D697+E697)*F697*G697	3	15
DDH009355	1	1	1	1	1	=(C698+D698+E698)*F698*G698	3	15
DDH009356	1	1	1	1	1	=(C699+D699+E699)*F699*G699	3	15
DDH009357	1	1	1	1	1	=(C700+D700+E700)*F700*G700	3	15
DDH009358	1	1	1	1	1	=(C701+D701+E701)*F701*G701	3	15
DDH009359	1	1	1	1	1	=(C702+D702+E702)*F702*G702	3	15
DDH009360	1	1	1	1	1	=(C703+D703+E703)*F703*G703	3	15
DDH009361	1	1	1	1	1	=(C704+D704+E704)*F704*G704	3	15
DDH009371	1	1	1	1	1	=(C705+D705+E705)*F705*G705	3	15
DDH009373	1	1	1	1	1	=(C706+D706+E706)*F706*G706	3	15
DDH009375	1	1	1	1	1	=(C707+D707+E707)*F707*G707	3	15
DDH009376	1	1	1	1	1	=(C708+D708+E708)*F708*G708	3	15
DDH009377	1	1	1	1	1	=(C709+D709+E709)*F709*G709	3	15
DDH009378	1	1	1	1	1	=(C710+D710+E710)*F710*G710	3	15
DDH009379	1	1	1	1	1	=(C711+D711+E711)*F711*G711	3	15
DDH009382	1	1	1	1	1	=(C712+D712+E712)*F712*G712	3	15
DDH009383	1	1	1	1	1	=(C713+D713+E713)*F713*G713	3	15
DDH009408	1	1	1	1	1	=(C714+D714+E714)*F714*G714	3	15
DDH009409	1	1	1	1	1	=(C715+D715+E715)*F715*G715	3	15
DDH009410	1	1	1	1	1	=(C716+D716+E716)*F716*G716	3	15
DDH009414	1	1	1	1	1	=(C717+D717+E717)*F717*G717	3	15
DDH009427	1	1	1	1	1	=(C718+D718+E718)*F718*G718	3	15
DDH009432	1	1	1	1	1	=(C719+D719+E719)*F719*G719	3	15
DDH009448	1	1	1	1	1	=(C720+D720+E720)*F720*G720	3	15
DDH009449	1	1	1	1	1	=(C721+D721+E721)*F721*G721	3	15
DDH009450	1	1	1	1	1	=(C722+D722+E722)*F722*G722	3	15
DDH009451	1	1	1	1	1	=(C723+D723+E723)*F723*G723	3	15
DDH009452	1	1	1	1	1	=(C724+D724+E724)*F724*G724	3	15

