City of Oregon City

625 Center Street
Oregon City, OR 97045
503-657-0891

Meeting Agenda - Final

Planning Commission

Monday, October 14, 2019 | **7:00 PM** | **Commission Chambers**

1. Call to Order

2. Public Comments

3. Public Hearing

3a Request for Continuance: Planning Files GLUA-19-00017 (General Land Use Application), SP-19-00053 (Site Plan and Design Review), PARK-19-00002 (Parking Adjustment) - Milner Veterinary Clinic Parking Lot and Parking Adjustment

Sponsors: Assistant Planner Diliana Vassileva
Attachments: Staff Report

3b Planning Files: GLUA 19-00002: LEG 19-00001 & LEG 19-00005: Updates to the Oregon City Stormwater and Grading Design Standards and Stormwater Master Plan.

Sponsors: Sr. Planner Christina Robertson-Gardiner
Attachments: Commission Report
Staff Report
Applicant's Submittal
Draft 2019 Stomwater Master Plan
Draft 2019 Stormwater and Grading Design Standards

3c. Planning Files: LEG 19-00003 - Beavercreek Road Concept Plan- Code and Zoning Amendments- (Parks, Enhanced Home Occupation/Cottage Industry, Concept Plan Renaming)

Sponsors: Sr. Planner Christina Robertson-Gardiner
Attachments: Commission Report
Planning Commision Memo October 14, 2019 Hearing
Beavercreek Road Concept Plan- Cottage Industry- Expanded Home Occupation Options Survey Results
Planning Commission Question and Issues Matrix for October 14, 2019 PC Meeting
Public Comment Matrix for October 14, 2019 PC Meeting Combined
Beavercreek Road Concept Plan Overlay Map
Beavercreek Road Concept Plan Adopted 2008 (readopted 2016)
Vicinity Map

Applicant's Submittal

June 7, 2019 Draft Zoning Code Amendments

June 7, 2019 Revised Draft Zoning Map (with and without major streets)

June 7, 2019 Zoning Code Memo

June 7, 2019 Zoning Map Memo

Economic/Jobs Analysis Memo

Infrastructure Memo

Transportation Memo

Public Comment Tracker January 2019-June 2019

4. Approval of the Minutes

4a. Approval of Planning Commission Minutes for 2.25.2019 and 4.08.2019

Sponsors: Planner Pete Walter

Attachments: Draft Minutes PC 02.25.2019

Draft Minutes PC 03.08.2019

Draft Minutes PC WKSN 03.08.2019

5. Communications

6. Adjournment

Public Comments: The following guidelines are given for citizens presenting information or raising issues relevant to the City but not listed on the agenda.

- *Complete a Comment Card prior to the meeting and submit it to the staff member.*
- *When the Chair calls your name, proceed to the speaker table and state your name and city of residence into the microphone.*
- *Each speaker is given 3 minutes to speak. To assist in tracking your speaking time, refer to the timer at the dais.*
- *As a general practice, Oregon City Officers do not engage in discussion with those making comments.*

Agenda Posted at City Hall, Pioneer Community Center, Library, and City Web site(oregon-city.legistar.com).
Video Streaming & Broadcasts: The meeting is streamed live on Oregon City's Web site at www.orcity.org and is available on demand following the meeting.
ADA: City Hall is wheelchair accessible with entry ramps and handicapped parking located on the east side of the building. Hearing devices may be requested from the City staff member prior to the meeting. Disabled individuals requiring other assistance must make their request known 48 hours preceding the meeting by contacting the City Recorder's Office at 503-657-0891.

City of Oregon City

625 Center Street
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Staff Report

File Number: PC 19-106

Agenda Date: 10/14/2019

Status: Agenda Ready

To: Planning Commission

Agenda #: 3a

From: Assistant Planner Diliana Vassileva

File Type: Land Use Item

SUBJECT:
Request for Continuance: Planning Files GLUA-19-00017 (General Land Use Application), SP-19-00053 (Site Plan and Design Review), PARK-19-00002 (Parking Adjustment) - Milner Veterinary Clinic Parking Lot and Parking Adjustment

RECOMMENDED ACTION (Motion):
Staff recommends that the Planning Commission open the public hearing, take testimony from any member of the public present who wishes to testify, then continue the public hearing for Planning Files GLUA-19-00017, SP-19-00053, and PARK-19-00002 to the date certain of October 28, 2019, with the record open.

BACKGROUND:
The applicant has proposed to construct a new parking lot with 18 parking spaces on the south side of Warner Street, across from the Milner Veterinary Clinic which is located at 1034 Molalla Avenue. The application requires Planning Commission approval, because the number of total parking spaces would exceed the maximum number of parking spaces allowed by the Oregon City Municipal Code.

A continuance of the public hearing is requested because land use notice signs were not posted on the subject site at least twenty days prior to the hearing as requried by Oregon City Municipal Code 17.50.100.B. The applicant has granted a 14-day extension to the 120-day decision deadline, extending the deadline until December 27, 2019.

Staff will provide a staff report with recommended findings for Planning Files GLUA-19-00017, SP-19-00053, and PARK-19-00002 one week prior to the October 28, 2019 Public Hearing.

City of Oregon City

625 Center Street
Oregon City, OR 97045
503-657-0891

Staff Report

File Number: PC 19-107

Agenda Date: 10/14/2019

Status: Agenda Ready

To: Planning Commission

Agenda #: 3b

From: Sr. Planner Christina Robertson-Gardiner

File Type: Planning Item

SUBJECT:
Planning Files: GLUA 19-00002: LEG 19-00001 & LEG 19-00005:
Updates to the Oregon City Stormwater and Grading Design Standards and Stormwater Master Plan.

RECOMMENDED ACTION (Motion):
Staff recommends approval of GLUA 19-00002: LEG 19-00001 & LEG 19-00005

BACKGROUND:

Stormwater management is a key element in maintaining and enhancing livability within the City of Oregon City (City). There is a direct link between stormwater runoff and the City's surface and groundwater quality and quantity. As land is developed, creation of new impervious surfaces and loss of vegetation increases stormwater runoff during rainfall events, altering the natural hydrologic cycle. Without stormwater management, the increase in flows erodes stream channels and limits groundwater recharge. In addition, runoff that flows over roadways, parking areas, rooftops, and other impervious surfaces collects pollutants that are transported within the watershed to streams, rivers, and groundwater resources. Properly managing stormwater is vital to protecting our water resources for a great number of uses, including fish and wildlife habitat, recreation, and drinking water.

The City of Oregon City is seeking to adopt a new Stormwater Master Plan (SMP or Master Plan) to supersede all previously adopted city-wide and basin-specific drainage plans. The SMP identifies drainage system deficiencies and improvements necessary to address these deficiencies as capital improvements necessary to accommodate growth. The SMP will guide the City in planning for and expending funds allowing for orderly and efficient stormwater system improvements throughout the City and to the bounds of the urban growth boundary.

The City of Oregon City is also seeking to amend its 2015 Stormwater and Grading Design

Standards (Design Standards). The Design Standards prescribe standards for the planning and design stormwater conveyance and management systems. As required by City Code, the Design Standards apply to the development of all public and private projects throughout the City.

BUDGET IMPACT:
Amount:
FY(s):
Funding Source:

OREGON CITY

Community Development – Planning

698 Warner Parrott Road | Oregon City OR 97045
Ph (503) 722-3789 | Fax (503) 722-3880

STAFF REPORT AND RECOMMENDATION
October 7, 2019

FILE NO.: GLUA 19-00002: LEG 19-00001 & LEG 19-00005

HEARING DATES: Planning Commission
Monday, October 14, 2019
7:00 p.m., City Hall - Commission Chambers
625 Center Street, Oregon City, OR 97045

APPLICANT: Oregon City Public Works Department
John Lewis, P.E., Public Works Director
Josh Wheeler, P.E. Assistant City Engineer
Bob Balgos, P.E. Project Engineer
625 Center Street, Oregon City, Oregon 97045

REPRESENTATIVE: Brown and Caldwell, Consulting Engineers
6500 SW Macadam Avenue, Suite 200, Portland, OR 97239

REVIEWER: Christina Robertson-Gardiner, AICP, Senior Planner

REQUEST: Updates to the Oregon City Stormwater and Grading Design Standards and Stormwater Master Plan.

LOCATION: City-wide.

RECOMMENDATION: Staff recommends approval of the proposed amendments to the Stormwater and Grading Design Standards and approval of the Stormwater Master Plan as an ancillary document to the Oregon City Comprehensive Plan to the Planning Commission and City Commission.

17.50.170 - Legislative hearing process.
A. Purpose. Legislative actions involve the adoption or amendment of the city's land use regulations, comprehensive plan, maps, inventories and other policy documents that affect the entire city or large portions of it. Legislative actions which affect land use must begin with a public hearing before the planning commission.
B. Planning Commission Review.
1. Hearing Required. The planning commission shall hold at least one public hearing before recommending action on a legislative proposal. Any interested person may appear and provide written

or oral testimony on the proposal at or prior to the hearing. The community development director shall notify the Oregon Department of Land Conservation and Development (DLCD) as required by the post-acknowledgment procedures of ORS 197.610 to 197.625, as applicable.
2. The community development director's Report. Once the planning commission hearing has been scheduled and noticed in accordance with Section 17.50.090(C) and any other applicable laws, the community development director shall prepare and make available a report on the legislative proposal at least seven days prior to the hearing.
3. Planning Commission Recommendation. At the conclusion of the hearing, the planning commission shall adopt a recommendation on the proposal to the city commission. The planning commission shall make a report and recommendation to the city commission on all legislative proposals. If the planning commission recommends adoption of some form of the proposal, the planning commission shall prepare and forward to the city commission a report and recommendation to that effect.
C. City Commission Review.

1. City Commission Action. Upon a recommendation from the planning commission on a legislative action, the city commission shall hold at least one public hearing on the proposal. Any interested person may provide written or oral testimony on the proposal at or prior to the hearing. At the conclusion of the hearing, the city commission may adopt, modify or reject the legislative proposal, or it may remand the matter to the planning commission for further consideration. If the decision is to adopt at least some form of the proposal, and thereby amend the city's land use regulations, comprehensive plan, official zoning maps or some component of any of these documents, the city commission decision shall be enacted as an ordinance.
2. Notice of Final Decision. Not later than five days following the city commission final decision, the community development director shall mail notice of the decision to DLCD in accordance with ORS 197.615(2).
(Ord. No. 08-1014, §§ 1—3(Exhs. 1—3), 7-1-2009; Ord. No. 10-1003, § 1(Exh. 1), 7-7-2010)

IF YOU HAVE ANY QUESTIONS ABOUT THIS APPLICATION, PLEASE CONTACT THE PLANNING DIVISION OFFICE AT (503) 657-0891.

I. Proposal

Stormwater management is a key element in maintaining and enhancing livability within the City of Oregon City (City). There is a direct link between stormwater runoff and the City's surface and groundwater quality and quantity. As land is developed, creation of new impervious surfaces and loss of vegetation increases stormwater runoff during rainfall events, altering the natural hydrologic cycle. Without stormwater management, the increase in flows erodes stream channels and limits groundwater recharge. In addition, runoff that flows over roadways, parking areas, rooftops, and other impervious surfaces collects pollutants that are transported within the watershed to streams, rivers, and groundwater resources. Properly managing stormwater is vital to protecting our water resources for a great number of uses, including fish and wildlife habitat, recreation, and drinking water.

The City of Oregon City is seeking to adopt a new Stormwater Master Plan (SMP or Master Plan) to supersede all previously adopted city-wide and basin-specific drainage plans. The SMP identifies

drainage system deficiencies and improvements necessary to address these deficiencies as capital improvements necessary to accommodate growth. The SMP will guide the City in planning for and expending funds allowing for orderly and efficient stormwater system improvements throughout the City and to the bounds of the urban growth boundary.

The City of Oregon City is also seeking to amend its 2015 Stormwater and Grading Design Standards (Design Standards). The Design Standards prescribe standards for the planning and design stormwater conveyance and management systems. As required by City Code, the Design Standards apply to the development of all public and private projects throughout the City.

The new SMP assumes that all future stormwater improvements will be developed consistent with the Design Standards.

The scope of the amendments to the Design Standards is limited to providing greater clarification and instruction to applicants consistent with the City's current implementation practices. No changes in applicable land uses prescribed by zoning regulations are proposed. Therefore, the Standards and the Master Plan do not allow any uses which are more intensive than currently allowed today. Rather, the update of the Plan and the Standards will allow the City to have plans and standards in place which will allow the City to manage present and future stormwater needs as development occurs.

Stormwater Master Plan

The City of Oregon City (City) developed the citywide Master Plan to guide stormwater-related priorities and capital improvement projects (CIPs) over the next 10 to 15 years.

The City is currently managing more than 174 miles of stormwater infrastructure, including significant areas of aging systems. At the same time, development rates and projections indicate that the stormwater system will require continued expansion to accommodate future growth. The City's previous Drainage Master Plan was completed in 1988 and is no longer relevant following nearly 30 years of development across the city. The City needs a proactive plan to address immediate capacity needs, replace aging infrastructure, and provide regional solutions to larger flooding and water quality challenges. The updated CIP list, adopted as part of the Master Plan, and selected programmatic approaches included in this Master Plan will facilitate a prioritization of the City's resources and support future resource and financial planning.

Examples of recommended Capital Improvement Projects from the CIP list are:

- John Adams Basin Capacity Improvements to alleviate flooding and replace aging infrastructure. The storm pipes in this basin are among the oldest in the City and well past their expected life.

- Rivercrest Neighborhood Infrastructure Improvements to address an insufficient storm drain system. Portions of the neighborhood currently conveys stormwater into the sanitary system.
- The Cove Water Quality Improvements to address water quality. Stormwater entering Clackamette Cove is primarily runoff from industrial, commercial and other land use that can generate high pollutant loads. The areas were developed prior to water quality requirements, so the discharge entering the cove is primarily untreated.
- Newall Canyon Outfall Assessment to evaluate the stormwater outfalls in the Newall Canyon area. This area has several locations where erosion, bank sloughing and landslides have occurred during and following storm events. The assessment will identify significant problem locations and concept plans will be developed to stabilize degrading systems

The Master Plan documents the means and methods used to evaluate the City's drainage infrastructure and natural systems. Results of the evaluations conducted provide the City with CIPs and programmatic stormwater actions for implementation. The study area for this Master Plan covers drainage areas to receiving water bodies including Abernethy Creek, the Clackamas River, Beaver Creek, and the Willamette River.

Upon approval, this Stormwater Master Plan shall be incorporated as ancillary to the Oregon City Comprehensive Plan.

II. Public Involvement and Public Comment

Public Notice

Notice of the first evidentiary Planning Commission public hearings for the proposal was published in the local paper and along with the Planning Commission agenda was transmitted to neighborhood associations, departments, and variance agencies such as Metro, Tri-Met and Clackamas County.

In accordance with ORS 197.610 and OAR 660-018-000, a Post Acknowledgement Plan Amendment will be provided to the Oregon Department of Land Conservation and Development within 20 days of the City's final decision. The first notice to DLCD was sent more than 35 days in advance of the hearing.

The applicant, Oregon City Public Works Department, has presented the update for input to the Development Stakeholders Group on May 9, 2019. The update was provided on the City's website during the months of February through May 2019. Local civil engineering consultants and developers were notified via email on February 5, 2019 and April 24, 2019. The standards were presented in a City Commission Work Session on May 7, 2019. The City Commission considered these standards for approval on July 17, 2019. These standards will also be presented before the Planning Commission in October 2019 prior to approval by the City Commission.

Public comments provided throughout the previously described planning process have been incorporated into the document as needed. No formal public comments were received for this application.

III. DECISION-MAKING CRITERIA:

Oregon City Municipal Code Chapter 17.68 Zoning Changes and Comprehensive Plan Amendments
As this application was submitted on January 31, 2019, the code in effect on that date governs the application and does not include the recently adopted code amendments (August 2, 2019)

17.68.010 *- Initiation of the amendment.*
A text amendment to the comprehensive plan, or an amendment to the zoning code or map or the Comprehensive Plan map, may be initiated by:
A. A resolution request by the City Commission;
B. An official proposal by the Planning Commission;
C. An application to the Planning Division; or.
D. A Legislative request by the Planning Division.
All requests for amendment or change in this title shall be referred to the Planning Commission.
Finding: *The Public Works Department submitted the application to the Planning Division*

17.68.020 - Criteria.
The criteria for comprehensive plan amendment or text or map amendment in the zoning code are set forth as follows:
A. The proposal shall be consistent with the applicable goals and policies of the comprehensive plan;
Finding: Applicable goals and policies are identified within the body of the staff report.

B. That public facilities and services (water, sewer, storm drainage, transportation, schools, police and fire protection) are presently capable of supporting the uses allowed by the zone or plan amendment, or can be made available prior to issuing a certificate of occupancy. Service shall be sufficient to support the range of uses and development allowed by the zone or plan amendment;
Finding: Stormwater Master Plan: As discussed in this staff report, the Master Plan provides guidance for the timely, efficient and economic provision of stormwater service within the existing city and to new development areas within the Urban Growth Boundary consistent with the relevant goals, policies and implementing measures of the Comprehensive Plan. The proposed Master Plan is consistent with this policy.

Stormwater and Grading Design Standards: The Stormwater and Grading Design Standards provide technical guidance to design and construct projects outlined in the Stormwater Master Plan. The Stormwater Master Plan is consistent with the policies and measures of the comprehensive plan; therefore, the Standards also are consistent with these policies by reference.

C. The land uses authorized by the proposal are consistent with the existing or planned function, capacity and level of service of the transportation system serving the proposed zoning district or plan amendment; and
Finding: No land use zoning amendments are proposed for this application**.** *C*apacity and level of service analysis are performed when land is proposed to be rezoned through this chapter.

D. Statewide planning goals shall be addressed if the comprehensive plan does not contain specific policies or provisions which control the amendment.
Finding: While the Comprehensive Plan provides applicable polices for this matter, staff has provided responses to the State Land Use Goals to supplement the staff review of this application.

Stormwater and Grading Design Standards

The City of Oregon City developed updated Stormwater and Grading Design Standards in 2015. These standards updated existing standards from 1999. The updated standards were created to change the methodology of stormwater requirements from peak flow modeling to flow duration modeling.
This revision of the 2015 Standards is to provide clarification to the existing standards where they have not been clear to staff and the development community. Examples of clarifications include:

- Replacing the Natural Resource notation from the abbreviation WQRA to the abbreviation NROD which is consistent with the references to natural resource areas in OCMC 17.49.
- More clearly define the exemptions from the stormwater requirements in 1.2.2 by providing further description and additional language.
- Changing the Checklist obligation to set forth a preliminary design checklist rather than a planning checklist to be in line with how engineers talk about this section of the standards.
- Clarify the stormwater management strategy hierarchy in Figure 2-2 that better explains how a designer should prioritize stormwater management options and alternatives.
- Explain how to use the BMP sizing tool for underground stormwater management.
- Change the minimum velocity requirements of storm sewers to be consistent with the Oregon Department of Transportation standards.

The City Commission has the ability to adopt revisions to these Standards as provided by OCMC 13.12.020.

The Standards also exist to keep the City in compliance with the National Pollution Discharge Elimination System Municipal Separate Storm and Sewer System (NPDES) MS-4 Permit which the City has been operating under since 1996.

Stormwater Master Plan Objectives

The goal of this Master Plan is to provide guidance in planning and designing stormwater conveyance and managing infrastructure to protect the natural and built environment for the next 10 to 15 years. The primary method for guidance is through a prioritized CIP list. This Master Plan is intended to be used in conjunction with both the City's National Pollutant Discharge Elimination System (NPDES) municipal

separate storm sewer system (MS4) permit, and Stormwater Grading and Design Standards, which outline the City's stormwater quality and quantity related obligations and programs. The NPDES MS4 permit requires the City to implement a Stormwater Management Plan (SWMP1) that outlines programmatic water quality best management practices (BMPs) to reduce pollutants in urban stormwater discharges to receiving waters.

The City's Stormwater Grading and Design Standards require developers to address stormwater quality and quantity impacts associated with new development and redevelopment activities. In addition to addressing aging infrastructure, future growth, water quality, flooding, and capacity issues, the City values the natural systems and spaces available to the community. Protecting and maintaining a healthy environment is important to maintaining a livable and healthy city. This Master Plan was developed to support the City's healthy management of these resources, including natural channel and riparian areas, habitat, and water bodies with beneficial uses such as fishing and recreation.

Stormwater and Grading Design Standards Objectives

The goal of the update is to provide clarification and correct errors within the Standards.

Consistency with Oregon City Comprehensive Plan

The 2004 Oregon City Comprehensive Plan calls for the periodic review and updating of the Comprehensive Plan and contains criteria for approving changes to the comprehensive plan. See p 16. . Review of the comprehensive plan should consider:

1. Plan implementation process.
2. Adequacy of the Plan to guide land use actions, including an examination of trends.
3. Whether the Plan still reflects community needs, desires, attitudes and conditions. This shall include changing demographic patterns and economics.
4. Addition of updated factual information including that made available to the City of regional, state and federal governmental agencies.

1. Plan implementation process.

Finding – Stormwater Master Plan: The applicant, Oregon City Public Works Department, has presented the update for input by the Citizen Involvement Committee, engineering community, Planning Commission and City Commission in accordance with the recommended method described in the Comprehensive Plan and pursuant to the applicable process described in Oregon City Municipal Code section 17.50.170. The plan implementation process is consistent with the Comprehensive Plan.

Finding – Stormwater and Grading Design Standards: The applicant, Oregon City Public Works Department, has presented the update for input to the Development Stakeholders Group on May 9, 2019. The update was provided on the City's website during the months of February through May 2019. Local civil engineering consultants and developers were notified via email on February 5, 2019 and April 24, 2019. The standards were presented in a City Commission Work Session on May 7, 2019. The City

Commission considered these standards for approval on July 17, 2019. These standards will also be presented before the Planning Commission in October 2019 prior to approval by the City Commission.

2. Adequacy of the Plan to guide land use actions, including an examination of trends.

Finding – Stormwater Master Plan: As an ancillary document to the Comprehensive Plan, the updated Master Plan provides an analysis of existing stormwater facilities and provides direction for future development, funding and needs. The plan provides a comprehensive review of the stormwater system and provides an adequate guide for future land use actions and the development of criteria to be utilized in development review.

The update includes updated construction cost estimates and contingencies for the planning and design of recommended stormwater system facilities for the City (See Appendix H).
Adoption of the document will assist with the guidance of land use actions and responds to new requirements for improved stormwater management as discussed above.

Finding – Stormwater and Grading Design Standards: The Standards created in 2015 were in response to the City's MS-4 Permit under the NPDES regulations. The Standards also moved to a Flow Duration model rather than Peak Stormwater Model to follow trends in climate as well as modeling trends in the region. In 2015, Clackamas County's Department of Water Environment Services developed a BMP Sizing Tool for Flow Duration Stormwater Modeling. The City of Wilsonville and Oregon City adopted this tool and stormwater modeling method. That tool has or its regulations have not been changed with this 2019 Update of the Stormwater and Grading Design Standards.
The revised Standards also update the terminology of a Natural Resource Area from WQRA (Water Quality Resource Area) to NROD (Natural Resource Overlay District) to be consistent with City Code 17.49 as well as OCMC 13.12.

3. Whether the Plan still reflects community needs, desires, attitudes and conditions. This shall include changing demographic patterns and economics.

Finding – Stormwater Master Plan: As part of this effort, the consultant conducted technical analyses of the City's existing storm design standards. Since the manual is strictly an engineering document, any changes in demographic patterns and economics are reflected in the design requirements. For example, the stormwater design requirements for a dense multi-family development will differ from those for a low-density single-family residential lot. Adoption of the Stormwater and Grading Design Standards Manual will address necessary improvements to ensure the orderly review of stormwater, drainage and erosion control management to accommodate the projected growth envisioned in the City's Comprehensive Plan.

Finding – Stormwater and Grading Design Standards: As the Update to the Design Standards are for clarification and errors, not change in the actual technical standards, the Finding above for the Stormwater Master Plan also applies as a Finding to the Design Standards. With no structural changes in the Standards, the edits would not have any impact to demographic changes in the community.

4. Addition of updated factual information including that made available to the City of regional, state and federal governmental agencies.

Finding – Stormwater Master Plan: The consultant has included an analysis of the existing stormwater system based on available existing information provided by the City.
The projections of stormwater demand for existing and future service areas reflect updated population projections, recent comprehensive plan amendment areas (Park Place concept area and Beavercreek Road concept area), and new regulatory requirements at the state and federal level.

The City of Oregon City maintains benchmarks for service quality that are used to measure performance of the stormwater utility. The service standards set forth in this master plan are derived from regulations, rules, and recommendations established by a variety of sources including the Environmental Protection Agency (EPA). The Master Plan includes updated criteria based on the direct requirements of the City's existing NPDES MS4 permit. The addition of this updated information will allow the City to keep the Stormwater Master Plan current.

Finding – Stormwater and Grading Design Standards: The 2015 Standards were created based on the direct requirements of the City's existing NPDES MS4 permit. The 2019 Update provides no technical changes, only clarification, and remain in line with the requirements of the MS4 permit.

"Ancillary Plans. – Page 15
Since 1982, several documents have been adopted as ancillary to the 1982 Comprehensive Plan: the Public Facilities Plan (1990), Oregon City Transportation System Plan (2001), Oregon City Downtown Community Plan (1999), Oregon City Waterfront Master Plan (2002), City of Oregon City Water Master Plan (2003), City of Oregon City Sanitary Sewer Master Plan (2003), Drainage Master Plan (1988, updated in 1999 as the City of Oregon City Public Works Stormwater and Grading Design Standards), Caufield Basin Master Plan (1997), South End Basin Master Plan (1997), Molalla Avenue Boulevard and Bikeway Improvements Plan (2001), the Oregon City Park and Recreation Master Plan (1999), and the Oregon City Trails Master Plan (2004)."
*Note that the references to the updated master plan documents, including the Stormwater Master Plan proposed here will be updated with the future revision to the Comprehensive Plan.

Goal 5.4 Natural Resources-Identify and seek strategies to conserve and restore Oregon City's natural resources, including air, surface and subsurface water, geologic features, soils, vegetation, and fish and wildlife, in order to sustain quality of life for current and future citizens and visitors, and the long-term viability of the ecological systems.
Policy 5.4.1 Conserve and restore ecological structure, processes and functions within the city to closely approximate natural ecosystem structure, processes, and functions.

Finding – Stormwater Master Plan: Section 2 of the Master Plan identifies the natural systems within the City and describes the condition of these systems through assessments. Section 6 of the Master Plan outlines the assessments and field evaluations leading to capital project recommendations to address hydromodification, stream stability, water quality and flooding. The recommended capital projects in the Master Plan assume application of the City's Stormwater and Grading Design Standards which sets forth the requirements as described briefly in the Finding below. As a result, the proposed Master Plan will help to protect and conserve existing natural areas consistent with this policy.

Finding – Stormwater and Grading Design Standards: The introduction of the Stormwater and Grading Design Standards states the goal of these standards is to provide local engineers, developers, builders, and City staff clear guidance in planning and designing stormwater conveyance and management systems that are appropriate to the local climate, hydrogeology, and geology. The General Thresholds in section 1.2.1 of the Standards requires development within a Natural Resource Overlay District (NROD) follow certain guidelines. These guidelines were established in the 2015 adopted standards and have not been changed as part of this revision. Therefore, these Standards will continue to protect and conserve existing natural areas.

Goal 1.2 Community and Comprehensive Planning-Ensure that citizens, neighborhood groups, and affected property owners are involved in all phases of the comprehensive planning program.

Policy 1.2.1Encourage citizens to participate in appropriate government functions and land-use planning.

Finding: This goal is implemented through the applicable Goals and Policies in Section 1 of the Oregon City Comprehensive Plan: Citizen Involvement. Development of the plan included an public involvement effort. The applicant, Oregon City Public Works Department, has presented the update for input to the Development Stakeholders Group on May 9, 2019. The update was provided on the City's website during the months of February through May 2019. Local civil engineering consultants and developers were notified via email on February 5, 2019 and April 24, 2019. The standards were presented in a City Commission Work Session on May 7, 2019. The City Commission considered these standards for approval on July 17, 2019.

Policy 5.4.8 Conserve natural resources that have significant functions and values related to flood protection, sediment and erosion control, water quality, groundwater recharge and discharge, education, vegetation and fish, and wildlife habitat.

Finding – Stormwater Master Plan: Section 2 of the Master Plan identifies the natural systems within the City and describes the condition of these systems through assessments. Section 6 of the Master Plan outlines the assessments and field evaluations leading to capital project recommendations to address hydromodification, stream stability, water quality and flooding. One recommended capital project for example is the Newell Canyon Outfall Assessment. The project will require further study to identify significant problem locations where erosion, bank sloughing and landslides have occurred during heavy storm events. The study will lead to a development of concept plans to stabilize the degrading systems. The recommended capital projects in the Master Plan is intended to apply the City's Stormwater and Grading Design Standards which sets forth the requirements as described briefly in the Finding below. The proposed Master Plan is consistent with this policy.

Finding – Stormwater and Grading Design Standards: The introduction of the Stormwater and Grading Design Standards states the goal of these standards is to provide local engineers, developers, builders, and City staff clear guidance in planning and designing stormwater conveyance and management systems that are appropriate to the local climate, hydrogeology, and geology. The General Thresholds in section 1.2.1 of the Standards requires development within a Natural Resource Overlay District (NROD) should follow certain guidelines. The general design requirements establish water quality standards, stormwater management strategies, and LID Design criteria to protect the local environment. These guidelines were established in the 2015 adopted standards and have not been changed as part of this revision. Therefore, upon amendment, these Standards will remain consistent with this policy.

Policy 5.4.9-Protect and enhance riparian corridors along streams in Oregon City to increase shade, reduce streambank erosion and intrusion of sediments, and provide habitat for a variety of plants, animals, and fish.

Finding – Stormwater Master Plan: Section 2 of the Master Plan identifies the natural systems within the City and describes the condition of these systems through assessments. Section 6 of the Master Plan outlines the assessments and field evaluations leading to capital project recommendations to address hydromodification, stream stability, water quality and flooding. The recommended capital projects in the Master Plan is intended to apply the City's Stormwater and Grading Design Standards which sets forth the requirements as described briefly in the Finding below. The proposed Master Plan is consistent with this policy.

Finding – Stormwater and Grading Design Standards: The introduction of the Stormwater and Grading Design Standards states the goal of these standards is to provide local engineers, developers, builders, and City staff clear guidance in planning and designing stormwater conveyance and management systems that are appropriate to the local climate, hydrogeology, and geology. The General Thresholds in section 1.2.1 of the Standards requires development within a Natural Resource Overlay District (NROD) should follow certain guidelines. The general design requirements establish water quality standards,

stormwater management strategies, and LID Design criteria to protect the local environment. Water Quality Requirements are also provided. These guidelines and requirements were established in the 2015 adopted standards and have not been changed as part of this revision. Therefore, upon amendment, these Standards will remain consistent with this policy.

Policy 5.4.12-Use a watershed-scale assessment when reviewing and planning for the potential effects from development, whether private or public, on water quality and quantity entering streams.
Finding – Stormwater Master Plan: Chapter 5 of Stormwater and Grading Design Standards address the requirements of a downstream analysis from development whether private or public. The Master Plan is intended to apply the City's Stormwater and Grading Design Standards which sets forth the requirements as described in the Finding below. The proposed Master Plan is consistent with this policy.

Finding – Stormwater and Grading Design Standards: The introduction of the Stormwater and Grading Design Standards states the goal of these standards is to provide local engineers, developers, builders, and City staff clear guidance in planning and designing stormwater conveyance and management systems that are appropriate to the local climate, hydrogeology, and geology. The general thresholds in section 1.2.1 provide direction on when the requirements apply to a project. The general design requirements establish water quality standards, stormwater management strategies, and LID Design criteria to protect the local environment. Water Quality Requirements are also provided. A downstream analysis of existing systems is required these Standards. These guidelines and requirements were established in the 2015 adopted standards and have not been changed as part of this revision. Therefore, upon amendment, these Standards will remain consistent with this policy.

Policy 5.4.13-Adopt and/or establish standards for all new development that promote the use of pervious surfaces and prevent negative ecological effects of urban storm- water runoff on streams, creeks and rivers.

Finding – Stormwater Master Plan: Chapter 4 of Stormwater and Grading Design Standards describes the methods and criteria for selecting and designing stormwater management facilities including impervious area reduction techniques for all new development. The Master Plan is intended to apply the City's Stormwater and Grading Design Standards which sets forth the requirements as described in the Finding below. The proposed Master Plan is consistent with this policy.

Finding – Stormwater and Grading Design Standards: The Standards provide a Stormwater Management Strategy Hierarchy which promotes the use of infiltration and Best Management Practice (BMP) solutions. This section of the Standards was revised to provide clarity and explanation to the existing adopted standards from 2015. The revision only provides clarity and does not add to or change the intent of the existing standards. Therefore, upon amendment, these Standards will remain consistent with this policy.

Policy 5.4.16-Protect surface water quality by:

- *providing a vegetated corridor to separate protected water features from development*
- *maintaining or reducing stream temperatures with vegetative shading*
- *minimizing erosion and nutrient and pollutant loading into water*
- *providing infiltration and natural water purification by percolation through soil and vegetation*

Finding – Stormwater Master Plan: Section 5 of the Master Plan describes water quality priorities, retrofit evaluations and the regulatory requirements of the NPDES MS4 Permit. The Master Plan identifies areas of water quality deficiencies within the City and provides recommended capital projects and the continuing use of programmatic actions. The Master Plan is intended to apply the City's Stormwater and Grading Design Standards which outline the City's stormwater quality and quantity related obligations and programs. The proposed Master Plan is consistent with this policy.

Finding – Stormwater and Grading Design Standards: The Standards provide a Stormwater Management Strategy Hierarchy which promotes the use of infiltration and Best Management Practice (BMP) solutions. Note that the highest priority of the hierarchy is infiltration and the use of vegetated areas. Amendments are proposed for this section to provide clarity and explanation to the existing adopted standards from 2015. The revision only provides clarity and does not add to or change the intent or the City's practice of applying these existing standards. The Stormwater BMP Selection Guidance for Site Conditions Table 4-1 provides BMP solutions and alternatives. This table was not revised as part of this update. The Standards state a site must meet a specific water quality requirement that was adopted as part of the 2015 Standards. This revision does not change that requirement. The Standards provide a reference to the City of Oregon City Public Works Erosion and Sediment Control Standards. No change was made to this Standard as part of these revisions. Appendix A exists within the standards to provide guidance on facility plantings with plant lists and diagrams. This Appendix was revised for clarification and constructability and did not receive any structural changes, deletions or additions.

Goal 6.2 Water Quality-Control erosion and sedimentation associated with construction and development activities to protect water quality.
Policy 6.2.1-Prevent erosion and restrict the discharge of sediments into surface- and groundwater by requiring erosion prevention measures and sediment control practices.

Finding – Stormwater Master Plan: The Master Plan is intended to apply the City's Stormwater and Grading Design Standards. These standards provide a reference to the City of Oregon City Public Works Erosion and Sediment Control Standards in Chapter 7. The proposed Master Plan is consistent with this policy.

Finding – Stormwater and Grading Design Standards: The Standards provide a reference to the City of Oregon City Public Works Erosion and Sediment Control Standards in Chapter 7. No change was made to this Standard as part of these revisions. Therefore, upon amendment, these Standards will remain consistent with this policy.

Policy 6.2.2-Where feasible, use open, naturally vegetated drainage ways to reduce stormwater and improve water quality.

Finding – Stormwater Master Plan: Chapter 2 of Stormwater and Grading Design Standards describe the City's Stormwater Management Hierarchy Strategy whereas the highest priority is infiltration and use of vegetated areas. The Master Plan is intended to apply the City's Stormwater and Grading Design Standards which sets forth the requirements as described in the Finding below. The proposed Master Plan is consistent with this policy.

Finding – Stormwater and Grading Design Standards: The Standards provide a Stormwater Management Strategy Hierarchy which promotes the use of infiltration and Best Management Practice (BMP) solutions. This section of the Standards was revised to provide clarity and explanation to the existing adopted standards from 2015. The revision only provides clarity and does not add to or change the intent of the existing standards. The Stormwater BMP Selection Guidance for Site Conditions Table 4-1 provides BMP solutions and alternatives. This table was not revised as part of this update. Note that the highest priority of the hierarchy remains as infiltration and the use of vegetated areas.

Comp Plan Goal 11.1 Provision of Public Facilities- Serve the health, safety, education, welfare, and recreational needs of all Oregon City residents through the planning and provision of adequate public facilities.

Finding – Stormwater Master Plan: The Master Plan is necessary to maintain compliance with Statewide Planning Goal 11, Public Facilities. Goal 11 requires that public facilities and services be provided in a timely, orderly and efficient manner. The goal's central concept is that local governments should plan public services in accordance with the community's needs as a whole rather than be forced to respond to individual developments as they occur. This includes stormwater service. As shown in the findings below, the proposed update of the Stormwater Master Plan is consistent with Goal 11.1.

Finding – Stormwater and Grading Design Standards: The Design Standards were created to serve the health, safety, education, welfare, and recreational needs of all Oregon City residents through the planning and provision of adequate public facilities. Public Facilities include, but are not limited to, stormwater detention, stormwater management areas, swales, ponds, storm sewers and appurtenances. These public facilities are designed by the technical standards found within the Stormwater and Grading Design Standards which were prepared to improve water quality, reduce

flooding, convey stormwater to safe appropriate areas, prevent stagnation, and provide signage and fencing for education and safety where appropriate.

Comp Plan Policy 11.1.1 -Ensure adequate public funding for the following public facilities and services, if feasible:

• *Stormwater management*

Finding – Stormwater Master Plan: The Master Plan includes a recommended Capital Improvement Program with a comprehensive and detailed discussion of cost estimates and options to assure that the existing and future stormwater facilities can be funded. The City will retain the financial consultant, FCS Group, to perform a stormwater utility rate and System Development Charge (SDC) analysis to determine if the current stormwater rates and SDCs need to be adjusted to finance the recommended stormwater Capital Improvement Program. With respect to the maintenance and rehabilitation of the existing system, the plan includes a detailed Rehabilitation and Replacement Program.

Finding – Stormwater and Grading Design Standards: The technical design standards do not inherently use public funding; however, the facilities once built may become public facilities which are maintained by the public through Oregon City Public Works using funding as outlined through rates and system development charges related to the Stormwater Master Plan. In many cases, private development designs and constructs these facilities using private funding and after a two year maintenance period, the facilities become owned and maintained by the City.

Comp Plan Policy 11.1.2-Provide public facilities and services consistent with the goals, policies and implementing measures of the Comprehensive Plan, if feasible.

Finding – Stormwater Master Plan: As discussed in this staff report, the Master Plan provides guidance for the timely, efficient and economic provision of stormwater service within the existing city and to new development areas within the Urban Growth Boundary consistent with the relevant goals, policies and implementing measures of the Comprehensive Plan. The proposed Master Plan is consistent with this policy.

Finding – Stormwater and Grading Design Standards: The Stormwater and Grading Design Standards provide technical guidance to design and construct projects outlined in the Stormwater Master Plan. The Stormwater Master Plan is consistent with the policies and measures of the comprehensive plan; therefore, the Standards also are consistent with these policies by reference.

Comp Plan Policy 11.1.3-Confine urban public facilities and services to the city limits except where allowed for safety and health reasons in accordance with state land-use planning goals and regulations. Facilities that serve the public will be centrally located and accessible, preferably by multiple modes of transportation.

Finding – Stormwater Master Plan: Stormwater facilities are anticipated to be exclusively sited within city limits unless constrained by a unique or unanticipated situation.
Finding – Stormwater and Grading Design Standards: Stormwater and Grading Design Standards are only for use within the City Limits as stated within Chapter 1 of the Standards and as permitted through the City's MS4 permit.

Comp Plan Policy 11.1.4-Support development on underdeveloped or vacant buildable land within the city where public facilities and services are available or can be provided and where land-use compatibility can be found relative to the environment, zoning, and Comprehensive Plan goals.

Finding – Stormwater Master Plan: Chapter 7 of the Master Plan describes recommended Capital Improvement Projects for current and future needs to address water quality issues, capacity/flooding, asset management, and natural systems health. This analysis is based on future land use as shown on figure 2-6 and storm system capacity evaluation in Chapter 3. The analysis includes underdeveloped and vacant buildable land within the city and the urban growth boundary (See Figure ES-1). In most cases the extension of new stormwater services will occur in existing or planned public right-of-ways as part of development in accordance with applicable public works standards, land division laws and zoning regulations, including applicable environmental overlay district standards depending on where development occurs. The adopted city development code standards are sufficient to assure land use compatibility of proposed stormwater improvements are identified in the plan and are within the adopted land use categories in the City's Comprehensive Plan. The proposed Master Plan is consistent with this policy.

Finding – Stormwater and Grading Design Standards: The Stormwater and Grading Design Standards provide technical guidance for the design and construction of stormwater and grading improvements on underdeveloped and vacant land. The General Thresholds as outlined in section 1.2.1 provide cases when the Standards apply. Section 1.2.2 provides Exemptions for when the Standards do not apply.

Comp Plan Policy 11.1.5-Design the extension or improvement of any major public facility and service to an area to complement other public facilities and services at uniform levels.

Finding – Stormwater Master Plan: The Master Plan is designed to meet system services standards for existing and future development within the UGB. The review of the system needs includes review of the following:
2. Study Area Characteristics-
2.1 Location
2.2 Topography
2.3 Soils

2.4 Land Use
2.5 Climate and Rainfall
2.6 Natural Systems
2.7 Stormwater Infrastructure System
2.8 Recent Projects
2.9 Stormwater Program Management
3. Storm System Capacity Evaluation
3.1 Capacity Evaluation Approach
3.2 Problem Area Identification
3.3 Problem Area Classification
3.4 Levels of Service
3.5 Model Development Summary
3.6 Model Results
3.7 Capital Improvement Project Analysis
4. Storm System Condition Assessment
4.1 Background
4.2 System Assessment
4.3 Repair and Replacement Program
5. Water Quality/Retrofit Assessment
5.1 Water Quality Priorities
5.2 Water Quality Treatment Overview
5.3 Retrofit Evaluation
5.4 Water Quality/Retrofit Recommendations

Finding: These analyses reflect typical stormwater system industry standards. The plan includes a detailed analysis of levels of service and existing and projected stormwater demand within the UGB based on the City's comprehensive plan. Pursuant to these requirements, stormwater facilities are typically required to be extended to a new development area at the same time as other public facilities such as sanitary sewer, domestic water, and emergency services. The proposed Master Plan is consistent with this policy.

Finding – Stormwater and Grading Design Standards: The Standards are established to provide consistent uniform requirements for stormwater and grading improvements which are either private or public facilities.

Comp Plan Policy 11.1.7-Develop and maintain a coordinated Capital Improvements Plan that provides a framework, schedule, prioritization, and cost estimate for the provision of public facilities and services within the City of Oregon City and its Urban Growth Boundary.

Finding – Stormwater Master Plan: The plan includes a detailed Capital Improvements Program. The plan includes prioritization of capital improvement projects (CIPs) to serve capacity issues,

environmental benefits and benefits to the stormwater system, although the exact timing of these improvements is currently unknown. The plan also provides a discussion of the factors that will affect the timing of the rehabilitation and replacement program for existing facilities. The proposed Master Plan is consistent with this policy.
Finding – Stormwater and Grading Design Standards: The Design Standards do not relate to Capital Improvement Plans; therefore, Comp Plan Policy 11.1.7 does not apply.

Goal 11.4 Stormwater Management-
Comp Plan Goal 11.4 Stormwater Management-Seek the most efficient and economical means available for constructing, operating, and maintaining the City's stormwater management system while protecting the environment and meeting regional, state, and federal standards for protection and restoration of water resources and fish and wildlife habitat.

Finding – Stormwater Master Plan: A stormwater utility rate study and SDC analysis will be performed by the financial consultant to determine the most efficient and economic means to fund the Capital Improvement Program and the Repair and Replacement Program. The goal's central concept is that local governments should plan public services in accordance with the community's needs as a whole rather than be forced to respond to individual developments as they occur. As described in Section 5, the plan addresses meeting the regulatory requirements for protection of the fish and wildlife habitat by the implementation of the City's Stormwater and Grading Design Standards as described in the Finding below. The city is covered by an MS4 NPDES permit for stormwater discharges where evaluation is included to review the water quality treatment facilities across the city. The Oregon Department of Environmental Quality is required to conduct a water quality assessment of the state's water bodies every two years as part of the water quality standards program.

Finding – Stormwater and Grading Design Standards: Adoption of the Revised Stormwater and Grading Design Standards do not change what was approved in 2015 which ensured efficient and economical means available for constructing, operating, and maintaining the City's stormwater management system while protecting the environment and meeting regional, state, and federal standards for protection and restoration of water resources and fish and wildlife habitat. Design standards exist to guide developers and engineers how to provide stormwater management, conveyance, and grading. Design standards provide the technical guidance to design projects within a master plan or which are required based on thresholds directed by OCMC 13.12. The Design Standards provide the technical standards that do not change the degree by which the requirements are needed compared to the existing 2015 Stormwater and Grading Design Standards which precede this revision. Protection of properties, resources, and other items that are regulated by the Stormwater and Grading Design Standards do not reduce the protections to these systems in any way compared to the 2015 Standards that are currently adopted.

Comp Plan Policy 11.4.1-Plan, operate, and maintain the stormwater management system for all current and anticipated city residents within Oregon City's existing Urban Growth Boundary and plan strategically for future expansion areas.

Finding – Stormwater Master Plan: The purpose of updating the Master Plan is to assure that all current and anticipated city residents within the Urban Growth Boundary can receive a dependable and high-quality stormwater system as the city continues to develop. This includes maintenance, and where needed, upgrading the existing system as well as serving future expansion areas. The proposed Master Plan is consistent with this policy.

Finding – Stormwater and Grading Design Standards: Adoption of the Revised Stormwater and Grading Design Standards do not change what was approved in 2015 which explains in Chapter 8 how a Stormwater Management Facility is to be operated and maintained as referenced on OCMC 13.12.

Comp Plan Policy 11.4.2-Adopt "green streets" standards to reduce the amount of impervious surface and increase the use of bioswales for stormwater retention where practicable.

Finding – Stormwater Master Plan: As described in Section 5, implementing a green streets retrofit program for areas in need of additional treatment and opportunistically implementing along with roadway improvements by replacing landscape strips with stormwater planters to provide treatment for existing roadways and residential areas. The proposed Master Plan is consistent with this policy.

Finding – Stormwater and Grading Design Standards: Adoption of the Revised Stormwater and Grading Design Standards do not change what was approved in 2015 which describe site assessment and planning for stormwater management facilities which includes 'green' standards such as infiltration or bioswales and has a requirement for LID improvements (low impact development). The Design Standards do not specifically address 'green streets', only 'green' standards.

Comp Plan Policy 11.4.3-Ensure parking lot designs that mitigate stormwater impacts. Take measures to reduce waterflow and increase water absorption through the use of bioswales, vegetated landscaped islands with curb cuts to allow water inflow, and tree planting.

Finding – Stormwater Master Plan: Chapter 2 in the City's Stormwater and Grading Design Standards address site planning design objectives to reduce the impact of stormwater runoff from development including parking areas. Tables A-1 to A-3 in Appendix A from the Design Standards provide tree planting options through the use of stormwater planters, rain gardens and swales in parking areas.

Finding – Stormwater and Grading Design Standards: As described in the Finding above, the 2015 standards as well as the 2019 Update provide options for "LID Facilities". Adoption of the Revised Stormwater and Grading Design Standards do not change what was approved in 2015.

Comp Plan Policy 11.4.4-Maintain existing drainageways in a natural state for maximum water quality, water resource preservation, and aesthetic benefits.

Finding – Stormwater Master Plan: The Master Plan is intended to apply the City's Stormwater and Grading Design Standards which outline the City's stormwater quality and quantity related obligations and programs to provide a comprehensive review of the City based on current Design Standards to determine system deficiencies. One of the purposes of the Stormwater and Grading Design Standards is to minimize the introduction of pollutants and provide water quality treatment of stormwater runoff to preserve the beneficial uses of drainageways, lakes, ponds, wetlands, and other sensitive areas; however, the Master Plan does not further restrict or more fully allow any changes to the environment and infrastructure. It only addresses existing deficiencies based on the Stormwater and Grading Design Standards. Another purpose is to maintain the pre-development stormwater runoff characteristics to minimize effects on the drainageways such as sediment transport, erosion, and degradation generally associated with urbanization, through the use of Low Impact Development (LID) facilities and/or flow controls to address hydromodification. Projects are established by the Master Plan which were determined by an analysis of the City based on the Stormwater and Grading Design Standards. This project lists consists of capital projects like Scattering Canyon Stormwater Improvement and Coffee Creek Stream Restoration. The Scattering Canyon Project will enhance a current outfall and channel at the canyon to reduce erosion while addressing the lack of water quality and enhancing aesthetics. The Coffee Creek Project addresses flooding issues, the lack of water quality and providing stream stability to the existing drainageway.

Finding – Stormwater and Grading Design Standards: Adoption of the Revised Stormwater and Grading Design Standards do not change what was approved in 2015 which requires maintaining of existing drainageways, easements, water resource preservation, and water quality on conjunction with OCMC 13.12 and OCMC 17.49 . Chapter 3 refers to OCMC 17.49 and Chapter 5 refers to drainageways and easements while Chapter 8 refers to maintenance.

Comp Plan Policy 11.4.5-Design stormwater facilities to discharge surface water at pre-development rates and enhance stormwater quality in accordance with criteria in City of Oregon City Public Works Stormwater and Grading Design Standards.

Finding – Stormwater Master Plan: Part of the objective of the Master Plan is to design stormwater facilities in accordance with the criteria in City of Oregon City's Stormwater and Grading Design Standards. Chapter 4 in the Design Standards describes the methods and criteria for selecting and

designing stormwater management facilities for projects. A flow control requirement when discharging surface water shall be designed so that the duration of peak flow rates from post-development conditions shall be less than or equal to the duration of peak flow rates from pre-development conditions for all peak flows between 42 percent of the 2-year peak flow rate up to the 10-year peak flow rate. Water quality facilities shall be designed to capture and treat 80 percent of the average annual runoff volume to the MEP with the goal of 70 percent total suspended solids removal.

Finding – Stormwater and Grading Design Standards: Adoption of the Revised Stormwater and Grading Design Standards do not change what was approved in 2015 which describes how stormwater facilities shall discharge surface water at pre-development rates and enhance stormwater quality. Stormwater Management requirements and exemptions are stated in Chapter 1.

Comp Plan Policy 11.4.6-Regularly review and update the above standards to reflect evolving stormwater management techniques, maintenance practices, and environmental compatibility.

Finding – Stormwater Master Plan: Stormwater Management Implementation Plan establishes an annual program to inspect and assess the condition of the City's infrastructure and set the City up with a greater understanding of the system and the areas in need of imminent repair and replacement. Along with the implementation plan, current and future regulations and design standards will aid in ensuring that new development and redevelopment do not exacerbate any existing problems or place new stresses on the current system. Chapter 8 in the Stormwater and Grading Design Standards describes the requirement to perform regular maintenance to all stormwater management facilities.

Finding – Stormwater and Grading Design Standards: This revision of the 2015 Standards is to provide clarification to the existing standards where they have not been clear to staff and the development community. OCMC 13.12 provides direction to the City Commission to adopt updated standards from time to time. The goal of the update is to provide clarification and correct any errors within the Standards.

Comp Plan Policy 11.4.7-Provide stormwater management services and monitor, report and evaluate success of the services consistent with the NPDES MS-4 permit requirements.

Finding – Stormwater Master Plan: Section 2 of the Master Plan describes the City's Stormwater Program Management services that includes maintenance and programmatic stormwater activities. Program implementation is documented annually in the City's NPDES MS4 permit annual report. The evaluation of stormwater discharge is included to review the water quality treatment facilities across the city under the NPDES MS4 permit. The Oregon Department of Environmental Quality is required to conduct a water quality assessment of the state's water bodies every two years as part of the water quality standards program. The proposed Master Plan is consistent with this policy.

Finding – Stormwater and Grading Design Standards: See above Finding. The Design Standards themselves do not apply to Comp Plan Policy 11.4.7. The NPDES requirements of the MS4 permit is what makes the City required to follow this Comp Plan Policy.

STATEWIDE PLANNING GOAL 1:
To develop a citizen involvement program that insures the opportunity for citizens to be involved in all phases of the planning process.
Finding: Complies as Proposed. This goal is implemented through the applicable Goals and Policies in Section 1 of the Oregon City Comprehensive Plan: Citizen Involvement. Development of the plan included an public involvement effort. The applicant, Oregon City Public Works Department, has presented the update for input to the Development Stakeholders Group on May 9, 2019. The update was provided on the City's website during the months of February through May 2019. Local civil engineering consultants and developers were notified via email on February 5, 2019 and April 24, 2019. The standards were presented in a City Commission Work Session on May 7, 2019. The City Commission considered these standards for approval on July 17, 2019.

STATEWIDE PLANNING GOAL 2:
To establish a land use planning process and policy framework as a basis for all decision and actions related to use of land and to assure an adequate factual base for such decisions and actions.
Finding: Complies as Proposed. This goal is implemented through the applicable Goals and Policies in Section 2 of the Oregon City Comprehensive Plan: Land Use. Because the plan is an ancillary document to the City's Comprehensive Plan, the application was processed pursuant to the legislative hearing process outlined in Section 17.50.170 of the Oregon City Municipal Code.

STATEWIDE PLANNIG GOAL 3: Agricultural Lands and GOAL 4: Forest Lands
Finding: Not Applicable. By definition, Oregon City does not have rural resource lands such as for agricultural or forest use within its city limits or UGB and therefore those goals are not applicable.

STATEWIDE PLANNING GOAL 5:
To protect natural resources and conserve scenic and historic areas and open spaces.
Finding: Complies as Proposed. This goal is implemented through the applicable Goals and Policies in Section 5 of the Oregon City Comprehensive Plan: Open Spaces, Scenic and Historic Areas, and Natural Resources. The Oregon City Municipal Code contains review criteria for uses within overlay districts to assure that designated Goal 5 resources are appropriately considered when development is proposed. In particular, the Natural Resource Overlay District designation: "provides a framework for protection of Metro Titles 3 and 13 lands, and Statewide Planning Goal 5 resources within Oregon City. The Natural Resource Overlay District (NROD) implements the Oregon City Comprehensive Plan Natural Resource Goals and Policies, as well as Federal Clean Water Act requirements for shading of streams and reduction of water temperatures, and the recommendations of the Metro ESEE Analysis.

Regardless of the proposed amendments, the applicability of the Natural Resource Overlay District is the same. Addition of new impervious area within the NROD will be required to undergo review per Chapter 17.49 of the Oregon City Municipal code. Mitigation will be required for any new impervious surface added.

Stormwater facility development within historic districts or on landmarks are reviewed for compliance with OCMC 17.40 Historic Overlay District and the Design Guidelines for New Construction.

STATEWIDE PLANNING GOAL 6:
To maintain and improve the quality of the air, water and land resources of the state.
Finding: Complies as Proposed. This goal is implemented through the applicable Goals and Policies in Section 6 of the Oregon City Comprehensive Plan: Quality of Air, Water and Land Resources. By planning system improvements based on projected demand and land use patterns, the plan will ensure that land suited for development will be served efficiently. All new development will be subject to the City's Natural Resource Overlay District standards and erosion control standards, which implement state and local water quality standards.

STATEWIDE PLANNING Goal 7:
To protect life and property from natural disasters and hazards.
Finding: Not Applicable. This proposal does not change any regulations related to natural hazards in Oregon City, including Geologic Hazard and floodplain overlay districts.

STATEWIDE PLANNING GOAL 8:
To satisfy the recreational needs of the citizens of the state and visitors, and, where appropriate, to provide for the siting of necessary recreational facilities including destination resorts.
Finding: Not Applicable. This proposal does not affect any parks or recreation facilities in Oregon City.

STATEWIDE PLANNING GOAL 9:
To provide adequate opportunities throughout the state for a variety of economic activities vital to the health, welfare, and prosperity of Oregon's citizens.
Finding: Complies as Proposed. The adoption of these standards will allow the City to approve new development in the area that contributes to economic vitality.

STATEWIDE PLANNING Goal 10:
To provide for the housing needs of citizens of the state.
Finding: Complies as Proposed. This proposal allows for greater housing opportunities by creating a clear and objective process for reviewing and approving stormwater facilities relating to housing development.

STATEWIDE PLANNING GOAL 11:
To plan and develop a timely, orderly and efficient arrangement of public facilities and services to serve as a framework for urban and rural development.
Finding: Complies as Proposed. This goal is implemented through the applicable Goals and Policies in Section 11 of the Oregon City Comprehensive Plan: Public Facilities. As stated in Section 11, the Master Plan is necessary to maintain compliance with Statewide Planning Goal 11, Public Facilities. Goal 11 requires that public facilities and services be provided in a timely, orderly and efficient manner. The goal's central concept is that local governments should plan public services in accordance with the community's needs as a whole rather than be forced to respond to individual developments as they occur. This includes stormwater service. As shown in the findings below, the proposed update of the Stormwater Master Plan is consistent with Goal 11.1.

The Design Standards were created to serve the health, safety, education, welfare, and recreational needs of all Oregon City residents through the planning and provision of adequate public facilities. Public Facilities include, but are not limited to, stormwater detention, stormwater management areas, swales, ponds, storm sewers and appurtenances. These public facilities are designed by the technical standards found within the Stormwater and Grading Design Standards which were prepared to improve water

quality, reduce flooding, convey stormwater to safe appropriate areas, prevent stagnation, and provide signage and fencing for education and safety where appropriate.

STATEWIDE PLANNING GOAL 12:
To provide and encourage a safe, convenient and economic transportation system.
Finding: Complies as Proposed. This goal is implemented at the local level through the applicable Goals and Policies in the updated TSP, Section 2 (The Vision). This goal is also implemented at the state level through the Transportation Planning Rule (TPR), OAR 660-012. Creating a clear and objective process for reviewing and approving stormwater facilities relating to transportation development, provides the city and residents with additional cost details needed to make complicated transportation decisions.

STATEWIDE PLANNING GOAL 13: To conserve energy.
Land and uses developed on the land shall be managed and controlled so as to maximize the conservation of all forms of energy, based upon sound economic principles.
Finding: Complies as Proposed. This goal is implemented through the applicable Goals and Policies in Section 13 of the Oregon City Comprehensive Plan: Energy Conservation. The city promotes the efficient use of land and conservation of energy through its Comprehensive Plan and Zoning Code and through the implementation of public facility improvements and building codes. Higher density and mixed use zoning, land division, and site plan design standards promote more compact development patterns, and promote bicycling and walking instead of relying on the automobile for routine errands. New annexations are required to show that public utilities can be efficiently extended to new urban areas. Metro-approved Concept Plans are required prior to annexation to the city to assure that urban services and amenities will be developed in logical places as the community develops. Building codes require that new homes and businesses conserve energy through choice of materials, insulation, and installation of efficient plumbing, heating and cooling systems. The proposed stormwater and grading standards will assure that public facilities are efficiently used and that energy is conserved. Finally, The creation of green street standards and requirements of Low Impact Stormwater Development in the stormwater analysis look for approaches that do not overbuild infrastructure when not needed.

CHAPTER 17.50 ADMINISTRATION AND PROCEDURES

17.50.030 Summary of the City's Decision-Making Processes.
Finding: Complies as Proposed. The proposed Legislative application is being reviewed pursuant to the Type IV process. Notice was posted online and posted in the paper.

17.50.050 Preapplication Conference
A. Preapplication Conference. Prior to submitting an application for any form of permit, the applicant shall schedule and attend a preapplication conference with City staff to discuss the proposal. To schedule a preapplication conference, the applicant shall contact the Planning Division, submit the required materials, and pay the appropriate conference fee. At a minimum, an applicant should submit a short narrative describing the proposal and a proposed site plan, drawn to a scale acceptable to the City, which identifies the proposed land uses, traffic circulation, and public rights-of-way and all other required plans. The purpose of the preapplication conference is to provide an opportunity for staff to provide the applicant with information on the likely impacts, limitations, requirements, approval standards, fees and other information that may affect the proposal. The Planning Division shall provide the applicant(s) with the identity and contact persons for all affected neighborhood associations as well as a written summary of the preapplication conference. Notwithstanding any representations by City staff at a preapplication conference, staff is not authorized to waive any requirements of this code, and

any omission or failure by staff to recite to an applicant all relevant applicable land use requirements shall not constitute a waiver by the City of any standard or requirement.
B.A preapplication conference shall be valid for a period of six months from the date it is held. If no application is filed within six months of the conference or meeting, the applicant must schedule and attend another conference before the city will accept a permit application. The community development director may waive the preapplication requirement if, in the Director's opinion, the development does not warrant this step. In no case shall a preapplication conference be valid for more than one year.
Finding: Complies as Proposed. On February 13, 2018, a pre-application meeting was held. The application was filed with the City within one year of the pre-application meeting. These criteria are met.

17.50.055 Neighborhood Association Meeting
Finding: Complies as Proposed. This is a citywide application, no specific neighborhood association was identified and is not required with the code that as in affect in January 31, 2019

17.50.060 Application Requirements.
Finding: Complies as Proposed. All application materials required are submitted with this narrative.

17.50.070 Completeness Review and 120-day Rule.
Finding: Complies as Proposed. This is a Legislative Decision, there is not 120 day deadline for making a final city decision.

17.50.080 Complete Application--Required Information.
Finding: Complies as Proposed. This land use application was submitted on January 31, 2019
The application was deemed complete on August 27, 2019

17.50.090 Public Notices.
Finding: Complies as Proposed. Posted on the Oregon City website and in a general circulation newspaper. Staff provided email transmittal or the application and notice to affected agencies, and to all Neighborhood Associations requesting comment.

17.50.100 Notice Posting Requirements.
Finding: Complies as Proposed. No signs were posted as there is no specific property involved for this proposed Legislative amendment.

RECOMMENDATION
Based on the findings identified above, the proposal to amend Stormwater Master Plan and Stormwater Grading and Design Standards appears to comply with the review criteria. Staff recommends approval of Planning file GLUA 19-00002: LEG 19-00001 & LEG 19-00005.

EXHIBITS
1) Applicant's Submittal
2) Draft Stormwater Master Plan
3) Draft Stormwater Grading and Design Standards

OREGON CITY

Community Development – Planning

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LAND USE APPLICATION FORM

Type I (OCMC 17.50.030.A)	Type II (OCMC 17.50.030.B)	Type III / IV (OCMC 17.50.030.C)
❑ Compatibility Review	❑ Detailed Development Review	❑ Annexation
❑ Lot Line Adjustment	❑ Geotechnical Hazards	❑ Code Interpretation / Similar Use
❑ Non-Conforming Use Review	❑ Minor Partition (<4 lots)	❑ Concept Development Plan
❑ Natural Resource (NROD) Verification	❑ Minor Site Plan & Design Review	❑ Conditional Use
❑ Site Plan and Design Review	❑ Non-Conforming Use Review	☑ Comprehensive Plan Amendment (Text/Map)
❑ Extension of Approval	❑ Site Plan and Design Review	❑ Detailed Development Plan
	❑ Subdivision (4+ lots)	❑ Historic Review
	❑ Minor Variance	❑ Municipal Code Amendment
	❑ Natural Resource (NROD) Review	❑ Variance
		❑ Zone Change

File Number(s): _____

Proposed Land Use or Activity: Stormwater Master Plan Update

Project Name: Stormwater Master Plan Update Number of Lots Proposed (If Applicable): N/A

Physical Address of Site: N/A

Clackamas County Map and Tax Lot Number(s): N/A

Applicant(s):

Applicant(s) Signature: _____

Applicant(s) Name Printed: John M. Lewis Date: 1/31/2019

Mailing Address: 625 Center Street Oregon City, OR 97045

Phone: (503) 496-1545 Fax: N/A Email: jmlewis@orcity.org

Property Owner(s):

Property Owner(s) Signature: _____

Property Owner(s) Name Printed: Anthony J. Konkol, III Date: 1/31/2019

Mailing Address: 625 Center Street Oregon City, OR 97045

Phone: (503) 657-0891 Fax: N/A Email: tkonkol@orcity.org

Representative(s):

Representative(s) Signature: _____

Representative (s) Name Printed: N/A Date: N/A

Mailing Address: N/A

Phone: N/A Fax: N/A Email: N/A

All signatures represented must have the full legal capacity and hereby authorize the filing of this application and certify that the information and exhibits herewith are correct and indicate the parties willingness to comply with all code requirements.

APPLICANT SUBMITTAL

FILE NO.: Adoption of a New Stormwater Master Plan and revised Stormwater and Grading Design Standards

APPLICANT: Oregon City Public Works Department
John Lewis, P.E., Public Works Director
Bob Balgos, P.E., Project Engineer
Josh Wheeler, P.E., Assistant City Engineer
625 Center Street, Oregon City, Oregon 97045

REPRESENTATIVE: Brown and Caldwell, Consulting Engineers
6500 SW Macadam Avenue, Suite 200, Portland, OR 97239

REQUEST: Update of the Stormwater Master Plan and Revised Stormwater and Grading Design Standards

LOCATION: City-wide.

Introduction

Stormwater management is a key element in maintaining and enhancing livability within the City of Oregon City (City). There is a direct link between stormwater runoff and the City's surface and ground water quality and quantity. As land is developed, creation of new impervious surfaces and loss of vegetation increases stormwater runoff during rainfall events, altering the natural hydrologic cycle. Without stormwater management, the increase in flows erodes stream channels and limits groundwater recharge. In addition, runoff that flows over roadways, parking areas, rooftops, and other impervious surfaces collects pollutants that are transported within the watershed to streams, rivers, and groundwater resources. Properly managing stormwater is vital to protecting our water resources for a great number of uses, including fish and wildlife habitat, recreation, and drinking water.

The City of Oregon City is seeking to adopt a new Stormwater Master Plan (SMP or Master Plan) to supersede all previously adopted city-wide and basin-specific drainage plans. The SMP identifies drainage system deficiencies and improvements necessary to address these deficiencies as capital improvements necessary to accommodate growth. The SMP will guide the City in planning for and expending funds allowing for orderly and efficient stormwater system improvements throughout the City and to the bounds of the urban growth boundary.

The City of Oregon City is also seeking to amend its 2015 Stormwater and Grading Design Standards (Design Standards). The Design Standards prescribe standards for the planning and design stormwater conveyance and management systems. As required by City Code, the Design Standards apply to the development of all public and private projects throughout the City.

The new SMP assumes that all future stormwater improvements will be developed consistent with the Design Standards.

The scope of the amendments to the Design Standards is limited to providing greater clarification and instruction to applicants in ways that is entirely consistent with the City's current implementation practices. No changes in applicable land uses prescribed by zoning regulations are proposed. Therefore, the Standards and the Master Plan do not allow any uses which are more intensive than currently allowed today. Rather, the update of the Plan and the Standards will allow the City to have plans and standards in place which will allow the City to manage present and future stormwater needs as development occurs.

Stormwater Master Plan

The City of Oregon City (City) developed the citywide Master Plan to guide stormwater-related priorities and capital improvement projects (CIPs) over the next 10 to 15 years.

The City is currently managing more than 174 miles of stormwater infrastructure, including significant areas of aging systems. At the same time, development rates and projections indicate that the stormwater system will require continued expansion to accommodate future growth. The City's previous Drainage Master Plan was completed in 1988 and is no longer relevant following nearly 30 years of development across the city. The City needs a proactive plan to address immediate capacity needs, replace aging infrastructure, and provide regional solutions to larger flooding and water quality challenges. The updated CIP list, adopted as part of the Master Plan, and selected programmatic approaches included in this Master Plan will facilitate a prioritization of the City's resources and support future resource and financial planning.

Examples of recommended Capital Improvement Projects from the CIP list are:

- John Adams Basin Capacity Improvements to alleviate flooding and replace aging infrastructure. The storm pipes in this basin are among the oldest in the City and well past their expected life.
- Rivercrest Neighborhood Infrastructure Improvements to address an insufficient storm drain system. Portions of the neighborhood currently conveys stormwater into the sanitary system.

- The Cove Water Quality Improvements to address water quality. Stormwater entering Clackamette Cove is primarily runoff from industrial, commercial and other land use that can generate high pollutant loads. The areas were developed prior to water quality requirements, so the discharge entering the cove is primarily untreated.
- Newall Canyon Outfall Assessment to evaluate the stormwater outfalls in the Newall Canyon area. This area has several locations where erosion, bank sloughing and landslides have occurred during and following storm events. The assessment will identify significant problem locations and concept plans will be developed to stabilize degrading systems

The Master Plan documents the means and methods used to evaluate the City's drainage infrastructure and natural systems. Results of the evaluations conducted provide the City with CIPs and programmatic stormwater actions for implementation. The study area for this Master Plan covers drainage areas to receiving water bodies including Abernethy Creek, the Clackamas River, Beaver Creek, and the Willamette River.

Upon approval, this Stormwater Master Plan shall be incorporated as ancillary to the Oregon City Comprehensive Plan.

Stormwater and Grading Design Standards

The City of Oregon City developed updated Stormwater and Grading Design Standards in 2015. These standards updated existing standards from 1999. The updated standards were created to change the methodology of stormwater requirements from peak flow modeling to flow duration modeling.

This revision of the 2015 Standards is to provide clarification to the existing standards where they have not been clear to staff and the development community. Examples of clarifications include:

- Replacing the Natural Resource notation from the abbreviation WQRA to the abbreviation NROD which is consistent with the references to natural resource areas in OCMC 17.49.
- More clearly define the exemptions from the stormwater requirements in 1.2.2 by providing further description and additional language.
- Changing the Checklist obligation to set forth a preliminary design checklist rather than a planning checklist to be in line with how engineers talk about this section of the standards.
- Clarify the stormwater management strategy hierarchy in Figure 2-2 that better explains how a designer should prioritize stormwater management options and alternatives.
- Explain how to use the BMP sizing tool for underground stormwater management.
- Change the minimum velocity requirements of storm sewers to be consistent with the Oregon Department of Transportation standards.

The City Commission has the ability to adopt revisions to these Standards as provided by OCMC 13.12.020.

The Standards also exist to keep the City in compliance with the National Pollution Discharge Elimination System Municipal Separate Storm and Sewer System (NPDES) MS-4 Permit which the City has been operating under since 1996.

Stormwater Master Plan Objectives

The goal of this Master Plan is to provide guidance in planning and designing stormwater conveyance and managing infrastructure to protect the natural and built environment for the next 10 to 15 years. The primary method for guidance is through a prioritized CIP list. This Master Plan is intended to be used in conjunction with both the City's National Pollutant Discharge Elimination System (NPDES) municipal separate storm sewer system (MS4) permit, and Stormwater Grading and Design Standards, which outline the City's stormwater quality and quantity related obligations and programs. The NPDES MS4 permit requires the City to implement a Stormwater Management Plan (SWMP1) that outlines programmatic water quality best management practices (BMPs) to reduce pollutants in urban stormwater discharges to receiving waters.

The City's Stormwater Grading and Design Standards require developers to address stormwater quality and quantity impacts associated with new development and redevelopment activities. In addition to addressing aging infrastructure, future growth, water quality, flooding, and capacity issues, the City values the natural systems and spaces available to the community. Protecting and maintaining a healthy environment is important to maintaining a livable and healthy city. This Master Plan was developed to support the City's healthy management of these resources, including natural channel and riparian areas, habitat, and water bodies with beneficial uses such as fishing and recreation.

Stormwater and Grading Design Standards Objectives

The goal of the update is to provide clarification and correct errors within the Standards.

Consistency with Oregon City Comprehensive Plan

The 2004 Oregon City Comprehensive Plan calls for the periodic review and updating of the Comprehensive Plan and contains criteria for approving changes to the comprehensive plan. See p 16. . Review of the comprehensive plan should consider:

1. *Plan implementation process.*
2. *Adequacy of the Plan to guide land use actions, including an examination of trends.*

3. *Whether the Plan still reflects community needs, desires, attitudes and conditions. This shall include changing demographic patterns and economics.*
4. *Addition of updated factual information including that made available to the City of regional, state and federal governmental agencies.*

1. Plan implementation process.

Finding – Stormwater Master Plan: The applicant, Oregon City Public Works Department, has presented the update for input by the Citizen Involvement Committee, engineering community, Planning Commission and City Commission in accordance with the recommended method described in the Comprehensive Plan and pursuant to the applicable process described in Oregon City Municipal Code section 17.50.170. The plan implementation process is consistent with the Comprehensive Plan.

Finding – Stormwater and Grading Design Standards: The applicant, Oregon City Public Works Department, has presented the update for input to the Development Stakeholders Group on May 9, 2019. The update was provided on the City's website during the months of February through May 2019. Local civil engineering consultants and developers were notified via email on February 5, 2019 and April 24, 2019. The standards were presented in a City Commission Work Session on May 7, 2019. The City Commission considered these standards for approval on July 17, 2019. These standards will also be presented before the Planning Commission in October 2019 prior to approval by the City Commission.

2. Adequacy of the Plan to guide land use actions, including an examination of trends.

Finding – Stormwater Master Plan: As an ancillary document to the Comprehensive Plan, the updated Master Plan provides an analysis of existing stormwater facilities and provides direction for future development, funding and needs. The plan provides a comprehensive review of the stormwater system and provides an adequate guide for future land use actions and the development of criteria to be utilized in development review.

The update includes updated construction cost estimates and contingencies for the planning and design of recommended stormwater system facilities for the City (See Appendix H).

Adoption of the document will assist with the guidance of land use actions and responds to new requirements for improved stormwater management as discussed above.

Finding – Stormwater and Grading Design Standards: The Standards created in 2015 were in response to the City's MS-4 Permit under the NPDES regulations. The Standards also moved to a Flow Duration model rather than Peak Stormwater Model to follow trends in climate as well as modeling trends in the

region. In 2015, Clackamas County's Department of Water Environment Services developed a BMP Sizing Tool for Flow Duration Stormwater Modeling. The City of Wilsonville and Oregon City adopted this tool and stormwater modeling method. That tool has or its regulations have not been changed with this 2019 Update of the Stormwater and Grading Design Standards.

The revised Standards also update the terminology of a Natural Resource Area from WQRA (Water Quality Resource Area) to NROD (Natural Resource Overlay District) to be consistent with City Code 17.49 as well as OCMC 13.12.

3. *Whether the Plan still reflects community needs, desires, attitudes and conditions. This shall include changing demographic patterns and economics.*

Finding – Stormwater Master Plan: As part of this effort, the consultant conducted technical analyses of the City's existing storm design standards. Since the manual is strictly an engineering document, any changes in demographic patterns and economics are reflected in the design requirements. For example, the stormwater design requirements for a dense multi-family development will differ from those for a low-density single-family residential lot. Adoption of the Stormwater and Grading Design Standards Manual will address necessary improvements to ensure the orderly review of stormwater, drainage and erosion control management to accommodate the projected growth envisioned in the City's Comprehensive Plan.

Finding – Stormwater and Grading Design Standards: As the Update to the Design Standards are for clarification and errors, not change in the actual technical standards, the Finding above for the Stormwater Master Plan also applies as a Finding to the Design Standards. With no structural changes in the Standards, the edits would not have any impact to demographic changes in the community.

4. *Addition of updated factual information including that made available to the City of regional, state and federal governmental agencies.*

Finding – Stormwater Master Plan: The consultant has included an analysis of the existing stormwater system based on available existing information provided by the City.

The projections of stormwater demand for existing and future service areas reflect updated population projections, recent comprehensive plan amendment areas (Park Place concept area and Beavercreek Road concept area), and new regulatory requirements at the state and federal level.

The City of Oregon City maintains benchmarks for service quality that are used to measure performance of the stormwater utility. The service standards set forth in this master plan are derived from

regulations, rules, and recommendations established by a variety of sources including the Environmental Protection Agency (EPA).

The Master Plan includes updated criteria based on the direct requirements of the City's existing NPDES MS4 permit. The addition of this updated information will allow the City to keep the Stormwater Master Plan current.

Finding – Stormwater and Grading Design Standards: The 2015 Standards were created based on the direct requirements of the City's existing NPDES MS4 permit. The 2019 Update provides no technical changes, only clarification, and remain in line with the requirements of the MS4 permit.

"Ancillary Plans. – Page 15

Since 1982, several documents have been adopted as ancillary to the 1982 Comprehensive Plan: the *Public Facilities Plan* (1990), *Oregon City Transportation System Plan* (2001), *Oregon City Downtown Community Plan* (1999), *Oregon City Waterfront Master Plan* (2002), *City of Oregon City Water Master Plan* (2003), *City of Oregon City Sanitary Sewer Master Plan* (2003), *Drainage Master Plan* (1988, updated in 1999 as the *City of Oregon City Public Works Stormwater and Grading Design Standards*), *Caufield Basin Master Plan* (1997), *South End Basin Master Plan* (1997), *Molalla Avenue Boulevard and Bikeway Improvements Plan* (2001), the *Oregon City Park and Recreation Master Plan* (1999), and the *Oregon City Trails Master Plan* (2004)."

*Note that the references to the updated master plan documents, including the Stormwater Master Plan proposed here will be updated with the future revision to the Comprehensive Plan.

Goal 5.4 Natural Resources

Identify and seek strategies to conserve and restore Oregon City's natural resources, including air, surface and subsurface water, geologic features, soils, vegetation, and fish and wildlife, in order to sustain quality of life for current and future citizens and visitors, and the long-term viability of the ecological systems.

Policy 5.4.1

Conserve and restore ecological structure, processes and functions within the city to closely approximate natural ecosystem structure, processes, and functions.

Finding – Stormwater Master Plan: Section 2 of the Master Plan identifies the natural systems within the City and describes the condition of these systems through assessments. Section 6 of the Master Plan outlines the assessments and field evaluations leading to capital project recommendations to address

hydromodification, stream stability, water quality and flooding. The recommended capital projects in the Master Plan assume application of the City's Stormwater and Grading Design Standards which sets forth the requirements as described briefly in the Finding below. As a result, the proposed Master Plan will help to protect and conserve existing natural areas consistent with this policy.

Finding – Stormwater and Grading Design Standards: The introduction of the Stormwater and Grading Design Standards states the goal of these standards is to provide local engineers, developers, builders, and City staff clear guidance in planning and designing stormwater conveyance and management systems that are appropriate to the local climate, hydrogeology, and geology. The General Thresholds in section 1.2.1 of the Standards requires development within a Natural Resource Overlay District (NROD) follow certain guidelines. These guidelines were established in the 2015 adopted standards and have not been changed as part of this revision. Therefore, these Standards will continue to protect and conserve existing natural areas.

Policy 5.4.8

Conserve natural resources that have significant functions and values related to flood protection, sediment and erosion control, water quality, groundwater recharge and discharge, education, vegetation and fish, and wildlife habitat.

Finding – Stormwater Master Plan: Section 2 of the Master Plan identifies the natural systems within the City and describes the condition of these systems through assessments. Section 6 of the Master Plan outlines the assessments and field evaluations leading to capital project recommendations to address hydromodification, stream stability, water quality and flooding. One recommended capital project for example is the Newell Canyon Outfall Assessment. The project will require further study to identify significant problem locations where erosion, bank sloughing and landslides have occurred during heavy storm events. The study will lead to a development of concept plans to stabilize the degrading systems. The recommended capital projects in the Master Plan is intended to apply the City's Stormwater and Grading Design Standards which sets forth the requirements as described briefly in the Finding below. The proposed Master Plan is consistent with this policy.

Finding – Stormwater and Grading Design Standards: The introduction of the Stormwater and Grading Design Standards states the goal of these standards is to provide local engineers, developers, builders, and City staff clear guidance in planning and designing stormwater conveyance and management systems that are appropriate to the local climate, hydrogeology, and geology. The General Thresholds in section 1.2.1 of the Standards requires development within a Natural Resource Overlay District (NROD) should follow certain guidelines. The general design requirements establish water quality standards, stormwater management strategies, and LID Design criteria to protect the local environment. These guidelines were established in the 2015 adopted standards and have not been changed as part of this revision. Therefore, upon amendment, these Standards will remain consistent with this policy.

Policy 5.4.9

Protect and enhance riparian corridors along streams in Oregon City to increase shade, reduce streambank erosion and intrusion of sediments, and provide habitat for a variety of plants, animals, and fish.

Finding – Stormwater Master Plan: Section 2 of the Master Plan identifies the natural systems within the City and describes the condition of these systems through assessments. Section 6 of the Master Plan outlines the assessments and field evaluations leading to capital project recommendations to address hydromodification, stream stability, water quality and flooding. The recommended capital projects in the Master Plan is intended to apply the City's Stormwater and Grading Design Standards which sets forth the requirements as described briefly in the Finding below. The proposed Master Plan is consistent with this policy.

Finding – Stormwater and Grading Design Standards: The introduction of the Stormwater and Grading Design Standards states the goal of these standards is to provide local engineers, developers, builders, and City staff clear guidance in planning and designing stormwater conveyance and management systems that are appropriate to the local climate, hydrogeology, and geology. The General Thresholds in section 1.2.1 of the Standards requires development within a Natural Resource Overlay District (NROD) should follow certain guidelines. The general design requirements establish water quality standards, stormwater management strategies, and LID Design criteria to protect the local environment. Water Quality Requirements are also provided. These guidelines and requirements were established in the 2015 adopted standards and have not been changed as part of this revision. Therefore, upon amendment, these Standards will remain consistent with this policy.

Policy 5.4.12

Use a watershed-scale assessment when reviewing and planning for the potential effects from development, whether private or public, on water quality and quantity entering streams.

Finding – Stormwater Master Plan: Chapter 5 of Stormwater and Grading Design Standards address the requirements of a downstream analysis from development whether private or public. The Master Plan is intended to apply the City's Stormwater and Grading Design Standards which sets forth the requirements as described in the Finding below. The proposed Master Plan is consistent with this policy.

Finding – Stormwater and Grading Design Standards: The introduction of the Stormwater and Grading Design Standards states the goal of these standards is to provide local engineers, developers, builders, and City staff clear guidance in planning and designing stormwater conveyance and management systems that are appropriate to the local climate, hydrogeology, and geology. The general thresholds in section 1.2.1 provide direction on when the requirements apply to a project. The general design

requirements establish water quality standards, stormwater management strategies, and LID Design criteria to protect the local environment. Water Quality Requirements are also provided. A downstream analysis of existing systems is required these Standards. These guidelines and requirements were established in the 2015 adopted standards and have not been changed as part of this revision. Therefore, upon amendment, these Standards will remain consistent with this policy.

Policy 5.4.13

Adopt and/or establish standards for all new development that promote the use of pervious surfaces and prevent negative ecological effects of urban storm- water runoff on streams, creeks and rivers.

Finding – Stormwater Master Plan: Chapter 4 of Stormwater and Grading Design Standards describes the methods and criteria for selecting and designing stormwater management facilities including impervious area reduction techniques for all new development. The Master Plan is intended to apply the City's Stormwater and Grading Design Standards which sets forth the requirements as described in the Finding below. The proposed Master Plan is consistent with this policy.

Finding – Stormwater and Grading Design Standards: The Standards provide a Stormwater Management Strategy Hierarchy which promotes the use of infiltration and Best Management Practice (BMP) solutions. This section of the Standards was revised to provide clarity and explanation to the existing adopted standards from 2015. The revision only provides clarity and does not add to or change the intent of the existing standards. Therefore, upon amendment, these Standards will remain consistent with this policy.

Policy 5.4.16

Protect surfacewater quality by:

- providing a vegetated corridor to separate protected water features from development
- maintaining or reducing stream temperatures with vegetative shading
- minimizing erosion and nutrient and pollutant loading into water
- providing infiltration and natural water purification by percolation through soil and vegetation

Finding – Stormwater Master Plan: Section 5 of the Master Plan describes water quality priorities, retrofit evaluations and the regulatory requirements of the NPDES MS4 Permit. The Master Plan identifies areas of water quality deficiencies within the City and provides recommended capital projects and the continuing use of programmatic actions. The Master Plan is intended to apply the City's Stormwater and Grading Design Standards which outline the City's stormwater quality and quantity related obligations and programs. The proposed Master Plan is consistent with this policy.

Finding – Stormwater and Grading Design Standards: The Standards provide a Stormwater Management Strategy Hierarchy which promotes the use of infiltration and Best Management Practice

(BMP) solutions. Note that the highest priority of the hierarchy is infiltration and the use of vegetated areas. Amendments are proposed for this section to provide clarity and explanation to the existing adopted standards from 2015. The revision only provides clarity and does not add to or change the intent or the City's practice of applying these existing standards. The Stormwater BMP Selection Guidance for Site Conditions Table 4-1 provides BMP solutions and alternatives. This table was not revised as part of this update. The Standards state a site must meet a specific water quality requirement that was adopted as part of the 2015 Standards. This revision does not change that requirement. The Standards provide a reference to the City of Oregon City Public Works Erosion and Sediment Control Standards. No change was made to this Standard as part of these revisions. Appendix A exists within the standards to provide guidance on facility plantings with plant lists and diagrams. This Appendix was revised for clarification and constructability and did not receive any structural changes, deletions or additions.

Goal 6.2 Water Quality

Control erosion and sedimentation associated with construction and development activities to protect water quality.

Policy 6.2.1

Prevent erosion and restrict the discharge of sediments into surface- and groundwater by requiring erosion prevention measures and sediment control practices.

Finding – Stormwater Master Plan: The Master Plan is intended to apply the City's Stormwater and Grading Design Standards. These standards provide a reference to the City of Oregon City Public Works Erosion and Sediment Control Standards in Chapter 7. The proposed Master Plan is consistent with this policy.

Finding – Stormwater and Grading Design Standards: The Standards provide a reference to the City of Oregon City Public Works Erosion and Sediment Control Standards in Chapter 7. No change was made to this Standard as part of these revisions. Therefore, upon amendment, these Standards will remain consistent with this policy.

Policy 6.2.2

Where feasible, use open, naturally vegetated drainage ways to reduce stormwater and improve water quality.

Finding – Stormwater Master Plan: Chapter 2 of Stormwater and Grading Design Standards describe the City's Stormwater Management Hierarchy Strategy whereas the highest priority is infiltration and use of vegetated areas. The Master Plan is intended to apply the City's Stormwater and Grading Design Standards which sets forth the requirements as described in the Finding below. The proposed Master Plan is consistent with this policy.

Finding – Stormwater and Grading Design Standards: The Standards provide a Stormwater Management Strategy Hierarchy which promotes the use of infiltration and Best Management Practice (BMP) solutions. This section of the Standards was revised to provide clarity and explanation to the existing adopted standards from 2015. The revision only provides clarity and does not add to or change the intent of the existing standards. The Stormwater BMP Selection Guidance for Site Conditions Table 4-1 provides BMP solutions and alternatives. This table was not revised as part of this update. Note that the highest priority of the hierarchy remains as infiltration and the use of vegetated areas.

Goal 11.1 Provision of Public Facilities

Comp Plan Goal 11.1 Provision of Public Facilities

Serve the health, safety, education, welfare, and recreational needs of all Oregon City residents through the planning and provision of adequate public facilities.

Finding – Stormwater Master Plan: The Master Plan is necessary to maintain compliance with Statewide Planning Goal 11, Public Facilities. Goal 11 requires that public facilities and services be provided in a timely, orderly and efficient manner. The goal's central concept is that local governments should plan public services in accordance with the community's needs as a whole rather than be forced to respond to individual developments as they occur. This includes stormwater service. As shown in the findings below, the proposed update of the Stormwater Master Plan is consistent with Goal 11.1.

Finding – Stormwater and Grading Design Standards: The Design Standards were created to serve the health, safety, education, welfare, and recreational needs of all Oregon City residents through the planning and provision of adequate public facilities. Public Facilities include, but are not limited to, stormwater detention, stormwater management areas, swales, ponds, storm sewers and appurtenances. These public facilities are designed by the technical standards found within the Stormwater and Grading Design Standards which were prepared to improve water quality, reduce flooding, convey stormwater to safe appropriate areas, prevent stagnation, and provide signage and fencing for education and safety where appropriate.

Comp Plan Policy 11.1.1

Ensure adequate public funding for the following public facilities and services, if feasible:

• *Stormwater management*

Finding – Stormwater Master Plan: The Master Plan includes a recommended Capital Improvement Program with a comprehensive and detailed discussion of cost estimates and options to assure that the existing and future stormwater facilities can be funded. The City will retain the financial consultant, FCS Group, to perform a stormwater utility rate and System Development Charge (SDC) analysis to determine if the current stormwater rates and SDCs need to be adjusted to finance the recommended

stormwater Capital Improvement Program. With respect to the maintenance and rehabilitation of the existing system, the plan includes a detailed Rehabilitation and Replacement Program.

Finding – Stormwater and Grading Design Standards: The technical design standards do not inherently use public funding; however, the facilities once built may become public facilities which are maintained by the public through Oregon City Public Works using funding as outlined through rates and system development charges related to the Stormwater Master Plan. In many cases, private development designs and constructs these facilities using private funding and after a two year maintenance period, the facilities become owned and maintained by the City.

Comp Plan Policy 11.1.2

Provide public facilities and services consistent with the goals, policies and implementing measures of the Comprehensive Plan, if feasible.

Finding – Stormwater Master Plan: As discussed in this staff report, the Master Plan provides guidance for the timely, efficient and economic provision of stormwater service within the existing city and to new development areas within the Urban Growth Boundary consistent with the relevant goals, policies and implementing measures of the Comprehensive Plan. The proposed Master Plan is consistent with this policy.

Finding – Stormwater and Grading Design Standards: The Stormwater and Grading Design Standards provide technical guidance to design and construct projects outlined in the Stormwater Master Plan. The Stormwater Master Plan is consistent with the policies and measures of the comprehensive plan; therefore, the Standards also are consistent with these policies by reference.

Comp Plan Policy 11.1.3

Confine urban public facilities and services to the city limits except where allowed for safety and health reasons in accordance with state land-use planning goals and regulations. Facilities that serve the public will be centrally located and accessible, preferably by multiple modes of transportation.

Finding – Stormwater Master Plan: Stormwater facilities are anticipated to be exclusively sited within city limits unless constrained by a unique or unanticipated situation.

Finding – Stormwater and Grading Design Standards: Stormwater and Grading Design Standards are only for use within the City Limits as stated within Chapter 1 of the Standards and as permitted through the City's MS4 permit.

Comp Plan Policy 11.1.4

Support development on underdeveloped or vacant buildable land within the city where public facilities and services are available or can be provided and where land-use compatibility can be found relative to the environment, zoning, and Comprehensive Plan goals.

Finding – Stormwater Master Plan: Chapter 7 of the Master Plan describes recommended Capital Improvement Projects for current and future needs to address water quality issues, capacity/flooding, asset management, and natural systems health. This analysis is based on future land use as shown on figure 2-6 and storm system capacity evaluation in Chapter 3. The analysis includes underdeveloped and vacant buildable land within the city and the urban growth boundary (See Figure ES-1). In most cases the extension of new stormwater services will occur in existing or planned public right-of-ways as part of development in accordance with applicable public works standards, land division laws and zoning regulations, including applicable environmental overlay district standards depending on where development occurs. The adopted city development code standards are sufficient to assure land use compatibility of proposed stormwater improvements are identified in the plan and are within the adopted land use categories in the City's Comprehensive Plan. The proposed Master Plan is consistent with this policy.

Finding – Stormwater and Grading Design Standards: The Stormwater and Grading Design Standards provide technical guidance for the design and construction of stormwater and grading improvements on underdeveloped and vacant land. The General Thresholds as outlined in section 1.2.1 provide cases when the Standards apply. Section 1.2.2 provides Exemptions for when the Standards do not apply.

Comp Plan Policy 11.1.5

Design the extension or improvement of any major public facility and service to an area to complement other public facilities and services at uniform levels.

Finding – Stormwater Master Plan: The Master Plan is designed to meet system services standards for existing and future development within the UGB. The review of the system needs includes review of the following:

2. Study Area Characteristics
2.1 Location
2.2 Topography
2.3 Soils
2.4 Land Use
2.5 Climate and Rainfall
2.6 Natural Systems
2.7 Stormwater Infrastructure System
2.8 Recent Projects
2.9 Stormwater Program Management

3. Storm System Capacity Evaluation
3.1 Capacity Evaluation Approach
3.2 Problem Area Identification
3.3 Problem Area Classification
3.4 Levels of Service
3.5 Model Development Summary
3.6 Model Results
3.7 Capital Improvement Project Analysis
4. Storm System Condition Assessment
4.1 Background
4.2 System Assessment
4.3 Repair and Replacement Program
5. Water Quality/Retrofit Assessment
5.1 Water Quality Priorities
5.2 Water Quality Treatment Overview
5.3 Retrofit Evaluation
5.4 Water Quality/Retrofit Recommendations
These analyses reflect typical stormwater system industry standards. The plan includes a detailed analysis of levels of service and existing and projected stormwater demand within the UGB based on the City's comprehensive plan. Pursuant to these requirements, stormwater facilities are typically required to be extended to a new development area at the same time as other public facilities such as sanitary sewer, domestic water, and emergency services. The proposed Master Plan is consistent with this policy.

Finding – Stormwater and Grading Design Standards: The Standards are established to provide consistent uniform requirements for stormwater and grading improvements which are either private or public facilities.

Comp Plan Policy 11.1.7

Develop and maintain a coordinated Capital Improvements Plan that provides a framework, schedule, prioritization, and cost estimate for the provision of public facilities and services within the City of Oregon City and its Urban Growth Boundary.

Finding – Stormwater Master Plan: The plan includes a detailed Capital Improvements Program. The plan includes prioritization of capital improvement projects (CIPs) to serve capacity issues, environmental benefits and benefits to the stormwater system, although the exact timing of these improvements is currently unknown. The plan also provides a discussion of the factors that will affect the timing of the rehabilitation and replacement program for existing facilities. The proposed Master Plan is consistent with this policy.

Finding – Stormwater and Grading Design Standards: The Design Standards do not relate to Capital Improvement Plans; therefore, Comp Plan Policy 11.1.7 does not apply.

Goal 11.4 Stormwater Management

Comp Plan Goal 11.4 Stormwater Management

Seek the most efficient and economical means available for constructing, operating, and maintaining the City's stormwater management system while protecting the environment and meeting regional, state, and federal standards for protection and restoration of water resources and fish and wildlife habitat.

Finding – Stormwater Master Plan: A stormwater utility rate study and SDC analysis will be performed by the financial consultant to determine the most efficient and economic means to fund the Capital Improvement Program and the Repair and Replacement Program. The goal's central concept is that local governments should plan public services in accordance with the community's needs as a whole rather than be forced to respond to individual developments as they occur. As described in Section 5, the plan addresses meeting the regulatory requirements for protection of the fish and wildlife habitat by the implementation of the City's Stormwater and Grading Design Standards as described in the Finding below. The city is covered by an MS4 NPDES permit for stormwater discharges where evaluation is included to review the water quality treatment facilities across the city. The Oregon Department of Environmental Quality is required to conduct a water quality assessment of the state's water bodies every two years as part of the water quality standards program.

Finding – Stormwater and Grading Design Standards: Adoption of the Revised Stormwater and Grading Design Standards do not change what was approved in 2015 which ensured efficient and economical means available for constructing, operating, and maintaining the City's stormwater management system while protecting the environment and meeting regional, state, and federal standards for protection and restoration of water resources and fish and wildlife habitat. Design standards exist to guide developers and engineers how to provide stormwater management, conveyance, and grading. Design standards provide the technical guidance to design projects within a master plan or which are required based on thresholds directed by OCMC 13.12. The Design Standards provide the technical standards that do not change the degree by which the requirements are needed compared to the existing 2015 Stormwater and Grading Design Standards which precede this revision. Protection of properties, resources, and other items that are regulated by the Stormwater and Grading Design Standards do not reduce the protections to these systems in any way compared to the 2015 Standards that are currently adopted.

Comp Plan Policy 11.4.1

Plan, operate, and maintain the stormwater management system for all current and anticipated city residents within Oregon City's existing Urban Growth Boundary and plan strategically for future expansion areas.

Finding – Stormwater Master Plan: The purpose of updating the Master Plan is to assure that all current and anticipated city residents within the Urban Growth Boundary can receive a dependable and high-quality stormwater system as the city continues to develop. This includes maintenance, and where needed, upgrading the existing system as well as serving future expansion areas. The proposed Master Plan is consistent with this policy.

Finding – Stormwater and Grading Design Standards: Adoption of the Revised Stormwater and Grading Design Standards do not change what was approved in 2015 which explains in Chapter 8 how a Stormwater Management Facility is to be operated and maintained as referenced on OCMC 13.12.

Comp Plan Policy 11.4.2

Adopt "green streets" standards to reduce the amount of impervious surface and increase the use of bioswales for stormwater retention where practicable.

Finding – Stormwater Master Plan: As described in Section 5, implementing a green streets retrofit program for areas in need of additional treatment and opportunistically implementing along with roadway improvements by replacing landscape strips with stormwater planters to provide treatment for existing roadways and residential areas. The proposed Master Plan is consistent with this policy.

Finding – Stormwater and Grading Design Standards: Adoption of the Revised Stormwater and Grading Design Standards do not change what was approved in 2015 which describe site assessment and planning for stormwater management facilities which includes 'green' standards such as infiltration or bioswales and has a requirement for LID improvements (low impact development). The Design Standards do not specifically address 'green streets', only 'green' standards.

Comp Plan Policy 11.4.3

Ensure parking lot designs that mitigate stormwater impacts. Take measures to reduce waterflow and increase water absorption through the use of bioswales, vegetated landscaped islands with curb cuts to allow water inflow, and tree planting.

Finding – Stormwater Master Plan: Chapter 2 in the City's Stormwater and Grading Design Standards address site planning design objectives to reduce the impact of stormwater runoff from development including parking areas. Tables A-1 to A-3 in Appendix A from the Design Standards provide tree planting options through the use of stormwater planters, rain gardens and swales in parking areas.

Finding – Stormwater and Grading Design Standards: As described in the Finding above, the 2015 standards as well as the 2019 Update provide options for "LID Facilities". Adoption of the Revised Stormwater and Grading Design Standards do not change what was approved in 2015.

Comp Plan Policy 11.4.4

Maintain existing drainageways in a natural state for maximum water quality, water resource preservation, and aesthetic benefits.

Finding – Stormwater Master Plan: The Master Plan is intended to apply the City's Stormwater and Grading Design Standards which outline the City's stormwater quality and quantity related obligations and programs to provide a comprehensive review of the City based on current Design Standards to determine system deficiencies. One of the purposes of the Stormwater and Grading Design Standards is to minimize the introduction of pollutants and provide water quality treatment of stormwater runoff to preserve the beneficial uses of drainageways, lakes, ponds, wetlands, and other sensitive areas; however, the Master Plan does not further restrict or more fully allow any changes to the environment and infrastructure. It only addresses existing deficiencies based on the Stormwater and Grading Design Standards. Another purpose is to maintain the pre-development stormwater runoff characteristics to minimize effects on the drainageways such as sediment transport, erosion, and degradation generally associated with urbanization, through the use of Low Impact Development (LID) facilities and/or flow controls to address hydromodification. Projects are established by the Master Plan which were determined by an analysis of the City based on the Stormwater and Grading Design Standards. This project lists consists of capital projects like Scattering Canyon Stormwater Improvement and Coffee Creek Stream Restoration. The Scattering Canyon Project will enhance a current outfall and channel at the canyon to reduce erosion while addressing the lack of water quality and enhancing aesthetics. The Coffee Creek Project addresses flooding issues, the lack of water quality and providing stream stability to the existing drainageway.

Finding – Stormwater and Grading Design Standards: Adoption of the Revised Stormwater and Grading Design Standards do not change what was approved in 2015 which requires maintaining of existing drainageways, easements, water resource preservation, and water quality on conjunction with OCMC 13.12 and OCMC 17.49 . Chapter 3 refers to OCMC 17.49 and Chapter 5 refers to drainageways and easements while Chapter 8 refers to maintenance.

Comp Plan Policy 11.4.5

Design stormwater facilities to discharge surface water at pre-development rates and enhance stormwater quality in accordance with criteria in City of Oregon City Public Works Stormwater and Grading Design Standards.

Finding – Stormwater Master Plan : Part of the objective of the Master Plan is to design stormwater facilities in accordance with the criteria in City of Oregon City's Stormwater and Grading Design

Standards. Chapter 4 in the Design Standards describes the methods and criteria for selecting and designing stormwater management facilities for projects. A flow control requirement when discharging surface water shall be designed so that the duration of peak flow rates from post-development conditions shall be less than or equal to the duration of peak flow rates from pre-development conditions for all peak flows between 42 percent of the 2-year peak flow rate up to the 10-year peak flow rate. Water quality facilities shall be designed to capture and treat 80 percent of the average annual runoff volume to the MEP with the goal of 70 percent total suspended solids removal.

Finding – Stormwater and Grading Design Standards: Adoption of the Revised Stormwater and Grading Design Standards do not change what was approved in 2015 which describes how stormwater facilities shall discharge surface water at pre-development rates and enhance stormwater quality. Stormwater Management requirements and exemptions are stated in Chapter 1.

Comp Plan Policy 11.4.6

Regularly review and update the above standards to reflect evolving stormwater management techniques, maintenance practices, and environmental compatibility.

Finding – Stormwater Master Plan: Stormwater Management Implementation Plan establishes an annual program to inspect and assess the condition of the City's infrastructure and set the City up with a greater understanding of the system and the areas in need of imminent repair and replacement. Along with the implementation plan, current and future regulations and design standards will aid in ensuring that new development and redevelopment do not exacerbate any existing problems or place new stresses on the current system. Chapter 8 in the Stormwater and Grading Design Standards describes the requirement to perform regular maintenance to all stormwater management facilities.

Finding – Stormwater and Grading Design Standards: This revision of the 2015 Standards is to provide clarification to the existing standards where they have not been clear to staff and the development community. OCMC 13.12 provides direction to the City Commission to adopt updated standards from time to time. The goal of the update is to provide clarification and correct any errors within the Standards.

Comp Plan Policy 11.4.7

Provide stormwater management services and monitor, report and evaluate success of the services consistent with the NPDES MS-4 permit requirements.

Finding – Stormwater Master Plan: Section 2 of the Master Plan describes the City's Stormwater Program Management services that includes maintenance and programmatic stormwater activities. Program implementation is documented annually in the City's NPDES MS4 permit annual report. The

evaluation of stormwater discharge is included to review the water quality treatment facilities across the city under the NPDES MS4 permit. The Oregon Department of Environmental Quality is required to conduct a water quality assessment of the state's water bodies every two years as part of the water quality standards program. The proposed Master Plan is consistent with this policy.

Finding – Stormwater and Grading Design Standards: See above Finding. The Design Standards themselves do not apply to Comp Plan Policy 11.4.7. The NPDES requirements of the MS4 permit is what makes the City required to follow this Comp Plan Policy.

Brown AND Caldwell

FINAL REPORT | Prepared for
The City of Oregon City

Stormwater Master Plan

July 2019









Oregon City Stormwater Master Plan

Prepared for
City of Oregon City, Oregon
July 2019

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List of Abbreviations

BC	Brown and Caldwell
BMP	best management practice
CCTV	closed-circuit television
CIP	capital improvement project
City	City of Oregon City
CMP	corrugated metal pipe
CWA	Clean Water Act
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
EPA	U.S. Environmental Protection Agency
FTE	full-time equivalent
GIS	geographic information system
GOCWC	Greater Oregon City Watershed Council
H/H	hydrologic and hydraulic
I-205	Interstate 205
I/I	infiltration and inflow
L	liter(s)
LF	linear foot/feet
mg	milligram(s)
MS4	municipal separate storm sewer system
NPDES	National Pollutant Discharge Elimination System
NRCS	National Resources Conservation Service
OCMC	Oregon City Municipal Code
ODOT	Oregon Department of Transportation
O&M	operations and maintenance
PCB	polychlorinated biphenyl
Plan	Stormwater Master Plan
R/R	rehabilitation and replacement
SWMP	Stormwater Management Plan
TMDL	total maximum daily load
UGB	Urban Growth Boundary

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Executive Summary

The City of Oregon City (City) developed this citywide Stormwater Master Plan (Master Plan) to guide stormwater-related priorities and capital improvement projects (CIPs) over the next 10 to 15 years. The City is currently managing more than 174 miles of stormwater infrastructure, including significant areas of aging systems. At the same time, development rates and projections indicate that the stormwater system will require continued expansion to accommodate future growth. The City's previous Drainage Master Plan was completed in 1988 and is no longer relevant following nearly 30 years of development across the city.

The City needs a proactive plan to address immediate capacity needs, replace aging infrastructure, and provide regional solutions to larger flooding and water quality challenges. The updated CIP list and selected programmatic approaches included in this Master Plan will facilitate a prioritization of the City's resources and support future resource and financial planning.

Oregon City Stormwater Overview

Oregon City is the oldest city in Oregon with a rich history and strong community identity. In addition to its pioneer history, the city takes great pride in its connection to natural resources. The City's 11.92 square miles are drained by Abernethy Creek, Beaver Creek, the Clackamas River, and the Willamette River (see Figure ES-1). The eastern edge of the City borders Newell Canyon, which includes land that has been purchased by Metro for preservation. The City takes pride in being a gateway to Willamette Falls and is a partner in the Willamette Falls Legacy Project, which will provide public access to the falls and facilitate redevelopment of the historic Blue Heron Mill property.

The City manages more than 160 miles of piped stormwater infrastructure and 14 miles of roadside drainage ditches. Oregon City has some of the oldest utility infrastructure in the state, with some areas of underground infrastructure suspected to be more than 100 years old. The downtown area of the city and the Canemah neighborhood were once served by a combined sanitary sewer and storm system, which was separated in the 1980s and 1990s. The pipes that previously served the old combined system are still used for stormwater flows. The City currently has a growing database of information regarding underground utility conditions from closed circuit television (CCTV) surveys, allowing the City to make informed decisions on infrastructure improvements.

While significant areas of stormwater assets are aging, the city continues to grow and expand at the northern and southern ends of town, increasing the miles of pipes and infrastructure that need to be managed and maintained.

Providing stormwater conveyance to prevent flooding is the primary function of the City's stormwater infrastructure. The City has several drainage systems that are too small and unable to convey existing flows. As part of the master planning evaluations, a series of hydraulic models were developed to analyze the capacity of the conveyance infrastructure. The modeling was used to evaluate both existing conditions and future conditions when development expansion and infill is expected to increase flows to the conveyance system.

The City also has a robust program to address water quality through programmatic actions, such as illicit discharge investigations, construction site regulations, and stringent standards for new development and redevelopment. These water quality programs address water quality issues at the source because stormwater, unlike wastewater, does not drain to a centralized treatment facility.

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Improving water quality conditions through retrofit of existing stormwater infrastructure is an important element of the City's overall stormwater management program. The City's water quality concerns extend to Newell Creek Canyon where studies have shown an increased susceptibility for erosion and channel modification due to increasing flows.

Planning Process

The planning process for this master plan included the following steps:

- Identify, investigate and study known problem areas.
- Create hydrologic and hydraulic models to evaluate system capacity for key problem areas or systems.
- Develop an integrated stormwater system capital improvement program to address storm system capacity needs and water quality.
- Evaluate stream channel conditions with respect to erosion and impacts from existing and future development.
- Identify implementation priorities and impacts to the program budget.
- Develop a Master Plan document that is useful and easy to read, reference, and up to date.

This Master Plan documents the means and methods used to evaluate the City's drainage infrastructure and natural systems. Results of the evaluations conducted provide the City with CIPs and programmatic stormwater actions for implementation. The study area for this Master Plan covers drainage areas to receiving water bodies including Abernethy Creek, the Clackamas River, Beaver Creek, and the Willamette River.

Master Plan Technical Analyses

Development of the Master Plan involved the following technical analyses to evaluate the stormwater infrastructure and related programs.

Problem Areas Survey. Meetings and interviews with City staff, compilation of public complaints, and site visits throughout the city provided a robust problem area list which included stormwater infrastructure, outfalls, and natural systems. The identified problems were then reviewed and studied to determine which areas needed further study through hydraulic modeling. Problem areas were classified into five categories: project opportunities, natural systems, maintenance concerns, deteriorating or missing infrastructure, and flooding. Problem area identification is discussed in Section 3.2.

Stormwater System Capacity Evaluation. Section 3 documents the development of the hydrologic and hydraulic models to simulate rainfall and runoff characteristics within the City. The models were used to simulate stormwater flows through pipe networks, drainage ditches, and culverts to identify areas of the system that are under capacity. The models were run to simulate both current conditions and the impacts of future development on stormwater flows.

Condition Assessment. Section 4 discusses the current state of the City's stormwater drainage system, as well as details the efforts currently underway via closed-circuit television surveys (CCTV). The condition of the system was analyzed in terms of its age, conveyance capacity, and state of repair based off of city records, construction documents (as-builts), and CCTV survey information.

Water Quality Retrofit. Section 5 discusses water quality improvement opportunities. In 2015, the City developed a Water Quality Retrofit Plan, which recommended that water quality retrofits be a focus of the Stormwater Master Plan. A city-wide assessment was completed to determine how water

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of other proposed capital projects. Through the stormwater management municipal code, new development and redevelopment projects are required to provide water quality treatment.

Natural Systems Assessment. The focus of the natural systems assessment was to evaluate physical stream conditions to identify impacts from stormwater runoff. The City includes areas that are clearly susceptible to channel erosion and modification due to increases in flow from surface water runoff. Section 6 outlines the recommended infrastructure improvements and land use policies to address natural channel impacts from stormwater runoff.

Integrated Management Strategy

The City's stormwater program was formed around addressing drainage capacity and flooding problems. In the last decade, the program has shifted to include programs that address water quality needs, natural system impacts and the aging infrastructure. The recommendations in Sections 7 and 8 present an integrated strategy of programs and projects to address stormwater priorities across the City. The major recommendations include:

- Replace deteriorating and failing infrastructure, particularly in older areas of the City where stormwater infrastructure is reaching the end of the design life.
- Upsize existing infrastructure to reduce identified flooding issues.
- Upsize existing infrastructure to carry flows from projected future development and support future roadway improvements.
- Install new stormwater infrastructure systems in unserved neighborhoods (Rivercrest and Harding) to reduce stormwater inflow and infiltration into the sanitary sewer system.
- Implement outfall assessment program to systematically monitor and stabilize Newell Canyon outfalls.
- Increase water quality treatment through targeted actions and by integrating treatment features into planned capital projects.
- Expand programs to monitor stormwater infrastructure condition to identify pipes, culverts, and outfalls in degraded condition.
- Develop funding strategy and prioritized CIP implementation schedule.

Recommendations include twelve capital improvement projects and three programmatic actions. Capital Improvement Projects (CIPs) have been developed to address existing and predicted future conditions flooding problems, integrate water quality elements, and replace deteriorating pipe segments. Table ES-1 below summarizes the identified CIPs, estimated costs and priority ranking. Figure ES-1 shows the location of the proposed CIPs. Detailed fact sheets for each CIP can be found in Appendix F. Planning level cost estimates and prioritization scoring information are provided in Appendices H and I, respectively.

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Table ES-1. Capital Improvement Projects and Prioritization			
Prioritization Score [a]	#	- Project Name	Conceptual Cost
18.5	#1	John Adams Basin Capacity Improvements	$8,555,000
15	#2	South End Road Stormwater Improvements	$3,209,000
12.5	#3	Division Street Infrastructure Improvements	$770,000
20.5	#4	Rivercrest Neighborhood Infrastructure Improvements	$2,428,000
26.5	#5	Harding Boulevard Sanitary Disconnect	$464,000
15	#6	Pebble Beach Pond Retrofit	$713,000
12.5	#7	Hiefield Court Culvert Improvements	$657,000
18.5	#8	The Cove Water Quality Improvements	$608,000
13	#9	Holcomb Boulevard Capacity Improvements	$3,893,000
13	#10	Coffee Creek Capacity Improvements	$1,096,000
22.5	#11	Scattering Canyon Stormwater Improvement	$521,000
24.5	#12	Newell Canyon Outfall Assessment (annual)	$100,000

a. Prioritization scores range from 12.5 to 26.5, with the higher scores representing projects that are most closely aligned with the City's stormwater planning objectives.

In addition to the identified capital projects, Section 8 identifies and recommends the following projects and studies:

- Closed Circuit Television (CCTV) of the entire stormwater system starting with the most aged areas of the Singer Basin (neighborhood in vicinity of Singer Creek), the John Adams Basin (McLoughlin neighborhood) and the Canemah neighborhood.
- Annual and ongoing Rehabilitation and Replacement (R/R) program to address failing infrastructure identified through the CCTV inspection program. The annual R/R budget is recommended between $300,000 and $750,000 per year depending on the extent of the R/R program.
- Ongoing outfall stabilization projects to upgrade and reconstruct outfalls around Newell Canyon, based on the recommendations from the outfall assessment in CIP #12.

Adoption and implementation of this Master Plan and the elements outlined within it are important for the City to move in a direction of preventive actions to minimize future and more expensive reactionary actions. Implementation of the CIPs and utilization of the prioritization matrix along with implementation of the programmatic recommendations will be critical to moving the City forward with respect to sound management of its stormwater infrastructure.

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City of Oregon City

GEOGRAPHIC INFORMATION SYSTEM

Figure ES-1. Capital Project Locations

- Proposed Capital Projects
- Storm Drainage Pipe
- Ditch
- Stream Lines
- City Limits

Clackamas River

CIP #8 The Cove Water Quality Improvements

CIP #9 Holcomb Boulevard Capacity Improvements

Abernethy Creek

CIP #3 Division Street Infrastructure Improvements

CIP #1 John Adams Basin Capacity Improvements

CIP #12 Newell Canyon Outfall Assessment

Willamette River

CIP #5 Harding Boulevard Sanitary Disconnect

Newell Creek

CIP #4 Rivercrest Neighborhood Infrastructure Improvements

CIP #10 Coffee Creek Capacity Improvements

CIP #11 Scattering Canyon Stormwater Improvements

CIP #7 Hiefield Court Culvert Improvements

CIP #2 South End Road Stormwater Improvements

CIP #6 Pebble Beach Pond Retrofit

Beaver Creek

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

The City of Oregon City makes no representations, express or implied, as to the accuracy, completeness and timeliness of the information displayed. This map is not suitable for legal, engineering, or surveying purposes. Notification of any errors is appreciated.

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OREGON CITY

Plot date: December 14, 2017
Plot name: Figure 7-1 Capital Project Locations.pdf
Map name: Figure 7-1 Capital Project Locations.mxd

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Section 1

Introduction

The City of Oregon City (City) developed this citywide Stormwater Master Plan (Master Plan) to guide stormwater-related priorities and capital improvement projects (CIPs) over the next 10 to 15 years. The City is currently managing more than 174 miles of stormwater infrastructure, including significant areas of aging systems. At the same time, development rates and projections indicate that the stormwater system will require continued expansion to accommodate future growth. The City's previous Drainage Master Plan was completed in 1988 and is no longer relevant following nearly 30 years of development across the city. The City needs a proactive plan to address immediate capacity needs, replace aging infrastructure, and provide regional solutions to larger flooding and water quality challenges. The updated CIP list and selected programmatic approaches included in this Master Plan will facilitate a prioritization of the City's resources and support future resource and financial planning.

This Master Plan documents the means and methods used to evaluate the City's drainage infrastructure and natural systems. Results of the evaluations conducted provide the City with CIPs and programmatic stormwater actions for implementation. The study area for this Master Plan covers drainage areas to receiving water bodies including Abernethy Creek, the Clackamas River, Beaver Creek, and the Willamette River.

1.1 Stormwater Master Plan Objectives

The goal of this Master Plan is to provide guidance in planning and designing stormwater conveyance and managing infrastructure to protect the natural and built environment for the next 10 to 15 years. The primary method for guidance is through a prioritized CIP list.

This Master Plan is intended to be used in conjunction with both the City's National Pollutant Discharge Elimination System (NPDES) municipal separate storm sewer system (MS4) permit, and Stormwater Grading and Design Standards, which outline the City's stormwater quality and quantity related obligations and programs. The NPDES MS4 permit requires the City to implement a Stormwater Management Plan (SWMP[1]) that outlines programmatic water quality best management practices (BMPs) to reduce pollutants in urban stormwater discharges to receiving waters. The City's Stormwater Grading and Design Standards require developers to address stormwater quality and quantity impacts associated with new development and redevelopment activities.

In addition to addressing aging infrastructure, future growth, water quality, flooding, and capacity issues, the City values the natural systems and spaces available to the community. Protecting and maintaining a healthy environment is important to maintaining a livable and healthy city. This Master Plan was developed to support the City's healthy management of these resources, including natural channel and riparian areas, habitat, and water bodies with beneficial uses such as fishing and recreation.

[1] There is frequent acronym confusion between a the City's Stormwater Management Plan (SWMP) (a document required by the NPDES MS4 permit, focused on water quality programs) and the Stormwater Master Plan (this document). To ease this confusion, this document is referred to as the "Master Plan," without use of an acronym.

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1.2 Background

Oregon City has a footprint of approximately 7,629 acres or 11.92 square miles. The City manages more than 160 miles of piped stormwater infrastructure and 14 miles of roadside drainage ditches. The city contributes runoff to four major water bodies: the Willamette River, Clackamas River, Abernethy Creek, and Beaver Creek. Each of these systems has unique needs that have been addressed through this planning process.

The Clean Water Act (CWA) of 1972 and the resulting NPDES permitting program require municipalities to develop and implement stormwater management plans to address water quality. Within the SWMP, the City committed to developing a Stormwater Master Plan to provide longer-term planning guidance in order to address requirements such as implementing a strategy to retrofit existing developments for better water quality, addressing total maximum daily load (TMDL) and 303(d) listed pollutants, and addressing hydromodification.

1.2.1 Previous Studies

Previous studies completed for the City address the built environment, the natural environment, and water quality. The following studies provide guidance for managing surface water in and around the City and were used as background information in the development of this Master Plan:

- **Oregon City Drainage Master Plan (1988):** In 1988 a Drainage Master Plan was completed for the City that largely addressed conveyance capacity concerns. CIPs resulting from the 1988 Drainage Master Plan primarily recommended culvert upsizing or pipe replacement. Some guidance was provided for open and closed channel maintenance activities, but water quality and the protection of natural resources were not specifically addressed.
- **Oregon City Hydromodification Assessment (2015):** The City completed a stream assessment in June 2015 to address one of the NPDES MS4 permit requirements. The hydromodification assessment included an evaluation of stream channels in the City to identify whether discharges from the municipal stormwater system have negatively impacted stream channels (i.e., caused downcutting, aggradation, or erosion), and how future development might contribute to additional impacts.
- **Oregon City Retrofit Plan (2015):** In July 2015 the City completed a Stormwater Quality Retrofit Plan to address another requirement of the NPDES MS4 permit. The retrofit plan documents the City's retrofit strategy for reducing water quality impacts from existing developed areas. The objectives of the retrofit strategy include concepts for reducing pollutants of concern and reducing the identified hydromodification impacts.
- **Greater Oregon City Watershed Council Watershed Action Plan (2010):** This plan was developed to provide a long-term, science-based program to restore the greater Oregon City watersheds. Primary objectives for restoring watershed health included restoring streams, removing barriers to fish passage, and implementing near-channel water quality projects. The plan focuses on the larger watershed areas draining to Abernethy Creek and Beaver Creek, with few projects identified within the urban area of Oregon City.
- **Oregon City Stormwater and Grading Design Standards (2015):** To meet another NPDES MS4 permit requirement, the City adopted updated stormwater standards for new development and redevelopment in 2015. These standards require developers to prioritize low-impact development and they require new development and redevelopment projects to manage surface runoff from impervious areas to mimic natural patterns.

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1.2.2 Regulatory Drivers

The CWA was enacted to protect waters of the United States and resulted in the establishment of water quality standards for surface waters and a permitting program to regulate discharges to surface waters. To address urban stormwater runoff, the U.S. Environmental Protection Agency (EPA) developed the NPDES MS4 permitting program.

The NPDES MS4 program requires municipalities to develop and implement SWMPs to address stormwater quality. Oregon City is a co-permittee on the Clackamas County NPDES MS4 permit. As a result, the City developed a SWMP that provides detailed information on how the NPDES MS4 permit requirements will be met. **The development of this Master Plan is one of the commitments identified in the City's SWMP.** Other commitments in the City's SWMP are mostly programmatic and are related to public education, public involvement, illicit discharge detection/elimination, construction site management, post-construction stormwater management, industrial/commercial facility inspections, good housekeeping practices for municipal operations, and operations and maintenance (O&M) activities for stormwater management facilities.

1.3 Planning Approach

The approach used to develop this Plan is provided in Figure 1-1. This process was established to first leverage City staff knowledge and existing data and then to conduct focused investigations leading to the development of CIPs. The investigation, including hydraulic modeling, focused on the problem areas rather than the whole city. This approach was used to minimize modeling and analysis costs and to focus on the areas identified as problems. The problem area identification, evaluation, CIP list development, and prioritization of CIPs were conducted in the following manner:

1. A kickoff workshop was conducted with City staff to identify potential stormwater and surface water problems in each of the City's 21 drainage basins.
2. Further problem area identification and data collection were conducted through meetings with maintenance and engineering staff to compile all available sources of problem areas and to define areas for focused data collection and evaluation.
3. Analysis and review of maps, plans, and record drawings, hydrologic and hydraulic (H/H) modeling, natural systems investigations, and additional field investigations were completed to further define problem areas and potential projects.
4. A workshop was conducted with City staff to refine the potential project list.
5. Additional H/H modeling following detailed data gathering, and evaluation resulted in a draft list of conceptual CIPs to review with City staff.
6. The development of CIP cost estimates, priorities, and a timeline for implementation were completed and vetted with City staff for inclusion in the draft Plan.
7. The Plan was developed to document the master planning approach, CIP list, and additional recommendations.

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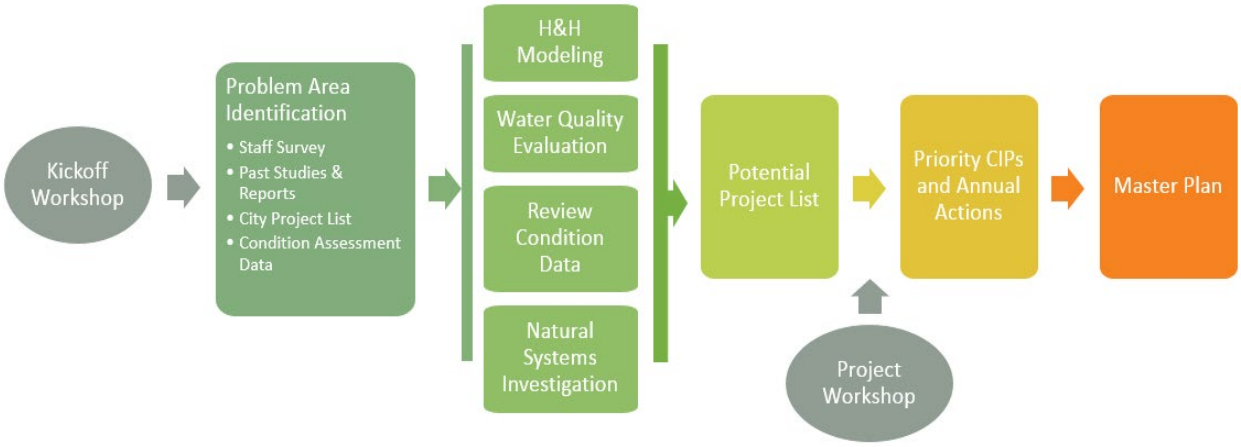


Figure 1-1. Stormwater Master Plan approach

City staff have provided input throughout every stage of the project process, starting with the kick-off workshop, where staff discussed known issues in each of the City's 21 drainage basin and continuing through problem area analysis, project development, and final project prioritization.

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Section 2

Study Area Characteristics

Oregon City is located adjacent to Willamette Falls, at the confluence of two of Oregon's major waterways: the Clackamas and Willamette rivers. Waterways and natural resources play a prominent part in the City's history and protection of these resources continues to be of high value for the City.

2.1 Location

The City of Oregon City is located 12 miles south of Portland, Oregon. Interstate 205 (I-205) and Pacific Highway 99E go through Oregon City and intersect in the northern portion of the city, as seen in Figure 2-1, below. The Willamette River bounds the city to the west and the Clackamas River bounds the city to the north. Unincorporated Clackamas County lands bound the eastern and southern city limits.

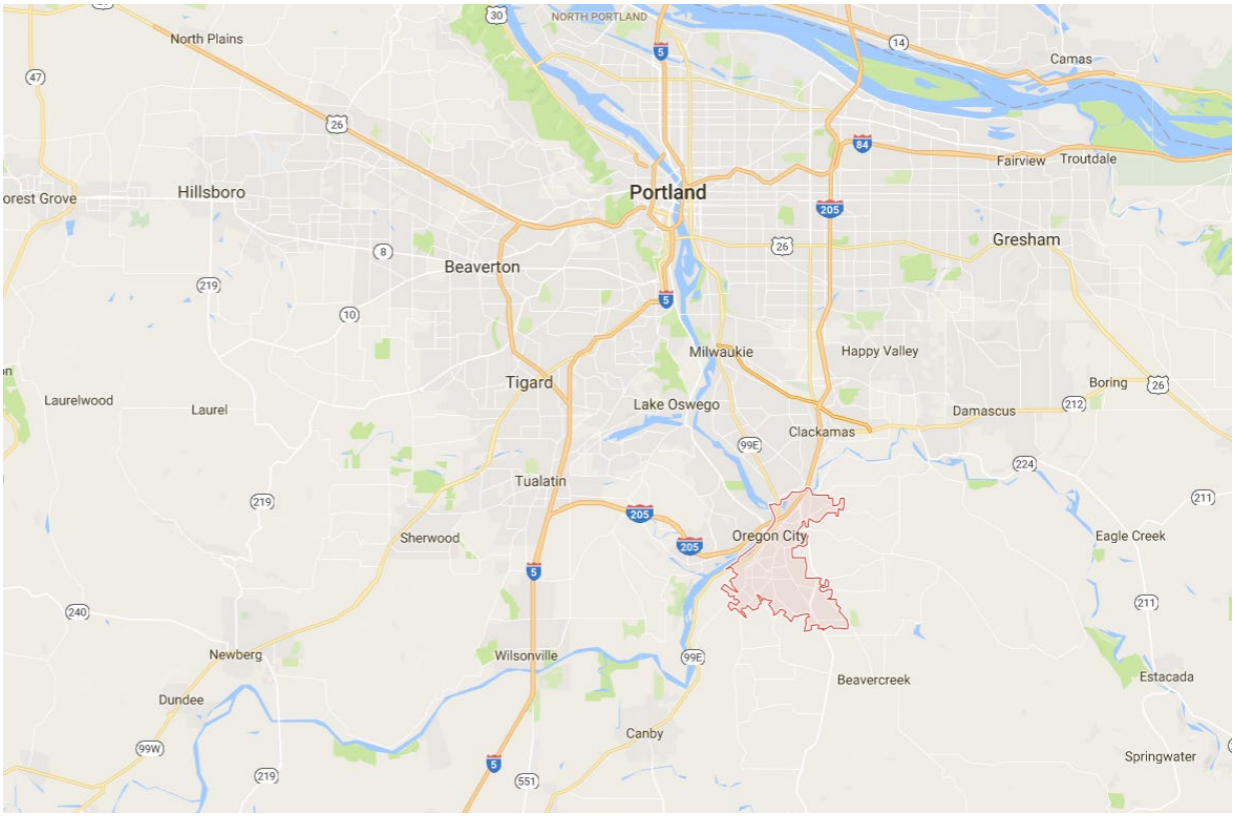


Figure 2-1. Location map

Oregon City is the oldest city in Oregon with a rich history and strong community identity. In addition to its pioneer history, the city takes great pride in its connection to natural resources. The City's 11.92 square miles are drained by Abernethy Creek, Beaver Creek, the Clackamas River, and the Willamette River.

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The eastern edge of the City borders Newell Canyon, which includes land that has been purchased by Metro for preservation. Abernethy Creek and the Clackamas River enter the Willamette River near the northern end of the city. Beaver Creek joins the Willamette River south of the city near the intersection of South End Road and Highway 99E. The City takes pride in being a gateway to Willamette Falls and is a partner in the Willamette Falls Legacy Project, which will provide public access to the falls and facilitate redevelopment of the historic Blue Heron Mill property.

2.2 Topography

Oregon City's topography is characterized by a significant escarpment or bluff that parallels the Willamette River (see Figure 2-2). Above the bluff the city has moderate slopes up to the intersection of Linn Avenue, Warner Parrott Road, Warner Milne Road, Central Point Road, and Leland Road, which is located at a high point of the city.

The northern portion of the city, north of Abernethy Creek, is characterized by gentle slopes that rise to the east and drain primarily to the Clackamas River and Abernethy Creek. To the south of the high point the city slopes more gently to the south. These areas are upper tributaries of the Beaver Creek watershed.

The eastern edge of the city is characterized by numerous steep slopes and ravines that drain through protected forest land to Newell Creek, which is a tributary to Abernethy Creek.

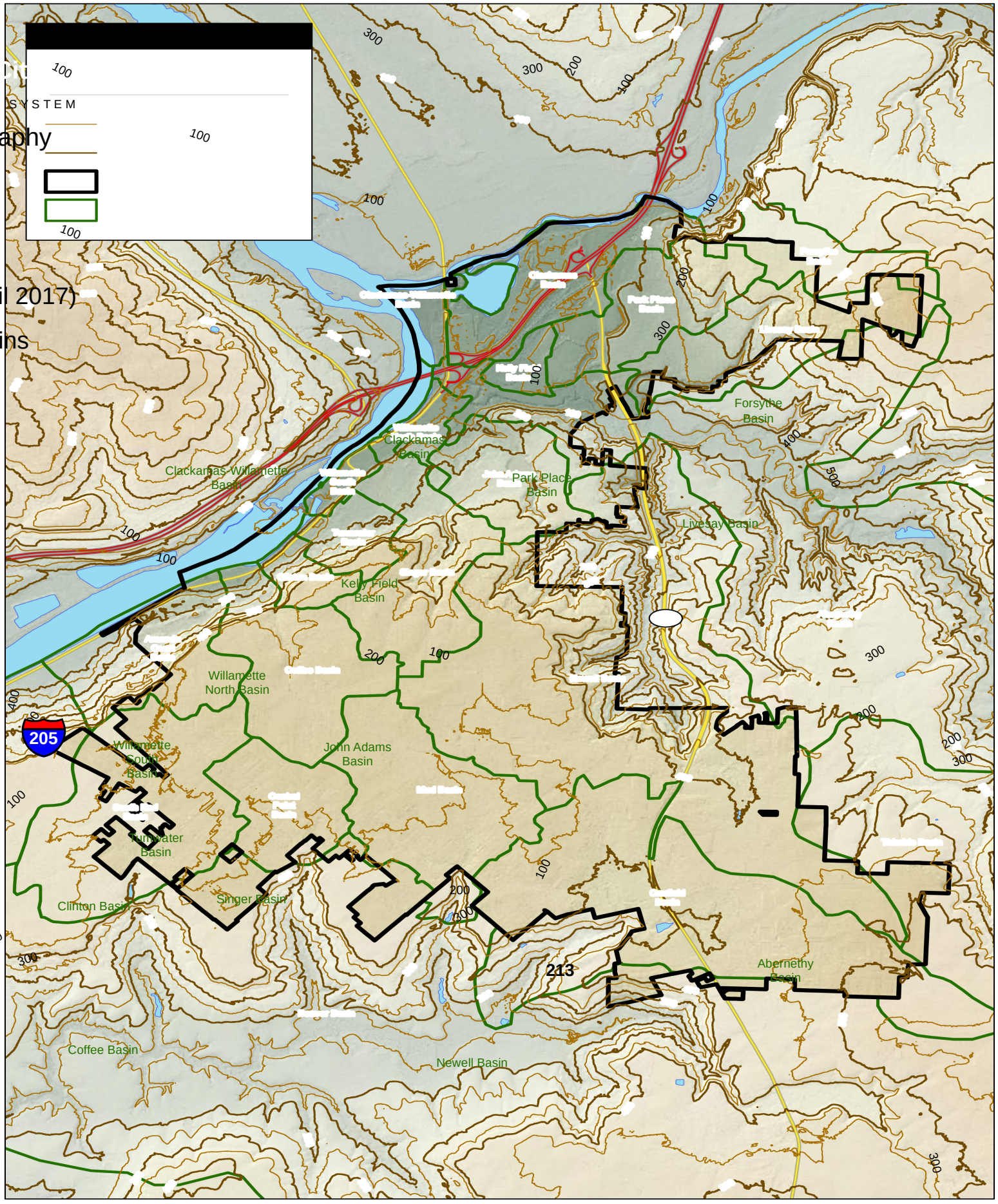
2.3 Soils

The Natural Resources Conservation Service (NRCS) Soil Survey online tool was used to gather soils information for Oregon City. Soils are an important watershed characteristic for evaluating potential runoff rates and volumes. Soils are generalized into four categories or hydrologic soil units, which approximate soil runoff potential. These groups are A, B, C, and D, where A soils are characterized by high rates of infiltration and low runoff potential and D soils are characterized by low rates of infiltration and high potential for runoff. Oregon City generally has C type soils with pockets of A, B, and D type soils. See Figure 2-3 for a soils map of the city.

Newell Canyon is a unique area of the city because of the highly erodible soils along the slopes of the canyon. The discharges from stormwater outfalls along with natural processes such as landslides have posed some additional risks for this area as development encroaches on the steeper slopes. This area requires more care during development because of the unique soils and slope conditions. Figure 2-4 highlights the Newell Canyon area.

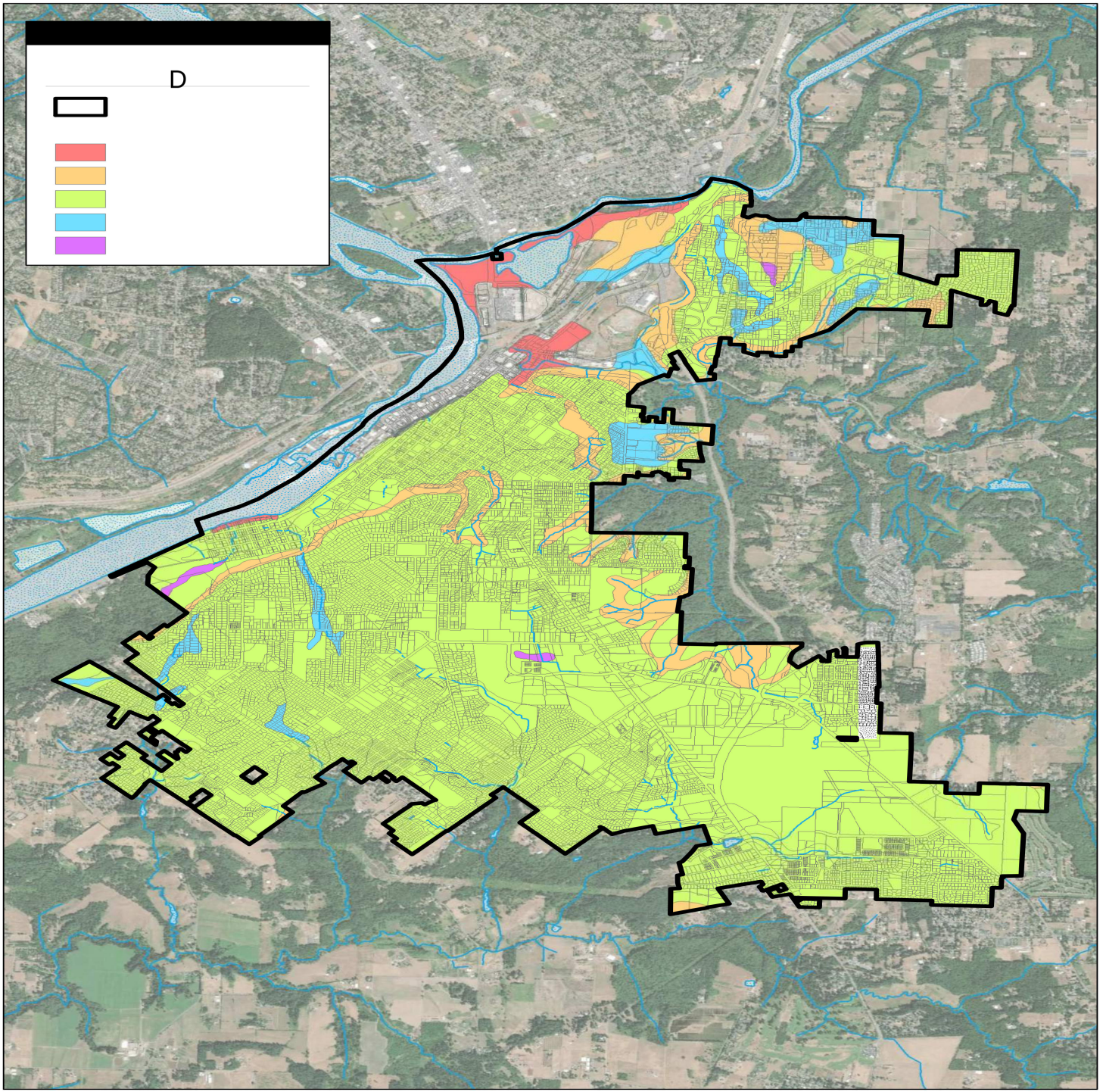
Table 2-1 below shows the soil types, NRCS map symbol, hydrologic soil group, and percent coverage within the city limits. This information is based on soil data from NRCS's Web Soil Survey and analysis done within Esri's ArcMap.

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100
300
200
100
100
100
100
200
300
100
Forsythe Basin
400
500
Clackamas Basin
Clackamas-Willamette Basin
Park Place Basin
Livesay Basin
100
100
Kelly Field Basin
200
100
300
Willamette North Basin
400
200
205
Willamette South Basin
John Adams Basin
200
300
100
Tumwater Basin
100
Clinton Basin
Singer Basin
200
300
200
300
213
Abernethy Basin
Coffee Basin
Newell Basin
300
400
Central Point Basin
Mud Basin
Thimble Basin

C

D



Haploxerolls, very steep

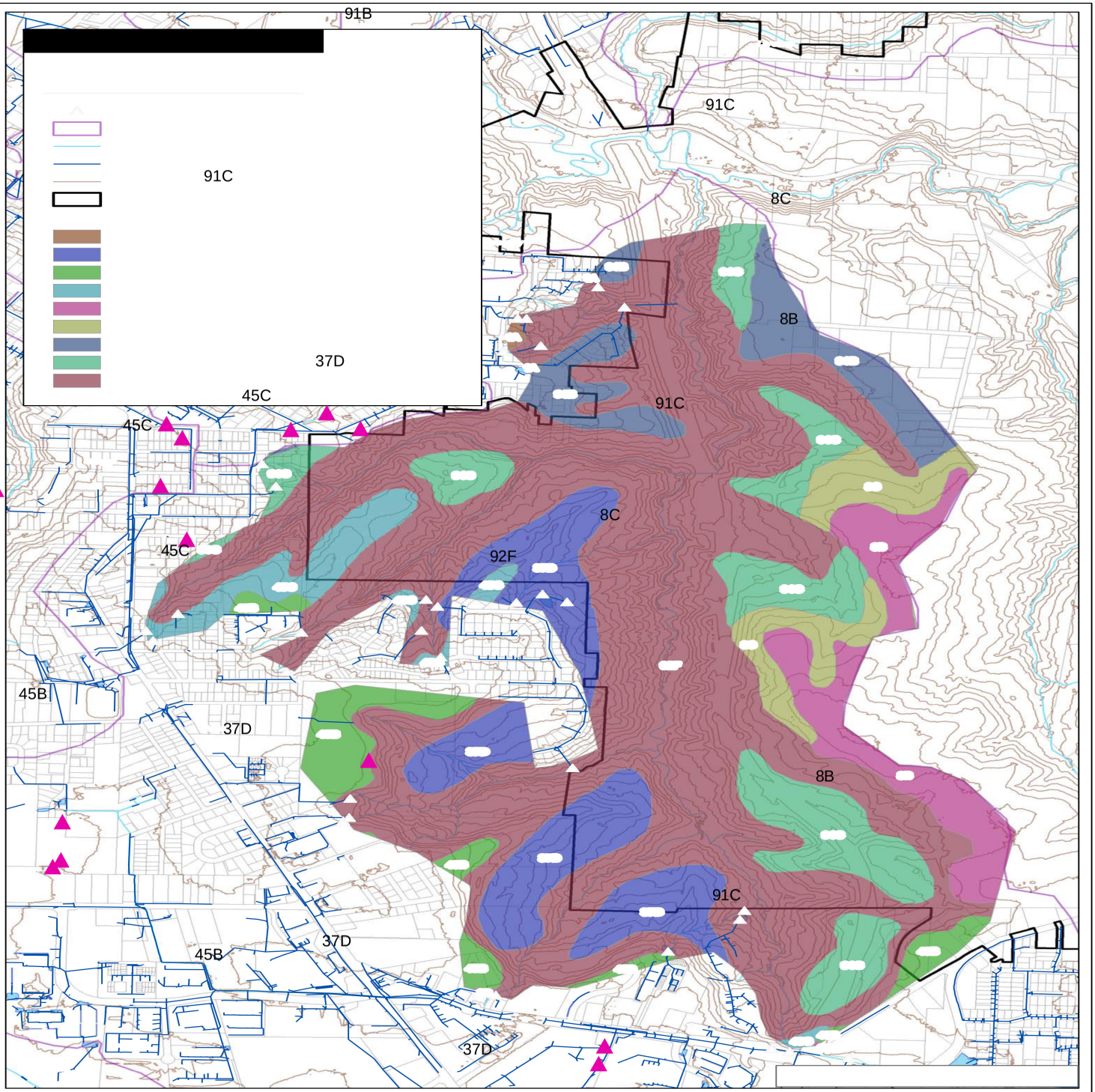


Table 2-1. Soil Types

NRCS map symbol	NRCS soil types	Hydrologic soil group	Acres within city limits	Percent of land within city limits
11	Camas gravelly sandy loam	A	9.23	0.15
13C	Cascade silt loam, 8%–15% slopes	C	33.50	0.53
16	Chehalis silt loam	B	51.33	0.81
17	Clackamas silt loam	C/D	40.05	0.63
1A	Aloha silt loam, 0%–3% slopes	C/D	43.92	0.70
1B	Aloha silt loam, 3%–6% slopes	C/D	12.50	0.20
23D	Cornelius silt loam, 15%–30% slopes	C	0.49	0.01
24B	Cottrell silty clay loam, 2%–8% slopes	C	185.56	2.94
25	Cove silty clay loam	D	9.01	0.14
3	Amity silt loam	C/D	33.94	0.54
30C	Delena silt loam, 3%–12% slopes	C/D	55.92	0.89
36C	Hardscrabble silt loam, 7%–20% slopes	D	3.86	0.06
37B	Helvetia silt loam, 3%–8% slopes	C	11.06	0.18
37C	Helvetia silt loam, 8%–15% slopes	C	57.59	0.91
37D	Helvetia silt loam, 15%–30% slopes	C	74.58	1.18
41	Huberly silt loam	C/D	8.30	0.13
45B	Jory silty clay loam, 2%–8% slopes	C	1,052.74	16.67
45C	Jory silty clay loam, 8%–15% slopes	C	97.52	1.54
45D	Jory silty clay loam, 15%–30% slopes	C	17.74	0.28
45E	Jory silty clay loam, 30%–60% slopes	C	3.38	0.05
46B	Jory stony silt loam, 3%–8% slopes	C	345.80	5.48
46C	Jory stony silt loam, 8%–15% slopes	C	43.88	0.69
54B	Laurelwood silt loam, 3%–8% slopes	B	11.34	0.18
54E	Laurelwood silt loam, 30%–60% slopes	B	1.00	0.02
56	McBee silty clay loam	C	29.06	0.46
64B	Nekia silty clay loam, 2%–8% slopes	C	87.22	1.38
67	Newberg fine sandy loam	A	108.74	1.72
73	Riverwash		7.36	0.12
76B	Salem silt loam, 0%–7% slopes	B	67.53	1.07
78B	Saum silt loam, 3%–8% slopes	C	149.81	2.37
78C	Saum silt loam, 8%–15% slopes	C	141.37	2.24
78D	Saum silt loam, 15%–30% slopes	C	99.22	1.57
78E	Saum silt loam, 30%–60% slopes	C	10.54	0.17
7B	Borges silty clay loam, 0%–8% slopes	D	5.21	0.08
82	Urban land		345.94	5.48
84	Wapato silty clay loam	C/D	43.27	0.69
8B	Bornstedt silt loam, 0%–8% slopes	C	1,818.23	28.79
8C	Bornstedt silt loam, 8%–15% slopes	C	68.29	1.08

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Table 2-1. Soil Types				
NRCS map symbol	NRCS soil types	Hydrologic soil group	Acres within city limits	Percent of land within city limits
91A	Woodburn silt loam, 0%–3% slopes	C	31.49	0.50
91B	Woodburn silt loam, 3%–8% slopes	C	268.79	4.26
91C	Woodburn silt loam, 8%–15% slopes	C	116.96	1.85
92F	Xerochrepts and Haploxerolls, very steep	B	399.09	6.32
93E	Xerochrepts-Rock outcrop complex, moderately steep	C	146.35	2.32
W	Water		165.82	2.63
Total			**6,314.57**	**100**

2.4 Land Use

Oregon City is a community of both historic development and rapid growth. Most of the city's developed areas are residential lands of various densities. The oldest and newest parts of the city tend to have smaller lots. Large parcel residential areas on the east side of the city are slowly being replaced by partitions, adding residential homes. Areas along major highways are generally mixed-use with small businesses and commercial areas. This includes the corridors of Highway 99E, I-205, Highway 213, 7th Street, and Molalla Avenue. The land in the southeast corner of the city between Beavercreek Road and Molalla Avenue has the largest concentration of industrial and commercial land.

The population of Oregon City has increased by 25 percent from 2010 to 2015, as illustrated in Figure 2-5. Vacant lands are scattered in small pockets across the city. However, Oregon City is somewhat unique in its metro area, as the area has large parcels of undeveloped land within existing city limits. This has and will continue to allow for rapid development at the northeast and southeast edges of the city, as parcels do not need to be annexed prior to land use approval. The city also has large undeveloped areas within the Urban Growth Boundary (UGB) that is expected to allow a continued high pace of development into the foreseeable future.

Future growth will occur based on the projected development patterns shown in Figure 2-6, including new industrial and mixed-use areas, primarily in the southeast and northwest corners of the city. Significant residential growth is expected along the northeast and south borders of the city.

2.5 Climate and Rainfall

The northern Willamette Valley climate is characterized by cool wet winters and warm dry summers. Most rainfall occurs between October and April. On average, November is the wettest month with an average of 5.6 inches of rainfall. July and August are the warmest and driest months with average high temperatures above 80 degrees Fahrenheit and less than 1 inch of rain per month. The average annual precipitation is just under 36 inches with an average of 4 inches of snowfall annually.

In December 2015 the Portland metro area experienced a large rainfall event that delivered more than 5 inches of rain over a 3-day period and 2.81 inches in one 24-hour period. This event was estimated to be between a 50- and 100-year event because of the intensity and nature of the rainfall. These "severe" events are expected to occur more frequently as the earth undergoes climate change.

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City of Oregon City

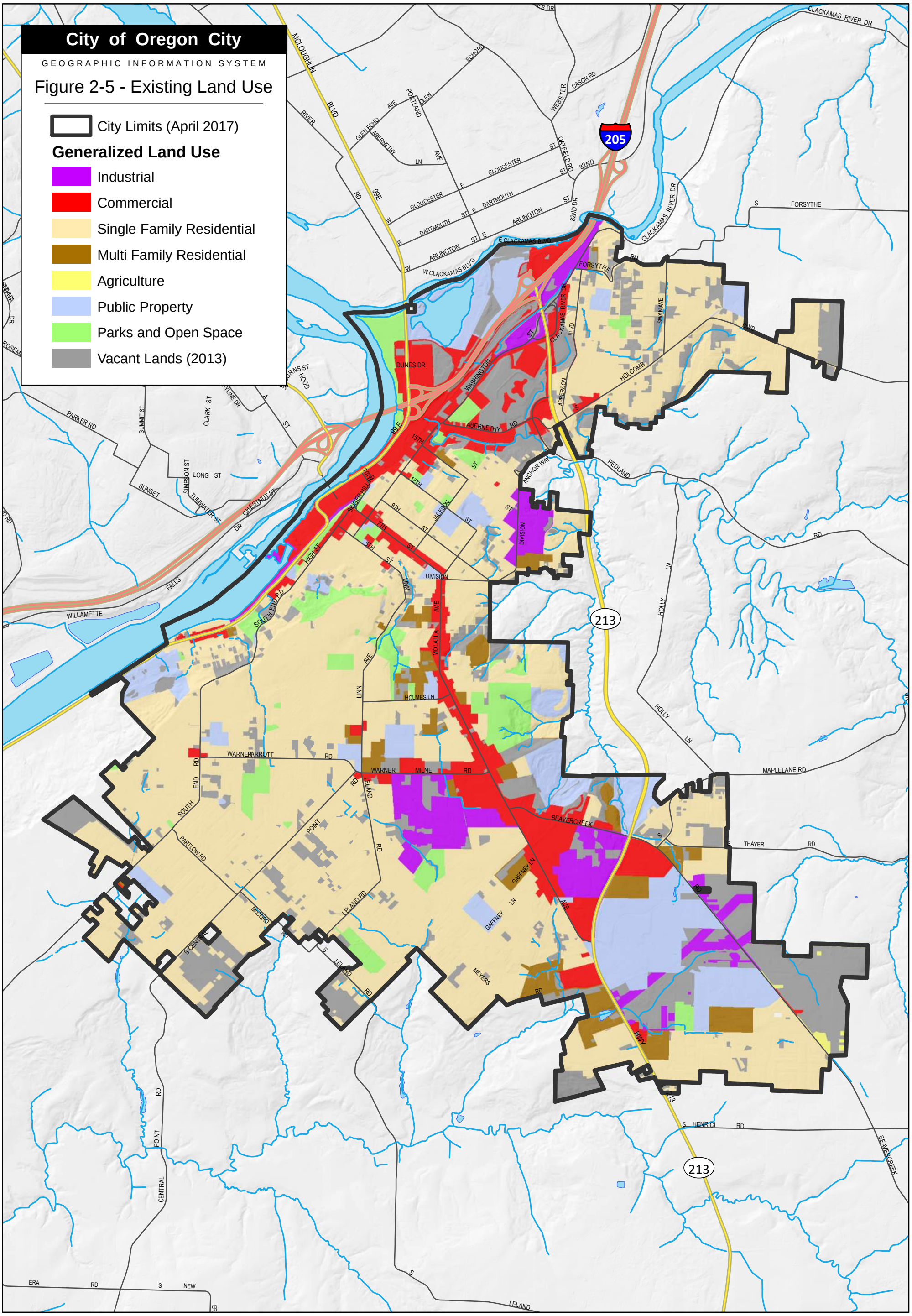
GEOGRAPHIC INFORMATION SYSTEM

Figure 2-5 - Existing Land Use

City Limits (April 2017)

Generalized Land Use

- Industrial
- Commercial
- Single Family Residential
- Multi Family Residential
- Agriculture
- Public Property
- Parks and Open Space
- Vacant Lands (2013)



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N W E S

0 0.5 1 2 Miles

0 5,000 10,000 Feet

City of Oregon City
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625 Center St
Oregon City, OR 97045
503-657-0891 phone
503-657-6629 fax
www.orcity.org

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Plot date: May 6, 2019
Plot name: SWMP - Existing Land Use - 11x17P - 20190506.pdf
Map name: SWMP - Existing Land Use - 11x17P.mxd

City of Oregon City

GEOGRAPHIC INFORMATION SYSTEM

Figure 2-6 - Future Land Use

City Limits (April 2017)

Generalized Land Use

- Industrial
- Commercial
- Single Family Residential
- Multi Family Residential
- Agriculture
- Public Property
- Parks and Open Space

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N W E S

0 0.5 1 2 Miles

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Plot name: SWMP - Future Land Use - 11x17P - 20190506.pdf
Map name: SWMP - Future Land Use - 11x17P.mxd

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2.6 Natural Systems

Oregon City land drains to three primary watersheds: the Willamette River, Abernethy Creek, and Beaver Creek. Relatively small portions of the city drain to the Clackamas River. Within these primary watershed areas, the City has identified 21 drainage areas, as shown in Figure 2-2. These drainage areas represent the drainage boundaries for smaller tributaries that contribute to the larger watersheds. Each of these systems has unique needs and is being impacted by development in different ways.

The area of Oregon City that drains directly to the Willamette River represents the older part of the City and is mostly developed. The land is primarily industrial, mixed use, parks, and residential. The natural systems within this area of the city are highly modified because of decades of development without stormwater management for water quality or flow control.



Beaver Creek is south of Oregon City with several tributaries to the creek originating within city limits. Many of these areas have seen significant residential development in the last few decades, and those developments have typically incorporated stormwater management as part of the development.

Abernethy Creek receives runoff from the east side of Oregon City. The land that drains to Abernethy Creek is a mix of residential, parks, public, commercial, and industrial.

Newell Creek or Newell Canyon, as it is referred to by the City, has several locations where erosion, bank sloughing, and landslides have occurred during and following storm events. The canyon is largely protected from development because of Metro ownership and protection. However, prior development of the drainage area contributing to Newell Canyon has resulted in some degradation of the natural systems.

2.7 Stormwater Infrastructure System

The City manages more than 160 miles (844,800 linear feet [LF]) of piped stormwater infrastructure and 14 miles (73,920 LF) of roadside drainage ditches. The topographic high point is generally at the center of the city and major receiving waters are located on all sides of the city. As a result, most of the City's drainage infrastructure consists of small, dispersed pipe and culvert systems, rather than large trunk lines. The City has more than 248 mapped outfalls from piped systems. At the time of this report-writing, the City currently manages over 2300 manholes, over 2400 catch basins, as well as 87 detention ponds, 88 drainage swales, 5 infiltration basins, 2 rain gardens, and 26 detention tanks.[2]

Oregon City has some of the oldest utility infrastructure in the state, with some areas of underground infrastructure suspected to be more than 100 years old. The downtown area of the city and the Canemah neighborhood were once served by a combined sanitary sewer and storm system, which was separated in the 1980s and 1990s. The pipes that previously served the old combined system

[2] For detailed information on the City's infrastructure please see the City of Oregon's online GIS portal at https://www.orcity.org/maps.

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are still used for stormwater flows. The City currently has a growing database of information regarding underground utility conditions from CCTV surveys (see Section 4).

While significant areas of stormwater assets are aging, the city continues to grow and expand at the northern and southern ends of town, increasing the miles of pipes and infrastructure that need to be managed and maintained.

2.8 Recent Projects

The City regularly implements stormwater-related projects to address acute problems and correct system deficiencies. Projects may be CIPs funded through the City's capital program or smaller construction efforts, implemented by the City's maintenance staff. The City's recent stormwater infrastructure projects have included the following:

- **15th Street Stormwater Repair.** Along 15th Street between Main and Center Streets, the City replaced 500 LF of pipe and installed two 60-inch manholes, two curb inlets, and two catch basins with sumps. The project also included installing a manhole and pipe on 15th Street between John Adams Street and Jackson Street.
- **High Street Reconstruction Project.** Stormwater improvements were incorporated into this street project on High Street between 1st and 2nd Streets; installed a ditch inlet, two manholes and 290 LF of pipe.
- **Coffee Creek Culvert Rehabilitation.** Installed four manholes and 200 LF of pipe near Hedges Street and 3rd Avenue.
- **14th Street Storm Drain Improvements.** Extended the stormwater collection system with 450 LF of pipe and sumped catch basins.
- **OR99E, Clackamas River Bridge to Dunes Drive Improvements.** Installation of a water quality treatment rain garden, water quality manhole, and a 2,550 LF collection system.
- **Oregon City Pavement Improvements.** The City works to incorporate water quality improvements into pavement projects. The work often involves installing sumped catch basins or manholes, replacing deteriorated pipe, and/or extending the upstream point of an existing collection system in areas where paving projects are opening up the roadway section. Recent work has occurred on Molalla Avenue, between Beverly Drive intersections, Brighton Avenue between Summit and Creed Streets, and at 9th Street and Washington Street.

2.9 Future Planning Areas

Future planning areas include areas of growth and new development, as well as infill and redevelopment. To date, the City has adopted three concept plans with stormwater implications and is in the planning stages for redevelopment of the Willamette Falls Downtown District. The City may identify additional planning areas in the future.

2.9.1 Concept Plans

Concept plans for major planning areas have been developed to guide future development and expansion as the City grows. Concept plans address areas that are included in the City and urban growth boundary or adjacent areas but have yet to undergo significant development. The plans facilitate communication with citizens and stakeholders by laying out how the area might be developed with respect to land use, transportation, natural resources and utility planning. Concept plans also aid in determining future financial implications and the level of potential investment required to develop throughout the planning area.

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Three concept plans have been developed for the City of Oregon City which include:

- *South End Concept Plan* completed in March of 2014. This plan includes the areas along South End Road from Rose Road at the north end to S May Road. The concept area surrounds a tributary to Beaver Creek that drains south, away from the City core.
- *Beavercreek Road Concept Plan* completed in August of 2008. This plan includes the areas east of S Beavercreek Road, south of S Thayer Road and north of S Old Acres Lane. The concept area is west of Thimble Creek and generally drains east, away from the City's primary stormwater conveyance systems.
- *Park Place Concept Plan* completed in March of 2008. The areas roughly east of Hwy 213, south of Holcomb Boulevard, north of S Morton Road and west of S Edenwild Lane. Abernethy Creek drains through the middle of the Park Place concept area.

These concept plans outline basic assumptions for the type and quantities of stormwater infrastructure that may be required to develop the planning areas. These assumptions are useful for fiscal planning (see Section 8.4), but the eventual layout of the stormwater conveyance systems and management facilities will be crafted through the preliminary and final design process for each area.

This master plan is a conceptual evaluation of future conditions. More refined analysis will be needed for concept areas to evaluate projected runoff rates and develop the details of the required stormwater infrastructure. That analysis should consider roadway layout, detailed land use plans, open space areas, and opportunities to manage stormwater green facilities, as well as the traditional piped conveyance system.

2.9.2 Redevelopment Areas

The City is a partner in the Willamette Falls Legacy Project, which will provide public access to the falls and facilitate redevelopment of the historic Blue Heron Mill property. Redevelopment of the Willamette Falls Downtown District will require stormwater collection, conveyance, and water quality treatment. The area is exempt from flow control, due to the proximity to the Willamette River.

Stormwater management in the Willamette Falls Downtown District will require a unique approach, including public and private partnerships, regional facilities, treatment trades, and fee-in-lieu agreements. Together, these approaches will achieve the overall stormwater management objectives of water quality treatment and natural resource protection on a district scale.

2.9.3 The Cove Development

The area around Clackamette Cove is another area planned for redevelopment. The full build-out of the Waterfront Residences project will consist of upgraded roadways, a multi-use esplanade path, residential and mixed use buildings, and associated parking and landscaping. The project is anticipated to include stormwater management conveyance systems, facilities that enhance water quality treatment, and mitigation to restore riparian habitat and designate recreational access.

2.10 Stormwater Program Management

Stormwater program management includes maintenance, program operations, and program funding as described in the following subsections.

2.10.1 Maintenance Obligations

Maintenance of the City's assets is important to ensure that the full life expectancy of these assets is realized. The City allocates nine full-time equivalents (FTEs) per year for stormwater system maintenance. However, City maintenance crews share responsibilities for multiple utility and

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infrastructure assets. Maintenance activities occur on a scheduled basis and in response to citizen and staff requests. In the prior budget biennium (2015–17), major accomplishments included the following:

- Swept 9,131 curb miles and collected 3,254 cubic yards of debris and leaves.
- Corrected four sanitary to storm cross-connections.
- Maintained 75 detention ponds.
- Mowed and maintained 17 drainage ditches and bioswales (7,700 LF).
- Inspected and/or cleaned 1,460 catch basins and 45 pollution control manholes.
- CCTV inspected over 200,000 LF of pipes.
- Transitioned all underground utility locates to a paperless electronic system.

2.10.2 Program Operations

Programmatic stormwater activities are generally implemented in response to NPDES MS4 permit requirements. Program implementation is documented annually in the City's NPDES MS4 permit annual report. Recent program highlights include:

- Continued stormwater quality sampling in coordination with Clackamas County Service District #1 and co-permittees.
- Completed more than 1,000 erosion control inspections.
- Developed and implemented a private stormwater quality facility inspection program.
- Developed and implemented a commercial/industrial inspection program.
- Completed quarterly water quality inspections of municipal operations facilities.

2.10.3 Program Funding

The stormwater program is funded primarily through stormwater utility fees (see Table 2-2). Utility fee revenue for 2017–18 and 2018–19 is projected to be approximately $2.65 million per year. In the past, the stormwater utility rate included an annual rate increase. At a rate increase of $0.30 per dwelling unit per month, the stormwater program revenue continued to grow each year. The annual increases are scheduled to lapse during the 2017–19 biennium. However, the City plans to complete a stormwater rate study that may result in a future adjustment to stormwater utility rates.

In addition to maintenance, staffing levels for the City's stormwater program are currently at 9.0 FTE, exclusive of shared administrative and supervisory personnel. Staffing of the program accounts for approximately 37 percent of the annual stormwater budget to cover engineering, maintenance, and water quality staff. Approximately 26 percent of the budget is allocated to materials and services and approximately 17 percent (roughly $1.1M) per year is allocated to capital improvements. The remaining budget covers other transfers and contingency funds.

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Table 2-2. Stormwater Operations Funding Summary, 2017-2019	
Resources	
Beginning Fund Balance	$1,140,500
Charges for Services (Utility Fees)	$5,302,842
Licenses and Permits	-
Intergovernmental	$28,000
Interest Income	$6,000
Miscellaneous Income	-
Total Resources	$6,477,342
Requirements	
Personnel Services	$ 2,418,834
Materials & Services	$1,679,704
Capital Outlay	$1,105,000
Transfers Out	$810,000
Contingency	$463,804
Unappropriated Fund Balance	-
Total Requirements	**$6,477,342**

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Section 3

Storm System Capacity Evaluation

Providing stormwater conveyance to prevent flooding is the primary function of the City's stormwater infrastructure. The City has several drainage systems that are too small and unable to convey existing flows. As part of the master planning evaluations, a series of hydraulic models were developed to analyze the capacity of the conveyance system.

The objectives of this storm system capacity evaluation included developing hydrologic and hydraulic (H/H) models. The hydrologic models estimate existing and future conditions flows across the city. Hydraulic modeling is used to analyze the conveyance system to verify problem areas, understand conveyance system complexities, and to analyze potential capital projects to alleviate problem areas and meet desired levels of service.

Developing a city-wide hydraulic model was determined to be cost-prohibitive, which led to the selection of 12 locations to analyze through focused hydraulic modeling. Key findings from the H/H model evaluation include:

- Central Point basin has an undersized conveyance system in the vicinity of Central Point Road that is further complicated by a series of irregular flow patterns and structure connections.
- The Coffee Creek area near Hazelwood Drive is an ongoing capacity concern that impacts private properties.
- The Holcomb Boulevard conveyance system is not large enough to accommodate current flows and expected to be further stressed by projected development in the Livesay basin.
- The John Adams basin has the greatest concentration of flooding stormwater structures, requiring significant capital investment to upsize existing infrastructure and relocate structures from private property into the public right-of-way.
- Existing culverts in the Park Place basin may not have capacity for current flows, but the drainage system is likely to be modified with future development.
- The conveyance systems through Singer Basin have inadequate capacity for peak storm events, and potential projects should be focused on replacing structures that are deteriorating due to age (See Section 4).
- The South End basin will need an upsized conveyance system to support future development and expansion of South End Road.
- The drainage system around Beavercreek Road and Molalla Avenue may pond in the roadways during peak events, as water is stored in underground detention tanks, which prevents higher flows to Newell Canyon.

The following section details how capacity issues were evaluated and discusses the development of models, and model results. The results of this evaluation led to a series of CIP recommendations to address both existing and future capacity constraints as outlined in Section 7.

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Figure 3-1 below illustrates identified stormwater problem areas and Figure 3-2 shows the locations of hydraulic model. Figures 3-3 through 3-10 show the hydraulic model framework, as well as locations of flooded nodes. For information on proposed improvements in these areas, please see the CIP fact sheets, in Appendix F.

3.1 Capacity Evaluation Approach

Rather than constructing an expensive citywide hydraulic model, this study focused the City's limited resources to evaluate areas where flooding is known or suspected to be a problem. Most areas developed since the adoption of the City's Stormwater Flow and Detention Standards (1999) have been designed for full buildout of the surrounding drainage area and therefore have adequate capacity for stormwater conveyance. However, older infrastructure areas may have trunk lines that were installed without long-term planning. These areas were targeted by this evaluation as suspected locations for undersized infrastructure.

The approach to evaluating stormwater conveyance capacity included the following five steps:

1. Compile a list of known and suspected problem areas
2. Classify problems according to suspected causes and determine which areas should be evaluated through H/H modeling
3. Identify the levels of service required for the various types of conveyance throughout the city
4. Develop hydraulic models to verify capacity problems and evaluate potential causes
5. Use the hydraulic models to simulate alternative conveyance system designs to identify potential solutions to capacity problems

The identification of problem areas can come from multiple sources such as City staff or residents. Typically, this information is generated through a survey and workshops with City staff. Problem areas are identified and then reviewed and evaluated for the likely cause of the issue if not known. Those areas that are identified as areas with capacity problems are then further evaluated through hydraulic modeling to determine the cause and/or potential CIP solution.

3.2 Problem Area Identification

Problem area identification is a synthesis of data and input from numerous sources to develop a master list of problem areas. This study followed this framework to develop a master list of problem areas, sorted by problem type and source. The identified problems are shown on Figure 3-1 and documented in a matrix provided in Appendix A.

Problem area data sources included the following:

- Watershed workshop with City staff
- City maintenance staff problem area maps and notes
- Citizen input at public meetings and events
- Previous technical studies and master plans

Winter storm events in 2015 and 2016 caused widespread flooding across the Portland Metro region. A driving assumption for this study was that recent storm events are good indicators of stormwater system capacity. Areas that did not experience significant flooding in 2015 or 2016 were assumed to have capacity for existing conditions flows.

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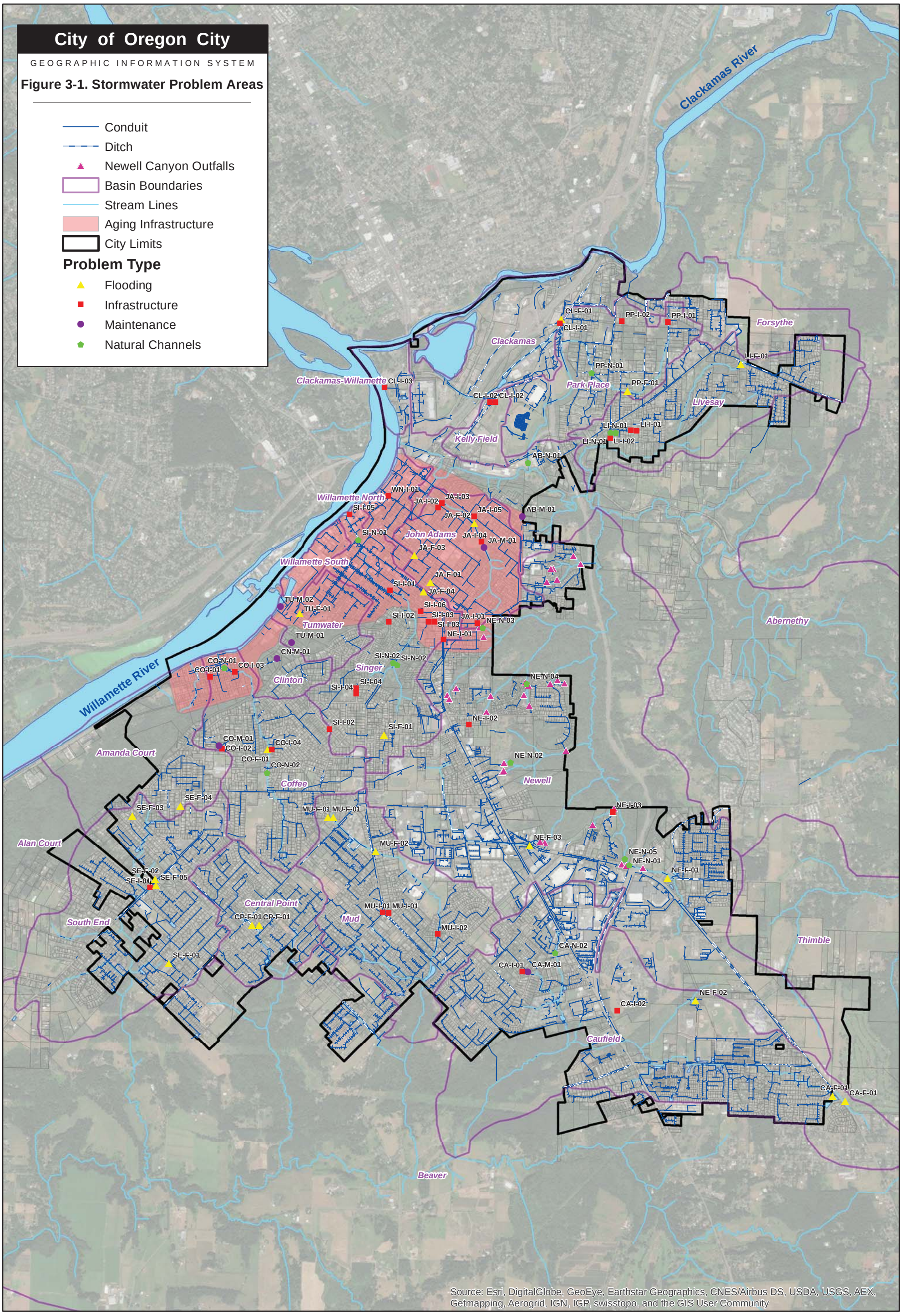
GEOGRAPHIC INFORMATION SYSTEM

Figure 3-1. Stormwater Problem Areas

- Conduit
- Ditch
- Newell Canyon Outfalls
- Basin Boundaries
- Stream Lines
- Aging Infrastructure
- City Limits

Problem Type

- Flooding
- Infrastructure
- Maintenance
- Natural Channels



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Plot date: June 20, 2017
Plot name: Figure 3-1 Problem Areas.pdf
Map name: Figure 3-1 Problem Areas.mxd

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GEOGRAPHIC INFORMATION SYSTEM

Figure 3-2. Hydraulic Model Locations

- Conduit
- Ditch
- Hydraulic Model Location
- Stream Lines
- City Limits

Clackamas River

Willamette River

Park Place

Livesay / Holcomb

John Adams

Singer Creek

Coffee Creek/ Hazelwood

Newell Creek

South End

Central Point

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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Map name: Figure 3-2 Hydraulic Model Locations.mxd

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3.2.1 Watershed Review Workshop

The watershed workshop conducted in December 2015 provided the primary opportunity for City staff to inform the problem areas list. The workshop allowed City and consultant staff to discuss stormwater system conditions in each of the City's 21 watershed areas. Staff from engineering, maintenance, development review, and water quality all attended the workshop to provide insights regarding stormwater system problems and opportunities. For each watershed area, the group discussed the development history, major stormwater facilities, anticipated development and redevelopment areas, and planned future projects. The group also brainstormed known and suspected problems related to flooding, failing infrastructure, missing infrastructure, water quality, and other concerns.

Following the workshop, all attendees were given an opportunity to review the workshop minutes and expand on the list of problem areas identified.

3.2.2 Maintenance Maps

Following the workshop, City maintenance staff also developed a series of maps, using sticky notes to mark problem areas throughout the city. The marked problem areas included locations that staff have observed themselves, areas where citizens have called to report drainage problems, and problem areas recorded in the City's Lucity tracking system. These maps provided additional detail to the information gathered during the larger staff workshop, as each note included the location, severity, and nature of the problem.

Through this effort, maintenance staff also identified locations of "priority drains" that commonly have flooding problems. Maintenance staff conduct drive-by inspections of priority drains during storm events so that they can remove blockages or post high-water warnings.

3.2.3 Public Meetings and Events

The following four public outreach events were conducted:

- Citizen Involvement Committee meeting (February 2017)
- Natural Resources Committee meeting (February 2017 and April 2019)
- Neighborhood meeting with the Canemah neighborhood (February 2017)

Public notice was provided through posted meeting agendas and information on the City's website. Additional information about the project was provided during Planning Commission meetings and briefings to City Commission.

At each event, a presentation was conducted to share an overview of the Plan, and attendees were given the opportunity to make notes on printed maps regarding drainage problem areas and other stormwater-related concerns. Attendees were also encouraged to complete a stormwater infrastructure survey to provide written input to the master planning process.

3.2.4 Previous Plans

The project team reviewed existing technical studies and previously developed master plans to document previously identified problem areas and/or recommended projects. The plans reviewed included the following:

- Oregon City Drainage Master Plan, 1988
- Caufield Basin Master Plan, 1997 (planning area concept plan)
- South End Basin Master Plan, 1997 (planning area concept plan)
- Greater Oregon City Watershed Council, Watershed Action Plan, 2010

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3.3 Problem Area Classification

While the stormwater problem area list is extensive, most of the reported problems have limited supporting data or specific documentation. The list of stormwater problem areas included descriptions based on one event, a citizen's phone call to City staff, or anecdotal evidence of flooding observed by maintenance crews working on another issue. Determining the source or cause of the reported problem can be challenging with such limited data, so additional investigation or modeling is required to evaluate the problem areas and investigate potential solutions.

Once the problem areas list was compiled and vetted with City staff, the master list was divided into problem types. For this study, the following five problem types were considered:

- **Flooding:** observed or reported capacity concerns in open channels or conveyance systems
- **Infrastructure:** locations of failing infrastructure or missing infrastructure, such as neighborhoods constructed without stormwater conveyance systems
- **Maintenance:** priority drains and other areas that require frequent maintenance attention
- **Natural systems:** erosion or water quality concerns in creeks and tributaries
- **Opportunities:** potential project areas, previously identified by other plans or staff observation

Duplicate entries were used for problem areas that fell into multiple categories. Duplicate entries were also used for problem areas that were reported by more than one source. This methodology resulted in some problem areas showing up multiple times in the problem areas list (Appendix A) and map (Figure 3-1).

Flooding or capacity problem areas were then further evaluated to determine if hydraulic modeling would be beneficial to better understand the problem or to develop a conceptual solution. Typically, the systems that require modeling are longer pipe segments that may have complex flow dynamics, larger catchments that have higher rates of flow, or areas where there are higher risks of impacts to infrastructure or private property if the problem is not addressed. City staff and the consultant team worked together to determine where hydraulic models should be developed as part of this storm system capacity evaluation.

3.4 Levels of Service

Levels of service are defined as the design storm (peak flow) that the conveyance infrastructure should carry downstream without surcharge or flooding. The level of service can vary depending on the location of the infrastructure and the drainage area. For instance, a pipe conveying flow from a residential neighborhood will require a level of service equal to the 25-year, 24-hour storm event. However, a culvert or pipe system conveying drainage from several neighborhoods may require that the level of service be equal to the 50 year, 24-hour storm event because of the consequences of failure for that culvert (road washout) as opposed to consequences of failure in a residential neighborhood (localized ponding).

For Oregon City, levels of service for the stormwater conveyance system are defined in the City's Stormwater and Grading Design Standards, February 2015. Table 3-1 documents the City's standard requirements, which were applied to this Master Plan. In most areas of the city, the municipal stormwater conveyance system should be designed for the 25-year, 24-hour storm event because contributing drainage areas are between 40 acres and 640 acres in area.

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Table 3-1. Stormwater Conveyance System Levels of Service			
Contributing drainage area	Design storm for conveyance system sizing		
	Storm sewer, culverts and outfall	Creek or stream channels	Bridges
Less than 40 acres	10-year, 24-hour storm	10-year, 24-hour storm	100-year, 24-hour storm
40–640 acres	25-year, 24-hour storm	25-year, 24-hour storm	
640 acres or greater	50-year, 24-hour storm	50-year, 24-hour storm	

Source: Oregon City Stormwater and Grading Design Standards.

3.5 Model Development Summary

The development of an H/H model typically includes two major steps. First, the hydrology (the relationship between rainfall and runoff) is developed for the catchment contributing to the problem area, which may include multiple subcatchments. The hydrology is also developed with consideration for the interest points where the hydrology input will be needed in the model such as at pipeline junctions, significant changes in system slope, or locations where there are changes in conveyance pipe or channel size. Second, the conveyance system is developed upstream and downstream of the identified problem areas to the extent that is necessary to appropriately assess the location hydraulics. The model is then used to verify the problem and develop alternatives to correct the deficiency.

There are eight locations (see Figure 3-2) where hydraulic models were developed as part of this master planning effort:

- **Central Point Basin:** Modeled from Vincent Drive to the outfall near Sunset Springs and McCord Road and from Crisp Drive to Pavilion Place down to Pease Road.
- **Coffee Creek Basin:** Modeled from Warner Parrot Road to Barker Road.
- **Livesay Basin:** Modeled Holcomb Blvd from Kittyhawk Avenue to the outfall on Oak Tree Terrace.
- **John Adams Basin:** Includes three conveyance systems that meet at Washington Street and 12th Street. The modeled segments start at 12th Street and Harrison, 8th Street and Taylor, and 9th Street and Madison Street.
- **Park Place Basin:** Modeled from Swan Avenue to the outfall at Apperson Blvd and La Rae Street.
- **Singer Creek Basin:** Modeled from 6th Street and Harrison Street to the outfall at Singer Hill and 7th Street.
- **South End Basin:** Modeled South End Road from S Gentry Way to the outfall between Salmonberry Drive and S Forest Ridge Road.
- **Newell Creek Basin:** Modeled the Warner Milne system from Beavercreek Road, across Molalla Avenue, to the outfall west of the Beavercreek Road/Molalla Avenue intersection.

One-dimensional XP-SWMM hydraulic models were developed based on existing geographic information system (GIS) data provided by the City, field survey collected as part of the master planning effort, and site visits conducted by consultant staff.

The existing hydrology for the 25-year storm event was used in the initial model built to evaluate the capacity of the existing infrastructure. Future hydrology is based on the future land use classifications outlined in City planning documentation. The hydrology for future conditions was applied to the existing-conditions hydraulic model. This process enables the future hydrology to be applied to the existing infrastructure and assessed for future capacity and other potential problems.

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Limited model validation was performed by comparing the existing-conditions hydraulic modeling results to anecdotal flood reports. No model calibration was included with this study because of a lack of available flow data, images from storm events, or verbal descriptions of flooding.

Additional details related to H/H model development and analysis are included in Appendices B and C.

3.6 Model Results

The modeling shows flooding and capacity problems that are generally consistent with reported problem areas. The following sections summarize the model results and suspected causes of system capacity problems. Appendix C provides more detailed information and model results in a tabular format.

3.6.1 Central Point Basin

The hydraulic model results (see Figure 3-3 and Table 3-2) for the Central Point Basin show that the pipe at the downstream end of the open channel along South McCord Road between South Central Point Road and Sunset Springs Drive is undersized. This causes flooding to occur during the 25-year design event. This flooding simulated by the model is consistent with problems reported by City staff. In addition to undersized pipes, the system capacity is further reduced by several 90-degree bends in the drainage network. The roadway drainage discharges on the west side of Central Point Road near Kathaway Court, where it joins the main channel to flow back under Central Point Road to the east. The flooding is most problematic at 19451 Sunset Springs Drive.

The second area of modeling shows that the existing infrastructure on Pease Road is at capacity and water surface elevations are near the surface, but it has adequate capacity to carry future flows during the 25-year storm event.

City maintenance staff have recently modified the inlet/outlet structures near Kathaway Court to reduce losses and improve flow capacity. These modifications improved conditions and reduced flooding during the 2016/17 winter storm events. No capacity projects are recommended for the Central Point conveyance system at this time. The City will continue to monitor the drainage network to determine if any further improvements are needed.



Inlet to culvert under Central Point Road on private property.

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Table 3-2. Central Point Basin Hydraulic Model Results for 25-yr Storm						
Link ID	Node name		Ground elevation (ft)		Existing max water surface elevation (ft)	
	US	DS	US	DS	US	DS
808424	42490_CP_0500	38777	444.58	448.68	443.97	440.61
803448	33962	35483	467.71	467.48	467.71	460.86
803449	35483	35481	467.48	450.42	460.86	444.94
803703	35630	35478	439.21	432.23	431.70	430.10
807429	37879_CP_0800	33962	468.84	467.71	477.46	467.71
808422	33002	39749	447.90	445.23	444.38	443.98
808427	39588	34501	438.46	438.50	434.54	434.27
808428	34502	39588	440.22	438.46	435.42	434.54
808653	38733_CP_0800	35630	440.18	439.21	432.43	431.70
808654	35481	38733_CP_0800	450.42	440.18	444.80	432.43
809337	34503	34502	441.35	440.22	436.83	435.42
809791	34248_CP_0100	35487	438.92	438.59	438.57	437.31
809793	35487	35484	438.59	437.00	437.31	435.23
812537	39749	42490_CP_0500	445.23	444.58	443.98	443.97
Link18	33700_CP_0600	33002	450.79	447.90	445.59	444.38
Link19	38888	30909_CP_0400	441.29	439.11	440.45	439.11
Link20	30909_CP_0400	34503	439.11	441.35	439.11	437.84
Link21	38777	38888	448.68	441.29	440.61	440.45
Link25	35484	35478	437.00	432.23	435.23	429.59
Link26	35478	40654	432.23	425.18	429.59	423.89
Link27	34501	33145	438.50	435.27	434.27	433.27

**Shaded rows indicate a flooded link during simulation of the 25-year design event.*

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3.6.2 Coffee Creek Basin

The hydraulic model was used to evaluate the open-channel system along the Coffee Creek alignment. The system is mostly open channels with culverts at road crossings and other restrictive hydraulic features on private property.

The hydraulic model results (see Figure 3-4 and Table 3-3) for the Coffee Creek Basin show flooding around hydraulic constrictions beginning at the 10-year design storm. The water overtops the banks of the channel, flooding the backyards of residential homes. The flooding is most problematic near 939 Hazelwood Drive where the creek crosses Hazelwood Drive. The southeast corner of Hartke City Park and properties in the area flood because of a restriction built into the channel. An undersized rusted corrugated metal pipe (CMP) in the backyard of the home at 965 Hazelwood Drive is another restriction along the creek. The system also has multiple constrictions and modified culvert inlets that greatly reduce the capacity of the open-channel system.

City staff have been actively working with homeowners to address constrictions in the existing system. In terms of CIPs, a 24-inch high-flow bypass is being recommended as a possible course of action to mitigate flooding within the neighborhood. Modeling of this scenario show reduced flooding in the private residential areas. The project may also require expanding the existing crossing near 930 Hazelwood Drive (Node "CO_0300" in Figure 3-4) to fully convey the 25-year peak flow.

Table 3-3. Coffee Creek Basin Hydraulic Model Results for 25-yr Storm

Link ID	Node name		Ground elevation (ft)		Existing max water surface elevation (ft)	
	US	DS	US	DS	US	DS
618.1	42534_CO_0500	42533	445.16	444.48	443.75	441.87
802016	40182_CO_0800	34657	456.03	456.54	455.71	453.97
808374.1	40182_CO_0800	34657	456.03	456.54	455.71	453.97
808377	42472_CO_0600	42473	453.69	454.24	452.54	450.47
808379.1	42475_CO_0400	42474	417.69	416.03	416.96	412.85
808379.2	42475_CO_0400	42474	417.69	416.03	416.96	412.85
808867	CO_0300	42552	433.21	432.52	433.21	430.25
Backyard	42534_CO_0500	42533	445.16	444.48	443.75	443.07
Link10	42552	42475_CO_0400	432.52	417.69	430.25	416.96
Link11	Node16	Node17	450.46	450.36	450.46	447.43
Link12	Node17	42534_CO_0500	450.36	445.16	447.43	443.75
Link13	42533	Node19	444.48	441.82	441.87	441.53
Link14	Node19	Node20	441.82	442.53	441.53	440.00
Link15	Node20	CO_0300	442.53	433.21	440.00	433.21
Link6	34657	40188_CO_0700	456.54	457.06	453.97	452.97
Link7	40188_CO_0700	42472_CO_0600	457.06	453.69	452.97	452.54
Link8	42473	Node16	454.24	450.46	450.47	450.46

**Shaded rows indicate a flooded link during simulation of the 25-year design event.*

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3.6.3 Livesay Basin

The Livesay Basin model was built to assess reported flooding and verify capacity of the existing infrastructure to manage flows from future development, as well as assess system capacity from recent developments already built at Abernethy Landing. Model results revealed that much of the infrastructure along Holcomb Boulevard is undersized and will need to be replaced if future development is to occur within the drainage area. A future conditions model was developed that takes into account the development and drainage improvements made as a part of the Abernethy Landing project. The updated model shows flooding begins for the future flow scenario at the 2-year design event. The most significant flooding occurs at the transition between open channels and piped flow where the stormwater system from the north side of Holcomb Boulevard crosses to the south side, west of Oaktree Terrace. Additional flooding occurs downstream of this location before the drainage system turns south under Oaktree Terrace. Modifying the inlet structures to increase hydraulic efficiency and properly sizing the downstream infrastructure is likely needed to alleviate flooding. In addition to proper sizing of conduits, relief of flooding has the potential to increase flows downstream. The design of improvements to alleviate flooding will also need to assess impacts to natural systems due to increased flows and velocities at the outfall to the natural system.

The Livesay Basin is an area of expected future development and the flooding problems are shown to be a result of increased flows as the basin is projected to increase in impervious surfaces. Projects to upsize the Holcomb Boulevard conveyance system should be constructed in conjunction with future development in the basin. The hydraulic model results for the Livesay Basin are shown in Table 3-4 with model extents shown on Figure 3-5.

Table 3-4. Livesay Basin Model Hydraulic Model Results for 25-yr Storm

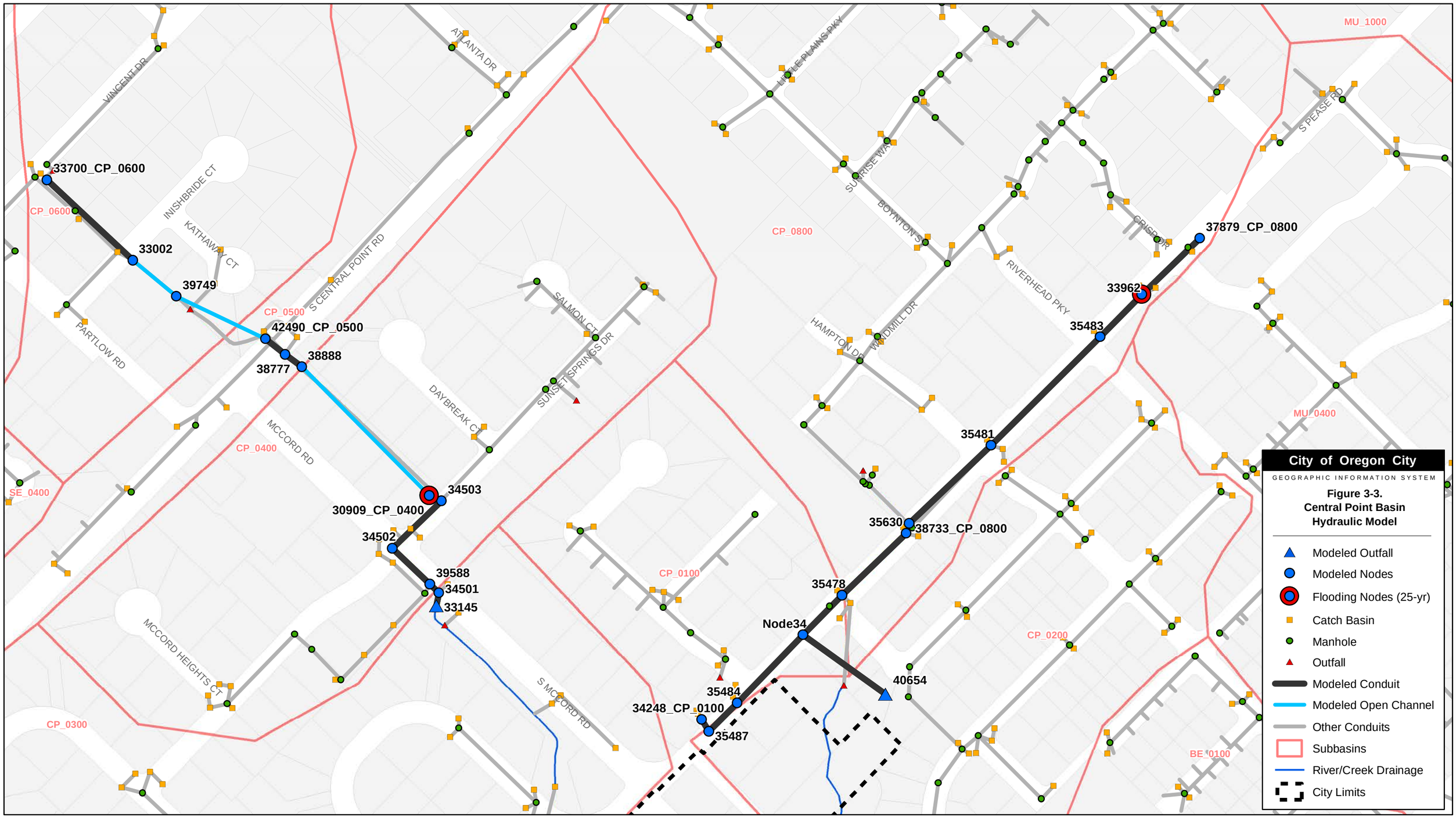
Link ID	Node name		Ground elevation (ft)		Existing max water surface elevation (ft)	
	US	DS	US	DS	US	DS
Link1	33740_LI_1200	33742	512.76	510.16	504.45	502.75
Link13	34160	42491	435.25	432.4	430.89	429.04
Link14	32573_LI_1100	34374_LI_1000	441.61	430.48	438.97	423.98
Link15	34374_LI_1000	35610	430.48	418.42	423.89	411.91
Link16	35610	35612	418.42	412.91	411.91	409.76
Link17	35612	35607	412.91	400.77	409.42	398.73
Link18	35607	35686	400.77	398.88	398.73	396.20
Link19	35686	39436	398.88	385.02	396.20	384.72
Link2	33742	34162_LI_1100	510.16	505.96	502.55	501.43
Link20	39436	34997	385.02	379.93	384.72	377.48
Link21	34997	30828_LI_0600	379.93	366.9	377.48	364.33
Link22	30828_LI_0600	39842	366.9	368.26	364.32	357.13
Link23	42491	39313_LI_1000	432.4	428	429.04	426.72
Link24	39313_LI_1000	Node25	428	403.39	426.12	403.03

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Table 3-4. Livesay Basin Model Hydraulic Model Results for 25-yr Storm						
Link ID	Node name		Ground elevation (ft)		Existing max water surface elevation (ft)	
	US	DS	US	DS	US	DS
Link25	Node25	35607	403.39	400.77	403.03	398.73
Link29	Node31	Node31.1	519.47	512.76	509.17	507.72
Link29.1	Node31.1	Node34	512.76	506.82	507.72	502.97
Link3	34162_LI_1100	34161	505.96	465.63	501.43	461.29
Link30	Node34	34162_LI_1100	506.82	505.96	502.97	501.73
Link4	34161	33066	465.63	453.44	461.29	450.27
Link5	33066	33065	453.44	438.65	450.22	436.36
Link6	33065	34160	438.65	435.25	436.36	430.89

**Shaded rows indicate a flooded link during simulation of the 25-year design event.*

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City of Oregon City

GEOGRAPHIC INFORMATION SYSTEM

Figure 3-3.
Central Point Basin
Hydraulic Model

- Modeled Outfall
- Modeled Nodes
- Flooding Nodes (25-yr)
- Catch Basin
- Manhole
- Outfall
- Modeled Conduit
- Modeled Open Channel
- Other Conduits
- Subbasins
- River/Creek Drainage
- City Limits

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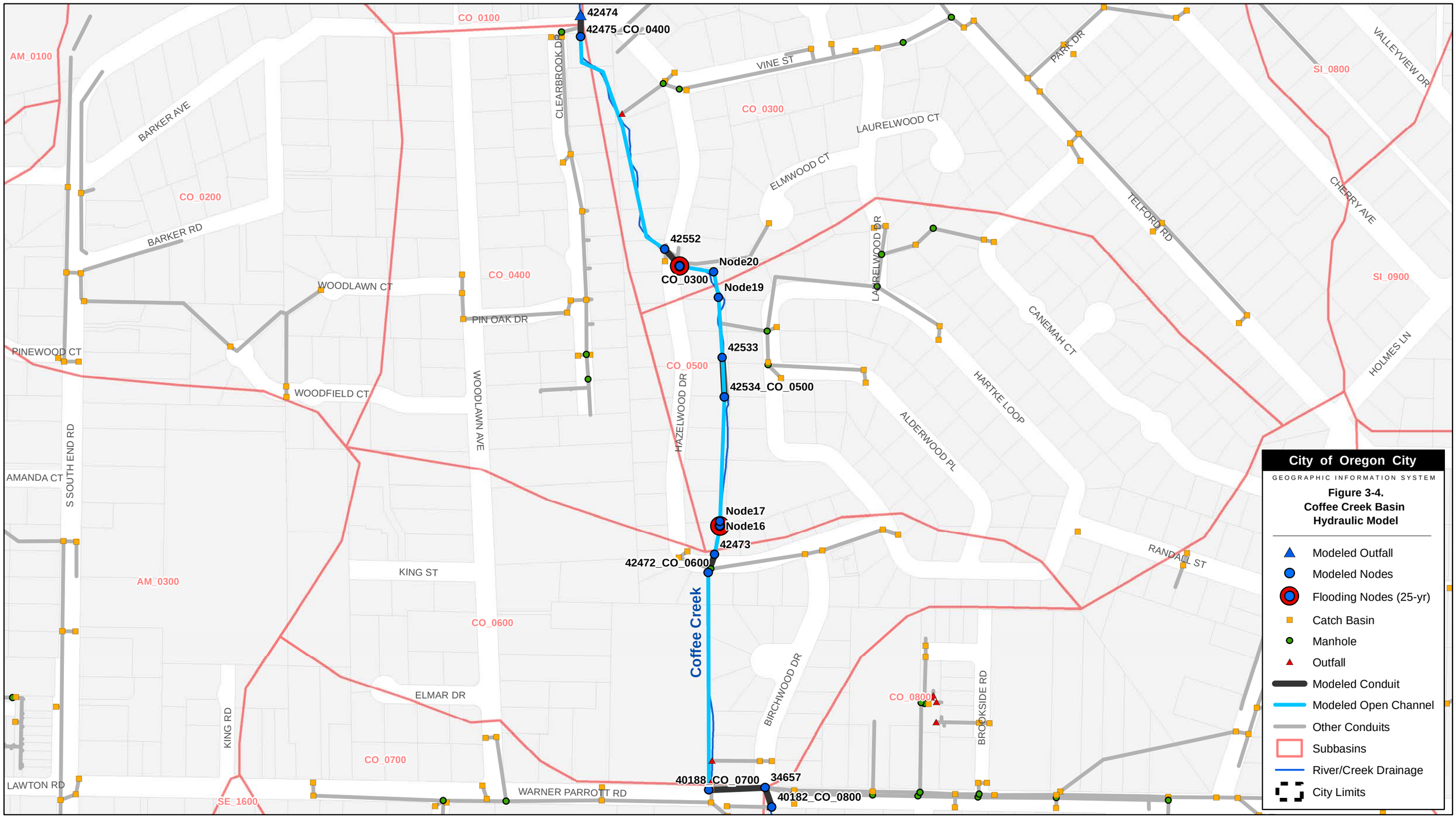
N W E S

0 200 400 800 1,200 Feet

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Plot date: June 20, 2017
Plot name: Figure 3-3 Central Point Basin.pdf
Map name: Figure 3-3 Central Point Basin.mxd



City of Oregon City

GEOGRAPHIC INFORMATION SYSTEM

Figure 3-4.
Coffee Creek Basin
Hydraulic Model

- Modeled Outfall
- Modeled Nodes
- Flooding Nodes (25-yr)
- Catch Basin
- Manhole
- Outfall
- Modeled Conduit
- Modeled Open Channel
- Other Conduits
- Subbasins
- River/Creek Drainage
- City Limits

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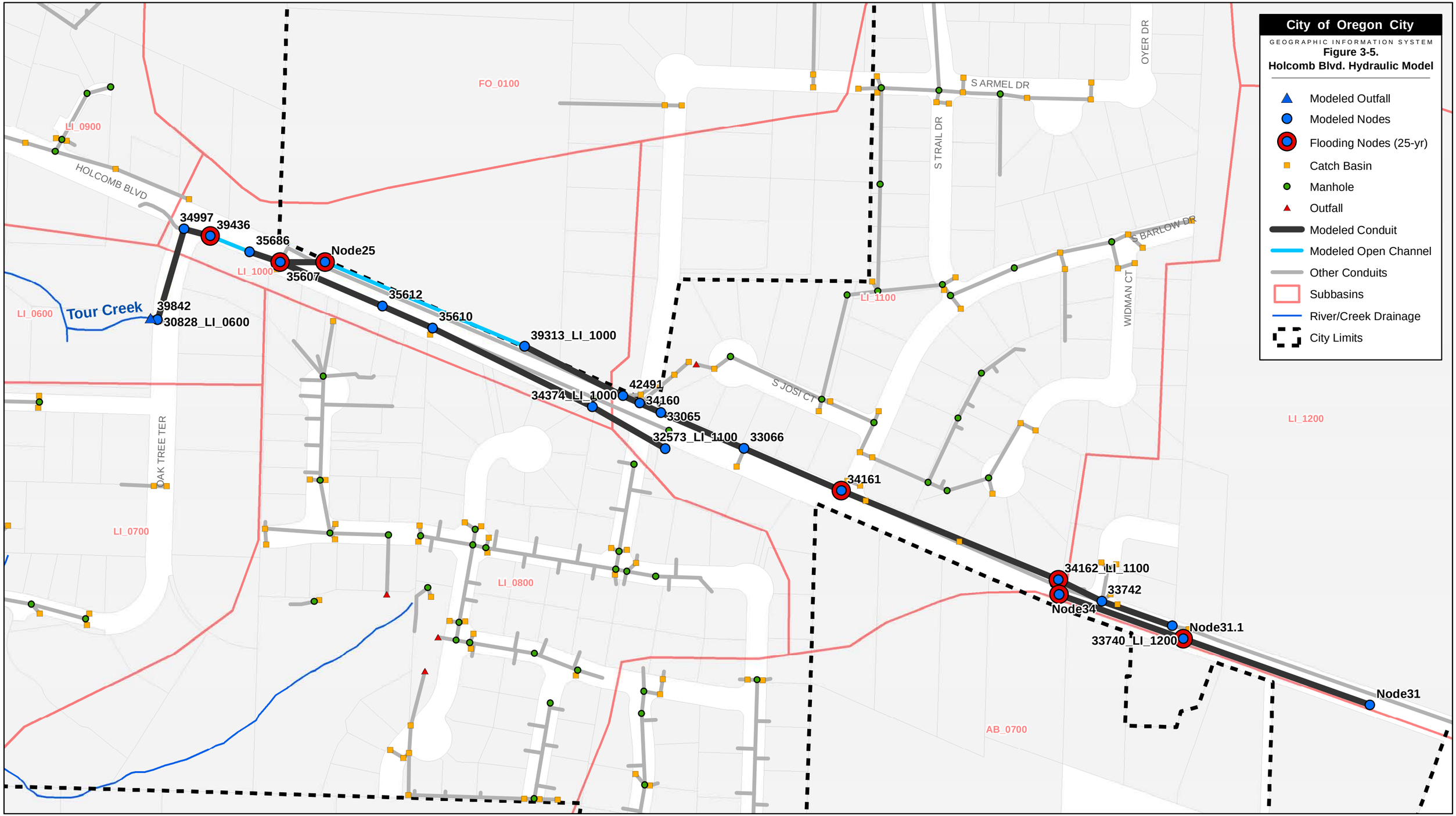
Plot date: June 20, 2017
Plot name: Figure 3-4 Coffee Creek Basin.pdf
Map name: Figure 3-4 Coffee Creek Basin.mxd

City of Oregon City

GEOGRAPHIC INFORMATION SYSTEM

Figure 3-5.
Holcomb Blvd. Hydraulic Model

- Modeled Outfall
- Modeled Nodes
- Flooding Nodes (25-yr)
- Catch Basin
- Manhole
- Outfall
- Modeled Conduit
- Modeled Open Channel
- Other Conduits
- Subbasins
- River/Creek Drainage
- City Limits



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Plot date: June 20, 2017
Plot name: Figure 3-5 Livesay Basin.pdf
Map name: Figure 3-5 Livesay Basin.mxd

3.6.4 John Adams Basin

The results of the John Adams Basin analysis reveal several areas where the system is undersized and floods, especially in areas where the stormwater system transitions from larger-diameter to smaller-diameter pipes. Routine flooding has been reported at the intersections of 9th and John Adams Streets, 11th and John Adams Streets, and 11th and Madison Streets, among other locations. Model-predicted flooding occurs during the 2-year design event, which is consistent with the reported flooding frequency.

This area has some of the oldest infrastructure in the city and is complex, while undersized for the areas it drains. Much of this infrastructure is well past its design life, suggesting there may be locations where pipes are partially collapsed or have root growth or other conditions that further reduce capacity. The system has many 90-degree bends and structures that act as flow splitters, which further reduce conveyance efficiency.

In addition to the frequent flooding locations reported above, the hydraulic model shows flooding during the 25-year event (see Figure 3-6) along most conveyance trunk lines between 9th and 12th Streets and between Washington and Van Buren Streets, as shown in Table 3-5.

Table 3-5. John Adams Basin Hydraulic Model Results for 25-yr Storm

Link ID	Node name		Ground elevation (ft)		Existing max water surface elevation (ft)	
	US	DS	US	DS	US	DS
800781	34313	33514	162.29	171.45	161.08	153.28
801568	33504	33474	261.10	254.51	261.10	254.51
801573	33473	34769	226.39	226.95	223.03	220.87
802603	33505_JA_1400	38651	316.50	286.90	310.38	281.42
802604	33566_JA_1600	34696	330.45	318.74	330.45	314.66
802606	34698	33504	289.22	261.10	283.03	261.10
804813	33520	43469	96.27	88.74	83.22	75.98
804814	33519	33520	99.89	96.27	93.02	87.25
804815	33521	34704_WN_0300	86.97	73.55	74.18	67.05
804841	33475_JA_1000	33473	243.58	226.39	243.58	223.03
804846	33469	33508	188.90	191.51	188.90	185.23
804848	33514	33515	171.45	153.00	153.03	145.34
804851	33515	34191_JA_0100	153.00	128.90	145.16	128.90
804860	33517_WN_0400	33516	185.10	179.60	182.36	179.60
804861	33523	33517_WN_0400	201.40	185.10	193.08	182.36
804867	34311_WN_0500	33523	207.50	201.40	200.31	193.42
804870	34767_JA_1100	34309	209.10	198.92	209.10	193.47
804934	38650_JA_1500	33475_JA_1000	269.84	243.58	269.84	243.58
804969	33513_JA_0300	33519	119.72	99.89	118.80	93.85
806396	37054	33513_JA_0300	162.35	119.72	159.31	118.80
806401	37059	37054	178.38	162.35	173.72	159.31
806402	37062	37059	208.79	178.38	206.49	173.73
806406	37064	37062	210.50	208.79	208.95	207.02

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Table 3-5. John Adams Basin Hydraulic Model Results for 25-yr Storm						
Link ID	Node name		Ground elevation (ft)		Existing max water surface elevation (ft)	
	US	DS	US	DS	US	DS
806411	37070_JA_0500	34769	224.81	226.95	224.81	220.87
806471	37118	37139_WN_0100	57.70	53.08	57.70	53.08
806474	37139_WN_0100	37142	53.08	53.08	53.08	50.09
808623	37142	41009	53.08	52.70	50.09	48.32
808624	43300	43301	61.81	61.81	46.43	44.94
808704	33474	33475_JA_1000	254.51	243.58	254.51	243.58
808721	34309	33508	198.92	191.51	190.80	183.92
812475	36378	34534	168.58	167.42	168.58	166.00
812477	33516	36378	179.60	168.58	179.60	168.58
812478	34534	43051	167.42	163.93	166.00	160.78
812479	43051	43050	163.93	155.49	160.78	151.78
812692	41009	43300	52.70	61.81	48.32	46.43
812695	43301	39733	61.81	19.40	43.94	14.79
812816	43469	33521	88.74	86.97	75.98	74.18
Link43	38651	33474	286.90	254.51	281.04	254.51
Link44	34696	34698	318.74	289.22	314.00	283.21
Link45	34692_JA_1300	37087	250.94	248.38	368.43	248.38
Link46	37087	33491_JA_0200	248.38	234.43	248.38	234.43
Link47	33491_JA_0200	37064	234.43	210.50	234.43	208.95
Link48	34769	33469	226.95	188.90	220.87	188.90
Link49	33508	34313	191.51	162.29	180.16	161.08
Link54	34704_WN_0300	37118	73.55	57.70	67.05	57.70
Link55	43050	Node58	155.49	126.51	151.10	124.78
Link56	Node58	Node59	126.51	114.00	124.67	111.72
Link57	Node59	33521	114.00	86.97	111.57	84.64
Link58	34191_JA_0100	34192	128.90	120.42	128.90	120.42
Link59	34192	41014	120.42	109.91	120.42	109.50
Link60	41014	33519	109.91	99.89	109.50	93.13

**Shaded rows indicate a flooded link during simulation of the 25-year design event.*

The conveyance system is undersized and surcharged or flooding at numerous locations throughout the John Adams Basin. Much of this system is aged and may need replacement regardless of capacity.

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3.6.5 Park Place Basin

The existing Park Place Basin model results showed no flooding at locations that were reported to be problem areas by residents and City staff. This inconsistency is suspected to be the result of private development changing the drainage patterns in these areas and reducing flows to the identified problem areas since the time staff and residents have observed problems. The hydraulic model extents for the Park Place Basin are shown on Figure 3-7.

The existing model does identify several other areas of flooding. The culvert crossing under Hiram Avenue shows flooding with the 2-year design event. Other locations show flooding during the 25-year, 24-hour storm, (see Table 3-6) including an undersized culvert near the intersection of Clear Street and Front Avenue, the transition from open channel to closed conveyance east of Hunter Avenue and south of Cleveland Street, and the culvert in the backyard of 16163 South Harley Avenue. These locations, identified as potential projects, should be on the City's watch list. No capital projects are proposed for the Park Place basin at this time, as culverts and problem areas are likely to be modified as part of future development.