DDH009453	1	1	1	1	1	=(C725+D725+E725)*F725*G725	3	15
DDH009457	1	1	1	1	1	=(C726+D726+E726)*F726*G726	3	15
DDH009458	1	1	1	1	1	=(C727+D727+E727)*F727*G727	3	15
DDH009459	1	1	1	1	1	=(C728+D728+E728)*F728*G728	3	15
DDH009460	1	1	1	1	1	=(C729+D729+E729)*F729*G729	3	15
DDH009461	1	1	1	1	1	=(C730+D730+E730)*F730*G730	3	15
DDH009463	1	1	1	1	1	=(C731+D731+E731)*F731*G731	3	15
DDH009464	1	1	1	1	1	=(C732+D732+E732)*F732*G732	3	15
DDH009465	1	1	1	1	1	=(C733+D733+E733)*F733*G733	3	15
DDH009466	1	1	1	1	1	=(C734+D734+E734)*F734*G734	3	15
DDH009467	1	1	1	1	1	=(C735+D735+E735)*F735*G735	3	15
DDH009468	1	1	1	1	1	=(C736+D736+E736)*F736*G736	3	15
DDH009469	1	1	1	1	1	=(C737+D737+E737)*F737*G737	3	15
DDH009470	1	1	1	1	1	=(C738+D738+E738)*F738*G738	3	15
DDH009471	1	1	1	1	1	=(C739+D739+E739)*F739*G739	3	15
DDH009472	1	1	1	1	1	=(C740+D740+E740)*F740*G740	3	15
DDH009473	1	1	1	1	1	=(C741+D741+E741)*F741*G741	3	15
DDH009474	1	1	1	1	1	=(C742+D742+E742)*F742*G742	3	15
DDH009475	1	1	1	1	1	=(C743+D743+E743)*F743*G743	3	15
DDH009479	1	1	1	1	1	=(C744+D744+E744)*F744*G744	3	15
DDH009480	1	1	1	1	1	=(C745+D745+E745)*F745*G745	3	15
DDH009481	1	1	1	1	1	=(C746+D746+E746)*F746*G746	3	15
DDH009483	1	1	1	1	1	=(C747+D747+E747)*F747*G747	3	15
DDH009484	1	1	1	1	1	=(C748+D748+E748)*F748*G748	3	15
DDH009524	1	1	1	1	1	=(C749+D749+E749)*F749*G749	3	15
DDH009525	1	1	1	1	1	=(C750+D750+E750)*F750*G750	3	15
DDH009543	1	1	1	1	1	=(C751+D751+E751)*F751*G751	3	15
DDH009544	1	1	1	1	1	=(C752+D752+E752)*F752*G752	3	15
DDH009545	1	1	1	1	1	=(C753+D753+E753)*F753*G753	3	15
DDH009546	1	1	1	1	1	=(C754+D754+E754)*F754*G754	3	15
DDH009547	1	1	1	1	1	=(C755+D755+E755)*F755*G755	3	15
DDH009548	1	1	1	1	1	=(C756+D756+E756)*F756*G756	3	15
DDH009549	1	1	1	1	1	=(C757+D757+E757)*F757*G757	3	15

DDH009552	1	1	1	1	1	=(C758+D758+E758)*F758*G758	3	15
DDH009553	1	1	1	1	1	=(C759+D759+E759)*F759*G759	3	15
DDH009554	1	1	1	1	1	=(C760+D760+E760)*F760*G760	3	15
DDH009555	1	1	1	1	1	=(C761+D761+E761)*F761*G761	3	15
DDH009556	1	1	1	1	1	=(C762+D762+E762)*F762*G762	3	15
DDH009557	1	1	1	1	1	=(C763+D763+E763)*F763*G763	3	15
DDH009559	1	1	1	1	1	=(C764+D764+E764)*F764*G764	3	15
DDH009561	1	1	1	1	1	=(C765+D765+E765)*F765*G765	3	15
DDH009562	1	1	1	1	1	=(C766+D766+E766)*F766*G766	3	15
DDH009563	1	1	1	1	1	=(C767+D767+E767)*F767*G767	3	15
DDH009564	1	1	1	1	1	=(C768+D768+E768)*F768*G768	3	15
DDH009566	1	1	1	1	1	=(C769+D769+E769)*F769*G769	3	15
DDH009569	1	1	1	1	1	=(C770+D770+E770)*F770*G770	3	15
DDH009570	1	1	1	1	1	=(C771+D771+E771)*F771*G771	3	15
DDH009574	1	1	1	1	1	=(C772+D772+E772)*F772*G772	3	15
DDH009575	1	1	1	1	1	=(C773+D773+E773)*F773*G773	3	15
DDH009576	1	1	1	1	1	=(C774+D774+E774)*F774*G774	3	15
DDH009577	1	1	1	1	1	=(C775+D775+E775)*F775*G775	3	15
DDH009578	1	1	1	1	1	=(C776+D776+E776)*F776*G776	3	15
DDH009579	1	1	1	1	1	=(C777+D777+E777)*F777*G777	3	15
DDH009580	1	1	1	1	1	=(C778+D778+E778)*F778*G778	3	15
DDH009582	1	1	1	1	1	=(C779+D779+E779)*F779*G779	3	15
DDH009584	1	1	1	1	1	=(C780+D780+E780)*F780*G780	3	15
DDH009587	1	1	1	1	1	=(C781+D781+E781)*F781*G781	3	15
DDH009594	1	1	1	1	1	=(C782+D782+E782)*F782*G782	3	15
DDH009595	1	1	1	1	1	=(C783+D783+E783)*F783*G783	3	15
DDH009596	1	1	1	1	1	=(C784+D784+E784)*F784*G784	3	15
DDH009599	1	1	1	1	1	=(C785+D785+E785)*F785*G785	3	15
DDH009610	1	1	1	1	1	=(C786+D786+E786)*F786*G786	3	15
DDH009611	1	1	1	1	1	=(C787+D787+E787)*F787*G787	3	15
DDH009612	1	1	1	1	1	=(C788+D788+E788)*F788*G788	3	15
DDH009633	1	1	1	1	1	=(C789+D789+E789)*F789*G789	3	15
DDH009634	1	1	1	1	1	=(C790+D790+E790)*F790*G790	3	15