Table 3-6. Park Place Basin Hydraulic Model Results for 25-yr Storm

Link ID	Node name		Ground elevation (ft)		Existing max water surface elevation (ft)	
	US	DS	US	DS	US	DS
801099	30675	30674	114.51	114.42	113.79	113.37
801520	34163	34164	201.5	194.73	190.96	188.49
801521	34164	34511	194.73	192.57	188.49	185.89
801522	34166	34163	195.75	201.5	192.45	191.37
804027	40789_PP_0800	40790	223.9	220.09	223.23	218.62
806132	30676	36849	116.68	115.17	114.92	114.29
806133	36849	30675	115.17	114.51	114.29	113.79
806138	36853	30676	134.95	116.68	133.01	114.92
806331	41420	37021	148.22	147.94	148.22	147.05
808078	30674	38518	114.42	113.64	113.37	112.85
808079	38518	PP_0500	113.64	113.49	112.85	112.41
809819	37021	41421_PP_0600	147.94	147.05	147.05	146.19
809820	41350	36853	133.49	134.95	133.49	133.01
812683	43287_PP_1000	43288_PP_0900	264.56	263.56	264.56	255.85
Link17	33393	34166	199.5	195.75	199.50	192.45
Link18	34511	PP_0700	192.57	192	183.25	182.06
Link20	40854	40855	103.38	98.5	103.38	96.03
Link21	41341	36790_PP_0300	93.79	90.65	92.65	82.32
Link22	36790_PP_0300	41342	90.65	80.85	82.32	69.12
Link23	43288_PP_0900	40789_PP_0800	263.56	223.9	255.85	223.23
Link24	40790	33393	220.09	199.5	218.62	199.50
Link27	41421_PP_0600	41350	147.05	133.49	146.19	133.49
Link28	PP_0500	40854	113.49	103.38	112.41	103.38
Link29	40855	41341	98.5	93.79	96.03	92.65
Link31	PP_0700	41420	192	148.22	182.06	148.22

**Shaded rows indicate a flooded link during simulation of the 25-year design event.*

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3.6.6 Singer Creek Basin

No flooding or problem areas were identified for this area but City staff requested that a model be built and the system be assessed because of its age and alignment through private property. The modeled system shows no flooding, yet it is surcharged and the water surface during the 25-year design event (see Table 3-7 and Figure 3-8) is at or near the surface.

The drainage basin contributing to Singer Creek is mostly built out, but as densification and infill occurs, care should be taken to address any increase in peak flows. The infrastructure is some of the oldest in the city and will require regular inspections and assessment to ensure function. Additionally, the creek is aligned across private property and directly under structures in a few instances. No capital projects are proposed for Singer Creek basin at this time. However, the trunk line should be relocated into the public right-of-way and out of private property as infill development impacts the affected properties.

Table 3-7. Singer Creek Basin Hydraulic Model Results for 25-yr Storm

Link ID	Node name		Ground elevation (ft)		Existing max water surface elevation (ft)	
	US	DS	US	DS	US	DS
800363	39390_SI_0500	33815	218.52	205.18	208.12	199.51
803639	34189	35537	174.46	174.00	173.05	171.26
803641	35540	34189	177.61	174.46	176.49	173.05
803643	SI_0300	35540	177.80	177.61	177.80	176.49
804123	35900	SI_0300	180.04	177.80	179.71	177.80
804124	35902	35900	180.96	180.04	180.96	179.71
804125	35903	35902	185.01	180.96	182.98	180.96
804126	34190	35903	189.08	185.01	185.11	182.98
804191	33815	35985	205.18	191.23	199.51	187.03
804192	35985	34190	191.23	189.08	187.03	185.11
804812	34187	35594	171.23	165.19	167.28	162.38
806469	37138	36507_SI_0400	164.15	159.74	160.12	155.12
806470	35594	37138	165.19	164.15	162.38	160.12
Link14	40796_SI_0600	40797	221.02	220.00	219.16	216.65
Link15	40797	Inlet	220.00	225.00	216.65	216.60
Link15.1	Inlet	40897	225.00	229.48	216.60	216.47
Link16	36023	39390_SI_0500	229.61	218.52	214.61	208.12
Link17	40897	36023	229.48	229.61	216.47	214.61
Link18	35537	34187	174.00	171.23	171.26	167.28
Link19	36507_SI_0400	42737	159.74	151.00	155.12	149.46

**Shaded rows indicate a flooded link during simulation of the 25-year design event.*

The hydraulic model extents for the Singer Creek Basin are shown on Figure 3-8.

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3.6.7 South End Basin: South End Road

The South End conveyance system includes a mix of open channels and large and small pipes, which has resulted in an inefficient system. Based on model results (see Table 3-8), this system starts to flood during the 2-year event. The flooding starts near South Rose Road where the open-channel system enters a closed system. The entrance grate configuration and pipes are not sized sufficiently to convey the runoff. The system then decreases in pipe diameter and significantly increases in slope. The conveyance infrastructure floods farther down South End Road where a culvert capturing the open-channel flow is under capacity. The hydraulic model extents for the South End Basin are shown on Figure 3-9. A capital project is proposed to upgrade the conveyance system along South End Road to address existing capacity problems. The project should construct a closed stormwater conveyance system that could serve a future roadway expansion.

Table 3-8. South End Basin Hydraulic Model Results for 25-yr Storm

Link ID	Node name		Ground elevation (ft)		Existing max water surface elevation (ft)	
	US	DS	US	DS	US	DS
2	39657	39658	433.30	433.56	431.72	431.11
681.1	39657	39658	433.30	433.56	431.72	431.11
800101	40224	38962	453.42	451.20	452.06	451.20
800102	38963	30628	450.92	450.12	450.13	450.12
800823	33801	33800	452.50	449.78	449.72	449.63
800824	30628	33801	450.12	452.50	450.12	449.72
801783	33800	42854	449.78	447.80	449.63	446.98
802067	33531_SE_1300	33530	461.95	459.99	460.89	458.34
802192	33899	40224	455.75	453.42	452.83	452.06
802326	32462_SE_1200	34366	440.93	447.02	437.82	437.31
802787	38962	38963	451.20	450.92	451.20	450.13
803617	35517_SE_1400	33531_SE_1300	465.59	461.95	465.59	460.89
807270	37785_SE_1000	33899	458.00	455.75	455.52	452.83
807271	37787	37785_SE_1000	459.02	458.00	456.16	455.52
808402	38973_SE_0800	39657	433.34	433.30	431.85	431.72
808415	39658	42487	433.56	431.11	431.11	431.11
808417	42487	39582	431.11	428.66	431.11	426.68
809300	33535_SE_1600	35517_SE_1400	468.36	465.59	468.34	465.59
809303	32769_SE_1500	33531_SE_1300	461.31	461.95	461.31	460.89
809312	33530	37788	459.99	459.22	458.34	456.92
809724	34366	34365_SE_1100	447.02	446.54	437.31	437.15
Link20	37788	37787	459.22	459.02	456.92	456.16
Link21	32798_SE_1000	34786	456.04	452.42	452.49	450.32
Link23	34786	Node65	452.42	450.47	450.32	448.86
Link24	Node65	Node66	450.47	448.92	448.70	447.66
Link25	Node66	Node67	448.92	448.55	447.66	447.17

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Table 3-8. South End Basin Hydraulic Model Results for 25-yr Storm

Link ID	Node name		Ground elevation (ft)		Existing max water surface elevation (ft)	
	US	DS	US	DS	US	DS
Link26	Node67	Node68	448.55	447.11	447.17	447.11
Link31	42854	34365_SE_1100	447.80	446.54	446.98	437.15
Link33	Node68	42854	447.11	447.80	447.11	446.98
Link36	34761_SE_0900	38973_SE_0800	438.14	433.34	435.10	431.85
Link37	34365_SE_1100	Node70	446.54	441.95	437.15	436.16
Link38	Node70	34761_SE_0900	441.95	438.14	436.16	435.10

**Shaded rows indicate a flooded link during simulation of the 25-year design event.*

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3.6.8 Newell Creek Basin: Beavercreek Road and Molalla Avenue

The modeling has shown that pipes are under capacity at the Beavercreek Road crossing east of Molalla Avenue. One undersized pipe, across Beavercreek Road, is a restriction thought to be constructed to aid in filling upstream pipes as a form of detention. Regardless of the reason, the pipe is now a restriction and the cause of minor flooding starting with the 2-year design event. The pipes along Molalla Avenue that drain to Beavercreek Road have capacity while the smaller pipes along Beavercreek Road that contribute to the trunk line are surcharged for short periods of time during the 2-year event (see Table 3-9).

Replacement of the existing 40 feet of 12-inch-diameter pipe and 10 feet of 42-inch-diameter pipe, across Beavercreek Road, to match the upstream and downstream pipe sizes, which are 48 inches in diameter, will likely remove most of the capacity issues within the trunk line of this system. However, the flow restrictions in this system are likely serving as flow attenuation and mitigating peak flows downstream. This conveyance system is located upstream of Newell Canyon where erosion is a significant concern (see Section 6).

Upsizing the conveyance system will result in downstream erosion impacts that were determined to be of greater concern than the current flooding. For this reason, the capacity problem identified was not addressed in the potential project recommendations at this time. Instead, ongoing monitoring of the flooding in this area is recommended to determine the impacts to surrounding properties.

As opposed to upsizing conduits, and potentially causing further erosion issues, the City should investigate upstream opportunities to install green infrastructure or additional detention systems that would slow down the time-to-peak in the watershed. The retention systems can reduce flooding, improve water quality, and lower peak flows, which will in turn mitigate erosion issues.

Table 3-9. Newell Creek Basin Hydraulic Model Results for 25-yr Storm

Link ID	Node name		Ground elevation (ft)		Existing max water surface elevation (ft)	
	US	DS	US	DS	US	DS
800688	34994	39666	430.02	415.38	418.97	412.81
800690	34611	30023	429.34	430.16	429.34	426.31
800854	39740_NE_1900	34616	436.51	436.91	433.41	429.90
801962	34604	34603	441.90	437.52	439.19	433.95
801965	34605_NE_3100	34604	444.01	441.90	442.26	439.59
801981	30056_NE_3100	37259	439.36	433.77	436.07	432.43
803140	30021	30023	431.51	430.16	427.60	426.31
803172	30030_NE_2200	30027	434.39	433.37	434.39	432.69
803176	30027	30025	433.37	430.71	432.69	429.54
803179	30025	30024	430.71	430.26	429.54	427.50
803180	30024	30023	430.26	430.16	427.50	426.31
806619	37234	37235	433.20	433.20	429.40	429.40
806620	37234	30021	433.20	431.51	429.40	427.60
807452	37903	37901	427.94	430.44	427.94	426.94
807453	37238_NE_2200	37903	430.54	427.94	430.54	427.94
808393	39739_NE_1900	34615	436.49	436.91	434.75	430.93

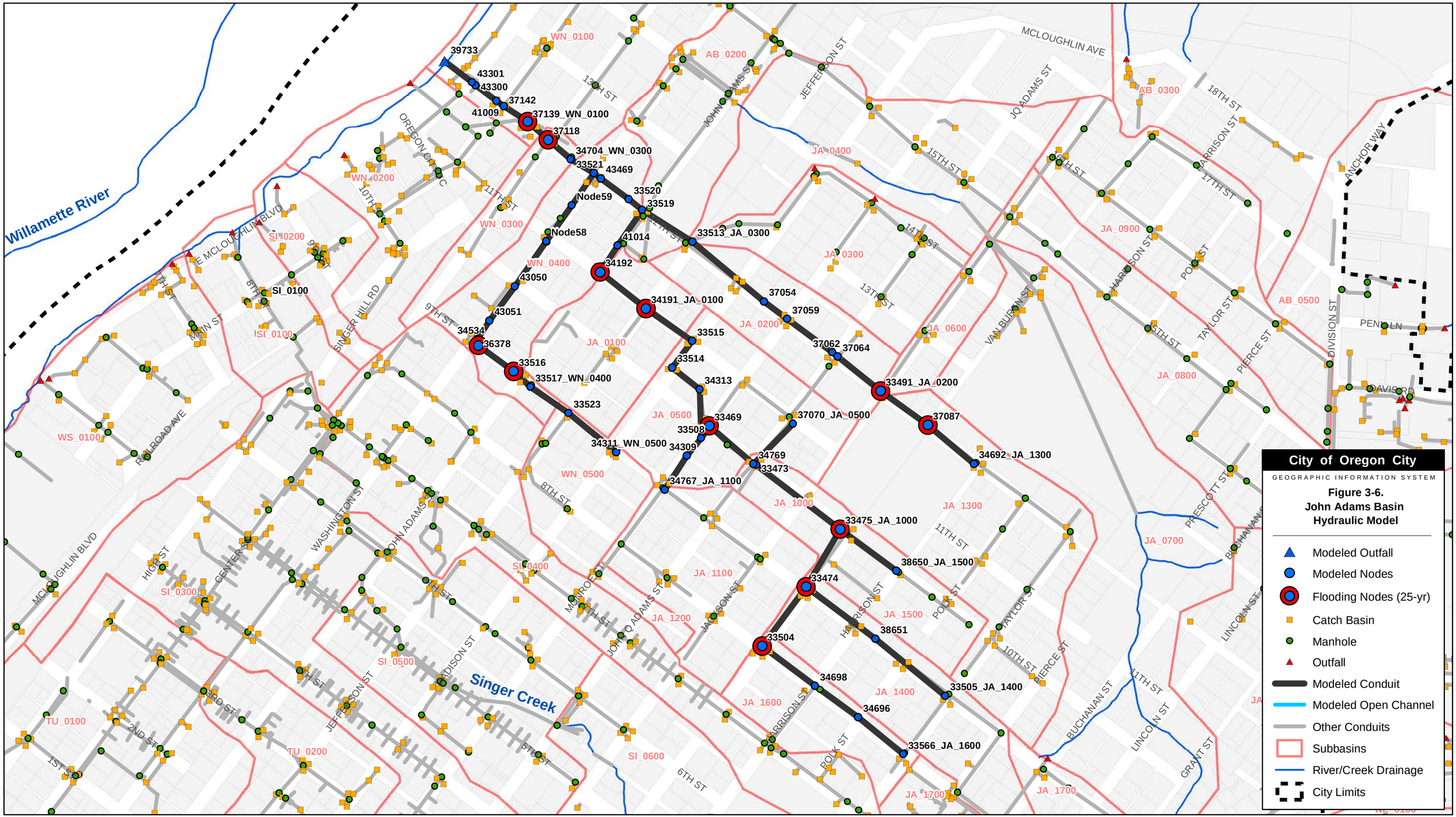
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Table 3-9. Newell Creek Basin Hydraulic Model Results for 25-yr Storm						
Link ID	Node name		Ground elevation (ft)		Existing max water surface elevation (ft)	
	US	DS	US	DS	US	DS
Link18	34615	41521	436.91	432.42	430.86	429.46
Link19	41521	37235	432.42	433.20	429.46	429.40
Link20	37235	34611	433.20	429.34	429.40	429.34
Link21	30023	Node35	430.16	429.89	426.31	424.58
Link22	Node35	34994	429.89	430.02	424.58	418.97
Link23	37901	Node35	430.44	429.89	426.94	424.58
Link24	34603	42867	437.52	432.33	433.95	430.46
Link25	42867	41521	432.33	432.42	430.46	429.46
Link26	34616	35735_NE_1600	436.91	434.20	429.90	429.89
Link27	35735_NE_1600	41522	434.20	432.04	429.89	429.64
Link28	41522	37234	432.04	433.20	429.64	429.40
Link29	37259	41522	433.77	432.04	432.43	429.64

**Shaded rows indicate a flooded link during simulation of the 25-year design event.*

The hydraulic model extents for the Newell Creek Basin are shown on Figure 3-10.

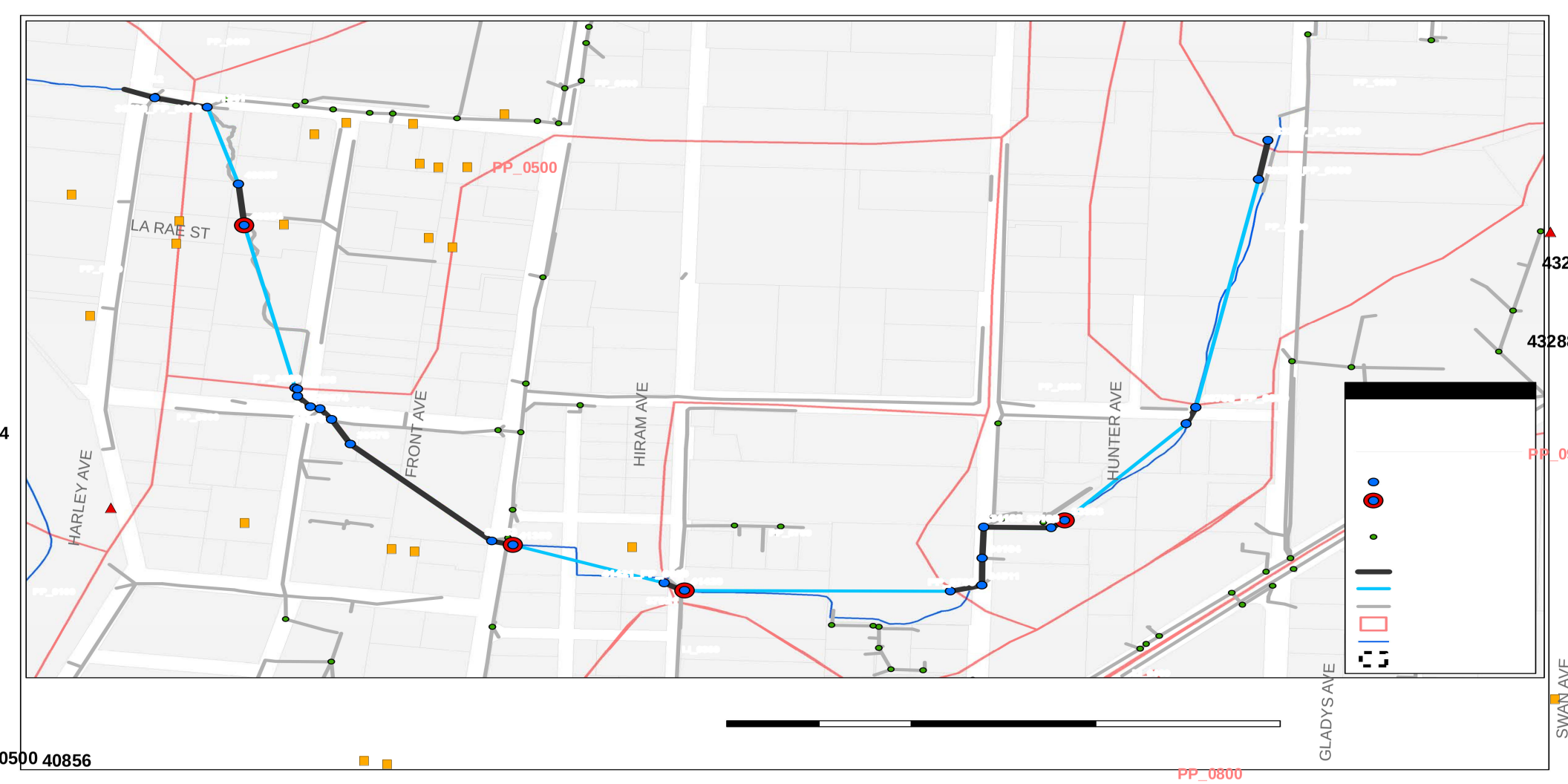
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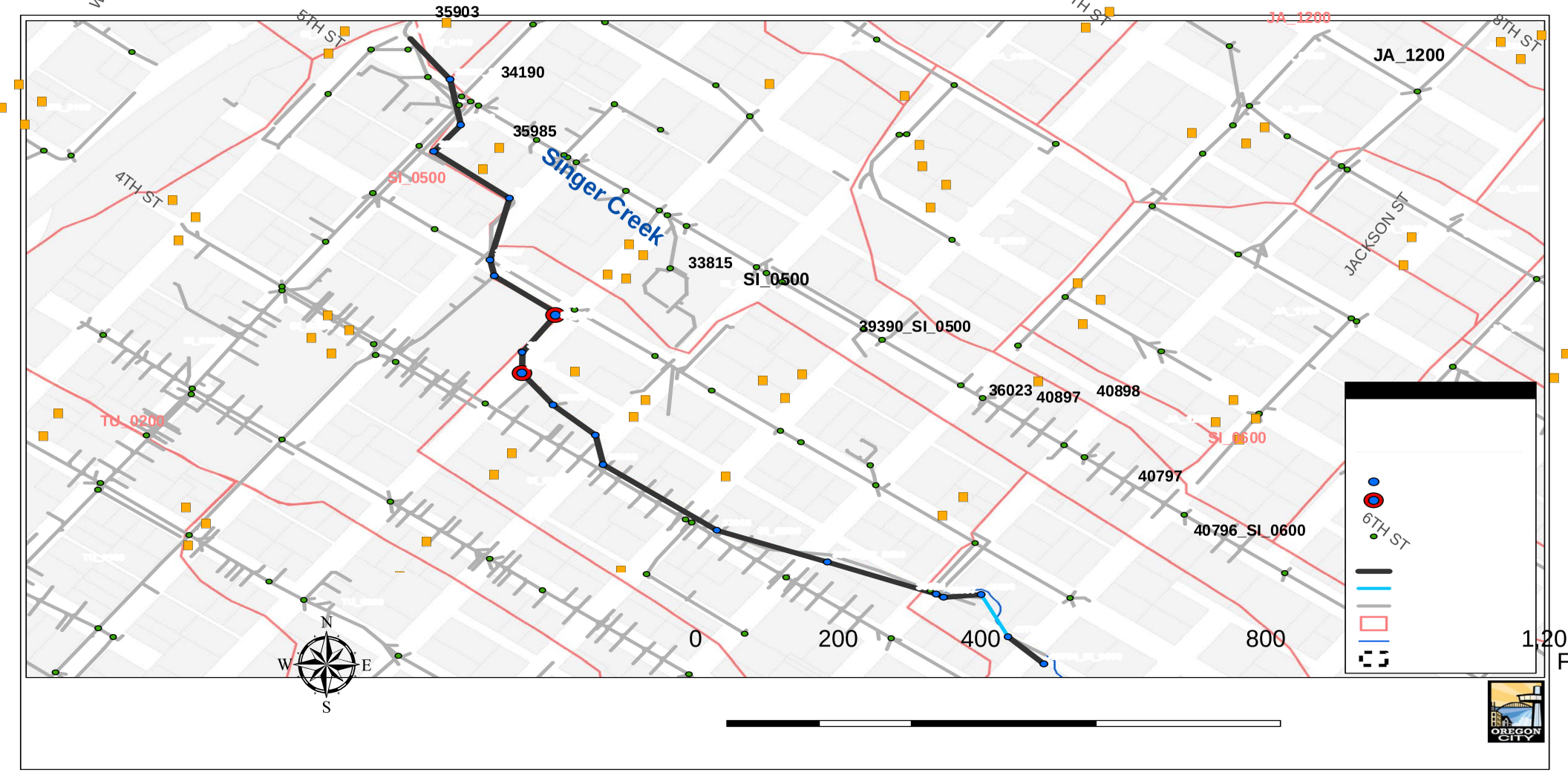


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Plot date: June 22, 2017
Plot name: Figure 3-6 John Adams Basin.pdf
Map name: Figure 3-6 John Adams Basin.mxd


PP_0500
LA RAE ST
HARLEY AVE
FRONT AVE
HIRAM AVE
HUNTER AVE
GLADYS AVE
SWAN AVE
PP_0800
0500 40856


35903
34190
35985
Singer Creek
SI_0500
33815
SI_0500
39390_SI_0500
36023
40897
40898
40797
40796_SI_0600
JA_1200
JACKSON ST
5TH ST
4TH ST
6TH ST
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TU_0200
0
200
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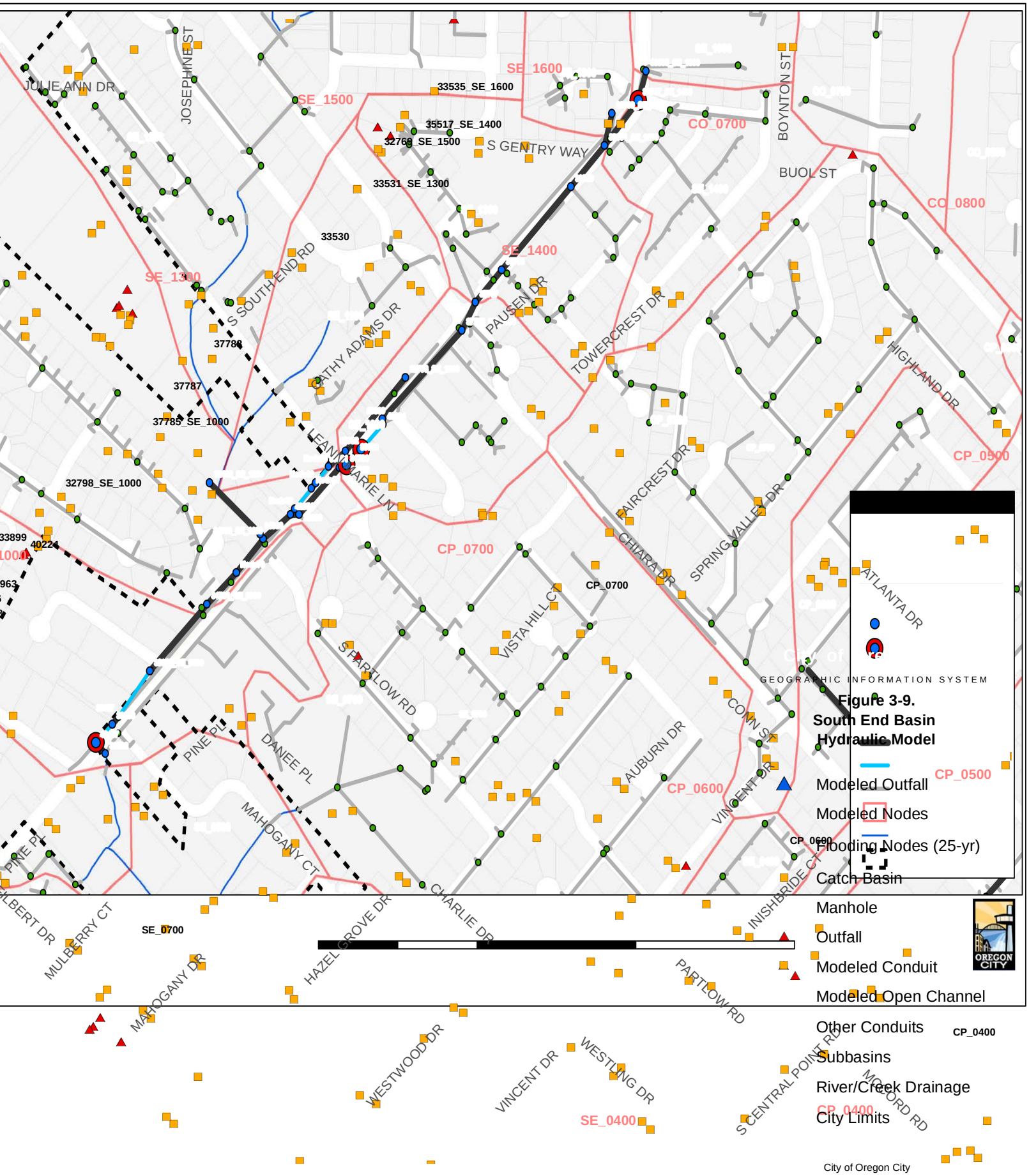
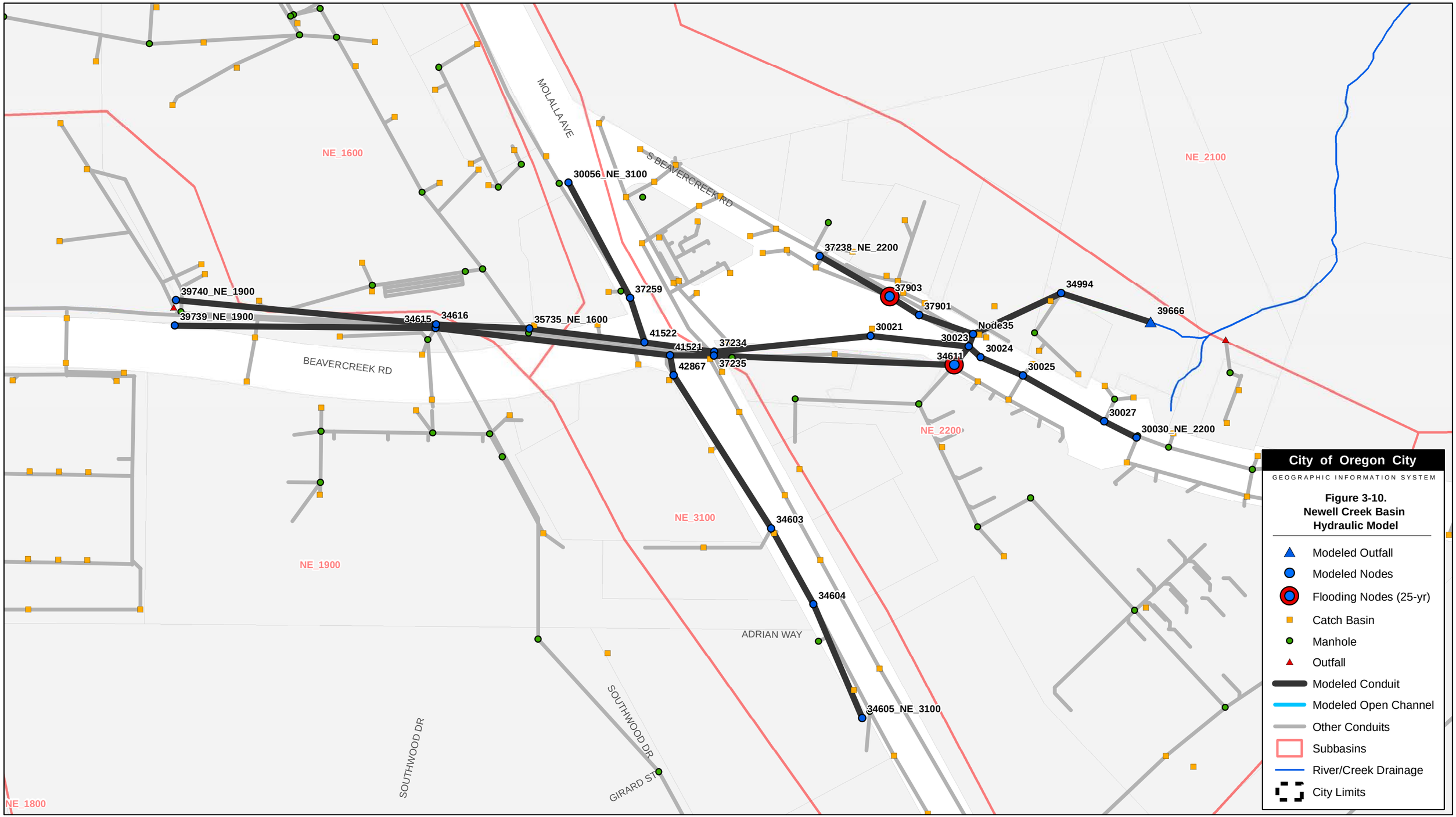


Figure 3-9.
South End Basin
Hydraulic Model

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Plot date: June 20, 2017
Plot name: Figure 3-9 South End Basin.pdf
Map name: Figure 3-9 South End Basin.mxd



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N
W E
S

0 150 300 600 900 Feet

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Plot date: June 20, 2017
Plot name: Figure 3-10 Newell Creek Basin.pdf
Map name: Figure 3-10 Newell Creek Basin.mxd

3.7 Capital Improvement Project Analysis

Based on the results of the system capacity analysis, two potential CIPs were identified to address capacity concerns. The John Adams and South End basins include multiple problem areas that could be addressed through modification of the stormwater conveyance infrastructure. In these areas, the hydraulic models were used to evaluate potential CIP alternatives and identify preferred conceptual solutions.

3.7.1 John Adams Infrastructure Replacement

The John Adams Basin is systemically undersized. Flooding was reported at multiple locations and the hydraulic model shows additional locations where the system is under capacity for the desired level of service. There is one location, at 9th Street and John Quincy Adams Street, where a manhole acts as a flow splitter directing incoming runoff down through two different pipes, which is an inefficient practice and is reflective of the challenges throughout this conveyance system. The storm alignment currently is routed through private property and around a home. The home is located at 1004 Madison Street. The pipe crosses through D.C. Latourette Tennis Courts Park and along the property line separating the park and home. The proposed CIP shifts the pipe alignment to the right-of-way and assumes the pipe through the park can be abandoned. The design engineer and contractor for this project should evaluate the drainage in this area to verify that no lateral connections exist in the sections of pipe that cross through the park and private property.

The CIP for this location recommends upsizing for every pipe that was modeled, except for two: the very last pipe in the system and one 24-inch-diameter pipe between 10th and 11th Streets along Madison Street. All remaining existing pipes are 18 inches in diameter or smaller, several of which are recommended for upsizing to 36-, 48-, and 54-inch-diameter pipes. The proposed improvement is anticipated to provide conveyance for the 25-year event (see Table 3-10) and is anticipated to remove flooding and surcharging of the system. During the 100-year event the system should not flood, but pipe surcharging into manholes may occur at four locations.

Table 3-10. John Adams Basin Hydraulic Model Parameters and Results for 25-yr Storm for Proposed Infrastructure

Link ID	Node name		Ground elevation (ft)		Future max water surface elevation (ft)	
	US	DS	US	DS	US	DS
800781	34313	33514	162.29	171.45	160.42	153.52
801568	33504	33474	261.10	254.51	258.03	244.78
801573	33473	34769	226.39	226.95	221.38	216.57
802603	33505_JA_1400	38651	316.50	286.90	310.38	281.42
802604	33566_JA_1600	34696	330.45	318.74	330.45	314.66
802606	34698	33504	289.22	261.10	283.02	258.63
804813	33520	43469	96.27	88.74	83.78	73.85
804814	33519	33520	99.89	96.27	93.86	87.68
804815	33521	34704_WN_0300	86.97	73.55	71.08	66.99
804841	33475_JA_1000	33473	243.58	226.39	237.13	221.88
804846	33469	33508	188.90	191.51	186.35	180.58
804848	33514	33515	171.45	153.00	153.50	145.67
804851	33515	34191_JA_0100	153.00	128.90	145.28	117.96
804860	33517_WN_0400	33516	185.10	179.60	179.81	175.85

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Table 3-10. John Adams Basin Hydraulic Model Parameters and Results for 25-yr Storm for Proposed Infrastructure

Link ID	Node name		Ground elevation (ft)		Future max water surface elevation (ft)	
	US	DS	US	DS	US	DS
804861	33523	33517_WN_0400	201.40	185.10	193.08	179.81
804867	34311_WN_0500	33523	207.50	201.40	200.31	193.42
804870	34767_JA_1100	34309	209.10	198.92	209.10	193.47
804934	38650_JA_1500	33475_JA_1000	269.84	243.58	269.84	237.13
804969	33513_JA_0300	33519	119.72	99.89	116.37	93.86
806396	37054	33513_JA_0300	162.35	119.72	157.45	116.57
806401	37059	37054	178.38	162.35	174.49	157.53
806402	37062	37059	208.79	178.38	199.83	174.61
806406	37064	37062	210.50	208.79	203.46	199.94
806411	37070_JA_0500	34769	224.81	226.95	224.81	219.01
806471	37118	37139_WN_0100	57.70	53.08	52.19	49.93
806474	37139_WN_0100	37142	53.08	53.08	49.93	49.08
808623	37142	41009	53.08	52.70	49.08	48.27
808624	43300	43301	61.81	61.81	47.28	46.22
808704	33474	33475_JA_1000	254.51	243.58	244.78	237.26
808721	34309	33508	198.92	191.51	190.80	183.92
812475	36378	34534	168.58	167.42	165.35	163.55
812477	33516	36378	179.60	168.58	173.63	165.35
812478	34534	43051	167.42	163.93	163.55	160.17
812479	43051	43050	163.93	155.49	160.12	151.85
812692	41009	43300	52.70	61.81	48.27	47.28
812695	43301	39733	61.81	19.40	44.74	15.37
812816	43469	33521	88.74	86.97	73.85	71.08
Link43	38651	33474	286.90	254.51	280.95	244.78
Link44	34696	34698	318.74	289.22	314.00	283.21
Link45	34692_JA_1300	37087	250.94	248.38	246.56	240.16
Link46	37087	33491_JA_0200	248.38	234.43	239.67	229.72
Link47	33491_JA_0200	37064	234.43	210.50	228.90	203.46
Link48	34769	33469	226.95	188.90	216.57	186.35
Link49	33508	34313	191.51	162.29	180.55	160.42
Link54	34704_WN_0300	37118	73.55	57.70	66.67	52.19
Link55	43050	Node58	155.49	126.51	151.20	123.86
Link56	Node58	Node59	126.51	114.00	123.80	110.82
Link57	Node59	33521	114.00	86.97	110.68	83.74
Link58	34191_JA_0100	34192	128.90	120.42	117.96	110.98
Link59	34192	41014	120.42	109.91	110.50	101.99
Link60	41014	33519	109.91	99.89	101.99	93.86

**Shaded rows indicate a flooded upstream node during the 100-year storm event.*

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A CIP fact sheet for this project is included in Appendix F.

3.7.2 South End Basin, South End Road

The South End conveyance system is a mix of open channels and large and small pipes, which results in an inefficient system. There is a conveyance system on both the north and south side of the roadway west of Filbert Drive. Near S Rose Road, the system on the south side of the road has an oversized pipe with a smaller pipe downstream just before the junction with the system on the north side of the road. Based on model results, this system starts to flood during the 2-year event. The flooding starts near S Rose Road where the open-channel system enters a closed system. The entrance grate configuration and pipes are not sized sufficiently to convey the runoff. The system then decreases in pipe diameter and significantly increases in slope. The conveyance infrastructure floods farther down South End Road where a culvert capturing the open-channel flow does not have sufficient capacity.

During the 25-year design event (see Table 3-11) the existing system also floods between S Forest Ridge Road and Salmonberry Drive where the open channels enter a culvert to cross under South End Road.

Alleviation of the flooding along South End Road will require a larger pipe from the outfall east to Long Standing Court. The Capital Project Fact Sheet in Appendix F provides a description of the improvements and a figure showing the extents and sizes of the upsized pipes. With the increase in capacity, the system is anticipated to provide 25-year level of service. During the 100-year event the system may be surcharged at several manholes with minor flooding near the intersection of Lafayette Avenue and South End Road. This is a significant improvement over current conditions.

Table 3-11. South End Basin Hydraulic Model Parameters and Results for 25-yr Storm for Proposed Infrastructure

Link ID	Node name		Ground elevation (ft)		Future max water surface elevation (ft)	
	US	DS	US	DS	US	DS
800101	40224	38962	453.92	452.20	452.82	452.20
800102	38963	30628	451.42	450.62	450.91	451.08
800823	33801	33800	452.50	449.78	447.91	442.35
800824	30628	33801	450.62	452.50	451.08	447.91
801783	33800	42854	449.78	447.80	442.35	440.88
802067	33531_SE_1300	33530	461.95	459.99	461.01	458.56
802192	33899	40224	455.75	453.92	453.37	452.82
802326	32462_SE_1200	34366	440.93	447.02	437.89	437.44
802787	38962	38963	452.20	451.42	452.20	450.91
803617	35517_SE_1400	33531_SE_1300	465.59	461.95	465.59	461.01
807270	37785_SE_1000	33899	458.00	455.75	455.85	453.37
807271	37787	37785_SE_1000	459.02	458.00	456.47	455.85
809300	33535_SE_1600	35517_SE_1400	468.36	465.59	468.36	465.59
809303	32769_SE_1500	33531_SE_1300	461.31	461.95	461.31	461.01
809312	33530	37788	459.99	459.22	458.56	457.20
809724	34366	34365_SE_1100	447.02	446.54	437.44	437.29

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Table 3-11. South End Basin Hydraulic Model Parameters and Results for 25-yr Storm for Proposed Infrastructure

Link ID	Node name		Ground elevation (ft)		Future max water surface elevation (ft)	
	US	DS	US	DS	US	DS
Link20	37788	37787	459.22	459.02	457.20	456.47
Link21	32798_SE_1000	34786	456.04	452.42	452.49	450.32
Link23	34786	Node65	452.42	450.47	450.32	448.86
Link24	Node65	Node66	450.47	448.92	448.70	447.66
Link25	Node66	Node67	448.92	448.55	447.66	446.77
Link26	Node67	Node68	448.55	447.11	446.77	445.85
Link31	42854	34365_SE_1100	447.80	446.54	440.88	437.29
Link33	Node68	42854	447.11	447.80	445.85	445.01
Link41	34365_SE_1100	34761_SE_0900	446.54	438.14	437.29	434.22
Link42	34761_SE_0900	38973_SE_0800	438.14	433.60	434.22	431.78
Link43	38973_SE_0800	Node75	433.60	434.25	431.78	429.95
Link44	Node75	Node76	434.25	430.16	429.95	428.50

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Section 4

Storm System Condition Assessment

Oregon City has some of the oldest infrastructure in the state of Oregon. The City needs a management strategy to identify needed pipe replacements and plan for long-term asset replacement, repair, and rehabilitation. The storm system condition assessment conducted for this Master Plan included an evaluation of existing infrastructure needs and recommends that a long-term rehabilitation and replacement (R/R) program be included as a critical element of the City's overall stormwater management program.

4.1 Background

Oregon City was established in 1829 and incorporated in 1844, which makes it the first city to be incorporated west of the Rocky Mountains.

While existing infrastructure is reaching its design life, the City's focus over the last several decades has been on providing new utility and roadway services for rapidly developing areas. Underground infrastructure problems are addressed on an as-needed basis when failures or flooding occur. The City is now working to establish a program to replace aging infrastructure, including roadways and utility systems. As a part of this effort, the city has acquired video inspection equipment and has begun Closed-Circuit Television (CCTV) inspections of the drainage system.

In addition to the review of pipe repair records, and as-builts from previous infrastructure projects, this visual inspection will be a valuable aid to the city in implementing a pipe replacement and prioritization system. While it is not unusual for stormwater pipes to remain viable for much longer than similar sanitary sewer systems, visual inspection by a trained individual can help differentiate levels of service in aging pipe segments.

4.2 System Assessment

The goal of a traditional stormwater system condition assessment is to review existing stormwater system information to identify areas of current or imminent failure as well as areas that are rapidly deteriorating. At the time of this study, the City had performed CCTV video inspections and developed rating scores for about one-fifth of the City's buried stormwater infrastructure. The work to date covers approximately 40 miles of pipe, primarily in the southern neighborhoods. As a part of each survey, CCTV recordings of pipes are made, and each segment is given a rating between one and five, in accordance with the Pipeline Assessment Certification Program (PACP). A score of "1" indicates a pipe is new and/or very unlikely to fail within its given design life, while a "5" indicates a pipe that has failed or is extremely likely to fail. With 20 percent of the city surveyed in three years, establishing citywide baseline data would take roughly 12 years, assuming the city can maintain the current pace of surveying. The goal of this master planning evaluation is to outline a strategy that the City can implement to start collecting condition data to optimize their system assessment and inform future CIP decisions.

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4.2.1 Aging Infrastructure



Figure 4-1. Historic brick manhole along the Singer Creek alignment

As a result of early settlement, Oregon City has some of the oldest stormwater infrastructure in the region. The John Adams Basin, Canemah Neighborhood, and Singer Basin all likely have pipes and infrastructure that are more than 100 years old. Clay pipe was the most common material used before concrete pipes. Significant portions of the three basins likely have clay pipe. Clay pipe can last many decades but if disturbed is highly susceptible to failure.

The downtown area (John Adams Basin) had a combined sanitary sewer and storm collection system, which is approximately 70 years old. In the 1980s and 1990s a new sanitary sewer collection system was constructed. The former combined system remains in place, well past the expected life of the pipe, and continues to be used to manage stormwater.

In other areas of the city, pipe age was evaluated by looking at the dates of neighborhood development, since most stormwater infrastructure in residential areas is constructed as part of residential development. The areas south of downtown and north of roughly Warner Parrott Road and Warner Milne Road are made up of infrastructure constructed between 1940 and 1980. Areas south of Warner Parrott and Warner Milne roads are primarily built after 1980 and should have several decades of service remaining. This is also true for the portion of the city north of downtown, where infrastructure was constructed after 1990. See Figure 4-2 for a map detailing these areas.

4.2.2 Existing Condition Data

Because of the age of the infrastructure in the older portion of Oregon City there is little information with regard to its condition. The information available for the rest of the city is slightly more robust but still lacking in detail to inform an assessment program. The City has inspected approximately 20 percent of the piped conveyance system via closed-circuit television (CCTV) inspections, primarily in the southern portion of the city (See Figure 4-3).

As shown in Table 4-1, of the pipes inspected, approximately 77 percent received a score less than 2.0, indicating failure is extremely unlikely within the design life of the pipes, while approximately 6 percent received scores of 4 or higher, indicating poor condition, and a high probability of failure.

Table 4-1. CCTV Results to-Date (March 2019)

Score	Pipes Inspected LF	% of Total Inspected
1.0 – 1.9	166,785	77.3
2.0 – 2.9	23,736	11.0
3.0 – 3.9	11,934	5.5
4.0 – 4.9	7,617	3.5
5.0	5,753	2.7
Total Inspected	**215,824**	

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Detailed review of the CCTV reports did not identify any pipe segments that are in immediate need of replacement. This highlights the need for a detailed engineering assessment to evaluate pipes with condition concerns, prior to prioritizing replacement projects.

Some limited amount of condition data is available from visual inspections. For example, the drainage network along the historic Singer Creek has been observed to be formed out of bedrock and concrete walls with aged manholes built out of bricks (see Figure 4-1). The primary creek channel appears to flow through a constructed channel that has been enhanced over the decades with concrete walls (in some places), and a top. The channel is similar in shape to a box culvert.

During visual inspections of structures, the Singer trunk line infrastructure appears aged but does not appear to need significant repair. However, CCTV inspection has been completed on three segments of the Singer trunk line, two of which scored a 4, warranting more assessment of this area. Based on modeling results (see Section 3) the system capacity is adequate for the desired level of service, but a review of the specific pipe inspections in this vicinity would be helpful to understand whether pipe replacement is warranted. Visual inspections of structures can effectively be paired with already completed CCTV to build a fuller picture of system health.

The City continues to track pipe and storm drain infrastructure using Lucity (now CentralSquare Technologies) as well as compiling information from the pipe surveying software Granite. Using these in tandem with their GIS geodatabase of infrastructure positions the City to make informed decisions on infrastructure improvements.

4.2.3 Sanitary Sewer System and Stormwater

Modern conveyance systems for storm and sanitary are separated so that the two do not mix. However, this is not always the case. There are portions of the city where no stormwater conveyance system was ever constructed and therefore runoff is routed to the sanitary system. The areas that lack storm conveyance infrastructure should be slated for storm system construction. This would likely require that private lateral connections be updated.

In the John Adams Basin, as mentioned previously, large portions of the conveyance infrastructure for storm and sanitary were combined at one time and the old combined system pipes are still used for stormwater conveyance. These old pipes are suspected of having areas that are deteriorating, compromised by tree roots, or otherwise damaged. While the public trunk lines are no longer serving combined sanitary and storm, several of these have been surveyed along 12th Avenue, and have scored in the fours and fives, suggesting further surveys may be warranted. It is also likely that private laterals, which remain from before the sewer separation, and that may manage roof runoff, foundation drains, and small area drains are still connected to the sanitary system.

The plans or as-builts of the separation of the storm and sanitary sewer infrastructure in the old portions of town may provide insights into how this separation was conducted and how the private and public laterals were handled. Some of the old infrastructure was constructed deeper than most traditional stormwater systems because of its former use as a combined system. The depth of the system may make replacement or rehabilitation more challenging.

4.2.4 Other Considerations

The City is in the process of establishing an inspection and replacement program for the sanitary system. To date, the work has included an infiltration and inflow (I/I) study in key neighborhoods as well CCTV inspections. The City has also conducted smoke testing to locate cross-connections between the sanitary and storm systems in the John Adams and Singer Basins. That work was completed in 2016/17 and reported in *I/I Abatement Program, Smoke Testing* (BC), February 10, 2017.

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The City also has an ongoing pavement maintenance program, which includes reconstruction of roadways in older neighborhoods. Because these projects cause significant disruption to neighborhood residents, coordinating any needed underground utility improvements with pavement maintenance projects is desirable.

4.3 Rehabilitation and Replacement Program

R/R programs can be broadly described as a process of investigation, assessment, recommendations, and implementation. The implementation of CCTV inspections is the first step in establishing an R/R program to assess and evaluate the stormwater system. The City has also implemented an inspection and replacement program for the sanitary system as part of its 2014 Sanitary Sewer Master Plan, and has seen the value in systematic assessment and evaluation. A similar program is recommended for the storm system.

Conducting a citywide rehabilitation program that investigates all areas of the city on a rotating basis is likely cost-prohibitive, so the R/R program recommendations will utilize existing and on-going CCTV survey information for establishing priorities for focused inspections.

4.3.1 Aging Infrastructure Area

Oregon City is in a unique position locally in the Portland metropolitan area because of the excessive age of some portions of the city's buried infrastructure. However, the City also manages an ever-expanding network of new stormwater infrastructure, constructed to support rapid development. Rather than conduct a citywide R/R program, the R/R program alternatives described below are based on identifying a priority area for inspections.

The "aging infrastructure area" is defined as those areas of the city where the stormwater system is assumed to be at least 60 years old. Development records, as-builts, and anecdotal information provided by City staff were used to estimate pipe age across the city. The City's GIS inventory was then used to calculate the piped conveyance system assets. The aging infrastructure area encompasses most of the Singer and John Adams Basins, as well as the Canemah Neighborhood.

Table 4-2 compares the length of pipe inside the aging infrastructure area to the City's total piped infrastructure.

Table 4-2. Stormwater Asset Inventory

Asset type	Aging infrastructure area, LF	City total, LF
Pipe total	140,000+	760,000+
10–12 inch pipe	113,500	589,700
15–18 inch pipe	18,000	106,500
21–14 inch pipe	5,200	34,300
30–36 inch pipe	3,700	23,800
42+ inch pipe	300	6,100
Catch basins, all types	860	4,300
Manholes	420	2,400
Connected downspouts	Unknown	Unknown

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4.3.2 Inspection Program

In 2016, Brown and Caldwell met with City staff to explore possible directions to go in when establishing an inspection program for the aging stormwater system. The inspection program will allow the City to collect quality data to guide decisions about infrastructure rehabilitation and replacement. Several alternative approaches were discussed with the City to determine whether the City would embark on a widespread CCTV inspection program or target inspections to highest risk areas. Subsequent to the initial alternatives meeting, the City embarked on a widespread CCTV inspection program that has inspected over forty miles of stormwater pipe, as described in Section 4.2.2. Collecting a significant amount of condition information prior to identifying R/R areas will allow projects to be focused on the areas of greatest need.

The City should continue CCTV inspections, focused on three areas: the aging infrastructure area, areas in the vicinity of high priority CIP projects, and roadways and neighborhoods that are scheduled for pavement replacement. Focusing in these areas will allow the City to identify acute problems that should be corrected during ongoing pavement maintenance projects and/or CIP projects. After inspections are completed in these areas, it is recommended that the City continue an ongoing cycle of CCTV inspections, with the aim of covering all public stormwater infrastructure in the City on a 10-year cycle. Depending on staffing levels, the long-term CCTV inspection could be completed by City maintenance crews.

4.3.3 Replacement Program

The City currently funds stormwater CIPs at approximately $500,000 per year, so widespread replacement of the aging infrastructure area is cost-prohibitive. Review of the CCTV inspection data collected to date identified that approximately six percent of the inspected pipes have scores of 4 or 5, indicating a condition concern. This percentage is expected to increase as the inspections move into older areas of the City. However, detailed review of the CCTV reports did not identify any pipe segments that are in immediate need of replacement. This highlights the need for a detailed engineering assessment to evaluate pipes with condition concerns, prior to prioritizing replacement projects.

Continuing to utilize the completed and on-going CCTV information will allow the City to identify pipes in critical need of replacement and to focus capital construction resources in the areas of highest need, as well as coordinate with transportation improvement projects, and CIP projects. It is assumed that a higher percentage of pipes (20-25 percent) will require replacement in the aging infrastructure area, but that newer areas will require fewer replacements. For a planning assumption, the City should plan to replace 5 to 10 percent of the public infrastructure over the next 20 to 25 years. With over 150 miles of publicly managed stormwater pipe, the annual replacement cost would be between $300,000 and $750,000 per year, depending on the extent of pipe replacements, size of pipes, type of rehabilitation, and the speed at which the City wants to implement the program.

Pipe replacement projects would be in addition to the CIPs outlined in Section 7 and should be scored and prioritized in a similar manner, as the City determines where to direct stormwater program resources.

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4.3.4 Additional Actions

The CCTV inspection program gives the City a long-term plan to investigate and rehabilitate aging stormwater infrastructure. However, it will likely be 5 to 10 years before any construction projects identified through the inspection program are completed (depending on funding).

In addition to the CCTV inspections and pipe replacement program, CIP 1: John Adams Basin Capacity Improvements include the planned replacement of 7,300 LF of pipe and associated drainage structures within the aging infrastructure area (see Section 7). This CIP meets multiple objectives through upsizing infrastructure to reduce flooding while also replacing aging infrastructure. The areas included in CIP 1 will not need to be included in the initial CCTV inspections, as all sections of pipe in the project area are planned for replacement to address capacity concerns.

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City of Oregon City

GEOGRAPHIC INFORMATION SYSTEM

Figure 4-2. Aging Infrastructure

- Conduit
- Ditch
- Basin Boundaries
- Stream Lines
- Aging Infrastructure
- City Limits

Problem Type

- Flooding
- Infrastructure
- Maintenance
- Natural Channels

Park Place
Kelly Field
Abernethy
Willamette North
Willamette South
John Adams
Singer
Tumwater
Clinton
Newell
Canemah
Coffee
Amanda Court
Willamette River

WN-I-01
JA-I-03
JA-I-02
SI-I-05
JA-I-05
JA-F-02
AB-M-01
SI-N-01
JA-I-04
JA-M-01
JA-F-03
JA-F-01
JA-F-04
SI-I-01
TU-M-02
TU-F-01
SI-I-06
SI-I-02
SI-I-03
SI-I-03
JA-I-01
NE-N-03
NE-I-01
TU-M-01
CN-M-01
SI-N-02
SI-N-02
CO-N-01
CO-I-03
CO-I-01
SI-I-04
SI-I-04
NE-N-04

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Map name: Figure 4-2 Aging Infrastructure.mxd

City of Oregon City

GEOGRAPHIC INFORMATION SYSTEM

Figure 4-3. CCTV Data

PACP Pipe Index Rating

- 1.0
- 2.0 - 3.0
- 3.0 - 4.0
- 4.0 - 5.0
- All Pipes (No Rating)
- City Limits

Clackamas River

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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Plot date: March 11, 2019
Plot name: Figure 4-3 CCTV Data.pdf
Map name: Figure 4-3 PipeInspectionAreas.mxd

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Section 5

Water Quality/Retrofit Assessment

Improving water quality conditions through retrofit of existing stormwater infrastructure is an important element of the City's overall stormwater management program. The City has programs and projects to address water quality issues at the source because stormwater, unlike wastewater, does not drain to a centralized treatment facility. The primary objective for a stormwater retrofit program is to improve the overall level of water quality treatment in developed areas of the city. New development and redevelopment projects are required to add water quality treatment during development, but existing development that was constructed prior to treatment standards will receive treatment only through public retrofits.

5.1 Water Quality Priorities

There is a direct link between stormwater runoff and the City's surface water and groundwater quality and quantity. As land is developed, creation of new impervious surfaces and loss of vegetation increases stormwater runoff during rainfall events, altering the natural hydrologic cycle. Runoff that flows over roadways, parking areas, rooftops, and other impervious surfaces collects pollutants that are transported within the watershed to streams, rivers, and groundwater resources. Properly managing stormwater is vital to protecting the City's water resources for a great number of uses, including fish and wildlife habitat, recreation, and drinking water.

5.1.1 Regulatory Requirements

Oregon City is adjacent to several major water bodies including Abernethy Creek, Newell Creek, Beaver Creek, the Clackamas River, and the Willamette River. Regulatory requirements for these systems are driven primarily by the CWA and related regulations. As described in Section 1.2.2, the City is covered by an NPDES MS4 permit for stormwater discharges. In addition to ongoing programmatic requirements in the permit, the City was recently required to develop several plans to evaluate and assess stormwater programs and impacts. In 2015, the City was required to develop a Water Quality Retrofit Plan to evaluate existing water quality measures and outline a plan for long-term retrofit of developed areas. One of the recommended actions in the retrofit plan was to conduct retrofit planning as part of the master planning process. This water quality/retrofit assessment builds on the 2015 plan and incorporates recommendations from the City's Pollutant Load Reduction Evaluation and the Wasteload Allocation Attainment Assessment, both of which were additional requirements of the NPDES MS4 Permit.

5.1.2 Pollutants of Concern

Stormwater runoff is known to have negative impacts on receiving waters. The mixture of contaminants can vary by region and area within a city depending on the land use and inputs to runoff. However, across urbanized areas, the pollutants of concern and treatment approaches remain generally consistent.

As part of the water quality standards program, the Oregon Department of Environmental Quality is required to conduct a water quality assessment of the state's water bodies every 2 years. If a water body is found to have pollutant levels that exceed water quality standards, it is placed on what is referred to as a 303(d) list. Once on the 303(d) list, a water body is in line for the development of a

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TMDL requirement. A TMDL requirement will specify limits on allowable loads from each discharger. Three TMDLs have been developed that apply to Oregon City. These include bacterial TMDLs for the Clackamas River, the Middle Willamette River Direct, and the Middle Willamette River tributaries.

In addition, several water bodies have been identified as water quality limited on the 303(d) list and are in line for TMDLs. 303(d) listed water bodies in Oregon City are provided in Table 5-1. These water quality issues were considered in the development of CIPs for this Master Plan.

Table 5-1. 2010 303(d) Parameters Applicable to Oregon City

Water body	River mile	Season	Parameter
Middle Willamette Subbasin			
Abernethy Creek	0.0–15.3	Year round	Biological criteria[a]
Willamette River	0.0–54.8	Summer	Chlorophyll a[a]
Willamette River	24.8–54.8	Year round	Aldrin
Willamette River	24.8–54.8	Year round	Biological criteria
Willamette River	24.8–54.8	Year round	DDT and DDT metabolite (DDE)
Willamette River	24.8–54.8	Year round	Dieldrin
Willamette River	24.8–54.8	Year round	Iron
Willamette River	24.8–54.8	Year round	PCBs
Clackamas River Subbasin			
Clackamas River	0.0–83.2	Year round	Biological criteria[a]
Clackamas River	0.0–8.8	October 15–May 15	Dissolved oxygen[a] (spawning: not <11. 0 mg/L or 95% of saturation)

a. Parameter added with the 2010 list.

5.2 Water Quality Treatment Overview

In 2015, the City developed a retrofit evaluation in response to NPDES permit requirements. The evaluation included a review of water quality treatment facilities across the city to identify areas where there may not be adequate treatment.

Areas of the city that have been developed in the last 20 years generally have included the implementation of water quality treatment facilities. This includes roughly the southern third of the city. The areas developed during the 1950s through the 1990s are less likely to include water quality treatment, as the City's design standards requiring treatment were adopted in 1999. The oldest portion of the city that was developed prior to 1950 does not include water quality treatment facilities. These untreated areas include most of the industrial and commercial areas north of downtown, in the vicinity of Abernethy Creek and the Clackamas River. Over time some of the areas not originally serviced with water quality facilities may have been retrofit with public facilities to meet regulatory guidelines, when public projects or private redevelopment projects were constructed, but those areas are small compared to the total drainage area.

The City's Wasteload Allocation Attainment Assessment, completed in 2016, identified the level of water quality treatment that would be required in order to achieve TMDL wasteload allocations for bacteria. That study showed that TMDL wasteload allocations may not be attainable goals. However, the wasteload allocation is currently representative of a target for only one pollutant (bacteria). There is still significant value in improving water quality over current conditions by addressing a wide range

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of pollutants of concern. Increasing the percentage of the city that receives water quality treatment remains an objective for the city and part of the NPDES permit requirements. Increasing treatment across the City will occur through various mechanisms including future development, redevelopment, and opportunities identified by the City to build water quality facilities.

5.3 Retrofit Evaluation

A citywide evaluation was performed to identify priority areas for water quality treatment. This evaluation considered existing areas of treatment, potential pollutant loads, and downstream resources that could benefit from improved water quality. Based on this evaluation, the area draining to the Clackamette Cove was identified as the focus for stormwater retrofit projects. Several potential CIP locations were identified for water quality retrofit facilities.

5.3.1 Priority Area

The Clackamette Cove is an area with strong development interest. Several new mixed-use development projects are in the planning or construction stage. These developments identify Clackamette Cove as an attractive water feature, with the potential for recreation and wildlife viewing. At the same time, Clackamette Cove is known to have water quality challenges with temperature and algal blooms. Clackamette Cove has only one connection to the Clackamas River and during low-flows, essentially behaves as a lake, as opposed to a part of the river, and does not experience enough mixing. Stagnant waters, higher temperatures, and high pollutant levels result in water quality problems.

Located at the confluence of the Willamette River and the Clackamas River, Clackamette Cove is an area with significant natural resources value. The Cove provides habitat for juvenile salmon, steelhead, and pacific lamprey, while the land around the cove provides habitat for deer, coyotes, minks, otters, and beavers. In addition to wildlife, the Cove is also host to various recreational activities for residents, and is a popular location for boating, swimming, fishing, and hiking. While these recreational activities have an impact on the Cove's habitability, so do groundwater and stormwater.

Studies conducted in this area have detected contamination from nearby sites from stormwater runoff, as well as migration from sites only connected through groundwater. Recent sediment testing of soils around former asphalt plants revealed contaminants such as diesel, petroleum, arsenic, and lead, with some of these also showing up along the Cove's eastern shoreline.

With respects to stormwater runoff, there are currently three major stormwater outfalls into the cove. One discharges from a fairly large drainage area to the east of the cove that includes land uses such as residential, transportation, commercial, and some light industrial. The second outfall is near the Oregon City Shopping Center, which drains transportation, commercial, and mixed land uses. The third outfall receives water from a drainage swale between a residential apartment complex and the Oregon City Shopping Center. These three outfalls convey runoff from large urban areas, and those drainage areas receive little water quality treatment prior to discharging into the cove. The City, through its National Pollutant Discharge Elimination System (NPDES) permit, is required to monitor and sample at these outfalls, the results of which consistently show the presence of dissolved copper, zinc and lead, which all have been linked to negative effects on salmon and steelhead. A map of the drainage area is included in Figure 5-1.

The combination of higher pollutant-generating land uses and important downstream natural resources makes the Clackamette Cove drainage area a logical focus for the City's water quality retrofit program.

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5.3.2 Potential Project Locations

The drainage networks contributing to the three Clackamette Cove outfalls includes a mix of both public and private infrastructure. The conveyance systems are old, with complicated networks and areas of unknown connections. However, the disjointed development throughout this area has resulted in a series of underdeveloped properties and slivers of undevelopable land.

Using existing GIS data, land use data were investigated to locate publicly owned properties as well as underdeveloped properties where a property owner might become a willing partner in the implementation of a water quality retrofit project. Within the Clackamette Cove drainage area, the following three general opportunity areas were identified:

- The South Metro Transfer Station, which has an existing water quality treatment facility. This facility could be retrofitted to manage a larger drainage area and provide treatment for areas outside of the Metro property.
- Oregon City Shopping Center and the associated area drainage does not include any treatment at this time. A relatively large portion of the private property is undeveloped and adjacent to City-owned property to the north. This open space could provide a site for a water quality treatment facility to serve the entire shopping center and associated drainage.
- Several large pieces of property between I-205 and the railroad could include opportunity areas for a treatment facility. Some of this land is currently designated as wetland mitigation.

5.4 Water Quality/Retrofit Recommendations

Continuing to improve water quality within the city will require a combination of programmatic actions, opportunistic investments, and specific projects.

5.4.1 Water Quality Capital Improvement Projects

Based on the evaluation presented in Section 5.3, one water quality retrofit project has been included in the recommended CIP list. CIP 10 is proposed to install a water quality treatment facility north of the Oregon City Shopping Center. The facility has the potential to provide treatment for the entire shopping center and other additional impervious area that is currently untreated. This CIP was selected based on the simplicity and opportunity to retrofit existing infrastructure by redirecting flow to the new facility, and the availability of land for the construction of a water quality facility.

Implementation of this CIP will require close coordination with the existing property owner, as well as an easement to locate and maintain the facility on private property. With a heightened regional interest in improving water quality in Clackamette Cove, the CIP could also be well positioned to compete for grants and other competitive funding. See Section 7 for more information regarding this CIP.

Water quality features will also be incorporated into proposed capital projects at Pebble Beach Pond and Scattering Canyon. Over time, outfall improvements through Newell Canyon have the potential to improve water quality by reducing erosion and sediment contributions to Newell Creek. The City may also elect to evaluate water quality retrofit opportunities in conjunction with stormwater conveyance projects. Retrofits could include installing green streets or treatment swales as part of the upgraded conveyance system.

In the long term the City may also investigate the feasibility of constructing additional water quality retrofit facilities on the other properties listed in Section 5.3.2.

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5.4.2 Water Quality Programs

In response to the NPDES permit requirements, the City already has a robust program to address water quality through programmatic actions. These programs address water quality at the source through illicit discharge investigations, construction site regulations, and stringent standards for new development and redevelopment.

In addition to these existing programs, the City may investigate other focused water quality retrofit plans. Some examples include:

- Opportunistically incorporating water quality treatment into municipal projects, such as roadway improvements and building remodels.
- Implementing a green streets retrofit program for areas in need of additional treatment and opportunistically implementing along with roadway improvements by replacing landscape strips with stormwater planters to provide treatment for existing roadways and residential areas.
- Incorporating water quality enhancements at existing stormwater outfalls when outfall rehabilitations are constructed (see Section 6).
- Community outreach programs to encourage private property owners to install rain gardens, swales, or other treatment facilities on individual properties.
- Retrofitting existing facilities to enhance treatment. An example of this is the Pebble Beach CIP discussed in Section 7.

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City of Oregon City

GEOGRAPHIC INFORMATION SYSTEM

Figure 5-1.
Clackamette Cove Drainage Area

- Conduit
- Ditch
- City Limits
- Stream Lines
- Cove Drainage Area

Clackamas River

Tri-City Wastewater Treatment Plant

205

Clackamette Cove

213

Outfall #1

Outfall #3

Outfall #2

Metro South Transfer Station

99E

Oregon City Shopping Center

Willamette River

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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Map name: Figure 5-1 Cove Drainage Area.mxd

Section 6

Natural Systems Assessment

The focus of this natural systems assessment was to evaluate physical stream conditions to identify impacts from stormwater runoff. As Oregon City has developed over the decades the percentage of impervious area has increased, causing an increase in peak flows and a decrease in base flow. The result of this is channel erosion and modification that is not beneficial to the health of the stream and its ecosystem. Stormwater runoff also has significant potential to impact in-stream water quality and natural systems, as discussed in Section 5 of this Master Plan.

The City includes areas that are clearly susceptible to channel erosion and modification due to increases in flow from surface water runoff. It is recommended that proper stormwater infrastructure and land use policies be implemented by the City to address natural channel impacts from stormwater runoff.

6.1 Background

Oregon City's geography and topography are unique. While the city is located adjacent to the Willamette River, much of the city drains to smaller tributary streams, including tributaries to Newell Creek, Beaver Creek, and Abernethy Creek.

As an urbanized area, stormwater discharges generated in the city have the potential to impact stream conditions through hydromodification. Increasing impervious area through development and redevelopment activities alters runoff conditions and increases peak flow to stream channels, typically increasing stream energy and decreasing base flow. Increased stream energy can alter stream channels through flooding, bank erosion, bed incision, sediment production, and other impacts.

The City has been implementing stormwater management design standards for new development and redevelopment since 1999. Those standards have required developments to manage peak flows, resulting in numerous stormwater detention ponds constructed across the city. Further evaluation is needed to determine whether the facilities constructed during peak periods of development have been sufficient to offset impacts from increased stormwater runoff.

This natural systems assessment builds heavily upon the City's 2015 Hydromodification Assessment (described in Section 1.2.1) to identify citywide recommendations to address in-stream channel modification caused by surface water runoff.

6.2 2015 Hydromodification Study

The City's NPDES MS4 permit required the City to complete and submit a hydromodification assessment, which was completed in July 2015. The study was focused on evaluating hydromodification impacts associated with urbanization and discharges from the MS4. The assessment included a review of existing planning documents, a GIS desktop evaluation of watershed conditions, and targeted field assessments to identify hydromodification indicators. The assessment included an evaluation of stream channels in the city to determine whether discharges from the MS4 have impacted stream channels and whether future development patterns are likely to contribute to additional impacts.

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Because of time constraints, field assessments in 2015 were focused on the Abernethy Creek tributaries, including Newell Canyon areas. Additional evaluation was still needed for Beaver Creek tributaries.

The assessment then identified strategies to address the hydromodification impacts. Partly in response to the hydromodification assessment, the City adopted new Stormwater and Grading Design Standards. These standards require new development and redevelopment projects to control both the peak flow and the volume of stormwater runoff to better protect natural systems.

The 2015 study identified key CIPs to address in-stream hydromodification problems. These CIPs included:

- Installing energy dissipation measures to address active erosion and incision problems on Newell Creek, downstream of Beavercreek Road and Highway 213
- Reconstructing the drainage channel to better manage current flows in Scattering Canyon, located in the Mountain View Cemetery
- Installing energy dissipation at the Livesay Creek culvert outfall downstream of Holcomb Boulevard
- Installing grade control structures and energy dissipation features in Park Place Creek downstream of Abernethy Road Culvert[3]

The 2015 study also recommended annual monitoring of known and potential problem areas to determine whether the City should take immediate corrective action. Some stream channels that look to be problematic may be showing signs of historical erosion that has since stabilized. Annual site visits to conduct visual monitoring will allow the City to identify active erosion problem areas. The sites identified for annual monitoring included:

- Newell Creek at Beavercreek Road and Highway 213 outfalls (site 004)
- Newell Creek tributary at Mountain View Cemetery, known as Scattering Canyon (site 012)
- Livesay Creek culvert downstream of Holcomb Boulevard (site 002)
- Park Place Creek downstream of Abernethy Road (site 001)
- Newell Creek tributary at stormwater system outfall downstream of Eluria Street near Logus Street (site 008)
- Stormwater system outfall channel adjacent to 17883 Peter Skene Way (site 013)

The 2016 field evaluations included site visits to these previously identified monitoring locations to assess hydromodification and general system conditions. The field evaluations and descriptions of the conditions are presented below in Sections 6.3 through 6.5.

6.3 2016 Field Evaluations

The purpose of the 2016 field evaluations was to expand and enhance the 2015 hydromodification assessment results. Field evaluations were conducted by the City and consultant staff on May 24, 2016.

The field assessment was qualitative in nature, and focused on documenting existing channel conditions. Locations for the 2016 field assessment were selected based on known problem areas, annual monitoring sites listed in Section 6.2 and locations throughout the Beaver Creek tributary subbasins that were not evaluated in 2015.

[3] This CIP was subsequently removed from the potential CIP list, as a follow-up site visit in 2016 revealed little change in the channel conditions.

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Nearly all the field observations could be made from public property. City staff identified field assessment locations with public access to the stream channels, including locations of road culverts, easements, and the Mountain View Cemetery. Metro also owns and manages 300 acres of property with access to Newell Creek. Table 6-1 lists the specific locations of field observations. Field observation locations for the 2015 hydromodification study and this Master Plan are identified on the map in Figure 6-1.

Table 6-1. Hydromodification Assessment Field Observation Locations

Site no.	Water body	Location	Description
001	Park Place Creek	Channel downstream of Abernethy Rd., behind property at 13530 Redland Rd.	• City-identified problem area due to minor incision and channel deepening • City water quality monitoring location
002	Livesay Creek	Storm outfall at 14010 Beemer Way, downstream of Holcomb Blvd.	• City-identified problem area due to severe channel incision at stormwater outfall
003	Newell Creek	Beavercreek Rd. and Hwy. 213, upstream and east of Hwy. 213	• Reference reach of channel conditions reflecting an urbanized area with upstream flow control • Approximately 500 feet upstream of site 004
004	Newell Creek	Beavercreek Rd. and Hwy. 213, downstream and west of Hwy. 213	• City-identified problem area due to severe erosion at stormwater outfalls
005	Tributary to Newell Creek	1635 Beavercreek Rd.	• City-identified problem area with possible outfall erosion and channel incision • Discharge location for drainage system from Warner Milne Rd.
006	Stormwater outfall in Newell Creek Basin	702 Hilltop Ave.	• City-identified problem area at stormwater outfall
007	Tributary to Newell Creek	Tributary in Newell Canyon, accessed from Hilltop Ave.	• Reference reach of tributary stream in Newell Canyon Metro property
008	Tributary to Newell Creek	Stormwater outfall and channel downstream of Eluria St. near 613 Logus St.	• City-identified problem area due to stormwater outfall causing bank erosion along channel adjacent to private property
009–010	High School Creek (John Adams Basin)	Culverts under Madison St. and Monroe St.	• City-identified problem area due to channel incision at stormwater outfalls
011	Stormwater system in Central Point Basin	11976 Kathaway Ct.	• City-identified stormwater system problem area • Potential future CIP to address conveyance issues associated with open-channel conveyance along private property
012	Tributary to Newell Creek	Scattering Canyon in Mountain View Cemetery	• City-identified problem area due to channel incision • Location of potential project identified by the GOCWC
013	Tributary to Newell Creek	17883 Peter Skene Way	• City-identified problem area due to channel incision
014	Coffee Creek	Canemah Neighborhood	• City-identified problem area due to various channel conditions through Canemah neighborhood • Potential future CIP to address conveyance needs including relocation of the conveyance system within the public ROW
200	Tributary to Caufield Creek	South of Meyers Rd. near Trails End Market Place	• City-identified problem area due to erosion issues at outfall • Minimal erosion witnessed during site visit
201/202	Caufield Creek	Downstream of Hwy. 213	• City-identified problem area due to erosion/incision issues
203	Mud Creek	Frontier Parkway near pump station	• Natural pond formed by beaver activity
204	Tributary to Beaver Creek	Orchard Grove Drive	• Stormwater ponds in Beaver Creek Basin
205	Coffee Creek	Hazelwood Drive	• Investigating conditions and flooding issues in Coffee Creek
206	Singer Creek	Singer Creek Park	• City-identified problem area due to bank stability • Western bank has slid off into creek but now appears stable

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The field assessment was used to document hydromodification indicators by taking photographs at each site (see Appendix D) and completing Stream Channel Observation Forms for major observed reaches (see Appendix E).

6.4 Observations

Table 6-2 below, lists the hydromodification indicators observed during site visits in 2015 and 2016. General observations of the impacts to these systems due to the runoff generated within Oregon City are summarized below.

Newell Canyon. Newell Canyon has been established as a problem area that is characterized by steep slopes and erodible soils. The development that exists in this watershed is generally older and lacks water quality or flow control facilities. The combination of development without flow control and highly erodible soils has resulted in observed stream incision, erosion at the outfalls, and severely altered stream channels. Newell Canyon hillsides have also experienced sloughing and small landslides, though those problems cannot be attributed solely to stormwater runoff. Newell Creek has some areas of severe downcutting and incision in the upper reaches of the creek (site 003), but lower reaches of the creek seem to be well preserved (site 007). Several stormwater outfalls (sites 008 and 013) showed noticeable degradation between the 2015 and 2016 site visits.

Beaver Creek. The tributaries to Beaver Creek that are within the city are managed through manmade and natural features such as wetlands that appear to be managing the changes in hydrology caused by increased impervious surfaces. Newer development that has occurred since 1999 has been designed with the required water quality and flow control facilities that appear to be protecting the integrity of the tributaries and natural systems. Recent field visits to the tributaries of Beaver Creek show that the channels downstream of large residential developments appear to be stable and preserved in their natural state (sites 200, 201, and 202). Hydromodification does not appear to be occurring in these areas.

Abernethy Creek. Field investigations for Abernethy Creek were focused on stormwater outfalls from the urbanized area, as much of the Abernethy Creek watershed is located upstream of the city. Stormwater outfalls and culverts in Abernethy Creek tributaries are generally in poor condition. The soils in this watershed are loose, highly erodible, and susceptible to damage by changes in the hydrology of the watershed. Several of the outfalls inspected in 2015 had exposed bedrock, indicating severe downcutting (sites 001 and 002). However, follow-up visits in 2016 showed little change at these outfalls and culverts. It appears that the channel degradation occurred during older periods of development and the stream channels have since re-stabilized to the modified hydrology.

Clackamas River. The northern portion of the city discharges to the Clackamas River. Few observations have occurred in this area. There have been few reports from City staff of negative impacts to the system due to development.

Willamette River. The Willamette River is impacted by the areas of the city that have been long established and developed. The results are long-established flow patterns. The areas of the city that drain to the Willamette River are naturally protected from the negative impacts of development by the rocky nature of the geology. No negative impacts from development have been observed in these areas.

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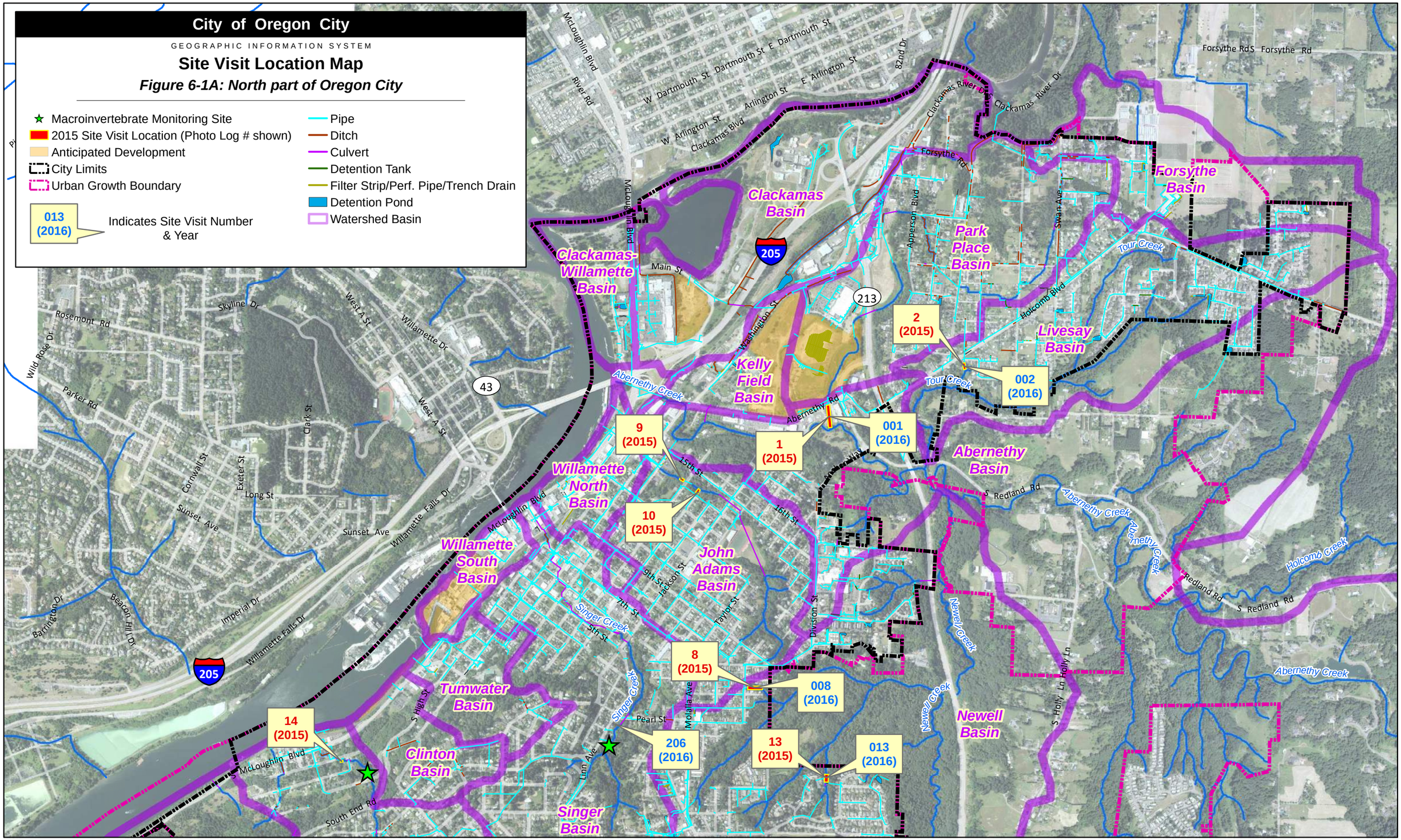
Site Visit Location Map

Figure 6-1A: North part of Oregon City

- ★ Macroinvertebrate Monitoring Site
- 2015 Site Visit Location (Photo Log # shown)
- Anticipated Development
- City Limits
- Urban Growth Boundary

013 (2016) — Indicates Site Visit Number & Year

- Pipe
- Ditch
- Culvert
- Detention Tank
- Filter Strip/Perf. Pipe/Trench Drain
- Detention Pond
- Watershed Basin



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GEOGRAPHIC INFORMATION SYSTEM

Site Visit Location Map

Figure 6-1B - South part of Oregon City

- Macroinvertebrate Monitoring Site
- 2015 Site Visit Location (Photo Log # shown)
- Anticipated Development
- City Limits
- Urban Growth Boundary

013 (2016) — Indicates Site Visit Number & Year

- Pipe
- Ditch
- Culvert
- Detention Tank
- Filter Strip/Perf. Pipe/Trench Drain
- Detention Pond
- Watershed Basin

The City of Oregon City makes no representations, express or implied, as to the accuracy, completeness and timeliness of the information displayed. This map is not suitable for legal, engineering, or surveying purposes. Notification of any errors is appreciated.

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Oregon City, OR 97045
503-657-0891
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Plot date: June 23, 2017; Plot name: SWMP - Site Visit Location Map - South - 11x17L - 20170623.pdf; Map name: SWMP - Site Visit Location Map - South - 11x17L.mxd

Table 6-2. Hydromodification Indicators in Oregon City Watersheds

Indicators	Abernethy Creek and tributaries (Livesay Creek, High School Creek, Park Place Creek)	Newell Creek and tributaries	Willamette River tributaries (Coffee Creek, Singer Creek)	Beaver Creek tributaries (Caufield Creek, Mud, Central Point
Flooding	• None observed or reported during limited field observations. • Observed open-channel areas are typically in small canyons, limiting potential flooding.	• None observed or reported associated with stream channel discharges. • Localized flooding problems are associated with specific areas of the conveyance system.	• None observed or reported.	• None observed or reported.
Degradation/ bed incision	• Bed incision on Park Place Creek downstream of Abernethy Road (site 001) looks to be historical channel change. Culverts currently sit above the elevation of the lowered channel bed. • Significant bed incision on tributary to Livesay Creek downstream of Holcomb Boulevard (site 002). Past channel protections, including a large concrete outfall, are continuing to degrade.	• Most observed locations show little incision. • Significant bed incision at Beavercreek Road/Hwy. 213 outfalls (site 004) caused by multiple stormwater discharge pipes in single, steep channel. Portions of bed are armored with natural bedrock and boulders. • Active incision at Scattering Canyon tributary. Evidence of nick points and plunge pools forming between cobbles. • Bed stabilization projects on small tributaries (site 008) looks to be providing adequate protection.	• Observed portion of Coffee Creek Channel under private property has signs of historical incision. • Channel beds contain cobbles and larger material, providing natural resistance to incision.	• None observed or reported. Channels look to be retaining natural shape and connections to larger floodplains.
Bank erosion/widening	• Erosion around culvert outlets on observed tributaries. • Significant erosion of channel banks near outfall at site 002.	• Channel sections with sufficient setbacks have maintained floodplain connection and do not show signs of ongoing erosion. • Significant bank erosion at Beavercreek Road/Hwy. 213 outfalls (site 004) caused by multiple stormwater discharge pipes in single, steep channel. Portions of channel bed are naturally armored with boulders and cobbles. • Minor channel widening at Scattering Canyon tributary (site 012). • Localized erosion around stormwater outfalls.	• None observed or reported during limited field observations.	• None observed or reported.

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Table 6-2. Hydromodification Indicators in Oregon City Watersheds

Indicators	Abernethy Creek and tributaries (Livesay Creek, High School Creek, Park Place Creek)	Newell Creek and tributaries	Willamette River tributaries (Coffee Creek, Singer Creek)	Beaver Creek tributaries (Caufield Creek, Mud, Central Point
Lack of riparian vegetation	• Development encroachment has reduced riparian vegetation in some areas. • Invasive species observed in urbanized channel areas. • High School Creek (site 009-010) is located in a deep canyon and has protected vegetated corridor through the urbanized area.	• Observed channel areas have good vegetative cover. • Protected areas of Newell Canyon are vegetated with natives. Little evidence of invasive species. • Development encroachment on smaller tributaries has potential to impact riparian vegetation.	• Development encroachment has reduced riparian vegetation in some areas, particularly in Coffee Creek Basin. • Singer Creek has protected riparian corridors around the stream channel.	• None observed or reported. Channels are in protected corridors with abundant natural vegetation.
Aggradation/sediment loads (evidence of increasing sediment loads without capacity to transport)	• None observed or reported during limited field observations.	• None observed or reported. • Stream channel observations show good gradation of channel bed materials, little siltation.	• None observed or reported during limited field observations.	• None observed or reported during limited field observations.
Other observed problems	NA	• Potential water quality concerns at Scattering Canyon (site 012). Hillside seepage and drainage pipes from old landfill could be source of pollutants.	• Limited open-channel areas in these drainage basins. • Some locations of the piped conveyance system are located on or under existing structures and/or private property. Limited potential to daylight channel or increase conveyance capacity.	NA
Unique features that may inform hydromodification strategies	• Future development areas in the UGB adjacent to Livesay Road and Redland Road have potential to impact Abernethy Creek and tributaries. • Future development of old landfill site could impact problem area at Park Place Creek downstream of Abernethy Road (site 001).	• Large portions of Newell Canyon are under Metro protection, limiting near-stream development and maintaining riparian and floodplain protection. • Future developments in headwaters areas have the potential to impact Newell Creek and Newell Creek tributaries. • GOCWC has been pursuing funding for a restoration project at Scattering Canyon. The City has also allocated funds for this project.	• Limited channel observations in this watershed. • Steep slopes and more limited upstream development potential in these basins.	• Development in this watershed has largely included stormwater management facilities. • Natural wetland areas at headwaters of tributaries provide natural attenuation for stormwater runoff.

Note: Representative conditions identified based on available data. Beaver Creek tributaries (Caufield, Mud, Central Point, and South End basins) not included in priority field assessments, though impacts are expected to be similar to those in the Newell and Abernethy basins.

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6.5 Natural Systems Recommendations

The natural systems assessment builds upon the hydromodification assessment, completed by the City in 2015. Additional data collected in 2016 lead to the refinement of the CIP recommendations from the 2015 study.

Several of the program recommendations from the 2015 study were completed in conjunction with this Master Plan. This included collecting additional field data, completing a surface water master plan, conducting annual monitoring visits to problem areas, and developing a water quality retrofit program. In addition, the City is implementing the updated Stormwater and Grading Design Standards that include requirements for developments related to addressing hydromodification.

6.5.1 Capital Project Recommendations

Table 6-3 lists the potential in-stream CIPs that were identified in 2015 with additional information regarding the incorporation of those CIPs into the Master Plan. One additional CIP that was also identified in 2016 has been added to the table below.

Table 6-3. Potential In-stream Capital Improvement Project Locations

Basin	Site visit location	CIP location	Description	Potential hydromodification benefits	Implementation Plan
Newell Creek	004	Newell Creek downstream of Beavercreek Road and Highway 213	• Energy dissipation at existing outfalls and downstream channel improvements • Vegetation management associated with reconstructed channel and floodplain • Requires geotechnical evaluation to determine extent of roadway impacts and methods of armoring the stream channel in locations of the road subgrade	• Addresses active erosion and incision problems • Reduces stream energy and dissipates concentrated flows • Improves in-stream function • Enhances riparian zone	• This problem area is being addressed through a separate ODOT project.
Newell Creek	012	Scattering Canyon in Mountain View Cemetery	• Reconstruct drainage channel to accommodate current flow regime • Install energy dissipation features and reconnect floodplain for overbank peak flows • Vegetation management associated with reconstructed channel • Requires upstream investigation to determine source and extent of current flow contributions	• Addresses active erosion and incision problems • Reduces stream energy and dissipates concentrated flows • Improves in-stream function • Enhances riparian zone	• At the time of this Plan, this CIP is in the design phase.
Livesay Creek	002	Livesay Creek culvert outfall downstream of Holcomb Boulevard	• Energy dissipation at existing outfalls and downstream channel improvements • Vegetation management associated with reconstructed channel and floodplain • May require private property acquisition to reconstruct channel and floodplain	• Addresses active erosion and incision problems • Reduces stream energy and dissipates concentrated flows • Improves in-stream function • Enhances riparian zone	• 2016 site visit showed no ongoing degradation. CIP was removed from the priority list.

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Table 6-3. Potential In-stream Capital Improvement Project Locations

Basin	Site visit location	CIP location	Description	Potential hydromodification benefits	Implementation Plan
Park Place Creek	001	Park Place Creek channel downstream of Abernethy Road culvert	• Enhance in-stream channel diversity and energy dissipation through vegetation management and installation of woody debris • Consider grade control structures to prevent further incision • Consider long-term property acquisition to restore floodplain connection • Coordinate with GOCWC on adjacent floodplain restoration project along Abernethy Creek	• Addresses ongoing incision • Potential to reconnect floodplain and reduce stream energy	• 2016 site visit showed no ongoing degradation. CIP was removed from the priority list.
Newell Canyon	008 and 013	Newell Canyon Outfalls	• Outfall investigation program to prioritize and evaluate Newell Canyon outfalls. • Stabilization projects to reduce erosion and bank sloughing at priority outfalls.	• Identifies and addresses active erosion and incision problems • Reduces stream energy and dissipates concentrated flows • Improves in-stream function • Enhances riparian zone	• Incorporated into this Plan as a CIP.

6.5.2 Outfall Assessment Recommendations

The 2016 site visits revealed a clear need for ongoing monitoring and in-depth investigation of stormwater outfalls in Newell Canyon (last row of Table 6-3). Sites 008 and 013 showed noticeable degradation in a 1-year time frame. The City has constructed outfall stabilization projects in the past, but a more comprehensive investigation is warranted.

To facilitate the necessary level of effort to continue to inspect and then repair or rehabilitate some of the outfalls and systems, a programmatic CIP has been developed. The outfall inspection program would include conducting widespread assessment of stormwater outfalls in Newell Canyon to identify and prioritize projects that would stabilize failing areas, reduce stream energy and enhance riparian areas. Projects identified through the outfall inspection program could be included as additions to the CIP list provided in Section 7 and should be scored and prioritized in a similar manner as the City determines where to direct CIP resources.

The City's first step in this process is to conduct a widespread outfall assessment to evaluate stormwater outfalls, identify significant problem locations, and develop concept plans to stabilize degrading systems. The assessment should include the following:

- Develop outfall evaluation criteria for a desktop evaluation and onsite evaluation.
- Conduct desktop evaluation using available mapping data and problem area reports to prioritize locations for onsite assessments.
- Based on the prioritization outcome, conduct outfall inspections at roughly 15-20 high priority outfalls. Inspections would evaluate outfall condition, stabilization measures, bank stability and degradation. Inspections would also evaluate construction opportunities and constraints for future stabilization projects.
- Develop a priority matrix of outfall stabilization projects and a recommended schedule for design and construction.

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- Develop concept level designs and cost estimates for outfall stabilization measures at the highest priority project areas (approximately five outfalls).

Follow-up work is expected to include numerous outfall stabilization projects. Some projects may be completed by City crews, while others could require significant design and construction contracts. It is recommended that $100,000 per year be set aside for outfall stabilization projects identified through the outfall assessment study. The project implementation timeline will depend on the severity of degradation and potential risks of deterioration at each outfall. Future goals may include proactive work to stabilize lower priority outfalls before significant problems arise to avoid more costly emergency fixes down the road.

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Section 7

Capital Improvement Project Development

This section describes the CIPs recommended to address the problem areas identified throughout this master planning process. These CIPs address current and future needs to address water quality issues, capacity/flooding, asset management, and natural systems health.

7.1 Project Identification

Potential CIP locations were identified by reviewing the problem areas matrix presented in Appendix A. The matrix includes problems reported by City staff, as well as problem areas identified through modeling (Section 3) and the natural systems assessment (Section 6).

After documenting the problem areas on a map and in a matrix, the problems were grouped into potential CIP areas. Many of the reported problems were identified as having a clearly identifiable solution. Examples of this include culvert upsizing to increase capacity, adding infrastructure in underserved areas, and construction of water quality treatment facilities for untreated urbanized areas. Other problem areas were identified as requiring additional investigation through modeling, site visits, or desktop assessment in order to recommend CIPs.

Appendix G includes a comprehensive matrix of potential CIPs resulting from the problem area review. This list includes far more CIPs than the City could reasonably implement during the planning period, but it provides an overview that helped to identify focus areas.

Using the potential CIPs matrix in Appendix G, Brown and Caldwell led a workshop with City staff to review, prioritize, and narrow the list of potential CIPs. During the workshop, each problem area was reviewed with respect to the nature of the problem, the severity of the problem, and how the problem or potential solution would benefit residents and private or public assets. CIP timing was also discussed as some CIPs were already under development and not appropriate for inclusion in this future planning document.

7.2 Recommended Capital Improvement Projects

Based on feedback from the strategy workshop the potential CIP list was prioritized and narrowed down to twelve CIPs for further evaluation and development. Six projects include water quality enhancements, five replace old and undersized infrastructure to address capacity issues, and three construct new infrastructure in areas currently lacking a system. Several projects address multiple objectives. These identified CIPs are listed in Table 7-1 below.

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Table 7-1. Comprehensive CIP Summary				
CIP no.	CIP type	CIP name	CIP description	Estimated implementation cost
1	Capacity	John Adams Basin Capacity Improvements	Pipe capacity improvements	$8,555,000
2	Capacity Water quality	South End Road Stormwater Improvements	Pipe capacity improvements	$3,209,000
3	New infrastructure	Division Street Infrastructure Improvements	New conveyance infrastructure	$770,000
4	New infrastructure	Rivercrest Neighborhood Infrastructure Improvements	New infrastructure and existing pipe capacity improvements: sanitary disconnect	$2,428,000
5	New infrastructure	Harding Boulevard Sanitary Disconnect	New infrastructure and sanitary disconnect	$464,000
6	Water quality	Pebble Beach Pond Retrofit	Detention and water quality pond retrofit	$713,000
7	Capacity	Hiefield Court Culvert Improvements	Update culvert inlets to reduce losses and assess capacity of existing system	$657,000
8	Water quality	The Cove Water Quality Improvements	Construction of water quality facility and retrofit of existing conveyance system	$608,000
9	Capacity	Holcomb Boulevard Capacity Improvements	Pipe capacity improvements	$3,893,000
10	Capacity Water quality	Coffee Creek Stream Restoration	Daylighting and restoration of Coffee Creek through Hazelwood Drive neighborhood.	$1,096,000
11	Water quality	Scattering Canyon Stormwater Improvement	Enhance current outfall and channel at canyon to reduce erosion while enhancing water quality and aesthetics	$521,000
12	Water quality	Newell Canyon Outfall Assessment	Visit, assess and develop concept design for outfall repair	$100,000

A map of CIP locations is included as Figure 7-1. Fact sheets for each of the CIPs are included in Appendix F.

7.3 Design Assumptions

This section includes a summary of the CIP sizing and conceptual design criteria based on the type of system improvements proposed. CIP design concepts include capacity projects, water quality projects, and new stormwater infrastructure. The design assumptions used to develop conceptual project solutions generally followed the City's Stormwater and Grading Design Standards. CIP concepts were designed to an approximate 10 percent design level with preliminary concept sketches and cost estimates included in the CIP Fact Sheets in Appendix F.

Capacity Projects. CIP concepts that include construction of new conveyance infrastructure, or that replace existing conveyance infrastructure, were developed following the City design standards for sizing. All CIPs in this plan systems were sized for conveyance of the 25-year, 24-hour event. This is required for catchment areas between 40 and 640 acres.

Water Quality Projects. Six CIPs include elements that provide water quality benefits for the city. The conceptual facility at the Cove was sized using the City's BMP Sizing Tool. The tool provides facility sizing for flow control and/or water quality. The Pebble Beach retrofit CIP will be sized using the tool when the time comes for detailed design. For the conceptual design, the assumption was made that increased water quality treatment will be provided within the existing facility footprint to the extent possible with the inclusion of new outlet structures. Other projects incorporate water quality enhancements to larger capacity focused projects or are opportunistic enhancements, based on the available land area.

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City of Oregon City

GEOGRAPHIC INFORMATION SYSTEM

Figure 7-1. Capital Project Locations

- Proposed Capital Projects
- Storm Drainage Pipe
- Ditch
- Stream Lines
- City Limits

Clackamas River

CIP #8 The Cove Water Quality Improvements

CIP #9 Holcomb Boulevard Capacity Improvements

Abernethy Creek

CIP #3 Division Street Infrastructure Improvements

CIP #1 John Adams Basin Capacity Improvements

CIP #12 Newell Canyon Outfall Assessment

Willamette River

CIP #5 Harding Boulevard Sanitary Disconnect

Newell Creek

CIP #4 Rivercrest Neighborhood Infrastructure Improvements

CIP #10 Coffee Creek Capacity Improvements

CIP #11 Scattering Canyon Stormwater Improvements

CIP #7 Hiefield Court Culvert Improvements

CIP #2 South End Road Stormwater Improvements

CIP #6 Pebble Beach Pond Retrofit

Beaver Creek

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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Plot date: December 14, 2017
Plot name: Figure 7-1 Capital Project Locations.pdf
Map name: Figure 7-1 Capital Project Locations.mxd

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New Infrastructure. Several of the CIPs include new infrastructure to be constructed in locations where no previous storm systems existed. Concepts of these systems are illustrated in the CIP Fact Sheets in Appendix F with generalized locations provided in public rights-of-way. However, consideration for other utilities, conflicts, depth, and location of manholes and catch basins will all need to be investigated in more detail for final design. The actual design may need additional structures, may require an alternate alignment because of conflicts, or may be deeper or shallower than what was assumed for the conceptual CIP in this Master Plan.

7.4 Cost Estimates

The cost estimates generated for each CIP were based on the proposed layout and general design assumptions. The unit pricing was based on past CIP bid tabs adjusted for 2019 based on a historical cost index and recent construction bids in the Portland Metro area.

Preliminary CIP cost estimates were based on the unit cost information for construction elements plus a 30 percent contingency. Contingencies for permitting, surveying and design, and construction administration costs were based on a general percentage of the total construction cost. A market adjustment of 15 percent was also added to cost estimates, based on higher than usual construction costs in the Portland metropolitan area. Land acquisition costs were not included in the estimates.

Appendix H includes the unit cost tables that were used for this Master Plan, and the concept-level project cost estimate for each CIP.

7.5 Capital Improvement Project Prioritization

CIP prioritization is an important step in developing a plan for the City that provides an implementable path forward and direction in terms of sequencing CIPs. The prioritization process included a set of scoring categories or criteria and point values for CIP conditions associated with each criterion. Over time, the City may choose to add weighting factors to place more emphasis on a particular scoring category as new CIPs are added to the list and scored.

For Oregon City, a CIP prioritization meeting was conducted with City staff. Multiple CIP example scoring criteria were provided, and City staff identified the preferred criteria and scoring framework as shown in Table 7-2 below.

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Table 7-2. Capital Improvement Project Prioritization Criteria			
Scoring category	Weight	Rating level	Score
Capacity issue (safety/liability)	1.0	Significant flooding hazard; threat to life and limb and/or property	5
		Moderate safety hazard	3
		No flooding or safety hazard	1
Benefit to sanitary system	1.0	Significant benefit to sanitary system	5
		Moderate benefit to sanitary system	3
		No benefit to sanitary system	1
Cost	1.0	Small CIP (less than $500,000)	5
		Medium CIP (greater than $500,000 and less than $1,000,000)	3
		Large CIP (more than $1,000,000)	1
Environmental benefit	1.0	Significantly improves water quality	5
		Moderately improves water quality	3
		No improvement to water quality	1
Maintenance (long- and short-term)	1.0	CIP will significantly reduce ongoing maintenance requirements	5
		CIP will moderately reduce ongoing maintenance requirements	3
		CIP will not reduce ongoing maintenance requirements	1
Existing condition	0.5	System is failing or beyond its expected design life	5
		System appears to be in good working order and is not beyond expected design life	3
		System is in excellent shape and relatively new	1
Impact	1.0	Problem affects regionwide area with significant downstream and/or upstream impacts	5
		CIP will address multiple blocks or properties	3
		CIP will address a few properties	1

The prioritization criteria focus on system capacity and condition with consideration for cost, maintenance, and environmental benefit, which are included in Table 7-2. Unique to Oregon City, the scoring categories include consideration for a CIP's potential benefit to the sanitary sewer system, as the City is facing challenges related to stormwater and sanitary sewer interconnections. All scoring criteria were weighted equally, with the exception of the "existing conditions" criterion, which was given half the weight of the other criteria. The maximum possible CIP score was 35.

The CIP scoring and the resulting ranking is included in Table 7-3 below. Prioritization scores range from 12.5 to 26.5, with the higher scores representing projects that are most closely aligned with the City's stormwater planning objectives.

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Table 7-3. Capital Improvement Project Prioritization		
Score	CIP ranking	
26.5	1	Harding Blvd Sanitary Disconnect
24.5	2	Newell Canyon Outfall Assessment
22.5	3	Scattering Canyon Stormwater Improvements
20.5	4	Rivercrest Neighborhood Infrastructure Improvements
18.5	5	John Adams Basin Capacity Improvements
18.5	6	The Cove Water Quality Improvements
15.0	7	South End Road Stormwater Improvements
15.0	8	Pebble Beach Pond Retrofit
13.0	9	Holcomb Road Capacity Improvements
13.0	10	Coffee Creek Capacity Improvements
12.5	11	Hiefield Ct Culvert Improvements
12.5	12	Division Street Infrastructure Improvements

The full CIP prioritization scoring matrix is included in Appendix I.

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Section 8

Integrated Stormwater Management Strategy

The City needs a proactive plan to address immediate capacity needs, replace aging infrastructure, and provide regional solutions to larger flooding and water quality challenges. This section provides a summary of recommendations to address existing storm system capacity deficiencies, future storm system needs, asset management, and water quality objectives.

8.1 Integrated Stormwater Management Overview

The management of a stormwater program is multifaceted and requires the integration of multiple elements. Ensuring that the conveyance infrastructure has adequate capacity and is managed to ensure long-term reliability forms the backbone of the stormwater system. The outfalls from the conveyance system and the natural systems that carry the resulting urban runoff require management that is aided through water quality treatment and flow control facilities incorporated into the urban stormwater infrastructure. Guiding the integration of the City's stormwater management strategy is City code, design standards, and state and federal management requirements.

The City's stormwater program was formed around addressing drainage capacity and flooding problems. In the last decade, the program has shifted to include programs that address water quality needs, natural system impacts and the aging infrastructure. The recommendations in Sections 7 and 8 present an integrated strategy of programs and projects to address stormwater priorities across the City. The major recommendations include:

- Replace deteriorating and failing infrastructure, particularly in older areas of the City where stormwater infrastructure is reaching the end of the design life.
- Upsize existing infrastructure to reduce identified flooding issues.
- Upsize existing infrastructure to carry flows from projected future development and support future roadway improvements.
- Install new stormwater infrastructure systems in unserved neighborhoods (Rivercrest and Harding) to reduce stormwater inflow and infiltration into the sanitary sewer system.
- Implement outfall assessment program to systematically monitor and stabilize Newell Canyon outfalls.
- Increase water quality treatment through targeted actions and by integrating treatment features into planned capital projects.
- Expand programs to monitor stormwater infrastructure condition to identify pipes, culverts, and outfalls in degraded condition.
- Develop funding strategy and prioritized CIP implementation schedule.

Recommendations include twelve capital improvement projects and three programmatic actions. Capital Improvement Projects (CIPs) have been developed to address existing and predicted future

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conditions flooding problems, integrate water quality elements, and replace deteriorating pipe segments.

8.2 Capital Improvement Projects

Implementation of the CIPs outlined in Section 7 will be important to continue to provide the necessary infrastructure for a healthy and well-maintained stormwater system. The CIPs provide a list of projects to enhance all aspects of the City's stormwater infrastructure and program.

The twelve recommended CIPs cover multiple objectives. Three CIPs install infrastructure in areas that are not currently served, six include water quality enhancements, five replace old or undersized infrastructure to improve conveyance capacity, and one programmatic project focuses on assessment of current conditions.

Based on priority rankings, the City's highest priority is to implement CIP #5 – Harding Boulevard Sanitary Disconnect to install new infrastructure in neighborhood without a stormwater system. Other high priorities include conducting systematic outfall assessments across Newell Canyon (CIP #12) and reconstructing the outfall channel in Scattering Canyon (CIP #11).

To support upcoming projects, it is recommended that the City begin investigating property acquisition for a water quality improvement near the Cove (CIP #8), and initiate coordination with private property owners to assess the viability of installing new stormwater systems for the Harding and Rivercrest neighborhoods.

The scheduling of CIPs will depend on funding sources and availability, as described in Section 8.4 below.

8.3 Programmatic Recommendations

In addition to the recommended CIPs, the following program recommendations would allow the City to improve understanding of the existing drainage infrastructure conditions and enhance stormwater-related services.

8.3.1 Stormwater R/R Program

The stormwater R/R program outlined in Section 4 includes two primary elements: annual inspections and ongoing pipe R/R projects.

This plan recommends continuing the CCTV inspections with a focus on the aging infrastructure area and areas of the City where pavement rehabilitation projects are planned in the next five years. After inspections are completed in the aging infrastructure area, it is recommended that the City continue an ongoing cycle of CCTV inspections, with the aim of covering all public stormwater infrastructure the City on a 10-year cycle. Depending on staffing levels, the long-term CCTV inspection could be completed by City maintenance crews.

Completing the inspection program will allow the City to identify pipes in critical need of replacement. Replacing deteriorating stormwater infrastructure could cost over $750,000 per year, depending on the extent of pipe replacements, size of pipes, type of rehabilitation, and the speed at which the City wants to implement the program. Pipe replacement projects would be in addition to the CIPs outlined in Section 7 and should be scored and prioritized in a similar manner as they are added to the list.

8.3.2 Outfall Stabilization Project

The outfall inspection assessment outlined in Section 6 and CIP #12 is focused on investigating stormwater outfalls in Newell Canyon to document changing (or stabilized) conditions at each City-owned outfall and identify areas where stabilization measures are needed.

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Follow-up work is expected to include numerous outfall stabilization projects. Some projects may be completed by City crews, while others could require significant design and construction contracts. It is recommended that $100,000 per year be set aside for outfall stabilization projects identified through the outfall assessment study. The project implementation timeline will depend on the severity of degradation and potential risks of deterioration at each outfall. Future goals may include proactive work to stabilize lower priority outfalls before significant problems arise to avoid more costly emergency fixes down the road.

8.3.3 Additional Recommendations

Maintenance is a necessary requirement for the long-term health and stability of the City's stormwater program. This includes the maintenance of conveyance systems, flow control or detention facilities, water quality facilities, roadways and hard surfaces, outfalls and natural systems, and other elements of the stormwater system. Neglected systems perform at a lower level than maintained systems and it is typically more expensive to fix a neglected system than to conduct preventive maintenance. Maintenance is recommended to be a priority for all elements of the City's stormwater system.

8.4 Future Development Planning

The three concept plans for Beavercreek Road Concept Area, South End Concept Area and Park Place Concept Area all include financial evaluations to estimate the cost to construct transportation, utilities, and parks in the future planning areas. The financial details for the three plans have been completed at different time periods with different underlying assumptions. The costs associated with each of the concept plans for the necessary stormwater infrastructure associated with the area in the plan are provided below. Costs have been normalized to the cost per equivalent dwelling unit (EDU) or equivalent residential unit (ERU).

- Beavercreek Road Concept Plan: $14,206 per EDU for stormwater infrastructure only provided in 2007 dollars
- South End Concept Plan: $21,464 per ERU for all public facilities in 2014 dollars
- Park Place Concept Plan: $473 per EDU stormwater infrastructure only provided in 2008 dollars

The City is also a partner in the Willamette Falls Legacy Project, which will provide public access to the falls and facilitate redevelopment of the historic Blue Heron Mill property. Redevelopment of the Willamette Falls Downtown District will require an investment in infrastructure and utilities, including conveyance and water quality treatment facilities for stormwater.

Additional evaluation is needed to establish updated cost estimates for stormwater infrastructure in all of the planning areas and to determine which portions of the stormwater infrastructure (if any) should be paid for through SDCs. Updated cost estimates could be needed to support a future stormwater utility and SDC rate study as part of the Stormwater Master Plan implementation.

8.5 Stormwater Master Plan Fiscal Discussion

This Master Plan includes a recommendation for twelve capital projects and three programs. The total capital cost for the twelve CIPs is estimated at $20,335,000. The annual cost to fund these infrastructure CIPs over the next 15 years is $1,489,000. The two management programs (stormwater R/R program and outfall stabilizations) are estimated at $400,000 per year, assuming a smaller value and longer term R/R program. The annual budget to implement the twelve CIPs and two management programs outlined in this Master Plan is $1,889,000.

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The City's current budget allocates roughly 17 percent of the stormwater program budget to capital improvements. This equates to roughly $550,000 per year. If the City were to address the CIPs outlined in this Master Plan using existing capital project allocations and neglected all other small stormwater project work, there would still be a significant budget shortfall. Given the importance of these CIPs, it is recommended that a stormwater utility rate study be completed as a follow-up to this Master Plan. The rate study can provide a deeper understanding of the financial implications and an opportunity to evaluate alternative funding mechanisms and plans.

In addition to the capital project costs noted above, the concept plans discussed in Section 8.4 could require a significant public investment in stormwater infrastructure. Costs for infrastructure in the concept plan areas should be incorporated into the City's financial analysis.

8.6 Stormwater Management Implementation Plan

Adoption and implementation of this Master Plan and the elements outlined within it are important for the City to move in a direction of preventive actions to minimize future and more expensive reactionary actions. Implementation of the CIPs and utilization of the prioritization matrix along with implementation of the programmatic recommendations will be critical to moving the City forward with respect to sound management of its stormwater infrastructure.

Following this study with a rate study and funding assessment will enable the City to address some of the funding challenges.

Establishing an annual program to inspect and assess the condition of the City's infrastructure will set the City up with a greater understanding of the system and the areas in need of imminent repair and replacement. Implementing design and construction of the listed CIPs will address the areas currently identified as problems. Current and future regulations and design standards will aid in ensuring that new development and redevelopment do not exacerbate any existing problems or place new stresses on the current system.

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Section 9

Limitations

This document was prepared solely for Oregon City in accordance with professional standards at the time the services were performed and in accordance with the contract between Oregon City and Brown and Caldwell dated March 17, 2016. This document is governed by the specific scope of work authorized by Oregon City; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. We have relied on information or instructions provided by Oregon City and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

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Section 10

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Appendices

Appendix A: Problem Area Matrix

Appendix B: Hydrologic Modeling TM

Appendix C: Hydraulic Modeling TM

Appendix D: Field Observation Photo Log

Appendix E: Stream Channel Observation Forms

Appendix F: CIP Fact Sheets

Appendix G: Potential Project Matrix

Appendix H: CIP Cost Estimates

Appendix I: Project Prioritization Scoring Matrix

Appendix A: Problem Area Matrix

Table A-1. Stormwater Problem Areas – Opportunities A-3
Table A-2. Stormwater Problem Areas – Natural Systems A-4
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Table A-1. Stormwater Problem Areas – Opportunities							
Name/no.	Basin	Location	Problem type	Source	Site visit	Description	Comments/notes
LI-O-01	Livesay	Northeast corner of city	Opportunities	Staff workshop		Need master planning for future development near Holcomb and Winston and Oak Tree Ter.	
CA-O-02	Caufield	Andrea Lynn Ter.	Opportunities	City asset review		Evaluate Pond inflow/outflow – looks like it may overtop.	JM - low
CL-O-01	Clackamas/Kelly Field	Melinda St.	Opportunities	Staff workshop		Possibly redirect flow at Melinda/Forsythe toward Jughandle.	
CL-O-02	Clackamas/Kelly Field	Kelly Field	Opportunities	Staff workshop		Need master planning for future development near Kelly Field.	
CO-O-02	Coffee Creek	Linn Ave. at Mt Pleasant Apartments	Opportunities	City asset review		Large puddle forms at the entrance of apartments.	JM - low
MU-O-02	Mud	Existing ponds	Opportunities	Staff workshop		Potential to retrofit existing ponds for greater benefit.	
NE-O-01	Newell Creek	Newell Canyon outfalls	Opportunities	Staff workshop		Possible ongoing line item CIP to evaluate and stabilize outfalls discharging into Newell Canyon (ex. 42" outfall at Rocky Younger property).	
SE-O-01	South End	Basin wide	Opportunities	Staff workshop		Are there opportunities to add regional facilities and/or in-line facilities along creek corridor to serve future development?	Consider with WQ retrofit evaluation Need to review South End Concept Plan for potential projects.

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Table A-2. Stormwater Problem Areas – Natural Systems							
Name/no.	Basin	Location	Problem type	Source	Site visit	Description	Comments/notes
NE-N-04	Newell Creek	17883 Peter Skene Way	Natural channels	Natural systems investigation	013	City-installed rip-rap has stabilized stream bed however water seeping through bank is causing severe erosion. Source of water possibly from above detention/infiltration pond.	
NE-N-01	Newell Creek	Hwy 213 and Beavercreek Rd.	Natural channels	Natural systems investigation	004	Significant erosion and incision at Beavercreek Rd./Hwy 213 outfalls; potentially an ODOT issue.	City is starting coordination with ODOT EH - high priority
CO-N-02 (CO-P-01)	Coffee Creek	Between Hazelwood Dr. and Warner Parrott Rd.	Natural channels	City asset review		Stream bank eroding near foundation of house.	JM - high priority
LI-N-01	Livesay	Private property at 14040 Beemer Way (Jacobs Way and Holcomb Blvd.)	Natural channels	Natural systems investigation City asset review	002	Significant erosion; Concrete outfall structure conveying discharge from Holcomb Road to creek. Evidence of channel incision and high flows with boulders in channel bed. Eroding banks and exposed roots.	
AB-N-01	Abernethy Creek	13530 Redland Rd. (current dry weather monitoring location)	Natural channels	Natural systems investigation	001	Some bed erosion and stream incision.	
CO-N-01	Coffee Creek	Hedges St.	Natural channels	Staff workshop		Loose rocks in channel downstream of Hedges Ave.	
NE-N-02	Newell Creek	Scatter Canyon	Natural channels	Staff workshop		Channel erosion contributing to water quality concerns.	Project under development
NE-N-03	Newell Creek	Logus St. and Eluria St.	Natural channels	Natural systems investigation	008	Ongoing erosion on southern bank of tributary to Newell Creek. Limited vegetation is growing along this bank.	
PP-N-01	Park Place	Harley and Cleveland	Natural channels	Staff workshop		Erosion in large regional ditches.	
SI-N-01	Singer Creek	Singer Creek Falls	Natural channels	Staff workshop		Occasional observations of discoloration at outfall; unable to identify upstream source.	
SI-N-02	Singer Creek	Singer Creek Park	Natural channels	Natural systems investigation City asset review	206	Western bank has slid off into creek. Further bank stabilization may be required. Culvert evaluation needed.	May be an isolated incident. JM - low
CA-N-02 (CA-P-01)	Caufield	Char Diaz - outfall	Natural channels	City asset review		Erosion issues at outfall.	EH - high priority

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Table A-3. Stormwater Problem Areas – Maintenance							
Name/no.	Basin	Location	Problem type	Source	Site visit	Description	Comments/notes
CN-M-01	Clinton	512 Center and 517 Sunset	Maintenance	Staff workshop		Drainage from bluff to Center Street (asphalt channel) at 512 Center and 517 Sunset are both subject to grate clogging.	
CO-M-01	Coffee Creek	Woodly Ct.	Maintenance	Staff workshop		Roots plugging pipe downstream of Woodly Ct.	
JA-M-01	John Adams	High School Creek - Jackson St and upstream	Maintenance	City asset review		No access for maintenance of storm lines across high school field.	
TU-M-01	Tumwater	S. Center St. and Clinton St.	Maintenance	City asset review		Stormwater from Ogden stream runs down the bank and the inlet at Center and Clinton plugs.	JM - high priority
TU-M-02	Tumwater	Discharge pipe	Maintenance	Staff workshop		Broken discharge pipe to river at outfall.	Would like to understand the extent of damage and potential liability
CA-M-01	Caufield	Falcon Dr.	Maintenance	Staff workshop City asset review		Limited maintenance access and flooding into private areas. Need additional storm infrastructure - drainage issues at outfall to creek.	EH - medium priority

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Table A-4. Stormwater Problem Areas – Infrastructure							
Name/no.	Basin	Location	Problem type	Source	Site visit	Description	Comments/notes
CO-I-01	Coffee Creek	Canemah District	Infrastructure	Staff workshop		Historic channels are deteriorating and need repair. Pipes and channels through private property and under buildings.	Would like to see a Canemah District "Stormwater Restoration Project" that includes systematic upgrades to channels with historic preservation.
CO-I-04	Coffee Creek	965 Hazelwood Drive	Infrastructure	Staff workshop		Culvert is in poor condition and failing - needs replacement.	JM-high priority
JA-I-03	John Adams	Madison Street between 12th and 15th	Infrastructure	City asset review		Culvert needs inspection for potential replacement.	EH - high priority
JA-I-04	John Adams	High School Creek - Jackson St. and upstream	Infrastructure	City asset review		Video inspect and evaluate.	
JA-I-05	John Adams	15th and Van Buren to Jackson	Infrastructure	City asset review		Install additional storm line to pick up year round drainage.	EH - high priority
JA-I-01	John Adams	Eluria St., Willamette St.	Infrastructure	City asset review		Replace aged storm system, numerous structural issues.	EH - medium priority
LI-I-02	Livesay	Private property at 14040 Beemer Way (Jacobs Way and Holcomb Blvd)	Infrastructure	City asset review		Severe erosion at outfall - needs repair.	EH - High Priority
SI-I-01	Singer Creek	Old Singer Creek alignment	Infrastructure	Staff workshop		Failing infrastructure along old singer creek alignment. Concern for condition of pipes and locations of pipes under private property.	
SI-I-02	Singer Creek	Rivercrest neighborhood	Infrastructure	Staff workshop		No storm drain system; drains to sewer.	
SI-I-04	Singer Creek	Harding Boulevard	Infrastructure	Staff workshop City asset review		Planned project to add infrastructure on Harding Boulevard. Multiple CB's connected to sanitary.	Budgeted for 2017
SI-I-06	Singer Creek	Harrison St and Division	Infrastructure	City asset review		Drainage problem area.	EH - high priority
SE-I-01	South End	South End St. from Lafayette to Forest ridge	Infrastructure	City asset review		Storm system drains poorly.	EH - low priority
WN-I-01	Willamette North	Main and 12th	Infrastructure	Staff workshop		20" CMP needs replacement; pipe type changes to concrete in vacant lot.	
SE-F-01	South End	Hazelnut St.	Flooding/ infrastructure	Staff workshop		Culvert under Hazelnut upstream of Hazelgrove Park needs replacement; currently 18-inch pipe.	
TU-F-01	Tumwater	2nd and High St.	Flooding/ infrastructure	Staff workshop		Alley flooding between 1st and 2nd, at S 2nd and High St.; upstream erosion plugs system; potential pipe project.	

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Table A-4. Stormwater Problem Areas – Infrastructure							
Name/no.	Basin	Location	Problem type	Source	Site visit	Description	Comments/notes
CO-I-02	Coffee Creek	Woodfield Ct.	Infrastructure	City asset review		Storm line is in poor condition.	JM - medium priority
CO-I-03	Coffee Creek	Ganong St.	Infrastructure	City asset review		Coffee Creek is piped under house - consider realignment.	JM - low
CA-I-02	Caufield	Meyers Rd. extension	Infrastructure	Staff workshop		Meyers Rd. extension will need stormwater system.	Planned project
CL-I-01	Clackamas/ Kelly Field	Park Place Ct.	Infrastructure	Staff workshop		Old rail culvert is rusted through.	Operations is working to redirect flow
CL-I-02	Clackamas/ Kelly Field	Washington Street system	Infrastructure	Staff workshop City asset review		Culverts cross back and forth across roadway at Clackamas Landscape Supply; Home Depot intersection flows to I-205 culverts; need pipe system to replace culvert/ditch system.	EH - low priority
CL-I-03	Clackamas/ Kelly Field	Clackamette Park outfall	Infrastructure	Staff workshop		Outfall at Clackamette Park is submerged and possibly deteriorating.	
JA-I-02	John Adams	Madison Street between 12th and 15th	Infrastructure	City asset review		Change flow direction of pipe to flow towards High School Creek.	EH - medium priority
LI-I-01	Livesay	Between Hunter Ave. and S Jacobs Way	Infrastructure	Staff workshop City asset review		No connection between Hunter and Jacobs; stormwater system discharges onto private property. Homes along Jacobs Way flood out during large events.	EH - medium priority
MU-I-01	Mud	Leland/Meyers	Infrastructure	Staff workshop City asset review		Culvert/ditch system needs upgrade to serve future road improvements.	Low
NE-I-01	Newell Creek	Roosevelt and Molalla	Infrastructure	City asset review		MH lid blows off during large events.	NA
NE-I-02	Newell Creek	Hilda St. and Gleason St.	Infrastructure	City asset review		Need additional storm infrastructure.	EH - low priority
PP-I-01	Park Place	N. end of Swan Ave.	Infrastructure	City asset review		Upsize existing 8-inch pipe to 12-inch pipe.	EH - medium priority
PP-I-02	Park Place	N. end of Hiram St.	Infrastructure	City asset review		Inadequate storm infrastructure.	EH - low priority
SI-I-02	Singer Creek	1st and Jackson	Infrastructure	Staff workshop		Missing infrastructure.	Note that many roof drains are likely still connected to sewer laterals and contribute to sewer flows.
SI-I-03	Singer Creek	Willamette St. between Molalla and Holmes St.	Infrastructure	Staff workshop City asset review		No stormwater system on Willamette St; results in nuisance flooding on street and adjacent lots between Molalla and Holmes St.	EH - high priority
SI-I-05	Singer Creek	8th and 9th St. outfalls	Infrastructure	City asset review		Rusted outfalls need replacement.	EH
MU-I-02 (MU-P-01)	Mud	Mud Creek - Wassail Ln. to Meyers Rd.	Infrastructure	City asset review		Video and evaluate pipe.	EH - medium priority
AB-I-01	Abernethy Creek	Penn Ln., Anchor Way	Infrastructure	City asset review		Upgrade catch basin and storm drain system on Division.	EH - high priority

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Table A-5. Stormwater Problem Areas – Flooding

Name/no.	Basin	Location	Problem type	Source	Site visit	Description	Comments/notes
CO-F-01	Coffee Creek	965 Hazelwood Dr.	Flooding	City asset review		Channel flooding on private property downstream of Hazelwood Drive; Private owners have constructed walls to contain channel. 24-inch CMP failed during Dec 2015 event.	What is City's obligation to address private property flooding?
JA-F-01	John Adams	8th and Van Buren	Flooding	Staff workshop		Manhole blow offs during flood events; roots growing into pipes; basement flooding; sections of clay pipe.	Need modeling evaluation.
JA-F-02	John Adams	Van Buren between 14th and 15th	Flooding	Staff workshop		Missing Infrastructure and drainage from high school field results in flooding at 1410 Van Buren.	
JA-F-03	John Adams	9th and Monroe	Flooding	Staff workshop		18-inch Pipe connects to 8-inch pipe.	Need modeling evaluation Recent project fixed adjacent problems on 7th.
CP-F-01	Central Point	Kathaway Court to Sunset Springs	Flooding	Staff workshop City asset review		Public system adjacent to private property regularly floods during peak events. Roadway drainage discharges to swale on private property before crossing Central Point Road. Problem stream corridor, fences etc., across stream.	City is working on solution for complicated drainage at Kathaway Court EH - high priority
SE-F-03 (SE-P-02)	South End	Oaktree Ct.	Potential project	City asset review		House flooded during storms - potentially from WQ facility uphill?	NA
SE-F-02	South End	Rose Rd	Flooding	Staff workshop		Rose Road culvert and roadside ditch are often surcharged with standing water.	Runoff is from County management area
MU-F-02	Mud	Hiefield Ct	Flooding	Staff workshop		Hiefield Court experiences flooding at culvert crossing; currently two, 30-inch culverts.	
NE-F-01	Newell Creek	14652 Thayer Ct	Flooding	Staff workshop		Low lying properties; ditch easily overtops; private pumps cannot manage current volumes	Area recently annexed from the County
NE-F-02	Newell Creek	"School District pond"	Flooding	Staff workshop		School district pond usually drains to Caufield, but overflows to Newell in heavy events; floods ball field/parking lot.	City wants to confirm that flows are following the intended configuration
JA-F-04 (JA-P-01)	John Adams	7th and Van Buren	Potential Project	City asset review		Drainage sheet flows from 7th to Van Buren and jumps a curb and then floods garage.	NA
CL-F-01	Clackamas/ Kelly Field	Park Place Ct	Flooding	Staff workshop		Flooding and maintenance issues on Park Place Ct.	Operations is working to redirect flow
MU-F-01	Mud	Round Tree Rd	Flooding	Staff workshop City asset review		Yard flooding at apartments downstream of Round Tree Rd., adjacent to natural system.	Low
PP-F-01	Park Place	Swan Ave to Apperson Ct	Flooding	Staff workshop		Culverts along channel downstream of Swan Ave. have some capacity problems.	

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Table A-5. Stormwater Problem Areas – Flooding							
Name/no.	Basin	Location	Problem type	Source	Site visit	Description	Comments/notes
SE-F-04 (SE-P-03)	South End	Josephine and Bjerke	Flooding	City asset review		Poor drainage in area system.	JM - Medium Priority
SI-F-01 (SI-P-01)	Singer Creek	Holmes and Leonard	Flooding	City asset review		Flooding at the corner.	JM - low
CA-F-01 (CA-P-03)	Caufield	Beavercreek Rd	Flooding	City asset review		Flooding over Beavercreek during heaving rain events from golf course to SWQF pond.	EH
SE-F-05	South End	South End Rd	Flooding	H&H modeling			
NE-F-01	Newell Creek	Beavercreek Rd and Molalla Ave	Flooding	H&H modeling			
LI-F-01	Livesay	Holcomb Rd	Flooding	H&H modeling			

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Appendix B: Hydrologic Modeling TM

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Technical Memorandum

Prepared for: City of Oregon City

Project Title: Stormwater Master Plan

Project No.: 149133

Technical Memorandum

Subject: Subcatchment Hydrology

Date: October 17, 2016

To: Jon Archibald, Project Engineer

From: Matt Grzegorzewski

Copy to: Alissa Maxwell, P.E., Ryan Retzlaff, File

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Reviewed by: Alissa Maxwell, P.E.

Limitations:

This document was prepared solely for City Oregon City in accordance with professional standards at the time the services were performed and in accordance with the contract between City Oregon City and Brown and Caldwell dated March 16, 2016. This document is governed by the specific scope of work authorized by City Oregon City; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. We have relied on information or instructions provided by City Oregon City and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

Section 1: Introduction

The City of Oregon City (City) is developing a stormwater master plan to update existing planning documents to guide surface and stormwater program decisions. The master plan will address both water quantity and quality for constructed and natural systems under the City's management. The master plan requires a clear understanding of existing and future runoff conditions across the city to identify long-term stormwater project needs.

This memorandum has been developed to document the methodology used to evaluate the hydrology, primarily as peak flows, generated by all subcatchments within the city for existing and anticipated future developed conditions. The modeling results show that peak flows are expected to remain fairly constant in watersheds such as South End and John Adams where most land area is currently built to maximum zoning allowances. The most significant flow increases are anticipated in the Park Place and Clackamas catchments because of significant vacant lands that are slated for future development.

The results of the hydrology model will be used to analyze the hydraulics of conveyance systems in key areas of concern. The hydrology results can also be used to identify natural system areas that may be more susceptible to channel erosion or channel impacts because of increasing flows.

Section 2: Hydrology Model Development

The hydrology model was developed using XP-Storm Water Management Model (SWMM) version 2016.1. The necessary parameters for the Santa Barbara Urban Hydrograph method include subcatchment areas, impervious percentages, pervious curve numbers, and times of concentration. This section includes detailed descriptions of the methodology used in determining each of the hydrology model parameters.

2.1 Basin Boundaries

The purpose of the basin boundary delineation is to define the major watershed boundaries or collection catchments within the city. The major collection catchments were then subdivided further to facilitate hydrologic evaluation.

Watershed boundaries for 23 watershed areas were provided by the City as a geographic information system (GIS) shapefile: Alan Court, Amanda Court, Central Point, South End, Mud, Clackamas-Willamette, Willamette South, Clinton, Coffee, Thimble, Livesay, Beaver, Tumwater, Singer, Park Place, Forsythe, Newell, Caufield, Kelly Field, Clackamas, Willamette North, Abernethy, and John Adams. These larger watershed boundaries are defined based on topography and conveyance system routing.

Sub-basin boundaries were defined using a combination of contour lines, streets, tax lots, stormwater conduits, and the City-provided watershed boundaries. As a starting point the sub-basins were hand drawn on large maps with a size ranging between 20 and 50 acres. Sub-basins are generally smaller in urbanized areas where the pipe network is more complex. The sub-basin delineation includes larger sub-basin areas in the outer areas of the city and in rural/agricultural areas that are not yet developed. In areas of discrepancy, basin boundary questions were resolved through the use of as-built records, GIS invert data, and City staff knowledge of the existing drainage system. A total of 185 sub-basins were defined, ranging in size from 1.0 to 194.0 acres with an average area of 39.8 acres. The watershed and sub-basin boundaries are shown in Figures 1 and 2.

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Each sub-basin name was assigned a name in the format XX_####. The two-letter abbreviation was from the City-provided watershed name (e.g., AB for Abernethy). The numbers began at 0100 near the outlet of the sub-basin and increased in increments of 100. Sub-basin names are shown in Attachment A, Table A-1.

Sub-basin areas were calculated in ArcGIS and are also shown in Attachment A, Table A-1.

2.2 Time of Concentration

The methodology used to calculate the time of concentration for all sub-basins used three different methods. Rather than using the traditional approach of calculating the overland flow, shallow concentrated flow and channel or pipe flow, staff applied a streamlined method to the sub-basins based on land use and density of development. These are roughly divided into the categories of residential, commercial (COM), and rural/parks. The methods used are described in more detail in the narrative below.

The first method to be implemented selected 20 sub-basins with developed residential land use across Oregon City out of a total of 101 sub-basins. The longest pipe flow path to the outlet was measured for each subcatchment. A linear regression analysis was performed with subcatchment surface area in acres as the independent variable (x) and longest pipe flow length as the dependent variable (y), which yielded the following equation:

$$Y = 37.09x + 554.35 \ (R^2 = 0.73)$$

This regression equation was applied to the remaining 81 residential subcatchments, 101 in total, to determine the pipe flow lengths. An average velocity of 4 feet per second (ft/s) was used to calculate pipe travel time. We assumed a sheet flow length of 100 feet and no shallow concentrated flow. Slopes were measured using contour lines within ArcGIS derived from light detecting and ranging (LiDAR). From this information the time of concentration was quickly calculated for all sub-basins that are largely made up of residential land use.

The second time of concentration method calculation was implemented for more developed and densely populated areas (downtown, COM, and industrial [IND]). A shorter sheet flow length of 5 minutes was assumed because of the increased amount of impervious surfaces. The same regression equation from above was then used to calculate pipe flow lengths and average velocity within those pipes was assumed to be 4 ft/s. This methodology was applied to a total of 62 subcatchments.

For less developed areas the traditional approach was used. This includes identifying the longest flow path lines in ArcGIS then dividing the path into sheet flow, shallow concentrated flow, and pipe/channel flow. The maximum sheet flow length was set to 100 feet and the shallow concentrated flow length was used until reaching an open channel or pipe. The distance of pipe/open channel flow was measured in ArcGIS and the average velocity was assumed to be 4 ft/s. The remaining 22 sub-basin times of concentration were calculated in this way.

The times of concentration for the sub-basins ranged from 7.5 to 49.6 minutes with an average of 21.7 minutes.

Attachment A provides a data table that includes the time of concentration for each sub-basin. Attachment A also documents other parameters used within the model such as area, pervious curve number, and existing/future impervious percentages, which are all discussed in greater detail in the following sections.

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2.3 Existing Conditions Land Use

During development of the 2015 *Pollutant Load Reduction Evaluation* the City generated an updated GIS layer to represent existing land use coverage (City 2015b). The land use coverage is based on the City's *Oregon City Comprehensive Plan* land use data and also incorporated vacant land data from Metro, which is based on 2013 aerial photos (City 2004). The land use categories from the *Oregon City Comprehensive Plan* were grouped into the land use modeling categories as shown in Figure 3. These updated GIS layers formed the basis of the existing condition land use analysis.

2.4 Future Conditions Land Use

For future conditions land use, it is assumed all vacant lands under existing conditions land use will be developed to match the City's comprehensive plan zoning. An additional shapefile was provided by the City for future land use, which is shown in Figure 4.

2.5 Impervious Coverage

The City calculated the impervious cover percentage for each modeled land use category in 2015. Each parcel in the city was assigned an impervious area percentage based on either Metro impervious area coverages or Clackamas County Assessor's data. Roads were assumed to have a 90 percent impervious coverage. The average impervious coverage for all parcels within each modeled land use category was then calculated as shown in Table 1.

Table 1. Modeled Land Use Categories

Comprehensive plan land use category	Modeled land use category	2015 modeled impervious percentage
Low-density residential (LR)	Single-family residential	45
Medium-density residential (MR)	Single-family residential	
High-density residential (HR)	Multi-family residential	57
Commercial (COM)	Commercial	74
Mixed-use corridor (MUC)	Commercial	
Mixed-use downtown (MUD)	Commercial	
Industrial (IND)	Industrial	63
Mixed-use employment (MUE)	Industrial	
Quasi-public	Public facility	34
Parks	Parks and open space	19
Future urban holding (FUH)	Agriculture [a]	48
All vacant	Vacant [b]	21

a. The impervious percentage for agriculture is higher than expected because the only areas designated as agriculture are portions of small farms along Beavercreek Road in the southeast corner of Oregon City. The areas included in Oregon City limits are typically driveways and houses, which include the bulk of the impervious area for those properties.

b. Vacant lands include areas of all land use categories that are not currently developed or are not developed to the density indicated in the comprehensive plan (City 2004). Vacant land includes unused COM and IND land along the Oregon Highway 205 corridor.

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Impervious coverage within each sub-basin is dependent on its land use. There are a total of eight land use categories, which are all mapped in GIS and have assigned values of impervious percentage (see Table 1). The land use categories were overlaid with the sub-basin boundaries in GIS and area-weighted average impervious percentages were calculated for each sub-basin within GIS. A number of sub-basins had a portion of land area outside of city limits with no land use data available. It is assumed these regions are vacant with an impervious percentage of 21 percent. The impervious percentages for each sub-basin are shown in Attachment A, Table A-1.

2.6 Pervious Area Curve Number

The pervious area curve number is a dimensionless number that depends on hydrologic soil group, cover type, and antecedent moisture conditions. Runoff curve numbers for pervious areas were estimated from typical runoff curve number tables provided in the Soil and Conservation Service (SCS) Technical Release 55, titled *Urban Hydrology for Small Watersheds* (SCS 1986). Curve number values are shown in Table 2 and were selected based on hydrologic soil group for the pervious portions of each sub-basin. A map of hydrologic soil groups is shown in Figure 5. Aerial imagery was used to choose the correct land use description and associated pervious area curve number for sub-basins with large wooded parks. A curve number of 98 was assumed for impervious areas.

Table 2. Runoff Curve Numbers for Urban Areas

Land use descriptions	Curve numbers for hydrologic soil group			
	A	B	C	D
Fully developed urban areas (vegetation establish):				
Open space (lawns, parks, golf courses, cemeteries, etc.)				
Good condition (grass cover >75%)	39	61	74	80
Fair condition (grass cover 50–75%)	49	69	79	84
Poor condition (grass cover <50%)	68	79	86	89
Paved parking lots, roofs, driveways, etc.	98	98	98	98
Streets and roads:				
Paved; curbs and storm sewers (excluding rights-of-way)	98	98	98	98
Gravel (including rights-of-way)	76	85	89	91
Dirt (including rights-of-way)	72	82	87	89
Paved with open ditches (including rights-of-way)	83	89	92	93
Woods-grass combination:				
Poor condition	57	73	82	86
Fair condition	43	65	76	82
Good condition	32	58	72	79
Woods:				
Poor condition	45	66	77	83
Fair condition	36	60	73	79
Good condition	30	55	70	77

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2.7 Design Storms

Design storms are precipitation patterns that are typically used to evaluate the capacity of storm drainage systems and design capital improvements for the desired level of service. Design storms evaluated for this study include the, 1.2-year, 2-year, 10-year, 25-year, 50-year, and 100-year recurrence intervals. The rainfall depths for most events were based on isopluvial maps published in the National Oceanic and Atmospheric Administration (NOAA) in Atlas 2, Volume X, which is referenced in the City's *Stormwater and Grading Design Standards* (City 2015a). The rainfall distribution for these design storms is based on the SCS 24-hour, Type IA distribution, which is applicable to western Oregon, Washington, and northwestern California.

Table 3 lists the precipitation depths from the NOAA Atlas 2, Volume X, used for design storms in the model.

Table 3. Design Storm Depths

Design storm event	Rainfall depth, inches
1.2-year, 24-hour	1.18
2-year, 24-hour	2.8
10-year, 24-hour	3.5
25-year, 24-hour	4.0
50-year, 24-hour	4.4
100-year, 24-hour	4.5

The 1.2-year rainfall depth is representative of the water quality design storm as documented in the technical memorandum *Selection of Representative Rainfall Volume and Rainfall Intensities to Result in Capture and Treatment of 80% of the Average Annual Runoff Volume* (BC 2010). According to a 2008 Oregon Department of Transportation (ODOT) study titled *Water Quantity (Flow Control) Design Storm Performance Standard*, 42 percent of the 2-year peak flow rate can be used as an analog for the 1.2-year peak flow rate (ODOT 2008).

Section 3: Hydrology Model Results

The XP-SWMM simulations were run for the 2-year, 10-year, 25-year, 50-year, and 100-year storm for both current and future development conditions. The model results show no/minimal increases in future flows for sub-basins that are fully developed and the largest increases for sub-basins with existing vacant land with planned development.

Results of the hydrologic simulations for all events and sub-basins are tabulated in Attachment B (Table B-1). Results are displayed as maximum flows within each sub-basin for each design storm.

The channel-forming event—1.2-year peak flow—is included in Attachment B, calculated based on the 2-year peak runoff as described in Section 2.7.

Attachment C, Table C-1 provides the change in peak discharge and percent increase between the existing and future conditions flows for each sub-basin.

Use of contents on this sheet is subject to the limitations specified at the beginning of this document.

Section 4: References

Brown and Caldwell (BC). 2010. *Selection of Representative Rainfall Volume and Rainfall Intensities to Result in Capture and Treatment of 80% of the Average Runoff Volume*. May 11.

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City. 2015a. Storm*water and Grading Design Standards*. February.

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National Oceanic and Atmospheric Administration (NOAA). 2010. Atlas 2, Volume X.

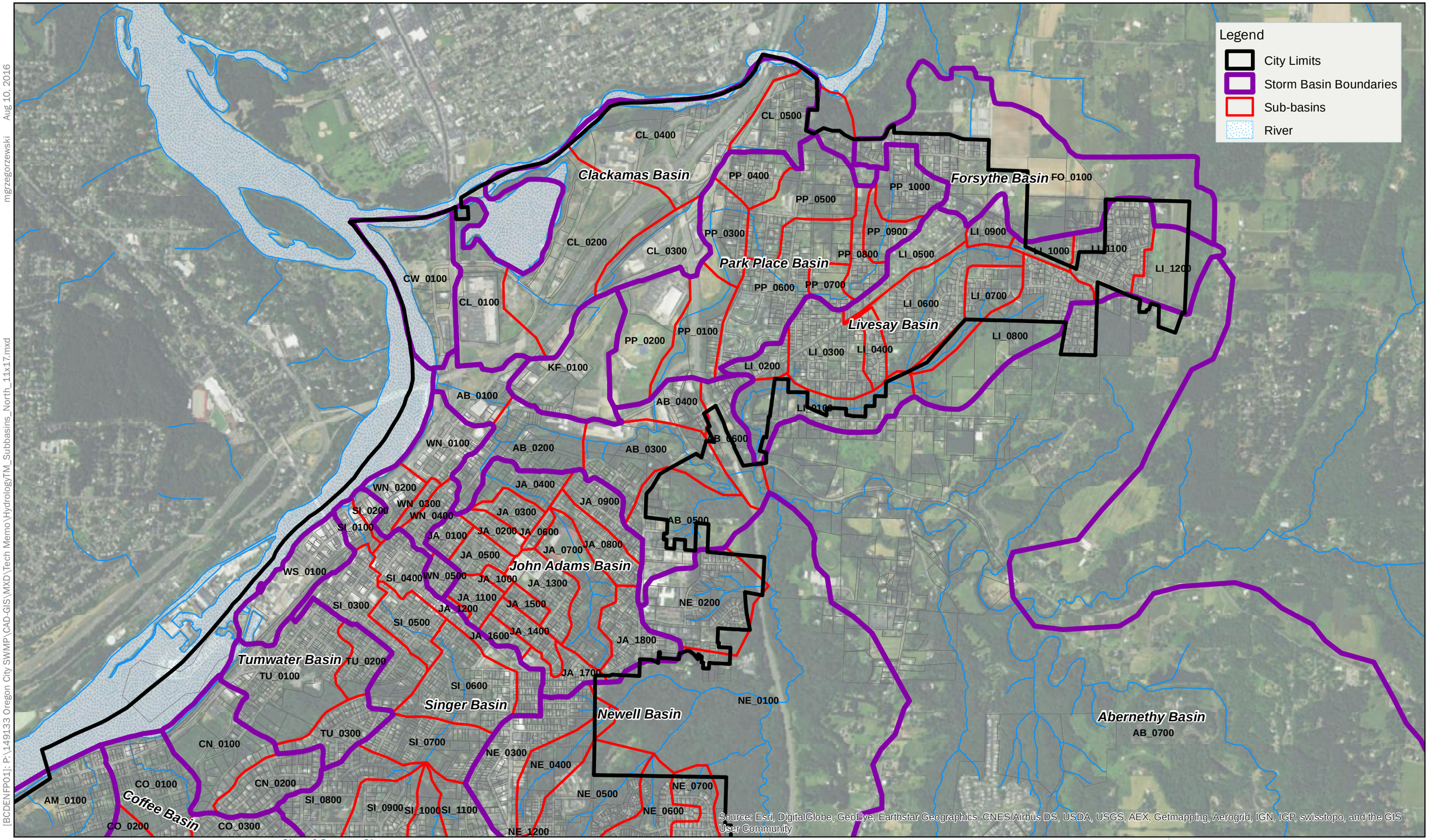
Oregon Department of Transportation (ODOT). 2008. *Water Quantity (Flow Control) Design Storm Performance Standard*.

Soil Conservation Service (SCS). 1986. *Urban Hydrology for Small Watersheds*, Technical Release 55. June.

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Figures

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[BCDENFP01]: P:\149133 Oregon City SWMP\CAD-GIS\MXD\Tech Memo\HydrologyTM_Subbasins_North_11x17.mxd
mgrzegorzewski Aug 10, 2016

Brown AND Caldwell

City of Oregon City

Stormwater Master Plan

Date: July 2016
Project: Project 149133

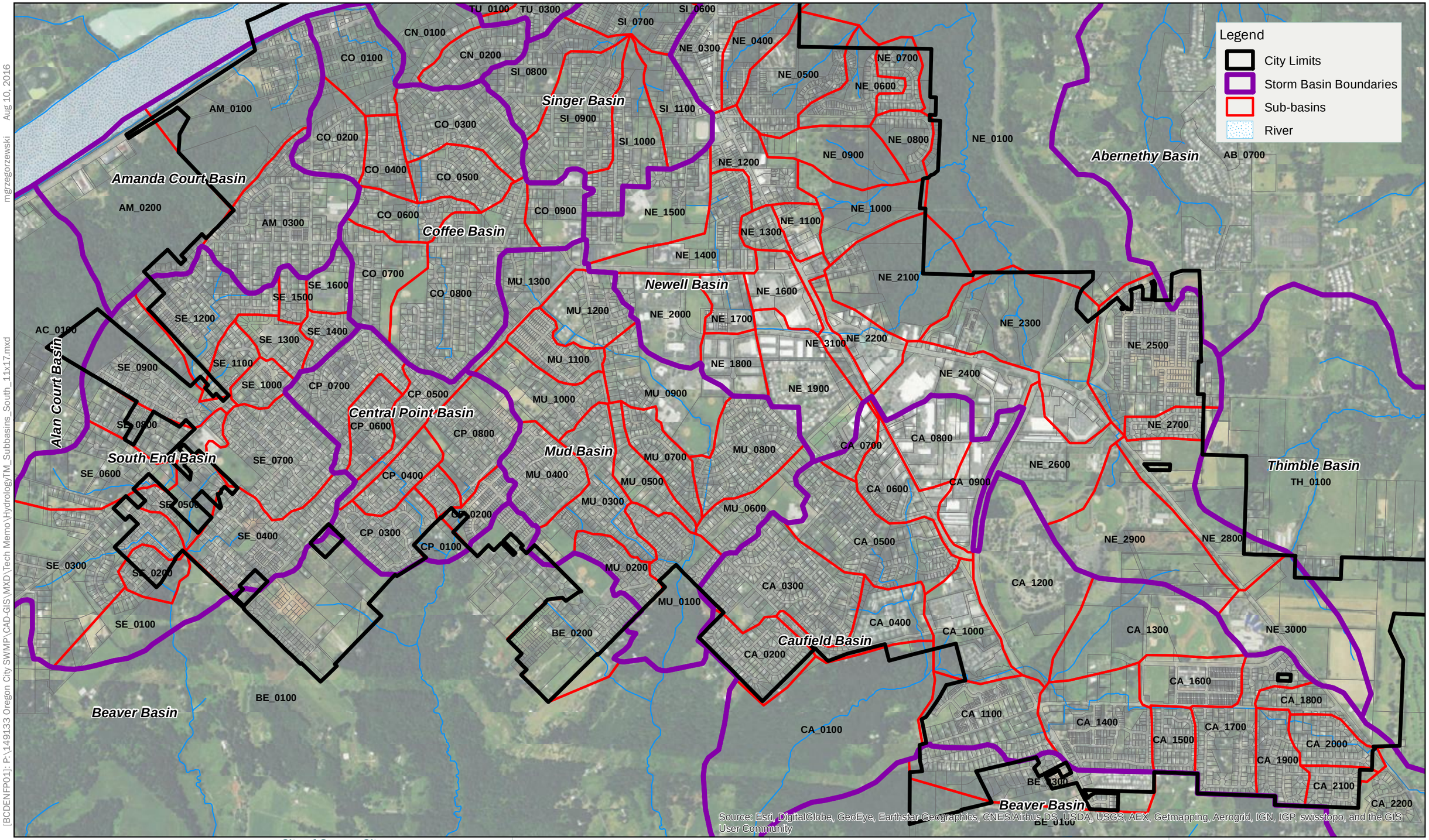
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0 1,500 3,000 Feet

Notes:
1. Projection: NAD 1983 State Plane Oregon North (feet)

Figure 1

Northern Sub-basins



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City of Oregon City

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Project: Project 149133

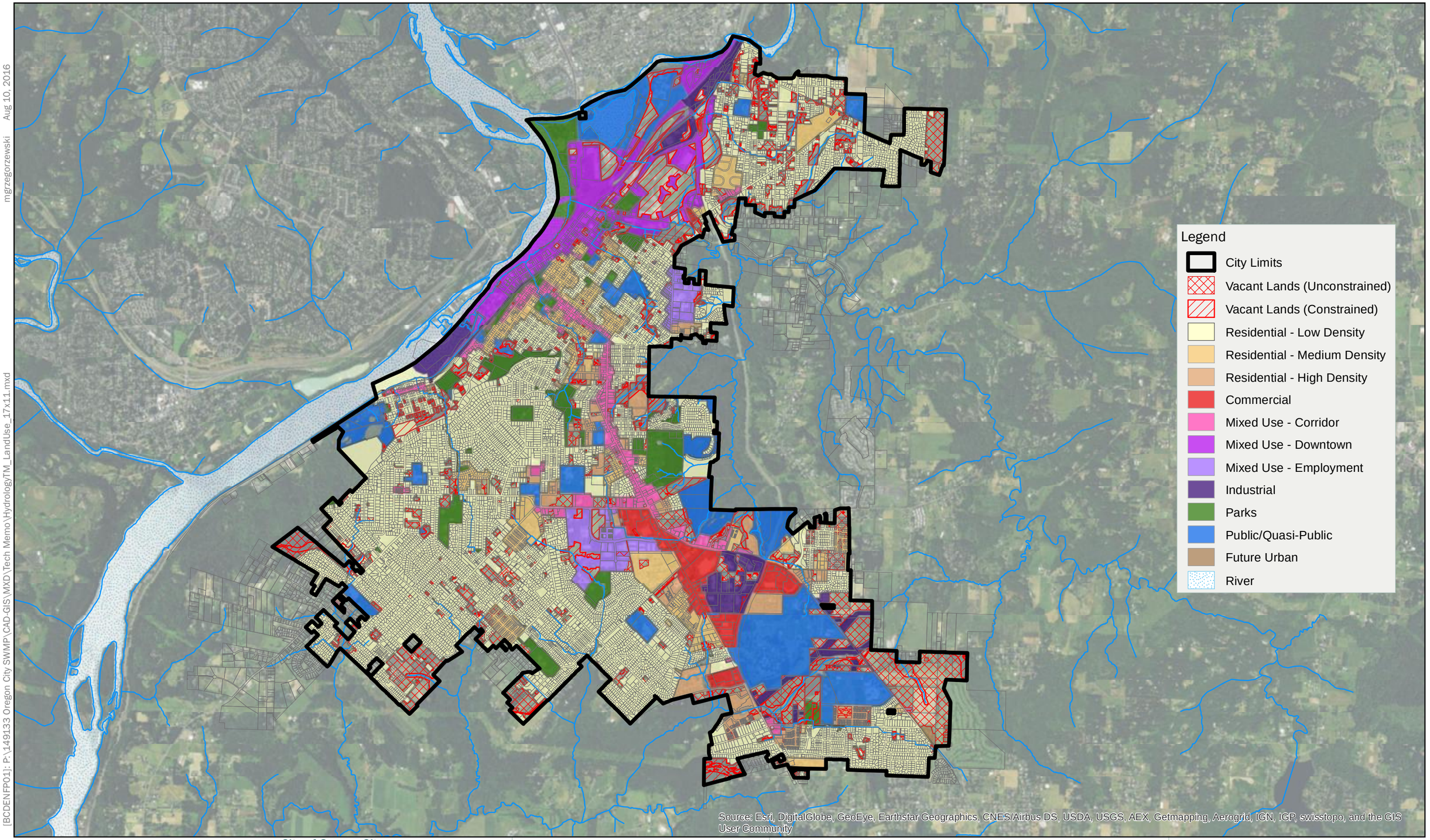
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0 1,500 3,000 Feet

Notes:
1. Projection: NAD 1983 State Plane Oregon North (feet)

Figure 2

Southern Sub-basins



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Project: Project 149133

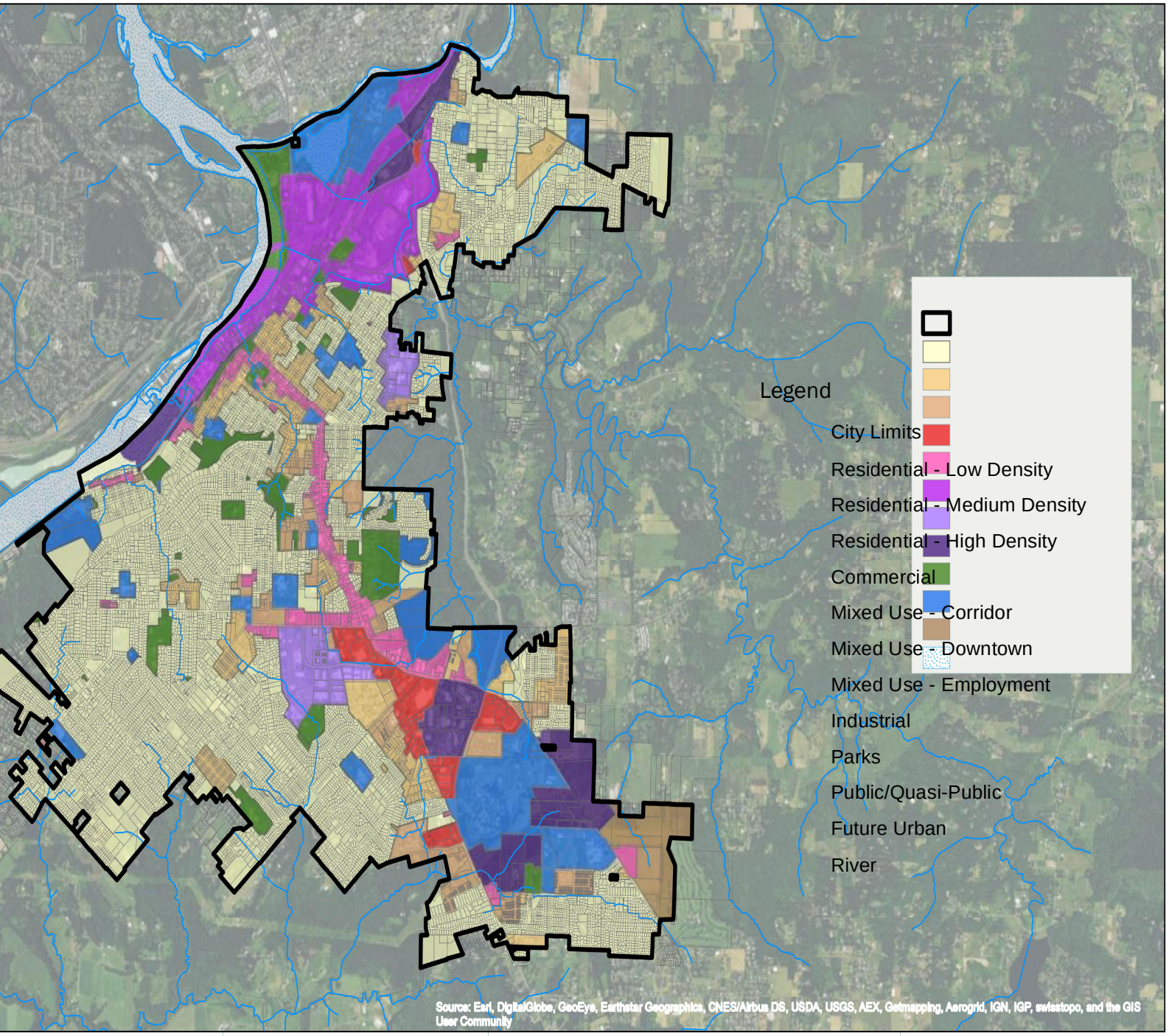
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0 3,000 6,000 Feet

Notes:
1. Projection: NAD 1983 State Plane Oregon North (feet)

Figure 3

Existing Conditions Land Use



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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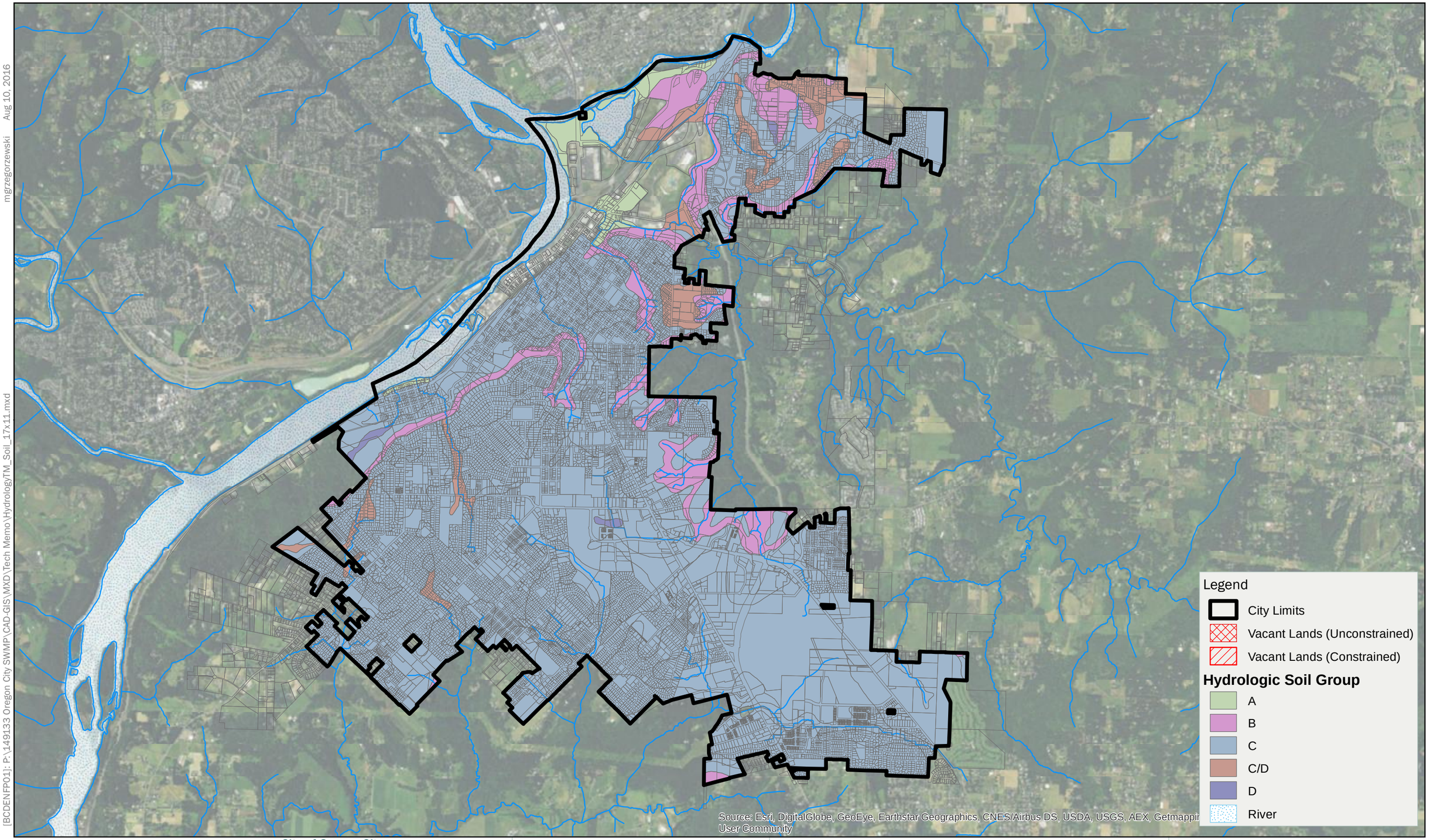
Notes:
1. Projection: NAD 1983 State Plane Oregon North (feet)

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Feet

Figure 4

Future Conditions Land Use

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City of Oregon City

Stormwater Master Plan

Date: July 2016
Project: Project 149133

N

0 3,000 6,000 Feet

Notes:
1. Projection: NAD 1983 State Plane Oregon North (feet)

Figure 5

Hydrologic Soil Group

Attachment A: Hydrology Model Results

Table A-1: Subcatchment Parameters					
Name	Area (acres)	Time of concentration (minutes)	Pervious CN	Existing impervious percentage	Future impervious percentage
Abernathy Creek Basin					
AB_0100	27	11.48	79	68.99	70.19
AB_0200	45	21.98	69	50.6	56.7
AB_0300	54	23.99	79	29.76	41.1
AB_0400	19	10.25	79	56.44	67.28
AB_0500	58	16.27	79	21.21	21.58
AB_0600	30	30.16	79	21.36	22.31
Alan Court Basin					
AC_0100	725	10	79	20.71	20.71
Amanda Court Basin					
AM_0100	116	19.74	73	33.38	34.64
AM_0200	136	10	79	19.94	19.95
AM_0300	86	38.82	79	44.42	44.97
Beaver Basin					
BE_0200	71	10	79	25.94	32.22
BE_0300	70	10	79	21.9	23.92
Caufield Basin					
CA_0100	194	31.3	73	20.59	20.6
CA_0200	39	25.93	79	36.77	36.77
CA_0300	80	29.63	79	43.41	44.53
CA_0400	35	27.46	79	46.31	50.94
CA_0500	75	37.12	79	42.15	44.57
CA_0600	34	12.56	79	55.1	55.61
CA_0700	11	9.01	79	55.35	55.35
CA_0800	43	13.96	79	61.83	64.68
CA_0900	28	11.64	79	68.4	68.82
CA_1000	44	14.11	79	45.44	49.82
CA_1100	56	27.06	79	42.52	44.19
CA_1200	95	21.99	79	35.63	39.67
CA_1300	79	19.52	79	28.25	47.49
CA_1400	63	29.64	79	44.1	49.46
CA_1500	18	22.69	79	44.28	44.99
CA_1600	34	30.78	79	47.55	47.63
CA_1700	51	27.79	79	42.56	43.93
CA_1800	21	28.77	79	41.76	45.67

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Table A-1: Subcatchment Parameters					
Name	Area (acres)	Time of concentration (minutes)	Pervious CN	Existing impervious percentage	Future impervious percentage
CA_1900	26	20.39	79	44.71	44.97
CA_2000	24	20.98	79	40	41.08
CA_2100	15	24.37	79	39.83	39.83
CA_2200	108	49.63	79	21	21
Clackamas Basin					
CL_0100	52	15.35	79	56.1	63.34
CL_0200	106	23.69	69	38.77	52.37
CL_0300	35	12.72	79	55.02	67.01
CL_0400	96	22.15	69	49.41	52.37
CL_0500	31	19.82	79	42.43	48.86
Clinton Basin					
CN_0100	49	24.84	79	39.97	43.65
CN_0200	29	26.53	79	45	45
Coffee Basin					
CO_0100	47	21.77	79	42.86	48.66
CO_0200	33	30.63	79	43.48	45
CO_0300	53	33.72	79	44.84	45
CO_0400	21	23.15	79	43.66	45
CO_0500	31	30.32	79	43.11	43.41
CO_0600	27	29.7	79	40.38	44.61
CO_0700	39	36.93	74	34.96	37.14
CO_0800	103	48.86	79	41.46	42.9
CO_0900	25	11.17	79	45.97	46.71
Central Point Basin					
CP_0100	18	24.83	79	21.12	21.69
CP_0200	17	35.57	79	34.65	37.87
CP_0300	34	27.3	79	44.3	44.57
CP_0400	22	28.93	79	41.62	45
CP_0500	25	29.39	79	44.34	45
CP_0600	23	25.6	79	44.18	45
CP_0700	46	32.64	79	44.95	45
CP_0800	46	25.51	79	39.04	45
Clackamas-Willamette Basin					
CW_0100	61	22.32	43	28.47	29.43

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Table A-1: Subcatchment Parameters					
Name	Area (acres)	Time of concentration (minutes)	Pervious CN	Existing impervious percentage	Future impervious percentage
Forsythe Basin					
FO_0100	190	10	79	18.07	18.55
John Adams Basin					
JA_0100	8	8.55	79	45	45
JA_0200	9	8.7	79	39.4	39.4
JA_0300	11	9.01	79	41.31	41.91
JA_0400	18	10.09	69	45.27	48.11
JA_0500	12	9.16	79	41.21	41.21
JA_0600	3	14.97	79	43.27	43.27
JA_0700	36	19.21	69	36.79	41.3
JA_0800	19	28.46	79	47.81	47.92
JA_0900	18	24.83	79	45.27	46.27
JA_1000	3	7.77	79	43.43	43.43
JA_1100	12	9.16	79	45.98	46.67
JA_1200	1	7.46	79	59.14	59.14
JA_1300	22	10.71	79	40.62	40.63
JA_1400	12	9.16	79	44.7	45
JA_1500	6	8.24	79	43.04	43.77
JA_1600	6	8.24	79	51.71	51.71
JA_1700	13	17.65	79	42.71	42.71
JA_1800	26	26.07	79	47.01	47.57
Kelly Field Basin					
KF_0100	55	15.81	79	37.91	66.05
Livesay Basin					
LI_0100	49	25.97	69	17.66	21.24
LI_0200	11	9.01	79	51.24	56.41
LI_0300	42	20.54	79	42.18	45
LI_0400	10	17.92	79	41	45
LI_0500	25	29.39	79	43.35	44.98
LI_0600	56	23.68	79	38.08	45
LI_0700	24	19.35	79	28.07	30.54
LI_0800	67	32.4	79	19.27	19.5
LI_0900	10	18.82	79	38.34	42.6
LI_1000	9	17.03	79	19.09	19.09
LI_1100	39	23.3	79	32.98	33.59

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Table A-1: Subcatchment Parameters					
Name	Area (acres)	Time of concentration (minutes)	Pervious CN	Existing impervious percentage	Future impervious percentage
LI_1200	31	24.7	79	18.82	29.31
Mud Basin					
MU_0100	64	28.29	79	19.43	19.77
MU_0200	20	25.14	79	43	43
MU_0300	52	30.09	79	40.41	41.63
MU_0400	38	25.78	79	43.56	45
MU_0500	22	28.93	79	42.44	45
MU_0600	33	27.15	79	40.77	41.67
MU_0700	25	25.91	79	44.28	44.28
MU_0800	52	27.94	79	44.07	44.13
MU_0900	55	23.38	74	40.36	46.5
MU_1000	39	28.08	79	41.12	45
MU_1100	24	29.24	79	43.99	45
MU_1200	33	25	79	45.2	47.86
MU_1300	32	37.89	79	43.52	44.86
Newell Basin					
NE_0100	542	10	79	20.31	20.31
NE_0200	60	27.67	79	42.28	43.63
NE_0300	50	15.04	79	53.53	55.23
NE_0400	29	24.39	69	32.29	43.12
NE_0500	57	30.86	79	30.67	34.65
NE_0600	30	15.86	76	31.85	32.05
NE_0700	17	19.9	79	36.33	36.33
NE_0800	19	18.58	79	39.17	39.17
NE_0900	38	16.78	76	24.31	24.75
NE_1000	40	24.23	60	26.87	36.71
NE_1100	14	9.47	79	53.86	55.14
NE_1200	33	12.41	79	56.83	58.54
NE_1300	11	9.01	79	56.75	56.75
NE_1400	47	14.57	79	49.79	58.99
NE_1500	53	15.5	79	44.65	44.65
NE_1600	24	11.02	79	73.98	73.98
NE_1700	17	9.94	79	57	63.37
NE_1800	23	10.86	79	60	62.94
NE_1900	59	16.43	79	50.29	53.54

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Table A-1: Subcatchment Parameters					
Name	Area (acres)	Time of concentration (minutes)	Pervious CN	Existing impervious percentage	Future impervious percentage
NE_2000	42	13.8	79	52.67	62.62
NE_2100	77	19.21	79	28.59	36.25
NE_2200	26	11.33	79	65.36	73.84
NE_2300	107	23.85	69	42.3	48.1
NE_2400	50	15.04	79	61.22	67.4
NE_2500	94	40.05	79	32.76	36.54
NE_2600	58	16.27	79	49.78	49.79
NE_2700	16	22.38	79	35.95	35.99
NE_2800	53	15.5	79	31.85	51.12
NE_2900	91	21.37	79	36.63	45.12
NE_3000	72	18.44	79	25.68	48.84
NE_3100	15	9.63	79	67.08	67.08
Park Place Basin					
PP_0100	34	12.56	69	41.4	66.71
PP_0200	46	14.42	79	44.34	74
PP_0300	25	25.91	69	45.09	61.16
PP_0400	20	18.73	79	41.66	46.3
PP_0500	45	20.6	69	35.15	43.44
PP_0600	62	14.09	76	40.66	43.03
PP_0700	10	15.19	79	34.93	45
PP_0800	14	22.07	79	41.5	45
PP_0900	13	17.65	79	36.37	45
PP_1000	25	36.81	79	40.16	45
South End Basin					
SE_0100	47	32.96	76	20.81	20.81
SE_0200	18	22.69	79	19.8	19.8
SE_0300	115	43.3	79	18.99	19.01
SE_0400	65	42.99	79	39.47	41.41
SE_0500	28	21.6	79	18.96	20.07
SE_0600	56	28.56	79	20.49	20.49
SE_0700	67	32.4	79	42.86	43.23
SE_0800	38	27.92	79	18.83	18.85
SE_0900	59	34.64	79	24.99	28.85
SE_1000	14	24.21	79	44.37	44.72
SE_1100	16	35.42	79	35.68	37.98

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Table A-1: Subcatchment Parameters					
Name	Area (acres)	Time of concentration (minutes)	Pervious CN	Existing impervious percentage	Future impervious percentage
SE_1200	56	30.7	79	35.62	37.02
SE_1300	18	24.83	79	44.41	44.41
SE_1400	13	18.38	79	43.71	44.21
SE_1500	9	34.33	79	45	45
SE_1600	15	18.69	79	36.46	44.95
Singer Basin					
SI_0100	8	8.55	79	61.53	61.63
SI_0200	6	8.24	79	67.54	67.54
SI_0300	42	27.01	79	46.42	46.93
SI_0400	36	12.87	79	55.94	56.53
SI_0500	21	10.56	79	49.5	50.45
SI_0600	49	24.84	79	45.63	48.58
SI_0700	35	25.31	79	41.86	44.47
SI_0800	40	22.18	76	39.68	39.68
SI_0900	60	24.92	79	42.75	42.75
SI_1000	43	32.17	79	38.91	41.93
SI_1100	33	12.41	79	40.12	42.85
Thimble Basin					
TH_0100	945	10	79	19.22	19.46
Tumwater Basin					
TU_0100	71	12.98	73	38.64	40
TU_0200	17	24.68	79	40.6	41.38
TU_0300	23	36.5	79	44.09	44.4
Willamette North Basin					
WN_0100	27	11.48	79	64.93	68.39
WN_0200	15	9.63	79	64.12	65.82
WN_0300	4	7.93	79	50.66	51.75
WN_0400	12	9.16	79	46.91	46.91
WN_0500	7	8.39	79	46.79	46.79
Willamette South Basin					
WS_0100	41	13.65	79	68.83	69.16

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Attachment B: Hydrology Results

Table B-1: Hydrology Model Results

Subbasin	Existing							Future						
	Impervious %	Max flow (cfs)						Impervious %	Max flow (cfs)					
		1.2 yr	2 yr	10 yr	25 yr	50 yr	100 yr		1.2 yr	2 yr	10 yr	25 yr	50 yr	100 yr
Abernethy Basin														
AB_0100	68.99	5.27	12.54	16.98	20.16	22.69	23.33	70.19	5.33	12.69	17.14	20.32	22.85	23.48
AB_0200	50.60	4.24	10.09	15.68	19.89	23.36	24.23	56.70	4.85	11.54	17.38	21.73	25.27	26.17
AB_0300	29.76	5.31	12.64	19.32	24.33	28.43	29.47	41.10	6.22	14.80	21.82	27.00	31.21	32.27
AB_0400	56.44	3.29	7.83	10.95	13.20	15.01	15.46	67.28	3.70	8.81	11.97	14.24	16.05	16.50
AB_0500	21.21	5.73	13.65	21.37	27.20	32.01	33.22	21.58	5.77	13.73	21.46	27.30	32.11	33.33
AB_0600	21.36	2.36	5.62	8.88	11.37	13.42	13.94	22.31	2.39	5.70	8.98	11.48	13.54	14.06
Alan Court Basin														
AC_0100	20.71	79.74	189.86	295.11	374.46	439.64	456.12	20.71	79.74	189.86	295.11	374.46	439.64	456.12
Amanda Court Basin														
AM_0100	33.38	9.37	22.31	36.27	46.95	55.81	58.06	34.64	9.63	22.93	37.01	47.77	56.68	58.93
AM_0200	19.94	14.79	35.22	54.89	69.74	81.93	85.02	19.95	14.79	35.22	54.90	69.74	81.94	85.03
AM_0300	44.42	8.48	20.19	29.58	36.50	42.12	43.53	44.97	8.54	20.34	29.75	36.68	42.30	43.72
Beaver Basin														
BE_0200	25.94	8.41	20.03	30.59	38.50	44.97	46.60	32.22	9.16	21.82	32.66	40.72	47.28	48.94
BE_0300	21.90	7.83	18.65	28.87	36.56	42.88	44.47	23.92	8.06	19.20	29.51	37.26	43.60	45.21
Caufield Basin														
CA_0100	20.59	9.56	22.77	40.37	54.23	65.89	68.90	20.60	9.57	22.78	40.37	54.24	65.90	68.91
CA_0200	36.77	4.11	9.78	14.63	18.23	21.17	21.91	36.77	4.11	9.78	14.63	18.23	21.17	21.91
CA_0300	43.41	8.73	20.79	30.53	37.72	43.55	45.02	44.53	8.86	21.10	30.89	38.09	43.94	45.41
CA_0400	46.31	4.10	9.75	14.18	17.43	20.07	20.73	50.94	4.35	10.36	14.85	18.13	20.79	21.45
CA_0500	42.15	7.31	17.41	25.66	31.76	36.77	38.03	44.57	7.55	17.98	26.31	32.47	37.50	38.77
CA_0600	55.10	5.61	13.35	18.76	22.68	25.83	26.62	55.61	5.64	13.43	18.85	22.77	25.92	26.71
CA_0700	55.35	1.91	4.55	6.37	7.69	8.75	9.01	55.35	1.91	4.55	6.37	7.69	8.75	9.01
CA_0800	61.83	7.49	17.83	24.64	29.54	33.47	34.45	64.68	7.73	18.40	25.23	30.14	34.07	35.05
CA_0900	68.40	5.42	12.90	17.49	20.78	23.41	24.06	68.82	5.44	12.95	17.55	20.84	23.46	24.12
CA_1000	45.44	6.30	15.00	21.68	26.58	30.54	31.53	49.82	6.65	15.83	22.60	27.54	31.52	32.52
CA_1100	42.52	6.27	14.93	21.95	27.14	31.34	32.40	44.19	6.41	15.27	22.33	27.54	31.76	32.82
CA_1200	35.63	10.48	24.96	37.36	46.59	54.10	56.00	39.67	11.07	26.37	38.98	48.31	55.88	57.79
CA_1300	28.25	8.18	19.49	29.83	37.58	43.93	45.53	47.49	10.60	25.25	36.40	44.59	51.20	52.86
CA_1400	44.10	6.94	16.52	24.21	29.88	34.48	35.64	49.46	7.45	17.73	25.57	31.30	35.94	37.11
CA_1500	44.28	2.21	5.25	7.66	9.43	10.86	11.23	44.99	2.23	5.30	7.71	9.49	10.92	11.28
CA_1600	47.55	3.86	9.18	13.33	16.37	18.83	19.45	47.63	3.86	9.19	13.34	16.38	18.85	19.46
CA_1700	42.56	5.65	13.46	19.79	24.47	28.27	29.22	43.93	5.76	13.71	20.08	24.77	28.58	29.53
CA_1800	41.76	2.27	5.40	7.97	9.87	11.41	11.80	45.67	2.39	5.69	8.30	10.22	11.77	12.16
CA_1900	44.71	3.32	7.91	11.50	14.14	16.28	16.82	44.97	3.33	7.94	11.53	14.18	16.32	16.85
CA_2000	40.00	2.86	6.80	10.04	12.43	14.37	14.86	41.08	2.90	6.90	10.15	12.54	14.49	14.98

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Table B-1: Hydrology Model Results

Subbasin	Existing							Future						
	Impervious %	Max flow (cfs)						Impervious %	Max flow (cfs)					
		1.2 yr	2 yr	10 yr	25 yr	50 yr	100 yr		1.2 yr	2 yr	10 yr	25 yr	50 yr	100 yr
CA_2100	39.83	1.69	4.02	5.95	7.38	8.54	8.83	39.83	1.69	4.02	5.95	7.38	8.54	8.83
CA_2200	21.00	6.78	16.15	25.62	32.84	38.81	40.32	21.00	6.78	16.15	25.62	32.84	38.81	40.32
Clackamas Basin														
CL_0100	56.10	8.30	19.76	27.75	33.54	38.19	39.35	63.34	9.01	21.45	29.55	35.38	40.04	41.21
CL_0200	38.77	7.21	17.18	28.82	37.81	45.30	47.21	52.37	10.10	24.04	37.07	46.86	54.89	56.92
CL_0300	55.02	5.75	13.69	19.25	23.28	26.52	27.33	67.01	6.57	15.64	21.31	25.37	28.61	29.42
CL_0400	49.41	8.77	20.88	32.67	41.58	48.91	50.76	52.37	9.38	22.34	34.39	43.45	50.88	52.75
CL_0500	42.43	3.88	9.24	13.53	16.68	19.25	19.89	48.86	4.21	10.03	14.41	17.61	20.20	20.85
Clinton Basin														
CN_0100	39.97	5.48	13.06	19.32	23.96	27.73	28.67	43.65	5.76	13.71	20.07	24.75	28.54	29.49
CN_0200	45.00	3.38	8.05	11.75	14.47	16.67	17.23	45.00	3.38	8.05	11.75	14.47	16.67	17.23
Coffee Basin														
CO_0100	42.86	5.74	13.66	19.99	24.66	28.44	29.39	48.66	6.18	14.72	21.17	25.90	29.71	30.67
CO_0200	43.48	3.55	8.46	12.43	15.36	17.74	18.34	45.00	3.63	8.64	12.63	15.57	17.95	18.55
CO_0300	44.84	5.57	13.26	19.44	23.99	27.68	28.61	45.00	5.58	13.29	19.47	24.03	27.72	28.65
CO_0400	43.66	2.53	6.03	8.82	10.87	12.53	12.95	45.00	2.58	6.14	8.94	11.00	12.66	13.08
CO_0500	43.11	3.34	7.94	11.68	14.44	16.68	17.25	43.41	3.35	7.98	11.72	14.48	16.72	17.29
CO_0600	40.38	2.82	6.73	9.97	12.38	14.33	14.82	44.61	2.99	7.12	10.42	12.85	14.83	15.32
CO_0700	34.96	2.66	6.34	10.16	13.08	15.49	16.10	37.14	2.78	6.62	10.50	13.46	15.89	16.51
CO_0800	41.46	8.81	20.97	31.04	38.55	44.67	46.21	42.90	8.98	21.38	31.52	39.07	45.21	46.75
CO_0900	45.97	3.78	8.99	12.95	15.84	18.17	18.76	46.71	3.81	9.08	13.04	15.93	18.27	18.86
Central Point Basin														
CP_0100	21.12	1.53	3.65	5.76	7.36	8.68	9.01	21.69	1.55	3.68	5.80	7.40	8.72	9.06
CP_0200	34.65	1.52	3.62	5.46	6.84	7.97	8.26	37.87	1.59	3.79	5.65	7.05	8.20	8.48
CP_0300	44.30	3.88	9.25	13.53	16.68	19.23	19.88	44.57	3.90	9.28	13.57	16.72	19.28	19.92
CP_0400	41.62	2.37	5.64	8.32	10.31	11.92	12.32	45.00	2.48	5.90	8.62	10.62	12.24	12.65
CP_0500	44.34	2.77	6.60	9.67	11.92	13.75	14.21	45.00	2.80	6.66	9.73	11.99	13.83	14.29
CP_0600	44.18	2.69	6.41	9.37	11.54	13.31	13.75	45.00	2.72	6.48	9.44	11.63	13.39	13.84
CP_0700	44.95	4.91	11.70	17.13	21.13	24.38	25.19	45.00	4.92	11.71	17.14	21.14	24.39	25.20
CP_0800	39.04	5.03	11.98	17.79	22.09	25.59	26.47	45.00	5.45	12.97	18.91	23.28	26.82	27.71
Clackamas-Willamette Basin														
CW_0100	28.47	0.42	1.00	1.88	2.62	3.87	4.23	29.43	0.44	1.04	1.94	2.77	4.12	4.50
Forsythe Basin														
FO_0100	18.07	20.10	47.87	75.10	95.70	112.65	116.94	18.55	20.25	48.21	75.51	96.14	113.12	117.41
John Adams Basin														
JA_0100	45.00	1.24	2.95	4.25	5.19	5.96	6.15	45.00	1.24	2.95	4.25	5.19	5.96	6.15

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Table B-1: Hydrology Model Results

Subbasin	Existing							Future						
	Impervious %	Max flow (cfs)						Impervious %	Max flow (cfs)					
		1.2 yr	2 yr	10 yr	25 yr	50 yr	100 yr		1.2 yr	2 yr	10 yr	25 yr	50 yr	100 yr
JA_0200	39.40	1.30	3.09	4.52	5.58	6.43	6.64	39.40	1.30	3.09	4.52	5.58	6.43	6.64
JA_0300	41.31	1.62	3.86	5.61	6.90	7.94	8.20	41.91	1.63	3.88	5.64	6.93	7.98	8.24
JA_0400	45.27	1.86	4.42	6.98	8.92	10.51	10.92	48.11	1.98	4.71	7.32	9.29	10.91	11.32
JA_0500	41.21	1.76	4.19	6.10	7.51	8.64	8.93	41.21	1.76	4.19	6.10	7.51	8.64	8.93
JA_0600	43.27	0.41	0.98	1.43	1.76	2.02	2.09	43.27	0.41	0.98	1.43	1.76	2.02	2.09
JA_0700	36.79	2.52	6.01	10.16	13.37	16.05	16.73	41.30	2.84	6.77	11.09	14.40	17.15	17.85
JA_0800	47.81	2.24	5.32	7.71	9.46	10.87	11.23	47.92	2.24	5.33	7.72	9.47	10.88	11.24
JA_0900	45.27	2.16	5.15	7.50	9.22	10.62	10.97	46.27	2.19	5.22	7.57	9.30	10.70	11.05
JA_1000	43.43	0.46	1.10	1.58	1.94	2.23	2.30	43.43	0.46	1.10	1.58	1.94	2.23	2.30
JA_1100	45.98	1.87	4.44	6.38	7.80	8.94	9.23	46.67	1.88	4.48	6.42	7.84	8.99	9.27
JA_1200	59.14	0.18	0.44	0.61	0.73	0.83	0.85	59.14	0.18	0.44	0.61	0.73	0.83	0.85
JA_1300	40.62	3.13	7.46	10.90	13.43	15.48	15.99	40.63	3.13	7.46	10.90	13.43	15.48	15.99
JA_1400	44.70	1.84	4.38	6.31	7.72	8.86	9.15	45.00	1.84	4.39	6.32	7.74	8.88	9.17
JA_1500	43.04	0.91	2.17	3.14	3.85	4.42	4.57	43.77	0.92	2.19	3.16	3.87	4.45	4.59
JA_1600	51.71	1.01	2.40	3.40	4.12	4.70	4.84	51.71	1.01	2.40	3.40	4.12	4.70	4.84
JA_1700	42.71	1.69	4.03	5.89	7.26	8.37	8.65	42.71	1.69	4.03	5.89	7.26	8.37	8.65
JA_1800	47.01	3.13	7.46	10.82	13.28	15.28	15.78	47.57	3.16	7.52	10.88	13.35	15.34	15.84
Kelly Field Basin														
KF_0100	37.91	6.94	16.52	24.46	30.34	35.12	36.32	66.05	9.75	23.21	31.75	37.88	42.78	44.01
Livesay Basin														
LI_0100	17.66	1.63	3.87	7.90	11.20	14.09	14.83	21.24	1.86	4.43	8.65	12.10	15.07	15.84
LI_0200	51.24	1.82	4.34	6.15	7.46	8.52	8.78	56.41	1.93	4.61	6.43	7.75	8.81	9.07
LI_0300	42.18	5.18	12.34	18.08	22.31	25.74	26.60	45.00	5.37	12.80	18.59	22.85	26.30	27.17
LI_0400	41.00	1.27	3.02	4.43	5.48	6.33	6.54	45.00	1.33	3.18	4.61	5.67	6.52	6.74
LI_0500	43.35	2.74	6.51	9.57	11.82	13.65	14.11	44.98	2.80	6.66	9.73	11.99	13.82	14.28
LI_0600	38.08	6.22	14.81	22.03	27.38	31.73	32.83	45.00	6.82	16.24	23.65	29.10	33.51	34.62
LI_0700	28.07	2.49	5.92	9.07	11.43	13.36	13.85	30.54	2.58	6.14	9.32	11.70	13.64	14.13
LI_0800	19.27	4.95	11.79	18.74	24.08	28.51	29.64	19.50	4.97	11.83	18.79	24.14	28.57	29.70
LI_0900	38.34	1.21	2.87	4.25	5.28	6.11	6.32	42.60	1.28	3.04	4.44	5.48	6.31	6.53
LI_1000	19.09	0.85	2.02	3.19	4.08	4.81	5.00	19.09	0.85	2.02	3.19	4.08	4.81	5.00
LI_1100	32.98	4.06	9.67	14.61	18.30	21.32	22.08	33.59	4.09	9.75	14.71	18.41	21.42	22.18
LI_1200	18.82	2.55	6.07	9.67	12.40	14.66	15.24	29.31	2.99	7.12	10.92	13.76	16.09	16.68
Mud Basin														
MU_0100	19.43	5.01	11.93	19.03	24.42	28.88	30.01	19.77	5.04	12.00	19.10	24.51	28.97	30.10
MU_0200	43.00	2.32	5.52	8.10	10.00	11.54	11.93	43.00	2.32	5.52	8.10	10.00	11.54	11.93
MU_0300	40.41	5.41	12.89	19.11	23.72	27.47	28.41	41.63	5.50	13.10	19.36	23.98	27.74	28.68

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Table B-1: Hydrology Model Results

Subbasin	Existing							Future						
	Impervious %	Max flow (cfs)						Impervious %	Max flow (cfs)					
		1.2 yr	2 yr	10 yr	25 yr	50 yr	100 yr		1.2 yr	2 yr	10 yr	25 yr	50 yr	100 yr
MU_0400	43.56	4.40	10.47	15.34	18.92	21.83	22.56	45.00	4.48	10.67	15.56	19.16	22.07	22.81
MU_0500	42.44	2.39	5.70	8.39	10.38	12.00	12.40	45.00	2.48	5.90	8.62	10.62	12.24	12.65
MU_0600	40.77	3.60	8.58	12.69	15.72	18.19	18.81	41.67	3.65	8.69	12.81	15.85	18.32	18.95
MU_0700	44.28	2.92	6.94	10.15	12.50	14.42	14.90	44.28	2.92	6.94	10.15	12.50	14.42	14.90
MU_0800	44.07	5.87	13.97	20.46	25.23	29.11	30.08	44.13	5.87	13.98	20.47	25.25	29.12	30.10
MU_0900	40.36	5.06	12.06	18.76	23.81	27.96	29.01	46.50	5.67	13.51	20.46	25.65	29.89	30.95
MU_1000	41.12	4.22	10.05	14.85	18.40	21.29	22.01	45.00	4.45	10.59	15.46	19.04	21.95	22.68
MU_1100	43.99	2.65	6.32	9.26	11.43	13.19	13.64	45.00	2.69	6.41	9.36	11.54	13.30	13.74
MU_1200	45.20	3.95	9.40	13.70	16.85	19.41	20.05	47.86	4.09	9.73	14.07	17.24	19.81	20.45
MU_1300	43.52	3.15	7.50	11.01	13.60	15.72	16.26	44.86	3.21	7.64	11.17	13.77	15.89	16.43
Newell Basin														
NE_0100	20.31	59.27	141.12	219.65	278.89	327.56	339.87	20.31	59.27	141.12	219.65	278.89	327.56	339.87
NE_0200	42.28	6.64	15.80	23.26	28.77	33.24	34.36	43.63	6.76	16.09	23.59	29.11	33.60	34.72
NE_0300	53.53	7.78	18.52	26.19	31.77	36.25	37.37	55.23	7.94	18.90	26.60	32.19	36.68	37.80
NE_0400	32.29	1.62	3.86	6.81	9.13	11.08	11.58	43.12	2.19	5.21	8.48	10.99	13.08	13.60
NE_0500	30.67	5.10	12.15	18.62	23.48	27.45	28.46	34.65	5.41	12.88	19.47	24.39	28.41	29.42
NE_0600	31.85	2.98	7.10	11.12	14.15	16.65	17.28	32.05	2.99	7.13	11.15	14.18	16.68	17.32
NE_0700	36.33	1.96	4.67	6.96	8.66	10.05	10.40	36.33	1.96	4.67	6.96	8.66	10.05	10.40
NE_0800	39.17	2.33	5.54	8.18	10.14	11.73	12.13	39.17	2.33	5.54	8.18	10.14	11.73	12.13
NE_0900	24.31	3.24	7.72	12.50	16.16	19.20	19.97	24.75	3.27	7.79	12.58	16.25	19.29	20.06
NE_1000	26.87	0.76	1.81	4.42	6.81	8.90	9.46	36.71	1.33	3.17	6.52	9.30	11.71	12.33
NE_1100	53.86	2.38	5.66	7.97	9.63	10.97	11.31	55.14	2.41	5.75	8.05	9.73	11.07	11.40
NE_1200	56.83	5.56	13.25	18.53	22.35	25.42	26.18	58.54	5.67	13.51	18.81	22.63	25.70	26.47
NE_1300	56.75	1.94	4.62	6.45	7.77	8.83	9.09	56.75	1.94	4.62	6.45	7.77	8.83	9.09
NE_1400	49.79	7.04	16.77	23.96	29.20	33.43	34.49	58.99	7.85	18.70	26.04	31.34	35.60	36.66
NE_1500	44.65	7.34	17.47	25.34	31.12	35.80	36.97	44.65	7.34	17.47	25.34	31.12	35.80	36.97
NE_1600	73.98	4.95	11.79	15.76	18.60	20.85	21.42	73.98	4.95	11.79	15.76	18.60	20.85	21.42
NE_1700	57.00	2.97	7.08	9.88	11.91	13.53	13.94	63.37	3.19	7.60	10.42	12.45	14.08	14.49
NE_1800	60.00	4.11	9.79	13.56	16.28	18.45	19.00	62.94	4.24	10.11	13.89	16.62	18.79	19.34
NE_1900	50.29	8.63	20.54	29.34	35.76	40.94	42.23	53.54	8.97	21.37	30.24	36.69	41.89	43.19
NE_2000	52.67	6.60	15.71	22.25	27.01	30.83	31.79	62.62	7.40	17.61	24.29	29.08	32.93	33.89
NE_2100	28.59	8.06	19.19	29.33	36.93	43.15	44.72	36.25	8.97	21.35	31.83	39.62	45.97	47.57
NE_2200	65.36	4.89	11.65	15.92	18.98	21.43	22.05	73.84	5.33	12.70	17.00	20.05	22.49	23.10
NE_2300	42.30	7.97	18.99	31.09	40.37	48.07	50.03	48.10	9.21	21.92	34.62	44.25	52.18	54.19
NE_2400	61.22	8.50	20.25	28.04	33.66	38.16	39.28	67.40	9.10	21.67	29.53	35.16	39.66	40.78
NE_2500	32.76	7.77	18.50	28.14	35.37	41.28	42.77	36.54	8.20	19.53	29.34	36.66	42.63	44.13

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Table B-1: Hydrology Model Results

Subbasin	Existing							Future						
	Impervious %	Max flow (cfs)						Impervious %	Max flow (cfs)					
		1.2 yr	2 yr	10 yr	25 yr	50 yr	100 yr		1.2 yr	2 yr	10 yr	25 yr	50 yr	100 yr
NE_2600	49.78	8.45	20.12	28.78	35.10	40.19	41.47	49.79	8.45	20.12	28.78	35.10	40.20	41.47
NE_2700	35.95	1.76	4.20	6.28	7.82	9.08	9.40	35.99	1.76	4.20	6.28	7.83	9.09	9.40
NE_2800	31.85	6.19	14.75	22.25	27.84	32.40	33.55	51.12	7.95	18.93	26.96	32.81	37.52	38.70
NE_2900	36.63	10.28	24.48	36.52	45.46	52.73	54.56	45.12	11.51	27.40	39.83	48.96	56.35	58.20
NE_3000	25.68	7.32	17.43	26.89	34.00	39.85	41.33	48.84	10.00	23.81	34.20	41.79	47.93	49.46
NE_3100	67.08	2.94	6.99	9.51	11.30	12.74	13.10	67.08	2.94	6.99	9.51	11.30	12.74	13.10
Park Place Basin														
PP_0100	41.40	3.05	7.27	11.80	15.27	18.14	18.86	66.71	5.23	12.45	17.78	21.67	24.80	25.59
PP_0200	44.34	6.46	15.38	22.32	27.40	31.52	32.55	74.00	9.05	21.54	28.86	34.07	38.23	39.27
PP_0300	45.09	1.93	4.60	7.41	9.56	11.33	11.78	61.16	2.78	6.62	9.78	12.12	14.02	14.49
PP_0400	41.66	2.52	6.01	8.81	10.88	12.56	12.98	46.30	2.68	6.38	9.23	11.32	13.01	13.43
PP_0500	35.15	2.93	6.99	11.99	15.87	19.12	19.95	43.44	3.66	8.71	14.10	18.21	21.62	22.49
PP_0600	40.66	7.37	17.55	26.49	33.15	38.59	39.96	43.03	7.65	18.22	27.26	33.98	39.45	40.83
PP_0700	34.93	1.23	2.92	4.36	5.43	6.30	6.52	45.00	1.40	3.33	4.82	5.92	6.81	7.03
PP_0800	41.50	1.67	3.98	5.85	7.23	8.35	8.63	45.00	1.75	4.16	6.06	7.45	8.57	8.86
PP_0900	36.37	1.56	3.71	5.52	6.87	7.96	8.24	45.00	1.74	4.15	6.02	7.40	8.51	8.79
PP_1000	40.16	2.38	5.67	8.40	10.43	12.10	12.52	45.00	2.54	6.05	8.84	10.91	12.59	13.02
South End Basin														
SE_0100	20.81	2.87	6.84	11.39	14.91	17.84	18.59	20.81	2.87	6.84	11.39	14.91	17.84	18.59
SE_0200	19.80	1.56	3.70	5.86	7.50	8.86	9.20	19.80	1.56	3.70	5.86	7.50	8.86	9.20
SE_0300	18.99	7.45	17.74	28.29	36.41	43.13	44.83	19.01	7.46	17.75	28.29	36.42	43.14	44.84
SE_0400	39.47	5.73	13.63	20.31	25.27	29.32	30.34	41.41	5.88	14.00	20.74	25.73	29.79	30.82
SE_0500	18.96	2.43	5.80	9.19	11.77	13.90	14.44	20.07	2.48	5.90	9.31	11.91	14.04	14.58
SE_0600	20.49	4.44	10.57	16.79	21.52	25.42	26.41	20.49	4.44	10.57	16.79	21.52	25.42	26.41
SE_0700	42.86	6.98	16.62	24.49	30.30	35.03	36.21	43.23	7.01	16.70	24.58	30.40	35.13	36.32
SE_0800	18.83	2.96	7.06	11.28	14.49	17.14	17.82	18.85	2.97	7.06	11.28	14.49	17.15	17.82
SE_0900	24.99	4.63	11.03	17.19	21.84	25.70	26.68	28.85	4.91	11.68	17.96	22.70	26.61	27.60
SE_1000	44.37	1.68	3.99	5.83	7.18	8.27	8.55	44.72	1.69	4.01	5.85	7.20	8.30	8.57
SE_1100	35.68	1.45	3.46	5.21	6.51	7.59	7.86	37.98	1.50	3.58	5.34	6.66	7.74	8.01
SE_1200	35.62	5.40	12.86	19.38	24.24	28.20	29.20	37.02	5.51	13.12	19.68	24.55	28.53	29.53
SE_1300	44.41	2.14	5.09	7.43	9.15	10.55	10.90	44.41	2.14	5.09	7.43	9.15	10.55	10.90
SE_1400	43.71	1.69	4.03	5.88	7.24	8.34	8.61	44.21	1.70	4.06	5.91	7.27	8.37	8.64
SE_1500	45.00	0.94	2.24	3.28	4.05	4.67	4.83	45.00	0.94	2.24	3.28	4.05	4.67	4.83
SE_1600	36.46	1.77	4.21	6.27	7.80	9.04	9.36	44.95	1.98	4.70	6.83	8.40	9.66	9.98
Singer Basin														
SI_0100	61.53	1.50	3.56	4.91	5.87	6.65	6.84	61.63	1.50	3.57	4.91	5.88	6.65	6.84

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Table B-1: Hydrology Model Results

Subbasin	Existing							Future						
	Impervious %	Max flow (cfs)						Impervious %	Max flow (cfs)					
		1.2 yr	2 yr	10 yr	25 yr	50 yr	100 yr		1.2 yr	2 yr	10 yr	25 yr	50 yr	100 yr
SI_0200	67.54	1.20	2.85	3.87	4.60	5.18	5.32	67.54	1.20	2.85	3.87	4.60	5.18	5.32
SI_0300	46.42	4.96	11.80	17.15	21.07	24.25	25.05	46.93	4.99	11.88	17.23	21.16	24.35	25.14
SI_0400	55.94	5.96	14.20	19.92	24.06	27.39	28.22	56.53	6.01	14.30	20.03	24.17	27.49	28.33
SI_0500	49.50	3.34	7.96	11.33	13.79	15.78	16.27	50.45	3.38	8.05	11.43	13.89	15.88	16.38
SI_0600	45.63	5.91	14.08	20.47	25.17	28.98	29.94	48.58	6.14	14.62	21.08	25.81	29.64	30.60
SI_0700	41.86	3.99	9.50	13.98	17.28	19.97	20.64	44.47	4.13	9.83	14.36	17.68	20.38	21.06
SI_0800	39.68	4.07	9.70	14.79	18.59	21.71	22.50	39.68	4.07	9.70	14.79	18.59	21.71	22.50
SI_0900	42.75	6.96	16.57	24.32	30.03	34.66	35.83	42.75	6.96	16.57	24.32	30.03	34.66	35.83
SI_1000	38.91	4.25	10.13	15.12	18.82	21.83	22.59	41.93	4.44	10.56	15.61	19.34	22.38	23.14
SI_1100	40.12	4.54	10.82	15.86	19.57	22.58	23.34	42.85	4.70	11.20	16.29	20.02	23.05	23.81
Thimble Basin														
TH_0100	19.22	101.70	242.15	378.36	481.25	565.85	587.25	19.46	102.06	243.00	379.37	482.35	567.00	588.42
Tumwater Basin														
TU_0100	38.64	7.25	17.25	27.09	34.53	40.66	42.21	40.00	7.44	17.72	27.64	35.13	41.29	42.85
TU_0200	40.60	1.92	4.58	6.76	8.38	9.69	10.02	41.38	1.94	4.63	6.82	8.44	9.75	10.08
TU_0300	44.09	2.32	5.52	8.08	9.99	11.54	11.93	44.40	2.33	5.54	8.11	10.02	11.57	11.96
Willamette North Basin														
WN_0100	64.93	5.05	12.02	16.44	19.62	22.16	22.79	68.39	5.23	12.46	16.90	20.08	22.62	23.25
WN_0200	64.12	2.85	6.78	9.29	11.08	12.52	12.88	65.82	2.90	6.90	9.41	11.21	12.65	13.01
WN_0300	50.66	0.67	1.59	2.25	2.73	3.12	3.21	51.75	0.68	1.61	2.27	2.75	3.14	3.24
WN_0400	46.91	1.89	4.49	6.44	7.86	9.00	9.29	46.91	1.89	4.49	6.44	7.86	9.00	9.29
WN_0500	46.79	1.11	2.64	3.78	4.62	5.29	5.46	46.79	1.11	2.64	3.78	4.62	5.29	5.46
Willamette South Basin														
WS_0100	68.83	7.74	18.42	24.99	29.69	33.45	34.39	69.16	7.76	18.49	25.06	29.76	33.51	34.45

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Attachment C: Existing and Future Hydrology Comparison

Table C-1: Existing and Future Hydrology Comparison												
Subbasin	Absolute increase in maximum flow (cfs)						Percent increase in maximum flow (%)					
	1.2 yr	2 yr	10 yr	25 yr	50 yr	100 yr	1.2 yr	2 yr	10 yr	25 yr	50 yr	100 yr
Abernethy Basin												
AB_0100	0.07	0.15	0.16	0.16	0.16	0.15	1.24	1.24	0.93	0.78	0.68	0.66
AB_0200	0.61	1.46	1.70	1.83	1.92	1.94	14.42	14.42	10.85	9.21	8.21	7.99
AB_0300	0.91	2.17	2.50	2.67	2.77	2.80	17.15	17.15	12.92	10.96	9.75	9.49
AB_0400	0.41	0.98	1.02	1.04	1.04	1.04	12.46	12.46	9.35	7.85	6.91	6.70
AB_0500	0.03	0.08	0.09	0.10	0.10	0.10	0.56	0.56	0.42	0.36	0.32	0.31
AB_0600	0.03	0.08	0.10	0.11	0.12	0.12	1.46	1.46	1.15	0.98	0.88	0.85
Alan Court Basin												
AC_0100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Amanda Court Basin												
AM_0100	0.26	0.61	0.74	0.82	0.87	0.88	2.75	2.75	2.05	1.74	1.56	1.51
AM_0200	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
AM_0300	0.06	0.15	0.17	0.18	0.18	0.19	0.74	0.74	0.57	0.49	0.43	0.44
Beaver Basin												
BE_0200	0.75	1.79	2.07	2.22	2.32	2.34	8.94	8.94	6.78	5.77	5.15	5.02
BE_0300	0.23	0.55	0.64	0.69	0.73	0.73	2.93	2.93	2.22	1.90	1.70	1.65
Caufield Basin												
CA_0100	0.00	0.01	0.01	0.01	0.01	0.01	0.03	0.03	0.02	0.02	0.02	0.01
CA_0200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CA_0300	0.13	0.32	0.36	0.38	0.39	0.39	1.52	1.52	1.17	1.00	0.89	0.87
CA_0400	0.25	0.60	0.67	0.70	0.72	0.72	6.16	6.16	4.71	4.02	3.57	3.48
CA_0500	0.24	0.57	0.65	0.71	0.73	0.74	3.30	3.30	2.54	2.23	1.99	1.94
CA_0600	0.03	0.08	0.08	0.09	0.09	0.09	0.59	0.59	0.45	0.38	0.34	0.33
CA_0700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CA_0800	0.24	0.57	0.60	0.60	0.60	0.60	3.19	3.19	2.41	2.04	1.80	1.74
CA_0900	0.02	0.06	0.06	0.06	0.06	0.06	0.43	0.43	0.33	0.27	0.24	0.24
CA_1000	0.35	0.83	0.92	0.96	0.98	0.98	5.55	5.55	4.24	3.61	3.21	3.12
CA_1100	0.14	0.34	0.38	0.40	0.41	0.42	2.26	2.26	1.74	1.48	1.32	1.29
CA_1200	0.59	1.41	1.61	1.72	1.78	1.79	5.65	5.65	4.32	3.69	3.29	3.20
CA_1300	2.42	5.76	6.57	7.00	7.27	7.33	29.56	29.56	22.03	18.63	16.55	16.10
CA_1400	0.51	1.21	1.35	1.42	1.46	1.47	7.31	7.31	5.59	4.77	4.24	4.13
CA_1500	0.02	0.05	0.06	0.06	0.06	0.06	0.91	0.91	0.72	0.60	0.55	0.53
CA_1600	0.00	0.01	0.01	0.01	0.01	0.01	0.11	0.11	0.08	0.07	0.06	0.06
CA_1700	0.10	0.25	0.28	0.30	0.31	0.31	1.85	1.85	1.42	1.22	1.09	1.06
CA_1800	0.12	0.29	0.33	0.35	0.36	0.36	5.39	5.39	4.13	3.52	3.14	3.05
CA_1900	0.01	0.03	0.03	0.03	0.03	0.03	0.34	0.34	0.25	0.23	0.20	0.19

Use of contents on this sheet is subject to the limitations specified at the beginning of this document.