DDH009636	1	1	1	1	1	=(C791+D791+E791)*F791*G791	3	15
DDH009637	1	1	1	1	1	=(C792+D792+E792)*F792*G792	3	15
DDH009638	1	1	1	1	1	=(C793+D793+E793)*F793*G793	3	15
DDH009639	1	1	1	1	1	=(C794+D794+E794)*F794*G794	3	15
DDH009642	1	1	1	1	1	=(C795+D795+E795)*F795*G795	3	15
DDH009657	1	1	1	1	1	=(C796+D796+E796)*F796*G796	3	15
DDH009660	1	1	1	1	1	=(C797+D797+E797)*F797*G797	3	15
DDH009668	1	1	1	1	1	=(C798+D798+E798)*F798*G798	3	15
DDH009672	1	1	1	1	1	=(C799+D799+E799)*F799*G799	3	15
DDH009677	1	1	1	1	1	=(C800+D800+E800)*F800*G800	3	15
DDH009678	1	1	1	1	1	=(C801+D801+E801)*F801*G801	3	15
DDH009679	1	1	1	1	1	=(C802+D802+E802)*F802*G802	3	15
DDH009680	1	1	1	1	1	=(C803+D803+E803)*F803*G803	3	15
DDH009691	1	1	1	1	1	=(C804+D804+E804)*F804*G804	3	15
DDH009692	1	1	1	1	1	=(C805+D805+E805)*F805*G805	3	15
DDH009693	1	1	1	1	1	=(C806+D806+E806)*F806*G806	3	15
DDH009694	1	1	1	1	1	=(C807+D807+E807)*F807*G807	3	15
DDH009695	1	1	1	1	1	=(C808+D808+E808)*F808*G808	3	15
DDH009696	1	1	1	1	1	=(C809+D809+E809)*F809*G809	3	15
DDH009699	1	1	1	1	1	=(C810+D810+E810)*F810*G810	3	15
DDH009704	1	1	1	1	1	=(C811+D811+E811)*F811*G811	3	15
DDH009708	1	1	1	1	1	=(C812+D812+E812)*F812*G812	3	15
DDH009709	1	1	1	1	1	=(C813+D813+E813)*F813*G813	3	15
DDH009710	1	1	1	1	1	=(C814+D814+E814)*F814*G814	3	15
DDH009716	1	1	1	1	1	=(C815+D815+E815)*F815*G815	3	15
DDH009718	1	1	1	1	1	=(C816+D816+E816)*F816*G816	3	15
DDH009720	1	1	1	1	1	=(C817+D817+E817)*F817*G817	3	15
DDH009721	1	1	1	1	1	=(C818+D818+E818)*F818*G818	3	15
DDH009724	1	1	1	1	1	=(C819+D819+E819)*F819*G819	3	15
DDH009726	1	1	1	1	1	=(C820+D820+E820)*F820*G820	3	15
DDH009736	1	1	1	1	1	=(C821+D821+E821)*F821*G821	3	15
DDH009737	1	1	1	1	1	=(C822+D822+E822)*F822*G822	3	15
DDH009738	1	1	1	1	1	=(C823+D823+E823)*F823*G823	3	15