Table C-1: Existing and Future Hydrology Comparison												
Subbasin	Absolute increase in maximum flow (cfs)						Percent increase in maximum flow (%)					
	1.2 yr	2 yr	10 yr	25 yr	50 yr	100 yr	1.2 yr	2 yr	10 yr	25 yr	50 yr	100 yr
CA_2000	0.04	0.10	0.11	0.12	0.12	0.12	1.46	1.46	1.11	0.95	0.85	0.82
CA_2100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CA_2200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Clackamas Basin												
CL_0100	0.71	1.70	1.81	1.84	1.85	1.85	8.59	8.59	6.51	5.49	4.85	4.71
CL_0200	2.88	6.87	8.25	9.05	9.59	9.71	39.97	39.97	28.64	23.94	21.16	20.57
CL_0300	0.82	1.95	2.06	2.09	2.09	2.09	14.23	14.23	10.69	8.97	7.90	7.66
CL_0400	0.61	1.46	1.72	1.87	1.97	1.99	6.99	6.99	5.28	4.50	4.02	3.91
CL_0500	0.33	0.79	0.88	0.93	0.96	0.96	8.55	8.55	6.52	5.59	4.98	4.84
Clinton Basin												
CN_0100	0.28	0.66	0.75	0.79	0.82	0.82	5.05	5.05	3.87	3.30	2.94	2.86
CN_0200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coffee Basin												
CO_0100	0.44	1.06	1.18	1.24	1.28	1.28	7.75	7.75	5.91	5.03	4.48	4.36
CO_0200	0.07	0.17	0.20	0.21	0.22	0.22	2.07	2.07	1.59	1.36	1.21	1.18
CO_0300	0.01	0.03	0.03	0.03	0.04	0.04	0.21	0.21	0.17	0.14	0.13	0.12
CO_0400	0.04	0.11	0.12	0.13	0.13	0.13	1.76	1.76	1.36	1.16	1.04	1.01
CO_0500	0.01	0.03	0.04	0.04	0.04	0.04	0.40	0.40	0.32	0.27	0.24	0.23
CO_0600	0.17	0.40	0.45	0.48	0.49	0.50	5.90	5.90	4.51	3.85	3.45	3.35
CO_0700	0.12	0.29	0.35	0.38	0.40	0.41	4.51	4.51	3.40	2.90	2.60	2.52
CO_0800	0.17	0.41	0.48	0.52	0.53	0.54	1.98	1.98	1.56	1.34	1.20	1.17
CO_0900	0.03	0.08	0.09	0.10	0.10	0.10	0.91	0.91	0.70	0.60	0.53	0.52
Central Point Basin												
CP_0100	0.01	0.03	0.04	0.04	0.04	0.04	0.90	0.90	0.68	0.57	0.52	0.50
CP_0200	0.07	0.17	0.19	0.21	0.22	0.22	4.61	4.61	3.53	3.11	2.78	2.71
CP_0300	0.01	0.03	0.04	0.04	0.04	0.04	0.36	0.36	0.28	0.24	0.21	0.21
CP_0400	0.11	0.26	0.30	0.31	0.32	0.33	4.67	4.67	3.56	3.05	2.72	2.65
CP_0500	0.02	0.06	0.07	0.07	0.07	0.07	0.89	0.89	0.67	0.58	0.52	0.51
CP_0600	0.03	0.07	0.08	0.08	0.09	0.08	1.09	1.09	0.83	0.71	0.64	0.62
CP_0700	0.00	0.01	0.01	0.01	0.01	0.01	0.07	0.07	0.05	0.04	0.04	0.04
CP_0800	0.42	1.00	1.13	1.19	1.23	1.24	8.32	8.32	6.34	5.41	4.81	4.69
Clackamas-Willamette Basin												
CW_0100	0.02	0.04	0.06	0.15	0.26	0.27	4.40	4.40	3.24	5.80	6.62	6.34
Forsythe Basin												
FO_0100	0.14	0.34	0.41	0.44	0.46	0.47	0.71	0.71	0.54	0.46	0.41	0.40

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Table C-1: Existing and Future Hydrology Comparison												
Subbasin	Absolute increase in maximum flow (cfs)						Percent increase in maximum flow (%)					
	1.2 yr	2 yr	10 yr	25 yr	50 yr	100 yr	1.2 yr	2 yr	10 yr	25 yr	50 yr	100 yr
John Adams Basin												
JA_0100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
JA_0200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
JA_0300	0.01	0.03	0.03	0.03	0.04	0.04	0.75	0.75	0.57	0.49	0.44	0.43
JA_0400	0.12	0.29	0.35	0.38	0.40	0.40	6.63	6.63	4.97	4.24	3.79	3.69
JA_0500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
JA_0600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
JA_0700	0.32	0.76	0.93	1.03	1.10	1.12	12.68	12.68	9.18	7.73	6.88	6.69
JA_0800	0.00	0.01	0.01	0.01	0.01	0.01	0.15	0.15	0.12	0.10	0.08	0.08
JA_0900	0.03	0.07	0.08	0.08	0.08	0.08	1.32	1.32	1.00	0.87	0.77	0.75
JA_1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
JA_1100	0.02	0.04	0.04	0.04	0.04	0.04	0.83	0.83	0.64	0.55	0.49	0.48
JA_1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
JA_1300	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
JA_1400	0.01	0.02	0.02	0.02	0.02	0.02	0.37	0.37	0.27	0.25	0.21	0.21
JA_1500	0.01	0.02	0.02	0.02	0.02	0.02	0.88	0.88	0.67	0.57	0.52	0.50
JA_1600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
JA_1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
JA_1800	0.02	0.05	0.06	0.06	0.07	0.07	0.74	0.74	0.55	0.48	0.43	0.41
Kelly Field Basin												
KF_0100	2.81	6.69	7.29	7.54	7.67	7.69	40.47	40.47	29.79	24.85	21.83	21.17
Livesay Basin												
LI_0100	0.23	0.55	0.76	0.90	0.99	1.01	14.22	14.22	9.60	8.06	7.01	6.79
LI_0200	0.11	0.26	0.28	0.29	0.30	0.30	6.06	6.06	4.62	3.91	3.46	3.36
LI_0300	0.19	0.46	0.52	0.54	0.56	0.57	3.73	3.73	2.86	2.44	2.18	2.13
LI_0400	0.07	0.16	0.18	0.19	0.20	0.20	5.30	5.30	4.08	3.47	3.10	3.01
LI_0500	0.06	0.14	0.16	0.17	0.18	0.18	2.21	2.21	1.69	1.45	1.30	1.26
LI_0600	0.60	1.43	1.62	1.72	1.77	1.79	9.68	9.68	7.37	6.27	5.59	5.44
LI_0700	0.09	0.21	0.25	0.27	0.28	0.28	3.60	3.60	2.73	2.35	2.10	2.05
LI_0800	0.02	0.04	0.05	0.06	0.06	0.06	0.36	0.36	0.28	0.24	0.21	0.21
LI_0900	0.07	0.17	0.19	0.20	0.21	0.21	5.75	5.75	4.42	3.79	3.37	3.29
LI_1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LI_1100	0.04	0.08	0.10	0.10	0.11	0.11	0.87	0.87	0.66	0.57	0.51	0.49
LI_1200	0.44	1.05	1.25	1.36	1.43	1.45	17.36	17.36	12.92	10.94	9.75	9.48
Mud Basin												
MU_0100	0.03	0.07	0.08	0.09	0.09	0.09	0.54	0.54	0.41	0.35	0.32	0.31

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Table C-1: Existing and Future Hydrology Comparison												
Subbasin	Absolute increase in maximum flow (cfs)						Percent increase in maximum flow (%)					
	1.2 yr	2 yr	10 yr	25 yr	50 yr	100 yr	1.2 yr	2 yr	10 yr	25 yr	50 yr	100 yr
MU_0200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MU_0300	0.09	0.22	0.25	0.26	0.27	0.27	1.68	1.68	1.30	1.11	0.99	0.97
MU_0400	0.08	0.20	0.23	0.24	0.25	0.25	1.92	1.92	1.48	1.26	1.12	1.09
MU_0500	0.08	0.20	0.23	0.24	0.24	0.25	3.51	3.51	2.68	2.29	2.04	1.99
MU_0600	0.04	0.11	0.12	0.13	0.13	0.13	1.24	1.24	0.95	0.81	0.72	0.70
MU_0700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MU_0800	0.00	0.01	0.01	0.01	0.01	0.01	0.08	0.08	0.06	0.05	0.05	0.05
MU_0900	0.61	1.45	1.70	1.83	1.92	1.94	12.03	12.03	9.06	7.70	6.87	6.69
MU_1000	0.23	0.54	0.61	0.64	0.66	0.67	5.34	5.34	4.09	3.50	3.12	3.03
MU_1100	0.04	0.09	0.10	0.10	0.10	0.11	1.36	1.36	1.05	0.89	0.80	0.78
MU_1200	0.14	0.33	0.37	0.39	0.40	0.40	3.51	3.51	2.69	2.30	2.05	1.99
MU_1300	0.06	0.14	0.15	0.16	0.17	0.17	1.81	1.81	1.40	1.20	1.09	1.07
Newell Basin												
NE_0100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NE_0200	0.12	0.29	0.33	0.35	0.36	0.36	1.83	1.83	1.41	1.20	1.07	1.05
NE_0300	0.16	0.38	0.41	0.42	0.43	0.43	2.03	2.03	1.56	1.32	1.18	1.14
NE_0400	0.57	1.35	1.68	1.87	2.00	2.03	34.93	34.93	24.60	20.43	18.03	17.52
NE_0500	0.31	0.73	0.85	0.91	0.95	0.96	5.98	5.98	4.55	3.89	3.47	3.38
NE_0600	0.01	0.03	0.03	0.03	0.03	0.04	0.35	0.35	0.27	0.23	0.20	0.20
NE_0700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NE_0800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NE_0900	0.03	0.06	0.08	0.09	0.09	0.09	0.83	0.83	0.62	0.53	0.47	0.46
NE_1000	0.57	1.36	2.09	2.49	2.81	2.87	75.10	75.10	47.33	36.60	31.56	30.37
NE_1100	0.03	0.08	0.09	0.09	0.09	0.09	1.47	1.47	1.12	0.96	0.85	0.82
NE_1200	0.11	0.26	0.28	0.28	0.29	0.29	1.96	1.96	1.50	1.27	1.13	1.09
NE_1300	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NE_1400	0.81	1.92	2.08	2.14	2.17	2.18	11.46	11.46	8.68	7.34	6.49	6.31
NE_1500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NE_1600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NE_1700	0.22	0.51	0.54	0.55	0.55	0.55	7.23	7.23	5.46	4.60	4.07	3.95
NE_1800	0.13	0.32	0.34	0.34	0.34	0.34	3.26	3.26	2.47	2.09	1.85	1.79
NE_1900	0.35	0.82	0.90	0.94	0.95	0.95	4.02	4.02	3.07	2.61	2.32	2.26
NE_2000	0.80	1.90	2.03	2.08	2.09	2.10	12.09	12.09	9.13	7.69	6.79	6.60
NE_2100	0.91	2.17	2.51	2.69	2.82	2.84	11.28	11.28	8.54	7.28	6.53	6.36
NE_2200	0.44	1.05	1.08	1.07	1.06	1.05	9.05	9.05	6.75	5.63	4.93	4.78
NE_2300	1.23	2.94	3.54	3.88	4.12	4.17	15.46	15.46	11.38	9.62	8.56	8.33

Use of contents on this sheet is subject to the limitations specified at the beginning of this document.

Table C-1: Existing and Future Hydrology Comparison												
Subbasin	Absolute increase in maximum flow (cfs)						Percent increase in maximum flow (%)					
	1.2 yr	2 yr	10 yr	25 yr	50 yr	100 yr	1.2 yr	2 yr	10 yr	25 yr	50 yr	100 yr
NE_2400	0.60	1.42	1.48	1.50	1.50	1.50	7.02	7.02	5.29	4.45	3.92	3.81
NE_2500	0.43	1.03	1.20	1.29	1.35	1.36	5.57	5.57	4.28	3.65	3.26	3.18
NE_2600	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
NE_2700	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.07	0.05	0.04	0.03	0.03
NE_2800	1.76	4.18	4.71	4.97	5.12	5.15	28.37	28.37	21.18	17.85	15.80	15.35
NE_2900	1.23	2.92	3.31	3.50	3.62	3.64	11.94	11.94	9.06	7.71	6.86	6.68
NE_3000	2.68	6.38	7.31	7.79	8.07	8.13	36.57	36.57	27.18	22.91	20.26	19.68
NE_3100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Park Place Basin												
PP_0100	2.17	5.17	5.98	6.40	6.67	6.73	71.15	71.15	50.65	41.94	36.77	35.66
PP_0200	2.59	6.16	6.54	6.67	6.71	6.71	40.06	40.06	29.33	24.34	21.29	20.62
PP_0300	0.85	2.02	2.37	2.56	2.68	2.71	43.99	43.99	31.99	26.79	23.67	23.00
PP_0400	0.15	0.37	0.42	0.44	0.45	0.45	6.14	6.14	4.73	4.03	3.59	3.49
PP_0500	0.72	1.73	2.11	2.34	2.50	2.54	24.70	24.70	17.61	14.74	13.07	12.71
PP_0600	0.28	0.67	0.77	0.83	0.86	0.87	3.82	3.82	2.92	2.49	2.23	2.17
PP_0700	0.17	0.41	0.46	0.49	0.51	0.51	14.05	14.05	10.65	9.05	8.05	7.83
PP_0800	0.08	0.19	0.21	0.22	0.23	0.23	4.68	4.68	3.59	3.07	2.73	2.65
PP_0900	0.19	0.44	0.50	0.53	0.55	0.56	11.98	11.98	9.13	7.76	6.92	6.74
PP_1000	0.16	0.38	0.43	0.47	0.49	0.49	6.76	6.76	5.16	4.53	4.05	3.95
South End Basin												
SE_0100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SE_0200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SE_0300	0.00	0.01	0.01	0.01	0.01	0.01	0.03	0.03	0.02	0.02	0.02	0.02
SE_0400	0.16	0.37	0.43	0.46	0.47	0.48	2.74	2.74	2.10	1.80	1.61	1.57
SE_0500	0.04	0.10	0.12	0.13	0.14	0.14	1.74	1.74	1.32	1.13	1.01	0.98
SE_0600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SE_0700	0.04	0.09	0.09	0.10	0.10	0.10	0.51	0.51	0.39	0.33	0.30	0.29
SE_0800	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.03	0.02	0.02	0.02
SE_0900	0.28	0.66	0.78	0.86	0.91	0.92	5.96	5.96	4.52	3.94	3.54	3.45
SE_1000	0.01	0.02	0.02	0.02	0.02	0.02	0.45	0.45	0.36	0.29	0.27	0.26
SE_1100	0.05	0.11	0.13	0.14	0.15	0.15	3.26	3.26	2.50	2.21	1.96	1.92
SE_1200	0.11	0.26	0.30	0.32	0.33	0.33	2.01	2.01	1.54	1.32	1.18	1.15
SE_1300	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SE_1400	0.01	0.03	0.03	0.03	0.03	0.03	0.64	0.64	0.49	0.41	0.37	0.37
SE_1500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SE_1600	0.21	0.50	0.57	0.60	0.62	0.62	11.79	11.79	9.02	7.68	6.83	6.65

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Table C-1: Existing and Future Hydrology Comparison												
Subbasin	Absolute increase in maximum flow (cfs)						Percent increase in maximum flow (%)					
	1.2 yr	2 yr	10 yr	25 yr	50 yr	100 yr	1.2 yr	2 yr	10 yr	25 yr	50 yr	100 yr
Singer Basin												
SI_0100	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.11	0.08	0.07	0.06	0.06
SI_0200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SI_0300	0.03	0.08	0.09	0.09	0.09	0.10	0.67	0.67	0.51	0.44	0.39	0.38
SI_0400	0.04	0.10	0.10	0.11	0.11	0.11	0.68	0.68	0.52	0.44	0.39	0.38
SI_0500	0.04	0.09	0.10	0.10	0.10	0.10	1.13	1.13	0.87	0.74	0.66	0.64
SI_0600	0.23	0.55	0.61	0.64	0.65	0.66	3.89	3.89	2.98	2.54	2.26	2.20
SI_0700	0.14	0.34	0.38	0.40	0.41	0.42	3.53	3.53	2.71	2.31	2.06	2.01
SI_0800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SI_0900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SI_1000	0.18	0.43	0.49	0.53	0.55	0.55	4.28	4.28	3.27	2.80	2.50	2.44
SI_1100	0.16	0.38	0.43	0.45	0.47	0.47	3.53	3.53	2.71	2.31	2.06	2.01
Thimble Basin												
TH_0100	0.36	0.86	1.01	1.10	1.16	1.17	0.35	0.35	0.27	0.23	0.20	0.20
Tumwater Basin												
TU_0100	0.20	0.47	0.55	0.60	0.63	0.64	2.71	2.71	2.05	1.75	1.56	1.52
TU_0200	0.02	0.05	0.05	0.06	0.06	0.06	1.07	1.07	0.81	0.69	0.62	0.61
TU_0300	0.01	0.02	0.03	0.03	0.03	0.03	0.42	0.42	0.32	0.28	0.25	0.24
Willamette North Basin												
WN_0100	0.19	0.45	0.46	0.46	0.46	0.46	3.70	3.70	2.79	2.34	2.07	2.00
WN_0200	0.05	0.12	0.13	0.13	0.13	0.13	1.80	1.80	1.37	1.15	1.01	0.99
WN_0300	0.01	0.02	0.02	0.02	0.02	0.02	1.32	1.32	0.98	0.81	0.74	0.72
WN_0400	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WN_0500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Willamette South Basin												
WS_0100	0.03	0.06	0.07	0.07	0.06	0.06	0.34	0.34	0.26	0.22	0.19	0.19

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Appendix C: Hydraulic Modeling TM

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Brown AND Caldwell

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Technical Memorandum

Prepared for: City of Oregon City

Project title: Stormwater Master Plan

Project no.: 149133

Technical Memorandum

Subject: Hydraulic Models

Date: October 5, 2017

To: Jon Archibald, Project Engineer

From: Matt Grzegorzewski

Copy to: Alissa Maxwell, P.E., Ryan Retzlaff, File

Prepared by: Matt Grzegorzewski

Reviewed by: Alissa Maxwell, P.E.

Limitations:

This document was prepared solely for City Oregon City in accordance with professional standards at the time the services were performed and in accordance with the contract between City Oregon City and Brown and Caldwell dated March 16, 2016. This document is governed by the specific scope of work authorized by City Oregon City; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. We have relied on information or instructions provided by City Oregon City and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

Section 1: Introduction

The City of Oregon City (City) is developing a stormwater master plan to update existing planning documents and guide surface water and stormwater decisions. The master plan will address both water quantity and quality for the constructed and natural storm drainage systems under the City's management. The master plan requires a clear understanding of existing and future infrastructure capacity across the city to identify long-term (10 to 20 years) stormwater project needs.

This technical memorandum (TM) has been developed to document the methodology used to analyze the hydraulics of stormwater conveyance systems in key areas of concern. The modeling results reveal system capacity problems consistent with City staff visual observations and input from citizens of Oregon City. The modeling shows significant flooding in the John Adams and Livesay basins along South End Road. Other areas, such as those in the Singer Creek and Central Point basins, show adequate capacity for design storms.

As a result of this analysis capital projects to increase infrastructure capacity in the John Adams neighborhood and along South End Road are recommended. An additional recommendation includes continued monitoring of recent infrastructure improvements along Coffee Creek and at Kathaway Court (Central Point Basin) to determine if further modifications may be necessary.

Section 2: Modeling Areas

Oregon City includes 23 major drainage basins. This project includes the development of hydraulic models to analyze the stormwater conveyance systems of greatest concern. Future efforts may expand the hydraulic modeling to include additional portions of the city.

City staff identified multiple areas of the city where there are known capacity or flooding issues. Some identified problem areas were considered to have a clear project solution such as those that are maintenance-related. Other areas were identified as in need of a more detailed hydraulic analysis to determine the cause of the flooding and/or develop a preferred solution. In a workshop setting with the City and Brown and Caldwell (BC), the identified problem areas were pared down to nine priority modeling locations. The extent of the modeled systems has been largely based on modeling the area upstream and downstream sufficiently to capture the problem. The outfall and downstream systems have been included as needed. The nine selected priority areas are described below.

While hydraulic modeling was limited to these nine priority areas, citywide hydrology modeling to document runoff patterns and rates was developed and documented in the *Subcatchment Hydrology* TM by BC, dated October 17, 2016.

2.1 Central Point Basin

The Central Point Basin has two reported flooding areas. Kathaway Court to Sunset Springs experiences flooding due to roadway drainage flooding over the roadway and causing localized flooding of homes. A hydraulic model was developed to include the storm system starting at Vincent Drive and following the system south to the outfall near S McCord Road.

The other location modeled starts with the storm system at Crisp Drive and follows Pease Road to an outfall near Pavilion Place.

The two modeled areas are shown in Figure 1.

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2.2 Coffee Creek Basin

The Hazelwood neighborhood has been built up around Coffee Creek, which drains through the backyards of numerous homes. Coffee Creek has been channelized with significant modification to the drainage system. The system has multiple culverts and includes complicated entrance and exit conditions. One home has a culvert that is partially deteriorated, causing some localized flooding in the backyard of the property. The model for this storm system begins at Warner Parrott Road and follows the creek alignment under Hazelwood Drive, through a residential area to Barker Avenue. Barker Avenue was determined to be the end of the model due to no identified downstream problem areas and the channel showing no signs of downcutting or instability downstream of Barker Avenue.

The modeled area is shown in Figure 2.

2.3 Livesay Basin

The northeast corner of the city is expected to see significant future development, which may influence stormwater infrastructure capacity. The existing drainage systems along Holcomb Boulevard and Oaktree Terrace were modeled to identify existing and future sources of flooding and to determine how best to correct the flooding. A combination of pipes, open ditches, and culverts convey runoff west along Holcomb Boulevard, then south at Oaktree Terrace where the system outfalls to Tour Creek.

The modeled area is shown in Figure 3.

2.4 John Adams Basin

The John Adams Basin has some of the oldest infrastructure in the city. Many pipes are undersized, causing localized flooding throughout the basin. Flooding has been reported at the following locations:

- Intersection of 8th and Van Buren streets
- Van Buren Street between 14th Street and 15th Street
- Intersection of 9th and Monroe streets
- Intersection of 7th and Van Buren streets

Modeling for this basin is extensive compared to the other basins. The most upstream ends of the modeled system are at the intersection of 8th and Taylor streets and at the intersection of Harrison and 12th streets. A third modeled pipe segment starts at the intersection of 9th and Madison streets. The modeled system outfall is at the end of 12th Street.

The modeled area is shown in Figure 4.

2.5 Park Place Basin

The reported problems in the Park Place Basin include flooding near Swan Avenue, undersized culverts downstream of Swan Avenue to Apperson Boulevard, and some erosion near the intersection of Harley Avenue and Cleveland Street. The stormwater infrastructure in this basin is primarily aging culverts and pipe segments, following the original stream path. The City is concerned that the existing infrastructure would not support future development in the area. The model starts with the system west of Swan Avenue just south of Blue Mountain Way and follows the original stream path forming a half circle, which ends at the intersection of Apperson Boulevard and La Rae Street.

The modeled area is shown in Figure 5.

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2.6 Singer Creek Basin

The concerns in the Singer Creek Basin are primarily due to aging infrastructure. The current alignment through the old portion of town includes brick, rock, and concrete channels and structures that have been paved and built on as the area developed. Portions of the system do not have a solid bottom and may be exfiltrating into underlying soils. The alignment also goes under several buildings. While capacity is not an immediate concern, understanding the limitations of the system is important to the City. The model starts with the system at Jackson Street between 5th and 6th streets and continues down to the Singer outfall at the corner of 7th Street, Singer Hill, and High Street.

The modeled area is shown in Figure 6.

2.7 South End Basin

South End Road has several pipes that are smaller than the upstream pipes. It is not clear whether these constrictions were intentional efforts at flow control, or design oversights. The constrictions are causing the system flooding of homes and streets in the areas around Oaktree Court, Rose Road, and the intersection of Josephine and Bjerke streets. This system also collects flow from a tributary creek near Filbert Drive that contributes significant discharge to the capacity-limited system. Starting at S Gentry Way the model then follows South End Road to the existing outfall between Salmonberry Drive and S Forest Ridge Road.

The modeled area is shown in Figure 7.

2.8 Newell Basin at Molalla Avenue and Beaver Creek Road

The City manages dozens of small stormwater systems that discharge to Newell Canyon or associated tributaries. This modeling effort included the evaluation of the most complicated drainage network in the vicinity of the S Beavercreek Road and Molalla Avenue intersection. Stormwater infrastructure is undersized in this system in several locations and has some critical erosion occurring at the outfall. The area also includes several underground detention pipes, installed to restrict downstream flows. The model extends east and west of Molalla Avenue along Beavercreek Road with north and south pipes along Molalla Avenue contributing to the Beavercreek Road system. The model outfall is just downstream of Beavercreek Road, toward a tributary to Newell Creek.

The modeled area is shown in Figure 8.

Section 3: Hydraulic Model Development

The hydraulic models were developed using XP Solutions, Storm Water Management Model (SWMM) version 2016.1. This section includes detailed descriptions of the inputs and methodology used to define the hydraulic characteristics of the modeled systems. Data sources to populate the hydraulic model included the City's geographic information system (GIS), field survey data collected in June 2017, and site visits performed by both BC and City staff. The design storms, survey, model naming conventions, and hydraulic model methods are described below.

3.1 Design Storms

The City's design event for conveyance systems depends on the size of the catchment draining to the infrastructure as follows:

- Catchment areas of less than 40 acres require a 10-year, 24-hour design event
- Catchment areas between 40 and 640 acres require a 25-year, 24-hour design event

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- Catchment areas greater than 640 acres require a 50-year, 24-hour design event

New public and private conveyance systems are designed to carry the design event without surcharging. For analysis of existing systems, the design events are used to identify current and future capacity problems and then provide a target capacity for capital projects. To support these goals, each of the hydraulic models was used to simulate existing conditions for the 2-year, 10-year, 25-year, and 100-year, 24-hour design storms.

The 1.2-year rainfall depth is representative of the water quality design storm as documented in the technical memorandum *Selection of Representative Rainfall Volume and Rainfall Intensities to Result in Capture and Treatment of 80% of the Average Annual Runoff Volume* (BC 2010). According to a 2008 Oregon Department of Transportation (ODOT) study titled *Water Quantity (Flow Control) Design Storm Performance Standard*, 42 percent of the 2-year peak flow rate can be used as an analog for the 1.2-year peak flow rate (ODOT 2008). This event represents a depth of 1.18 inches of rainfall. The 1.2 year rainfall event is not included in the hydraulic results table in Attachment A because it does not impact capacity analyses of the conveyance system. However, it is an important consideration for water quality and bank forming events and is included in the city-wide hydrology analysis.

A hydrology model was developed for the 185 subbasins located within Oregon City prior to the hydraulic model. The Santa Barbara Urban Hydrograph (SBUH) was used to develop runoff hydrographs for multiple storm events. The necessary input parameters for estimating hydrology include subcatchment area, pervious and impervious percentages, pervious curve numbers, rainfall, and time of concentration. For more detailed descriptions of the methodology used in determining each of the hydrologic model parameters, see the *Subcatchment Hydrology* TM by BC, dated August 10, 2016.

Results from the hydrology model were used as input to the hydraulic models to simulate flows in the selected pipe networks. Hydrology input nodes were placed at hydraulic stormwater structures near the downstream ends of contributing subcatchments.

3.2 Conveyance Naming Convention

The naming convention for Oregon City's drainage system was provided via GIS by the City, which includes the links (pipes, open channels, culverts, etc.) and nodes (manholes, catch basins, etc.). Links have a unique six-digit facility identifier (ID) beginning with the number 800000, and nodes have a unique five-digit facility ID beginning with the number 30000. The naming convention used in the City's GIS was applied to the systems simulated in the XPSWMM model.

Links or nodes that were not found in the existing GIS database and that were added to the hydraulic models were named with the default nomenclature provided by XPSWMM (e.g., Link 34 and Node 23).

3.3 Input Parameters

The primary purpose of the modeling was to conduct a hydraulic analysis of select storm drainage systems to evaluate system capacity. Hydraulic input parameters included pipe name, upstream (US) node (name, invert elevation, rim elevation), downstream (DS) node (name, invert elevation, rim elevation), pipe length, pipe slope, pipe shape, pipe diameter, and Manning's roughness coefficient. Attachment A, Hydraulic Model Parameters and Results, includes all pipe and node data for each model. The following sections describe the parameters that were required for development of the models.

3.3.1 Upstream and Downstream Node Names

The upstream and downstream node names for each link were assigned based on the naming convention provided by the City's GIS, as explained in Section 3.2. Nodes in the hydraulic model that also include model hydrologic input information were renamed with the nomenclature *NodeName_SubbasinName_hydraulicnodename* (e.g. 42534_CO_0500).

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3.3.2 Length and Slope of Segment

The length of each link was provided by the City from the City's GIS. Lengths were extended or combined with other segments as necessary to ensure continuity in the system. Where the information provided in the GIS did not align with observations, other means to estimate the length of infrastructure were employed, such as a site visit, field survey, Google Earth measurement, or GIS measurement.

Segment slopes were calculated in XPSWMM using upstream and downstream node invert elevations and segment lengths.

3.3.3 Invert Elevations

Upstream and downstream invert elevations for each pipe segment were extracted from node data in GIS. If invert information was missing, the invert data were collected via field survey as is described in Section 3.4.

3.3.4 Rim Elevations

The rim elevation at each node location is necessary to simulate possible flooding of the drainage system. Many rim elevations were missing in the City' GIS database. Missing rim elevations were estimated using light detecting and ranging (LiDAR) data. Field survey was collected for structures where rim elevations were inconclusive from LIDAR.

3.3.5 Diameter and Shape

Existing pipe diameters for pipe segments were obtained from GIS or collected through field survey or site visits. For pipes where diameter data were not provided or could not be field-verified, the diameter was assumed to be the same size as the pipe segment immediately upstream. This assumption provides a conservative estimate of hydraulic system capacity.

Pipes were assumed to be circular in shape with the exception of conduits that convey flow from Singer Creek downstream of Node 33815 to the outfall at Node 42737. During a field visit conducted by BC staff on August 31, 2016, these pipe segments were observed to have a rectangular cross-section.

Open channels were assumed to be trapezoidal in shape with dimensions approximated based on measurements obtained during field visits by BC or City staff.

3.3.6 Manning's Roughness Coefficient

Manning's roughness coefficient "n" is dependent on the surface material of pipes and open channels. It was assumed that all pipes were composed of concrete with an associated roughness coefficient of 0.014. A roughness coefficient range of 0.014 to 0.040 was assigned to all open-channel surfaces based on observations from aerial photography and site visits. The low roughness of 0.014 for an open channel was applied to a concrete-lined open channel. Other vegetated, rock, or dirt channels with higher roughness had a Manning's "n" of up to 0.040.

3.4 Survey Needs

After determining the extent of area to be modeled for each problem area, missing invert elevations and pipe diameters within these areas were identified based on a query of GIS data in order to develop a data gaps list. A total of 126 structures were identified as needing a survey to supplement the existing GIS data. AKS Engineering & Forestry performed the survey in May 2016 to obtain the missing data necessary for modeling. Survey results were delivered in the form of a computer-aided design (CAD) file and an Excel spreadsheet. BC staff incorporated the updated elevations into the GIS database. Subsequently, the data were exported from GIS into XPSWMM.

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3.5 Vertical Datum

To verify the vertical datum used in the GIS data provided by the City, ground elevations of nodes were extracted from LIDAR data and compared to rim elevations within the GIS database. Ground elevations from LIDAR, which was known to use the North American Vertical Datum of 1988 (NAVD88), were consistently 3.5 feet higher than the City-provided rim elevations. Based on this observation, it was assumed that a majority of the City data used the National Geodetic Vertical Datum of 1929 (NGVD29). There were a few exceptions where the difference between the elevations was near zero feet. These nodes were updated by the City more recently and most likely already use NAVD88. No adjustment was made to these nodes. The remaining nodes were adjusted using the datum shift between NAVD88 and NGVD29 for Oregon City, Oregon (3.52 feet) to bring the City GIS data to NAVD88.

3.6 Hydraulic Model Methods

To evaluate system capacity and flooding hazards, the XPSWMM computer model was used to simulate the hydraulic performance of the piped and open-channel systems. The hydrology routine in XPSWMM converts rainfall into stormwater runoff based on design storm parameters (e.g., volume and intensity of rainfall) and subbasin characteristics such as topography, land use, vegetation, and soil types. The hydraulics routine in the model then routes the stormwater runoff through the drainage system and enables estimates to be made of discharge through the conveyance system, water surface elevations, and velocities for design storms.

Problem areas identified by BC and City staff for modeling were based on known issues. These areas are shown in Figure 9.

To check model results and validate the hydrologic and hydraulic modeling, the results were compared to anecdotal problem area descriptions. Problem area descriptions provided by the City did not include specific flooding elevations or measured extents in any of the basins. A general model validation was performed to check that all the models are showing flooding in areas where flooding was reported by City staff.

3.7 Hydraulic Scenarios

Two scenarios were simulated using the hydraulic models: existing and future development conditions.

- The existing-conditions models were based on hydrology for the existing land use conditions as described in the *Subcatchment Hydrology* TM by BC, dated August 10, 2016. The hydraulics models were based on the infrastructure currently in place and represented in the GIS supplemented with surveyed data.
- The future-conditions models were based on hydrology for the future land use conditions as described in the *Subcatchment Hydrology* TM by BC, dated August 10, 2016. The future-conditions models typically resulted in higher flows due to increased impervious percentages associated with new development. These models were used to assess the ability of existing infrastructure to handle future flows and to identify locations where additional or new capacity problems might occur as a result of buildout.

In areas where flooding problems indicated a need for a modification of the drainage infrastructure, an additional hydraulic model was created. The proposed capital improvement project (CIP) hydraulic features were incorporated into the future conditions models to identify conceptual designs for the new infrastructure.

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Section 4: Hydraulic Model Results

The XPSWMM simulations were run for the 2-year, 10-year, 25-year, and 50-year event for both current and future development conditions. The model results show no/minimal increases for future flows for the modeled areas that are already fully developed. As expected, the largest projected flow increases were seen in areas with existing vacant land that is slated for future development. The model results also provided validation of the problem areas as reported by City staff and they provided additional information about potential sources of the problems. When reviewing model results, flooding was considered to be a problem when the maximum water surface elevation at any modeled node was equal to or greater than the rim elevation of the node. Surcharging of the system was not considered to be a flooding problem.

A summary of the model results is described below. See Tables A-1 through A-4 in Attachment A for modeling result details.

4.1.1 Central Point Basin

The hydraulic model results for the Central Point Basin show that the pipe at the downstream end of the open channel along S McCord Road between S Central Point Road and Sunset Springs Drive is undersized and results in flooding during the 25-year design event. This flooding as simulated by the model is consistent with problems reported by City staff. In addition to undersized pipes, the system capacity is further reduced by several 90-degree bends in the drainage network. The roadway drainage discharges on the west side of Central Point Road near Kathaway Court, where it joins the main channel to flow back under Central Point Road to the east. The flooding is most problematic at 19451 Sunset Springs Drive. The modeling shows that the existing infrastructure on Pease Road has adequate capacity to carry future flows during the 25-year storm event.

City maintenance staff have recently modified the inlet/outlet structures near Kathaway Court to reduce losses and improve flow capacity. These modifications reduced flooding during the 2016/17 winter storm events. The City will continue to monitor the drainage network to determine if any further improvements are needed.

4.1.2 Coffee Creek Basin

The hydraulic model results for the Coffee Creek Basin show minor/significant flooding around hydraulic constrictions beginning at the 10-year design storm. This system is mostly open channel with a few culverts. The water overtops the banks of the channel, flooding the backyards of residential homes. The flooding is most problematic near the backyard of 965 Hazelwood Drive which has an undersized culvert that was installed by a private party. The system has multiple constrictions and modified culvert inlets that greatly reduce the capacity of the open channel.

City staff has been actively working with homeowners to address constrictions in the existing system. No capital projects are recommended for this basin at this time. However, the City may consider opportunities for small drainage improvements when other public projects are connected to the creek.

4.1.3 Livesay Basin

The Livesay Basin model was built to assess reported flooding and verify capacity of the existing infrastructure as the area is nearly fully developed. Model results revealed some deficiencies in the system where the reported flooding is occurring. Much of the infrastructure along Holcomb Boulevard is undersized and will need to be replaced if future development is to occur within the drainage area. Flooding begins for the future flow scenario beginning at the 2-year design event. The most significant flooding occurs at the transition be-

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tween open channels and piped flow where the stormwater system from the north side of Holcomb Boulevard crosses to the south side, west of Oaktree Terrace. Modifying the inlet structures to increase hydraulic efficiency and properly sizing the downstream infrastructure is likely needed to alleviate flooding.

4.1.4 John Adams Basin

The results of the John Adams Basin analysis reveal several areas where the system is undersized and floods, especially in areas where the stormwater system transitions from larger-diameter to smaller-diameter pipe. This occurs at the intersections of 9th and John Adams streets, 11th and John Adams streets, and 11th and Madison streets, among others. Flooding has been observed in the field and has been confirmed with the existing-conditions model at these locations. The scope of the model built and areas modeled included areas identified as problems. Modeled flooding occurs during the 2-year design event, which is consistent with the reported flooding that is said to occur during routine events.

This area has some of the oldest infrastructure in the city and is complex while undersized for the areas it drains. Much of this infrastructure is well past its design life, suggesting there may be locations where pipes are partially collapsed or have root growth or other conditions that reduce capacity.

4.1.5 Park Place Basin

Reports of flooding in the Park Place neighborhoods are related to inconsistencies in the channelized system and abrupt changes in either flow direction or conveyance material.

The existing Park Place model results show flooding at the culvert crossing under Hiram Avenue starting with the 2-year design event. Other locations that flood during the 25-year, 24-hour storm include an undersized culvert farther downstream near the intersection of Clear Street and Front Avenue, the transition from open channel to closed east of Hunter Avenue and south of Cleveland Street, and the culvert that appears to be in the backyard of 16163 S Harley Avenue.

4.1.6 Singer Creek Basin

No flooding or problem areas were identified for this area but City staff requested that a model be built and the system be assessed because of its age and alignment through private property. The modeled system shows no flooding, yet it is surcharged and the water surface during the 25-year design event is at or near the surface. The system is running full during the 25-year design event and is surcharged. The drainage basin contributing to Singer Creek is mostly built out but as densification and infill occurs, care should be taken to assess impacts of any increase in discharge or peak flows. The infrastructure is some of the oldest in the city and will require regular inspections and assessment to ensure function. Additionally, the creek is aligned across private property and directly under structures in a few instances. As the system is updated the trunk line should be relocated into the public right-of-way and out of private property whenever possible.

4.1.7 South End Basin: South End Road

The South End conveyance system is a mix of open channels and large and small pipes, which results in an inefficient system. Based on model results, this system starts to flood during the 2-year event. The flooding starts near South Rose Road where the open-channel system enters a closed system. The entrance grate configuration and pipes are not sized sufficiently to convey the runoff. The existing entrance grate could also be an issue for debris accumulation. The system then decreases in pipe diameter and significantly increases in slope. The conveyance infrastructure floods farther down South End Road where a culvert capturing the open-channel flow does not have capacity.

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4.1.8 Newell Creek Basin: Beavercreek Road and Molalla Avenue

The modeling has shown that pipes are under capacity at the Beavercreek Road crossing east of Molalla Avenue. One undersized pipe, across Beavercreek Road, looks to be an intentional restriction to create an underground detention system for stormwater management. The underground detention pipes may not be adequately sized for the expected peak flows and the pipe across Beavercreek Road is the cause of flooding starting with the 2-year design event. The pipes along Molalla Avenue that drain to Beavercreek Road have capacity while the smaller pipes along Beavercreek Road that contribute to the trunk line are surcharged during the 2-year event. Future monitoring for flooding in this area is recommended.

Replacement of the existing 40 feet of 12-inch-diameter pipe and 10 feet of 3.5-foot-diameter pipe, across Beavercreek Road, to match the upstream and downstream pipe size, which is 4.0 feet in diameter, will likely remove much of the capacity issues within the trunk line of this system.

Results of the hydraulic simulations for all events and locations are tabulated in Attachment A: Hydraulic Model Parameters and Results.

Section 5: References

Brown and Caldwell (BC). 2010. *Selection of Representative Rainfall Volume and Rainfall Intensities to Result in Capture and Treatment of 80% of the Average Runoff Volume*. May 11.

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Attachment A: Hydraulic Model Parameters and Results

Table A-1. Hydraulic Model Parameters and Results for 2-yr Storm

Table A-2. Hydraulic Model Parameters and Results for 10-yr Storm

Table A-3. Hydraulic Model Parameters and Results for 25-yr Storm

Table A-4. Hydraulic Model Parameters and Results for 100-yr Storm

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Table A-1. Hydraulic Model Parameters and Results for 2-yr and 1.2-yr Storms

					Node Name		Invert Elevation (ft)		Ground Elevation (ft)		Existing Max Water Surface Elevation (ft)		Future Max Water Surface Elevation (ft)		Max Flow (cfs)		1.2-yr Max Flow (cfs)		Flooding at DS Node	
Link ID	Length (ft)	Shape	Diameter/Height (in)	Slope (%)	US	DS	US	DS	US	DS	US	DS	US	DS	Existing	Future	Existing	Future	Existing	Future
Central Point Basin																				
808424	57.6	Circular	36	3.44	42490_CP_0500	38777	441.58	439.60	444.58	448.68	443.13	440.27	443.15	440.27	12.86	13.00	5.40	5.46		
803448	135.1	Circular	12	1.58	33962	35483	461.35	459.21	467.71	467.48	462.44	459.99	463.01	460.06	3.97	4.29	1.67	1.80		
803449	349.8	Circular	12	4.26	35483	35481	459.01	444.12	467.48	450.42	459.59	444.67	459.62	444.70	3.97	4.29	1.67	1.80		
803703	202.6	Circular	30	0.59	35630	35478	429.72	428.53	439.21	432.23	431.03	429.64	431.10	429.69	11.87	12.85	4.99	5.39		
807429	182.8	Circular	12	0.77	37879_CP_0800	33962	463.41	462.00	468.84	467.71	466.05	462.85	466.70	463.01	3.98	4.30	1.67	1.81		
808422	128.1	Circular	36	0.71	33002	39749	443.14	442.23	447.90	445.23	443.93	443.17	443.94	443.18	6.39	6.46	2.68	2.71		
808427	28.5	Circular	36	0.04	39588	34501	432.78	432.77	438.46	438.50	434.54	434.27	434.54	434.27	17.05	17.05	7.16	7.16		
808428	118.5	Circular	36	1.05	34502	39588	434.03	432.78	440.22	438.46	435.42	434.54	435.42	434.54	17.05	17.05	7.16	7.16		
808653	18.7	Circular	30	2.20	38733_CP_0800	35630	430.33	429.92	440.18	439.21	431.68	431.03	431.75	431.10	11.88	12.85	4.99	5.40		
808654	259.3	Circular	12	4.75	35481	38733_CP_0800	443.92	431.60	450.42	440.18	444.49	432.13	444.52	432.16	3.97	4.29	1.67	1.80		
809337	155.2	Circular	36	0.95	34503	34502	435.50	434.03	441.35	440.22	436.83	435.42	436.83	435.42	17.05	17.06	7.16	7.16		
809791	34.0	Circular	15	0.00	34248_CP_0100	35487	430.72	430.73	438.92	438.59	432.07	431.73	432.08	431.74	3.64	3.67	1.53	1.54		
809793	91.2	Circular	15	0.27	35487	35484	430.53	430.28	438.59	437.00	431.73	431.05	431.74	431.05	3.64	3.67	1.53	1.54		
812537	128.1	Trapezoidal	30	0.71	39749	42490_CP_0500	442.23	441.58	445.23	444.58	443.17	443.13	443.18	443.15	6.32	6.40	2.66	2.69		
Link18	292.2	Circular	36	0.41	33700_CP_0600	33002	444.35	443.14	450.79	447.90	445.25	443.93	445.26	443.94	6.41	6.48	2.69	2.72		
Link19	447.2	Trapezoidal	30	0.49	38888	30909_CP_0400	438.79	436.61	441.29	439.11	440.07	439.11	440.08	439.11	12.80	12.95	5.37	5.44	YES	YES
Link20	33.0	Circular	27	0.62	30909_CP_0400	34503	436.61	436.40	439.11	441.35	439.11	437.84	439.11	437.84	17.05	17.05	7.16	7.16		
Link21	10.0	Circular	36	13.10	38777	38888	439.60	438.29	448.68	441.29	440.27	440.07	440.27	440.08	12.86	12.99	5.40	5.46		
Link25	341.0	Circular	15	0.55	35484	35478	430.08	428.20	437.00	432.23	431.01	429.15	430.95	429.18	3.63	3.66	1.53	1.54		
Link26	215.0	Circular	30	2.57	35478	40654	428.20	422.68	432.23	425.18	429.15	423.54	429.18	423.57	15.50	16.51	6.51	6.93		
Link27	38.5	Circular	36	1.30	34501	33145	432.77	432.27	438.50	435.27	434.27	433.27	434.27	433.27	17.05	17.05	7.16	7.16		
Coffee Creek Basin																				
618.1	116.9	Circular	24	0.58	42534_CO_0500	42533	440.66	439.98	445.16	444.48	443.58	441.51	443.59	441.53	14.95	14.95	6.28	6.28		
802016	56.9	Circular	24	1.63	40182_CO_0800	34657	453.03	452.10	456.03	456.54	454.64	452.87	454.67	452.88	8.40	8.63	3.53	3.62		
808374	56.9	Circular	24	1.63	40182_CO_0800	34657	453.03	452.10	456.03	456.54	454.64	452.87	454.67	452.88	8.40	8.63	3.53	3.62		
808377	62.4	Circular	48	1.07	42472_CO_0600	42473	448.69	448.02	453.69	454.24	451.07	449.49	451.13	449.54	31.25	32.31	13.13	13.57		
808379	68.6	Circular	30	2.90	42475_CO_0400	42474	413.69	411.70	417.69	416.03	416.77	412.79	416.78	412.79	25.54	25.60	10.73	10.75		
808379	68.6	Circular	30	2.90	42475_CO_0400	42474	413.69	411.70	417.69	416.03	416.77	412.79	416.78	412.79	25.54	25.60	10.73	10.75		
808867	76.2	Circular	36	0.91	CO_0300	42552	429.21	428.52	433.21	432.52	433.21	430.25	433.21	430.25	45.08	45.08	18.93	18.94		
Backyard	116.9	Trapezoidal	24	0.00	42534_CO_0500	42533	443.16	442.48	445.16	444.48	443.58	442.90	443.59	442.91	23.84	24.95	10.01	10.48		
Link10	686.1	Trapezoidal	48	2.16	42552	42475_CO_0400	428.52	413.69	432.52	417.69	430.25	416.77	430.25	416.78	45.08	45.08	18.93	18.93		
Link11	6.0	Rectangular	30	1.73	Node16	Node17	446.46	446.35	450.46	450.36	449.34	447.26	449.40	447.28	31.24	32.30	13.12	13.57		
Link12	329.2	Trapezoidal	48	1.73	Node17	42534_CO_0500	446.35	440.66	450.36	445.16	447.26	443.58	447.28	443.59	31.24	32.30	13.12	13.57		
Link13	180.0	Trapezoidal	24	0.58	42533	Node19	439.98	438.82	444.48	441.82	441.51	441.14	441.53	441.17	39.77	40.87	16.70	17.17		
Link14	50.0	Trapezoidal	36	0.58	Node19	Node20	438.82	438.53	441.82	442.53	441.14	439.73	441.17	439.75	39.76	40.87	16.70	17.16		
Link15	100.5	Trapezoidal	48	9.27	Node20	CO_0300	438.53	429.21	442.53	433.21	439.73	433.21	439.75	433.21	39.76	40.87	16.70	17.16	YES	YES
Link6	174.1	Circular	36	0.67	34657	40188_CO_0700	451.30	450.14	456.54	457.06	452.78	451.85	452.81	451.89	16.80	17.25	7.05	7.25		
Link7	587.5	Trapezoidal	60	0.25	40188_CO_0700	42472_CO_0600	450.14	448.69	457.06	453.69	451.85	451.07	451.89	451.13	24.87	25.57	10.44	10.74		
Link8	90.3	Trapezoidal	48	1.73	42473	Node16	448.02	446.46	454.24	450.46	449.49	449.34	449.54	449.40	31.24	32.31	13.12	13.57		

Table A-1. Hydraulic Model Parameters and Results for 2-yr and 1.2-yr Storms

					Node Name		Invert Elevation (ft)		Ground Elevation (ft)		Existing Max Water Surface Elevation (ft)		Future Max Water Surface Elevation (ft)		Max Flow (cfs)		1.2-yr Max Flow (cfs)		Flooding at DS Node	
Link ID	Length (ft)	Shape	Diameter/Height (in)	Slope (%)	US	DS	US	DS	US	DS	US	DS	US	DS	Existing	Future	Existing	Future	Existing	Future
Livesay Basin																				
Link1	169.8	Circular	1	1.00	33740_LI_1200	33742	504.45	502.75	512.76	510.16	512.35	506.09	505.61	505.61	5.86	0.00	2.46	0.00		
Link13	41.7	Circular	1.5	4.31	34160	42491	429.05	427.25	435.25	432.40	426.66	424.12	431.00	428.29	10.36	13.83	4.35	5.81		
Link14	185.2	Circular	1	8.09	32573_LI_1100	34374_LI_1000	438.68	423.70	441.61	430.48	434.71	423.87	438.90	423.92	0.73	0.96	0.31	0.40		
Link15	399.6	Circular	1	3.02	34374_LI_1000	35610	423.47	411.42	430.48	418.42	423.57	411.73	423.80	411.77	1.07	1.30	0.45	0.55		
Link16	124.8	Circular	1	1.67	35610	35612	411.36	409.27	418.42	412.91	411.73	409.61	411.77	409.65	1.07	1.30	0.45	0.55		
Link17	252.8	Circular	1	5.17	35612	35607	409.06	395.99	412.91	400.77	409.31	400.77	409.34	400.77	1.07	1.30	0.45	0.55	YES	YES
Link18	73.6	Circular	1	0.56	35607	35686	395.79	395.38	400.77	397.38	400.77	395.67	400.77	395.61	6.48	4.20	2.72	1.76		
Link19	96.2	Trapezoidal	2	14.41	35686	39436	395.38	381.52	397.38	383.52	395.67	383.52	395.61	383.52	6.48	4.20	2.72	1.76	YES	YES
Link2	106.9	Circular	1	1.91	33742	34162_LI_1100	502.55	500.51	510.16	505.96	506.09	501.92	505.61	505.60	5.86	0.00	2.46	0.00		
Link20	61.8	Circular	1	8.24	39436	34997	381.52	376.43	383.52	379.80	383.52	376.89	383.52	376.89	4.09	4.09	1.72	1.72		
Link21	218.2	Circular	1	5.92	34997	30828_LI_0600	376.23	363.31	379.80	366.90	376.78	363.82	376.78	363.82	4.09	4.09	1.72	1.72		
Link22	19.2	Circular	1	32.88	30828_LI_0600	39842	362.77	356.46	366.90	368.26	363.10	356.79	363.29	356.79	4.50	4.54	1.89	1.91		
Link23	198.9	Circular	2	0.88	42491	39313_LI_1000	426.75	425.00	432.40	427.01	424.12	417.72	428.29	426.24	10.38	13.83	4.36	5.81		
Link24	542.8	Trapezoidal	2	4.63	39313_LI_1000	Node25	425.00	399.89	427.01	401.89	417.72	401.89	425.93	401.89	11.94	15.51	5.02	6.51	YES	YES
Link25	125.0	Circular	2	3.12	Node25	35607	399.89	395.99	401.89	400.77	401.89	400.77	401.89	400.77	11.28	11.28	4.74	4.74	YES	YES
Link29	455.6	Circular	1.25	0.39	Node31	Node31.1	508.23	506.44	519.47	512.76	NA_1	NA_1	513.21	512.76	NA_1	1.82	NA_1	0.76		YES
Link29.1	296.1	Circular	1.25	1.70	Node31.1	Node34	506.24	501.21	512.76	506.82	NA_1	NA_1	512.76	506.82	NA_1	9.29	NA_1	3.90		YES
Link3	525.9	Circular	1.25	7.72	34162_LI_1100	34161	500.41	459.83	505.96	465.63	501.71	465.66	505.60	465.63	14.56	16.05	6.11	6.74	YES	YES
Link30	23.7	Circular	1.25	1.69	Node34	34162_LI_1100	501.01	500.61	506.82	505.96	NA_1	NA_1	506.82	505.60	NA_1	9.18	NA_1	3.86		
Link4	241.2	Circular	1.25	4.46	34161	33066	459.84	449.09	465.63	453.44	465.66	453.43	465.63	450.34	12.59	13.83	5.29	5.81		
Link5	206.8	Circular	1.25	6.95	33066	33065	449.09	434.71	453.44	438.65	453.43	435.98	450.21	436.48	10.36	13.83	4.35	5.81		
Link6	52.1	Circular	1.25	12.00	33065	34160	435.15	428.90	438.65	435.25	435.80	426.66	436.48	431.00	10.36	13.83	4.35	5.81		YES
John Adams Basin																				
800781	159.3	Circular	16	4.81	34313	33514	160.19	152.53	162.29	171.45	161.08	153.28	161.08	153.28	9.48	9.48	3.98	3.98		
801568	335.0	Circular	8	4.06	33504	33474	257.58	243.99	261.10	254.51	261.10	253.96	261.10	253.99	1.93	1.93	0.81	0.81		
801573	15.0	Circular	12	28.92	33473	34769	220.25	215.90	226.39	226.95	223.03	220.87	223.03	220.87	6.58	6.58	2.76	2.76		
802603	417.6	Circular	12	6.93	33505_JA_1400	38651	309.65	280.69	316.50	286.90	310.15	281.19	310.15	281.19	4.36	4.38	1.83	1.84		
802604	268.7	Circular	8	2.85	33566_JA_1600	34696	321.64	313.99	330.45	318.74	326.74	314.66	326.74	314.66	2.38	2.38	1.00	1.00		
802606	301.1	Circular	8	8.09	34698	33504	282.51	258.15	289.22	261.10	282.96	261.10	282.96	261.10	2.38	2.38	1.00	1.00	YES	YES
804813	157.0	Circular	18	6.34	33520	43469	82.29	72.34	96.27	88.74	83.21	75.92	83.21	75.92	12.63	12.63	5.31	5.30		
804814	78.8	Circular	18	7.00	33519	33520	92.03	86.51	99.89	96.27	93.02	87.25	93.02	87.25	12.61	12.61	5.30	5.30		
804815	124.1	Circular	18	2.66	33521	34704_WN_0300	68.67	65.37	86.97	73.55	74.12	66.87	74.12	66.87	19.03	19.03	7.99	7.99		
804841	513.2	Circular	12	2.94	33475_JA_1000	33473	235.76	220.69	243.58	226.39	243.58	223.03	243.58	223.03	6.58	6.58	2.76	2.76		
804846	64.5	Circular	12	1.18	33469	33508	185.00	184.24	188.90	191.51	188.90	185.23	188.90	185.23	6.27	6.27	2.63	2.63		
804848	150.6	Circular	24	5.05	33514	33515	152.33	144.73	171.45	153.00	153.03	145.34	153.03	145.34	9.48	9.48	3.98	3.98		
804851	256.1	Circular	18	8.38	33515	34191_JA_0100	144.53	123.08	153.00	128.90	145.16	128.90	145.16	128.90	9.48	9.48	3.98	3.98	YES	YES
804860	101.6	Circular	18	3.60	33517_WN_0400	33516	178.61	174.95	185.10	179.60	179.81	178.88	179.81	178.88	7.07	7.07	2.97	2.97		
804861	211.6	Circular	18	6.54	33523	33517_WN_0400	192.64	178.81	201.40	185.10	192.97	179.81	192.97	179.81	2.64	2.64	1.11	1.11		
804867	274.3	Circular	18	2.49	34311_WN_0500	33523	199.70	192.86	207.50	201.40	200.14	193.28	200.14	193.28	2.64	2.64	1.11	1.11		
804870	183.5	Circular	8	6.02	34767_JA_1100	34309	203.85	192.80	209.10	198.92	209.10	193.47	209.10	193.47	3.22	3.22	1.35	1.35		
804934	296.9	Circular	8	9.23	38650_JA_1500	33475_JA_1000	263.28	235.87	269.84	243.58	263.70	243.58	263.71	243.58	2.17	2.19	0.91	0.92	YES	YES
804969	247.9	Circular	8	8.24	33513_JA_0300	33519	113.61	93.18	119.72	99.89	118.80	93.85	118.80	93.85	3.55	3.55	1.49	1.49		
806396	444.2	Circular	8	8.37	37054	33513_JA_0300	151.18	114.01	162.35	119.72	159.31	118.80	159.31	118.80	3.55	3.55	1.49	1.49		
806401	131.5	Circular	8	16.53	37059	37054	173.12	151.38	178.38	162.35	173.72	159.31	173.72	159.31	3.58	3.58	1.50	1.51		
806402	255.5	Circular	10	12.82	37062	37059	206.06	173.32	208.79	178.38	206.49	173.73	206.49	173.73	3.55	3.55	1.49	1.49		
806406	30.6	Circular	10	2.72	37064	37062	207.09	206.26	210.50	208.79	208.95	207.02	208.95	207.02	3.55	3.55	1.49	1.49		

1. Existing model based on infrastructure in place in 2017. Future conditions model includes recently installed infrastructure.

Table A-1. Hydraulic Model Parameters and Results for 2-yr and 1.2-yr Storms

					Node Name		Invert Elevation (ft)		Ground Elevation (ft)		Existing Max Water Surface Elevation (ft)		Future Max Water Surface Elevation (ft)		Max Flow (cfs)		1.2-yr Max Flow (cfs)		Flooding at DS Node	
Link ID	Length (ft)	Shape	Diameter/Height (in)	Slope (%)	US	DS	US	DS	US	DS	US	DS	US	DS	Existing	Future	Existing	Future	Existing	Future
806411	253.8	Circular	8	1.92	37070_JA_0500	34769	223.30	218.42	224.81	226.95	224.81	220.87	224.81	220.87	1.40	1.40	0.59	0.59		
806471	131.0	Circular	18	3.17	37118	37139_WN_0100	50.10	45.95	57.70	53.08	57.70	53.08	57.70	53.08	15.12	15.12	6.35	6.35	YES	YES
806474	123.1	Circular	18	0.56	37139_WN_0100	37142	45.72	45.03	53.08	53.08	53.08	50.09	53.08	50.09	12.38	12.37	5.20	5.19		
808623	41.5	Circular	18	0.63	37142	41009	44.93	44.67	53.08	52.70	50.09	48.32	50.09	48.32	12.37	12.37	5.19	5.19		
808624	19.1	Circular	18	-0.52	43300	43301	43.51	43.61	61.81	61.81	46.43	44.94	46.43	44.94	12.37	12.37	5.19	5.19		
808704	305.9	Circular	12	2.42	33474	33475_JA_1000	243.75	236.34	254.51	243.58	253.96	243.58	253.99	243.58	6.02	6.03	2.53	2.53	YES	YES
808721	103.2	Circular	12	6.62	34309	33508	190.32	183.49	198.92	191.51	190.80	183.92	190.80	183.92	3.22	3.22	1.35	1.35		
812475	29.8	Circular	12	4.05	36378	34534	163.75	162.54	168.58	167.42	168.58	166.00	168.58	166.00	6.66	6.66	2.80	2.80		
812477	198.1	Circular	12	4.42	33516	36378	172.70	163.95	179.60	168.58	178.88	168.58	178.88	168.58	7.07	7.07	2.97	2.97	YES	YES
812478	100.6	Circular	12	3.01	34534	43051	162.24	159.21	167.42	163.93	166.00	160.78	166.00	160.78	6.65	6.65	2.79	2.79		
812479	194.4	Circular	12	4.18	43051	43050	159.11	150.99	163.93	155.49	160.78	151.78	160.78	151.78	6.48	6.48	2.72	2.72		
812692	119.5	Circular	18	0.80	41009	43300	44.57	43.61	52.70	61.81	48.32	46.43	48.32	46.43	12.37	12.37	5.19	5.19		
812695	158.3	Circular	54	18.38	43301	39733	43.51	14.40	61.81	19.40	43.94	14.79	43.94	14.79	12.37	12.37	5.19	5.19		
812816	39.8	Circular	18	8.12	43469	33521	72.10	68.87	88.74	86.97	75.92	74.12	75.92	74.12	12.71	12.72	5.34	5.34		
Link43	393.4	Circular	12	9.22	38651	33474	280.27	243.99	286.90	254.51	280.75	253.96	280.75	253.99	4.36	4.38	1.83	1.84		
Link44	240.8	Circular	8	12.78	34696	34698	313.57	282.80	318.74	289.22	313.96	283.17	313.96	283.17	2.38	2.38	1.00	1.00		
Link45	276.4	Circular	8	1.36	34692_JA_1300	37087	242.56	238.80	250.94	248.38	308.28	248.38	308.28	248.38	7.33	7.33	3.08	3.08	YES	YES
Link46	256.7	Circular	8	3.82	37087	33491_JA_0200	238.60	228.79	248.38	234.43	248.38	234.43	248.38	234.43	2.72	2.72	1.14	1.14	YES	YES
Link47	259.8	Circular	8	7.96	33491_JA_0200	37064	227.98	207.29	234.43	210.50	234.43	208.95	234.43	208.95	3.55	3.55	1.49	1.49		
Link48	262.9	Circular	12	13.33	34769	33469	220.25	185.20	226.95	188.90	220.87	188.90	220.87	188.90	7.94	7.94	3.34	3.34	YES	YES
Link49	225.3	Circular	16	8.60	33508	34313	179.51	160.14	191.51	162.29	180.16	161.08	180.16	161.08	9.48	9.48	3.98	3.98		
Link54	132.7	Circular	18	11.25	34704_WN_0300	37118	65.33	50.40	73.55	57.70	66.68	57.70	66.68	57.70	20.59	20.61	8.65	8.66	YES	YES
Link55	249.5	Circular	12	10.53	43050	Node58	150.49	124.22	155.49	126.51	151.10	124.78	151.10	124.78	6.48	6.48	2.72	2.72		
Link56	122.1	Circular	12	10.53	Node58	Node59	124.02	111.16	126.51	114.00	124.67	111.72	124.67	111.72	6.47	6.47	2.72	2.72		
Link57	257.4	Circular	12	10.44	Node59	33521	110.96	84.08	114.00	86.97	111.57	84.64	111.57	84.64	6.46	6.46	2.71	2.71		
Link58	291.0	Circular	15	2.29	34191_JA_0100	34192	116.25	109.60	128.90	120.42	128.90	120.42	128.90	120.42	9.89	9.89	4.16	4.16	YES	YES
Link59	121.6	Circular	12	6.76	34192	41014	109.22	101.00	120.42	109.91	120.42	109.50	120.42	109.50	9.20	9.25	3.87	3.88		
Link60	192.3	Circular	12	4.46	41014	33519	100.71	92.13	109.91	99.89	109.50	93.13	109.50	93.13	9.07	9.07	3.81	3.81		
Park Place Basin																				
801099	22.4	Circular	24	1.30	30675	30674	111.81	111.52	114.51	114.42	113.73	113.30	113.73	113.30	11.91	11.91	5.00	5.00		
801520	86.9	Circular	30	2.60	34163	34164	189.81	187.55	201.50	194.73	190.83	188.35	190.87	188.40	13.22	14.24	5.55	5.98		
801521	75.8	Circular	30	3.03	34164	34511	187.35	185.05	194.73	192.57	188.35	185.81	188.40	185.84	13.22	14.24	5.55	5.98		
801522	146.7	Circular	30	0.46	34166	34163	190.69	190.01	195.75	201.50	192.23	191.23	192.31	191.28	13.22	14.24	5.55	5.98		
804027	51.3	Circular	30	5.92	40789_PP_0800	40790	220.63	217.59	223.90	220.09	221.31	218.53	221.34	218.56	13.24	14.26	5.56	5.99		
806132	80.2	Circular	24	0.26	30676	36849	112.88	112.67	116.68	115.17	114.90	114.25	114.90	114.25	11.91	11.91	5.00	5.00		
806133	38.7	Circular	24	1.45	36849	30675	112.57	112.01	115.17	114.51	114.25	113.73	114.25	113.73	11.91	11.91	5.00	5.00		
806138	409.7	Circular	15	4.13	36853	30676	130.15	113.23	134.95	116.68	133.01	114.90	133.01	114.90	11.91	11.91	5.00	5.00		
806331	7.1	Circular	24	5.33	41420	37021	145.72	145.34	148.22	147.94	148.22	146.97	148.22	146.98	15.07	15.07	6.33	6.33		
808078	41.1	Circular	24	1.17	30674	38518	111.62	111.14	114.42	113.64	113.30	112.73	113.30	112.73	11.91	11.91	5.00	5.00		
808079	9.4	Circular	24	-1.39	38518	PP_0500	110.86	110.99	113.64	113.49	112.73	112.19	112.73	112.19	11.91	11.91	5.00	5.00		
809819	37.6	Circular	24	2.10	37021	41421_PP_0600	145.34	144.55	147.94	147.05	146.97	145.94	146.98	145.95	15.07	15.07	6.33	6.33		
809820	47.5	Circular	24	1.56	41350	36853	130.99	130.25	133.49	134.95	133.49	133.01	133.49	133.01	12.88	12.83	5.41	5.39		
812683	109.8	Circular	18	7.07	43287_PP_1000	43288_PP_0900	262.76	255.00	264.56	263.56	264.27	255.72	264.35	255.75	5.67	6.05	2.38	2.54		
Link17	32.9	Circular	24	16.70	33393	34166	197.00	191.50	199.50	195.75	197.57	192.23	197.59	192.31	13.22	14.25	5.55	5.98		
Link18	28.6	Circular	36	3.71	34511	PP_0700	182.06	181.00	192.57	192.00	183.09	181.93	183.14	181.95	13.22	14.24	5.55	5.98		
Link20	116.2	Circular	24	3.58	40854	40855	98.78	94.62	103.38	98.50	101.79	95.90	101.79	95.90	18.73	18.72	7.87	7.86		
Link21	114.7	Circular	30	7.12	41341	36790_PP_0300	89.66	81.50	93.79	90.65	92.01	82.18	92.01	82.18	18.72	18.71	7.86	7.86		

Table A-1. Hydraulic Model Parameters and Results for 2-yr and 1.2-yr Storms

					Node Name		Invert Elevation (ft)		Ground Elevation (ft)		Existing Max Water Surface Elevation (ft)		Future Max Water Surface Elevation (ft)		Max Flow (cfs)		1.2-yr Max Flow (cfs)		Flooding at DS Node	
Link ID	Length (ft)	Shape	Diameter/Height (in)	Slope (%)	US	DS	US	DS	US	DS	US	DS	US	DS	Existing	Future	Existing	Future	Existing	Future
Link22	69.7	Circular	36	18.65	36790_PP_0300	41342	81.50	68.50	90.65	80.85	82.18	69.03	82.18	69.03	18.72	18.71	7.86	7.86		
Link23	628.5	Trapezoidal	30	5.47	43288_PP_0900	40789_PP_0800	255.00	220.63	263.56	223.90	255.72	221.31	255.75	221.34	9.28	10.12	3.90	4.25		
Link24	389.1	Trapezoidal	30	5.29	40790	33393	217.59	197.00	220.09	199.50	218.53	197.57	218.56	197.59	13.22	14.25	5.55	5.98		
Link27	416.8	Trapezoidal	30	3.25	41421_PP_0600	41350	144.55	130.99	147.05	133.49	145.94	133.49	145.95	133.49	32.51	33.24	13.66	13.96	YES	YES
Link28	567.6	Trapezoidal	30	2.15	PP_0500	40854	110.99	98.78	113.49	103.38	112.19	101.79	112.19	101.79	18.84	18.83	7.91	7.91		
Link29	270.3	Trapezoidal	30	1.84	40855	41341	94.62	89.66	98.50	93.79	95.90	92.01	95.90	92.01	18.83	19.05	7.91	8.00		
Link31	718.8	Trapezoidal	30	5.60	PP_0700	41420	181.00	145.72	192.00	148.22	181.93	148.22	181.95	148.22	15.99	17.02	6.72	7.15	YES	YES
Singer Creek Basin																				
800363	257.5	Circular	36	3.20	39390_SI_0500	33815	206.45	198.22	218.52	205.18	207.67	199.07	207.69	199.09	21.66	22.29	9.10	9.36		
803639	45.1	Rectangular	30	0.55	34189	35537	167.56	167.31	174.46	174.00	170.68	169.63	170.81	169.73	33.35	34.08	14.01	14.31		
803641	165.3	Rectangular	30	2.81	35540	34189	172.21	167.56	177.61	174.46	173.91	170.68	173.95	170.81	33.36	34.08	14.01	14.31		
803643	10.1	Rectangular	30	1.58	SI_0300	35540	172.37	172.21	177.80	177.61	175.03	173.91	175.08	173.95	33.37	34.09	14.02	14.32		
804123	131.4	Rectangular	30	1.65	35900	SI_0300	174.74	172.37	180.04	177.80	176.23	175.03	176.27	175.08	21.65	22.28	9.09	9.36		
804124	57.9	Rectangular	30	2.02	35902	35900	175.91	174.74	180.96	180.04	177.45	176.23	177.49	176.27	21.65	22.29	9.09	9.36		
804125	114.9	Rectangular	30	2.34	35903	35902	178.60	175.91	185.01	180.96	179.85	177.45	179.88	177.49	21.66	22.29	9.10	9.36		
804126	124.7	Rectangular	30	2.57	34190	35903	181.81	178.60	189.08	185.01	182.98	179.85	183.01	179.88	21.66	22.29	9.10	9.36		
804191	308.3	Rectangular	30	4.28	33815	35985	198.22	185.02	205.18	191.23	199.07	186.08	199.09	186.11	21.66	22.29	9.10	9.36		
804192	84.1	Rectangular	30	3.82	35985	34190	185.02	181.81	191.23	189.08	186.08	182.98	186.11	183.01	21.66	22.29	9.10	9.36		
804812	212.8	Rectangular	30	2.11	34187	35594	165.13	160.43	171.23	165.19	166.81	162.00	166.84	162.02	33.31	34.05	13.99	14.30		
806469	153.9	Rectangular	30	3.91	37138	36507_SI_0400	158.98	152.96	164.15	159.74	159.88	154.52	159.89	154.54	33.31	34.04	13.99	14.30		
806470	94.8	Rectangular	30	1.32	35594	37138	160.43	158.98	165.19	164.15	162.00	159.88	162.02	159.89	33.31	34.05	13.99	14.30		
Link14	94.4	Circular	36	2.90	40796_SI_0600	40797	218.02	215.28	221.02	220.00	218.87	216.10	218.89	216.12	14.07	14.62	5.91	6.14		
Link15	156.0	Trapezoidal	36	0.55	40797	Inlet	215.28	214.42	220.00	225.00	216.10	215.76	216.12	215.80	14.05	14.60	5.90	6.13		
Link15.1	94.0	Circular	36	0.50	Inlet	40897	214.42	213.95	225.00	229.48	215.76	215.61	215.80	215.65	13.99	14.53	5.87	6.10		
Link16	240.5	Circular	36	2.89	36023	39390_SI_0500	213.41	206.45	229.61	218.52	214.27	207.67	214.29	207.69	13.98	14.52	5.87	6.10		
Link17	19.1	Circular	36	2.81	40897	36023	213.95	213.41	229.48	229.61	215.61	214.27	215.65	214.29	13.98	14.53	5.87	6.10		
Link18	192.9	Rectangular	30	1.13	35537	34187	167.31	165.13	174.00	171.23	169.63	166.81	169.73	166.84	33.31	34.05	13.99	14.30		
Link19	115.4	Rectangular	30	4.30	36507_SI_0400	42737	152.96	148.00	159.74	151.00	154.52	149.11	154.54	149.12	46.83	47.53	19.67	19.96		
South End Basin																				
2	40.1	Circular	30	0.30	39657	39658	428.74	428.62	433.30	433.56	431.31	431.11	431.32	431.11	28.25	28.93	11.86	12.15		
681.1	40.1	Circular	30	0.30	39657	39658	428.74	428.62	433.30	433.56	431.31	431.11	431.32	431.11	13.53	13.87	5.68	5.82		
800101	225.2	Trapezoidal	24	0.76	40224	38962	450.92	449.20	453.42	451.20	451.92	451.20	451.93	451.20	18.44	18.96	7.75	7.96	YES	YES
800102	53.6	Trapezoidal	24	2.42	38963	30628	448.92	448.12	450.92	450.12	450.10	450.12	450.10	450.12	9.30	9.32	3.91	3.91	YES	YES
800823	249.0	Circular	30	0.65	33801	33800	446.64	445.01	452.50	449.78	449.63	449.52	449.64	449.52	7.42	7.47	3.12	3.14		
800824	33.2	Circular	18	4.16	30628	33801	448.12	446.74	450.12	452.50	450.12	449.63	450.12	449.64	7.95	7.93	3.34	3.33		
801783	37.0	Circular	12	1.54	33800	42854	445.01	444.44	449.78	447.80	449.52	446.41	449.52	446.42	7.33	7.37	3.08	3.10		
802067	213.1	Circular	24	0.40	33531_SE_1300	33530	455.40	454.55	461.95	459.99	458.13	456.47	458.35	456.54	15.51	16.02	6.52	6.73		
802192	20.1	Circular	30	0.10	33899	40224	450.94	450.92	455.75	453.42	452.55	451.92	452.57	451.93	18.44	18.96	7.75	7.96		
802326	286.5	Circular	60	0.28	32462_SE_1200	34366	435.93	435.14	440.93	447.02	437.20	436.66	437.21	436.68	12.83	13.09	5.39	5.50		
802787	32.5	Circular	18	0.00	38962	38963	449.20	448.92	451.20	450.92	451.20	450.10	451.20	450.10	7.97	7.97	3.35	3.35		
803617	221.5	Circular	15	1.46	35517_SE_1400	33531_SE_1300	458.84	455.60	465.59	461.95	463.19	458.13	464.02	458.35	8.21	8.72	3.45	3.66		
807270	476.7	Circular	30	0.30	37785_SE_1000	33899	452.38	450.94	458.00	455.75	454.44	452.55	454.49	452.57	18.45	18.97	7.75	7.97		
807271	119.5	Circular	30	0.00	37787	37785_SE_1000	452.74	452.38	459.02	458.00	454.90	454.44	454.96	454.49	15.28	15.79	6.42	6.63		
808402	204.7	Trapezoidal	24	0.29	38973_SE_0800	39657	429.34	428.74	433.34	433.30	431.40	431.31	431.42	431.32	41.77	42.79	17.54	17.97		
808415	100.2	Trapezoidal	24	0.51	39658	42487	428.62	428.11	433.56	431.11	431.11	431.11	431.11	431.11	41.78	42.80	17.55	17.98	YES	YES
808417	58.9	Circular	36	4.16	42487	39582	428.11	425.66	431.11	428.66	431.11	426.68	431.11	426.68	31.29	31.29	13.14	13.14		
809300	116.5	Circular	15	1.52	33535_SE_1600	35517_SE_1400	460.81	459.04	468.36	465.59	464.01	463.19	465.04	464.02	4.19	4.68	1.76	1.97		

Table A-1. Hydraulic Model Parameters and Results for 2-yr and 1.2-yr Storms

					Node Name		Invert Elevation (ft)		Ground Elevation (ft)		Existing Max Water Surface Elevation (ft)		Future Max Water Surface Elevation (ft)		Max Flow (cfs)		1.2-yr Max Flow (cfs)		Flooding at DS Node	
Link ID	Length (ft)	Shape	Diameter/Height (in)	Slope (%)	US	DS	US	DS	US	DS	US	DS	US	DS	Existing	Future	Existing	Future	Existing	Future
809303	93.7	Circular	12	1.10	32769_SE_1500	33531_SE_1300	456.63	455.60	461.31	461.95	458.74	458.13	458.96	458.35	2.25	2.25	0.94	0.94		
809312	433.6	Circular	30	0.30	33530	37788	454.55	453.25	459.99	459.22	456.47	455.42	456.54	455.49	15.39	15.90	6.46	6.68		
809724	17.8	Circular	60	1.12	34366	34365_SE_1100	434.94	434.74	447.02	446.54	436.66	436.56	436.68	436.58	12.82	13.08	5.39	5.49		
Link20	166.2	Circular	30	0.31	37788	37787	453.25	452.74	459.22	459.02	455.42	454.90	455.49	454.96	15.29	15.80	6.42	6.64		
Link21	369.9	Circular	12	0.00	32798_SE_1000	34786	451.89	449.90	456.04	452.42	452.31	450.20	452.32	450.20	0.74	0.75	0.31	0.31		
Link23	84.9	Circular	12	1.68	34786	Node65	449.90	448.47	452.42	450.47	450.20	448.75	450.20	448.76	0.74	0.74	0.31	0.31		
Link24	92.2	Trapezoidal	24	1.68	Node65	Node66	448.47	446.92	450.47	448.92	448.63	447.41	448.63	447.41	0.74	0.74	0.31	0.31		
Link25	22.2	Circular	12	1.68	Node66	Node67	446.92	446.55	448.92	448.55	447.41	446.71	447.41	446.71	0.74	0.74	0.31	0.31		
Link26	85.9	Trapezoidal	24	1.68	Node67	Node68	446.55	445.11	448.55	447.11	446.71	446.45	446.71	446.46	0.74	0.74	0.31	0.31		
Link31	156.4	Circular	12	6.03	42854	34365_SE_1100	444.37	434.94	447.80	446.54	446.41	436.56	446.42	436.58	7.55	7.54	3.17	3.17		
Link33	52.5	Circular	12	1.02	Node68	42854	445.11	444.57	447.11	447.80	446.45	446.41	446.46	446.42	0.73	0.74	0.31	0.31		
Link36	322.9	Circular	48	1.10	34761_SE_0900	38973_SE_0800	432.88	429.34	438.14	433.34	434.45	431.40	434.47	431.42	34.73	35.75	14.59	15.01		
Link37	207.7	Circular	54	0.24	34365_SE_1100	Node70	434.74	434.24	446.54	441.95	436.56	435.63	436.58	435.64	23.71	24.07	9.96	10.11		
Link38	172.0	Circular	54	0.56	Node70	34761_SE_0900	434.04	433.08	441.95	438.14	435.61	434.45	435.62	434.47	23.71	24.07	9.96	10.11		
Newell Creek Basin at Molalla Avenue and Beaver Creek Road																				
800688	160.5	Circular	48	3.51	34994	39666	417.02	411.38	430.02	415.38	418.52	412.54	418.54	412.55	46.09	46.93	19.36	19.71		
800690	39.8	Circular	12	1.66	34611	30023	423.69	423.03	429.34	430.16	428.37	425.52	428.39	425.55	6.39	6.36	2.68	2.67		
800854	442.7	Circular	42	0.82	39740_NE_1900	34616	433.01	429.39	436.51	436.91	433.32	429.69	433.33	429.70	1.31	1.36	0.55	0.57		
801962	148.0	Circular	15	3.87	34604	34603	438.50	432.77	441.90	437.52	439.01	433.44	439.01	433.44	3.73	3.73	1.57	1.57		
801965	205.9	Circular	15	0.43	34605_NE_3100	34604	439.49	438.60	444.01	441.90	440.61	439.38	440.61	439.38	3.73	3.73	1.57	1.57		
801981	230.0	Circular	18	1.54	30056_NE_3100	37259	435.30	431.75	439.36	433.77	435.91	432.18	435.91	432.19	3.27	3.28	1.38	1.38		
803140	168.1	Circular	42	0.78	30021	30023	424.29	422.98	431.51	430.16	426.41	425.52	426.45	425.55	32.31	33.17	13.57	13.93		
803172	61.7	Circular	12	0.66	30030_NE_2200	30027	426.11	425.70	434.39	433.37	434.39	432.53	434.39	432.54	4.89	4.94	2.05	2.08		
803176	159.5	Circular	12	0.92	30027	30025	425.53	424.07	433.37	430.71	432.53	429.08	432.54	429.09	4.83	4.85	2.03	2.04		
803179	78.3	Circular	12	0.57	30025	30024	423.92	423.47	430.71	430.26	429.08	426.83	429.09	426.86	4.79	4.81	2.01	2.02		
803180	27.5	Circular	12	0.87	30024	30023	423.45	423.21	430.26	430.16	426.83	425.52	426.86	425.55	4.78	4.79	2.01	2.01		
806619	6.3	Circular	48	0.00	37234	37235	426.45	426.45	433.20	433.20	428.37	428.37	428.40	428.40	-16.60	-17.35	-6.97	-7.29		
806620	267.8	Circular	42	0.68	37234	30021	426.45	424.63	433.20	431.51	428.37	426.41	428.40	426.45	32.34	33.20	13.58	13.94		
807452	59.3	Circular	12	-4.99	37903	37901	423.40	426.36	427.94	430.44	427.94	426.90	427.94	426.90	2.84	2.84	1.19	1.19		
807453	135.4	Circular	12	2.29	37238_NE_2200	37903	428.50	425.40	430.54	427.94	430.54	427.94	430.54	427.94	4.04	4.04	1.70	1.70	YES	YES
808393	446.8	Circular	42	0.81	39739_NE_1900	34615	432.99	429.39	436.49	436.91	434.25	430.53	434.28	430.55	19.15	19.92	8.04	8.36		
Link18	394.5	Circular	48	0.49	34615	41521	428.89	426.95	436.91	432.42	430.25	428.50	430.28	428.53	19.14	19.91	8.04	8.36		
Link19	82.1	Circular	48	0.49	41521	37235	426.95	426.55	432.42	433.20	428.50	428.37	428.53	428.40	22.84	23.59	9.59	9.91		
Link20	410.9	Circular	48	0.67	37235	34611	426.45	423.69	433.20	429.34	428.37	428.37	428.40	428.39	8.68	8.49	3.65	3.56		
Link21	9.3	Circular	42	3.23	30023	Node35	423.03	422.73	430.16	429.89	425.52	424.16	425.55	424.17	43.25	44.09	18.16	18.52		
Link22	168.9	Circular	48	3.38	Node35	34994	422.73	417.02	429.89	430.02	424.16	418.52	424.17	418.54	46.09	46.93	19.36	19.71		
Link23	98.6	Circular	12	3.68	37901	Node35	426.36	422.73	430.44	429.89	426.90	424.16	426.90	424.17	2.84	2.85	1.19	1.19		
Link24	309.6	Circular	15	1.44	34603	42867	432.77	428.30	437.52	432.33	433.44	429.00	433.44	429.01	3.73	3.73	1.57	1.57		
Link25	45.0	Circular	15	2.77	42867	41521	428.20	426.95	432.33	432.42	429.00	428.50	429.01	428.53	3.73	3.73	1.56	1.56		
Link26	158.4	Circular	48	0.80	34616	35735_NE_1600	428.89	427.62	436.91	434.20	429.18	429.05	429.19	429.07	1.31	1.36	0.55	0.57		
Link27	203.9	Circular	48	0.34	35735_NE_1600	41522	427.62	426.93	434.20	432.04	429.05	428.67	429.07	428.69	12.96	13.05	5.44	5.48		
Link28	114.2	Circular	48	0.34	41522	37234	426.93	426.55	432.04	433.20	428.67	428.37	428.69	428.40	16.12	16.22	6.77	6.81		
Link29	85.4	Circular	15	5.64	37259	41522	431.75	426.93	433.77	432.04	432.18	428.67	432.19	428.69	3.27	3.27	1.37	1.37		

Table A-2. Hydraulic Model Parameters and Results for 10-yr Storm

					Node Name		Invert Elevation (ft)		Ground Elevation (ft)		Existing Max Water		Future Max Water Surface		Max Flow (cfs)		Flooding at DS Node	
Link ID	Length (ft)	Shape	Diameter/Height (in)	Slope (%)	US	DS	US	DS	US	DS	US	DS	US	DS	Existing	Future	Existing	Future
Central Point Basin																		
808424	57.6	Circular	36	3.44	42490_CP_0500	38777	441.58	439.60	444.58	448.68	443.63	440.48	443.64	440.48	18.81	18.96		
803448	135.1	Circular	12	1.58	33962	35483	461.35	459.21	467.71	467.48	465.52	460.16	466.23	460.20	5.89	6.26		
803449	349.8	Circular	12	4.26	35483	35481	459.01	444.12	467.48	450.42	459.79	444.84	459.84	444.87	5.89	6.25		
803703	202.6	Circular	30	0.59	35630	35478	429.72	428.53	439.21	432.23	431.43	429.93	431.51	429.99	17.63	18.74		
807429	182.8	Circular	12	0.77	37879_CP_0800	33962	463.41	462.00	468.84	467.71	472.13	465.52	473.58	466.23	5.90	6.27		
808422	128.1	Circular	36	0.71	33002	39749	443.14	442.23	447.90	445.23	444.17	443.64	444.18	443.65	9.33	9.40		
808427	28.5	Circular	36	0.04	39588	34501	432.78	432.77	438.46	438.50	434.54	434.27	434.54	434.27	17.05	17.05		
808428	118.5	Circular	36	1.05	34502	39588	434.03	432.78	440.22	438.46	435.42	434.54	435.42	434.54	17.05	17.05		
808653	18.7	Circular	30	2.20	38733_CP_0800	35630	430.33	429.92	440.18	439.21	432.12	431.43	432.21	431.51	17.64	18.75		
808654	259.3	Circular	12	4.75	35481	38733_CP_0800	443.92	431.60	450.42	440.18	444.68	432.29	444.73	432.32	5.88	6.25		
809337	155.2	Circular	36	0.95	34503	34502	435.50	434.03	441.35	440.22	436.83	435.42	436.83	435.42	17.06	17.06		
809791	34.0	Circular	15	0.00	34248_CP_0100	35487	430.72	430.73	438.92	438.59	435.06	434.26	434.72	433.91	5.74	5.78		
809793	91.2	Circular	15	0.27	35487	35484	430.53	430.28	438.59	437.00	434.26	432.95	433.91	432.58	5.73	5.77		
812537	128.1	Trapezoidal	30	0.71	39749	42490_CP_0500	442.23	441.58	445.23	444.58	443.64	443.63	443.65	443.64	9.26	9.33		
Link18	292.2	Circular	36	0.41	33700_CP_0600	33002	444.35	443.14	450.79	447.90	445.45	444.17	445.46	444.18	9.37	9.44		
Link19	447.2	Trapezoidal	30	0.49	38888	30909_CP_0400	438.79	436.61	441.29	439.11	440.31	439.11	440.31	439.11	18.78	18.93	YES	YES
Link20	33.0	Circular	27	0.62	30909_CP_0400	34503	436.61	436.40	439.11	441.35	439.11	437.84	439.11	437.84	17.05	17.05		
Link21	10.0	Circular	36	13.10	38777	38888	439.60	438.29	448.68	441.29	440.48	440.31	440.48	440.31	18.81	18.96		
Link25	341.0	Circular	15	0.55	35484	35478	430.08	428.20	437.00	432.23	432.95	429.41	432.58	429.45	5.73	5.77		
Link26	215.0	Circular	30	2.57	35478	40654	428.20	422.68	432.23	425.18	429.41	423.75	429.45	423.78	23.36	24.51		
Link27	38.5	Circular	36	1.30	34501	33145	432.77	432.27	438.50	435.27	434.27	433.27	434.27	433.27	17.05	17.05		
Coffee Creek Basin																		
618.1	116.9	Circular	24	0.58	42534_CO_0500	42533	440.66	439.98	445.16	444.48	443.73	441.82	443.73	441.82	14.98	14.98		
802016	56.9	Circular	24	1.63	40182_CO_0800	34657	453.03	452.10	456.03	456.54	455.29	453.40	455.33	453.44	13.07	13.34		
808374	56.9	Circular	24	1.63	40182_CO_0800	34657	453.03	452.10	456.03	456.54	455.29	453.40	455.33	453.44	13.07	13.34		
808377	62.4	Circular	48	1.07	42472_CO_0600	42473	448.69	448.02	453.69	454.24	451.93	450.47	451.99	450.47	47.67	48.90		
808379	68.6	Circular	30	2.90	42475_CO_0400	42474	413.69	411.70	417.69	416.03	416.91	412.82	416.91	412.82	26.94	27.00		
808379	68.6	Circular	30	2.90	42475_CO_0400	42474	413.69	411.70	417.69	416.03	416.91	412.82	416.91	412.82	26.94	27.00		
808867	76.2	Circular	36	0.91	CO_0300	42552	429.21	428.52	433.21	432.52	433.21	430.25	433.21	430.25	45.08	45.08		
Backyard	116.9	Trapezoidal	24	0.00	42534_CO_0500	42533	443.16	442.48	445.16	444.48	443.73	443.05	443.73	443.05	39.71	39.79		
Link10	686.1	Trapezoidal	48	2.16	42552	42475_CO_0400	428.52	413.69	432.52	417.69	430.25	416.91	430.25	416.91	45.08	45.08		
Link11	6.0	Rectangular	30	1.73	Node16	Node17	446.46	446.35	450.46	450.36	450.46	447.43	450.46	447.43	42.67	42.67		
Link12	329.2	Trapezoidal	48	1.73	Node17	42534_CO_0500	446.35	440.66	450.36	445.16	447.43	443.73	447.43	443.73	42.67	42.67		
Link13	180.0	Trapezoidal	24	0.58	42533	Node19	439.98	438.82	444.48	441.82	441.82	441.48	441.82	441.48	55.26	55.33		
Link14	50.0	Trapezoidal	36	0.58	Node19	Node20	438.82	438.53	441.82	442.53	441.48	439.96	441.48	439.96	55.25	55.32		
Link15	100.5	Trapezoidal	48	9.27	Node20	CO_0300	438.53	429.21	442.53	433.21	439.96	433.21	439.96	433.21	55.25	55.32	YES	YES
Link6	174.1	Circular	36	0.67	34657	40188_CO_0700	451.30	450.14	456.54	457.06	453.40	452.48	453.44	452.53	26.14	26.68		
Link7	587.5	Trapezoidal	60	0.25	40188_CO_0700	42472_CO_0600	450.14	448.69	457.06	453.69	452.48	451.93	452.53	451.99	38.26	39.09		
Link8	90.3	Trapezoidal	48	1.73	42473	Node16	448.02	446.46	454.24	450.46	450.47	450.46	450.47	450.46	47.67	48.91	YES	YES
Livesay Basin																		
Link1	169.75	Circular	1.00	1.00	33740_LI_1200	33742	504.45	502.75	512.76	510.16	512.35	508.95	505.98	505.97	5.88	0.00		
Link13	41.73	Circular	1.50	4.31	34160	42491	429.05	427.25	435.25	432.40	426.66	424.13	431.02	428.29	5.87	13.84		
Link14	185.23	Circular	1.00	8.09	32573_LI_1100	34374_LI_1000	438.68	423.7	441.61	430.48	434.77	423.93	438.96	423.97	17.20	1.45		
Link15	399.60	Circular	1.00	3.02	34374_LI_1000	35610	423.47	411.42	430.48	418.42	423.65	411.85	423.88	411.90	12.59	1.99		
Link16	124.78	Circular	1.00	1.67	35610	35612	411.36	409.27	418.42	412.91	411.85	409.71	411.90	409.75	10.36	1.98		
Link17	252.76	Circular	1.00	5.17	35612	35607	409.06	395.99	412.91	400.77	409.38	400.77	409.42	400.77	10.36	1.98	YES	YES
Link18	73.60	Circular	1.00	0.56	35607	35686	395.79	395.38	400.77	397.38	400.77	395.67	400.77	395.61	10.36	4.20		

Table A-2. Hydraulic Model Parameters and Results for 10-yr Storm

					Node Name		Invert Elevation (ft)		Ground Elevation (ft)		Existing Max Water		Future Max Water Surface		Max Flow (cfs)		Flooding at DS Node	
Link ID	Length (ft)	Shape	Diameter/Height (in)	Slope (%)	US	DS	US	DS	US	DS	US	DS	US	DS	Existing	Future	Existing	Future
Link19	96.21	Trapezoidal	2.00	14.41	35686	39436	395.38	381.52	397.38	383.52	395.67	383.52	395.61	383.52	1.18	4.20	YES	YES
Link2	106.92	Circular	1.00	1.91	33742	34162_LI_1100	502.55	500.51	510.16	505.96	508.95	506.72	505.97	505.96	10.39	0.00	YES	YES
Link20	61.79	Circular	1.00	8.24	39436	34997	381.52	376.43	383.52	379.80	383.52	376.89	383.52	376.89	1.71	4.09		
Link21	218.18	Circular	1.00	5.92	34997	30828_LI_0600	376.23	363.31	379.80	366.90	376.78	363.82	376.78	363.82	1.71	4.09		
Link22	19.19	Circular	1.00	32.88	30828_LI_0600	39842	362.77	356.46	366.90	368.26	363.11	356.80	363.31	356.80	12.90	4.75		
Link23	198.91	Circular	2.00	0.88	42491	39313_LI_1000	426.75	425	432.40	427.01	424.13	417.75	428.29	426.24	1.71	13.83		
Link24	542.80	Trapezoidal	2.00	4.63	39313_LI_1000	Node25	425	399.89	427.01	401.89	417.75	401.89	425.95	401.89	11.28	16.48	YES	YES
Link25	125.02	Circular	2.00	3.12	Node25	35607	399.89	395.991	401.89	400.77	401.89	400.77	401.89	400.77	6.48	11.28	YES	YES
Link29	455.63	Circular	1.25	0.39	Node31	Node31.1	508.23	506.44	519.47	512.76	NA[1]	NA[1]	513.93	512.76	NA[1]	2.93		YES
Link29.1	296.12	Circular	1.25	1.70	Node31.1	Node34	506.24	501.21	512.76	506.82	NA[1]	NA[1]	512.76	506.82	NA[1]	9.46		YES
Link3	525.87	Circular	1.25	7.72	34162_LI_1100	34161	500.41	459.83	505.96	465.63	506.72	465.66	505.96	465.63	6.48	16.15	YES	YES
Link30	23.69	Circular	1.25	1.69	Node34	34162_LI_1100	501.01	500.61	506.82	505.96	NA[1]	NA[1]	506.82	505.96	NA[1]	9.04		YES
Link4	241.20	Circular	1.25	4.46	34161	33066	459.84	449.09	465.63	453.44	465.66	453.43	465.63	450.34	4.09	13.83		
Link5	206.81	Circular	1.25	6.95	33066	33065	449.09	434.71	453.44	438.65	453.43	435.98	450.21	436.49	4.09	13.83		
Link6	52.10	Circular	1.25	12.00	33065	34160	435.15	428.9	438.65	435.25	435.80	426.66	436.49	431.02	4.70	13.83		
John Adams Basin																		
800781	159.3	Circular	16	4.81	34313	33514	160.19	152.53	162.29	171.45	161.08	153.28	161.08	153.28	9.48	9.48		
801568	335.0	Circular	8	4.06	33504	33474	257.58	243.99	261.10	254.51	261.10	254.51	261.10	254.51	1.91	1.91	YES	YES
801573	15.0	Circular	12	28.92	33473	34769	220.25	215.90	226.39	226.95	223.03	220.87	223.03	220.87	6.58	6.58		
802603	417.6	Circular	12	6.93	33505_JA_1400	38651	309.65	280.69	316.50	286.90	310.28	281.32	310.28	281.32	6.29	6.31		
802604	268.7	Circular	8	2.85	33566_JA_1600	34696	321.64	313.99	330.45	318.74	330.45	314.66	330.45	314.66	2.78	2.78		
802606	301.1	Circular	8	8.09	34698	33504	282.51	258.15	289.22	261.10	283.03	261.10	283.03	261.10	2.78	2.78	YES	YES
804813	157.0	Circular	18	6.34	33520	43469	82.29	72.34	96.27	88.74	83.21	75.93	83.21	75.93	12.63	12.63		
804814	78.8	Circular	18	7.00	33519	33520	92.03	86.51	99.89	96.27	93.02	87.25	93.02	87.25	12.61	12.61		
804815	124.1	Circular	18	2.66	33521	34704_WN_0300	68.67	65.37	86.97	73.55	74.13	66.92	74.13	66.92	19.05	19.05		
804841	513.2	Circular	12	2.94	33475_JA_1000	33473	235.76	220.69	243.58	226.39	243.58	223.03	243.58	223.03	6.58	6.58		
804846	64.5	Circular	12	1.18	33469	33508	185.00	184.24	188.90	191.51	188.90	185.23	188.90	185.23	6.27	6.27		
804848	150.6	Circular	24	5.05	33514	33515	152.33	144.73	171.45	153.00	153.03	145.34	153.03	145.34	9.48	9.48		
804851	256.1	Circular	18	8.38	33515	34191_JA_0100	144.53	123.08	153.00	128.90	145.16	128.90	145.16	128.90	9.48	9.48	YES	YES
804860	101.6	Circular	18	3.60	33517_WN_0400	33516	178.61	174.95	185.10	179.60	181.46	179.60	181.46	179.60	10.21	10.21	YES	YES
804861	211.6	Circular	18	6.54	33523	33517_WN_0400	192.64	178.81	201.40	185.10	193.03	181.46	193.03	181.46	3.78	3.78		
804867	274.3	Circular	18	2.49	34311_WN_0500	33523	199.70	192.86	207.50	201.40	200.24	193.37	200.24	193.37	3.78	3.78		
804870	183.5	Circular	8	6.02	34767_JA_1100	34309	203.85	192.80	209.10	198.92	209.10	193.47	209.10	193.47	3.22	3.22		
804934	296.9	Circular	8	9.23	38650_JA_1500	33475_JA_1000	263.28	235.87	269.84	243.58	266.19	243.58	266.45	243.58	3.10	3.12	YES	YES
804969	247.9	Circular	8	8.24	33513_JA_0300	33519	113.61	93.18	119.72	99.89	118.80	93.85	118.80	93.85	3.55	3.55		
806396	444.2	Circular	8	8.37	37054	33513_JA_0300	151.18	114.01	162.35	119.72	159.31	118.80	159.31	118.80	3.55	3.55		
806401	131.5	Circular	8	16.53	37059	37054	173.12	151.38	178.38	162.35	173.72	159.31	173.72	159.31	3.55	3.55		
806402	255.5	Circular	10	12.82	37062	37059	206.06	173.32	208.79	178.38	206.49	173.73	206.49	173.73	3.55	3.55		
806406	30.6	Circular	10	2.72	37064	37062	207.09	206.26	210.50	208.79	208.95	207.02	208.95	207.02	3.55	3.55		
806411	253.8	Circular	8	1.92	37070_JA_0500	34769	223.30	218.42	224.81	226.95	224.81	220.87	224.81	220.87	1.40	1.40		
806471	131.0	Circular	18	3.17	37118	37139_WN_0100	50.10	45.95	57.70	53.08	57.70	53.08	57.70	53.08	15.12	15.12	YES	YES
806474	123.1	Circular	18	0.56	37139_WN_0100	37142	45.72	45.03	53.08	53.08	53.08	50.09	53.08	50.09	12.38	12.37		
808623	41.5	Circular	18	0.63	37142	41009	44.93	44.67	53.08	52.70	50.09	48.32	50.09	48.32	12.37	12.37		
808624	19.1	Circular	18	-0.52	43300	43301	43.51	43.61	61.81	61.81	46.43	44.94	46.43	44.94	12.37	12.37		
808704	305.9	Circular	12	2.42	33474	33475_JA_1000	243.75	236.34	254.51	243.58	254.51	243.58	254.51	243.58	6.19	6.19	YES	YES
808721	103.2	Circular	12	6.62	34309	33508	190.32	183.49	198.92	191.51	190.80	183.92	190.80	183.92	3.22	3.22		
812475	29.8	Circular	12	4.05	36378	34534	163.75	162.54	168.58	167.42	168.58	166.00	168.58	166.00	6.71	6.71		
812477	198.1	Circular	12	4.42	33516	36378	172.70	163.95	179.60	168.58	179.60	168.58	179.60	168.58	7.33	7.33	YES	YES

1. Existing model based on infrastructure in place in 2017. Future conditions model includes recently installed infrastructure.

Table A-2. Hydraulic Model Parameters and Results for 10-yr Storm

					Node Name		Invert Elevation (ft)		Ground Elevation (ft)		Existing Max Water		Future Max Water Surface		Max Flow (cfs)		Flooding at DS Node	
Link ID	Length (ft)	Shape	Diameter/Height (in)	Slope (%)	US	DS	US	DS	US	DS	US	DS	US	DS	Existing	Future	Existing	Future
812478	100.6	Circular	12	3.01	34534	43051	162.24	159.21	167.42	163.93	166.00	160.78	166.00	160.78	6.66	6.66		
812479	194.4	Circular	12	4.18	43051	43050	159.11	150.99	163.93	155.49	160.78	151.78	160.78	151.78	6.49	6.49		
812692	119.5	Circular	18	0.80	41009	43300	44.57	43.61	52.70	61.81	48.32	46.43	48.32	46.43	12.37	12.37		
812695	158.3	Circular	54	18.38	43301	39733	43.51	14.40	61.81	19.40	43.94	14.79	43.94	14.79	12.37	12.37		
812816	39.8	Circular	18	8.12	43469	33521	72.10	68.87	88.74	86.97	75.93	74.13	75.93	74.13	12.70	12.70		
Link43	393.4	Circular	12	9.22	38651	33474	280.27	243.99	286.90	254.51	280.91	254.51	280.91	254.51	6.29	6.31	YES	YES
Link44	240.8	Circular	8	12.78	34696	34698	313.57	282.80	318.74	289.22	314.00	283.21	314.00	283.21	2.78	2.78		
Link45	276.4	Circular	8	1.36	34692_JA_1300	37087	242.56	238.80	250.94	248.38	343.79	248.38	343.79	248.38	10.74	10.74	YES	YES
Link46	256.7	Circular	8	3.82	37087	33491_JA_0200	238.60	228.79	248.38	234.43	248.38	234.43	248.38	234.43	2.72	2.72	YES	YES
Link47	259.8	Circular	8	7.96	33491_JA_0200	37064	227.98	207.29	234.43	210.50	234.43	208.95	234.43	208.95	3.55	3.55		
Link48	262.9	Circular	12	13.33	34769	33469	220.25	185.20	226.95	188.90	220.87	188.90	220.87	188.90	7.94	7.94	YES	YES
Link49	225.3	Circular	16	8.60	33508	34313	179.51	160.14	191.51	162.29	180.16	161.08	180.16	161.08	9.48	9.48		
Link54	132.7	Circular	18	11.25	34704_WN_0300	37118	65.33	50.40	73.55	57.70	66.92	57.70	66.92	57.70	21.29	21.32	YES	YES
Link55	249.5	Circular	12	10.53	43050	Node58	150.49	124.22	155.49	126.51	151.10	124.78	151.10	124.78	6.47	6.47		
Link56	122.1	Circular	12	10.53	Node58	Node59	124.02	111.16	126.51	114.00	124.67	111.72	124.67	111.72	6.47	6.47		
Link57	257.4	Circular	12	10.44	Node59	33521	110.96	84.08	114.00	86.97	111.57	84.64	111.57	84.64	6.43	6.44		
Link58	291.0	Circular	15	2.29	34191_JA_0100	34192	116.25	109.60	128.90	120.42	128.90	120.42	128.90	120.42	9.89	9.89	YES	YES
Link59	121.6	Circular	12	6.76	34192	41014	109.22	101.00	120.42	109.91	120.42	109.50	120.42	109.50	9.11	9.11		
Link60	192.3	Circular	12	4.46	41014	33519	100.71	92.13	109.91	99.89	109.50	93.13	109.50	93.13	9.07	9.07		
Park Place Basin																		
801099	22.4	Circular	24	1.30	30675	30674	111.81	111.52	114.51	114.42	113.76	113.34	113.76	113.34	11.91	11.91		
801520	86.9	Circular	30	2.60	34163	34164	189.81	187.55	201.50	194.73	190.96	188.49	190.96	188.49	16.26	16.26		
801521	75.8	Circular	30	3.03	34164	34511	187.35	185.05	194.73	192.57	188.49	185.89	188.49	185.89	16.26	16.26		
801522	146.7	Circular	30	0.46	34166	34163	190.69	190.01	195.75	201.50	192.45	191.37	192.45	191.37	16.26	16.26		
804027	51.3	Circular	30	5.92	40789_PP_0800	40790	220.63	217.59	223.90	220.09	222.96	218.57	223.03	218.58	18.36	19.08		
806132	80.2	Circular	24	0.26	30676	36849	112.88	112.67	116.68	115.17	114.91	114.27	114.91	114.27	11.91	11.91		
806133	38.7	Circular	24	1.45	36849	30675	112.57	112.01	115.17	114.51	114.27	113.76	114.27	113.76	11.91	11.91		
806138	409.7	Circular	15	4.13	36853	30676	130.15	113.23	134.95	116.68	133.01	114.91	133.01	114.91	11.91	11.91		
806331	7.1	Circular	24	5.33	41420	37021	145.72	145.34	148.22	147.94	148.22	147.01	148.22	147.02	15.07	15.07		
808078	41.1	Circular	24	1.17	30674	38518	111.62	111.14	114.42	113.64	113.34	112.80	113.34	112.80	11.91	11.91		
808079	9.4	Circular	24	-1.39	38518	PP_0500	110.86	110.99	113.64	113.49	112.80	112.32	112.80	112.32	11.91	11.91		
809819	37.6	Circular	24	2.10	37021	41421_PP_0600	145.34	144.55	147.94	147.05	147.01	146.09	147.02	146.10	15.07	15.07		
809820	47.5	Circular	24	1.56	41350	36853	130.99	130.25	133.49	134.95	133.49	133.01	133.49	133.01	12.25	12.22		
812683	109.8	Circular	18	7.07	43287_PP_1000	43288_PP_0900	262.76	255.00	264.56	263.56	264.56	255.81	264.56	255.83	7.05	7.05		
Link17	32.9	Circular	24	16.70	33393	34166	197.00	191.50	199.50	195.75	199.50	192.45	199.50	192.45	16.26	16.26		
Link18	28.6	Circular	36	3.71	34511	PP_0700	182.06	181.00	192.57	192.00	183.24	182.04	183.24	182.04	16.26	16.26		
Link20	116.2	Circular	24	3.58	40854	40855	98.78	94.62	103.38	98.50	102.85	95.98	102.85	95.98	23.23	23.22		
Link21	114.7	Circular	30	7.12	41341	36790_PP_0300	89.66	81.50	93.79	90.65	92.46	82.28	92.46	82.28	23.20	23.19		
Link22	69.7	Circular	36	18.65	36790_PP_0300	41342	81.50	68.50	90.65	80.85	82.28	69.10	82.28	69.10	23.20	23.19		
Link23	628.5	Trapezoidal	30	5.47	43288_PP_0900	40789_PP_0800	255.00	220.63	263.56	223.90	255.81	222.96	255.83	223.03	12.54	13.04		
Link24	389.1	Trapezoidal	30	5.29	40790	33393	217.59	197.00	220.09	199.50	218.57	199.50	218.58	199.50	18.35	19.06	YES	YES
Link27	416.8	Trapezoidal	30	3.25	41421_PP_0600	41350	144.55	130.99	147.05	133.49	146.09	133.49	146.10	133.49	41.48	42.25	YES	YES
Link28	567.6	Trapezoidal	30	2.15	PP_0500	40854	110.99	98.78	113.49	103.38	112.32	102.85	112.32	102.85	23.80	23.79		
Link29	270.3	Trapezoidal	30	1.84	40855	41341	94.62	89.66	98.50	93.79	95.98	92.46	95.98	92.46	23.23	23.22		
Link31	718.8	Trapezoidal	30	5.60	PP_0700	41420	181.00	145.72	192.00	148.22	182.04	148.22	182.04	148.22	20.59	20.59	YES	YES

Table A-2. Hydraulic Model Parameters and Results for 10-yr Storm

					Node Name		Invert Elevation (ft)		Ground Elevation (ft)		Existing Max Water		Future Max Water Surface		Max Flow (cfs)		Flooding at DS Node	
Link ID	Length (ft)	Shape	Diameter/Height (in)	Slope (%)	US	DS	US	DS	US	DS	US	DS	US	DS	Existing	Future	Existing	Future
Singer Creek Basin																		
800363	257.5	Circular	36	3.20	39390_SI_0500	33815	206.45	198.22	218.52	205.18	207.93	199.34	207.95	199.36	31.19	31.88		
803639	45.1	Rectangular	30	0.55	34189	35537	167.56	167.31	174.46	174.00	173.05	171.26	173.05	171.26	44.47	44.47		
803641	165.3	Rectangular	30	2.81	35540	34189	172.21	167.56	177.61	174.46	176.49	173.05	176.49	173.05	44.47	44.47		
803643	10.1	Rectangular	30	1.58	SI_0300	35540	172.37	172.21	177.80	177.61	177.80	176.49	177.80	176.49	44.47	44.47		
804123	131.4	Rectangular	30	1.65	35900	SI_0300	174.74	172.37	180.04	177.80	179.26	177.80	179.33	177.80	31.18	31.87	YES	YES
804124	57.9	Rectangular	30	2.02	35902	35900	175.91	174.74	180.96	180.04	180.23	179.26	180.34	179.33	31.18	31.87		
804125	114.9	Rectangular	30	2.34	35903	35902	178.60	175.91	185.01	180.96	181.59	180.23	181.76	180.34	31.18	31.87		
804126	124.7	Rectangular	30	2.57	34190	35903	181.81	178.60	189.08	185.01	183.55	181.59	183.62	181.76	31.18	31.87		
804191	308.3	Rectangular	30	4.28	33815	35985	198.22	185.02	205.18	191.23	199.34	186.48	199.36	186.51	31.20	31.89		
804192	84.1	Rectangular	30	3.82	35985	34190	185.02	181.81	191.23	189.08	186.48	183.55	186.51	183.62	31.19	31.89		
804812	212.8	Rectangular	30	2.11	34187	35594	165.13	160.43	171.23	165.19	167.28	162.38	167.28	162.38	44.47	44.47		
806469	153.9	Rectangular	30	3.91	37138	36507_SI_0400	158.98	152.96	164.15	159.74	160.12	155.00	160.12	155.01	44.47	44.47		
806470	94.8	Rectangular	30	1.32	35594	37138	160.43	158.98	165.19	164.15	162.38	160.12	162.38	160.12	44.47	44.47		
Link14	94.4	Circular	36	2.90	40796_SI_0600	40797	218.02	215.28	221.02	220.00	219.04	216.38	219.06	216.41	20.46	21.08		
Link15	156.0	Trapezoidal	36	0.55	40797	Inlet	215.28	214.42	220.00	225.00	216.38	216.23	216.41	216.28	20.37	20.98		
Link15.1	94.0	Circular	36	0.50	Inlet	40897	214.42	213.95	225.00	229.48	216.23	216.12	216.28	216.16	20.26	20.86		
Link16	240.5	Circular	36	2.89	36023	39390_SI_0500	213.41	206.45	229.61	218.52	214.47	207.93	214.49	207.95	20.25	20.85		
Link17	19.1	Circular	36	2.81	40897	36023	213.95	213.41	229.48	229.61	216.12	214.47	216.16	214.49	20.26	20.86		
Link18	192.9	Rectangular	30	1.13	35537	34187	167.31	165.13	174.00	171.23	171.26	167.28	171.26	167.28	44.48	44.48		
Link19	115.4	Rectangular	30	4.30	36507_SI_0400	42737	152.96	148.00	159.74	151.00	155.00	149.40	155.01	149.40	64.37	64.48		
South End Basin																		
2	40.1	Circular	30	0.30	39657	39658	428.74	428.62	433.30	433.56	431.52	431.11	431.53	431.11	40.88	41.75		
681.1	40.1	Circular	30	0.30	39657	39658	428.74	428.62	433.30	433.56	431.52	431.11	431.53	431.11	19.40	19.74		
800101	225.2	Trapezoidal	24	0.76	40224	38962	450.92	449.20	453.42	451.20	452.03	451.20	452.03	451.20	23.48	23.49	YES	YES
800102	53.6	Trapezoidal	24	2.42	38963	30628	448.92	448.12	450.92	450.12	450.12	450.12	450.12	450.12	9.98	9.96	YES	YES
800823	249.0	Circular	30	0.65	33801	33800	446.64	445.01	452.50	449.78	449.68	449.58	449.68	449.59	7.45	7.44		
800824	33.2	Circular	18	4.16	30628	33801	448.12	446.74	450.12	452.50	450.12	449.68	450.12	449.68	7.57	7.64		
801783	37.0	Circular	12	1.54	33800	42854	445.01	444.44	449.78	447.80	449.58	446.75	449.59	446.76	7.39	7.38		
802067	213.1	Circular	24	0.40	33531_SE_1300	33530	455.40	454.55	461.95	459.99	460.33	457.83	460.33	457.83	18.81	18.80		
802192	20.1	Circular	30	0.10	33899	40224	450.94	450.92	455.75	453.42	452.78	452.03	452.78	452.03	23.48	23.50		
802326	286.5	Circular	60	0.28	32462_SE_1200	34366	435.93	435.14	440.93	447.02	437.56	437.04	437.58	437.06	19.32	19.62		
802787	32.5	Circular	18	0.00	38962	38963	449.20	448.92	451.20	450.92	451.20	450.12	451.20	450.12	7.97	7.97		
803617	221.5	Circular	15	1.46	35517_SE_1400	33531_SE_1300	458.84	455.60	465.59	461.95	465.59	460.33	465.59	460.33	9.48	9.56		
807270	476.7	Circular	30	0.30	37785_SE_1000	33899	452.38	450.94	458.00	455.75	455.14	452.78	455.15	452.78	23.49	23.50		
807271	119.5	Circular	30	0.00	37787	37785_SE_1000	452.74	452.38	459.02	458.00	455.72	455.14	455.72	455.15	18.77	18.77		
808402	204.7	Trapezoidal	24	0.29	38973_SE_0800	39657	429.34	428.74	433.34	433.30	431.65	431.52	431.67	431.53	60.27	61.48		
808415	100.2	Trapezoidal	24	0.51	39658	42487	428.62	428.11	433.56	431.11	431.11	431.11	431.11	431.11	60.28	61.49	YES	YES
808417	58.9	Circular	36	4.16	42487	39582	428.11	425.66	431.11	428.66	431.11	426.68	431.11	426.68	31.29	31.29		
809300	116.5	Circular	15	1.52	33535_SE_1600	35517_SE_1400	460.81	459.04	468.36	465.59	467.37	465.59	467.70	465.59	6.27	6.83	YES	YES
809303	93.7	Circular	12	1.10	32769_SE_1500	33531_SE_1300	456.63	455.60	461.31	461.95	461.31	460.33	461.31	460.33	3.17	3.17		
809312	433.6	Circular	30	0.30	33530	37788	454.55	453.25	459.99	459.22	457.83	456.44	457.83	456.45	18.78	18.77		
809724	17.8	Circular	60	1.12	34366	34365_SE_1100	434.94	434.74	447.02	446.54	437.04	436.90	437.06	436.92	19.29	19.58		
Link20	166.2	Circular	30	0.31	37788	37787	453.25	452.74	459.22	459.02	456.44	455.72	456.45	455.72	18.77	18.77		
Link21	369.9	Circular	12	0.00	32798_SE_1000	34786	451.89	449.90	456.04	452.42	452.42	450.27	452.42	450.27	1.08	1.09		
Link23	84.9	Circular	12	1.68	34786	Node65	449.90	448.47	452.42	450.47	450.27	448.82	450.27	448.82	1.08	1.09		
Link24	92.2	Trapezoidal	24	1.68	Node65	Node66	448.47	446.92	450.47	448.92	448.67	447.56	448.67	447.56	1.08	1.09		
Link25	22.2	Circular	12	1.68	Node66	Node67	446.92	446.55	448.92	448.55	447.56	446.75	447.56	446.75	1.08	1.08		

Table A-2. Hydraulic Model Parameters and Results for 10-yr Storm

					Node Name		Invert Elevation (ft)		Ground Elevation (ft)		Existing Max Water		Future Max Water Surface		Max Flow (cfs)		Flooding at DS Node	
Link ID	Length (ft)	Shape	Diameter/Height (in)	Slope (%)	US	DS	US	DS	US	DS	US	DS	US	DS	Existing	Future	Existing	Future
Link26	85.9	Trapezoidal	24	1.68	Node67	Node68	446.55	445.11	448.55	447.11	446.75	446.83	446.75	446.84	1.08	1.08		
Link31	156.4	Circular	12	6.03	42854	34365_SE_1100	444.37	434.94	447.80	446.54	446.75	436.90	446.76	436.92	7.52	7.52		
Link33	52.5	Circular	12	1.02	Node68	42854	445.11	444.57	447.11	447.80	446.83	446.75	446.84	446.76	1.09	1.09		
Link36	322.9	Circular	48	1.10	34761_SE_0900	38973_SE_0800	432.88	429.34	438.14	433.34	434.83	431.65	434.86	431.67	49.09	50.29		
Link37	207.7	Circular	54	0.24	34365_SE_1100	Node70	434.74	434.24	446.54	441.95	436.90	435.92	436.92	435.94	31.91	32.34		
Link38	172.0	Circular	54	0.56	Node70	34761_SE_0900	434.04	433.08	441.95	438.14	435.92	434.83	435.94	434.86	31.91	32.33		
Newell Creek Basin at Molalla Avenue and Beaver Creek Road																		
800688	160.5	Circular	48	3.51	34994	39666	417.02	411.38	430.02	415.38	418.82	412.72	418.84	412.73	60.81	61.69		
800690	39.8	Circular	12	1.66	34611	30023	423.69	423.03	429.34	430.16	428.97	426.04	429.02	426.07	6.45	6.45		
800854	442.7	Circular	42	0.82	39740_NE_1900	34616	433.01	429.39	436.51	436.91	433.38	429.74	433.39	429.75	1.87	1.93		
801962	148.0	Circular	15	3.87	34604	34603	438.50	432.77	441.90	437.52	439.11	433.62	439.11	433.62	5.08	5.08		
801965	205.9	Circular	15	0.43	34605_NE_3100	34604	439.49	438.60	444.01	441.90	441.44	439.51	441.44	439.51	5.08	5.08		
801981	230.0	Circular	18	1.54	30056_NE_3100	37259	435.30	431.75	439.36	433.77	436.01	432.32	436.01	432.32	4.45	4.45		
803140	168.1	Circular	42	0.78	30021	30023	424.29	422.98	431.51	430.16	427.14	426.04	427.18	426.07	47.01	47.89		
803172	61.7	Circular	12	0.66	30030_NE_2200	30027	426.11	425.70	434.39	433.37	434.39	432.64	434.39	432.64	5.01	5.00		
803176	159.5	Circular	12	0.92	30027	30025	425.53	424.07	433.37	430.71	432.64	429.38	432.64	429.40	4.82	4.82		
803179	78.3	Circular	12	0.57	30025	30024	423.92	423.47	430.71	430.26	429.38	427.27	429.40	427.30	4.78	4.79		
803180	27.5	Circular	12	0.87	30024	30023	423.45	423.21	430.26	430.16	427.27	426.04	427.30	426.07	4.76	4.78		
806619	6.3	Circular	48	0.00	37234	37235	426.45	426.45	433.20	433.20	428.98	428.99	429.02	429.03	-25.85	-26.66		
806620	267.8	Circular	42	0.68	37234	30021	426.45	424.63	433.20	431.51	428.98	427.14	429.02	427.18	47.07	47.94		
807452	59.3	Circular	12	-4.99	37903	37901	423.40	426.36	427.94	430.44	427.94	426.92	427.94	426.93	2.87	2.87		
807453	135.4	Circular	12	2.29	37238_NE_2200	37903	428.50	425.40	430.54	427.94	430.54	427.94	430.54	427.94	4.04	4.04	YES	YES
808393	446.8	Circular	42	0.81	39739_NE_1900	34615	432.99	429.39	436.49	436.91	434.55	430.77	434.57	430.79	27.36	28.20		
Link18	394.5	Circular	48	0.49	34615	41521	428.89	426.95	436.91	432.42	430.59	429.05	430.63	429.09	27.33	28.17		
Link19	82.1	Circular	48	0.49	41521	37235	426.95	426.55	432.42	433.20	429.05	428.99	429.09	429.03	32.25	33.09		
Link20	410.9	Circular	48	0.67	37235	34611	426.45	423.69	433.20	429.34	428.99	428.97	429.03	429.02	7.82	7.83		
Link21	9.3	Circular	42	3.23	30023	Node35	423.03	422.73	430.16	429.89	426.04	424.43	426.07	424.45	57.94	58.82		
Link22	168.9	Circular	48	3.38	Node35	34994	422.73	417.02	429.89	430.02	424.43	418.82	424.45	418.84	60.81	61.69		
Link23	98.6	Circular	12	3.68	37901	Node35	426.36	422.73	430.44	429.89	426.92	424.43	426.93	424.45	2.87	2.87		
Link24	309.6	Circular	15	1.44	34603	42867	432.77	428.30	437.52	432.33	433.62	429.75	433.62	429.79	5.07	5.07		
Link25	45.0	Circular	15	2.77	42867	41521	428.20	426.95	432.33	432.42	429.75	429.05	429.79	429.09	5.05	5.06		
Link26	158.4	Circular	48	0.80	34616	35735_NE_1600	428.89	427.62	436.91	434.20	429.51	429.50	429.53	429.53	1.95	2.01		
Link27	203.9	Circular	48	0.34	35735_NE_1600	41522	427.62	426.93	434.20	432.04	429.50	429.22	429.53	429.26	17.35	17.44		
Link28	114.2	Circular	48	0.34	41522	37234	426.93	426.55	432.04	433.20	429.22	428.98	429.26	429.02	21.62	21.69		
Link29	85.4	Circular	15	5.64	37259	41522	431.75	426.93	433.77	432.04	432.32	429.22	432.32	429.26	4.45	4.45		

Table A-3. Hydraulic Model Parameters and Results for 25-yr Storm

					Node Name		Invert Elevation (ft)		Ground Elevation (ft)		Existing Max Water		Future Max Water		Max Flow (cfs)		Flooding at DS Node	
Link ID	Length (ft)	Shape	Diameter/Height (in)	Slope (%)	US	DS	US	DS	US	DS	US	DS	US	DS	Existing	Future	Existing	Future
Central Point Basin																		
808424	57.6	Circular	36	3.44	42490_CP_0500	38777	441.58	439.60	444.58	448.68	443.97	440.61	443.98	440.61	23.14	23.29		
803448	135.1	Circular	12	1.58	33962	35483	461.35	459.21	467.71	467.48	467.71	460.86	467.71	460.86	7.02	7.02		
803449	349.8	Circular	12	4.26	35483	35481	459.01	444.12	467.48	450.42	460.86	444.94	460.86	444.94	6.79	6.79		
803703	202.6	Circular	30	0.59	35630	35478	429.72	428.53	439.21	432.23	431.70	430.10	431.76	430.13	21.39	22.18		
807429	182.8	Circular	12	0.77	37879_CP_0800	33962	463.41	462.00	468.84	467.71	477.46	467.71	478.47	467.71	7.34	7.74	YES	YES
808422	128.1	Circular	36	0.71	33002	39749	443.14	442.23	447.90	445.23	444.38	443.98	444.38	443.99	11.46	11.54		
808427	28.5	Circular	36	0.04	39588	34501	432.78	432.77	438.46	438.50	434.54	434.27	434.54	434.27	17.05	17.05		
808428	118.5	Circular	36	1.05	34502	39588	434.03	432.78	440.22	438.46	435.42	434.54	435.42	434.54	17.05	17.05		
808653	18.7	Circular	30	2.20	38733_CP_0800	35630	430.33	429.92	440.18	439.21	432.43	431.70	432.49	431.76	21.45	22.21		
808654	259.3	Circular	12	4.75	35481	38733_CP_0800	443.92	431.60	450.42	440.18	444.80	432.43	444.80	432.49	6.80	6.80		
809337	155.2	Circular	36	0.95	34503	34502	435.50	434.03	441.35	440.22	436.83	435.42	436.83	435.42	17.06	17.06		
809791	34.0	Circular	15	0.00	34248_CP_0100	35487	430.72	430.73	438.92	438.59	438.57	437.31	437.96	436.68	7.33	7.37		
809793	91.2	Circular	15	0.27	35487	35484	430.53	430.28	438.59	437.00	437.31	435.23	436.68	434.56	7.32	7.36		
812537	128.1	Trapezoidal	30	0.71	39749	42490_CP_0500	442.23	441.58	445.23	444.58	443.98	443.97	443.99	443.98	11.37	11.45		
Link18	292.2	Circular	36	0.41	33700_CP_0600	33002	444.35	443.14	450.79	447.90	445.59	444.38	445.59	444.38	11.54	11.62		
Link19	447.2	Trapezoidal	30	0.49	38888	30909_CP_0400	438.79	436.61	441.29	439.11	440.45	439.11	440.45	439.11	23.11	23.26	YES	YES
Link20	33.0	Circular	27	0.62	30909_CP_0400	34503	436.61	436.40	439.11	441.35	439.11	437.84	439.11	437.84	17.05	17.05		
Link21	10.0	Circular	36	13.10	38777	38888	439.60	438.29	448.68	441.29	440.61	440.45	440.61	440.45	23.14	23.28		
Link25	341.0	Circular	15	0.55	35484	35478	430.08	428.20	437.00	432.23	435.23	429.59	434.56	429.61	7.31	7.36		
Link26	215.0	Circular	30	2.57	35478	40654	428.20	422.68	432.23	425.18	429.59	423.89	429.61	423.91	28.65	29.53		
Link27	38.5	Circular	36	1.30	34501	33145	432.77	432.27	438.50	435.27	434.27	433.27	434.27	433.27	17.05	17.05		
Coffee Creek Basin																		
618.1	116.9	Circular	24	0.58	42534_CO_0500	42533	440.66	439.98	445.16	444.48	443.75	441.87	443.75	441.87	14.98	14.98		
802016	56.9	Circular	24	1.63	40182_CO_0800	34657	453.03	452.10	456.03	456.54	455.71	453.97	455.74	454.04	16.61	16.90		
808374	56.9	Circular	24	1.63	40182_CO_0800	34657	453.03	452.10	456.03	456.54	455.71	453.97	455.74	454.04	16.61	16.90		
808377	62.4	Circular	48	1.07	42472_CO_0600	42473	448.69	448.02	453.69	454.24	452.54	450.47	452.61	450.47	59.94	61.26		
808379	68.6	Circular	30	2.90	42475_CO_0400	42474	413.69	411.70	417.69	416.03	416.96	412.85	416.97	412.85	27.97	28.03		
808379	68.6	Circular	30	2.90	42475_CO_0400	42474	413.69	411.70	417.69	416.03	416.96	412.85	416.97	412.85	27.97	28.03		
808867	76.2	Circular	36	0.91	CO_0300	42552	429.21	428.52	433.21	432.52	433.21	430.25	433.21	430.25	45.08	45.08		
Backyard	116.9	Trapezoidal	24	0.00	42534_CO_0500	42533	443.16	442.48	445.16	444.48	443.75	443.07	443.75	443.07	42.66	42.71		
Link10	686.1	Trapezoidal	48	2.16	42552	42475_CO_0400	428.52	413.69	432.52	417.69	430.25	416.96	430.25	416.97	45.08	45.08		
Link11	6.0	Rectangular	30	1.73	Node16	Node17	446.46	446.35	450.46	450.36	450.46	447.43	450.46	447.43	42.67	42.67		
Link12	329.2	Trapezoidal	48	1.73	Node17	42534_CO_0500	446.35	440.66	450.36	445.16	447.43	443.75	447.43	443.75	42.67	42.67		
Link13	180.0	Trapezoidal	24	0.58	42533	Node19	439.98	438.82	444.48	441.82	441.87	441.53	441.87	441.54	58.09	58.13		
Link14	50.0	Trapezoidal	36	0.58	Node19	Node20	438.82	438.53	441.82	442.53	441.53	440.00	441.54	440.00	58.07	58.11		
Link15	100.5	Trapezoidal	48	9.27	Node20	CO_0300	438.53	429.21	442.53	433.21	440.00	433.21	440.00	433.21	58.07	58.11	YES	YES
Link6	174.1	Circular	36	0.67	34657	40188_CO_0700	451.30	450.14	456.54	457.06	453.97	452.97	454.04	453.02	33.21	33.80		
Link7	587.5	Trapezoidal	60	0.25	40188_CO_0700	42472_CO_0600	450.14	448.69	457.06	453.69	452.97	452.54	453.02	452.61	48.32	49.21		
Link8	90.3	Trapezoidal	48	1.73	42473	Node16	448.02	446.46	454.24	450.46	450.47	450.46	450.47	450.46	59.94	61.26	YES	YES
Livesay Basin																		
Link1	169.8	Circular	1	1.00	33740_LI_1200	33742	504.45	502.75	512.76	510.16	512.35	508.95	506.04	506.00	5.86	0.00		
Link13	41.7	Circular	1.5	4.31	34160	42491	429.05	427.25	435.25	432.40	426.66	424.12	431.01	428.29	10.36	13.83		
Link14	185.2	Circular	1	8.09	32573_LI_1100	34374_LI_1000	438.68	423.70	441.61	430.48	434.81	423.97	438.99	424.00	1.52	1.82		
Link15	399.6	Circular	1	3.02	34374_LI_1000	35610	423.47	411.42	430.48	418.42	423.71	411.93	423.93	411.99	2.20	2.50		
Link16	124.8	Circular	1	1.67	35610	35612	411.36	409.27	418.42	412.91	411.93	409.78	411.99	409.82	2.20	2.50		
Link17	252.8	Circular	1	5.17	35612	35607	409.06	395.99	412.91	400.77	409.45	400.77	409.48	400.77	2.20	2.50	YES	YES

Table A-3. Hydraulic Model Parameters and Results for 25-yr Storm

					Node Name		Invert Elevation (ft)		Ground Elevation (ft)		Existing Max Water		Future Max Water		Max Flow (cfs)		Flooding at DS Node	
Link ID	Length (ft)	Shape	Diameter/Height (in)	Slope (%)	US	DS	US	DS	US	DS	US	DS	US	DS	Existing	Future	Existing	Future
Link18	73.6	Circular	1	0.56	35607	35686	395.79	395.38	400.77	397.38	400.77	395.67	400.77	395.61	6.48	4.20		
Link19	96.2	Trapezoidal	2	14.41	35686	39436	395.38	381.52	397.38	383.52	395.67	383.52	395.61	383.52	6.48	4.20	YES	YES
Link2	106.9	Circular	1	1.91	33742	34162_LI_1100	502.55	500.51	510.16	505.96	508.95	506.72	506.00	505.96	5.88	0.00	YES	YES
Link20	61.8	Circular	1	8.24	39436	34997	381.52	376.43	383.52	379.80	383.52	376.89	383.52	376.89	4.09	4.09		
Link21	218.2	Circular	1	5.92	34997	30828_LI_0600	376.23	363.31	379.80	366.90	376.78	363.82	376.78	363.82	4.09	4.09		
Link22	19.2	Circular	1	32.88	30828_LI_0600	39842	362.77	356.46	366.90	368.26	363.12	356.80	363.32	356.81	4.85	4.90		
Link23	198.9	Circular	2	0.88	42491	39313_LI_1000	426.75	425.00	432.40	427.01	424.12	417.78	428.29	426.24	10.38	13.83		
Link24	542.8	Trapezoidal	2	4.63	39313_LI_1000	Node25	425.00	399.89	427.01	401.89	417.78	401.89	425.97	401.89	13.62	17.22	YES	YES
Link25	125.0	Circular	2	3.12	Node25	35607	399.89	395.99	401.89	400.77	401.89	400.77	401.89	400.77	11.28	11.28	YES	YES
Link29	455.6	Circular	1.25	0.39	Node31	Node31.1	508.23	506.44	519.47	512.76	NA[1]	NA[1]	514.84	512.76	NA[1]	3.92		YES
Link29.1	296.1	Circular	1.25	1.70	Node31.1	Node34	506.24	501.21	512.76	506.82	NA[1]	NA[1]	512.76	506.82	NA[1]	9.43		YES
Link3	525.9	Circular	1.25	7.72	34162_LI_1100	34161	500.41	459.83	505.96	465.63	506.72	465.66	505.96	465.63	17.20	16.15	YES	YES
Link30	23.7	Circular	1.25	1.69	Node34	34162_LI_1100	501.01	500.61	506.82	505.96	NA[1]	NA[1]	506.82	505.96	NA[1]	9.16		YES
Link4	241.2	Circular	1.25	4.46	34161	33066	459.84	449.09	465.63	453.44	465.66	453.43	465.63	450.34	12.59	13.83		
Link5	206.8	Circular	1.25	6.95	33066	33065	449.09	434.71	453.44	438.65	453.43	435.98	450.21	436.49	10.36	13.83		
Link6	52.1	Circular	1.25	12.00	33065	34160	435.15	428.90	438.65	435.25	435.80	426.66	436.49	431.01	10.36	13.83		
John Adams Basin																		
800781	159.3	Circular	16	4.81	34313	33514	160.19	152.53	162.29	171.45	161.08	153.28	161.08	153.28	9.48	9.48		
801568	335.0	Circular	8	4.06	33504	33474	257.58	243.99	261.10	254.51	261.10	254.51	261.10	254.51	1.88	1.88	YES	YES
801573	15.0	Circular	12	28.92	33473	34769	220.25	215.90	226.39	226.95	223.03	220.87	223.03	220.87	6.58	6.58		
802603	417.6	Circular	12	6.93	33505_JA_1400	38651	309.65	280.69	316.50	286.90	310.38	281.42	310.38	281.42	7.70	7.72		
802604	268.7	Circular	8	2.85	33566_JA_1600	34696	321.64	313.99	330.45	318.74	330.45	314.66	330.45	314.66	2.78	2.78		
802606	301.1	Circular	8	8.09	34698	33504	282.51	258.15	289.22	261.10	283.03	261.10	283.03	261.10	2.78	2.78	YES	YES
804813	157.0	Circular	18	6.34	33520	43469	82.29	72.34	96.27	88.74	83.22	75.98	83.22	76.01	12.63	12.63		
804814	78.8	Circular	18	7.00	33519	33520	92.03	86.51	99.89	96.27	93.02	87.25	93.02	87.25	12.61	12.61		
804815	124.1	Circular	18	2.66	33521	34704_WN_0300	68.67	65.37	86.97	73.55	74.18	67.05	74.20	67.08	19.06	19.06		
804841	513.2	Circular	12	2.94	33475_JA_1000	33473	235.76	220.69	243.58	226.39	243.58	223.03	243.58	223.03	6.58	6.58		
804846	64.5	Circular	12	1.18	33469	33508	185.00	184.24	188.90	191.51	188.90	185.23	188.90	185.23	6.27	6.27		
804848	150.6	Circular	24	5.05	33514	33515	152.33	144.73	171.45	153.00	153.03	145.34	153.03	145.34	9.48	9.48		
804851	256.1	Circular	18	8.38	33515	34191_JA_0100	144.53	123.08	153.00	128.90	145.16	128.90	145.16	128.90	9.48	9.48	YES	YES
804860	101.6	Circular	18	3.60	33517_WN_0400	33516	178.61	174.95	185.10	179.60	182.36	179.60	182.36	179.60	12.46	12.46	YES	YES
804861	211.6	Circular	18	6.54	33523	33517_WN_0400	192.64	178.81	201.40	185.10	193.08	182.36	193.08	182.36	4.61	4.61		
804867	274.3	Circular	18	2.49	34311_WN_0500	33523	199.70	192.86	207.50	201.40	200.31	193.42	200.31	193.42	4.61	4.61		
804870	183.5	Circular	8	6.02	34767_JA_1100	34309	203.85	192.80	209.10	198.92	209.10	193.47	209.10	193.47	3.22	3.22		
804934	296.9	Circular	8	9.23	38650_JA_1500	33475_JA_1000	263.28	235.87	269.84	243.58	269.84	243.58	269.84	243.58	3.44	3.44	YES	YES
804969	247.9	Circular	8	8.24	33513_JA_0300	33519	113.61	93.18	119.72	99.89	118.80	93.85	118.80	93.85	3.55	3.55		
806396	444.2	Circular	8	8.37	37054	33513_JA_0300	151.18	114.01	162.35	119.72	159.31	118.80	159.31	118.80	3.55	3.55		
806401	131.5	Circular	8	16.53	37059	37054	173.12	151.38	178.38	162.35	173.72	159.31	173.72	159.31	3.55	3.55		
806402	255.5	Circular	10	12.82	37062	37059	206.06	173.32	208.79	178.38	206.49	173.73	206.49	173.73	3.55	3.55		
806406	30.6	Circular	10	2.72	37064	37062	207.09	206.26	210.50	208.79	208.95	207.02	208.95	207.02	3.55	3.55		
806411	253.8	Circular	8	1.92	37070_JA_0500	34769	223.30	218.42	224.81	226.95	224.81	220.87	224.81	220.87	1.40	1.40		
806471	131.0	Circular	18	3.17	37118	37139_WN_0100	50.10	45.95	57.70	53.08	57.70	53.08	57.70	53.08	15.12	15.12	YES	YES
806474	123.1	Circular	18	0.56	37139_WN_0100	37142	45.72	45.03	53.08	53.08	53.08	50.09	53.08	50.09	12.37	12.37		
808623	41.5	Circular	18	0.63	37142	41009	44.93	44.67	53.08	52.70	50.09	48.32	50.09	48.32	12.37	12.37		
808624	19.1	Circular	18	-0.52	43300	43301	43.51	43.61	61.81	61.81	46.43	44.94	46.43	44.94	12.37	12.37		
808704	305.9	Circular	12	2.42	33474	33475_JA_1000	243.75	236.34	254.51	243.58	254.51	243.58	254.51	243.58	6.19	6.19	YES	YES
808721	103.2	Circular	12	6.62	34309	33508	190.32	183.49	198.92	191.51	190.80	183.92	190.80	183.92	3.22	3.22		

1. Existing model based on infrastructure in place in 2017. Future conditions model includes recently installed infrastructure.

Table A-3. Hydraulic Model Parameters and Results for 25-yr Storm

					Node Name		Invert Elevation (ft)		Ground Elevation (ft)		Existing Max Water		Future Max Water		Max Flow (cfs)		Flooding at DS Node	
Link ID	Length (ft)	Shape	Diameter/Height (in)	Slope (%)	US	DS	US	DS	US	DS	US	DS	US	DS	Existing	Future	Existing	Future
812475	29.8	Circular	12	4.05	36378	34534	163.75	162.54	168.58	167.42	168.58	166.00	168.58	166.00	6.66	6.66		
812477	198.1	Circular	12	4.42	33516	36378	172.70	163.95	179.60	168.58	179.60	168.58	179.60	168.58	7.33	7.33	YES	YES
812478	100.6	Circular	12	3.01	34534	43051	162.24	159.21	167.42	163.93	166.00	160.78	166.00	160.78	6.65	6.65		
812479	194.4	Circular	12	4.18	43051	43050	159.11	150.99	163.93	155.49	160.78	151.78	160.78	151.78	6.49	6.49		
812692	119.5	Circular	18	0.80	41009	43300	44.57	43.61	52.70	61.81	48.32	46.43	48.32	46.43	12.37	12.37		
812695	158.3	Circular	54	18.38	43301	39733	43.51	14.40	61.81	19.40	43.94	14.79	43.94	14.79	12.37	12.37		
812816	39.8	Circular	18	8.12	43469	33521	72.10	68.87	88.74	86.97	75.98	74.18	76.01	74.20	12.67	12.67		
Link43	393.4	Circular	12	9.22	38651	33474	280.27	243.99	286.90	254.51	281.04	254.51	281.04	254.51	7.70	7.72	YES	YES
Link44	240.8	Circular	8	12.78	34696	34698	313.57	282.80	318.74	289.22	314.00	283.21	314.00	283.21	2.78	2.78		
Link45	276.4	Circular	8	1.36	34692_JA_1300	37087	242.56	238.80	250.94	248.38	368.43	248.38	368.43	248.38	13.26	13.26	YES	YES
Link46	256.7	Circular	8	3.82	37087	33491_JA_0200	238.60	228.79	248.38	234.43	248.38	234.43	248.38	234.43	2.72	2.72	YES	YES
Link47	259.8	Circular	8	7.96	33491_JA_0200	37064	227.98	207.29	234.43	210.50	234.43	208.95	234.43	208.95	3.55	3.55		
Link48	262.9	Circular	12	13.33	34769	33469	220.25	185.20	226.95	188.90	220.87	188.90	220.87	188.90	7.94	7.94	YES	YES
Link49	225.3	Circular	16	8.60	33508	34313	179.51	160.14	191.51	162.29	180.16	161.08	180.16	161.08	9.48	9.48		
Link54	132.7	Circular	18	11.25	34704_WN_0300	37118	65.33	50.40	73.55	57.70	67.05	57.70	67.08	57.70	21.77	21.79	YES	YES
Link55	249.5	Circular	12	10.53	43050	Node58	150.49	124.22	155.49	126.51	151.10	124.78	151.10	124.78	6.46	6.46		
Link56	122.1	Circular	12	10.53	Node58	Node59	124.02	111.16	126.51	114.00	124.67	111.72	124.67	111.72	6.47	6.47		
Link57	257.4	Circular	12	10.44	Node59	33521	110.96	84.08	114.00	86.97	111.57	84.64	111.57	84.64	6.44	6.44		
Link58	291.0	Circular	15	2.29	34191_JA_0100	34192	116.25	109.60	128.90	120.42	128.90	120.42	128.90	120.42	9.89	9.89	YES	YES
Link59	121.6	Circular	12	6.76	34192	41014	109.22	101.00	120.42	109.91	120.42	109.50	120.42	109.50	9.09	9.10		
Link60	192.3	Circular	12	4.46	41014	33519	100.71	92.13	109.91	99.89	109.50	93.13	109.50	93.13	9.07	9.07		
Park Place Basin																		
801099	22.4	Circular	24	1.29638	30675	30674	111.81	111.52	114.51	114.42	113.79	113.37	113.79	113.37	11.908	11.91		
801520	86.9	Circular	30	2.60048	34163	34164	189.81	187.55	201.5	194.73	190.96	188.49	190.96	188.49	16.256	16.26		
801521	75.8	Circular	30	3.0327	34164	34511	187.35	185.05	194.73	192.57	188.49	185.89	188.49	185.89	16.256	16.26		
801522	146.7	Circular	30	0.46347	34166	34163	190.69	190.01	195.75	201.5	192.45	191.37	192.45	191.37	16.256	16.26		
804027	51.3	Circular	30	5.92212	40789_PP_0800	40790	220.63	217.59	223.9	220.09	223.23	218.62	223.31	218.64	21.076	21.83		
806132	80.2	Circular	24	0.2617	30676	36849	112.88	112.67	116.68	115.17	114.92	114.29	114.92	114.29	11.909	11.91		
806133	38.7	Circular	24	1.44651	36849	30675	112.57	112.01	115.17	114.51	114.29	113.79	114.29	113.79	11.908	11.91		
806138	409.7	Circular	15	4.12944	36853	30676	130.15	113.23	134.95	116.68	133.01	114.92	133.01	114.92	11.909	11.91		
806331	7.1	Circular	24	5.32735	41420	37021	145.72	145.34	148.22	147.94	148.22	147.05	148.22	147.05	15.065	15.07		
808078	41.1	Circular	24	1.16689	30674	38518	111.62	111.14	114.42	113.64	113.37	112.85	113.37	112.85	11.908	11.91		
808079	9.4	Circular	24	-1.39037	38518	PP_0500	110.86	110.99	113.64	113.49	112.85	112.41	112.85	112.41	11.91	11.91		
809819	37.6	Circular	24	2.09989	37021	41421_PP_0600	145.34	144.55	147.94	147.05	147.05	146.19	147.05	146.21	15.067	15.07		
809820	47.5	Circular	24	1.55773	41350	36853	130.99	130.25	133.49	134.95	133.49	133.01	133.49	133.01	12.088	12.17		
812683	109.8	Circular	18	7.0674	43287_PP_1000	43288_PP_0900	262.76	255	264.56	263.56	264.56	255.85	264.56	255.86	7.046	7.05		
Link17	32.9	Circular	24	16.7021	33393	34166	197	191.5	199.5	195.75	199.50	192.45	199.50	192.45	16.256	16.26		
Link18	28.6	Circular	36	3.70629	34511	PP_0700	182.06	181	192.57	192	183.25	182.06	183.25	182.06	16.256	16.26		
Link20	116.2	Circular	24	3.57911	40854	40855	98.78	94.62	103.38	98.5	103.38	96.03	103.38	96.03	25.192	25.19		
Link21	114.7	Circular	30	7.11669	41341	36790_PP_0300	89.66	81.5	93.79	90.65	92.65	82.32	92.65	82.32	25.192	25.19		
Link22	69.7	Circular	36	18.646	36790_PP_0300	41342	81.5	68.5	90.65	80.85	82.32	69.12	82.32	69.12	25.191	25.19		
Link23	628.5	Trapezoidal	30	5.46849	43288_PP_0900	40789_PP_0800	255	220.63	263.56	223.9	255.85	223.23	255.86	223.31	13.878	14.41		
Link24	389.1	Trapezoidal	30	5.29183	40790	33393	217.59	197	220.09	199.5	218.62	199.50	218.64	199.50	21.059	21.81	YES	YES
Link27	416.8	Trapezoidal	30	3.25375	41421_PP_0600	41350	144.55	130.99	147.05	133.49	146.19	133.49	146.21	133.49	48.13	48.96	YES	YES
Link28	567.6	Trapezoidal	30	2.15128	PP_0500	40854	110.99	98.78	113.49	103.38	112.41	103.38	112.41	103.38	27.66	27.65	YES	YES
Link29	270.3	Trapezoidal	30	1.8352	40855	41341	94.62	89.66	98.5	93.79	96.03	92.65	96.03	92.65	25.191	25.19		
Link31	718.8	Trapezoidal	30	5.60378	PP_0700	41420	181	145.72	192	148.22	182.06	148.22	182.06	148.22	21.654	21.65	YES	YES

Table A-3. Hydraulic Model Parameters and Results for 25-yr Storm

					Node Name		Invert Elevation (ft)		Ground Elevation (ft)		Existing Max Water		Future Max Water		Max Flow (cfs)		Flooding at DS Node	
Link ID	Length (ft)	Shape	Diameter/Height (in)	Slope (%)	US	DS	US	DS	US	DS	US	DS	US	DS	Existing	Future	Existing	Future
Singer Creek Basin																		
800363	257.5	Circular	36	3.20	39390_SI_0500	33815	206.45	198.22	218.52	205.18	208.12	199.51	208.14	199.52	38.11	38.83		
803639	45.1	Rectangular	30	0.55	34189	35537	167.56	167.31	174.46	174.00	173.05	171.26	173.05	171.26	44.47	44.47		
803641	165.3	Rectangular	30	2.81	35540	34189	172.21	167.56	177.61	174.46	176.49	173.05	176.49	173.05	44.47	44.47		
803643	10.1	Rectangular	30	1.58	SI_0300	35540	172.37	172.21	177.80	177.61	177.80	176.49	177.80	176.49	44.47	44.47		
804123	131.4	Rectangular	30	1.65	35900	SI_0300	174.74	172.37	180.04	177.80	179.71	177.80	179.71	177.80	35.57	35.57	YES	YES
804124	57.9	Rectangular	30	2.02	35902	35900	175.91	174.74	180.96	180.04	180.96	179.71	180.96	179.71	35.57	35.57		
804125	114.9	Rectangular	30	2.34	35903	35902	178.60	175.91	185.01	180.96	182.98	180.96	183.06	180.96	38.11	38.82	YES	YES
804126	124.7	Rectangular	30	2.57	34190	35903	181.81	178.60	189.08	185.01	185.11	182.98	185.27	183.06	38.11	38.82		
804191	308.3	Rectangular	30	4.28	33815	35985	198.22	185.02	205.18	191.23	199.51	187.03	199.52	187.13	38.12	38.84		
804192	84.1	Rectangular	30	3.82	35985	34190	185.02	181.81	191.23	189.08	187.03	185.11	187.13	185.27	38.11	38.82		
804812	212.8	Rectangular	30	2.11	34187	35594	165.13	160.43	171.23	165.19	167.28	162.38	167.28	162.38	44.47	44.47		
806469	153.9	Rectangular	30	3.91	37138	36507_SI_0400	158.98	152.96	164.15	159.74	160.12	155.12	160.12	155.12	44.48	44.48		
806470	94.8	Rectangular	30	1.32	35594	37138	160.43	158.98	165.19	164.15	162.38	160.12	162.38	160.12	44.47	44.47		
Link14	94.4	Circular	36	2.90	40796_SI_0600	40797	218.02	215.28	221.02	220.00	219.16	216.65	219.18	216.69	25.16	25.81		
Link15	156.0	Trapezoidal	36	0.55	40797	Inlet	215.28	214.42	220.00	225.00	216.65	216.60	216.69	216.65	24.99	25.62		
Link15.1	94.0	Circular	36	0.50	Inlet	40897	214.42	213.95	225.00	229.48	216.60	216.47	216.65	216.52	24.82	25.45		
Link16	240.5	Circular	36	2.89	36023	39390_SI_0500	213.41	206.45	229.61	218.52	214.61	208.12	214.63	208.14	24.81	25.44		
Link17	19.1	Circular	36	2.81	40897	36023	213.95	213.41	229.48	229.61	216.47	214.61	216.52	214.63	24.82	25.45		
Link18	192.9	Rectangular	30	1.13	35537	34187	167.31	165.13	174.00	171.23	171.26	167.28	171.26	167.28	44.49	44.49		
Link19	115.4	Rectangular	30	4.30	36507_SI_0400	42737	152.96	148.00	159.74	151.00	155.12	149.46	155.12	149.47	68.50	68.62		
South End Basin																		
2	40.1	Circular	30	0.30	39657	39658	428.74	428.62	433.30	433.56	431.72	431.11	431.74	431.11	50.61	51.42		
681.1	40.1	Circular	30	0.30	39657	39658	428.74	428.62	433.30	433.56	431.72	431.11	431.74	431.11	23.61	24.10		
800101	225.2	Trapezoidal	24	0.76	40224	38962	450.92	449.20	453.42	451.20	452.06	451.20	452.06	451.20	24.79	24.81	YES	YES
800102	53.6	Trapezoidal	24	2.42	38963	30628	448.92	448.12	450.92	450.12	450.13	450.12	450.13	450.12	10.14	10.15	YES	YES
800823	249.0	Circular	30	0.65	33801	33800	446.64	445.01	452.50	449.78	449.72	449.63	449.72	449.63	7.33	7.36		
800824	33.2	Circular	18	4.16	30628	33801	448.12	446.74	450.12	452.50	450.12	449.72	450.12	449.72	7.43	7.46		
801783	37.0	Circular	12	1.54	33800	42854	445.01	444.44	449.78	447.80	449.63	446.98	449.63	446.99	7.31	7.34		
802067	213.1	Circular	24	0.40	33531_SE_1300	33530	455.40	454.55	461.95	459.99	460.89	458.34	460.89	458.34	19.11	19.10		
802192	20.1	Circular	30	0.10	33899	40224	450.94	450.92	455.75	453.42	452.83	452.06	452.84	452.06	24.79	24.82		
802326	286.5	Circular	60	0.28	32462_SE_1200	34366	435.93	435.14	440.93	447.02	437.82	437.31	437.84	437.33	24.16	24.47		
802787	32.5	Circular	18	0.00	38962	38963	449.20	448.92	451.20	450.92	451.20	450.13	451.20	450.13	7.97	7.97		
803617	221.5	Circular	15	1.46	35517_SE_1400	33531_SE_1300	458.84	455.60	465.59	461.95	465.59	460.89	465.59	460.89	9.49	9.56		
807270	476.7	Circular	30	0.30	37785_SE_1000	33899	452.38	450.94	458.00	455.75	455.52	452.83	455.53	452.84	24.80	24.82		
807271	119.5	Circular	30	0.00	37787	37785_SE_1000	452.74	452.38	459.02	458.00	456.16	455.52	456.17	455.53	19.07	19.07		
808402	204.7	Trapezoidal	24	0.29	38973_SE_0800	39657	429.34	428.74	433.34	433.30	431.85	431.72	431.88	431.74	74.20	75.51		
808415	100.2	Trapezoidal	24	0.51	39658	42487	428.62	428.11	433.56	431.11	431.11	431.11	431.11	431.11	74.22	75.52	YES	YES
808417	58.9	Circular	36	4.16	42487	39582	428.11	425.66	431.11	428.66	431.11	426.68	431.11	426.68	31.29	31.29		
809300	116.5	Circular	15	1.52	33535_SE_1600	35517_SE_1400	460.81	459.04	468.36	465.59	468.34	465.59	468.36	465.59	7.80	7.84	YES	YES
809303	93.7	Circular	12	1.10	32769_SE_1500	33531_SE_1300	456.63	455.60	461.31	461.95	461.31	460.89	461.31	460.89	3.31	3.31		
809312	433.6	Circular	30	0.30	33530	37788	454.55	453.25	459.99	459.22	458.34	456.92	458.34	456.93	19.10	19.09		
809724	17.8	Circular	60	1.12	34366	34365_SE_1100	434.94	434.74	447.02	446.54	437.31	437.15	437.33	437.17	24.13	24.43		
Link20	166.2	Circular	30	0.31	37788	37787	453.25	452.74	459.22	459.02	456.92	456.16	456.93	456.17	19.08	19.08		
Link21	369.9	Circular	12	0.00	32798_SE_1000	34786	451.89	449.90	456.04	452.42	452.49	450.32	452.49	450.32	1.33	1.34		
Link23	84.9	Circular	12	1.68	34786	Node65	449.90	448.47	452.42	450.47	450.32	448.86	450.32	448.86	1.33	1.34		
Link24	92.2	Trapezoidal	24	1.68	Node65	Node66	448.47	446.92	450.47	448.92	448.70	447.66	448.70	447.66	1.33	1.34		

Table A-3. Hydraulic Model Parameters and Results for 25-yr Storm

					Node Name		Invert Elevation (ft)		Ground Elevation (ft)		Existing Max Water		Future Max Water		Max Flow (cfs)		Flooding at DS Node	
Link ID	Length (ft)	Shape	Diameter/Height (in)	Slope (%)	US	DS	US	DS	US	DS	US	DS	US	DS	Existing	Future	Existing	Future
Link25	22.2	Circular	12	1.68	Node66	Node67	446.92	446.55	448.92	448.55	447.66	447.17	447.66	447.17	1.33	1.34		
Link26	85.9	Trapezoidal	24	1.68	Node67	Node68	446.55	445.11	448.55	447.11	447.17	447.11	447.17	447.11	3.32	4.57	YES	YES
Link31	156.4	Circular	12	6.03	42854	34365_SE_1100	444.37	434.94	447.80	446.54	446.98	437.15	446.99	437.17	7.53	7.54		
Link33	52.5	Circular	12	1.02	Node68	42854	445.11	444.57	447.11	447.80	447.11	446.98	447.11	446.99	1.33	1.32		
Link36	322.9	Circular	48	1.10	34761_SE_0900	38973_SE_0800	432.88	429.34	438.14	433.34	435.10	431.85	435.13	431.88	59.85	61.15		
Link37	207.7	Circular	54	0.24	34365_SE_1100	Node70	434.74	434.24	446.54	441.95	437.15	436.16	437.17	436.18	38.03	38.48		
Link38	172.0	Circular	54	0.56	Node70	34761_SE_0900	434.04	433.08	441.95	438.14	436.16	435.10	436.18	435.13	38.03	38.47		
Newell Creek Basin at Molalla Avenue and Beaver Creek Road																		
800688	160.5	Circular	48	3.51	34994	39666	417.02	411.38	430.02	415.38	418.97	412.81	418.97	412.81	68.55	68.64		
800690	39.8	Circular	12	1.66	34611	30023	423.69	423.03	429.34	430.16	429.34	426.31	429.34	426.31	6.59	6.59		
800854	442.7	Circular	42	0.82	39740_NE_1900	34616	433.01	429.39	436.51	436.91	433.41	429.90	433.41	429.90	2.30	2.35		
801962	148.0	Circular	15	3.87	34604	34603	438.50	432.77	441.90	437.52	439.19	433.95	439.19	433.96	6.04	6.04		
801965	205.9	Circular	15	0.43	34605_NE_3100	34604	439.49	438.60	444.01	441.90	442.26	439.59	442.26	439.59	6.04	6.04		
801981	230.0	Circular	18	1.54	30056_NE_3100	37259	435.30	431.75	439.36	433.77	436.07	432.43	436.07	432.43	5.29	5.29		
803140	168.1	Circular	42	0.78	30021	30023	424.29	422.98	431.51	430.16	427.60	426.31	427.60	426.31	54.70	54.79		
803172	61.7	Circular	12	0.66	30030_NE_2200	30027	426.11	425.70	434.39	433.37	434.39	432.69	434.39	432.69	4.95	4.85		
803176	159.5	Circular	12	0.92	30027	30025	425.53	424.07	433.37	430.71	432.69	429.54	432.69	429.55	4.79	4.78		
803179	78.3	Circular	12	0.57	30025	30024	423.92	423.47	430.71	430.26	429.54	427.50	429.55	427.51	4.76	4.77		
803180	27.5	Circular	12	0.87	30024	30023	423.45	423.21	430.26	430.16	427.50	426.31	427.51	426.31	4.75	4.76		
806619	6.3	Circular	48	0.00	37234	37235	426.45	426.45	433.20	433.20	429.40	429.40	429.41	429.41	-30.46	-30.83		
806620	267.8	Circular	42	0.68	37234	30021	426.45	424.63	433.20	431.51	429.40	427.60	429.41	427.60	54.74	54.85		
807452	59.3	Circular	12	-4.99	37903	37901	423.40	426.36	427.94	430.44	427.94	426.94	427.94	426.94	2.88	2.88		
807453	135.4	Circular	12	2.29	37238_NE_2200	37903	428.50	425.40	430.54	427.94	430.54	427.94	430.54	427.94	4.04	4.04	YES	YES
808393	446.8	Circular	42	0.81	39739_NE_1900	34615	432.99	429.39	436.49	436.91	434.75	430.93	434.78	430.95	33.35	34.22		
Link18	394.5	Circular	48	0.49	34615	41521	428.89	426.95	436.91	432.42	430.86	429.46	430.89	429.47	33.37	34.22		
Link19	82.1	Circular	48	0.49	41521	37235	426.95	426.55	432.42	433.20	429.46	429.40	429.47	429.41	39.56	40.35		
Link20	410.9	Circular	48	0.67	37235	34611	426.45	423.69	433.20	429.34	429.40	429.34	429.41	429.34	11.41	12.07	YES	YES
Link21	9.3	Circular	42	3.23	30023	Node35	423.03	422.73	430.16	429.89	426.31	424.58	426.31	424.58	65.67	65.76		
Link22	168.9	Circular	48	3.38	Node35	34994	422.73	417.02	429.89	430.02	424.58	418.97	424.58	418.97	68.55	68.64		
Link23	98.6	Circular	12	3.68	37901	Node35	426.36	422.73	430.44	429.89	426.94	424.58	426.94	424.58	2.88	2.88		
Link24	309.6	Circular	15	1.44	34603	42867	432.77	428.30	437.52	432.33	433.95	430.46	433.96	430.47	6.03	6.03		
Link25	45.0	Circular	15	2.77	42867	41521	428.20	426.95	432.33	432.42	430.46	429.46	430.47	429.47	6.03	6.03		
Link26	158.4	Circular	48	0.80	34616	35735_NE_1600	428.89	427.62	436.91	434.20	429.90	429.89	429.90	429.90	2.45	2.49		
Link27	203.9	Circular	48	0.34	35735_NE_1600	41522	427.62	426.93	434.20	432.04	429.89	429.64	429.90	429.65	20.87	21.01		
Link28	114.2	Circular	48	0.34	41522	37234	426.93	426.55	432.04	433.20	429.64	429.40	429.65	429.41	26.22	26.35		
Link29	85.4	Circular	15	5.64	37259	41522	431.75	426.93	433.77	432.04	432.43	429.64	432.43	429.65	5.29	5.29		

Table A-4. Hydraulic Model Parameters and Results for 100-yr Storm

					Node Name		Invert Elevation (ft)		Ground Elevation (ft)		Existing Max Water		Future Max Water Surface		Max Flow (cfs)		Flooding at DS Node	
Link ID	Length (ft)	Shape	Diameter/Height (in)	Slope (%)	US	DS	US	DS	US	DS	US	DS	US	DS	Existing	Future	Existing	Future
Central Point Basin																		
808424	57.6	Circular	36	3.44	42490_CP_0500	38777	441.58	439.60	444.58	448.68	444.30	440.73	444.32	440.74	27.50	27.66		
803448	135.1	Circular	12	1.58	33962	35483	461.35	459.21	467.71	467.48	467.71	460.86	467.71	460.86	7.00	7.01		
803449	349.8	Circular	12	4.26	35483	35481	459.01	444.12	467.48	450.42	460.86	444.94	460.86	444.94	6.79	6.80		
803703	202.6	Circular	30	0.59	35630	35478	429.72	428.53	439.21	432.23	431.93	430.21	432.00	430.24	24.30	25.13		
807429	182.8	Circular	12	0.77	37879_CP_0800	33962	463.41	462.00	468.84	467.71	481.28	467.71	482.45	467.71	8.80	9.21	YES	YES
808422	128.1	Circular	36	0.71	33002	39749	443.14	442.23	447.90	445.23	444.62	444.31	444.63	444.33	13.60	13.68		
808427	28.5	Circular	36	0.04	39588	34501	432.78	432.77	438.46	438.50	434.54	434.27	434.54	434.27	17.05	17.05		
808428	118.5	Circular	36	1.05	34502	39588	434.03	432.78	440.22	438.46	435.42	434.54	435.42	434.54	17.05	17.05		
808653	18.7	Circular	30	2.20	38733_CP_0800	35630	430.33	429.92	440.18	439.21	432.68	431.93	432.77	432.00	24.33	25.16		
808654	259.3	Circular	12	4.75	35481	38733_CP_0800	443.92	431.60	450.42	440.18	444.80	432.68	444.80	432.77	6.79	6.78		
809337	155.2	Circular	36	0.95	34503	34502	435.50	434.03	441.35	440.22	436.83	435.42	436.83	435.42	17.06	17.06		
809791	34.0	Circular	15	0.00	34248_CP_0100	35487	430.72	430.73	438.92	438.59	438.92	437.63	438.92	437.52	7.55	7.87		
809793	91.2	Circular	15	0.27	35487	35484	430.53	430.28	438.59	437.00	437.63	435.49	437.52	435.19	7.46	7.79		
812537	128.1	Trapezoidal	30	0.71	39749	42490_CP_0500	442.23	441.58	445.23	444.58	444.31	444.30	444.33	444.32	13.50	13.58		
Link18	292.2	Circular	36	0.41	33700_CP_0600	33002	444.35	443.14	450.79	447.90	445.74	444.62	445.74	444.63	13.73	13.81		
Link19	447.2	Trapezoidal	30	0.49	38888	30909_CP_0400	438.79	436.61	441.29	439.11	440.57	439.11	440.58	439.11	27.48	27.63	YES	YES
Link20	33.0	Circular	27	0.62	30909_CP_0400	34503	436.61	436.40	439.11	441.35	439.11	437.84	439.11	437.84	17.05	17.05		
Link21	10.0	Circular	36	13.10	38777	38888	439.60	438.29	448.68	441.29	440.73	440.57	440.74	440.58	27.50	27.66		
Link25	341.0	Circular	15	0.55	35484	35478	430.08	428.20	437.00	432.23	435.49	429.68	435.19	429.72	7.46	7.79		
Link26	215.0	Circular	30	2.57	35478	40654	428.20	422.68	432.23	425.18	429.68	423.96	429.72	423.99	31.72	32.87		
Link27	38.5	Circular	36	1.30	34501	33145	432.77	432.27	438.50	435.27	434.27	433.27	434.27	433.27	17.05	17.05		
Coffee Creek Basin																		
618.1	116.9	Circular	24	0.58	42534_CO_0500	42533	440.66	439.98	445.16	444.48	443.78	441.91	443.78	441.92	14.98	14.97		
802016	56.9	Circular	24	1.63	40182_CO_0800	34657	453.03	452.10	456.03	456.54	456.40	454.86	456.47	454.99	20.27	20.60		
808374	56.9	Circular	24	1.63	40182_CO_0800	34657	453.03	452.10	456.03	456.54	456.40	454.86	456.47	454.99	20.27	20.60		
808377	62.4	Circular	48	1.07	42472_CO_0600	42473	448.69	448.02	453.69	454.24	453.16	450.50	453.22	450.50	72.48	73.86		
808379	68.6	Circular	30	2.90	42475_CO_0400	42474	413.69	411.70	417.69	416.03	417.03	412.87	417.03	412.87	29.01	29.07		
808379	68.6	Circular	30	2.90	42475_CO_0400	42474	413.69	411.70	417.69	416.03	417.03	412.87	417.03	412.87	29.01	29.07		
808867	76.2	Circular	36	0.91	CO_0300	42552	429.21	428.52	433.21	432.52	433.21	430.25	433.21	430.25	45.08	45.08		
Backyard	116.9	Trapezoidal	24	0.00	42534_CO_0500	42533	443.16	442.48	445.16	444.48	443.78	443.10	443.78	443.10	45.59	45.63		
Link10	686.1	Trapezoidal	48	2.16	42552	42475_CO_0400	428.52	413.69	432.52	417.69	430.25	417.03	430.25	417.03	45.08	45.08		
Link11	6.0	Rectangular	30	1.73	Node16	Node17	446.46	446.35	450.46	450.36	450.46	447.43	450.46	447.43	42.67	42.67		
Link12	329.2	Trapezoidal	48	1.73	Node17	42534_CO_0500	446.35	440.66	450.36	445.16	447.43	443.78	447.43	443.78	42.67	42.67		
Link13	180.0	Trapezoidal	24	0.58	42533	Node19	439.98	438.82	444.48	441.82	441.91	441.59	441.92	441.59	60.89	60.93		
Link14	50.0	Trapezoidal	36	0.58	Node19	Node20	438.82	438.53	441.82	442.53	441.59	440.03	441.59	440.03	60.87	60.91		
Link15	100.5	Trapezoidal	48	9.27	Node20	CO_0300	438.53	429.21	442.53	433.21	440.03	433.21	440.03	433.21	60.87	60.91	YES	YES
Link6	174.1	Circular	36	0.67	34657	40188_CO_0700	451.30	450.14	456.54	457.06	454.86	453.48	454.99	453.54	40.53	41.17		
Link7	587.5	Trapezoidal	60	0.25	40188_CO_0700	42472_CO_0600	450.14	448.69	457.06	453.69	453.48	453.16	453.54	453.22	58.64	59.58		
Link8	90.3	Trapezoidal	48	1.73	42473	Node16	448.02	446.46	454.24	450.46	450.50	450.46	450.50	450.46	72.48	73.87	YES	YES
Livesay Basin																		
Link1	169.8	Circular	1	1.00	33740_LI_1200	33742	504.45	502.75	512.76	510.16	512.35	508.96	506.13	506.06	5.87	0.00		
Link13	41.7	Circular	1.5	4.31	34160	42491	429.05	427.25	435.25	432.40	426.66	424.12	431.00	428.29	10.36	13.83		
Link14	185.2	Circular	1	8.09	32573_LI_1100	34374_LI_1000	438.68	423.70	441.61	430.48	434.85	424.00	439.03	424.03	1.88	2.19		
Link15	399.6	Circular	1	3.02	34374_LI_1000	35610	423.47	411.42	430.48	418.42	423.76	412.02	423.99	412.09	2.71	3.02		
Link16	124.8	Circular	1	1.67	35610	35612	411.36	409.27	418.42	412.91	412.02	409.85	412.09	409.89	2.70	3.02		
Link17	252.8	Circular	1	5.17	35612	35607	409.06	395.99	412.91	400.77	409.51	400.77	409.54	400.77	2.70	3.02	YES	YES
Link18	73.6	Circular	1	0.56	35607	35686	395.79	395.38	400.77	397.38	400.77	395.67	400.77	395.61	6.48	4.20		

Table A-4. Hydraulic Model Parameters and Results for 100-yr Storm

					Node Name		Invert Elevation (ft)		Ground Elevation (ft)		Existing Max Water		Future Max Water Surface		Max Flow (cfs)		Flooding at DS Node	
Link ID	Length (ft)	Shape	Diameter/Height (in)	Slope (%)	US	DS	US	DS	US	DS	US	DS	US	DS	Existing	Future	Existing	Future
Link19	96.2	Trapezoidal	2	14.41	35686	39436	395.38	381.52	397.38	383.52	395.67	383.52	395.61	383.52	6.48	4.20	YES	YES
Link2	106.9	Circular	1	1.91	33742	34162_LI_1100	502.55	500.51	510.16	505.96	508.96	506.72	506.06	505.96	5.86	0.00	YES	YES
Link20	61.8	Circular	1	8.24	39436	34997	381.52	376.43	383.52	379.80	383.52	376.89	383.52	376.89	4.09	4.09		
Link21	218.2	Circular	1	5.92	34997	30828_LI_0600	376.23	363.31	379.80	366.90	376.78	363.82	376.78	363.82	4.09	4.09		
Link22	19.2	Circular	1	32.88	30828_LI_0600	39842	362.77	356.46	366.90	368.26	363.12	356.81	363.34	356.81	5.00	5.05		
Link23	198.9	Circular	2	0.88	42491	39313_LI_1000	426.75	425.00	432.40	427.01	424.12	417.80	428.29	426.24	10.37	13.83		
Link24	542.8	Trapezoidal	2	4.63	39313_LI_1000	Node25	425.00	399.89	427.01	401.89	417.80	401.89	425.99	401.89	14.37	17.98	YES	YES
Link25	125.0	Circular	2	3.12	Node25	35607	399.89	395.99	401.89	400.77	401.89	400.77	401.89	400.77	11.28	11.28	YES	YES
Link29	455.6	Circular	1.25	0.39	Node31	Node31.1	508.23	506.44	519.47	512.76	NA[1]	NA[1]	516.07	512.76	NA[1]	4.97		YES
Link29.1	296.1	Circular	1.25	1.70	Node31.1	Node34	506.24	501.21	512.76	506.82	NA[1]	NA[1]	512.76	506.82	NA[1]	9.12		YES
Link3	525.9	Circular	1.25	7.72	34162_LI_1100	34161	500.41	459.83	505.96	465.63	506.72	465.66	505.96	465.63	17.20	16.15	YES	YES
Link30	23.7	Circular	1.25	1.69	Node34	34162_LI_1100	501.01	500.61	506.82	505.96	NA[1]	NA[1]	506.82	505.96	NA[1]	8.84		YES
Link4	241.2	Circular	1.25	4.46	34161	33066	459.84	449.09	465.63	453.44	465.66	453.43	465.63	450.34	12.59	13.83		
Link5	206.8	Circular	1.25	6.95	33066	33065	449.09	434.71	453.44	438.65	453.43	435.98	450.21	436.48	10.36	13.83		
Link6	52.1	Circular	1.25	12.00	33065	34160	435.15	428.90	438.65	435.25	435.80	426.66	436.48	431.00	10.36	13.83		
John Adams Basin																		
804870	183.5	Circular	8	6.02	34767_JA_1100	34309	203.85	192.80	209.10	198.92	209.10	193.47	209.10	193.47	3.22	3.22		
800781	159.3	Circular	16	4.81	34313	33514	160.19	152.53	162.29	171.45	161.08	153.28	161.08	153.28	9.48	9.48		
801568	335.0	Circular	8	4.06	33504	33474	257.58	243.99	261.10	254.51	261.10	254.51	261.10	254.51	1.88	1.88	YES	YES
801573	15.0	Circular	12	28.92	33473	34769	220.25	215.90	226.39	226.95	223.03	220.87	223.03	220.87	6.58	6.58		
802603	417.6	Circular	12	6.93	33505_JA_1400	38651	309.65	280.69	316.50	286.90	314.75	285.04	314.93	285.14	9.05	9.07		
802604	268.7	Circular	8	2.85	33566_JA_1600	34696	321.64	313.99	330.45	318.74	330.45	314.66	330.45	314.66	2.78	2.78		
802606	301.1	Circular	8	8.09	34698	33504	282.51	258.15	289.22	261.10	283.03	261.10	283.03	261.10	2.78	2.78	YES	YES
804813	157.0	Circular	18	6.34	33520	43469	82.29	72.34	96.27	88.74	83.28	77.10	83.28	77.12	12.64	12.64		
804814	78.8	Circular	18	7.00	33519	33520	92.03	86.51	99.89	96.27	93.02	87.25	93.02	87.25	12.61	12.61		
804815	124.1	Circular	18	2.66	33521	34704_WN_0300	68.67	65.37	86.97	73.55	75.31	68.13	75.33	68.15	19.21	19.24		
804841	513.2	Circular	12	2.94	33475_JA_1000	33473	235.76	220.69	243.58	226.39	243.58	223.03	243.58	223.03	6.58	6.58		
804846	64.5	Circular	12	1.18	33469	33508	185.00	184.24	188.90	191.51	188.90	185.23	188.90	185.23	6.27	6.27		
804848	150.6	Circular	24	5.05	33514	33515	152.33	144.73	171.45	153.00	153.03	145.34	153.03	145.34	9.48	9.48		
804851	256.1	Circular	18	8.38	33515	34191_JA_0100	144.53	123.08	153.00	128.90	145.16	128.90	145.16	128.90	9.48	9.48	YES	YES
804860	101.6	Circular	18	3.60	33517_WN_0400	33516	178.61	174.95	185.10	179.60	183.43	179.60	183.43	179.60	14.73	14.73	YES	YES
804861	211.6	Circular	18	6.54	33523	33517_WN_0400	192.64	178.81	201.40	185.10	193.12	183.43	193.12	183.43	5.45	5.45		
804867	274.3	Circular	18	2.49	34311_WN_0500	33523	199.70	192.86	207.50	201.40	200.37	193.48	200.37	193.48	5.45	5.45		
804934	296.9	Circular	8	9.23	38650_JA_1500	33475_JA_1000	263.28	235.87	269.84	243.58	269.84	243.58	269.84	243.58	3.44	3.44	YES	YES
804969	247.9	Circular	8	8.24	33513_JA_0300	33519	113.61	93.18	119.72	99.89	118.80	93.85	118.80	93.85	3.55	3.55		
806396	444.2	Circular	8	8.37	37054	33513_JA_0300	151.18	114.01	162.35	119.72	159.31	118.80	159.31	118.80	3.55	3.55		
806401	131.5	Circular	8	16.53	37059	37054	173.12	151.38	178.38	162.35	173.72	159.31	173.72	159.31	3.55	3.55		
806402	255.5	Circular	10	12.82	37062	37059	206.06	173.32	208.79	178.38	206.49	173.73	206.49	173.73	3.55	3.55		
806406	30.6	Circular	10	2.72	37064	37062	207.09	206.26	210.50	208.79	208.95	207.02	208.95	207.02	3.55	3.55		
806411	253.8	Circular	8	1.92	37070_JA_0500	34769	223.30	218.42	224.81	226.95	224.81	220.87	224.81	220.87	1.40	1.40		
806471	131.0	Circular	18	3.17	37118	37139_WN_0100	50.10	45.95	57.70	53.08	57.70	53.08	57.70	53.08	15.12	15.12	YES	YES
806474	123.1	Circular	18	0.56	37139_WN_0100	37142	45.72	45.03	53.08	53.08	53.08	50.09	53.08	50.09	12.38	12.38		
808623	41.5	Circular	18	0.63	37142	41009	44.93	44.67	53.08	52.70	50.09	48.32	50.09	48.32	12.37	12.37		
808624	19.1	Circular	18	-0.52	43300	43301	43.51	43.61	61.81	61.81	46.43	44.94	46.43	44.94	12.37	12.37		
808704	305.9	Circular	12	2.42	33474	33475_JA_1000	243.75	236.34	254.51	243.58	254.51	243.58	254.51	243.58	6.19	6.19	YES	YES
808721	103.2	Circular	12	6.62	34309	33508	190.32	183.49	198.92	191.51	190.80	183.92	190.80	183.92	3.22	3.22		
812475	29.8	Circular	12	4.05	36378	34534	163.75	162.54	168.58	167.42	168.58	166.00	168.58	166.00	6.69	6.69		
812477	198.1	Circular	12	4.42	33516	36378	172.70	163.95	179.60	168.58	179.60	168.58	179.60	168.58	7.33	7.33	YES	YES

1. Existing model based on infrastructure in place in 2017. Future conditions model includes recently installed infrastructure.

Table A-4. Hydraulic Model Parameters and Results for 100-yr Storm

					Node Name		Invert Elevation (ft)		Ground Elevation (ft)		Existing Max Water		Future Max Water Surface		Max Flow (cfs)		Flooding at DS Node	
Link ID	Length (ft)	Shape	Diameter/Height (in)	Slope (%)	US	DS	US	DS	US	DS	US	DS	US	DS	Existing	Future	Existing	Future
812478	100.6	Circular	12	3.01	34534	43051	162.24	159.21	167.42	163.93	166.00	160.78	166.00	160.78	6.66	6.66		
812479	194.4	Circular	12	4.18	43051	43050	159.11	150.99	163.93	155.49	160.78	151.78	160.78	151.78	6.47	6.47		
812692	119.5	Circular	18	0.80	41009	43300	44.57	43.61	52.70	61.81	48.32	46.43	48.32	46.43	12.37	12.37		
812695	158.3	Circular	54	18.38	43301	39733	43.51	14.40	61.81	19.40	43.94	14.79	43.94	14.79	12.37	12.37		
812816	39.8	Circular	18	8.12	43469	33521	72.10	68.87	88.74	86.97	77.10	75.31	77.12	75.33	12.71	12.72		
Link43	393.4	Circular	12	9.22	38651	33474	280.27	243.99	286.90	254.51	285.04	254.51	285.14	254.51	9.02	9.04	YES	YES
Link44	240.8	Circular	8	12.78	34696	34698	313.57	282.80	318.74	289.22	314.00	283.21	314.00	283.21	2.78	2.78		
Link45	276.4	Circular	8	1.36	34692_JA_1300	37087	242.56	238.80	250.94	248.38	393.18	248.38	393.18	248.38	15.81	15.81	YES	YES
Link46	256.7	Circular	8	3.82	37087	33491_JA_0200	238.60	228.79	248.38	234.43	248.38	234.43	248.38	234.43	2.72	2.72	YES	YES
Link47	259.8	Circular	8	7.96	33491_JA_0200	37064	227.98	207.29	234.43	210.50	234.43	208.95	234.43	208.95	3.55	3.55		
Link48	262.9	Circular	12	13.33	34769	33469	220.25	185.20	226.95	188.90	220.87	188.90	220.87	188.90	7.94	7.94	YES	YES
Link49	225.3	Circular	16	8.60	33508	34313	179.51	160.14	191.51	162.29	180.16	161.08	180.16	161.08	9.48	9.48		
Link54	132.7	Circular	18	11.25	34704_WN_0300	37118	65.33	50.40	73.55	57.70	68.13	57.70	68.15	57.70	22.26	22.28	YES	YES
Link55	249.5	Circular	12	10.53	43050	Node58	150.49	124.22	155.49	126.51	151.10	124.78	151.10	124.78	6.48	6.48		
Link56	122.1	Circular	12	10.53	Node58	Node59	124.02	111.16	126.51	114.00	124.67	111.72	124.67	111.72	6.46	6.46		
Link57	257.4	Circular	12	10.44	Node59	33521	110.96	84.08	114.00	86.97	111.57	84.64	111.57	84.64	6.45	6.45		
Link58	291.0	Circular	15	2.29	34191_JA_0100	34192	116.25	109.60	128.90	120.42	128.90	120.42	128.90	120.42	9.89	9.89	YES	YES
Link59	121.6	Circular	12	6.76	34192	41014	109.22	101.00	120.42	109.91	120.42	109.50	120.42	109.50	9.09	9.09		
Link60	192.3	Circular	12	4.46	41014	33519	100.71	92.13	109.91	99.89	109.50	93.13	109.50	93.13	9.07	9.07		
Park Place Basin																		
801099	22.4	Circular	24	1.30	30675	30674	111.81	111.52	114.51	114.42	113.82	113.41	113.82	113.41	11.91	11.91		
801520	86.9	Circular	30	2.60	34163	34164	189.81	187.55	201.50	194.73	190.96	188.49	190.96	188.49	16.26	16.26		
801521	75.8	Circular	30	3.03	34164	34511	187.35	185.05	194.73	192.57	188.49	185.89	188.49	185.89	16.26	16.26		
801522	146.7	Circular	30	0.46	34166	34163	190.69	190.01	195.75	201.50	192.45	191.37	192.45	191.37	16.26	16.26		
804027	51.3	Circular	30	5.92	40789_PP_0800	40790	220.63	217.59	223.90	220.09	223.50	218.68	223.58	218.70	23.83	24.61		
806132	80.2	Circular	24	0.26	30676	36849	112.88	112.67	116.68	115.17	114.94	114.31	114.94	114.31	11.91	11.91		
806133	38.7	Circular	24	1.45	36849	30675	112.57	112.01	115.17	114.51	114.31	113.82	114.31	113.82	11.91	11.91		
806138	409.7	Circular	15	4.13	36853	30676	130.15	113.23	134.95	116.68	133.01	114.94	133.01	114.94	11.91	11.91		
806331	7.1	Circular	24	5.33	41420	37021	145.72	145.34	148.22	147.94	148.22	147.09	148.22	147.10	15.07	15.07		
808078	41.1	Circular	24	1.17	30674	38518	111.62	111.14	114.42	113.64	113.41	112.91	113.41	112.91	11.91	11.91		
808079	9.4	Circular	24	-1.39	38518	PP_0500	110.86	110.99	113.64	113.49	112.91	112.49	112.91	112.49	11.91	11.91		
809819	37.6	Circular	24	2.10	37021	41421_PP_0600	145.34	144.55	147.94	147.05	147.09	146.29	147.10	146.30	15.07	15.07		
809820	47.5	Circular	24	1.56	41350	36853	130.99	130.25	133.49	134.95	133.49	133.01	133.49	133.01	12.21	12.18		
812683	109.8	Circular	18	7.07	43287_PP_1000	43288_PP_0900	262.76	255.00	264.56	263.56	264.56	255.89	264.56	255.90	7.05	7.05		
Link17	32.9	Circular	24	16.70	33393	34166	197.00	191.50	199.50	195.75	199.50	192.45	199.50	192.45	16.26	16.26		
Link18	28.6	Circular	36	3.71	34511	PP_0700	182.06	181.00	192.57	192.00	183.25	182.09	183.25	182.09	16.26	16.26		
Link20	116.2	Circular	24	3.58	40854	40855	98.78	94.62	103.38	98.50	103.38	96.03	103.38	96.03	25.19	25.19		
Link21	114.7	Circular	30	7.12	41341	36790_PP_0300	89.66	81.50	93.79	90.65	92.65	82.32	92.65	82.32	25.19	25.19		
Link22	69.7	Circular	36	18.65	36790_PP_0300	41342	81.50	68.50	90.65	80.85	82.32	69.12	82.32	69.12	25.19	25.19		
Link23	628.5	Trapezoidal	30	5.47	43288_PP_0900	40789_PP_0800	255.00	220.63	263.56	223.90	255.89	223.50	255.90	223.58	15.24	15.80		
Link24	389.1	Trapezoidal	30	5.29	40790	33393	217.59	197.00	220.09	199.50	218.68	199.50	218.70	199.50	23.82	24.60	YES	YES
Link27	416.8	Trapezoidal	30	3.25	41421_PP_0600	41350	144.55	130.99	147.05	133.49	146.29	133.49	146.30	133.49	54.93	55.79	YES	YES
Link28	567.6	Trapezoidal	30	2.15	PP_0500	40854	110.99	98.78	113.49	103.38	112.49	103.38	112.49	103.38	31.72	31.71	YES	YES
Link29	270.3	Trapezoidal	30	1.84	40855	41341	94.62	89.66	98.50	93.79	96.03	92.65	96.03	92.65	25.19	25.19		
Link31	718.8	Trapezoidal	30	5.60	PP_0700	41420	181.00	145.72	192.00	148.22	182.09	148.22	182.09	148.22	22.74	22.74	YES	YES

Table A-4. Hydraulic Model Parameters and Results for 100-yr Storm

					Node Name		Invert Elevation (ft)		Ground Elevation (ft)		Existing Max Water		Future Max Water Surface		Max Flow (cfs)		Flooding at DS Node	
Link ID	Length (ft)	Shape	Diameter/Height (in)	Slope (%)	US	DS	US	DS	US	DS	US	DS	US	DS	Existing	Future	Existing	Future
Singer Creek Basin																		
800363	257.5	Circular	36	3.20	39390_SI_0500	33815	206.45	198.22	218.52	205.18	208.25	199.81	208.14	199.52	45.05	38.83		
803639	45.1	Rectangular	30	0.55	34189	35537	167.56	167.31	174.46	174.00	173.05	171.26	173.05	171.26	44.47	44.47		
803641	165.3	Rectangular	30	2.81	35540	34189	172.21	167.56	177.61	174.46	176.49	173.05	176.49	173.05	44.48	44.47		
803643	10.1	Rectangular	30	1.58	SI_0300	35540	172.37	172.21	177.80	177.61	177.80	176.49	177.80	176.49	44.48	44.47		
804123	131.4	Rectangular	30	1.65	35900	SI_0300	174.74	172.37	180.04	177.80	179.71	177.80	179.71	177.80	35.57	35.57	YES	YES
804124	57.9	Rectangular	30	2.02	35902	35900	175.91	174.74	180.96	180.04	180.96	179.71	180.96	179.71	35.57	35.57		
804125	114.9	Rectangular	30	2.34	35903	35902	178.60	175.91	185.01	180.96	183.78	180.96	183.06	180.96	45.04	38.82	YES	YES
804126	124.7	Rectangular	30	2.57	34190	35903	181.81	178.60	189.08	185.01	186.74	183.78	185.27	183.06	45.04	38.82		
804191	308.3	Rectangular	30	4.28	33815	35985	198.22	185.02	205.18	191.23	199.81	189.13	199.52	187.13	45.04	38.84		
804192	84.1	Rectangular	30	3.82	35985	34190	185.02	181.81	191.23	189.08	189.13	186.74	187.13	185.27	45.04	38.82		
804812	212.8	Rectangular	30	2.11	34187	35594	165.13	160.43	171.23	165.19	167.28	162.38	167.28	162.38	44.47	44.47		
806469	153.9	Rectangular	30	3.91	37138	36507_SI_0400	158.98	152.96	164.15	159.74	160.12	155.26	160.12	155.12	44.51	44.48		
806470	94.8	Rectangular	30	1.32	35594	37138	160.43	158.98	165.19	164.15	162.38	160.12	162.38	160.12	44.48	44.47		
Link14	94.4	Circular	36	2.90	40796_SI_0600	40797	218.02	215.28	221.02	220.00	219.29	216.99	219.18	216.69	29.92	25.81		
Link15	156.0	Trapezoidal	36	0.55	40797	Inlet	215.28	214.42	220.00	225.00	216.99	216.98	216.69	216.65	29.62	25.62		
Link15.1	94.0	Circular	36	0.50	Inlet	40897	214.42	213.95	225.00	229.48	216.98	216.82	216.65	216.52	29.40	25.45		
Link16	240.5	Circular	36	2.89	36023	39390_SI_0500	213.41	206.45	229.61	218.52	214.74	208.25	214.63	208.14	29.39	25.44		
Link17	19.1	Circular	36	2.81	40897	36023	213.95	213.41	229.48	229.61	216.82	214.74	216.52	214.63	29.40	25.45		
Link18	192.9	Rectangular	30	1.13	35537	34187	167.31	165.13	174.00	171.23	171.26	167.28	171.26	167.28	44.47	44.49		
Link19	115.4	Rectangular	30	4.30	36507_SI_0400	42737	152.96	148.00	159.74	151.00	155.26	149.53	155.12	149.47	72.61	68.62		
South End Basin																		
2	40.1	Circular	30	0.30	39657	39658	428.74	428.62	433.30	433.56	432.07	431.10	432.11	431.10	59.96	60.81		
681.1	40.1	Circular	30	0.30	39657	39658	428.74	428.62	433.30	433.56	432.07	431.10	432.11	431.10	28.47	28.98		
800101	225.2	Trapezoidal	24	0.76	40224	38962	450.92	449.20	453.42	451.20	452.09	451.20	452.09	451.20	26.12	26.13	YES	YES
800102	53.6	Trapezoidal	24	2.42	38963	30628	448.92	448.12	450.92	450.12	450.13	450.12	450.13	450.12	10.21	10.25	YES	YES
800823	249.0	Circular	30	0.65	33801	33800	446.64	445.01	452.50	449.78	449.72	449.63	449.72	449.63	7.41	7.40		
800824	33.2	Circular	18	4.16	30628	33801	448.12	446.74	450.12	452.50	450.12	449.72	450.12	449.72	7.57	7.54		
801783	37.0	Circular	12	1.54	33800	42854	445.01	444.44	449.78	447.80	449.63	447.01	449.63	447.01	7.37	7.38		
802067	213.1	Circular	24	0.40	33531_SE_1300	33530	455.40	454.55	461.95	459.99	461.27	458.68	461.27	458.68	19.29	19.25		
802192	20.1	Circular	30	0.10	33899	40224	450.94	450.92	455.75	453.42	452.90	452.09	452.90	452.09	26.12	26.13		
802326	286.5	Circular	60	0.28	32462_SE_1200	34366	435.93	435.14	440.93	447.02	438.08	437.58	438.10	437.60	29.09	29.42		
802787	32.5	Circular	18	0.00	38962	38963	449.20	448.92	451.20	450.92	451.20	450.13	451.20	450.13	7.97	7.97		
803617	221.5	Circular	15	1.46	35517_SE_1400	33531_SE_1300	458.84	455.60	465.59	461.95	465.59	461.27	465.59	461.27	9.46	9.54		
807270	476.7	Circular	30	0.30	37785_SE_1000	33899	452.38	450.94	458.00	455.75	455.81	452.90	455.82	452.90	26.12	26.13		
807271	119.5	Circular	30	0.00	37787	37785_SE_1000	452.74	452.38	459.02	458.00	456.47	455.81	456.47	455.82	19.17	19.17		
808402	204.7	Trapezoidal	24	0.29	38973_SE_0800	39657	429.34	428.74	433.34	433.30	432.16	432.07	432.19	432.11	88.43	89.80		
808415	100.2	Trapezoidal	24	0.51	39658	42487	428.62	428.11	433.56	431.11	431.10	431.11	431.10	431.11	88.43	89.80	YES	YES
808417	58.9	Circular	36	4.16	42487	39582	428.11	425.66	431.11	428.66	431.11	426.68	431.11	426.68	31.29	31.29		
809300	116.5	Circular	15	1.52	33535_SE_1600	35517_SE_1400	460.81	459.04	468.36	465.59	468.36	465.59	468.36	465.59	7.84	7.84	YES	YES
809303	93.7	Circular	12	1.10	32769_SE_1500	33531_SE_1300	456.63	455.60	461.31	461.95	461.31	461.27	461.31	461.27	3.37	3.37		
809312	433.6	Circular	30	0.30	33530	37788	454.55	453.25	459.99	459.22	458.68	457.24	458.68	457.24	19.18	19.18		
809724	17.8	Circular	60	1.12	34366	34365_SE_1100	434.94	434.74	447.02	446.54	437.58	437.39	437.60	437.41	29.05	29.39		
Link20	166.2	Circular	30	0.31	37788	37787	453.25	452.74	459.22	459.02	457.24	456.47	457.24	456.47	19.18	19.17		
Link21	369.9	Circular	12	0.00	32798_SE_1000	34786	451.89	449.90	456.04	452.42	452.56	450.36	452.56	450.36	1.59	1.59		
Link23	84.9	Circular	12	1.68	34786	Node65	449.90	448.47	452.42	450.47	450.36	448.89	450.36	448.90	1.59	1.59		
Link24	92.2	Trapezoidal	24	1.68	Node65	Node66	448.47	446.92	450.47	448.92	448.72	447.77	448.72	447.77	1.59	1.59		
Link25	22.2	Circular	12	1.68	Node66	Node67	446.92	446.55	448.92	448.55	447.77	447.18	447.77	447.19	1.58	1.59		

Table A-4. Hydraulic Model Parameters and Results for 100-yr Storm

					Node Name		Invert Elevation (ft)		Ground Elevation (ft)		Existing Max Water		Future Max Water Surface		Max Flow (cfs)		Flooding at DS Node	
Link ID	Length (ft)	Shape	Diameter/Height (in)	Slope (%)	US	DS	US	DS	US	DS	US	DS	US	DS	Existing	Future	Existing	Future
Link26	85.9	Trapezoidal	24	1.68	Node67	Node68	446.55	445.11	448.55	447.11	447.18	447.11	447.19	447.11	4.97	5.04	YES	YES
Link31	156.4	Circular	12	6.03	42854	34365_SE_1100	444.37	434.94	447.80	446.54	447.01	437.39	447.01	437.41	7.52	7.52		
Link33	52.5	Circular	12	1.02	Node68	42854	445.11	444.57	447.11	447.80	447.11	447.01	447.11	447.01	1.31	1.32		
Link36	322.9	Circular	48	1.10	34761_SE_0900	38973_SE_0800	432.88	429.34	438.14	433.34	435.39	432.16	435.43	432.19	70.84	72.22		
Link37	207.7	Circular	54	0.24	34365_SE_1100	Node70	434.74	434.24	446.54	441.95	437.39	436.40	437.41	436.43	44.22	44.69		
Link38	172.0	Circular	54	0.56	Node70	34761_SE_0900	434.04	433.08	441.95	438.14	436.40	435.39	436.43	435.43	44.21	44.68		
Newell Creek Basin at Molalla Avenue and Beaver Creek Road																		
800688	160.5	Circular	48	3.51	34994	39666	417.02	411.38	430.02	415.38	418.99	412.82	418.99	412.83	69.66	69.78		
800690	39.8	Circular	12	1.66	34611	30023	423.69	423.03	429.34	430.16	429.34	426.35	429.34	426.36	6.61	6.61		
800854	442.7	Circular	42	0.82	39740_NE_1900	34616	433.01	429.39	436.51	436.91	433.44	430.07	433.44	430.08	2.71	2.77		
801962	148.0	Circular	15	3.87	34604	34603	438.50	432.77	441.90	437.52	439.41	435.81	439.41	435.82	6.99	6.99		
801965	205.9	Circular	15	0.43	34605_NE_3100	34604	439.49	438.60	444.01	441.90	443.16	439.66	443.16	439.66	7.00	7.00		
801981	230.0	Circular	18	1.54	30056_NE_3100	37259	435.30	431.75	439.36	433.77	436.14	432.53	436.14	432.53	6.13	6.13		
803140	168.1	Circular	42	0.78	30021	30023	424.29	422.98	431.51	430.16	427.70	426.35	427.72	426.36	55.86	55.99		
803172	61.7	Circular	12	0.66	30030_NE_2200	30027	426.11	425.70	434.39	433.37	434.39	432.70	434.39	432.70	4.79	4.79		
803176	159.5	Circular	12	0.92	30027	30025	425.53	424.07	433.37	430.71	432.70	429.57	432.70	429.57	4.76	4.78		
803179	78.3	Circular	12	0.57	30025	30024	423.92	423.47	430.71	430.26	429.57	427.54	429.57	427.54	4.75	4.76		
803180	27.5	Circular	12	0.87	30024	30023	423.45	423.21	430.26	430.16	427.54	426.35	427.54	426.36	4.75	4.76		
806619	6.3	Circular	48	0.00	37234	37235	426.45	426.45	433.20	433.20	429.49	429.49	429.50	429.51	-31.61	-31.97		
806620	267.8	Circular	42	0.68	37234	30021	426.45	424.63	433.20	431.51	429.49	427.70	429.50	427.72	55.90	56.04		
807452	59.3	Circular	12	-4.99	37903	37901	423.40	426.36	427.94	430.44	427.94	426.94	427.94	426.94	2.88	2.88		
807453	135.4	Circular	12	2.29	37238_NE_2200	37903	428.50	425.40	430.54	427.94	430.54	427.94	430.54	427.94	4.04	4.04	YES	YES
808393	446.8	Circular	42	0.81	39739_NE_1900	34615	432.99	429.39	436.49	436.91	434.95	431.08	434.99	431.11	39.39	40.37		
Link18	394.5	Circular	48	0.49	34615	41521	428.89	426.95	436.91	432.42	431.08	429.58	431.11	429.60	39.37	40.30		
Link19	82.1	Circular	48	0.49	41521	37235	426.95	426.55	432.42	433.20	429.58	429.49	429.60	429.51	46.39	47.31		
Link20	410.9	Circular	48	0.67	37235	34611	426.45	423.69	433.20	429.34	429.49	429.34	429.51	429.34	20.47	21.29	YES	YES
Link21	9.3	Circular	42	3.23	30023	Node35	423.03	422.73	430.16	429.89	426.35	424.60	426.36	424.60	66.78	66.90		
Link22	168.9	Circular	48	3.38	Node35	34994	422.73	417.02	429.89	430.02	424.60	418.99	424.60	418.99	69.66	69.78		
Link23	98.6	Circular	12	3.68	37901	Node35	426.36	422.73	430.44	429.89	426.94	424.60	426.94	424.60	2.88	2.88		
Link24	309.6	Circular	15	1.44	34603	42867	432.77	428.30	437.52	432.33	435.81	430.93	435.82	430.94	6.99	6.99		
Link25	45.0	Circular	15	2.77	42867	41521	428.20	426.95	432.33	432.42	430.93	429.58	430.94	429.60	6.99	6.99		
Link26	158.4	Circular	48	0.80	34616	35735_NE_1600	428.89	427.62	436.91	434.20	430.07	430.07	430.08	430.08	2.89	2.95		
Link27	203.9	Circular	48	0.34	35735_NE_1600	41522	427.62	426.93	434.20	432.04	430.07	429.78	430.08	429.80	23.95	24.08		
Link28	114.2	Circular	48	0.34	41522	37234	426.93	426.55	432.04	433.20	429.78	429.49	429.80	429.50	30.05	30.12		
Link29	85.4	Circular	15	5.64	37259	41522	431.75	426.93	433.77	432.04	432.53	429.78	432.53	429.80	6.12	6.12		

Figures

Figure 1. Central Point Basin/Central Point Models

Figure 2. Coffee Creek Basin/Coffee Creek Model

Figure 3. Livesay Basin/Holcomb Street Model

Figure 4. John Adams & Willamette North Basins/John Adams Model

Figure 5. Park Place Basin/Park Place Model

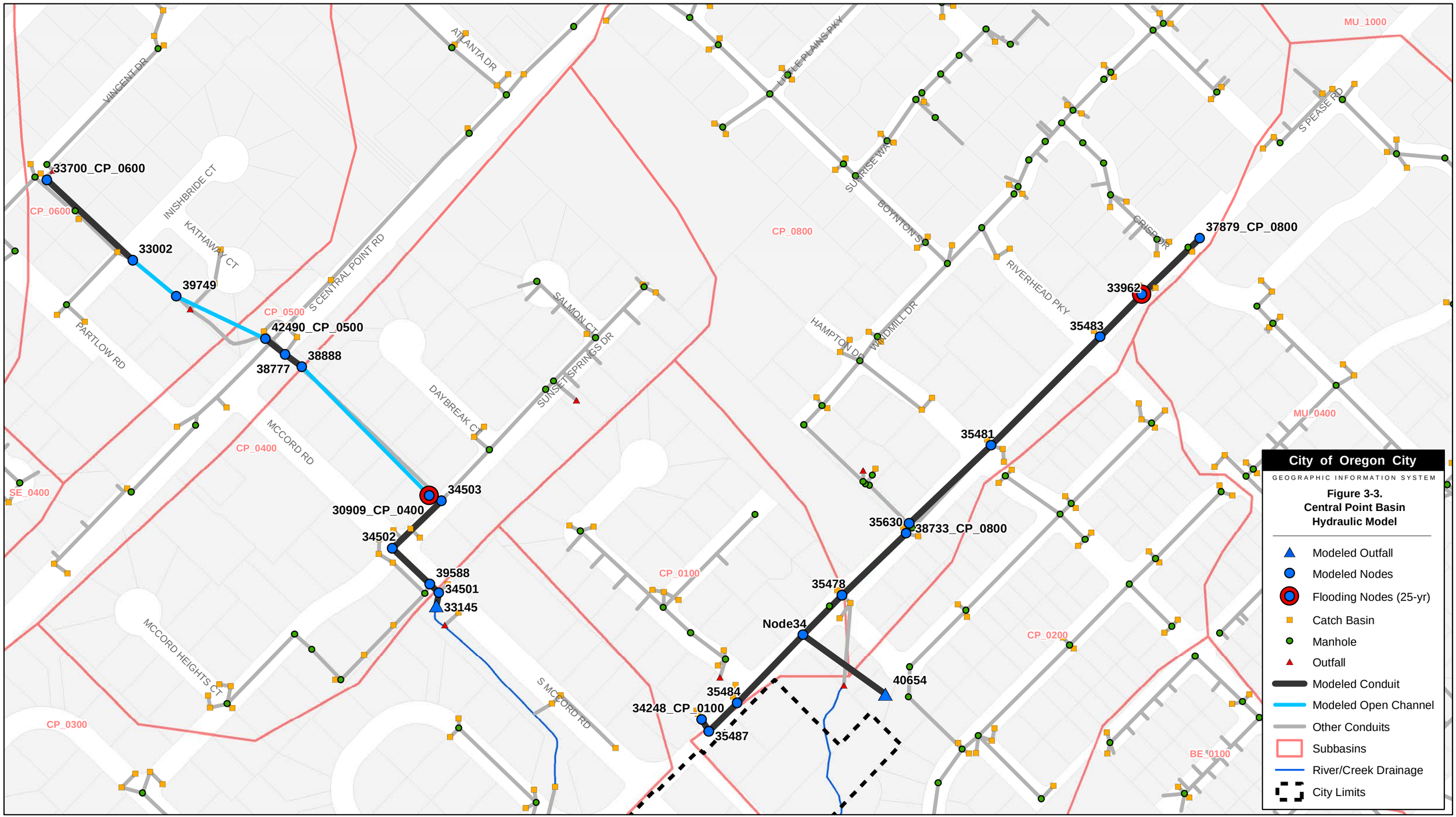
Figure 6. Singer Creek Basin/Singer Creek Model

Figure 7. South End Basin/South End Modeling Area

Figure 8. Newell Creek Basin/Beavercreek Road & Molalla Avenue Model

Figure 9. Problem Areas

Use of contents on this sheet is subject to the limitations specified at the beginning of this document.