DDH009739	1	1	1	1	1	=(C824+D824+E824)*F824*G824	3	15
DDH009740	1	1	1	1	1	=(C825+D825+E825)*F825*G825	3	15
DDH009741	1	1	1	1	1	=(C826+D826+E826)*F826*G826	3	15
DDH009742	1	1	1	1	1	=(C827+D827+E827)*F827*G827	3	15
DDH009743	1	1	1	1	1	=(C828+D828+E828)*F828*G828	3	15
DDH009745	1	1	1	1	1	=(C829+D829+E829)*F829*G829	3	15
DDH009746	1	1	1	1	1	=(C830+D830+E830)*F830*G830	3	15
DDH009747	1	1	1	1	1	=(C831+D831+E831)*F831*G831	3	15
DDH009757	1	1	1	1	1	=(C832+D832+E832)*F832*G832	3	15
DDH009758	1	1	1	1	1	=(C833+D833+E833)*F833*G833	3	15
DDH009759	1	1	1	1	1	=(C834+D834+E834)*F834*G834	3	15
DDH009760	1	1	1	1	1	=(C835+D835+E835)*F835*G835	3	15
DDH009762	1	1	1	1	1	=(C836+D836+E836)*F836*G836	3	15
DDH009782	1	1	1	1	1	=(C837+D837+E837)*F837*G837	3	15
DDH009783	1	1	1	1	1	=(C838+D838+E838)*F838*G838	3	15
DDH009784	1	1	1	1	1	=(C839+D839+E839)*F839*G839	3	15
DDH009785	1	1	1	1	1	=(C840+D840+E840)*F840*G840	3	15
DDH009786	1	1	1	1	1	=(C841+D841+E841)*F841*G841	3	15
DDH009789	1	1	1	1	1	=(C842+D842+E842)*F842*G842	3	15
DDH009790	1	1	1	1	1	=(C843+D843+E843)*F843*G843	3	15
DDH009791	1	1	1	1	1	=(C844+D844+E844)*F844*G844	3	15
DDH009792	1	1	1	1	1	=(C845+D845+E845)*F845*G845	3	15
DDH009793	1	1	1	1	1	=(C846+D846+E846)*F846*G846	3	15
DDH009794	1	1	1	1	1	=(C847+D847+E847)*F847*G847	3	15
DDH009795	1	1	1	1	1	=(C848+D848+E848)*F848*G848	3	15
DDH009796	1	1	1	1	1	=(C849+D849+E849)*F849*G849	3	15
DDH009798	1	1	1	1	1	=(C850+D850+E850)*F850*G850	3	15
DDH009799	1	1	1	1	1	=(C851+D851+E851)*F851*G851	3	15
DDH009800	1	1	1	1	1	=(C852+D852+E852)*F852*G852	3	15
DDH009801	1	1	1	1	1	=(C853+D853+E853)*F853*G853	3	15
DDH009803	1	1	1	1	1	=(C854+D854+E854)*F854*G854	3	15
DDH009804	1	1	1	1	1	=(C855+D855+E855)*F855*G855	3	15
DDH009805	1	1	1	1	1	=(C856+D856+E856)*F856*G856	3	15