City of Oregon City

GEOGRAPHIC INFORMATION SYSTEM

Figure 3-3.
Central Point Basin
Hydraulic Model

- Modeled Outfall
- Modeled Nodes
- Flooding Nodes (25-yr)
- Catch Basin
- Manhole
- Outfall
- Modeled Conduit
- Modeled Open Channel
- Other Conduits
- Subbasins
- River/Creek Drainage
- City Limits

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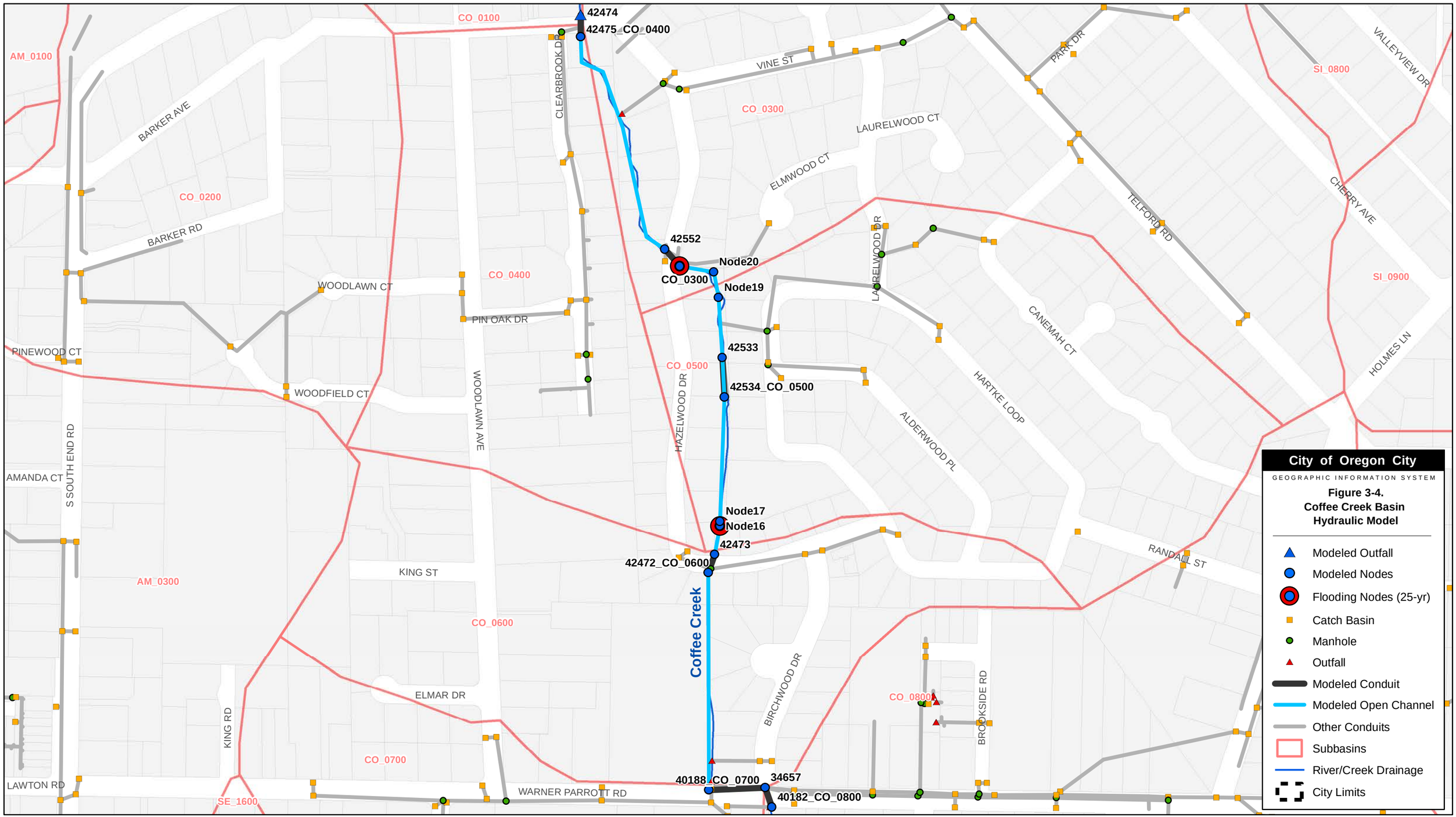
N W E S

0 200 400 800 1,200 Feet

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Plot date: June 20, 2017
Plot name: Figure 3-3 Central Point Basin.pdf
Map name: Figure 3-3 Central Point Basin.mxd



City of Oregon City

GEOGRAPHIC INFORMATION SYSTEM

Figure 3-4.
Coffee Creek Basin
Hydraulic Model

- Modeled Outfall
- Modeled Nodes
- Flooding Nodes (25-yr)
- Catch Basin
- Manhole
- Outfall
- Modeled Conduit
- Modeled Open Channel
- Other Conduits
- Subbasins
- River/Creek Drainage
- City Limits

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N W E S

0 250 500 1,000 1,500 Feet

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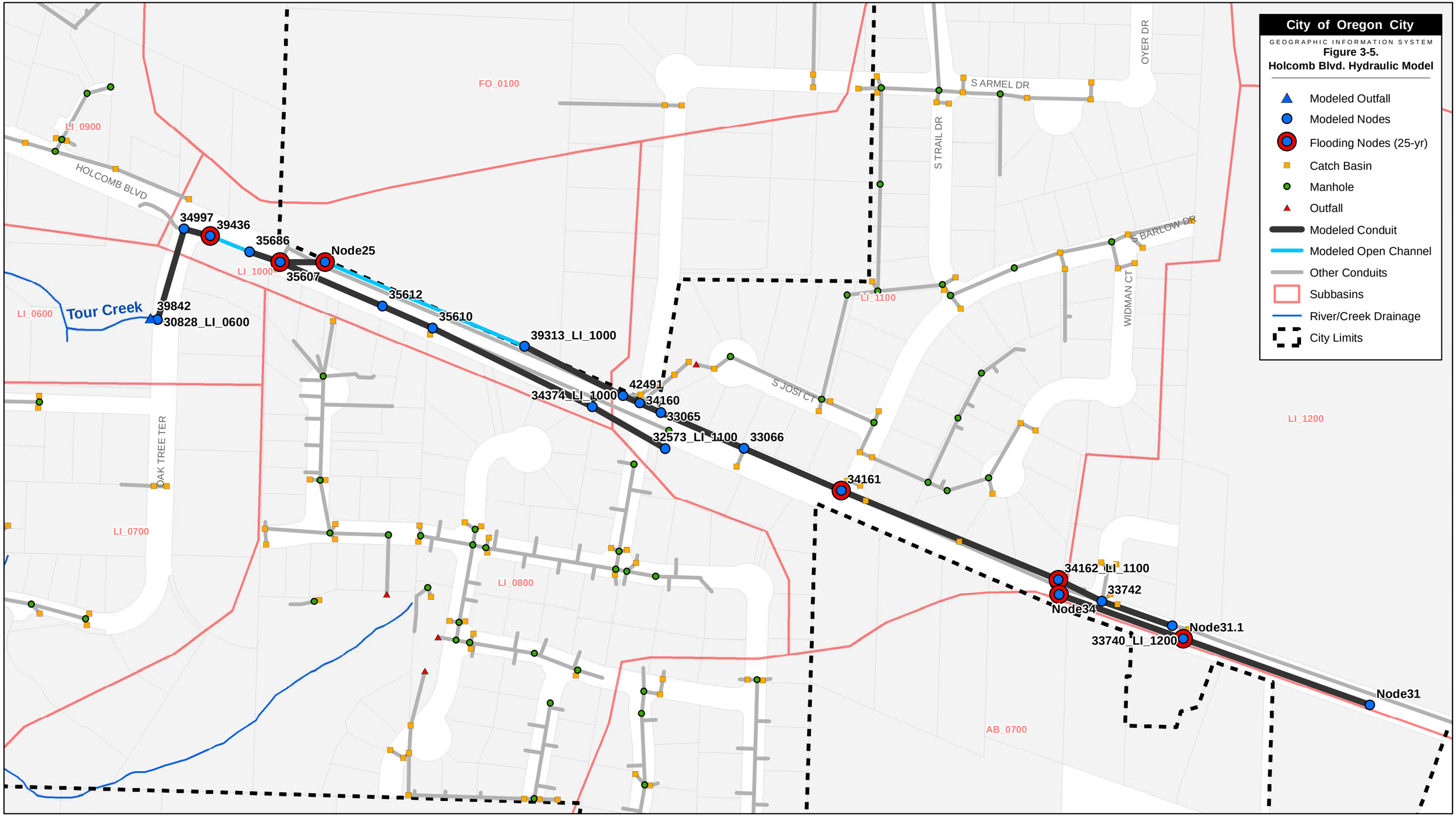
Plot date: June 20, 2017
Plot name: Figure 3-4 Coffee Creek Basin.pdf
Map name: Figure 3-4 Coffee Creek Basin.mxd

City of Oregon City

GEOGRAPHIC INFORMATION SYSTEM

Figure 3-5.
Holcomb Blvd. Hydraulic Model

- Modeled Outfall
- Modeled Nodes
- Flooding Nodes (25-yr)
- Catch Basin
- Manhole
- Outfall
- Modeled Conduit
- Modeled Open Channel
- Other Conduits
- Subbasins
- River/Creek Drainage
- City Limits



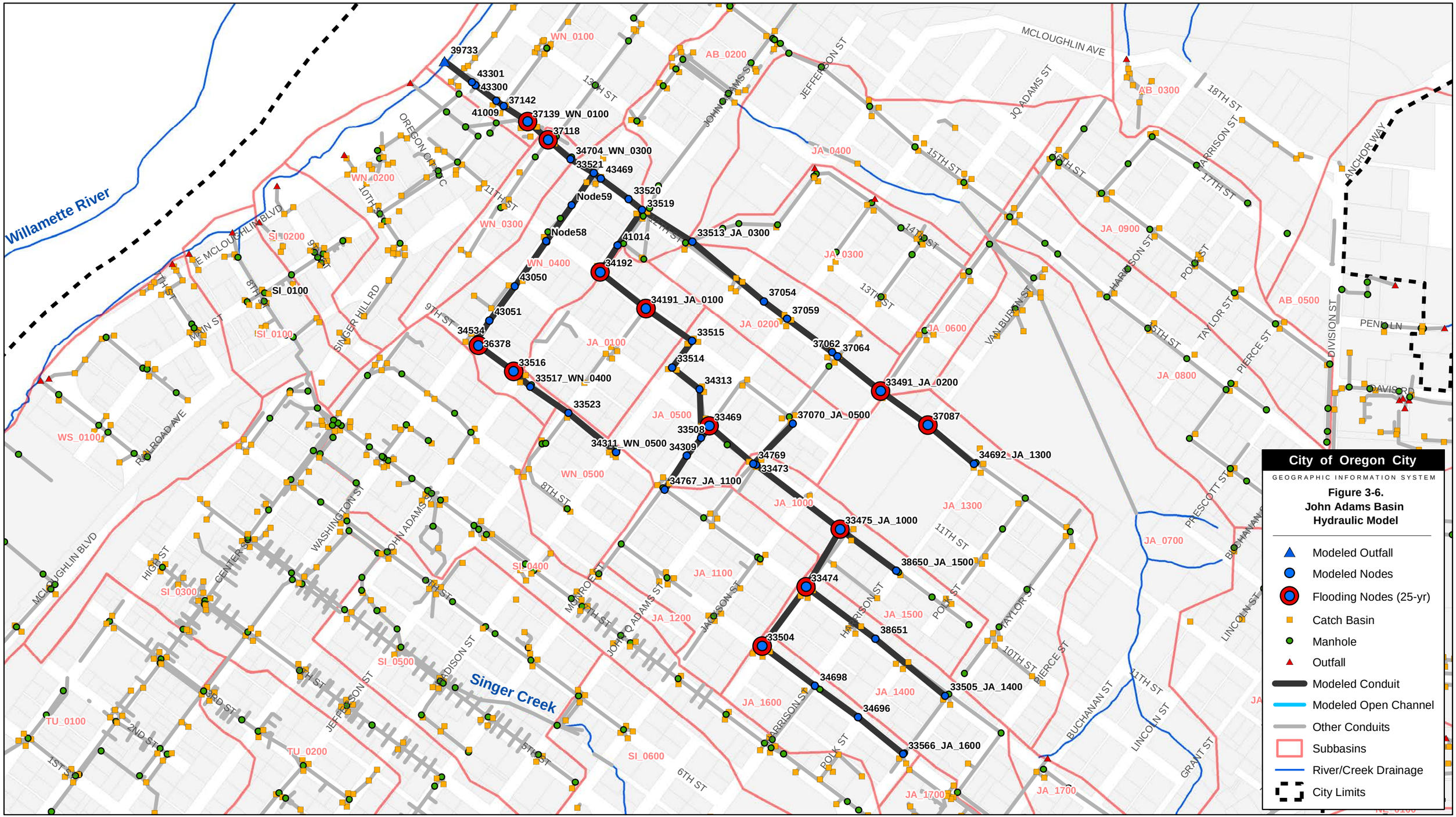
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0 200 400 800 1,200 Feet

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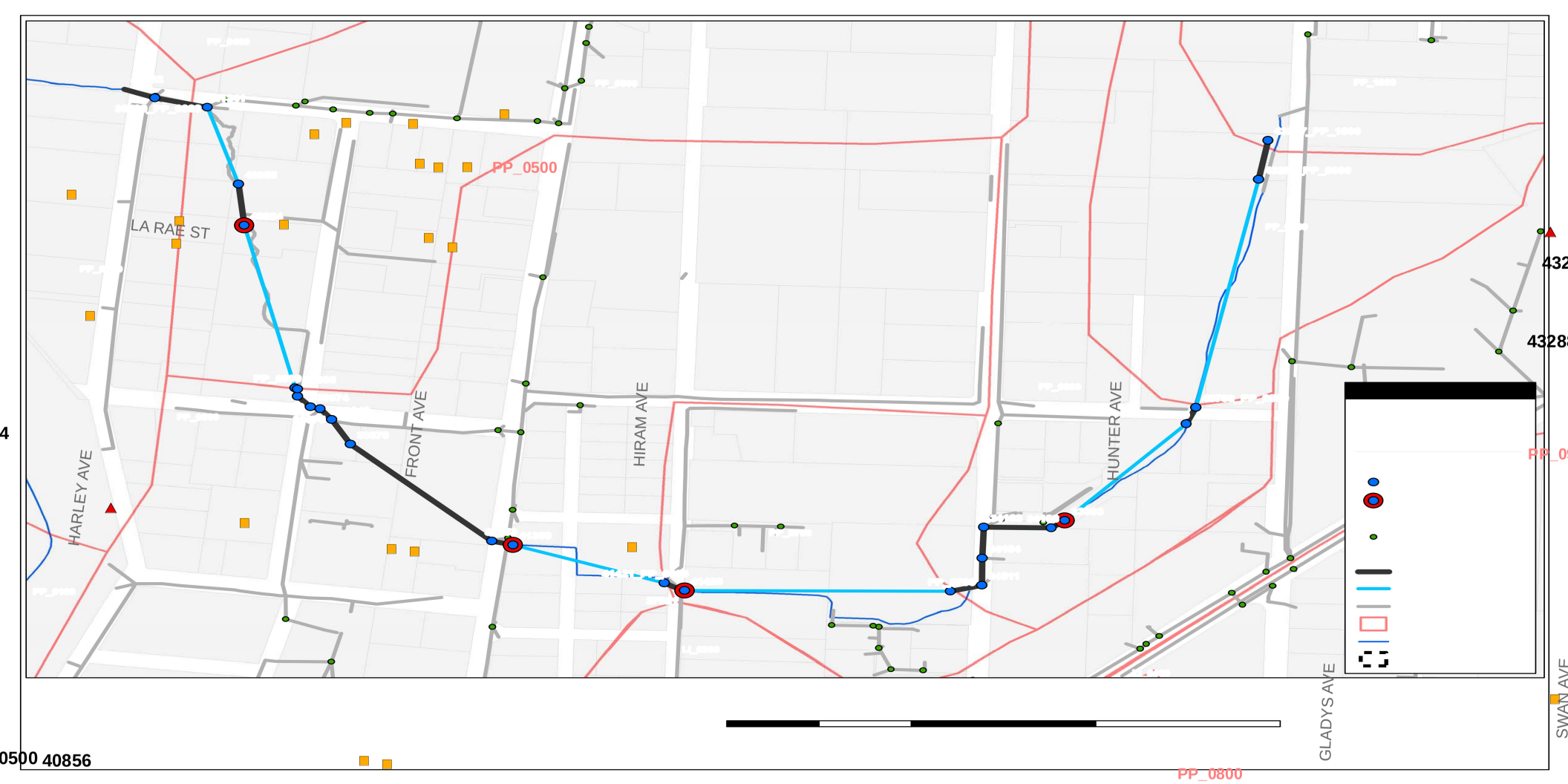
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Map name: Figure 3-5 Livesay Basin.mxd

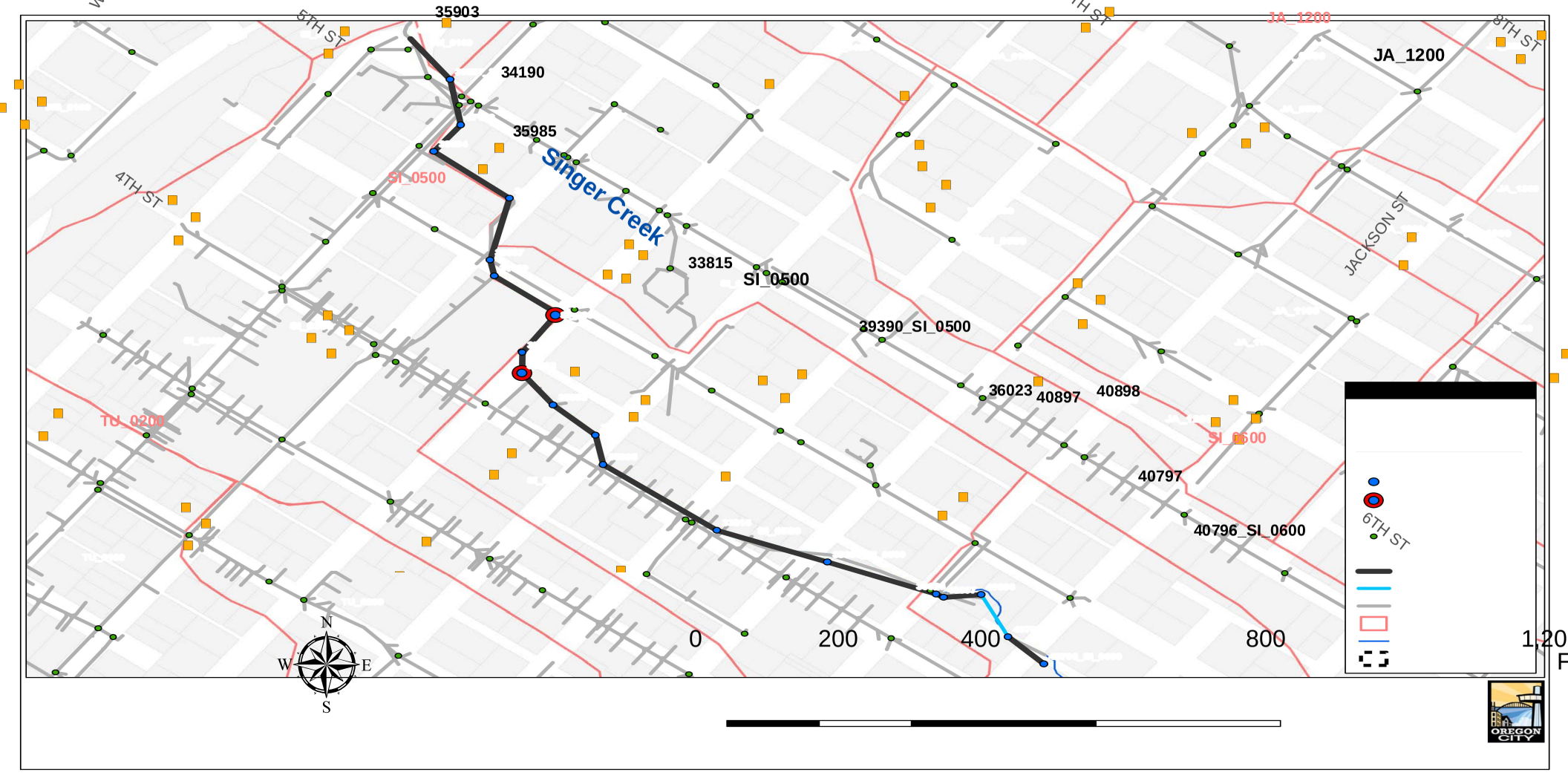


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Plot date: June 22, 2017
Plot name: Figure 3-6 John Adams Basin.pdf
Map name: Figure 3-6 John Adams Basin.mxd


PP_0500
LA RAE ST
HARLEY AVE
FRONT AVE
HIRAM AVE
HUNTER AVE
GLADYS AVE
SWAN AVE
PP_0800
0500 40856


35903
34190
35985
Singer Creek
SI_0500
33815
SI_0500
39390_SI_0500
36023
40897
40898
40797
40796_SI_0600
JA_1200
JACKSON ST
5TH ST
4TH ST
6TH ST
8TH ST
TU_0200
0
200
400
800
1,20
N
W
E
S

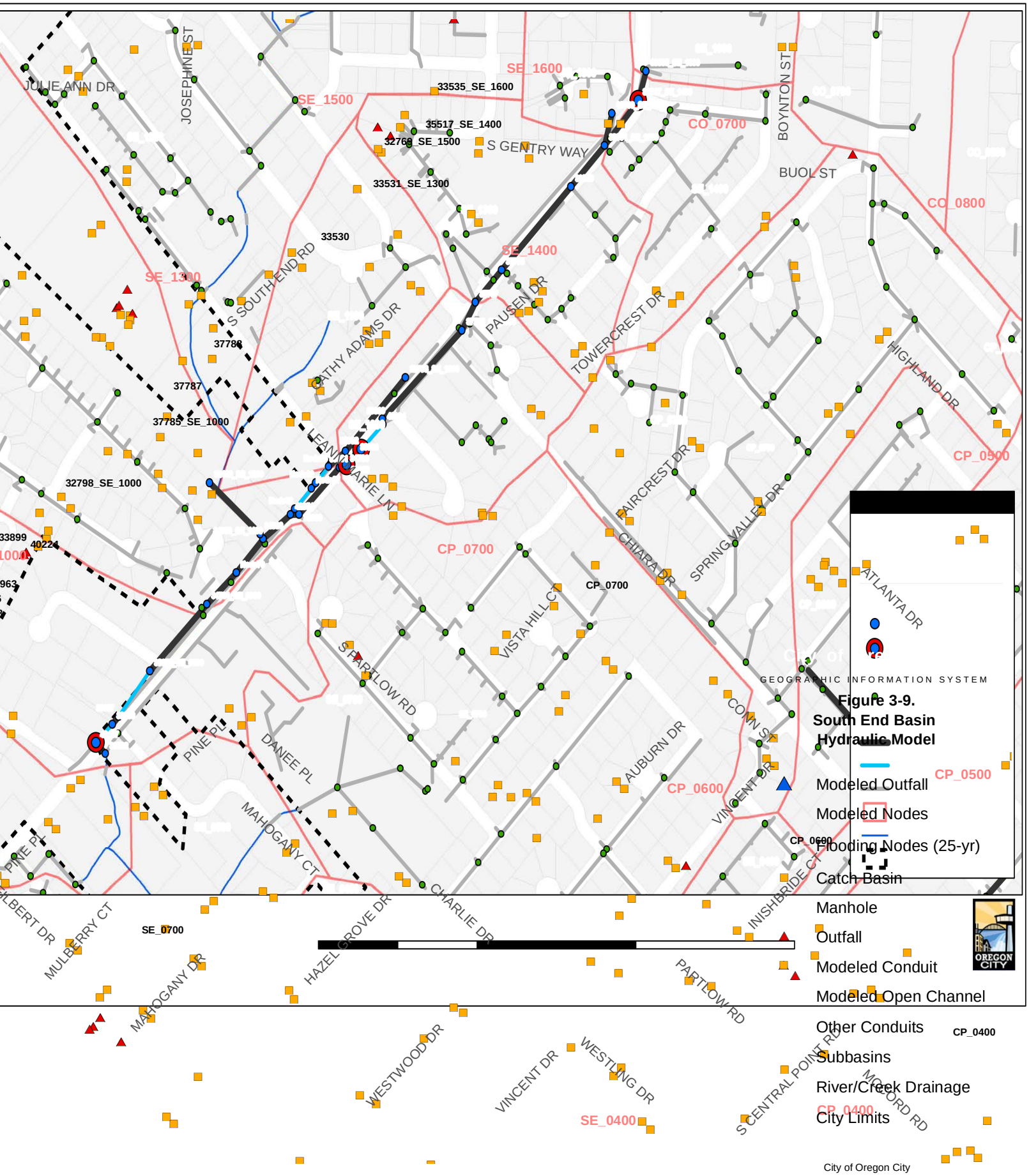
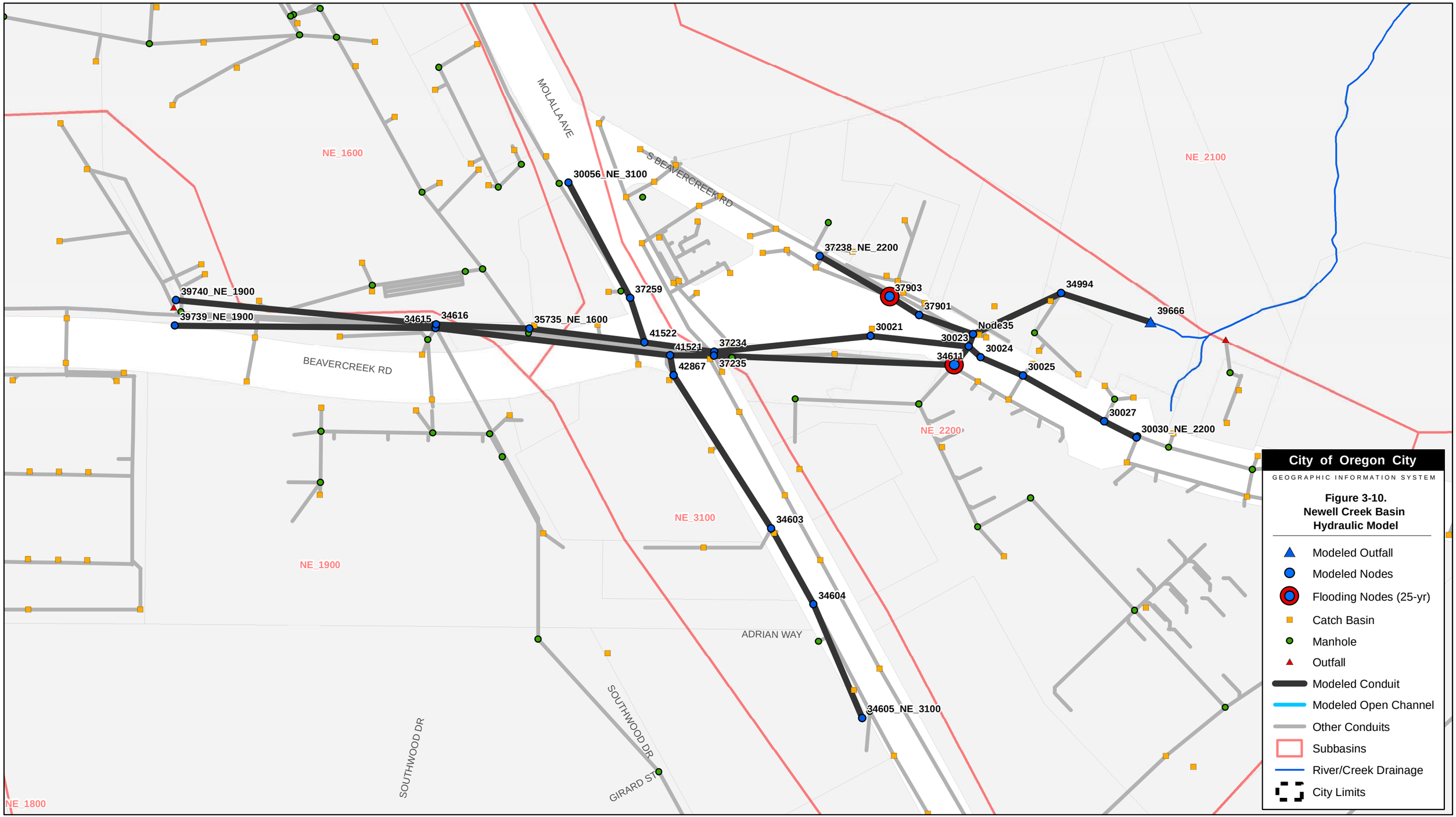


Figure 3-9.
South End Basin
Hydraulic Model

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Plot date: June 20, 2017
Plot name: Figure 3-9 South End Basin.pdf
Map name: Figure 3-9 South End Basin.mxd



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N
W E
S

0 150 300 600 900 Feet

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Plot date: June 20, 2017
Plot name: Figure 3-10 Newell Creek Basin.pdf
Map name: Figure 3-10 Newell Creek Basin.mxd

Legend

- Conduit
- Ditch
- Newell Canyon Outfalls
- Basin Boundaries
- Stream Lines
- Aging Infrastructure
- City Limits

Problem Type

- Flooding
- Infrastructure
- Maintenance
- Natural Channels

Clackamas River
Willamette River
Clackamas
Clackamas-Willamette
Kelly Field
Park Place
Forsythe
Livesay
Willamette North
John Adams
Willamette South
Tumwater
Clinton
Singer
Abernethy
Amanda Court
Coffee
Newell
Alan Court
Central Point
South End
Mud
Thimble
Caufield
Beaver

CL-F-01 CL-I-01 PP-I-02 PP-I-01 LI-F-01 PP-N-01 PP-F-01 CL-I-03 CL-I-02 CL-I-02 LI-N-01 LI-I-01 LI-N-01 LI-I-02 AB-N-01 WN-I-01 JA-I-02 JA-I-03 SI-I-05 JA-F-02 JA-I-05 AB-M-01 SI-N-01 JA-I-04 JA-M-01 JA-F-03 JA-F-01 SI-I-01 JA-F-04 TU-M-02 TU-F-01 SI-I-06 SI-I-02 SI-I-03 JA-I-01 NE-N-03 SI-I-03 NE-I-01 TU-M-01 CN-M-01 CO-N-01 CO-I-01 CO-I-03 SI-N-02 SI-N-02 SI-I-04 SI-I-04 NE-N-04 NE-I-02 SI-I-02 SI-F-01 CO-M-01 CO-I-02 CO-I-04 CO-F-01 CO-N-02 NE-N-02 SE-F-04 SE-F-03 MU-F-01 MU-F-01 NE-I-03 MU-F-02 NE-F-03 NE-N-05 NE-N-01 SE-F-02 SE-I-01 SE-F-05 NE-F-01 MU-I-01 MU-I-01 CP-F-01 CP-F-01 MU-I-02 CA-N-02 SE-F-01 CA-I-01 CA-M-01 NE-F-02 CA-I-02 CA-F-01 CA-F-01

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Brown AND Caldwell

City of Oregon City
Stormwater Master Plan

Date: May 2017
Project:149133

Notes:
1. Projection: NAD 1983 State Plane Oregon North (feet)
2. Refer to Hydrology Tech Memo (Date 8/10/2016) for subbasin delineation

0 1,250 2,500 5,000 Feet

N

Figure 9

Problem Areas

Appendix D: Field Observation Photo Log

Use of contents on this sheet is subject to the limitations specified at the end of this document.

Appendix D

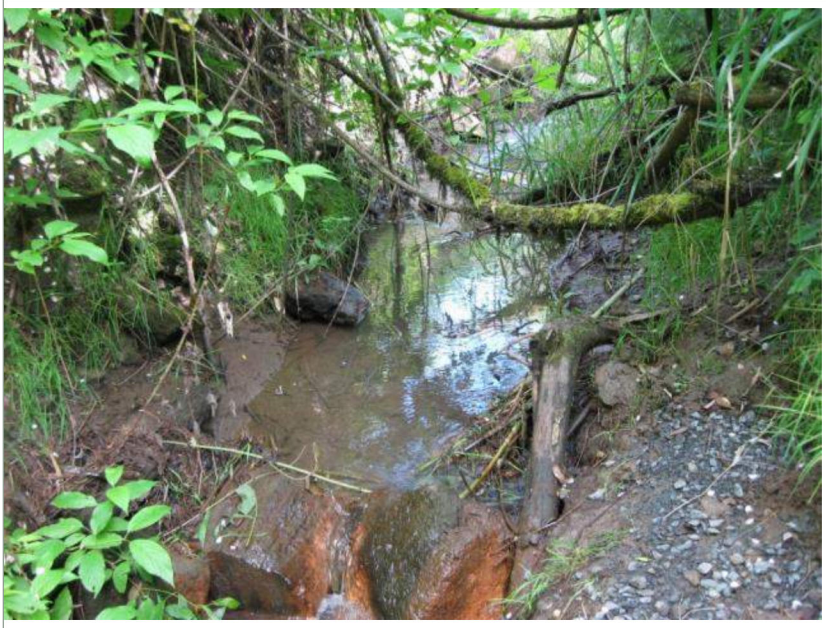
Field Observation Photo Log

Photographs and descriptions of the field investigation (by site) are provided on the following pages.

Waterbody:	Park Place Creek (tributary to Abernethy)
Reach description:	13530 Redland Road (current dry weather monitoring location)
Site locations:	001



Site location:	001
Photo number:	IMG_1461
Description:	Piped discharge from Abernethy Rd. to Park Place Creek at 13530 Redland Road.



Site location:	001
Photo number:	IMG_1455
Description:	Approximately 200' downstream from photo IMG_1461. Silty bed sediment with large boulders. Unconsolidated bed material.



Site location: 001

Photo number: IMG_1452

Description: Overhead view of photo IMG_1455. Stormwater water quality testing site.

Waterbody:	**Unnamed tributary to Livesay Creek**
Reach description:	**Private property at 14040 Beemer Way**
Site locations:	**002**



Site location:	002
Photo number:	IMG_1442
Description:	Concrete outfall structure conveying discharge from Holcomb Road to creek. Evidence of channel incision and high flows with boulders in channel bed.



Site location:	002
Photo number:	IMG_1446
Description:	Side view of channel. Approximately 15' channel depth. Limited vegetation (ivy) along channel bank and side slopes.



Site location:	002
Photo number:	IMG_1450
Description:	Zoomed in view of eroding bank and exposed roots.

Waterbody:	Newell Creek
Reach description:	Beavercreek Rd and Highway 213, west of Highway 213
Site location:	004



Site location: 004
Photo number: IMG_1449
Description: Significant contributing flow from adjacent roadway and commercial development.



Site location: 004
Photo number: IMG_1501
Description: Significant bank erosion. City identified location as area of concern.



Site location: 004
Photo number: IMG_1510
Description: Approximately 30' downstream of outfalls; observed channel incision and exposed bedrock.



Site location: 004
Photo number: IMG_1511
Description: Approximately 50' downstream of outfalls facing downstream. Unknown concrete pipe visible in left portion of image. Cobbles and boulders in streambed.

Waterbody:	**Unnamed tributary to Newell Creek**
Reach description:	Intersection of Logus Street and Eluria Street (approximate address 613 Logus St.)
Site locations:	008

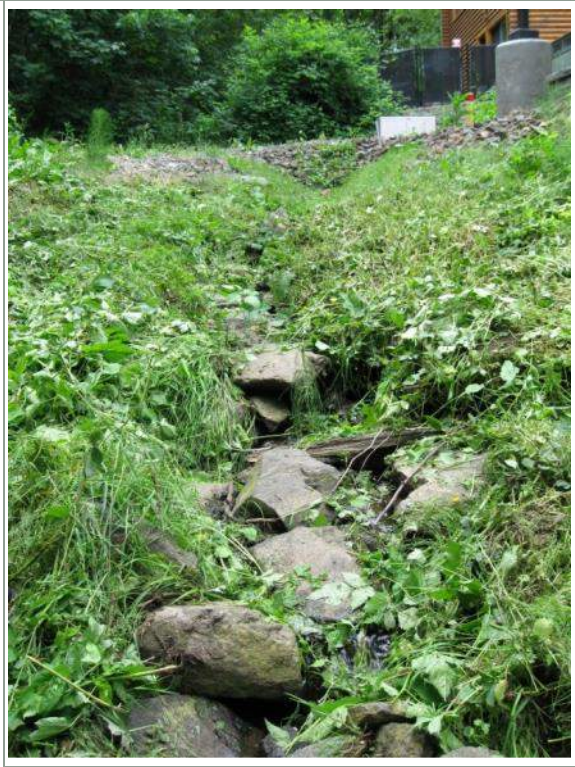


Site location:	008
Photo number:	IMG_1477
Description:	Spring/groundwater flowing into tributary. Bed appears stable with gravel and cobble.



Site location:	008
Photo number:	IMG_1470
Description:	Side view of channel. Southern (left) bank has minimal vegetation, indicative of ongoing erosion. Northern (right) bank contains established ivy.

Waterbody:	Unnamed tributary to Newell Creek
Reach description:	17883 Peter Skene Way
Site location:	013



Site location: 013
Photo number: IMG_1482
Description: Outfall from Peter Skeene Way



Site location: 013
Photo number: IMG_1480
Description: Downstream of outfall. Steep channel grade. City installed rip rap along channel segment



Site location: 013

Photo number: IMG_1483

Description: Approximately 50' downstream from outfall. Channel deepens. Bed composed of cobble and boulders.



Site location: 013

Photo number: IMG_1486

Description: Bank along right side of channel visible in photo IMG_1483. Water seeping through soil causing heavy erosion.



Site location:	013
Photo number:	IMG_1487
Description:	Looking downstream from photo IMG_1486. Heavy vegetation along channel.

Waterbody:	Tributary to Caufield Creek
Reach description:	South of Meyers Rd. near Trails End Market Place
Site location:	200



Site location:	200
Photo number:	IMG_1519
Description:	Stream bed of tributary where it crosses access trail. Bed composed of cobble and boulders. Minimal erosion.

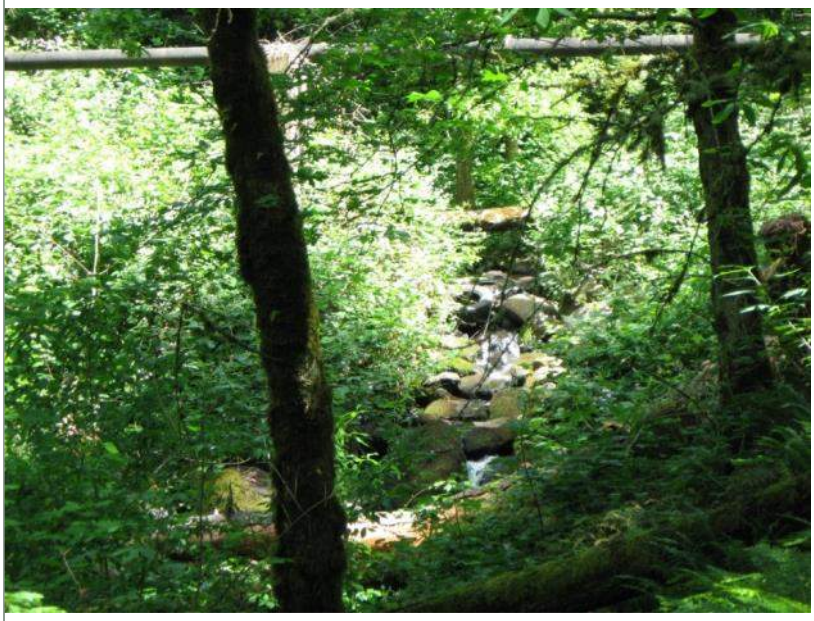


Site location:	200
Photo number:	IMG_1523
Description:	Approximately 40' upstream from photo IMG_1519. Stream flowing along access trail with minimal erosion. Bed has silty composition with some gravel and cobble.



Site location:	200
Photo number:	IMG_1529
Description:	Small pool located approximately 100' upstream from IMG_1523. Stream bed is silt and gravel. Water is discharged from Trails End Market Place.

Waterbody:	Caufield Creek
Reach description:	Downstream of 213
Site location:	201/202



Site location: 201
Photo number: IMG_1534
Description: Streambed primarily boulders.



Site location: 202
Photo number: IMG_1540
Description: Caufield Creek approximately 1000' downstream from photo IMG_1449. Minimal incision/erosion.



Site location:	202
Photo number:	IMG_1542
Description:	Bridge crossing over Caufield Creek. Streambed composed of compacted silt with some gravel and cobble.

Waterbody:	**Mud Creek**
Reach description:	**Frontier Parkway near pump station**
Site location:	**203**



Site location:	203
Photo number:	IMG_1555
Description:	Natural pond formed from beaver activity and downed vegetation. Provides flow control along Mud Creek.



Site location:	203
Photo number:	IMG_1553
Description:	Dense vegetation along pond composed of tall grasses, bushes, and blackberries.

Waterbody:	Tributary to Beaver Creek
Reach description:	Orchard Grove Drive
Site location:	204



Site location:	204
Photo number:	IMG_1557
Description:	Smaller Pond and inlet on private property at South McCord Road and Orchard Grove Drive



Site location:	204
Photo number:	IMG_1559
Description:	Larger pond on City property. Pond collecting sediment and filling in. Major maintenance overhaul may be required.

Waterbody:	**Coffee Creek**
Reach description:	**Hazelwood Drive**
Site location:	**205**



Site location:	205
Photo number:	IMG_1562
Description:	Ditch in Chapin City Park. No erosion visible.



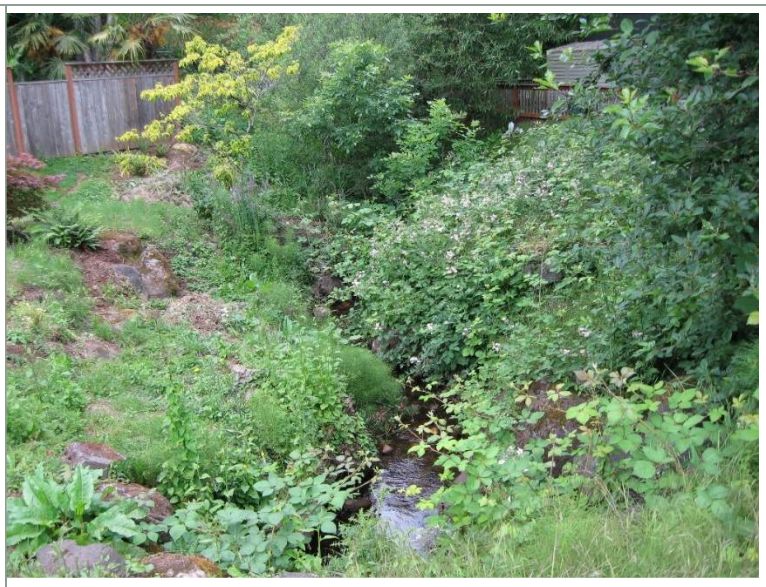
Site location:	206
Photo number:	IMG_1572
Description:	36" outfall to open ditch north of Warner Parrot Road.



Site location: 205
Photo number: IMG_1574
Description: Open channel near 1013 Hazelwood Drive. Channel bed formed of large rocks. No incision/erosion.



Site location: 205
Photo number: IMG_1575
Description: Coffee Creek channel just east of crossing with Hazelwood Drive at 939 Hazelwood Drive. This location is just downstream of natural spring that contributes base flow to Coffee Creek year-round. Creek bed in this location composed of large boulders.



Site location: 205
Photo number: IMG_1580
Description: Approximately 50' downstream of IMG_1574. Silty bed with large boulders. Minimal erosion.



Site location: 205
Photo number: IMG_1581
Description: Coffee Creek near 418 Barker Avenue. Streambed composed of silt, rocks, and boulders. Minor incision evident.

Waterbody:	**Singer Creek**
Reach description:	**Singer Creek Park**
Site location:	**206**



Site location:	206
Photo number:	IMG_1594
Description:	Deep channel (10-15'). Soil along western (left) bank has slid off into creek. Abandoned water line visible in image.



Site location:	206
Photo number:	IMG_1591
Description:	Silt, gravel, and cobble in streambed.



Site location:	206
Photo number:	IMG_1600
Description:	Streambed 100' upstream of IMG_1591. Primarily gravel. Minimal erosion/incision.

Appendix E: Stream Channel Observation Forms

Use of contents on this sheet is subject to the limitations specified at the end of this document.

Channel Stability Observation Form

Water Body:	Park Place Creek	**Date:**	5/24/16
Site/Location:	13530 Redland Rd. #001	**Time:**	9AM
		Crew:	GJ, JP, AM, MG
Photos:		**Weather:**	SUN
Channel Size:	4' wide	**Observed problems:**	A. Flooding
Channel Pattern:	Meandering		B. Degradation
	(Straight)		C. Bank Erosion
	Braided		D. Lack of Vegetation
	Channelized/Altered		E. Sediment Loads

A. Flooding	
Describe observed/known flooding problems:	N/A
B. Degradation/Bed Incision	
Primary Bed Material:	Bedrock Boulders Cobbles Gravel Sand (Silt) Clay
Degree of incision*	0-25% 26-50% 51-75% (76-100%)
Exposed Roots	None (Mild) Moderate Severe
Head cutting or nick points	Describe: Naturally stabilized
C. Bank Erosion/Widening	
Primary Bank Materials	Bedrock Boulders Gravel/Sand (Silt/Clay)
Bank Protection	(None) Left Bank Right Bank
Streambank Erosion	Left Bank: (None) Fluvial Mass Wasting — No widening from 2015
	Right Bank: (None) Fluvial Mass Wasting
Streambank Instability (% each bank failing)	Left Bank: (0-25%) 26-50% 51-75% 76-100%
	Right Bank: (0-25%) 26-50% 51-75% 76-100%
Vegetation Impacts	Exposed Roots Leaning Trees J-shaped Trees N/A
D. Lack of Vegetation	
Established riparian woody-vegetative cover	Left Bank: 0-25% 26-50% (51-75%) 76-100% — Bushes / Invasives
	Right Bank: 0-25% 26-50% (51-75%) 76-100%
E. Sediment Loads	
Aggradation	☐ Fresh sediment deposition: channel bar near structure overbank
	☒ Unconsolidated bed
	☐ Embedded Cobbles
Turbidity/ Siltation	Describe: Lots of silt
Other	
Known or observed problems	Minimal change from 2015.
Unique features	Appears Stable. No project required.
Field notes	

* Degree of incision = relative elevation of the "normal" low water compared to the floodplain/terrace. Normal water equal to the floodplain/terrace represents 100%.

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Channel Stability Observation Form

Water Body:	Livesay Creek	**Date:**	5/24/16
Site/Location:	Outfall @ 14040 Beemer Way #002	**Time:**	230 AM
		Crew:	GJ, JP, AM, MG, JA
Photos:		**Weather:**	SUN
Channel Size:	Deep Incise (20' deep x 5' wide)	**Observed problems:**	A. Flooding
Channel Pattern:	(Meandering)		(B. Degradation)
	Straight		(C. Bank Erosion)
	Braided		D. Lack of Vegetation
	Channelized/Altered		E. Sediment Loads

A. Flooding	
Describe observed/known flooding problems:	N/A
B. Degradation/Bed Incision	
Primary Bed Material:	Bedrock (Boulders) Cobbles (Gravel) Sand (Silt) Clay
Degree of incision*	0-25% 26-50% 51-75% (76-100%)
Exposed Roots	None Mild Moderate (Severe)
Head cutting or nick points	Describe: Concrete outfall for protection
C. Bank Erosion/Widening	
Primary Bank Materials	Bedrock (Boulders) (Gravel/Sand) (Silt/Clay)
Bank Protection	(None) Left Bank Right Bank
Streambank Erosion	Left Bank: (None) Fluvial Mass Wasting
	Right Bank: None Fluvial (Mass Wasting)
Streambank Instability (% each bank failing)	Left Bank: (0-25%) 26-50% 51-75% 76-100%
	Right Bank: 0-25% 26-50% (51-75%) 76-100%
Vegetation Impacts	(Exposed Roots) (Leaning Trees) J-shaped Trees
D. Lack of Vegetation	
Established riparian woody-vegetative cover	Left Bank: 0-25% 26-50% 51-75% (76-100%)
	Right Bank: 0-25% 26-50% 51-75% (76-100%)
E. Sediment Loads	
Aggradation	☐ Fresh sediment deposition: channel bar near structure overbank ☐ Unconsolidated bed ☐ Embedded Cobbles N/A
Turbidity/ Siltation	Describe: N/A
Other	
Known or observed problems	Heavy erosion on right bank unchanged
Unique features	from 2015, Tree growth in channel
Field notes	indicates stream stabilization.

* Degree of incision = relative elevation of the "normal" low water compared to the floodplain/terrace. Normal water equal to the floodplain/terrace represents 100%.

Channel Stability Observation Form

Water Body:	Nevell Creek	**Date:**	5/24/16
Site/Location:	Beavercreek Rd/ Hwy 213 #004	**Time:**	10 AM
		Crew:	GJ, JP, AM, MG, JA
Photos:		**Weather:**	SUN
Channel Size:	4-10' wide	**Observed problems:**	A. Flooding
Channel Pattern:	(Meandering)		B. Degradation
	Straight		(C. Bank Erosion)
	Braided		D. Lack of Vegetation
	Channelized/Altered		E. Sediment Loads

A. Flooding	
Describe observed/known flooding problems:	N/A
B. Degradation/Bed Incision	
Primary Bed Material:	Bedrock (Boulders) (Cobbles) (Gravel) Sand Silt Clay
Degree of incision*	0-25% 26-50% (51-75%) 76-100%
Exposed Roots	None Mild Moderate (Severe)
Head cutting or nick points	Describe: Major headcutting + nick points @ outfall
C. Bank Erosion/Widening	
Primary Bank Materials	Bedrock (Boulders) Gravel/Sand Silt/Clay
Bank Protection	(None) Left Bank Right Bank
Streambank Erosion	Left Bank: None Fluvial (Mass Wasting) > daily @ outfall Right Bank: None Fluvial (Mass Wasting)
Streambank Instability (% each bank failing)	Left Bank: (0-25%) 26-50% 51-75% 76-100% Right Bank: (0-25%) 26-50% 51-75% 76-100%
Vegetation Impacts	(Exposed Roots) (Leaning Trees) J-shaped Trees
D. Lack of Vegetation	
Established riparian woody-vegetative cover	Left Bank: 0-25% 26-50% 51-75% (76-100%) > ds of outfall Right Bank: 0-25% 26-50% 51-75% (76-100%)
E. Sediment Loads	
Aggradation	☐ Fresh sediment deposition: channel bar near structure overbank ☐ Unconsolidated bed ☐ Embedded Cobbles N/A
Turbidity/ Siltation	Describe: N/A
Other	
Known or observed problems **Unique features** **Field notes**	Still major wash out @ outfall, possibly worse than 2015. Cracks in concrete retaining walls above outfalls, City to coordinate with ODOT.

* Degree of incision = relative elevation of the "normal" low water compared to the floodplain/terrace. Normal water equal to the floodplain/terrace represents 100%.

Channel Stability Observation Form

Water Body:	Tributary to Newell Creek	**Date:**	5/24/16
Site/Location:	Elvira St. near 613 Logus St. #008	**Time:**	11 AM
		Crew:	GJ, JR, AM, MG, JA
Photos:		**Weather:**	Sun
Channel Size:	3-5' wide 3' deep low flow	**Observed problems:**	A. Flooding
Channel Pattern:	(Meandering)		(B. Degradation)
	Straight		(C. Bank Erosion)
	Braided		D. Lack of Vegetation
	Channelized/Altered		E. Sediment Loads

A. Flooding	
Describe observed/known flooding problems:	N/A
B. Degradation/Bed Incision	
Primary Bed Material:	Bedrock Boulders Cobbles (Gravel) (Sand) Silt Clay
Degree of incision*	0-25% 26-50% (51-75%) 76-100%
Exposed Roots	None (Mild) Moderate Severe
Head cutting or nick points	Describe: Minor @ outfall
C. Bank Erosion/Widening	
Primary Bank Materials	Bedrock Boulders Gravel/Sand (Silt/Clay)
Bank Protection	(None) Left Bank Right Bank
Streambank Erosion	Left Bank: None (Fluvial) Mass Wasting
	Right Bank: None (Fluvial) Mass Wasting
Streambank Instability (% each bank failing)	Left Bank: 0-25% 26-50% (51-75%) 76-100% ← more erosion than 2015
	Right Bank: 0-25% (26-50%) 51-75% 76-100%
Vegetation Impacts	Exposed Roots Leaning Trees J-shaped Trees N/A
D. Lack of Vegetation	
Established riparian woody-vegetative cover	Left Bank: 0-25% 26-50% 51-75% (76-100%) Ivy & Ferns
	Right Bank: 0-25% 26-50% 51-75% (76-100%)
E. Sediment Loads	
Aggradation	☐ Fresh sediment deposition: channel bar near structure overbank ☐ Unconsolidated bed ☐ Embedded Cobbles N/A
Turbidity/ Siltation	Describe:
Other	
Known or observed problems **Unique features** **Field notes**	Minor changes (more incision/erosion) compared to 2015. Private properties use tarps for stabilization.

* Degree of incision = relative elevation of the "normal" low water compared to the floodplain/terrace. Normal water equal to the floodplain/terrace represents 100%.

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Channel Stability Observation Form

Water Body:	Tributary to Newell Cr.	**Date:**	5/24/16
Site/Location:	17883 Peter Skene Way #013	**Time:**	1130 AM
		Crew:	GJ, JP, AM, MG, JA
Photos:		**Weather:**	SUN
Channel Size:	3'-5' wide 2-3' deep	**Observed problems:**	A. Flooding B. Degradation C. Bank Erosion D. Lack of Vegetation E. Sediment Loads
Channel Pattern:	Meandering d/s of riprap Straight Braided Channelized/Altered culverts/riprap added to stabilize		

A. Flooding								
Describe observed/known flooding problems:	N/A							
B. Degradation/Bed Incision								
Primary Bed Material:	Bedrock	Boulders	Cobbles	Gravel	Sand	Silt (downstream)	Clay	riprap V.S.
Degree of incision*	0-25%	26-50%	51-75%	76-100%				
Exposed Roots	None	Mild	Moderate	Severe				
Head cutting or nick points	Describe: V.S. portion stabilized w/ riprap							
C. Bank Erosion/Widening								
Primary Bank Materials	Bedrock	Boulders	Gravel/Sand	Silt/Clay				
Bank Protection	None	Left Bank	Right Bank					
Streambank Erosion	Left Bank:	None	Fluvial	Mass Wasting				
	Right Bank:	None	Fluvial	Mass Wasting				
Streambank Instability (% each bank failing)	Left Bank:	0-25%	26-50%	51-75%	76-100%			
	Right Bank:	0-25%	26-50%	51-75%	76-100%	← due to seepage from uphill stormwater facility		
Vegetation Impacts	Exposed Roots	Leaning Trees	J-shaped Trees					
D. Lack of Vegetation								
Established riparian woody-vegetative cover	Left Bank:	0-25%	26-50%	51-75%	76-100%			
	Right Bank:	0-25%	26-50%	51-75%	76-100%	Heavy vegetation d.s. of riprap		
E. Sediment Loads								
Aggradation	☐ Fresh sediment deposition:	channel bar	near structure	overbank				
	☐ Unconsolidated bed							
	☐ Embedded Cobbles N/A							
Turbidity/ Siltation	Describe:							
Other								
Known or observed problems	Incision increases downstream of riprap.							
Unique features	Observable changes from 2015.							
Field notes	Needs stabilization project.							

* Degree of incision = relative elevation of the "normal" low water compared to the floodplain/terrace. Normal water equal to the floodplain/terrace represents 100%.

Channel Stability Observation Form

Water Body:	Tributary to Caufield Creek	**Date:**	5/24/16
Site/Location:	S. Meyers Rd. near Trails End Market Place #200	**Time:**	1 PM
		Crew:	GJ, JP, AM, MG
Photos:		**Weather:**	SUN
Channel Size:	2'-3' wide 6" deep	**Observed problems:**	A. Flooding
Channel Pattern:	(Meandering)		B. Degradation
	Straight		C. Bank Erosion
	Braided		D. Lack of Vegetation
	Channelized/Altered		E. Sediment Loads

A. Flooding	
Describe observed/known flooding problems:	N/A
B. Degradation/Bed Incision	
Primary Bed Material:	~~Bedrock~~ (Boulders) (Cobbles) Gravel Sand (Silt) Clay
Degree of incision*	(~~0-25%~~) 26-50% 51-75% 76-100%
Exposed Roots	None (Mild) Moderate Severe
Head cutting or nick points	Describe: None
C. Bank Erosion/Widening	
Primary Bank Materials	Bedrock Boulders Gravel/Sand (Silt/Clay)
Bank Protection	(None) Left Bank Right Bank
Streambank Erosion	Left Bank: (~~None~~) Fluvial Mass Wasting
	Right Bank: (None) Fluvial Mass Wasting
Streambank Instability (% each bank failing)	Left Bank: (0-25%) 26-50% 51-75% 76-100%
	Right Bank: (0-25%) 26-50% 51-75% 76-100%
Vegetation Impacts	Exposed Roots Leaning Trees J-shaped Trees N/A
D. Lack of Vegetation	
Established riparian woody-vegetative cover	Left Bank: 0-25% 26-50% 51-75% (76-100%)
	Right Bank: 0-25% 26-50% 51-75% (76-100%)
E. Sediment Loads	
Aggradation	☐ Fresh sediment deposition: channel bar near structure overbank ☐ Unconsolidated bed ☐ Embedded Cobbles N/A
Turbidity/ Siltation	Describe: N/A
Other	
Known or observed problems **Unique features** **Field notes**	No incision or erosion observed.

* Degree of incision = relative elevation of the "normal" low water compared to the floodplain/terrace. Normal water equal to the floodplain/terrace represents 100%.

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Channel Stability Observation Form

Water Body:	Canfield Creek	**Date:**	8/24/16
Site/Location:	Downstream of Hwy 213 #201/202	**Time:**	2 PM
		Crew:	GJ, JP, AM, MG
Photos:		**Weather:**	SUN
Channel Size:	6'-8' wide 2'-3' deep	**Observed problems:**	A. Flooding
Channel Pattern:	(Meandering)		B. Degradation
	Straight		C. Bank Erosion
	Braided		D. Lack of Vegetation
	Channelized/Altered		E. Sediment Loads

A. Flooding	
Describe observed/known flooding problems:	N/A
B. Degradation/Bed Incision	
Primary Bed Material:	Bedrock (Boulders) (Cobbles) Gravel Sand (Silt) Clay
Degree of incision*	(0-25%) 26-50% 51-75% 76-100%
Exposed Roots	None (Mild) Moderate Severe
Head cutting or nick points	Describe: N/A
C. Bank Erosion/Widening	
Primary Bank Materials	Bedrock Boulders Gravel/Sand (Silt/Clay)
Bank Protection	(None) Left Bank Right Bank
Streambank Erosion	Left Bank: (None) Fluvial Mass Wasting
	Right Bank: None (Fluvial) Mass Wasting
Streambank Instability (% each bank failing)	Left Bank: (0-25%) 26-50% 51-75% 76-100%
	Right Bank: (0-25%) 26-50% 51-75% 76-100% ← Minor erosion
Vegetation Impacts	Exposed Roots Leaning Trees J-shaped Trees N/A
D. Lack of Vegetation	
Established riparian woody-vegetative cover	Left Bank: 0-25% 26-50% 51-75% (76-100%)
	Right Bank: 0-25% 26-50% 51-75% (76-100%)
E. Sediment Loads	
Aggradation	☐ Fresh sediment deposition: channel bar near structure overbank ☐ Unconsolidated bed ☐ Embedded Cobbles N/A
Turbidity/ Siltation	Describe: N/A
Other	
Known or observed problems **Unique features** **Field notes**	Very minor erosion observed

* Degree of incision = relative elevation of the "normal" low water compared to the floodplain/terrace. Normal water equal to the floodplain/terrace represents 100%.

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Channel Stability Observation Form

Water Body:	Mud Creek	**Date:**	5/24/16
Site/Location:	Frontier Parkway @ pump station # 203	**Time:**	230 PM
		Crew:	GJ, JP, AM, MG
Photos:		**Weather:**	SUN
Channel Size:	Main channel ~5' wide	**Observed problems:**	A. Flooding
Channel Pattern:	(Meandering)		B. Degradation
	Straight		C. Bank Erosion
	Braided		D. Lack of Vegetation
	Channelized/Altered		E. Sediment Loads

A. Flooding	
Describe observed/known flooding problems:	N/A
B. Degradation/Bed Incision	
Primary Bed Material:	Bedrock Boulders Cobbles Gravel Sand (Silt) Clay
Degree of incision*	(0-25%) 26-50% 51-75% 76-100%
Exposed Roots	(None) Mild Moderate Severe
Head cutting or nick points	Describe: N/A
C. Bank Erosion/Widening	
Primary Bank Materials	Bedrock Boulders Gravel/Sand (Silt/Clay)
Bank Protection	(None) Left Bank Right Bank
Streambank Erosion	Left Bank: (None) Fluvial Mass Wasting
	Right Bank: (None) Fluvial Mass Wasting
Streambank Instability (% each bank failing)	Left Bank: (0-25%) 26-50% 51-75% 76-100%
	Right Bank: (0-25%) 26-50% 51-75% 76-100%
Vegetation Impacts	Exposed Roots Leaning Trees J-shaped Trees N/A
D. Lack of Vegetation	
Established riparian woody-vegetative cover	Left Bank: 0-25% 26-50% 51-75% (76-100%) Blackberry bushes,
	Right Bank: 0-25% 26-50% 51-75% (76-100%) tall grasses, reeds
E. Sediment Loads	
Aggradation	☐ Fresh sediment deposition: channel bar near structure overbank ☐ Unconsolidated bed ☐ Embedded Cobbles N/A
Turbidity/ Siltation	Describe: N/A
Other	
Known or observed problems **Unique features** **Field notes**	Natural pond formed by beavers and downed vegetation. Natural & manmade wetlands are attenuating flow.

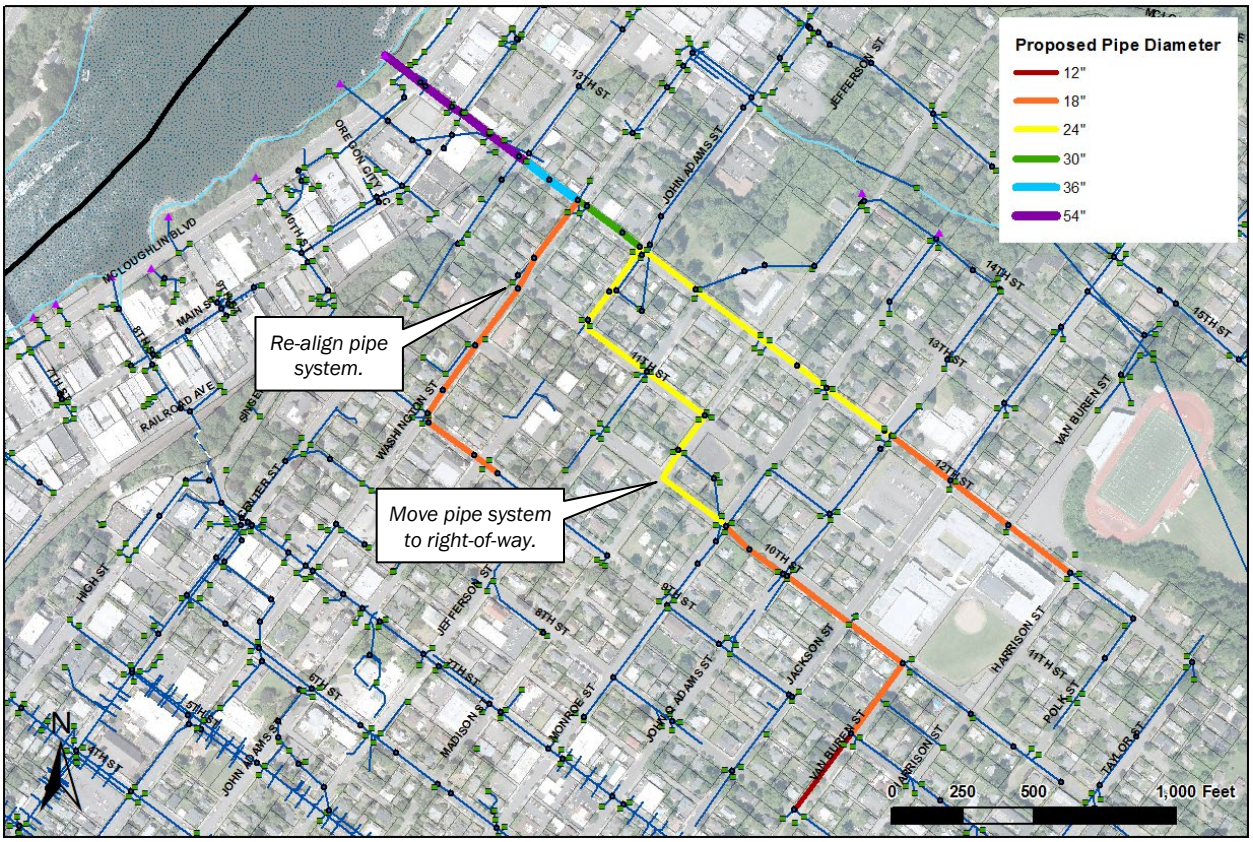
* Degree of incision = relative elevation of the "normal" low water compared to the floodplain/terrace. Normal water equal to the floodplain/terrace represents 100%.

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Appendix F: CIP Fact Sheets

CIP 1 John Adams Basin Capacity Improvements
CIP 2 South End Road Stormwater Improvement
CIP 3 Division Street Infrastructure Improvements
CIP 4 Rivercrest Neighborhood Infrastructure Improvements
CIP 5 Harding Boulevard Sanitary Disconnect
CIP 6 Pebble Beach Pond Retrofit
CIP 7 Hiefield Court Culvert Improvements
CIP 8 The Cove Water Quality Improvements

Use of contents on this sheet is subject to the limitations specified at the end of this document.



Project Identifier	**CIP 1**
Project Name	John Adams Basin Capacity Improvements
Detailed Location	Taylor Street to Main Street between 8th Street and 12th Street
Model File	Model FU3_JA2.xp
Objective(s) Addressed	Flood Reduction, Aging Infrastructure

Project Background

The primary problems identified in the John Adams basin are flooding and infrastructure age. Secondary problems include mismatched infrastructure and pipes located in private property. Areas near 9th and Monroe Streets and 8th and Van Buren have reported to have flooding in the past. There are several locations where downstream pipe segments are smaller than upstream pipes leading to surcharging and flooding. Modeling of the storm system revealed significant flooding beginning at the 2-year storm event. Pipe sections are currently undersized and will require replacement to alleviate flooding issues.

In addition, the storm pipes in this basin are among the oldest in the City and well past the expected life. Portions of the stormwater system were previously part of a combined stormwater/sanitary system which will be removed.

Project Description

Upsize drainage system in the John Adams Basin by installing 340 LF of 12-inch pipe, 4,000 LF of 18-inch pipe, 2,300 LF of 24-inch pipe, 240 LF of 30-inch pipe, 300 LF of 36-inch pipe, 130 LF of 48-inch pipe (represented as 54-inch in the figure), and 460 LF of 54-inch pipe. Pipe sizing recommendations are based on providing capacity for 25-year peak flows under full build-out conditions. The project includes the installation of an estimated 40 manhole structures, 21 connections to existing structures and 78 catch basins.

It is suspected that much of this basin does not have private stormwater laterals connected to the existing conveyance system. Stormwater runoff from roof drains may be contributing to the sanitary sewer collection system. Existing private stormwater laterals should be connected to the new stormwater system. Properties without stormwater laterals or downspout disconnection may have a combined lateral (sanitary and storm together) which may be addressed through coordination with the sanitary I/I abatement program. The number and cost for private lateral connection is unknown and therefore is not included in the cost estimate but is recommended as part of the CIP.

Design Considerations
Drainage system installation should be coordinated with roadway reconstruction projects to avoid multiple impacts to the same roadway segments. Detailed topographic survey is needed to conduct final engineering evaluation to determine the appropriate invert elevations and pipe diameters to maintain necessary cover depth in this flat terrain. Investigative work prior to design is necessary to determine appropriate handling of private laterals. Planning level design assumes most proposed structures are located near or at the same location as existing structures.
Comprehensive design effort across all four project phases is suggested to maintain continuity in design.

Phase 1 Planning-level Cost Estimate (Outfall to 12th/John Adams)	
Capital Expense Total (including contingency)	$1,656,000
Engineering and Permitting (40%)	$663,000
Market Climate (10%)	$166,000
Construction Administration (15%)	$248,000
Capital Project Implementation Cost Total*	**$2,733,000**

Phase 2 Planning-level Cost Estimate (12th/John Adams to 12th/Harrison)	
Capital Expense Total (including contingency)	$1,271,000
Engineering and Permitting (15%)	$191,000
Market Climate (10%)	$127,000
Construction Administration (15%)	$191,000
Capital Project Implementation Cost Total*	**$1,780,000**

Phase 3 Planning-level Cost Estimate (12th/John Adams to 8th/Van Buren)	
Capital Expense Total (including contingency)	$1,928,000
Engineering and Permitting (15%)	$289,000
Market Climate (10%)	$193,000
Construction Administration (5%)	$289,000
Capital Project Implementation Cost Total*	**$2,699,000**

Phase 4 Planning-level Cost Estimate (12th/Washington to 9th/John Adams)	
Capital Expense Total (including contingency)	$959,000
Engineering and Permitting (15%)	$144,000
Market Climate (10%)	$96,000
Construction Administration (5%)	$144,000
Capital Project Implementation Cost Total*	**$1,343,000**

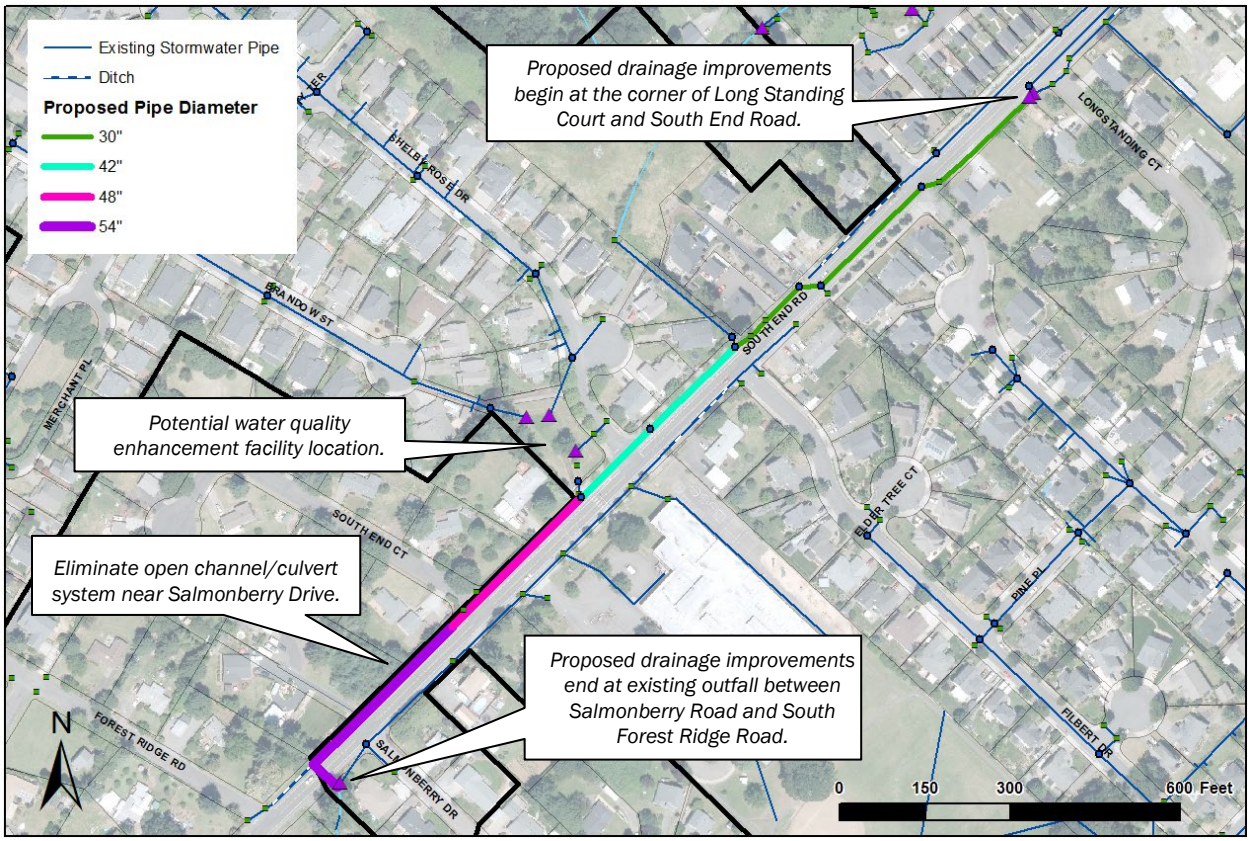
**Planning level cost estimates estimated in 2019 dollars, rounded to the nearest thousand. Project cost does not include property or easement acquisitions.*

Additional Project Information

The table below is provided to show the details of the planning level design and estimates for pipe size and invert elevations (this information should be considered planning level only and a formal design and analysis is needed). The table is color coded based on proposed pipe diameter.

Planning Level Infrastructure Data							
Link	Existing Diameter (in)	Proposed Diameter (in)	Proposed Length (ft)	US Node	DS Node	US Invert (ft)	DS Invert (ft)
Phase 1							
804813	12	30	157.0	33520	43469	82.29	72.34
804814	18	30	78.8	33519	33520	92.03	86.51
804815	18	36	124.1	33521	34704_WN_0300	68.67	65.37
806471	18	48	131.0	37118	37139_WN_0100	50.10	45.95
806474	18	54	123.1	37139_WN_0100	37142	45.72	45.03
808623	18	54	41.5	37142	41009	44.93	44.67
808624	18	54	19.1	43300	43301	43.51	43.61
812692	18	54	119.5	41009	43300	44.57	43.61
812695	18	54	158.3	43301	39733	43.51	14.40
812816	18	36	39.8	43469	33521	72.10	68.87
Link54	18	36	132.7	34704_WN_0300	37118	65.33	50.40
Phase 2							
804969	8	24	247.9	33513_JA_0300	33519	115.62	92.23
806396	8	24	444.2	37054	33513_JA_0300	156.65	115.82
806401	8	24	131.5	37059	37054	173.67	156.85
806402	8	24	255.5	37062	37059	199.01	173.87
806406	8	24	30.6	37064	37062	202.22	199.21
Link45	N/A	18	276.4	34692_JA_1300	37087	242.56	238.80
Link46	N/A	18	256.7	37087	33491_JA_0200	238.60	228.79
Link47	N/A	18	259.8	33491_JA_0200	37064	227.98	202.42

Planning Level Infrastructure Data							
Link	Existing Diameter (in)	Proposed Diameter (in)	Proposed Length (ft)	US Node	DS Node	US Invert (ft)	DS Invert (ft)
Phase 3							
800781	18	24	159.3	34313	33514	159.19	152.53
801568	8	12	335.0	33504	33474	257.58	243.99
801573	12	18	15.0	33473	34769	220.25	215.90
804841	12	18	513.2	33475_JA_1000	33473	235.76	220.69
804846	12	18	64.5	33469	33508	185.00	179.71
804848	24	24	150.6	33514	33515	152.33	144.73
804851	18	24	256.1	33515	34191_JA_0100	144.53	116.45
808704	12	18	305.9	33474	33475_JA_1000	243.75	236.34
Link48	12	18	262.9	34769	33469	215.75	185.20
Link49	12	18	225.3	33508	34313	179.51	159.14
Link58	18	24	291.0	34191_JA_0100	34192	116.25	109.60
Link59	12	24	121.6	34192	41014	109.22	101.00
Link60	12	24	192.3	41014	33519	100.71	92.13
Phase 4							
804860	12	18	101.6	33517_WN_0400	33516	178.61	174.95
804861	12	18	211.6	33523	33517_WN_0400	192.64	178.81
804867	12	18	274.3	34311_WN_0500	33523	199.70	192.86
812475	12	18	29.8	36378	34534	163.75	162.54
812477	12	18	198.1	33516	36378	172.70	163.95
812478	12	18	100.6	34534	43051	162.24	159.21
812479	12	18	194.4	43051	43050	159.11	150.99
Link55	12	18	249.5	43050	Node58	150.49	123.22
Link56	12	18	122.1	Node58	Node59	123.02	110.16
Link57	12	18	257.4	Node59	33521	109.96	83.08



Project Identifier	CIP 2
Project Name	South End Road Stormwater Improvement
Detailed Location	South End Road between Rose Road and South Forest Ridge Road Structures 33535 to 39582
Model File	Model FU3_SE4.xp
Objective(s) Addressed	Flood Reduction

Project Background

Flooding issues along South End Road were identified during the watershed problem identification workshop and as part of the City asset review. Near Rose Road, the existing pipe system transitions from a 30 Inch pipe down to a 12 Inch pipe, possibly as a prior flow control mechanism. Modeling of the storm system revealed significant flooding, especially in areas where downstream pipe segments were smaller than upstream pipes. Flooding occurs in the open channels when modeled with the 2-year storm event.

Project Description

Replace the existing open channel/culvert system with a closed pipe from Rose Road to the outfall between Salmonberry Drive and South Forest Ridge Road. Upsize and extend the drainage system to convey the 25-year peak flows for full buildout. The project will eliminate the existing open channel/culvert system near Salmonberry Drive.

Planning level design assumes proposed structures will be placed in the same locations as the existing manholes, spaced no more than 400 feet apart. The project includes installation of 800 LF of 30 inch pipe, 380 LF of 42 inch pipe, 325 LF of 48 inch pipe, and 400 LF of 54 inch pipe. The project includes 7 manhole structures, 2 are proposed and 5 existing manholes will be utilized. The project also assumes installation of 7 catch basins with a total of 140 feet of 12-inch connecting laterals to accommodate future road widening.

Design Considerations

South End Road is identified as an area for future roadway improvements. The drainage system installation should be planned as part of roadway reconstruction project or drainage system design should account for future roadway widths and curb/sidewalk locations. Detailed topographic survey is needed to conduct final engineering evaluation to determine the appropriate invert elevations and pipe diameters to maintain necessary cover depth in this flat terrain.

The downstream open channel, south of South End Road will require a capacity assessment prior to upsizing. Due to the existing undersized pipe system, the open channel is currently not experiencing peak flows and may need additional stabilization to manage peak flows.

This project has also been identified as a possible location for a water quality enhancement facility, which has been included in the cost estimate as a lump sum item. The enhancement could include an upgrade to the tract adjacent to South End Road or the installation of dispersed facilities along the roadway alignment.

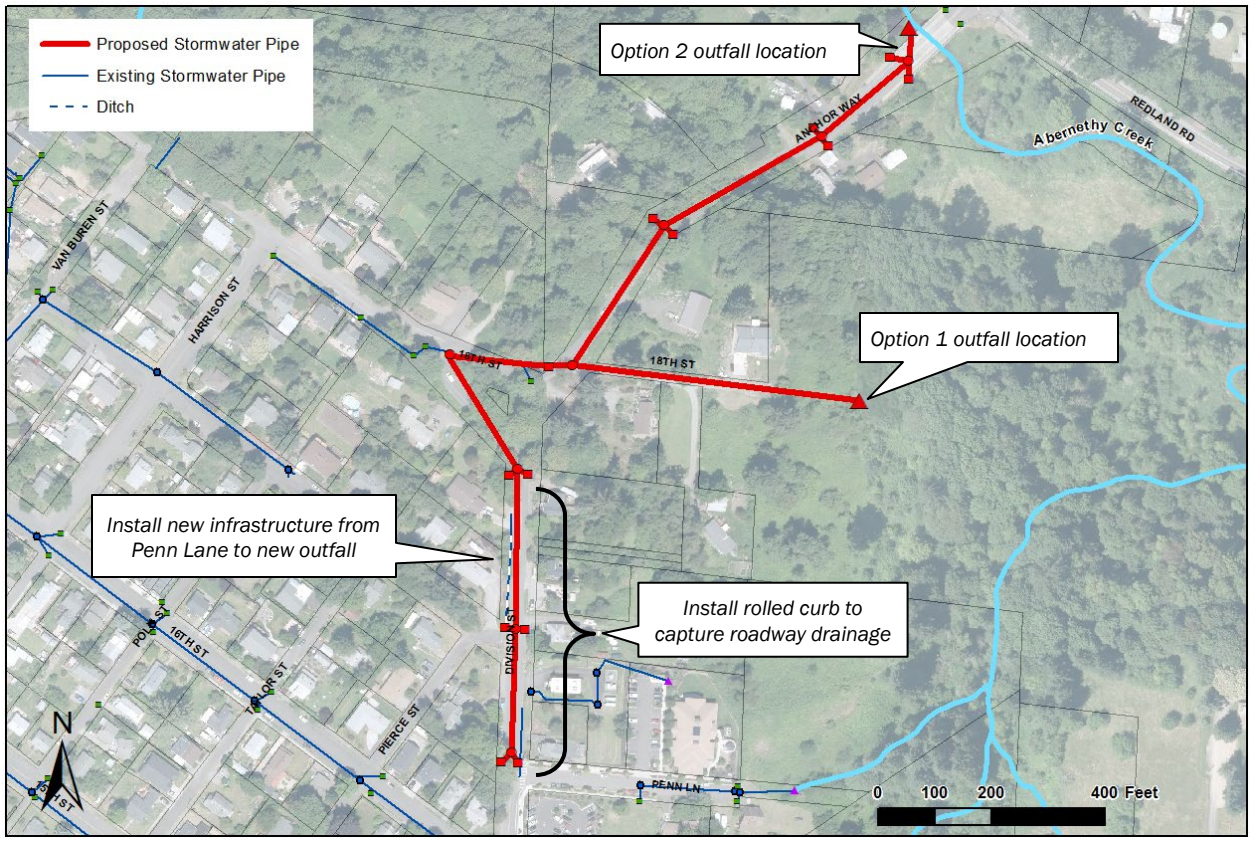
Planning-level Cost Estimate	
Capital Expense Total (including contingency)	$2,292,000
Engineering and Permitting (15%)	$344,000
Market Climate (10%)	$229,000
Construction Administration (15%)	$344,000
Capital Project Implementation Cost Total*	**$3,209,000**

* *Planning level cost estimates estimated in 2019 dollars, rounded to the nearest thousand. Project cost does not include property or easement acquisitions.*

Additional Project Information

The table below is provided to show the details of the planning level design and estimates for pipe size and invert elevations (this information should be considered planning level only and a formal design and analysis is needed).

Planning Level Infrastructure Data							
Link	Existing Diameter (in)	Proposed Diameter (in)	Proposed Length (ft)	US Node	DS Node	US Invert (ft)	DS Invert (ft)
800101	Open Channel	30	220	38963	30628	450.92	449.2
800102	Open Channel	30	60	40224	28962	448.92	448.12
800823	30	30	250	33801	33800	446.64	440.73
800824	18	30	35	30628	33801	448.12	446.74
801783	12	30	40	33800	42854	440.52	439.65
802787	18	30	35	38962	38963	449.2	448.92
Link31	12	30	160	42854	34365_SE_1100	439.45	435.74
Link41	54	42	380	34365_SE_1100	34761_SE_0900	434.74	431.57
Link42	48	48	325	34761_SE_0900	38973_SE_0800	431.07	428.38
Link43	Open Channel	54	340	38973_SE_0800	Node75	427.88	426.16
Link44	36	54	60	Node75	Node76	425.95	425.66



Project Identifier	**CIP 3**
Project Name	Division Street Infrastructure Improvements
Detailed Location	Division Street from Penn Lane to S Anchor Way
Model Connection	N/A
Objective(s) Addressed	Insufficient Infrastructure

Project Background

The City has identified insufficient infrastructure along Division Street near Penn Lane. Roadway drainage is currently managed through a series of ditches and culverts routing flow northward down Division Street, Anchor Way and 18th Street. Roadways occasionally experience flooding.

Project Description

The proposed project would pipe runoff from Division, Anchor Way and the associated catchments to one of two potential outfall locations toward Abernethy Creek. Both options include the same proposed infrastructure from Penn Lane downstream to the intersection of 18th Street and Anchor Way.

From the 18th Street and Anchor Way intersection, the Option 1 outfall location routes the storm system east of Anchor Way along 18th Street towards Abernethy Creek. 18th Street is an unimproved easement or existing right-of-way which will enable pipe and outfall to be constructed. Site conditions at the east end of 18th Street appear favorable for an outfall location. With this option, the proposed infrastructure will include the installation of approximately 1400 LF of 12-inch pipe, 7 catch basins with an associated 140 LF of inlet leads, 4 manholes, and an outfall structure. The project will require installation of rolled asphalt curbs along both sides of Division Street from Penn Lane to 18th Street.

The Option 2 outfall location routes the storm system northeast along Anchor Way towards the outfall at Abernethy Creek. In addition to the infrastructure necessary for option 1, this option will require the installation of an additional 500 LF of 12-inch pipe, 6 catch basins with an associated 120 LF of inlet leads, and 3 manholes.

Design Considerations

Option 1 would require slope stability analysis to verify that the proposed outfall would not contribute to hillside erosion. Option 2 is the preferred option because it uses an existing right-of-way alignment. Option 2 could also include improvements to address drainage concerns and pavement condition along Anchor Way.

Only preliminary calculations have been performed to identify conceptual pipe sizing. Design should verify pipe capacity needs, pipe location in right of way, outfall location and limits of rolled curb.

Detailed topographic survey is needed to conduct final engineering evaluation to determine the appropriate invert elevations and pipe diameters to maintain necessary cover depth.

Planning-level Cost Estimate (Option 1 Outfall Location)	
Capital Expense Total (including contingency)	$550,000
Engineering and Permitting (15%)	$82,000
Market Climate (10%)	$56,000
Construction Administration (15%)	$82,000
Capital Project Implementation Cost Total*	**$770,000**

Planning-level Cost Estimate (Option 2 Outfall Location)	
Capital Expense Total (including contingency)	$701,000
Engineering and Permitting (15%)	$105,000
Market Climate (10%)	$70,000
Construction Administration (15%)	$105,000
Capital Project Implementation Cost Total*	**$981,000**

* *Planning level cost estimates estimated in 2019 dollars, rounded to the nearest thousand. Does not include property or easement acquisitions.*

Additional Project Information

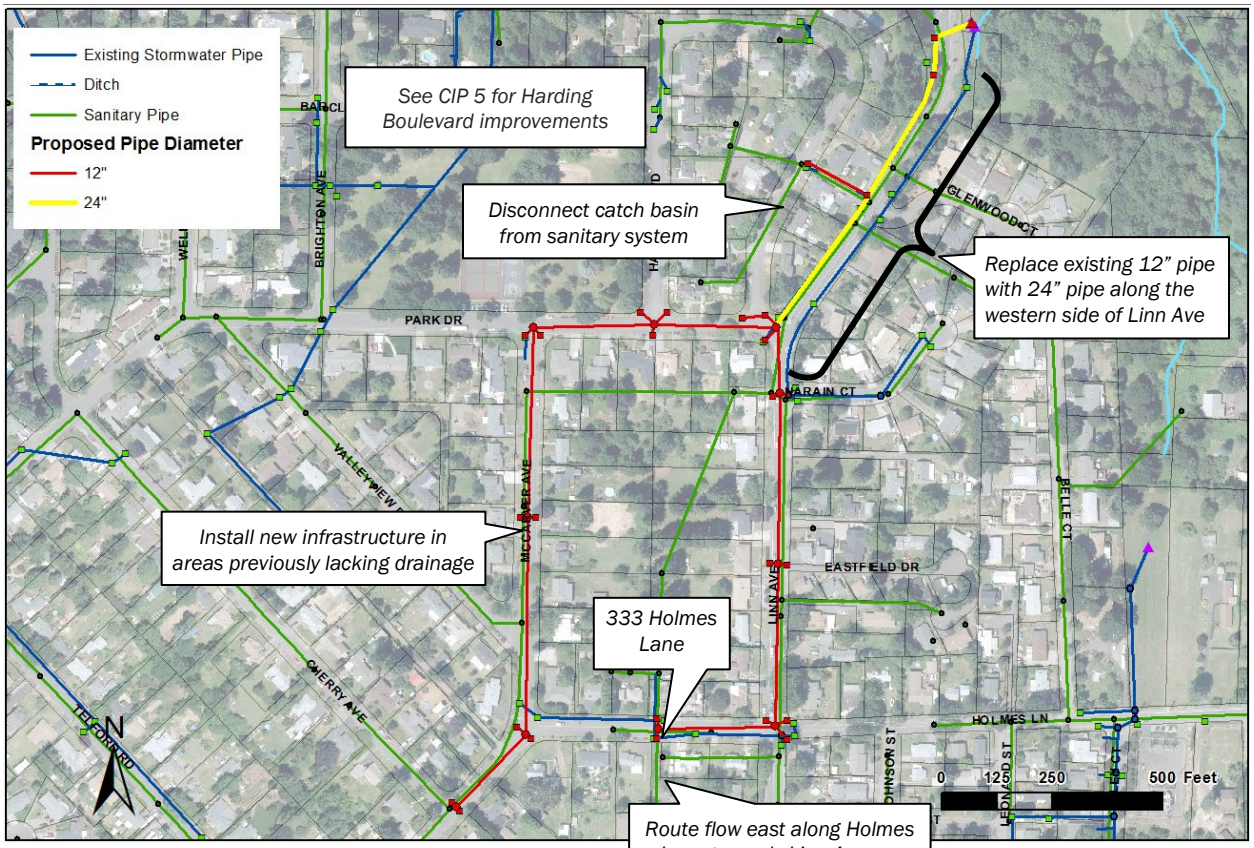
Images of the study area are included below.



Figure 1: Option 1 outfall location



Figure 2: View from Option 2 outfall location west towards Anchor Way



Project Identifier	**CIP 4**
Project Name	Rivercrest Neighborhood Infrastructure Improvements
Detailed Location	Linn Avenue between Holmes Lane and Park Drive
Model File	N/A
Objective(s) Addressed	Insufficient Infrastructure

Project Background

Portions of the Rivercrest Neighborhood lack a storm drain system. Drainage along Holmes Lane between McCarver and Linn Avenue currently discharges to an open channel near the northwest corner of 333 Holmes Lane. This open channel flows, to the north, through multiple backyards approximately along the existing sanitary sewer line and terminates near the intersection of Linn Ave and Park Drive. Two existing 12-inch stormwater pipes, providing stormwater conveyance along Linn Avenue north of Park Drive do not have capacity for the catchment based on modeling results.

Project Description

New storm infrastructure is proposed along Linn Ave, McCarver Avenue, Holmes Lane and Park Drive. The drainage discharging at 333 Holmes Lane will be rerouted east along Holmes Lane to a structure at the intersection with Linn Avenue where it will flow north towards Park Drive. The existing conveyance line in Linn Avenue will be replaced with a single, larger pipe along the west side of the road which will discharge into Singer Creek. The western side of Linn Avenue is the preferred drainage route because it has the wider roadway shoulder.

In addition, the single catch basin on Harding Blvd will be disconnected from the sanitary sewer and routed south east between the two homes to Linn Avenue.

The project includes 2,800 LF of 12-inch pipe along McCarver Avenue, Park Drive, Holmes Ln, and Linn Avenue and 900 LF of 24-inch pipe on Linn Avenue north of Park Drive. A total of 10 manhole structures will be installed, with the manhole at the intersection of Linn Avenue and Holmes Ln reaching a depth of approximately 15-20 feet. 27 catch basins and 440 feet of 12-inch inlet leads will also be installed.

Design Considerations

Only planning level calculations have been performed to identify conceptual sizing. Detailed topographic survey is needed to conduct final engineering evaluation to determine the appropriate invert elevations and pipe diameters to maintain necessary cover depth in this flat terrain.

Outfall inspections may be necessary for the proposed 24" pipe across Linn Avenue due to the increased flow associated with the additional infrastructure. A more suitable outfall location may be considered if the current proposed location is not stable enough to accommodate the larger peak flows.

Coordination with the SS Master Plan is recommended to avoid utility conflicts and multiple impacts to the same roadway segments.

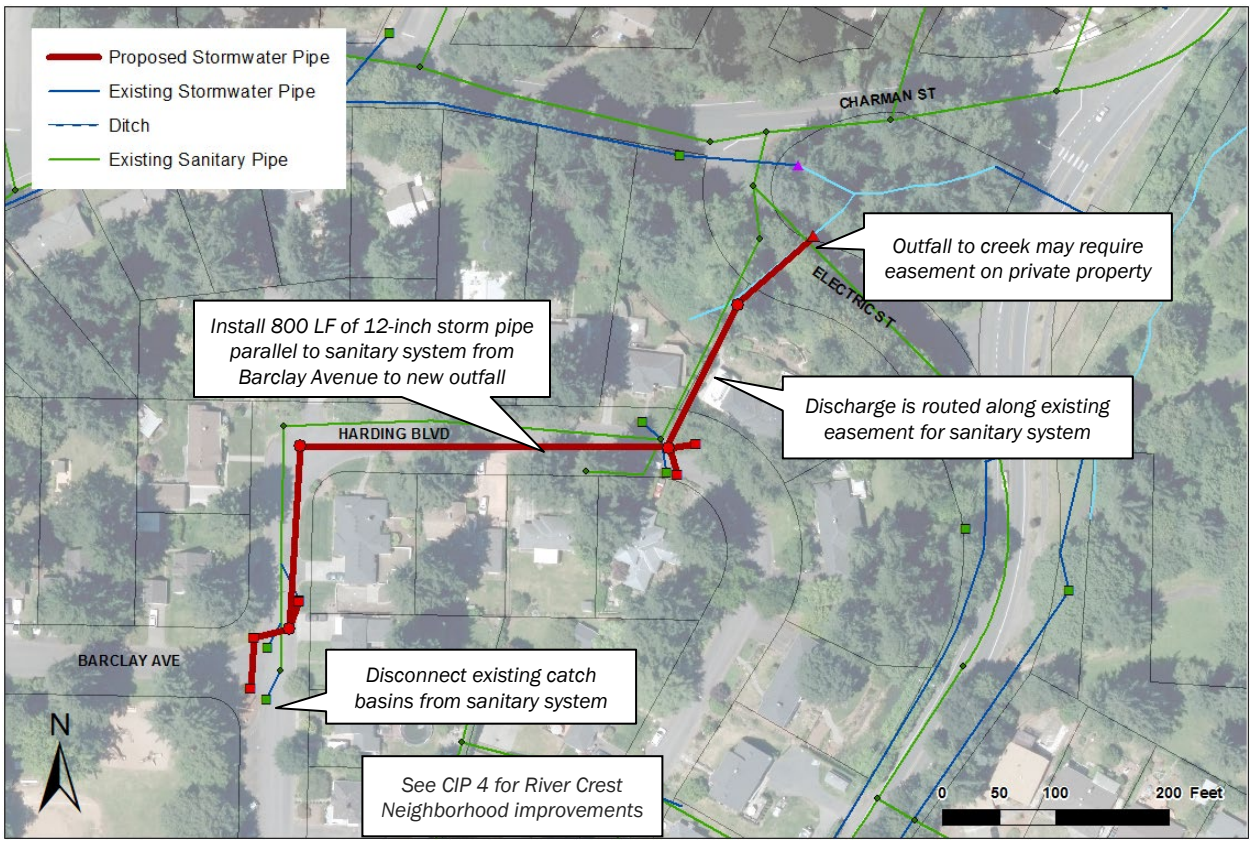
Planning-level Cost Estimate	
Capital Expense Total (including contingency)	$1,734,000
Engineering and Permitting (15%)	$260,000
Market Climate (10%)	$174,000
Construction Administration (15%)	$260,000
Capital Project Implementation Cost Total*	**$2,428,000**

* *Planning level cost estimates estimated in 2019 dollars, rounded to the nearest thousand. Project cost does not include property or easement acquisitions.*

Additional Project Information



Figure 1: Drainage outfall location behind 333 Holmes Lane



Project Identifier	**CIP 5**
Project Name	Harding Boulevard Sanitary Disconnect
Detailed Location	Harding Blvd from Barclay Ave to Linn Ave
Model File	N/A
Objective(s) Addressed	Disconnect stormwater from sanitary collection system

Project Background

Five catch basins are currently connected to the sanitary system along Harding Boulevard north of Barclay Avenue. This area has been identified as a contributor to sanitary sewer infiltration and inflow. This area is adjacent to CIP 4, which includes the installation of new stormwater infrastructure in the River Crest Neighborhood.

Project Description

Five catch basins will be disconnected from the sanitary collection system, redirecting roadway runoff and associated drainage to a proposed stormwater conveyance system with an outfall to Singer Creek. 800 LF of 12-inch will be installed parallel to the existing sanitary system. The project will include 4 manholes and assumes installation of 5 inlet structures with a total of 100 LF of 12-inch connecting laterals.

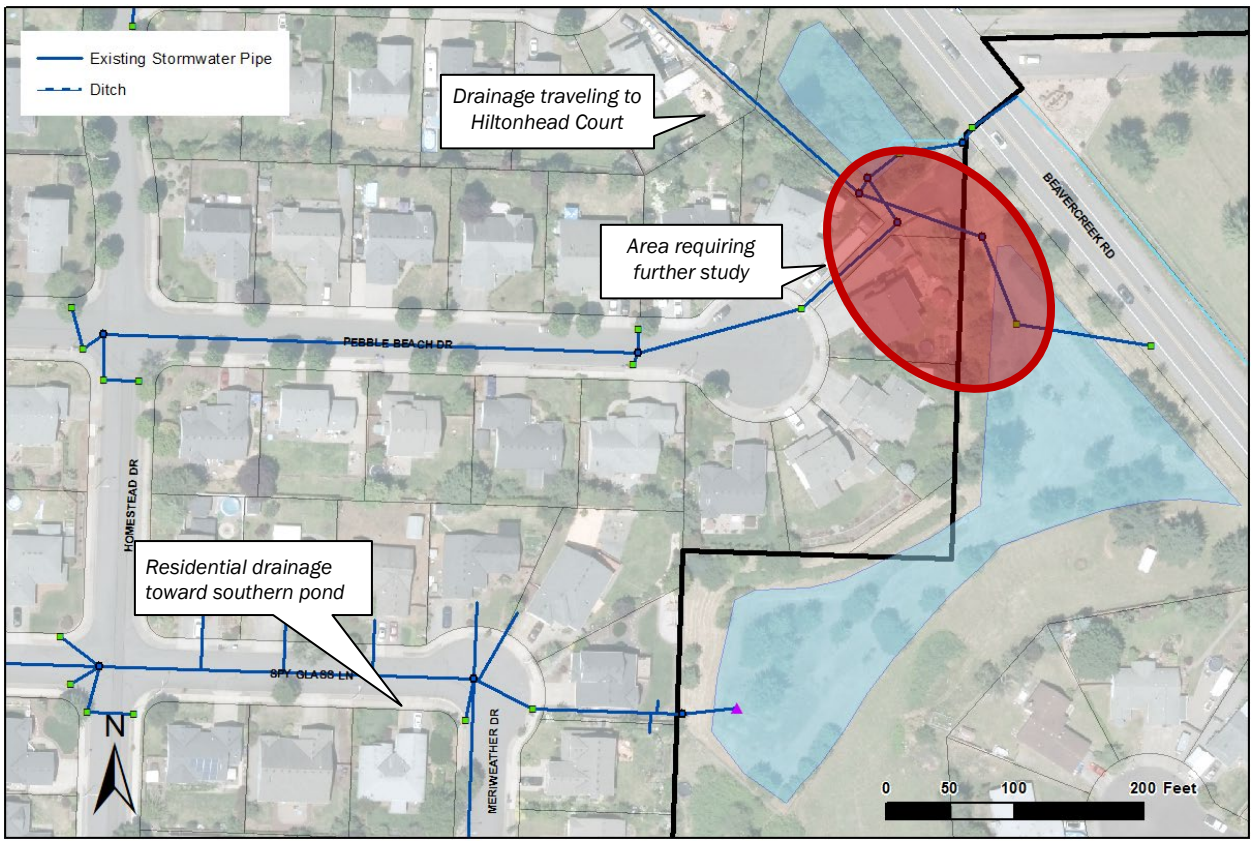
Design Considerations

The outfall will discharge to private property at the corner of Electric St and Linn Ave. An easement exists between 170 Harding Blvd and 178 Harding Blvd for the sanitary system which will be used for the new stormwater pipes, However, a new easement may be needed for the outfall at Electric St. A new easement may be necessary for the private property outfall north of Electric Street.

Detailed topographic survey is needed to conduct final engineering evaluation to determine the appropriate invert elevations and pipe diameters to maintain necessary cover depth in this flat terrain. Final design will need to address potential utility conflicts and proposed catch basin locations.

Planning-level Cost Estimate	
Capital Expense Total (including contingency)	$331,000
Engineering and Permitting (15%)	$50,000
Market Climate (10%)	$33,000
Construction Administration (15%)	$50,000
Capital Project Implementation Cost Total*	**$464,000**

**Planning level cost estimates estimated in 2019 dollars, rounded to the nearest thousand. Does not include property or easement acquisitions.*



Project Identifier	**CIP 6**
Project Name	Pebble Beach Pond Retrofit
Detailed Location	Near 15083 Pebble Beach Road
Model Connection	N/A
Objective(s) Addressed	Flooding

Project Background

Two stormwater management ponds are located near Thayer Court, adjacent to Beavercreek Road. During the watershed problem identification workshop, City staff indicated that the ponds are not working as intended with only one pond filling during storm events. During a site visit in March 2017, the small pond appeared to have a plugged outlet, as the water elevation was high and the emergency overflow was moving water into the outlet structure. The larger pond did not have any standing water and does not appear to provide detention or flow control.

Residential stormwater from the south contributes to the larger pond and from one inlet along Beavercreek Road. Most Beavercreek Road runoff contributes to the smaller pond. A portion of residential stormwater from Pebble Beach Drive discharges to the outfall structure of the small pond and therefore receives no treatment via the pond. The two ponds are isolated hydraulically but share a manhole, downstream of each pond, prior to being conveyed northwest toward Hiltonhead Court. Both ponds have deep risers in the emergency overflow structure with an orifice at the bottom.

Project Description

These two ponds could be optimized/retrofit to improve water quality treatment and flow control. The goals of optimization include: better utilization of storage for flow control, increase water quality treatment capacity and improve maintenance access.

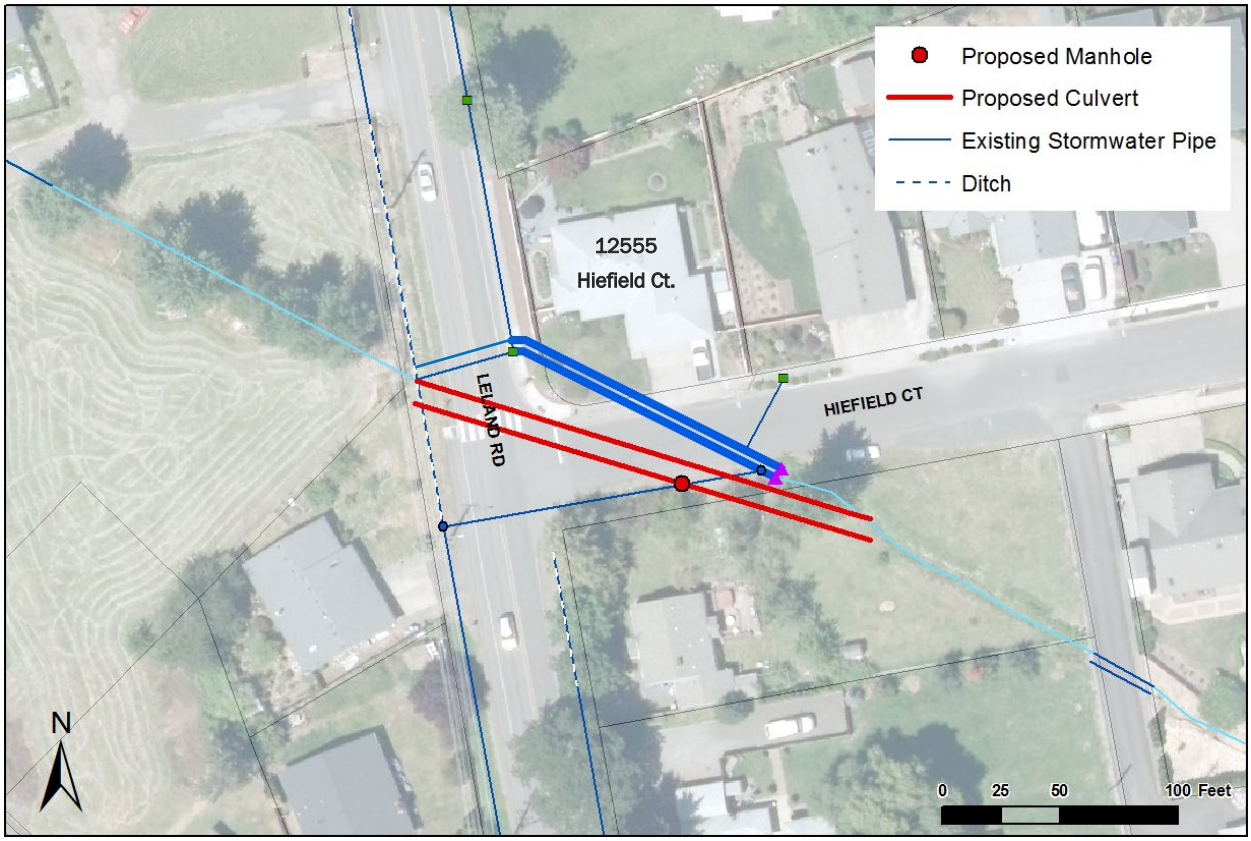
Further study is recommended for these ponds to determine the nature of the inputs and existing infrastructure to appropriately inform a design that would increase water quality treatment, reduce flooding, reduce maintenance and provide some flow control by updating the orifice structures.

Design Considerations
There are no design recommendations.

Planning-level Cost Estimate	
Capital Expense Total (including contingency)	$460,000
Engineering and Permitting (30%)**	$138,000
Market Climate (10%)	$46,000
Construction Administration (15%)	$69,000
Capital Project Implementation Cost Total*	**$713,000**

* *Planning level cost estimates estimated in 2019 dollars, rounded to the nearest thousand. Cost does not include property or easement acquisitions.*

** *Engineering and Permitting is 30% to allow for hydrologic and hydraulic assessment prior to engineering.*



Project Identifier	**CIP 7**
Project Name	Hiefield Court Culvert Improvements
Detailed Location	Culvert crossing at Hiefield Court and Leland Road
Model File	N/A
Objective(s) Addressed	Localized flooding

Project Background

The two existing culverts across Hiefield Court and Leland Road are prone to flooding at the inlet along Leland Road. The dual culvert begins on the west side of Leland Road with two 24" pipes. The culverts appear to have very low slope and minimal cover.

The north 24" inch drains to a large structure at the east side of Leland Road where the system transitions to 30". The 30" pipe conveys runoff under the corner of the adjacent private lot to the outfall on the south side of Hiefield Court. The south 24" pipe drains to an inlet structure and is parallel to the north line. A 30" pipe exits the inlet structure and parallels the north line to the outlet. Just before the outlet a 24" pipe enters the southern 30" as shown in the figure above.

The inlet of the two 24" culverts is not optimized to reduce inlet losses and the sharp bend in the structure on the east side of Leland Road does not optimize the movement of water downstream. Updating the channel alignment and reducing entrance/structure losses may alleviate the flooding currently occurring along the west side of Leland Road.

Project Description

Potential improvements include:

- Updating the inlet with wing walls to reduce head loss and reworking the pipe alignment such that the channel is in line with the culverts to facilitate the movement of water downstream,
- Adjusting the location of the 24" pipe that connects to the 30" such that the pipe has a separate outfall to the open channel drainage system.
- Replacing existing culverts with upsized culverts as shown in figure above.

The project should include a detailed hydrologic and hydraulic analysis (model) of this culvert system to determine the existing capacity and the optimal configuration and ensure that the proposed design can convey the design event for the contributing catchment.

Design Considerations

Any overtopping of the culverts should be directed to Hiefield Court and away from the home at 12555 Hiefield Court. Limited cover over the culvert may be a considerable design constraint.

Planning-level Cost Estimate

Capital Expense Total (including contingency)**	$460,000
Engineering and Permitting (25%)	$138,000
Market Climate (10%)	$46,000
Construction Administration (15%)	$69,000
Capital Project Implementation Cost Total*	$713,000

* *Planning level cost estimates estimated in 2019 dollars, rounded to the nearest thousand. Does not include property or easement acquisitions.*

** *Cost estimate based on culvert replacement.*

Additional Project Information

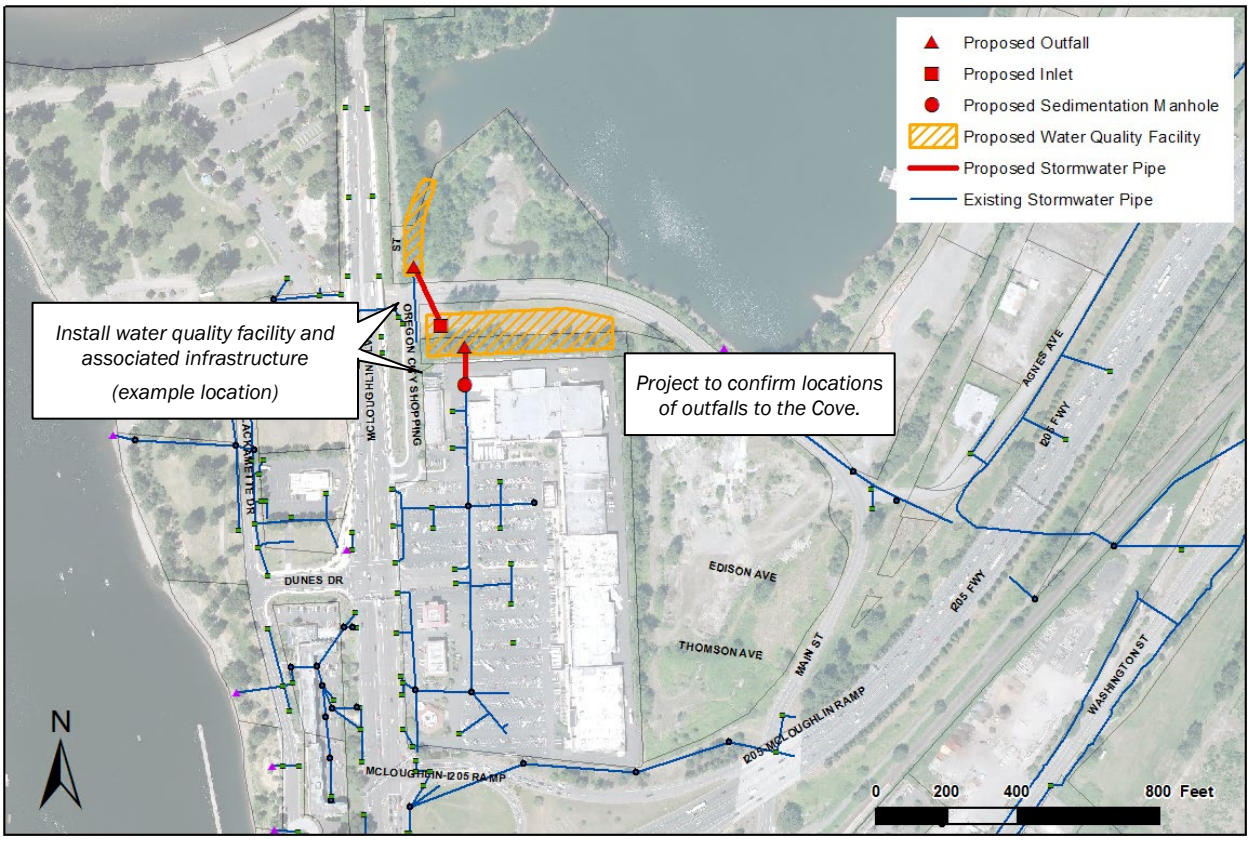
Images of the study area are included below.