DDH009806	1	1	1	1	1	=(C857+D857+E857)*F857*G857	3	15
DDH009807	1	1	1	1	1	=(C858+D858+E858)*F858*G858	3	15
DDH009808	1	1	1	1	1	=(C859+D859+E859)*F859*G859	3	15
DDH009810	1	1	1	1	1	=(C860+D860+E860)*F860*G860	3	15
DDH009811	1	1	1	1	1	=(C861+D861+E861)*F861*G861	3	15
DDH009812	1	1	1	1	1	=(C862+D862+E862)*F862*G862	3	15
DDH009813	1	1	1	1	1	=(C863+D863+E863)*F863*G863	3	15
DDH009814	1	1	1	1	1	=(C864+D864+E864)*F864*G864	3	15
DDH009816	1	1	1	1	1	=(C865+D865+E865)*F865*G865	3	15
DDH009817	1	1	1	1	1	=(C866+D866+E866)*F866*G866	3	15
DDH009818	1	1	1	1	1	=(C867+D867+E867)*F867*G867	3	15
DDH009819	1	1	1	1	1	=(C868+D868+E868)*F868*G868	3	15
DDH009820	1	1	1	1	1	=(C869+D869+E869)*F869*G869	3	15
DDH009821	1	1	1	1	1	=(C870+D870+E870)*F870*G870	3	15
DDH009822	1	1	1	1	1	=(C871+D871+E871)*F871*G871	3	15
DDH009823	1	1	1	1	1	=(C872+D872+E872)*F872*G872	3	15
DDH009824	1	1	1	1	1	=(C873+D873+E873)*F873*G873	3	15
DDH009827	1	1	1	1	1	=(C874+D874+E874)*F874*G874	3	15
DDH009828	1	1	1	1	1	=(C875+D875+E875)*F875*G875	3	15
DDH009829	1	1	1	1	1	=(C876+D876+E876)*F876*G876	3	15
DDH009830	1	1	1	1	1	=(C877+D877+E877)*F877*G877	3	15
DDH009831	1	1	1	1	1	=(C878+D878+E878)*F878*G878	3	15
DDH009832	1	1	1	1	1	=(C879+D879+E879)*F879*G879	3	15
DDH009833	1	1	1	1	1	=(C880+D880+E880)*F880*G880	3	15
DDH009834	1	1	1	1	1	=(C881+D881+E881)*F881*G881	3	15
DDH009835	1	1	1	1	1	=(C882+D882+E882)*F882*G882	3	15
DDH009836	1	1	1	1	1	=(C883+D883+E883)*F883*G883	3	15
DDH009837	1	1	1	1	1	=(C884+D884+E884)*F884*G884	3	15
DDH009838	1	1	1	1	1	=(C885+D885+E885)*F885*G885	3	15
DDH009839	1	1	1	1	1	=(C886+D886+E886)*F886*G886	3	15
DDH009840	1	1	1	1	1	=(C887+D887+E887)*F887*G887	3	15
DDH009842	1	1	1	1	1	=(C888+D888+E888)*F888*G888	3	15
DDH009843	1	1	1	1	1	=(C889+D889+E889)*F889*G889	3	15

DDH009844	1	1	1	1	1	=(C890+D890+E890)*F890*G890	3	15
DDH009845	1	1	1	1	1	=(C891+D891+E891)*F891*G891	3	15
DDH009848	1	1	1	1	1	=(C892+D892+E892)*F892*G892	3	15
DDH009854	1	1	1	1	1	=(C893+D893+E893)*F893*G893	3	15
DDH009857	1	1	1	1	1	=(C894+D894+E894)*F894*G894	3	15
DDH009859	1	1	1	1	1	=(C895+D895+E895)*F895*G895	3	15
DDH009866	1	1	1	1	1	=(C896+D896+E896)*F896*G896	3	15
DDH009868	1	1	1	1	1	=(C897+D897+E897)*F897*G897	3	15
DDH009886	1	1	1	1	1	=(C898+D898+E898)*F898*G898	3	15
DDH009887	1	1	1	1	1	=(C899+D899+E899)*F899*G899	3	15
DDH009892	1	1	1	1	1	=(C900+D900+E900)*F900*G900	3	15
DDH009893	1	1	1	1	1	=(C901+D901+E901)*F901*G901	3	15
DDH009894	1	1	1	1	1	=(C902+D902+E902)*F902*G902	3	15
DDH009911	1	1	1	1	1	=(C903+D903+E903)*F903*G903	3	15
DDH009912	1	1	1	1	1	=(C904+D904+E904)*F904*G904	3	15
DDH009913	1	1	1	1	1	=(C905+D905+E905)*F905*G905	3	15
DDH009918	1	1	1	1	1	=(C906+D906+E906)*F906*G906	3	15
DDH009924	1	1	1	1	1	=(C907+D907+E907)*F907*G907	3	15
DDH009925	1	1	1	1	1	=(C908+D908+E908)*F908*G908	3	15
DDH009927	1	1	1	1	1	=(C909+D909+E909)*F909*G909	3	15
DDH009928	1	1	1	1	1	=(C910+D910+E910)*F910*G910	3	15
DDH009929	1	1	1	1	1	=(C911+D911+E911)*F911*G911	3	15
DDH009945	1	1	1	1	1	=(C912+D912+E912)*F912*G912	3	15
DDH009946	1	1	1	1	1	=(C913+D913+E913)*F913*G913	3	15
DDH009947	1	1	1	1	1	=(C914+D914+E914)*F914*G914	3	15
DDH009948	1	1	1	1	1	=(C915+D915+E915)*F915*G915	3	15
DDH009949	1	1	1	1	1	=(C916+D916+E916)*F916*G916	3	15
DDH009950	1	1	1	1	1	=(C917+D917+E917)*F917*G917	3	15
DDH009951	1	1	1	1	1	=(C918+D918+E918)*F918*G918	3	15
DDH009952	1	1	1	1	1	=(C919+D919+E919)*F919*G919	3	15
DDH009953	1	1	1	1	1	=(C920+D920+E920)*F920*G920	3	15
DDH009954	1	1	1	1	1	=(C921+D921+E921)*F921*G921	3	15
DDH009956	1	1	1	1	1	=(C922+D922+E922)*F922*G922	3	15

DDH009957	1	1	1	1	1	=(C923+D923+E923)*F923*G923	3	15
DDH009958	1	1	1	1	1	=(C924+D924+E924)*F924*G924	3	15
DDH009959	1	1	1	1	1	=(C925+D925+E925)*F925*G925	3	15
DDH009960	1	1	1	1	1	=(C926+D926+E926)*F926*G926	3	15
DDH009961	1	1	1	1	1	=(C927+D927+E927)*F927*G927	3	15
DDH009962	1	1	1	1	1	=(C928+D928+E928)*F928*G928	3	15
DDH009969	1	1	1	1	1	=(C929+D929+E929)*F929*G929	3	15
DDH009970	1	1	1	1	1	=(C930+D930+E930)*F930*G930	3	15
DDH009973	1	1	1	1	1	=(C931+D931+E931)*F931*G931	3	15
DDH009976	1	1	1	1	1	=(C932+D932+E932)*F932*G932	3	15
DDH009977	1	1	1	1	1	=(C933+D933+E933)*F933*G933	3	15
DDH009978	1	1	1	1	1	=(C934+D934+E934)*F934*G934	3	15
DDH009979	1	1	1	1	1	=(C935+D935+E935)*F935*G935	3	15
DDH009980	1	1	1	1	1	=(C936+D936+E936)*F936*G936	3	15
DDH009981	1	1	1	1	1	=(C937+D937+E937)*F937*G937	3	15
DDH009982	1	1	1	1	1	=(C938+D938+E938)*F938*G938	3	15
DDH009983	1	1	1	1	1	=(C939+D939+E939)*F939*G939	3	15
DDH009984	1	1	1	1	1	=(C940+D940+E940)*F940*G940	3	15
DDH009985	1	1	1	1	1	=(C941+D941+E941)*F941*G941	3	15
DDH009986	1	1	1	1	1	=(C942+D942+E942)*F942*G942	3	15
DDH009988	1	1	1	1	1	=(C943+D943+E943)*F943*G943	3	15
DDH009989	1	1	1	1	1	=(C944+D944+E944)*F944*G944	3	15
DDH009990	1	1	1	1	1	=(C945+D945+E945)*F945*G945	3	15
DDH009991	1	1	1	1	1	=(C946+D946+E946)*F946*G946	3	15
DDH009992	1	1	1	1	1	=(C947+D947+E947)*F947*G947	3	15
DDH009993	1	1	1	1	1	=(C948+D948+E948)*F948*G948	3	15
DDH009994	1	1	1	1	1	=(C949+D949+E949)*F949*G949	3	15
DDH009995	1	1	1	1	1	=(C950+D950+E950)*F950*G950	3	15
DDH009996	1	1	1	1	1	=(C951+D951+E951)*F951*G951	3	15
DDH009997	1	1	1	1	1	=(C952+D952+E952)*F952*G952	3	15
DDH009998	1	1	1	1	1	=(C953+D953+E953)*F953*G953	3	15
DDH009999	1	1	1	1	1	=(C954+D954+E954)*F954*G954	3	15
DDH010000	1	1	1	1	1	=(C955+D955+E955)*F955*G955	3	15

Appendix B. Score Assigned to Drill Holes

DDH010001	1	1	1	1	1	=(C956+D956+E956)*F956*G956	3	15
DDH010002	1	1	1	1	1	=(C957+D957+E957)*F957*G957	3	15
DDH010003	1	1	1	1	1	=(C958+D958+E958)*F958*G958	3	15
DDH010017	1	1	1	1	1	=(C959+D959+E959)*F959*G959	3	15
DDH010020	1	1	1	1	1	=(C960+D960+E960)*F960*G960	3	15
DDH010021	1	1	1	1	1	=(C961+D961+E961)*F961*G961	3	15
DDH010023	1	1	1	1	1	=(C962+D962+E962)*F962*G962	3	15
DDH010024	1	1	1	1	1	=(C963+D963+E963)*F963*G963	3	15
DDH010025	1	1	1	1	1	=(C964+D964+E964)*F964*G964	3	15
DDH010029	1	1	1	1	1	=(C965+D965+E965)*F965*G965	3	15
DDH010030	1	1	1	1	1	=(C966+D966+E966)*F966*G966	3	15

CITY OF BEND

Engineering & Infrastructure Planning Department Erosion and Sediment Control Inspection Form

In compliance with the City of Bend's Municipal Separate Storm Sewer System Permit and Water Pollution Control Facilities Permit, EIPD City staff shall complete this form monthly in person at each capital improvement project site. If additional guidance or erosion expertise is needed contact Utility Department stormwater compliance technicians.

Project ID:_____ Project Name:_____ City PM:_____
Completed By (City staff): _____ Date (MM/DD/YYYY)_____Time: _____

Weather: ☐ Clear ☐ Wind ☐ Rain ☐ Overcast ☐ Snow

Instructions: *Complete a separate inspection form for each capital improvement project site once per month and send completed forms to the EIPD Project Manager (PM). The EIPD Project Manager is responsible to communicate inspection results, deficiencies, and needed corrections with the contractor at the weekly project meeting. Upload completed monthly forms for reporting to the Utility Department Stormwater Program on Sharepoint at https://bendoregon.sharepoint.com/sites/Util_SW/EIPD%20Erosion%20Control%20Inspections/Forms/AllItems.aspx*

Erosion and Sediment Control Best Management Practice (BMP) Requirements		Std Drawing, Code, or COSM	Yes/No/NA
1. Perimeter Control	Are downslope project areas protected by effective perimeter control(s)? Are stockpiles located within the perimeter control of the project and protected? Are stockpiles located on paved surfaces covered? Is perimeter control installed at the base of each stockpile when not worked and/or by the end of each day? *Sediment is not allowed to discharge to the storm system. Released material needs to be cleaned up immediately and properly disposed.*	E-1, E-4, E-10, E12 and E-13	
2. Inlet Protection	Do all stormwater inlets within and adjacent to the project area have functioning inlet protection devices installed?	E-2A, E-2B, and E-2C	
3. Construction Entrance(s)	Do adjacent paved surfaces have functioning and maintained rocked construction entrance(s)? *Sediment ramps are not allowed at access points. Intentionally washing track-off into stormwater inlets is not allowed. All loose material must be swept from paved surfaces, daily at a minimum. No visible trackout from the project is allowed.*	E-8	
4. Dust Control	Are dust control measures in place at the project site?	Bend Code Title 16	
5. Concrete Management	Is concrete waste contained in a designated washout area for proper disposal?	E-7	
6. Stabilization	Are areas with bare soil that are not actively being worked stabilized?	E-5, E-5B, and E-9	
7. Structural Stormwater Controls	Are sensitive areas and post construction infiltration facilities being protected from damage during construction?	See Site Plan	
8. Runoff Control	Are runoff controls such as diversion and settling basins provided? Are dewatering activities being effectively controlled to prevent sediment laden runoff from leaving the project site?	E-11, E-12, E-13, E-14 and E15	
9. Material Management	Are hazardous chemicals (oils, paints, fuels, etc.) appropriately stored to prevent spills with secondary containment as needed? Are material storage/lay down areas outside of the active right of way and protected?	Bend Code Title 16 and COSM Section 9	
10. Prior Month Deficiencies	Were all prior month deficiencies addressed/corrected? Comments:		

All applicable Best Management Practices (BMPs) shall be in conformance with City of Bend Standards and Specifications. Alternative measures and practices are allowed when approved by the City of Bend Project Manager. ***All deficiencies noted by a "No" above should be addressed in more detail using the BMP Deficiency Log on page 2 of this form.**

BMP Deficiency Log

#	Location/Rd Seg	Deficiency Description	Corrective Action	Due Date
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				