Figure 1: Downstream end of culverts south of Hiefield Court



Figure 2: Inlet of culverts west of Leland Road



Project Identifier	**CIP 8**
Project Name	The Cove Water Quality Improvements
Detailed Location	Linn Avenue between Holmes Lane and Park Drive
Model File	N/A
Objective(s) Addressed	Water Quality

Project Background

Stormwater entering Clackamette Cove is primarily runoff from industrial, commercial and other land use that can generate high pollutant loads. The areas were developed prior to water quality requirements, so the discharge entering the cove is primarily untreated.

Previous studies have identified significant water quality concerns in the cove, including algal blooms. Limited connection to the Clackamas River results in little circulation and turnover which contributes to the water quality concerns.

The area surrounding the cove is of high interest for development and redevelopment, due to the proximity to the rivers and large land parcels. As the surrounding property redevelops, more attention is placed on this water body and its use for recreation and habitat enhancement. Improving water quality from the contributing catchments has become a priority.

Project Description

Water quality treatment of Oregon City Shopping Center, located at the intersection of Mcloughlin Blvd and Dunes Dr., will be the primary goal of this project. Treatment may occur along the north sides of the shopping center and/or to the north, across Main Street, prior to the outfall into Clackamette Cove. Preliminary water quality facility sizing, utilizing the BMP sizing tool, for the entire shopping center results in a treatment area of 11,000 square feet.

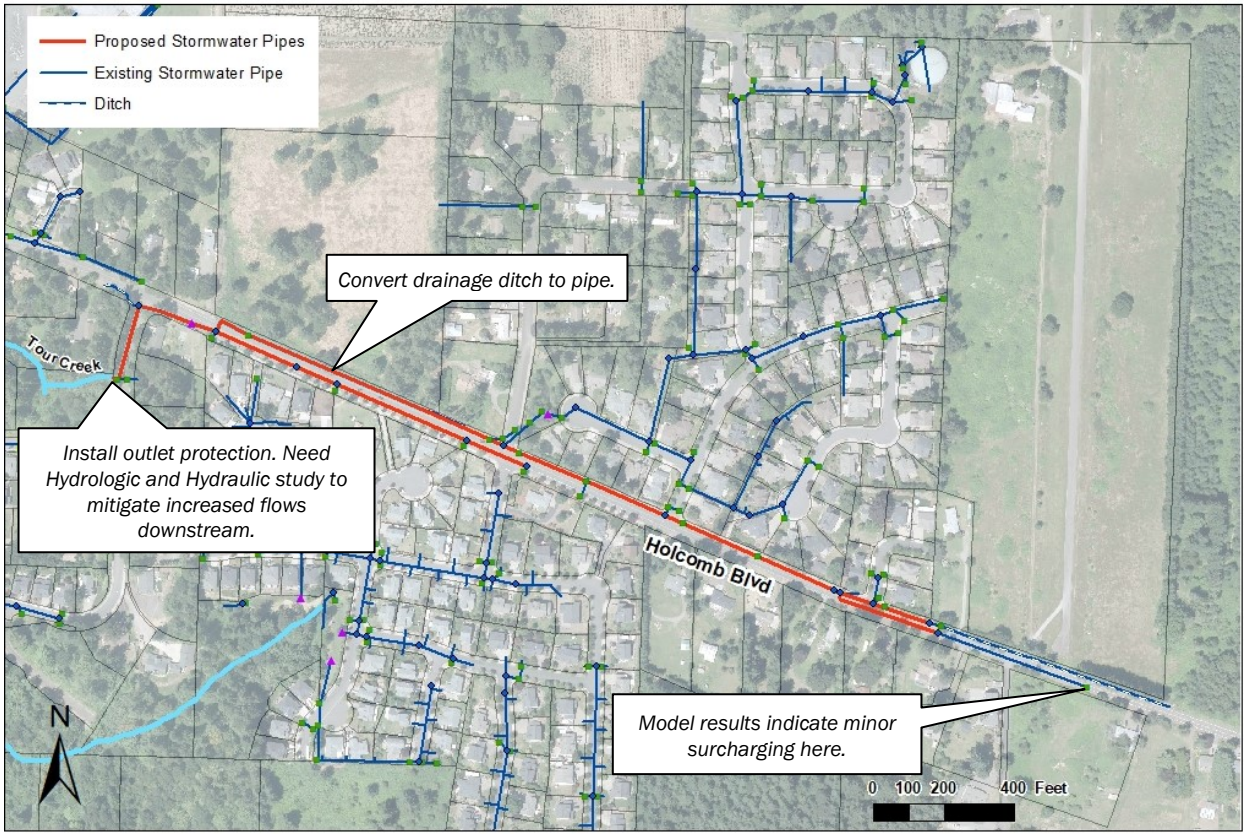
The water quality area shown in the figure above is not intended to show this size but to provide potential areas for facility placement. Existing onsite drainage infrastructure should be determined prior to formal adoption of where treatment will occur. Treatment of the parking lot drainage will be key to making significant change to the effluent water quality discharging to The Cove, which should be the priority for treatment and rerouting of existing storm infrastructure to the proposed water quality facility.

Design Considerations
The location and depth of existing stormwater infrastructure will be critical to the success of rerouting runoff to a treatment facility. Survey will be required. Wetland delineation and permitting may be needed for the area north of Main St. if wetlands exist in the area identified for a water quality facility. The specific design for the water quality retrofit could include a large regional facility as shown above. Other options include dispersed treatment filters throughout the parking area, a smaller rain garden or planters throughout the contributing drainage basin, or a combination of these. The area shown above is one such concept, developed to establish a cost estimate.

Planning-level Cost Estimate	
Capital Expense Total (including contingency)*	$406,000
Engineering and Permitting (25%)	$101,000
Market Climate (10%)	$40,000
Construction Administration (15%)	$61,000
Capital Project Implementation Cost Total**	**$608,000**

**Includes hydrologic & hydraulic modeling and survey. Does not include property or easement acquisitions.*

***Planning level cost estimates estimated in 2019 dollars, rounded to the nearest thousand.*



Project Identifier	**CIP 9**
Project Name	Holcomb Boulevard Capacity Improvements
Detailed Location	Holcomb Blvd from Kittyhawk Ave to Outfall at Tour Creek
Model File	FU3_HO1_v2019_25yr.xp
Objective(s) Addressed	Provide conveyance for the 25-year storm event and mitigate for future development

Project Background

Private development at Abernethy Landing recently made stormwater improvements to this stretch of Holcomb, adding a parallel conveyance line tied into the existing drainage system. Hydrologic and Hydraulic analysis of this area has revealed deficiencies in both the recently installed segments, as well as with existing infrastructure to the west. This area has projected future development and potential connections from Park Place Concept area. The Holcomb Boulevard system culminates with discharge to Tour Creek.

Project Description

The project includes the upsizing of approximately 4000 linear feet of pipe, as well as outlet and channel protection for Tour Creek., The new conveyance system will range from 24-inch pipe east of Jada Way and increase to 42-inch pipe at the outlet, as well as upsizing to the drainage line on the south side of Holcomb, from 12- to 15-inches. The project would replace approximately 550 LF of open channel with a closed conveyance system, allowing for future upgrades to Holcomb Boulevard. Portions of the drainage system between Jada Way, and the previously open channel segment are steep (between 4.5 and 12%), causing the upper end of the watershed to drain quickly, but putting added conveyance needs on the lower, flatter, portion of the system.

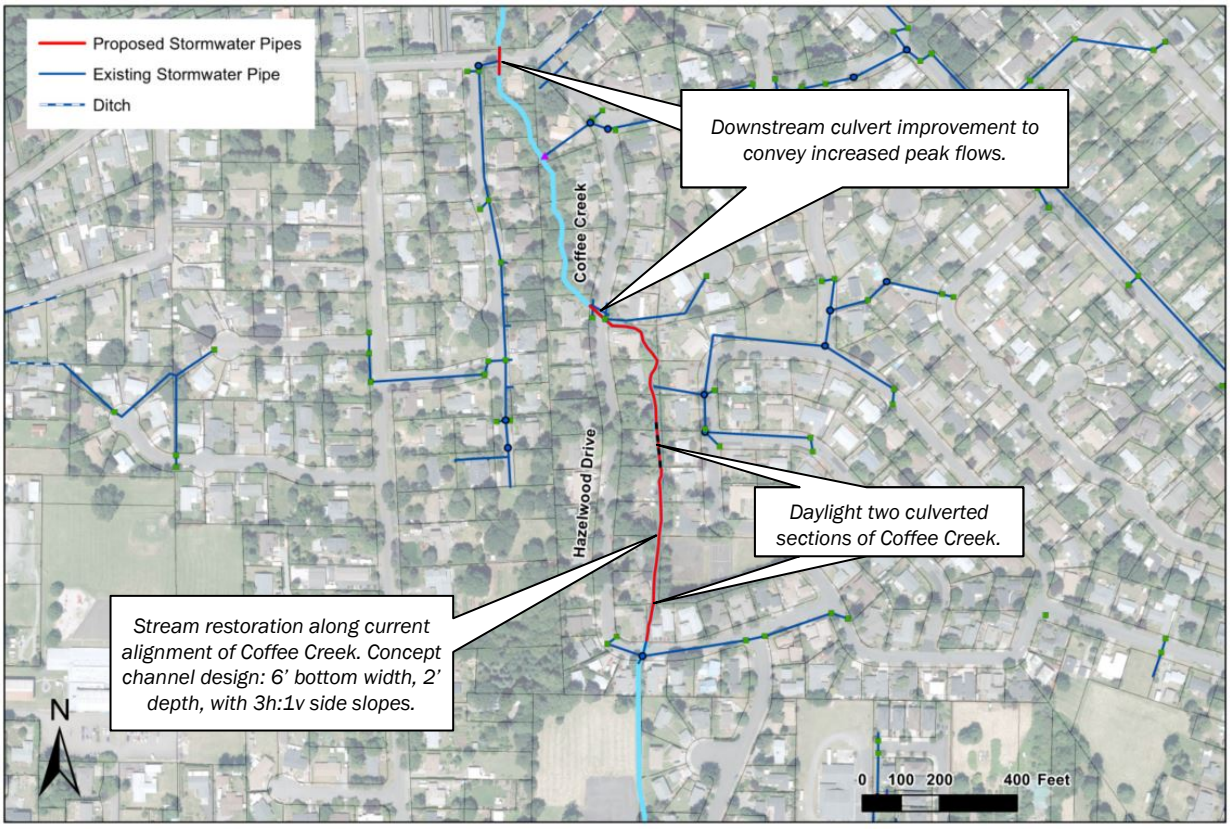
Design Considerations

Preliminary model results indicate a significant increase to the peak flow to Tour Creek, which warrants further study in order to confirm these results, as well as to provide a basis for mitigating the downstream impacts of the project. Project design should include detailed hydrologic evaluation to predict flow volumes and velocities for the design of outlet/erosion control measures.

Modeling results indicated minor surcharging at most upstream node along south-side main line on Holcomb (see callout) during 25-year event. This segment can be upsized from 15" to 18" to eliminate this surcharging and meet Oregon City design standards for a cost of approximately $90,000. Final design of system should consider refining pipe size, material, slopes, and depth to find most cost-effective solution to meet design objectives.

Planning-level Cost Estimate	
Capital Expense Total (including contingency)	$2,781,000
Engineering and Permitting (15%)	$417,000
Market Climate (10%)	$278,000
Construction Administration (15%)	$417,000
Capital Project Implementation Cost Total*	**$3,893,000**

**Planning level cost estimates estimated in 2019 dollars, rounded to the nearest thousand. Does not include property or easement acquisitions.*



Project Identifier	**CIP 10**
Project Name	Coffee Creek Stream Restoration
Detailed Location	Coffee Creek through Hazelwood Drive neighborhood between two Hazelwood Drive culverts.
Model File	FU3_CO1_Alt3_v05.xp
Objective(s) Addressed	Restore stream for improved water quality and stream stability. Provide additional conveyance during larger storm events to mitigate flooding issues on residential properties.

Project Background

Residents in the Hazelwood neighborhood have regularly complained of flooding issues during storm events. Due to prior development around Coffee Creek, the stream is routed through a series of pipes, culverts, and man-made channels of varying size. The existing system is located on private property, and is constricted through culverts twice within this stretch, creating uncertainty around maintenance responsibility and access. The system ranges from 48-inches in diameter at the upstream (southern) culvert crossing Hazelwood Drive, down to 24-inches at some points, causing chokepoints and localized flooding. The existing system has several unique drainage structures that are susceptible to debris accumulation.

In order to provide some relief for residents in this vicinity, the City is proposing a stream restoration project through the existing Coffee Creek alignment to provide additional channel capacity, stabilize the creek, and improve water quality.

Project Description

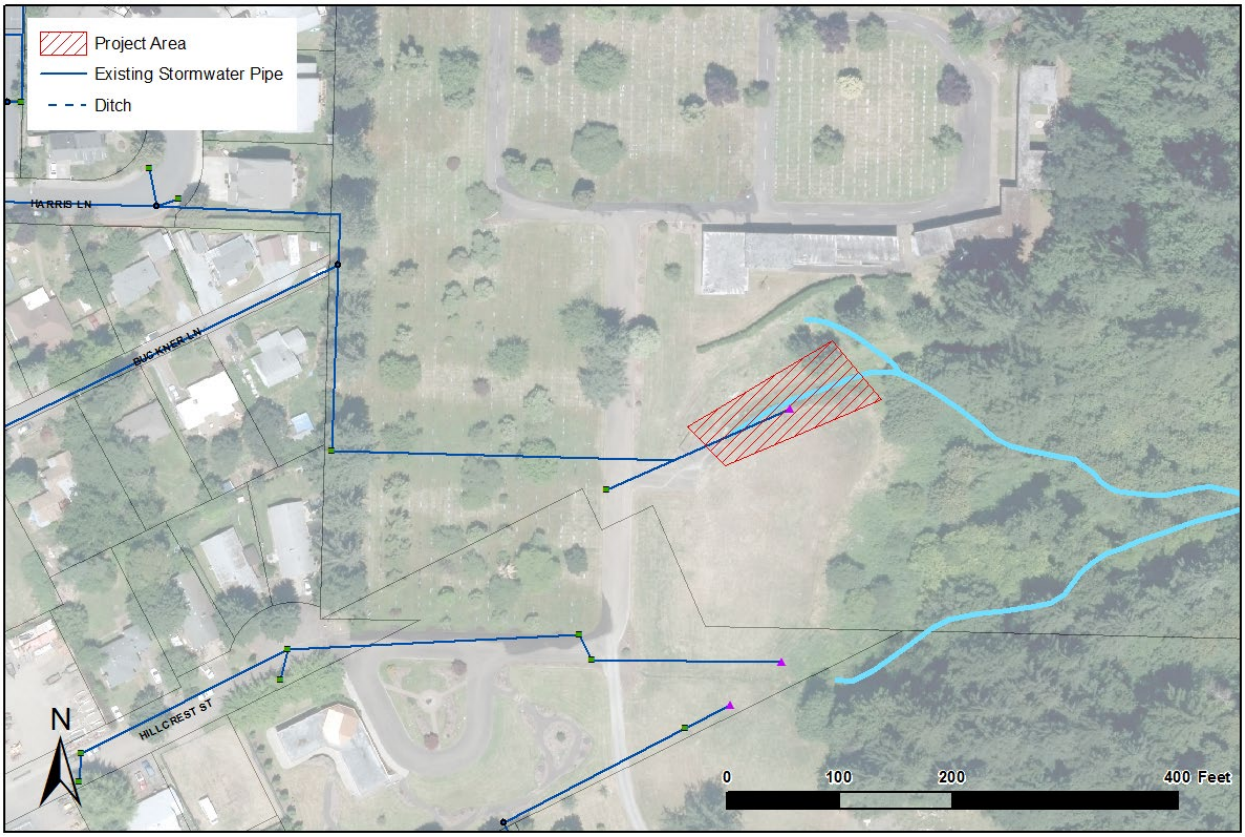
The project includes the removal of two culverts along the Coffee Creek alignment on private property with a combined length of approximately 120 feet. The preliminary concept design is based on installation of a uniform channel cross section, sized to have a 6 foot bottom width, 2 foot depth, and 3h:1v side slopes. Final design should include adjustments to channel cross section to match individual lot topography and create a varied and meandering channel.

The project includes approximately 870 linear feet of stream restoration, as well as downstream improvements to increase culvert sizes at the Hazelwood and Barker Ave crossings.

Design Considerations
The concept channel designed here is sized to provide conveyance for the 25-year design storm. A complete design is contingent upon survey of the area and space constraints. Buy-in from local residents will be necessary to complete construction on private property. Downstream impacts from an increased peak flow rate will need to be mitigated through upstream green infrastructure, up-sizing of downstream infrastructure, the installation of in-line flood storage, or a combination of these. Previous sanitary system work on Hazelwood Drive should provide valuable information on local geology that may impact construction costs and methods.

Planning-level Cost Estimate	
Capital Expense Total (including contingency)	$783,000
Engineering and Permitting (15%)	$117,000
Market Climate (10%)	$79,000
Construction Administration (15%)	$117,000
Capital Project Implementation Cost Total*	**$1,096,000**

**Planning level cost estimates estimated in 2019 dollars, rounded to the nearest thousand. Does not include property or easement acquisitions.*



Project Identifier	**CIP 11**
Project Name	Scattering Canyon Stormwater Improvement
Detailed Location	Mountain View Cemetery (500 Hilda Street)
Model File	N/A
Objective(s) Addressed	Erosion, Infrastructure Needs, Water Quality

Project Background

Scattering Canyon is located along a tributary to Newell Creek in the Mountain View Cemetery property. This area is often a place where ashes are scattered in the creek and is used by family and friends of the deceased. The creek has been experiencing hydromodification in the form of severe incision near the outfall and erosion further downstream resulting in a less than desirable setting. The pipe outfall at the start of the tributary conveys stormwater from roads and residential areas upstream.

Project Description

The project will consist of multiple improvements to Scattering Canyon. The current eroding channel will be modified to provide water quality treatment with 195 LF of 6-inch perforated underdrain pipe in the canyon to enhance water quality treatment. A diversion structure and pollution control manhole will direct water quality flows to the swale and divert high flows to an outfall further downstream via a new stormwater conveyance system consisting of two manholes and 250 LF of 12-inch pipe. Large boulders and vegetation will be placed near the existing outfall to prevent further incision. Multiple boulder check dams or steps will be installed in the swale for flow control to reduce erosive energy and provide a more approachable setting for visitors. The existing dirt road will have some minor regrading and will be paved with geo-grid grass pavers. Native trees and vegetation will also be planted with temporary irrigation as part of this project.

Design Considerations

Only 30% level design has been performed to identify conceptual plans. Detailed topographic survey and hydraulic modeling is needed to conduct final engineering evaluation to determine the appropriate invert elevations and verify pipe diameters to maintain necessary cover and convey the design event for the stormwater system.

Planning-level Cost Estimate	
General Requirements	$60,000
Earthwork	$170,000
Storm Utilities	$65,000
Landscaping/Irrigation	$65,000
Site Furniture	$19,000
10% Contingency	$38,000
Capital Project Implementation Cost Total*	**$417,000**
Engineering and Permitting (20%)	$83,000
Construction Administration (5%)	$21,000
Capital Project Implementation Cost Total*	**$521,000**

**Planning level cost estimates estimated in 2019 dollars, rounded to the nearest thousand. Project cost does not include property or easement acquisitions.*

Additional Project Information

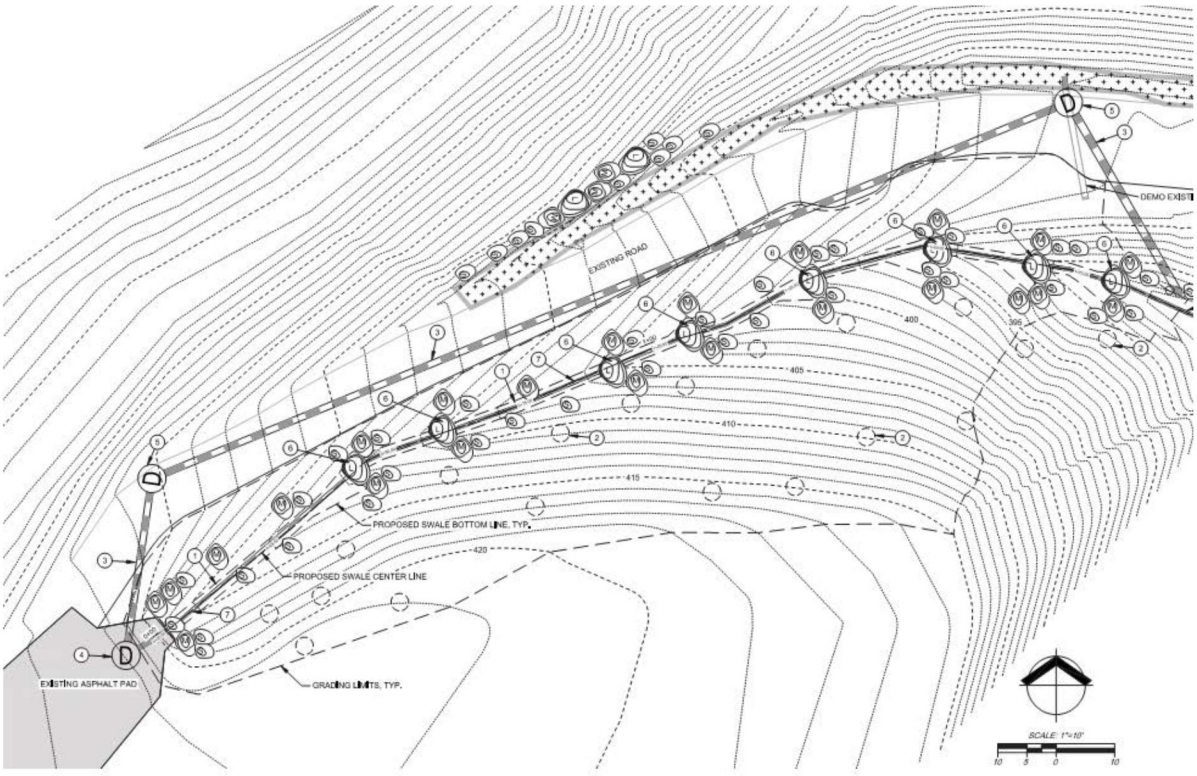
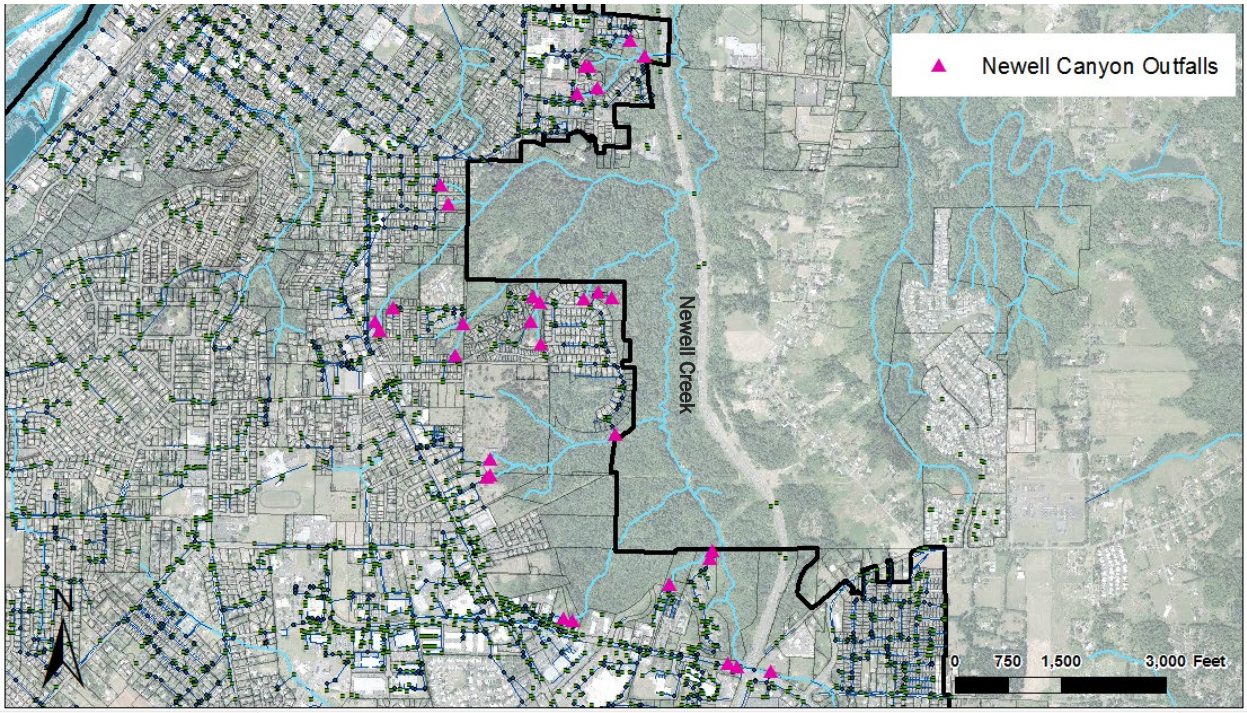


Image 1. Conceptual plan for Scattering Canyon



Project Identifier	CIP 12
Project Name	Newell Canyon Outfall Assessment
Detailed Location	Newell Creek
Model File	N/A
Objective(s) Addressed	Natural Systems, Infrastructure

Project Background

The area around Newell Creek, commonly referred to as Newell Canyon, has several locations where erosion, bank sloughing, and landslides have occurred during and following storm events. The canyon is largely protected from development because of Metro ownership and protection. However, prior development of the drainage area contributing to Newell Canyon has resulted in some degradation of the natural systems.

Newell Canyon has been established as a problem area that is characterized by steep slopes, erodible soils, and numerous stormwater outfalls and small drainage tributaries. The development in this watershed is generally lacks stormwater management facilities. The combination of development without flow control and highly erodible soils has resulted in observed stream incision, erosion at the outfalls, and severely altered stream channels. Newell Canyon hillsides have also experienced sloughing and small landslides, though those problems cannot be attributed solely to stormwater runoff. Newell Creek has some areas of severe downcutting and incision in the upper reaches of the creek but lower reaches of the creek through the base of the canyon seem to be well preserved.

Stream surveys and site visits in 2015 and 2016 by Brown and Caldwell staff documented areas where stormwater outfalls showed noticeable degradation. Outfalls showed visible increases in erosion and degradation over the course of 12 months. There is concern that ongoing degradation may lead to more significant bank and hillside stability problems.

Project Description

Further study is needed to evaluate the stormwater outfalls in the Newell Canyon area. This project includes conducting a widespread outfall assessment to evaluate stormwater outfalls, identify significant problem locations, and develop concept plans to stabilize degrading systems. The assessment should include the following:

- Develop outfall evaluation criteria for a desktop evaluation and onsite evaluation.
- Conduct desktop evaluation using available mapping data and problem area reports to prioritize locations for onsite assessments.
- Based on the prioritization outcome, conduct outfall inspections at roughly 15-20 high priority outfalls. Inspections would evaluate outfall condition, stabilization measures, bank stability and degradation. Inspections would also evaluate construction opportunities and constraints for future stabilization projects.
- Develop a priority matrix of outfall stabilization projects and a recommended schedule for design and construction.
- Develop concept level designs and cost estimates for outfall stabilization measures at the highest priority project areas (approximately 5 outfalls).

The planning level cost estimate includes the development of evaluation criteria, 15-20 site visits, and concept design for up to 5 locations.

Planning-level Cost Estimate	
Capital Project Implementation Cost Total	**$100,000**

Additional Project Information



Image 1. Degrading outfall location near Peter Skene Way



Image 2. Sloughing bank downstream of outfall location near Eluria Street

Appendix G: Potential Project Matrix

Use of contents on this sheet is subject to the limitations specified at the end of this document.

Table G-1. Potential Projects (as of April 2017)

Project no.	Project area/name	Problem areas addressed	Project description	Project type		Project benefits					
				Individual	Programmatic	Capacity	Asset upgrade/replacement	Water quality	Habitat/channel restoration	Erosion prevention/repair	Other
Project Recommendations											
1	John Adams Basin Capacity Improvements	JA-F-01 JA-F-02 JA-F-03 JA-F-04 JA-I-01 JA-I-03 JA-I-04 JA-I-05	Upsize pipes and/or re-route flow to address capacity problems and replace aging infrastructure.	X		X	X				
2	Infrastructure Inspection and Rehabilitation	JA... SI-I-01 CO-I-01	Program to conduct video inspection for aging infrastructure. Areas to include John Adams Basin, older parts of Singer Basin, and the Canemah District in the Coffee Creek Basin. Infrastructure replacement based on inspection results.		X		X				
3	Outfall Inspection and Stabilization	NE-N-04 LI-N-01 LI-I-02	Programmatic inspections and repairs to stabilize outfalls in Newell Canyon and other tributaries to Abernethy. Examples: Peter Skene Way, 14040 Beemer Way		X					X	X
4	South End Rd near Rose Rd	SE-F-02 SE-I-01	Upsize undersized pipes in South End Road and extend closed drainage system to outfall near S Salmonberry Drive.	X		X					
5	Division near Penn	AB-I-01	Upgrade catch basins and storm system along west side of Division, starting at 19th/Anchor Way and extending to Penn.	X		X	X				
6	Rivercrest Neighborhood	SI-I-02	Install storm drainage system to disconnect from sanitary system.	X			X				X
7	Harding Blvd	SI-I-04	Install storm drainage system to disconnect from sanitary system.	X			X				X
8	Pebble Beach Pond	CA-F-01	Retrofit existing ponds to improve operations/storage and increase water quality treatment	X		X		X			

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Table G-1. Potential Projects (as of April 2017)												
				Project type		Project benefits						
Project no.	Project area/name	Problem areas addressed	Project description	Individual	Programmatic	Capacity	Asset upgrade/replacement	Water quality	Habitat/channel restoration	Erosion prevention/repair	Other
Additional Potential Projects to Consider												
ODOT project	Hwy 213 and Beavercreek Rd	NE-N-01	Channel and outfall stabilization based on geotechnical investigation.	x						x	
Low priority	Kathaway Ct to Sunset Springs	CP-F-01	Extend pipes to collect drainage from Partlow and adjust outfall accordingly.	x		x					
Maintenance project	Harrison St & Division	SI-I-06	Maintenance upgrade to replace existing pipe and add berm, curb, or CB.	x			x				
Opportunity with other infrastructure priorities	Coffee Creek Culverts near Hazelwood	CO-F-01 CO-I-04	Replace aging culvert or re-grade and rehabilitate natural channel to improve capacity.	x		x					
	Hiefield Court	MU-F-02	Upsize existing culvert crossing Leland Rd to address flooding.	X		X					
	Livesay	NA	Holcomb Blvd from outfall at Oak Tree Ter upstream to roadside ditch on north side of road is undersized. System may require improvements/upsizing associated with development.	x		x					
	Park Place	NA	Several culverts may be undersized and contribute to flooding. Improvements to the system may be needed.	x		x					
	Newell Creek	NE-F-01	existing in line detention system may be contributing to localized flooding at the intersection of Beavercreek Rd and Molalla Ave.	x		x				x	

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Appendix H: CIP Cost Estimates

Unit Costs

CIP Summary Costs

CIP 1 John Adams Basin Capacity Improvements

- Phase 1 Outfall to 12th/John Adams
- Phase 2 12th/John Adams to 12th/Harrison
- Phase 3 12th/John Adams to 8th/Van Buren
- Phase 4 12th/Washington to 8th/John Adams

CIP 2 South End Road Stormwater Improvement

CIP 3 Division Street Infrastructure Improvements

- Option 1
- Option 2

CIP 4 Rivercrest Neighborhood Infrastructure Improvements

CIP 5 Harding Boulevard Sanitary Disconnect

CIP 6 Pebble Beach Pond Retrofit

CIP 7 Hiefield Court Culvert Improvements

CIP 8 The Cove Water Quality Improvements

CIP 9 Holcomb Boulevard Capacity Improvements

CIP 10 Coffee Creek Capacity Improvement

Use of contents on this sheet is subject to the limitations specified at the end of this document.

Oregon City 2019 SWMP

Unit Cost Table

Recommended unit cost for Oregon City 2019 SWMP.

Costs based on RS Means, collected bid tabs, and recent master planning efforts.

ITEM	UNIT	2019 Recommended Unit Costs
Water Quality Facility Installation		
General Earthwork/ Excavation	CY	20
Dewatering/flow bypass	LS	20,000
Embankment	CY	9
Clear and Grub brush including stumps	AC	8,200
Amended Soils and Mulch	CY	45
Jute Matting, Biodegradeable	SY	6
Geomembrane	SY	30
Energy dissapation pad - Rip-Rap, Class 50	CY	66
Drain Rock	CY	101
Pond Outflow Control Structure	EA	6,100
Pond Inlet Structure	EA	4,500
Water Quality Facility Plantings with Trees	SF	6
Rain Garden	SF	27
Stormwater Planter	SF	40
Gravel Access Road	SF	5
Beehive Overflow	EA	1,500
Structure Installation		
Precast Concrete Manhole (48", 0-8' deep)	EA	5,600
Precast Concrete Manhole (48", 9-12' deep)	EA	6,600
Precast Concrete Manhole (48", 13-20' deep)	EA	10,200
Precast Concrete Manhole (60", 0-8' deep)	EA	7,600
Precast Concrete Manhole (60", 9-12' deep)	EA	9,700
Precast Concrete Manhole (72", 0-8' deep)	EA	9,700
Precast Concrete Manhole (72", 9-12' deep)	EA	12,200
Drywell (48", 20-25' deep)	EA	12,200
Curb Inlet	EA	1,300
Catch Basin, all types	EA	2,000
Concrete Fill - UIC Decomissioning	EA	10,200
Connection to Existing Lateral	EA	1,200
Connection to Existing Structure, standard	EA	2,000
Connection to Existing Stone Structure	EA	7,500
Pipe Demo and Disposal	FT	70
Abandon Existing Pipe, no excavation (12")	FT	10
Abandon Existing Pipe, no excavation (15"-18")	FT	20
Abandon Existing Pipe, no excavation (21"-24")	FT	25
Abandon Existing Pipe, no excavation (27"-36")	FT	35
Abandon Existing Structure	EA	1,000
Remove Manhole Structure	EA	1,000
Plug Existing Pipe	EA	505
Outfall Improvements	EA	3,000-10,000
Restoration/ Resurfacing		
Non-Water Quality Facility Landscaping	AC	15,300
Riparian/Wetland Planting (Non-irrigated)	AC	20,300
Riparian/Wetland Planting (w/ temporary irrigation)	AC	32,500
4-foot Chain Link Fence	LF	22
Split Rail Fence	LF	25
Hydroseed, large quantities	AC	2,500
Seeding, small quantities	SF	6
Concrete Curbs	FT	40
Pipe Unit Cost		
Underdrain, 6" perforated HDPE	LF	56
HDPE Inlet Lead (12", 2-5' Deep)	FT	91
HDPE Pipeline w/ asphalt resurfacing (12", 5-10' Deep)	FT	140
HDPE Pipeline w/ asphalt resurfacing (12", 10-15' Deep)	FT	160
HDPE Pipeline w/ asphalt resurfacing (15", 10-15' Deep)	FT	180
HDPE Pipeline w/ asphalt resurfacing (18", 5-10' Deep)	FT	200
HDPE Pipeline w/ asphalt resurfacing (21", 5-10' Deep)	FT	240
HDPE Pipeline w/ asphalt resurfacing (24", 5-10' Deep)	FT	275
HDPE Pipeline w/ asphalt resurfacing (30", 5-10' Deep)	FT	325
HDPE Pipeline w/ asphalt resurfacing (36", 5-10' Deep)	FT	405
HDPE Pipeline w/ asphalt resurfacing (42", 5-10' Deep)	FT	485
HDPE Pipeline w/ asphalt resurfacing (48", 5-10' Deep)	FT	570
HDPE Pipeline w/ asphalt resurfacing (60", 5-10' Deep)	FT	820
Extra depth pipe	FT	51
Construction Contingencies and Multipliers		
Mobilization/Demobilization	LS	10%
Traffic Control/Utility Relocation	LS	10-15%
Erosion Control	LS	2%
Construction Contingency	LS	30%
Engineering and Permitting (%)	LS	15-40%
Construction Administration (%)	LS	15%
Market Climate (%)	LS	10%

Oregon City 2019 SWMP
Stormwater Master Plan Project Cost Summary
July 2019

CIP ID	Project Title	Total Cost (rounded)
CIP-1	John Adams Basin Capacity Improvements (all phases)	$8,555,000
CIP-2	South End Road Stormwater Improvement	$3,209,000
CIP-3	Division Street Infrastructure (Option 1)	$770,000
CIP-4	Rivercrest Sanitary Disconnect	$2,428,000
CIP-5	Harding Boulevard Sanitary Disconnect	$464,000
CIP-6	Pebble Beach Pond Retrofit	$713,000
CIP-7	Hiefield Court Culvert Improvements	$657,000
CIP-8	The Cove Water Quality Improvements	$608,000
CIP-9	Holcomb Boulevard Capacity Improvements	$3,893,000
CIP-10	Coffee Creek Capacity Improvements	$1,096,000
CIP-11	Scattering Canyon Stormwater Improvement	$521,000
Programmatic Activities		**Annual Cost**
CIP-12	Newell Canyon Outfall Assessment (annual)	$100,000
	Stormwater Short Term Repair Budget (annual)	TBD
	Stormwater Infrastructure Rehabilitation (annual)	TBD
	CIPs Total Cost:	**$23,014,000**

Oregon City 2019 SWMP

CIP Cost Estimate

CIP #1

John Adams Basin Capacity Improvements

Outfall to 12th/John Adams

ITEM	UNIT	Recommended Unit Cost	Quantity	Total Cost
Water Quality Facility Installation				
Energy dissapation pad - Rip-Rap, Class 50	CY	66	90	$5,940
Structure Installation				
Precast Concrete Manhole (60", 9-12' deep)	EA	9,700	12	$116,400
Catch Basin, all types	EA	2,000	15	$30,000
Connection to Existing Structure, standard	EA	2,000	5	$10,000
Pipe Demo and Disposal	FT	70	1140	$79,800
Remove Manhole Structure	EA	1,000	12	$12,000
Outfall Improvements	EA	3,000-10,000	10000	$10,000
Pipe Unit Cost				
HDPE Inlet Lead (12", 2-5' Deep)	FT	91	300	$27,300
HDPE Pipeline w/ asphalt resurfacing (36", 5-10' Deep)	FT	405	540	$218,700
HDPE Pipeline w/ asphalt resurfacing (60", 5-10' Deep)	FT	820	600	$492,000
Extra depth pipe	FT	51	820	$41,820
Project Sub-Total				$1,044,000
Constructtion Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$104,400
Traffic Control/Utility Relocation	LS	10%		$104,400
Erosion Control	LS	2%		$20,880
Construction Cost Subtotal				$1,274,000
Construction Contingency	LS	30%		$382,200
Capital Expense Total				$1,656,200
Engineering and Permitting (%)	LS	40%		$662,480
Market Climate (%)	LS	10%		$165,620
Construction Administration (%)	LS	15%		$248,430
			TOTAL	$2,733,000

Oregon City 2019 SWMP

CIP Cost Estimate

CIP #1

John Adams Basin Capacity Improvements

12th/John Adams to 12th/Harrison

ITEM	UNIT	Recommended Unit Cost	Quantity	Total Cost
Structure Installation				
Precast Concrete Manhole (60", 9-12' deep)	EA	9,700	8	$77,600
Catch Basin, all types	EA	2,000	21	$42,000
Connection to Existing Structure, standard	EA	2,000	4	$8,000
Pipe Demo and Disposal	FT	70	1900	$133,000
Remove Manhole Structure	EA	1,000	9	$9,000
Pipe Unit Cost				
HDPE Inlet Lead (12", 2-5' Deep)	FT	91	420	$38,220
HDPE Pipeline w/ asphalt resurfacing (18", 5-10' Deep)	FT	200	800	$160,000
HDPE Pipeline w/ asphalt resurfacing (24", 5-10' Deep)	FT	275	1100	$302,500
Project Sub-Total				$770,000
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$77,000
Traffic Control/Utility Relocation	LS	15%		$115,500
Erosion Control	LS	2%		$15,400
Construction Cost Subtotal				$978,000
Construction Contingency	LS	30%		$293,400
Capital Expense Total				$1,271,400
Engineering and Permitting (%)	LS	15%		$190,710
Market Climate (%)	LS	10%		$127,140
Construction Administration (%)	LS	15%		$190,710
			TOTAL	$1,780,000

Oregon City 2019 SWMP

CIP Cost Estimate

CIP #1

John Adams Basin Capacity Improvements

12th/John Adams to 8th/Van Buren

ITEM	UNIT	Recommended Unit Cost	Quantity	Total Cost
Structure Installation				
Precast Concrete Manhole (60", 9-12' deep)	EA	9,700	12	$116,400
Catch Basin, all types	EA	2,000	30	$60,000
Connection to Existing Structure, standard	EA	2,000	9	$18,000
Pipe Demo and Disposal	FT	70	3500	$245,000
Abandon Existing Pipe, no excavation (12")	FT	10	340	$3,400
Remove Manhole Structure	EA	1,000	13	$13,000
Pipe Unit Cost				
HDPE Inlet Lead (12", 2-5' Deep)	FT	91	600	$54,600
HDPE Pipeline w/ asphalt resurfacing (12", 5-10' Deep)	FT	140	340	$47,600
HDPE Pipeline w/ asphalt resurfacing (18", 5-10' Deep)	FT	200	1400	$280,000
HDPE Pipeline w/ asphalt resurfacing (24", 5-10' Deep)	FT	275	1200	$330,000
Project Sub-Total				$1,168,000
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$116,800
Traffic Control/Utility Relocation	LS	15%		$175,200
Erosion Control	LS	2%		$23,360
Construction Cost Subtotal				$1,483,000
Construction Contingency	LS	30%		$444,900
Capital Expense Total				$1,927,900
Engineering and Permitting (%)	LS	15%		$289,185
Market Climate (%)	LS	10%		$192,790
Construction Administration (%)	LS	15%		$289,185
			TOTAL	$2,699,000

Oregon City 2019 SWMP

CIP Cost Estimate

CIP #1

John Adams Basin Capacity Improvements

12th/Washington to 8th/John Adams

ITEM	UNIT	Recommended Unit Cost	Quantity	Total Cost
Structure Installation				
Precast Concrete Manhole (60", 9-12' deep)	EA	9,700	8	$77,600
Catch Basin, all types	EA	2,000	12	$24,000
Connection to Existing Structure, standard	EA	2,000	3	$6,000
Pipe Demo and Disposal	FT	70	1200	$84,000
Remove Manhole Structure	EA	1,000	8	$8,000
Pipe Unit Cost				
HDPE Inlet Lead (12", 2-5' Deep)	FT	91	240	$21,840
HDPE Pipeline w/ asphalt resurfacing (18", 5-10' Deep)	FT	200	1800	$360,000
Project Sub-Total				$581,000
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$58,100
Traffic Control/Utility Relocation	LS	15%		$87,150
Erosion Control	LS	2%		$11,620
Construction Cost Subtotal				$738,000
Construction Contingency	LS	30%		$221,400
Capital Expense Total				$959,400
Engineering and Permitting (%)	LS	15%		$143,910
Market Climate (%)	LS	10%		$95,940
Construction Administration (%)	LS	15%		$143,910
			TOTAL	$1,343,000

Oregon City 2019 SWMP
CIP Cost Estimate
CIP #2
South End Road Stormwater Improvement

ITEM	UNIT	Recommended Unit Cost	Quantity	Total Cost
Water Quality Facility Installation				
Water Quality Enhancement	LS	150,000	1	$150,000
Structure Installation				
Precast Concrete Manhole (48", 9-12' deep)	EA	6,600	3	$19,800
Precast Concrete Manhole (60", 9-12' deep)	EA	9,700	2	$19,400
Precast Concrete Manhole (72", 9-12' deep)	EA	12,200	2	$24,400
Catch Basin, all types	EA	2,000	7	$14,000
Abandon Existing Pipe, no excavation (12")	FT	10	200	$2,000
Abandon Existing Pipe, no excavation (15"-18")	FT	20	35	$700
Abandon Existing Pipe, no excavation (27"-36")	FT	35	1100	$38,500
Remove Manhole Structure	EA	1,000	7	$7,000
Outfall Improvements	EA	3,000-10,000	1	$3,000
Restoration/ Resurfacing				
Riparian/Wetland Planting (Non-irrigated)	AC	20,300	0.5	$10,150
Pipe Unit Cost				
HDPE Inlet Lead (12", 2-5' Deep)	FT	91	140	$12,740
HDPE Pipeline w/ asphalt resurfacing (36", 5-10' Deep)	FT	405	800	$324,000
HDPE Pipeline w/ asphalt resurfacing (48", 5-10' Deep)	FT	570	705	$401,850
HDPE Pipeline w/ asphalt resurfacing (60", 5-10' Deep)	FT	820	400	$328,000
Project Sub-Total				$1,356,000
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$135,600
Traffic Control/Utility Relocation	LS	15%		$203,400
Erosion Control	LS	5%		$67,800
Construction Cost Subtotal				$1,763,000
Construction Contingency	LS	30%		$528,900
Capital Expense Total				$2,291,900
Engineering and Permitting (%)	LS	15%		$343,785
Market Climate (%)	LS	10%		$229,190
Construction Administration (%)	LS	15%		$343,785
			TOTAL	$3,209,000

Oregon City 2019 SWMP

CIP Cost Estimate

CIP #3

Division Street Infrastructure Improvements

Option 1

ITEM	UNIT	Recommended Unit Cost	Quantity	Total Cost
Water Quality Facility Installation				
Energy dissapation pad - Rip-Rap, Class 50	CY	66	60	$3,960
Structure Installation				
Precast Concrete Manhole (60", 9-12' deep)	EA	9,700	4	$38,800
Catch Basin, all types	EA	2,000	7	$14,000
Outfall Improvements	EA	3,000-10,000	3000	$3,000
Restoration/ Resurfacing				
Riparian/Wetland Planting (Non-irrigated)	AC	20,300	0.5	$10,150
Seeding, small quantities	SF	6	1000	$6,000
Concrete Curbs	FT	40	1000	$40,000
Pipe Unit Cost				
HDPE Inlet Lead (12", 2-5' Deep)	FT	91	140	$12,740
HDPE Pipeline w/ asphalt resurfacing (12", 5-10' Deep)	FT	140	1400	$196,000
Project Sub-Total				$325,000
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$32,500
Traffic Control/Utility Relocation	LS	15%		$48,750
Erosion Control	LS	5%		$16,250
Construction Cost Subtotal				$423,000
Construction Contingency	LS	30%		$126,900
Capital Expense Total				$549,900
Engineering and Permitting (%)	LS	15%		$82,485
Market Climate (%)	LS	10%		$54,990
Construction Administration (%)	LS	15%		$82,485
			TOTAL	$770,000

Oregon City 2019 SWMP

CIP Cost Estimate

CIP #3

Division Street Infrastructure Improvements

Option 2

ITEM	UNIT	Recommended Unit Cost	Quantity	Total Cost
Water Quality Facility Installation				
Energy dissapation pad - Rip-Rap, Class 50	CY	66	60	$3,960
Structure Installation				
Precast Concrete Manhole (60", 9-12' deep)	EA	9,700	7	$67,900
Catch Basin, all types	EA	2,000	13	$26,000
Outfall Improvements	EA	3,000-10,000	3000	$3,000
Restoration/ Resurfacing				
Concrete Curbs	FT	40	1000	$40,000
Pipe Unit Cost				
HDPE Inlet Lead (12", 2-5' Deep)	FT	91	260	$23,660
HDPE Pipeline w/ asphalt resurfacing (12", 5-10' Deep)	FT	140	1900	$266,000
Project Sub-Total				$431,000
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$43,100
Traffic Control/Utility Relocation	LS	10%		$43,100
Erosion Control	LS	5%		$21,550
Construction Cost Subtotal				$539,000
Construction Contingency	LS	30%		$161,700
Capital Expense Total				$700,700
Engineering and Permitting (%)	LS	15%		$105,105
Market Climate (%)	LS	10%		$70,070
Construction Administration (%)	LS	15%		$105,105
			TOTAL	$981,000

Oregon City 2019 SWMP

CIP Cost Estimate

CIP #4

Rivercrest Neighborhood Infrastructure Improvements

ITEM	UNIT	Recommended Unit Cost	Quantity	Total Cost
Water Quality Facility Installation				
Energy dissapation pad - Rip-Rap, Class 50	CY	66	60	$3,960
Structure Installation				
Precast Concrete Manhole (48", 13-20' deep)	EA	10,200	1	$10,200
Precast Concrete Manhole (60", 9-12' deep)	EA	9,700	9	$87,300
Catch Basin, all types	EA	2,000	27	$54,000
Abandon Existing Pipe, no excavation (15"-18")	FT	20	1500	$30,000
Outfall Improvements	EA	3,000-10,000	3000	$3,000
Restoration/ Resurfacing				
Riparian/Wetland Planting (Non-irrigated)	AC	20,300	0.5	$10,150
Pipe Unit Cost				
HDPE Inlet Lead (12", 2-5' Deep)	FT	91	440	$40,040
HDPE Pipeline w/ asphalt resurfacing (12", 5-10' Deep)	FT	140	2800	$392,000
HDPE Pipeline w/ asphalt resurfacing (12", 10-15' Deep)	FT	160	700	$112,000
HDPE Pipeline w/ asphalt resurfacing (24", 5-10' Deep)	FT	275	900	$247,500
Extra depth pipe	FT	51	700	$35,700
Project Sub-Total				$1,026,000
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$102,600
Traffic Control/Utility Relocation	LS	15%		$153,900
Erosion Control	LS	5%		$51,300
Construction Cost Subtotal				$1,334,000
Construction Contingency	LS	30%		$400,200
Capital Expense Total				$1,734,200
Engineering and Permitting (%)	LS	15%		$260,130
Market Climate (%)	LS	10%		$173,420
Construction Administration (%)	LS	15%		$260,130
			TOTAL	$2,428,000

Oregon City 2019 SWMP

CIP Cost Estimate

CIP #5

Harding Boulevard Sanitary Disconnect

ITEM	UNIT	Recommended Unit Cost	Quantity	Total Cost
Water Quality Facility Installation				
Energy dissapation pad - Rip-Rap, Class 50	CY	66	60	$3,960
Structure Installation				
Precast Concrete Manhole (60", 9-12' deep)	EA	9,700	4	$38,800
Catch Basin, all types	EA	2,000	5	$10,000
Abandon Existing Pipe, no excavation (12")	FT	10	160	$1,600
Abandon Existing Structure	EA	1,000	5	$5,000
Plug Existing Pipe	EA	505	5	$2,525
Outfall Improvements	EA	3,000-10,000	3000	$3,000
Restoration/ Resurfacing				
Riparian/Wetland Planting (Non-irrigated)	AC	20,300	0.5	$10,150
Pipe Unit Cost				
HDPE Inlet Lead (12", 2-5' Deep)	FT	91	100	$9,100
HDPE Pipeline w/ asphalt resurfacing (12", 5-10' Deep)	FT	140	800	$112,000
Project Sub-Total				$196,000
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$19,600
Traffic Control/Utility Relocation	LS	15%		$29,400
Erosion Control	LS	5%		$9,800
Construction Cost Subtotal				$255,000
Construction Contingency	LS	30%		$76,500
Capital Expense Total				$331,500
Engineering and Permitting (%)	LS	15%		$49,725
Market Climate (%)	LS	10%		$33,150
Construction Administration (%)	LS	15%		$49,725
			TOTAL	$464,000

Oregon City 2019 SWMP
CIP Cost Estimate
CIP #6
Pebble Beach Pond Retrofit

ITEM	UNIT	Recommended Unit Cost	Quantity	Total Cost
Water Quality Facility Installation				
General Earthwork/ Excavation	CY	20	400	$8,000
Amended Soils and Mulch	CY	45	2000	$90,000
Pond Outflow Control Structure	EA	6,100	2	$12,200
Pond Inlet Structure	EA	4,500	2	$9,000
Structure Installation				
Precast Concrete Manhole (60", 9-12' deep)	EA	9,700	3	$29,100
Outfall Improvements	EA	3,000-10,000	3000	$3,000
Restoration/ Resurfacing				
Riparian/Wetland Planting (Non-irrigated)	AC	20,300	0.5	$10,150
Riparian/Wetland Planting (w/ temporary irrigation)	AC	32,500	1.2	$39,000
Pipe Unit Cost				
HDPE Pipeline w/ asphalt resurfacing (24", 5-10' Deep)	FT	275	300	$82,500
Project Sub-Total				$283,000
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$28,300
Traffic Control/Utility Relocation	LS	10%		$28,300
Erosion Control	LS	5%		$14,150
Construction Cost Subtotal				$354,000
Construction Contingency	LS	30%		$106,200
Capital Expense Total				$460,200
Engineering and Permitting (%)	LS	30%		$138,060
Market Climate (%)	LS	10%		$46,020
Construction Administration (%)	LS	15%		$69,030
			TOTAL	$713,000

Oregon City 2019 SWMP
CIP Cost Estimate
CIP #7
Hiefield Court Culvert Improvements

ITEM	UNIT	Recommended Unit Cost	Quantity	Total Cost
Modeling				
Hydrology and hydraulic assessment	EA	30,000	1	$30,000
Water Quality Facility Installation				
General Earthwork/ Excavation	CY	20	100	$2,000
Inlet structure	LS	1,500	1	$15,000
Structure Installation				
Precast Concrete Manhole (60", 0-8' deep)	EA	7,600	1	$7,600
Pipe Demo and Disposal	FT	70	210	$14,700
Outfall Improvements	EA	3,000-10,000	3000	$3,000
Restoration/ Resurfacing				
Riparian/Wetland Planting (Non-irrigated)	AC	20,300	0.5	$10,150
Seeding, small quantities	SF	6	2500	$15,000
Pipe Unit Cost				
HDPE Pipeline w/ asphalt resurfacing (36", 5-10' Deep)	FT	405	400	$162,000
Project Sub-Total				$259,000
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$25,900
Traffic Control/Utility Relocation	LS	15%		$38,850
Erosion Control	LS	5%		$12,950
Construction Cost Subtotal				$337,000
Construction Contingency	LS	30%		$101,100
Capital Expense Total				$438,100
Engineering and Permitting (%)	LS	25%		$109,525
Market Climate (%)	LS	10%		$43,810
Construction Administration (%)	LS	15%		$65,715
			TOTAL	$657,000

Oregon City 2019 SWMP

CIP Cost Estimate

CIP #8

The Cove Water Quality Improvements

ITEM	UNIT	Recommended Unit Cost	Quantity	Total Cost
Survey				
Survey	EA	20,000	1	$20,000
Modeling				
Hydrology and hydraulic assessment	EA	20,000	1	$20,000
Water Quality Facility Installation				
General Earthwork/ Excavation	CY	20	1700	$34,000
Amended Soils and Mulch	CY	45	450	$20,250
Energy dissapation pad - Rip-Rap, Class 50	CY	66	200	$13,200
Structure Installation				
Catch Basin, all types	EA	2,000	4	$8,000
Outfall Improvements	EA	3,000	3	$9,000
Restoration/ Resurfacing				
Water Quality Facility Planting with Irrigation	SF	2	11000	$22,000
Pipe Unit Cost				
HDPE Pipeline w/ asphalt resurfacing (24", 5-10' Deep)	FT	275	400	$110,000
Project Sub-Total				$256,000
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$25,600
Traffic Control/Utility Relocation	LS	10%		$25,600
Erosion Control	LS	2%		$5,120
Construction Cost Subtotal				$312,000
Construction Contingency	LS	30%		$93,600
Capital Expense Total				$405,600
Engineering and Permitting (%)	LS	25%		$101,400
Market Climate (%)	LS	10%		$40,560
Construction Administration (%)	LS	15%		$60,840
			TOTAL	$608,000

Oregon City 2019 SWMP

CIP Cost Estimate

CIP #9

Holcomb Boulevard Capacity Improvements

ITEM	UNIT	Recommended Unit Cost	Quantity	Total Cost
Structure Installation				
Precast Concrete Manhole (60", 0-8' deep)	EA	7,600	16	$121,600
Abandon Existing Structure	EA	1,000	4	$4,000
Pipe Demo and Disposal	FT	70	3750	$262,500
Outfall Improvements	EA	3,000-10,000	3000	$10,000
Restoration/ Resurfacing				
Riparian/Wetland Planting (Non-irrigated)	AC	20,300	0.5	$10,150
Seeding, small quantities	SF	6	2500	$15,000
Pipe Unit Cost				
HDPE Pipeline w/ asphalt resurfacing (15", 10-15' Deep)	FT	180	980	$176,400
HDPE Pipeline w/ asphalt resurfacing (24", 5-10' Deep)	FT	275	300	$82,500
HDPE Pipeline w/ asphalt resurfacing (30", 5-10' Deep)	FT	325	1070	$347,750
HDPE Pipeline w/ asphalt resurfacing (36", 5-10' Deep)	FT	405	800	$324,000
HDPE Pipeline w/ asphalt resurfacing (42", 5-10' Deep)	FT	485	600	$291,000
Project Sub-Total				$1,645,000
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$164,500
Traffic Control/Utility Relocation	LS	15%		$246,750
Erosion Control	LS	5%		$82,250
Construction Cost Subtotal				$2,139,000
Construction Contingency	LS	30%		$641,700
Capital Expense Total				$2,780,700
Engineering and Permitting (%)	LS	15%		$417,105
Market Climate (%)	LS	10%		$278,070
Construction Administration (%)	LS	15%		$417,105
			TOTAL	$3,893,000

Oregon City 2019 SWMP
CIP Cost Estimate
CIP #10
Coffee Creek Capacity Improvements

ITEM	UNIT	Recommended Unit Cost	Quantity	Total Cost
Water Quality Facility Installation				
General Earthwork/ Excavation	CY	20	800	$16,000
Dewatering/Flow bypass	LS	20,000	1	$20,000
Clear and Grub brush including stumps	AC	8,200	0.5	$4,100
Jute Matting, Biodegradeable	SY	6	1200	$7,200
Energy dissapation pad - Rip-Rap, Class 50	CY	66	10	$660
Rip-Rap, Class 100	CY	80	900	$72,000
Drain Rock	CY	101	300	$30,300
Water Quality Facility Plantings with Trees	SF	6	16200	$97,200
Inlet structure	LS	1,500	1	$15,000
Structure Installation				
Pipe Demo and Disposal	FT	70	300	$21,000
Outfall Improvements	EA	3,000-10,000	3000	$3,000
Restoration/ Resurfacing				
Riparian/Wetland Planting (Non-irrigated)	AC	20,300	0.5	$10,150
Seeding, small quantities	SF	6	2500	$15,000
Pipe Unit Cost				
HDPE Pipeline w/ asphalt resurfacing (48", 5-10' Deep)	FT	570	80	$45,600
HDPE Pipeline w/ asphalt resurfacing (60", 5-10' Deep)	FT	820	70	$57,400
Extra depth pipe*	FT	51	950	$48,450
Project Sub-Total				$463,000
Contingencies and Multipliers				
Mobilization/Demobilization	LS	10%		$46,300
Traffic Control/Utility Relocation	LS	15%		$69,450
Erosion Control	LS	5%		$23,150
Construction Cost Subtotal				$602,000
Construction Contingency	LS	30%		$180,600
Capital Expense Total				$782,600
Engineering and Permitting (%)	LS	15%		$117,390
Market Climate (%)	LS	10%		$78,260
Construction Administration (%)	LS	15%		$117,390
			TOTAL	$1,096,000

Appendix I: Project Prioritization Scoring Matrix

Use of contents on this sheet is subject to the limitations specified at the end of this document.

Table I-1. Project Prioritization Scoring Matrix

Criteria	Weight	Rating Criteria Definition		
		5	3	1
1. Capacity Issue (safety/liability) *Are existing/future capacity and safety/liability issues addressed?*	1.0	Significant flooding hazard; Threat to life and limb and/or property	Moderate flooding safety hazard	No flooding safety hazard
2. Benefit to Sanitary System *Does the project address storm and sanitary infrastructure needs?*	1.0	Significant benefit to sanitary system	Moderate benefit to sanitary system	No benefit to sanitary system
3. Cost *What is the expected capital investment?*	1.0	Small capital project (less than $500,000)	Medium capital project (greater than $500,000 and less than $1,000,000)	Large capital project (more than $1,000,000)
4. Environmental Benefit (sustainability/livability) *Does the project address water quality, other environmental benefits?*	1.0	Significantly improves water quality	Moderately improves water quality	No improvement to water quality
5. Maintenance (long-/short-term) *Will this cause a long term maintenance burden?*	1.0	Project will significantly reduce ongoing maintenance requirements	Project will moderately reduce ongoing maintenance requirements	Project will not reduce ongoing maintenance requirements
6. Existing Condition *How close is the system to its expected design life or is it failing?*	0.5	System is failing or beyond its expected design life	System appears to be in average working order and is not beyond expected design life	System is in good shape and relatively new
7. Impact *How large an area and/or how many people does the problem impact?*	1.0	Problem affects regionwide area with significant downstream and/or upstream impacts	Project will address multiple blocks or properties	Project will address a few properties

CIP Scoring Criteria						CIP Project Scoring									
	Criteria	Weight	Rating Criteria Definition			1	2	3	4	5	6	7	8	9	10
			5	3	1	John Adams	South End Rd	Division St	River Crest	Harding Blvd	Pebble Beach	Hiefield Ct	The Cove	Newell Canyon	Scatter Canyon
1	Capacity Issue	1.0	Significant hazard	Moderate hazard	No hazard	3	3	1	3	5	1	3	1	3	3
2	Benefit to Sanitary System	1.0	Significant benefit	Moderate benefit	No benefit	1	1	1	5	5	1	1	1	1	1
3	Cost	1.0	Small capital project	Medium capital project	Large capital project	1	1	3	1	5	3	3	3	5	5
4	Environmental Benefit	1.0	Significantly improves water quality	Moderately improves water quality	No improvement to water quality	1	1	1	3	3	5	3	5	3	3
5	Maintenance	1.0	Significant reduction	Moderate reduction	No reduction	5	3	3	3	3	3	1	3	5	5
6	Existing Condition	0.5	poor	average	good	2.5	1.5	2.5	2.5	2.5	1.5	0.5	0.5	2.5	2.5
7	Impact	1.0	Regionwide impact	10-15 years	Short term	5	5	1	3	3	1	1	3	5	3
Totals						**18.5**	**15.5**	**12.5**	**20.5**	**26.5**	**15.5**	**12.5**	**16.5**	**24.5**	**22.5**
					Rank	**6**	**8**	**10**	**4**	**1**	**7**	**9**	**5**	**2**	**3**

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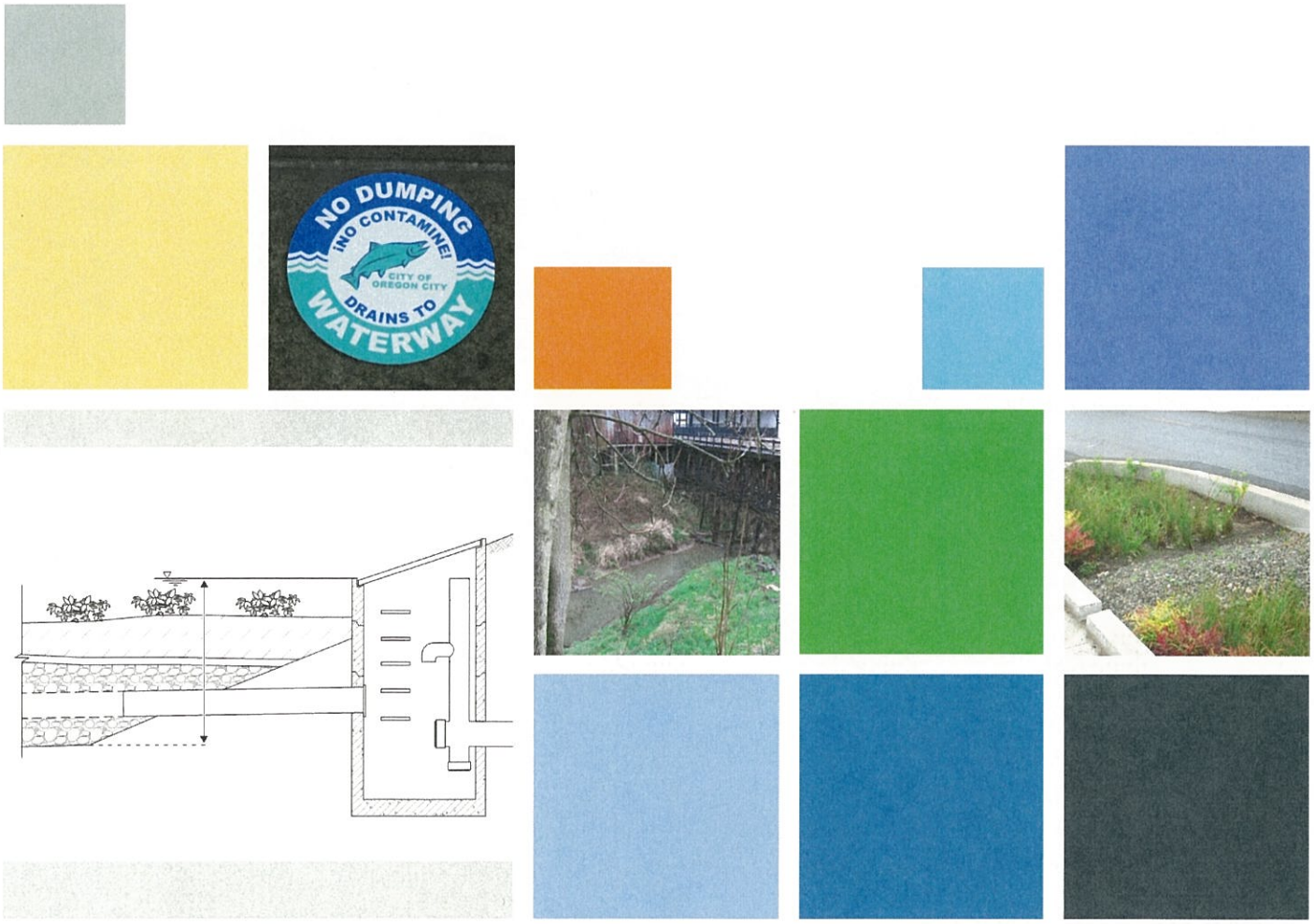
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Stormwater and Grading Design Standards

July 2019

OREGON CITY



Stormwater and Grading Design Standards

February 2015

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ACRONYMS AND ABBREVIATIONS

2h:1v	two-horizontal to one-vertical
4h:1v	four-horizontal to one-vertical
AASHTO	American Society of State Highway and Transportation Officials
AC	Asphalt Concrete
ADT	Average Daily Traffic
ASTM	American Society of Testing and Materials
BMP	Best Management Practice
cfs	cubic feet per second
City	City of Oregon City
CFR	Code of Federal Regulations
CMP	Corrugated Metal Pipe
CPEP	Corrugated High-Density Polyethylene
CWA	Federal Clean Water Act of 1972
ESC	Erosion and Sediment Control
ESCP	Erosion and Sediment Control Plan
Erosion Standards	*City of Oregon City, Public Works Erosion and Sediment Control Standards*
FEMA	Federal Emergency Management Agency
fps	feet per second
gpm	gallons per minute
HDPE	High-Density Polyethylene
HGL	Hydraulic Grade Line
LID	Low Impact Development
MEP	Maximum Extent Practicable
MS4	Municipal Separate Storm Sewer System
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NROD	Natural Resource Overlay District
O&M	Operation and Maintenance
OCMC	Oregon City Municipal Code
ODEQ	Oregon Department of Environmental Quality
ODSL	Oregon Department of State Lands
ODOT	Oregon Department of Transportation
OPC	Oregon Plumbing Code
ORS	Oregon Revised Statutes

OSC	Oregon Structural Code
PC	Point of Curvature
ppm	parts per million
PT	Point of Tangency
PVC	Poly-Vinyl Chloride
RCB	Reinforced Concrete Box
ROW	Right-of-Way
SF	square feet
SPCC	Spill Prevention, Countermeasure, and Containment
SWMM	Stormwater Management Model
SWMP	Stormwater Management Plan
Tc	Time of Concentration
TR-55	Technical Release 55
UIC	Underground Injection Control
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
WPCF	Water Pollution Control Facility

FORWARD

Pursuant to Oregon City Municipal Code (OCMC) 13.12.020, these Stormwater and Grading Design Standards have been developed to implement the Stormwater Management standards as outlined in OCMC 13.12.

Stormwater management is a key element in maintaining and enhancing livability within the City of Oregon City (City). There is a direct link between stormwater runoff and the City's surface and ground water quality and quantity. As land is developed, creation of new impervious surfaces and loss of vegetation increases stormwater runoff during rainfall events, altering the natural hydrologic cycle. Without stormwater management, the increase in flows erodes stream channels and limits groundwater recharge. In addition, runoff that flows over roadways, parking areas, rooftops, and other impervious surfaces collects pollutants that are transported within the watershed to streams, rivers, and groundwater resources. Properly managing stormwater is vital to protecting our water resources for a great number of uses, including fish and wildlife habitat, recreation, and drinking water.

The Federal Clean Water Act of 1972 (CWA) established a national commitment to restore and maintain the chemical, physical, and biological integrity of the nation's waters. The CWA prohibits the discharge of pollutants into water of the United States, unless the discharge is in compliance with a **National Pollutant Discharge Elimination System (NPDES) Permit**. The CWA requires cities such as Oregon City to obtain an NPDES permit for discharge from the **Municipal Separate Storm Sewer System (MS4)**. The City's MS4, which is comprised of catch basins, pipes, ditches, stormwater management facilities, and other structures, conveys runoff from private and public properties within the City and drains directly into the Willamette River, Clackamas River, and other local waterways such as Abernethy Creek. The Oregon Department of Environmental Quality (ODEQ) administers the state's NPDES program and issues NPDES permits on the federal government's behalf. The City was reissued its current NPDES MS4 permit in 2012, which requires the City to implement a comprehensive stormwater management program, including establishing controls for stormwater runoff from developing areas.

The City's stormwater management and grading standards, set forth in OCMC 13.12, 15.48, and 17.47 and these Stormwater and Grading Design Standards, emphasize low-impact development (LID) practices, source controls for higher pollutant generating activities, erosion prevention and sediment controls, and operation and maintenance practices designed to properly manage stormwater runoff and protect our water resources. **Each of these measures has been or are being implemented as direct requirements under the City's existing NPDES MS4 permit.**

The goal of these updated standards is to provide local engineers, developers, builders, and City staff clear guidance in planning and designing stormwater conveyance and management systems that are appropriate to the local climate, hydrogeology, and geology. These standards apply to public and private projects throughout the City.

DEFINITIONS

Applicant – Is any person who applies for an approval and/or permit from the City.

Approved Point of Discharge – A location down slope from a development that the City has deemed adequate to accept stormwater flows from all or a portion of the development area.

BMP Sizing Tool – A computer program, approved by the City, for use in calculating the required size of stormwater management facilities. This tool is limited to a set list of pre-defined stormwater management facilities.

Contractor – A person duly licensed or approved by the State of Oregon to perform the type of work to be done under a permit or contract.

Design Storm – The distribution of rainfall intensity over time, identified to have a probability of recurrence, given in years (i.e., five-year design storm).

Detention – The release of surface water runoff from a site at a slower rate than it is collected by the drainage system, the difference being held in temporary storage.

Development – Any manmade change to improved or unimproved real estate, including but not limited to buildings or other structures, utility infrastructure, streets or other structures or facilities, mining, dredging, paving, filling, or excavation. Development does not include the following: (1) stream enhancement or restoration projects approved by the City; (2) farming practices as defined in ORS 30.930 and farm use as defined in ORS 215.203, except that buildings associated with farm practices and farm uses are subject to the requirements of this chapter.

Director – The City's Public Works Director, or designated representative.

Discharge – Any addition of water, stormwater, wastewater, process water, or any pollutant or combination of pollutants to waters of the State, directly or indirectly, by actions of dumping, spilling, disposing, or physically connecting to the public storm system or natural drainage conveyance.

Drainageway – A natural or manmade channel formed by existing or manmade topography which directs and/or carries surface or stormwater runoff.

Drywell – An approved receptacle used to receive storm, surface, and other water, the sides and bottom being porous, permitting the contents to seep into the ground. A drywell must conform to local agency standards and ODEQ Underground Injection Control standards.

Easement – A permanent or temporary interest or right to lay down, construct, reconstruct, replace, operate, inspect, and perpetually maintain storm drainage or surface water pipelines, and all related facilities through, under, and along a described property, either public or private.

Engineer – A registered professional engineer licensed to practice in the State of Oregon.

Erosion – The visual or measurable movement of soil particles resulting from the flow of, or pressure from, water, wind, or earth movement.

Government Agency – Any municipal or quasi-municipal jurisdiction, County, State, or Federal agency.

Hazardous Materials – Materials described as hazardous by ODEQ, including any toxic chemicals listed as toxic under Section 307(a) of the Clean Water Act or Section 313 of Title III of the Superfund Amendments and Reauthorization Act (SARA).

Highly Erodible – Soils with erosion (K) factors greater than 0.25, as listed in the Soil Survey of Clackamas County Area, Oregon, developed by the Natural Resource Conservation Service.

Hydromodification – The effects of hydrologic changes to the natural environment caused by changes in runoff and/or discharge patterns. These effects include increased erosion of streambanks, increased incision and/or aggradation of stream channels, reduction of high value riparian habitat, impacts to aquatic organisms, and degradation of water quality.

Impervious Surface – A hard surface area which prevents or retards the entry of water into the soil mantle and/or causes water to run off the surface in greater than natural quantities or at an increased rate. Impervious surfaces may include, but are not limited to, rooftops, walkways, patios, driveways, parking lots, concrete or asphalt paving, gravel surfaces with compacted subgrade, packed earthen materials, and oiled macadam or other surfaces which similarly impede the natural infiltration of stormwater. Open, uncovered stormwater management facilities shall not be considered impervious surfaces.

Industrial Waste – Any liquid, gaseous, radioactive, or solid waste substance, or a combination thereof, resulting from any process of industry, manufacturing, trade or business, or from the development or recovery of any sensitive areas, or as defined by ODEQ or the United States Environmental Protection Agency, exclusive of domestic sewage.

Infiltration System – A drainage facility designed to use the hydrologic process of surface and stormwater runoff soaking into the ground to dispose of surface and stormwater runoff.

Inspector – A person authorized by the City, County, or State to enter upon public or private property to inspect construction sites and activities related to these standards.

Intermittent Streams – Streams and springs that consistently do not have year-round water or saturated soil within their channel or swale in a year with wet to average precipitation patterns. Intermittent flow must occur with some degree of regularity and must be in a definite direction. **Section 3.5.3** provides the methodology for determining intermittent status.

Landscape Architect – A registered Landscape Architect licensed to practice in the State of Oregon.

Low Impact Development (LID) – A sustainable site design and development approach that is used to replicate the natural watershed functions and/or address targeted watershed goals and objectives, including protection of existing sensitive areas.

LID Facility – A stormwater facility that mimics natural surface hydrological functions through infiltration or evapotranspiration, or that involves stormwater reuse. Examples of LID facilities are included in **Chapter 4**.

Manufactured Treatment Device – A manufactured device, often proprietary, in which stormwater receives treatment before being discharged to the conveyance system, another stormwater management facility, or to the receiving water. This is a broad category of stormwater management facilities with a variety of pollutant removal mechanisms and varying pollutant removal efficiencies.

Minor Modification – A slight change or alteration made to the standards during the construction phase of a development that does not change the functionality, maintenance, or intent of the standards.

Municipal Separate Stormwater System (MS4) – A conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, manmade channels, or storm drains) as defined in 40 CFR 122.26(b)(8).

National Pollutant Discharge Elimination System, or NPDES, Permit – A permit issued pursuant to Chapter 402 of the Clean Water Act (40 CFR 122, 123, 124, and 504).

NROD – Natural Resource Overlay District – A designation that provides a framework for protection of Metro Titles 3 and 13 lands, and Statewide Planning Goal 5 resources within Oregon City. It is intended to resolve conflicts between development and conservation of habitat, stream corridors, wetlands, and floodplains identified in the City's maps as described in OCMC 17.49.

Owner – The owner(s) of record title or the purchaser(s) under a recorded sale agreement and other persons having an interest of record in the described real property.

Parcel of Land – A lot, parcel, block or other tract of land that may be occupied by a structure or structures or other use and includes yards and other undeveloped areas required under the zoning, subdivision, or other development ordinances.

Perennial Streams – Streams and springs that have year-round water or saturated soil within the channel, in a year with wet to average precipitation patterns. A stream will be considered perennial unless determined to be intermittent using one of the criteria outlined in **Section 3.5.3**.

Permit – Any authorization required pursuant to these standards or any other regulation.

Permittee – The person to whom a building permit, development permit or any other permit described in these standards is issued.

Person – Any individual or legal entity.

Plant Community – A grouping of plants that often occur together growing in a uniform habitat.

Pollutant – Any of the following, but not restricted to: oil, grease, soil, mining waste, spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, heavy metals, asbestos, wrecked or discharged equipment, cellar dirt and untreated industrial, municipal, and agricultural discharges into water.

Porous Pavement – Surface to walk, drive, or park on that may reduce stormwater runoff by allowing water to soak into the ground. Examples are permeable pavers, pervious concrete, porous asphalt, and gravel.

Post-developed Conditions – Conditions after development.

Pre-developed Conditions – The conditions of the land prior to the original development. For the purpose of hydrological evaluations, the pre-developed conditions will use the historical vegetation which existed in the City prior to the original development.

Pretreatment or Treatment – The reduction of the amount of pollutants to the MEP, the elimination of pollutants, or the alteration of the nature of pollutant properties in water to a less harmful state.

Private Storm System – That portion of the storm system owned and/or located outside the public right-of-way.

Public Stormwater System – In general, those portions of the stormwater conveyance systems that are within a dedicated right-of-way or within a public stormwater easement. Public stormwater systems also include those stormwater conveyance systems that are within dedicated right-of-way and permitted by another jurisdictional agency such as ODOT, County, etc.

Public Right-of-Way – A right-of-way on which legal right of passage has been given to the public and is under City, County, State, or Federal jurisdiction.

Redevelopment – See Development.

Retention – The process of collecting and holding surface water runoff from a design storm with no surface outflow.

Retrofit – The creation or modification of an urban runoff management system in a previously developed area. A retrofit can consist of the construction of a new stormwater management facility in a developed area, the enhancement of an existing runoff management structure, or a combination of improvement and new construction.

Sensitive Areas – Sensitive Areas include:

a. Existing or created wetlands, including all mitigated wetlands; limits defined by wetlands reports approved by both the ODSL and/or the City.

b. Rivers, streams, sloughs, swamps, creeks; limits defined by the top of the bank or first break in slope measured upland from the mean high water line;

c. Impoundments (lakes and ponds); limits defined by the top of the bank or first break in slope measured upland from the mean high water line.

Sensitive areas shall not include stormwater management facilities including constructed wetlands, rain gardens, and detention ponds, vegetative buffers adjacent to sensitive areas, or water features, such as lakes, constructed during an earlier phase of a development for specific purposes such as recreation.

Source Control – Stormwater management facilities and/or specific actions taken that attempt to control high risk pollutant loading from entering the stormwater runoff through site activities and site design.

Standards – The adopted principles and policies established by the City to meet the intent of preserving water quality and minimizing the impacts development has on the environment.

Storm Drainage/Storm Sewer – A pipe or drainageway or any method of conveyance that carries stormwater, surface runoff, or drainage.

Stormwater – Waters on the surface of the ground resulting from precipitation.

Stormwater Management – A program to provide surface water quality and quantity controls through structural and nonstructural methods and capital improvement projects. Examples of Structural controls include the facilities included in Chapter 4 of this manual as well as structural source control measures, such as covers and awnings, curbs for isolation, spill control manholes, and shut-off valves described in Chapter 6. Nonstructural controls include maintenance of surface water facilities, public education, water quality monitoring, implementation of intergovernmental agreements to provide for regional coordination, and preparation of water quality control ordinances and regulations.

Stormwater Management Facility – Any structure or drainageway that is designed, constructed, and maintained to collect, filter, retain, or detain surface water runoff during and after a storm event for the purpose of controlling flows and/or reducing pollutants in stormwater runoff. It may include, but is not limited to constructed wetlands, rain gardens, water quality swales, stormwater planters, infiltration systems, and ponds.

Stormwater Management Plan (SWMP) – Proposed stormwater plan approved and/or permitted by the City which provides for storm or surface water infiltration, water quality, and flow control as provided within these standards.

Stream – A surface concentration of flow in a channel or swale in which flow of water occurs either perennially or intermittently. For the purposes of this manual, streams refer to drainageways that are determined to be jurisdictional by ODSL or USACE.

Undue Hardship – Special or specified circumstances that compel an applicant for development to request a modification of these standards so as to avoid an unreasonable or disproportionate burden or obstacle to development. The financial viability of meeting the requirements of these design standards is not in itself a justification of undue hardship.

Vegetated Buffer – A corridor adjacent to a sensitive area that is preserved and maintained to protect riparian area functions. Refer to OCMC Title 17 for dimensions and locations of regulated vegetated buffers.

Vegetated Corridor – See Vegetated Buffer.

Waters of the State – Those waters defined in ORS Chapter 468B.005 or as amended which include lakes, bays, ponds, impounding reservoirs, springs, wells, rivers, streams, creeks, estuaries, marshes, inlets, canals, the Pacific Ocean within the territorial limits of the State of Oregon, and all other bodies of surface or underground waters, natural or artificial, inland or coastal, fresh or salt, public or private (except those private waters which do not combine or effect a junction with natural surface or underground waters), which are wholly or partially within or bordering the state or within its jurisdiction.

Wetland – Areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands are those areas identified and delineated by a qualified wetlands specialist as set forth in the Federal Manual for Identifying and Delineating Jurisdictional Wetlands, January 1987, or by an ODSL/USACE 404 permit. Wetlands may also consist of:

a. *Constructed Wetlands.* As defined in Section 404 of the Clean Water Act, constructed wetlands are those areas developed as a water quality or quantity facility, subject to maintenance as such. These areas must be clearly separated from existing or created wetlands.

b. *Created Wetlands.* Created wetlands are those wetlands developed in an area previously identified as a non-wetland to replace or mitigate wetland destruction or displacement.

c. *Existing Wetlands.* Existing wetlands are those identified and delineated as set forth in the Federal Manual for Identifying the Delineating Jurisdictional Wetlands, January 1987, or as amended, by a qualified wetlands specialist.

Wet Pond – A constructed treatment facility where a portion of the facility is dedicated to being an open body of water.

Wet Weather Measures – Erosion prevention and sediment control methods deemed necessary to meet the types of conditions that occur during the wet weather season, as identified in the City's current erosion control manual.

Wet Weather Season – The portion of the year when rainfall amounts and frequency tend to have the most significant effect on erosion prevention and sediment control (October 1 to May 31).

Work Area – Areas of disturbance for activities defined under "Development". Work area includes areas used for storage of equipment or materials that are used for these activities.

CHAPTER 1

General Information

CHAPTER 1. GENERAL INFORMATION

The Stormwater and Grading Design Standards describe requirements and methods for minimizing the impacts of development within the City of Oregon City (City). Implementing these standards will help protect water resources which, in turn, will benefit human health, fish and wildlife habitat, recreational resources, and drinking water.

This chapter describes the purpose, applicability, jurisdictional, and administrative requirements of the Stormwater and Grading Design Standards.

1.1 Purpose of the Stormwater and Grading Design Standards

The purposes of the Stormwater and Grading Design Standards include but are not limited to the following:

A. Meet federal and state National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permitting requirements.

B. Minimize the introduction of pollutants and provide water quality treatment of stormwater runoff to preserve the beneficial uses of drainageways, lakes, ponds, wetlands, and other sensitive areas.

C. Enhance water quality by protecting sensitive areas and the required vegetative buffers.

D. Reduce stormwater runoff volumes and maximize groundwater recharge through the process of infiltration of runoff into vegetated stormwater facilities.

E. Maintain the pre-development stormwater runoff characteristics to minimize effects on the drainageways such as sediment transport, erosion, and degradation generally associated with urbanization, through the use of Low Impact Development (LID) facilities and/or flow controls to address hydromodification.

F. Protect the safety of persons and property by safely conveying all stormwater runoff from site development and preventing the uncontrolled or irresponsible discharge of stormwater onto adjoining public or private property.

G. Provide for orderly development by preserving the drainageways and natural conveyance systems created by the existing topography and creating man-made conveyance systems with adequate capacity for future development upstream.

H. Construct stormwater management facilities which are safe, effective, and economical to maintain and minimize future replacement costs.

I. Provide guidance to designers and engineers in meeting the requirements of stormwater regulations when developing land and constructing infrastructure within the City of Oregon City.

1.2 Applicability of the Stormwater and Grading Design Standards

These standards are intended for use by property owners, developers, and design professionals as general design guidelines for all publicly and privately-owned and maintained stormwater management facilities within the City.

All development, as defined by the City, is subject to the requirements of these standards during the land use decision and permitting processes. These processes generally include all land use proposals, site development, and permit approvals within or proposed to be within City boundaries.

All private storm drains outside the building envelope shall be designed using these standards, along with the Oregon Structural Code (OSC), Oregon Plumbing Code (OPC), and/or other applicable codes as appropriate.

1.2.1 General Thresholds

The site development thresholds and applicability of these standards are as follows:

A. Development activities that result in **5,000 square feet of new or replaced impervious surface,** cumulative over a 5-year period, are subject to the requirements of these standards.

B. Development activities that will result in the **creation of more than 500 square feet of new impervious surface within a natural resource overlay district (NROD)** (as defined by Oregon City Municipal Code [OCMC] 17.49), cumulative over a 5-year period, are subject to the requirements of these standards.

C. Development activities that will **disturb 1,000 square feet of existing impervious surface within an NROD as part of a commercial or industrial redevelopment**, cumulative over a 5-year period, are subject to the requirements of these standards.

D. All development that results in **1,000 square feet of new or replaced impervious surface shall be subject to the erosion prevention and sediment control requirements** outlined in **Chapter 7**.

E. All site **development that results in any new or replaced impervious surfaces and is categorized as high risk for increased pollutant loading** in stormwater runoff is required to comply with **Chapter 6** in addition to all requirements within these standards. High-risk sites, as defined in Chapter 6, include the following site use categories:

- Fuel Dispensing Facilities and Surrounding Traffic Areas
- Above-Ground Storage of Liquid Materials
- Solid Waste Storage Areas, Containers, and Trash Compactors
- Exterior Storage of Bulk Materials
- Material Transfer Areas/Loading Docks
- Equipment and/or Vehicle Washing Facilities
- Development on Land with Suspected or Known Contamination
- Covered Vehicle Parking Areas for Commercial or Industrial Uses
- Industrial and Commercial High-Traffic Areas
- Land Uses Subject to Oregon Department of Environmental Quality 1200-Z Industrial Stormwater Permit Requirements

1.2.2 Exemptions

Projects in the following categories are generally exempt from the requirements of these standards:

A. **Stream enhancement or restoration projects** approved by the City

B. **Farming practices** as defined by Oregon Revised Statutes (ORS) 30.930 and **farm use** as defined in ORS 214.200, except that buildings associated with farm practices and farm use are subject to the requirements of these standards

C. Actions by a public utility or any other governmental agency **to remove or alleviate an emergency condition**

D. **Road and parking area preservation/maintenance projects** such as pothole and square cut patching, surface sealing, mill/resurface or overlaying of existing asphalt or concrete pavement, provided the preservation/maintenance activity does not expand the existing area of impervious coverage above the thresholds listed in **Section 1.2.1**

E. **Pavement reconstruction/rehabilitation projects** located within the public right-of-way that alter the subgrade shall be required to meet water quality and flow control standards for the net new impervious surface created

F. **Pedestrian and bicycle improvements** (sidewalks, trails, pathways, transit stops, multi-modal stops, and bicycle paths/lanes) that are standalone projects where no other impervious surfaces are created or replaced

G. **Underground utility projects** that replace the ground surface with in-kind material or materials with similar runoff characteristics

H. **Maintenance or repair** of existing utilities

I. An exemption to the flow control requirements (see **Section 4.2**) of these standards will be granted when **all** of the following apply:

- The development site discharges directly to the Willamette River, Clackamas River, or Abernethy Creek; and
- That development lies within the 100-year floodplain or is up to 10 feet above the design flood elevation (design flood elevation is equal to 50.7 feet NAVD 88) as defined by OCMC 17.42; and
- The project site must be drained by a conveyance system that is comprised entirely of manmade elements (e.g., pipes, ditches, culverts, outfall protection, etc.) and extends to the ordinary high water line of the exempt receiving water; and
- The conveyance system between the project site and the exempt receiving water shall have sufficient hydraulic capacity and erosion stabilization measures to convey discharges from the proposed conditions of the project site and the existing conditions from non-project areas from which runoff is collected.

1.3 General Stormwater Management Principles

The City restricts the uncontrolled and untreated discharge of pollutants into any stormwater system and/or natural drainageway area. The City's stormwater standards are intended to provide guidance for the reduction of pollutants in stormwater to the Maximum Extent Practicable (MEP).

Stormwater pollutants are generally separated into the following categories: suspended solids (sediment), oxygen-demanding pollutants, bacteria, organic carbon, hydrocarbons, metals (lead, copper, zinc, mercury, and cadmium), nutrients (nitrogen and phosphorous), and pesticides/herbicides.

The most effective method for preserving stormwater quality is preventing pollution of stormwater runoff at the source. Constructed stormwater management facilities are the last line of defense for removing pollutants contained in stormwater runoff.

Stormwater management facilities use a variety of methods to remove pollutants from stormwater, such as infiltration, sedimentation, filtration, plant uptake, ion exchange, adsorption, and bacterial decomposition. Infiltration is the preferred method to address stormwater runoff for water quality and flow control requirements. In some cases, a combination of stormwater management facilities, referred to as a treatment train, may be the most effective strategy for removal of specific pollutants of concern in designated high-risk areas.

In selecting a stormwater management approach, the designer must consider site characteristics, anticipated land uses, runoff characteristics, and treatment objectives. Once the site analysis is complete, the designer may incorporate the most effective stormwater management facilities into the stormwater management plan for the proposed development. See **Chapter 2** for additional details on site assessment and planning and **Chapter 4** for design criteria, design methods, and facility selection and sizing.

1.4 Stormwater Management Requirements

The following requirements apply to all projects:

1.4.1 General Design Requirements

Design of stormwater management plans must include provisions to control runoff adequately from impervious and pervious areas within and upstream of the development without exceeding capacities of available facilities and downstream drainageways. General design considerations are as follows:

A. Surface or subsurface drainage, caused or affected by development, shall not flow over adjacent public or private property in a volume or location significantly different from that which existed prior to development, but shall be collected and conveyed to an acceptable point of discharge as approved by the City.

B. The City generally does not allow the diversion of stormwater from one drainage basin or watershed to another drainage basin or watershed.

C. Surface drainage entering a development from offsite areas shall be intercepted at the naturally occurring locations. Offsite surface drainage shall be conveyed through the site in a separate system and will not be mixed with the stormwater collected and treated in onsite stormwater management facilities unless the onsite storm-

water management facilities are designed to manage the additional flows from the upstream drainage basin(s) assuming full development potential.

D. All public storm drainage systems shall be gravity systems without the use of pumps or other mechanical means to convey or transport stormwater.

E. The point of discharge for all stormwater may be a piped system, curb and gutter, or open channel as approved by the City. All outfalls to an existing or proposed stormwater facility, conveyance system, or drainageway shall be approved by the City.

F. When an approved point of discharge is located on an adjacent private property, the applicant shall be responsible to acquire all applicable downstream private and/or public stormwater easements.

G. In compliance with Oregon Drainage Law, development shall not adversely impact downstream properties. Stormwater runoff from a development shall be safely conveyed to prevent the uncontrolled or irresponsible discharge of stormwater onto adjoining public or private property.

H. The point of discharge for stormwater shall not be the City's sanitary sewerage system, except as provided in **Chapter 6**.

I. No project or development shall directly or indirectly discharge to the public storm system any quantity of stormwater, pollutant, substance, or wash water that will violate the discharger's permit (if one is issued), the City's NPDES MS4 permit, OCMC, or other environmental laws or regulations.

1.4.2 Stormwater Management Plan

All projects that meet the thresholds in **Section 1.2.1** shall prepare a Stormwater Management Plan that addresses the following elements. Each requirement is explained in further detail in the following chapters and sections.

A. Site Assessment and Planning – **Section 2.2**

B. Grading, Fill, and Excavation – **Section 3.1**

C. Stormwater Management Facility Design – **Section 4.2**

D. Stormwater Conveyance – **Section 5.1**

E. Source Controls – **Section 6.1**

F. Erosion Prevention and Sediment Control – **Section 7.1**

G. Operation and Maintenance of Stormwater Facilities – **Section 8.1**

1.4.3 Stormwater Site Design Incentives

Incentive programs are continuously changing and evolving. While the City does not administer an incentive program for stormwater-related design elements, applicants may find that required stormwater facilities can be beneficial in qualifying for incentives or benefits from other agencies. Examples include the Leadership in Energy and Environmental Design program, the Envision Rating System administered by the Institute of Sustainable Infrastructure, Salmon-Safe, Earth Advantage, and the Sustainable Sites Initiative. Information on these programs should be discussed with representatives from the sponsoring agency.

1.4.4 Additional Requirements

The requirements presented in these standards do not exclude or replace the requirements of other applicable codes or regulations, such as the Willamette Basin Total Maximum Daily Load Program, the industrial NPDES permitting program, or any other applicable federal or state regulations or permit requirements.

All development within Federal Emergency Management Agency (FEMA)-regulated streams and floodplain overlay zones shall meet the FEMA floodplain permit approval process requirements and the requirements of OCMC 17.42 through the local planning and building authority.

If it is determined by the City that stormwater management or conveyance facilities, in addition to the onsite facilities required by these standards, are necessary to manage and protect natural resources, municipal infrastructure, and/or private property effectively, the City may require additional facilities or modifications.

1.4.5 Alternative Materials and Methods

Alternative materials and methods for stormwater management will be accepted only if the applicant can demonstrate that the existing standards are not appropriate for a given site and the proposed alternative provides the same or greater level of stormwater management as defined in these standards. Alternate materials or methods not explicitly approved herein will be considered for approval through the modification process outlined in **Section 1.6**. All requests will be evaluated on a case-by-case basis, and approval of alternative materials and methods for one development proposal will not imply an approval under similar circumstances in another proposal.

1.4.6 Stormwater Easements

Drainage easements shall be provided in a proposed development for all stormwater facilities that are not located in public rights-of-way or tracts. Said drainage easements shall be granted to the parties responsible for providing ongoing maintenance of the stormwater facilities.

City-maintained stormwater management facilities, including access roads to said facilities, shall require a public stormwater easement or dedication as described in **Chapter 5** and **Chapter 8**. The stormwater easement shall include access to all stormwater management facilities to accommodate maintenance of the facilities. The owner shall provide the City with all necessary documentation granting such easements. The City will not approve the final construction plans until all public and private easement documents have been completed to the satisfaction of the City.

1.4.7 Operations and Maintenance (O&M) Requirements and Access

Stormwater management facilities that serve a single property owner may be privately maintained. Stormwater management facilities that serve multiple properties (e.g. facilities for residential subdivisions) shall be transferred to public ownership following the 2-year maintenance warranty period. Regardless of ownership, all stormwater management facilities are required to comply with O&M requirements described in **Chapter 8**.

1.5 Jurisdictional Requirements

1.5.1 Jurisdiction

The City may promulgate new or amended policies pertaining to these standards in accordance with any other rules and regulations issued by the City and approved by the governing body.

1.5.2 Compliance with Laws

Conformance with these standards shall not be a substitute for, or eliminate the necessity of, conforming with any and all federal, state, and local laws, ordinances, rules, and regulations which are now, or may in the future, be in effect.

1.5.3 Conflicts

Any provisions or limitations of these standards and any regulation and order adopted pursuant hereto are suspended and supplemented by any applicable federal, state, or local requirements existing or adopted subsequent hereto which are more stringent than the provisions and limitations contained herein, provided, always, that any provision of these standards and policies adopted pursuant thereto which are more stringent than any applicable federal, state, or local requirement shall prevail and shall be the standard for compliance by all properties within the city boundary.

1.6 Modification Process

Modification to the adopted stormwater standards may be requested in accordance with OCMC 16.12 and 13.12.100 using the following process.

1.6.1 Modification Request Submittal

Requests to modify the stormwater standards shall be submitted in writing to the City and include the following:

A. The desired modification(s).

B. The reason(s) for the request(s).

C. A comparison between the specification(s) and standard(s) and the modification(s) for performance, function, maintainability, safety, etc.

D. References to regional and/or national accepted standards, record of successful use by other agencies, or other supportive information.

E. It is the responsibility of the applicant to obtain all approvals from any federal, state, or local entity that has authority over or is responsible for permitting of the activities before proceeding with an approved modification.

1.6.2 Criteria for Modification of Standards

The City may grant a modification to the adopted standards when the use thereof does not compromise public safety, environmental protection, or the intent of the stormwater standards and any one of the following conditions are met:

A. The standard is deemed not applicable for the particular application.

B. Topography or other geographic conditions impose an environmental or safety concern and an equivalent alternative exists, which can accomplish the same design intent as provided in these standards.

C. A minor change to the standard is required to address a specific design or construction problem which, if not enacted, will result in an undue hardship.

D. The proposed modification is in the public interest and requirements for safety, function, appearance, and maintainability based on sound engineering and technical judgment are fully met.

E. The financial viability of meeting the requirements of these design standards is not in itself an adequate justification for granting a modification of the standards.

1.7 Design Professional

Much of the information covered in this document is addressed to professional engineers. In order to assist the professional engineer in fulfilling his/her responsibilities related to a development project, the following comments address the City's expectations regarding the responsibilities of the project engineer and other design professionals.

1.7.1 Project Engineer's Responsibilities

All engineering plans, reports, or documents must be stamped and signed by a professional civil engineer registered in the State of Oregon. The project engineer is responsible for reviewing any proposed improvements or modifications to the existing storm drain system with City staff prior to commencement of design work to determine any special requirements and whether the proposal is permissible.

When specifically indicated in this document, some submittals do not require the approval or stamp of a professional engineer. These include but are not limited to the site assessment and planning checklist, the use of the BMP Sizing Tool to size stormwater facilities, and the design of planting plans.

The project engineer's responsibilities include:

A. The project engineer shall prepare construction plans for site development meeting City standards. The engineer shall remain responsible for the accuracy, completeness, and scope of all work submitted to the City. The project engineer shall be responsible for correcting all deficiencies, when necessary, should errors, omissions, or inaccurate data due to the engineer's work come to the City's attention in the future. The project engineer shall be responsible for any damages resulting from the incorrect work.

B. The project engineer shall incorporate recommendations from geotechnical engineering reports and any other engineering recommendations into the construction plans for site development.

C. The project engineer shall, when required by the City, be responsible for the inspection and approval of the construction within the engineer's area of technical expertise. This responsibility shall include, but need not be limited to, construction observation and approval as to the establishment of line, grade, maintenance, and implementation of Best Management Practices (BMP) and drainage of the develop-

ment area. In conjunction with the execution of this responsibility, copies of any on-site inspection reports shall be submitted by the engineer to the City, when so requested. Inspection under this paragraph means the visual observation and documentation of the construction of the stormwater system and BMPs as compared to the approved plans, specifications, and City standards.

D. The project engineer shall act as the coordinating agent in the event the need arises for liaison between the owner, other professionals, contractors, the City, and other agencies.

E. The project engineer shall be responsible for the preparation of revised plans and the submittal of as-built plans or record drawings, as applicable upon completion of work.

F. The project engineer shall be responsible for verification of excavation and embankment quantities, detention pond volumes, slope steepness, and compliance with approved construction plans.

G. Approval of plans and issuance of permits by the City does not in any way relieve the project engineer of his/her responsibility to meet all requirements of the City or other affected jurisdictions, or the obligation to protect the life, health, and property of the public. The design for any project must be revised or supplemented at any time it is determined or suspected by the City or the engineer of record that the full requirements of the City were not met.

1.7.2 Geotechnical Engineer's Responsibilities

When a geotechnical investigation report is required, the minimum responsibilities of the geotechnical engineer shall be as follows:

A. The preparation of any required geotechnical investigation report.

B. All reports, field data, test data, and recommendations shall be submitted to the project engineer and to the City Engineer.

C. The geotechnical engineer shall provide infiltration testing when required, following the requirements in Appendix D.

D. The geotechnical engineer shall provide, when required by the project engineer or the City Engineer, professional inspection and approval concerning the preparation of ground to receive fills and testing for required compaction. The geotechnical engineer shall also provide oversight on stability of all finished slopes and the design of embankment fills.

E. The geotechnical engineer shall prepare, when required by the project engineer or the City Engineer, a final soils report which includes locations and elevations of field density tests. The final soils report shall also include summaries of field and laboratory tests and other substantiating data and comments on any changes made during site development.

1.7.3 Landscape Architect's Responsibilities

When plans for a proposed stormwater management facility are prepared by a licensed landscape architect, the landscape architect shall prepare construction plans for site development meeting the standards and requirements of this document. The landscape architect shall be responsible for correcting all deficiencies, when necessary, should errors, omissions, or inaccurate data due to the landscape architect's work come to the City Engineer's attention in the future. The landscape architect shall be responsible for any damages resulting from the incorrect work.

CHAPTER 2

Site Assessment and Planning

CHAPTER 2. SITE ASSESSMENT AND PRELIMINARY DESIGN

The Stormwater and Grading Design Standards are intended to guide site-specific stormwater management improvements. Strategies for meeting the requirements in these standards depend on a number of site factors including soil infiltration capacity, available infrastructure, and proposed development plans. To use these standards effectively, applicants must demonstrate an understanding of the development site conditions and the upstream and downstream impacts resulting from the proposed development and the required stormwater management improvements.

2.1 Introduction and Applicability

This chapter describes the process for preparing the Site Assessment and Preliminary Design submittal, the first step in meeting the City of Oregon City's (City) stormwater management requirements. The *Site Assessment and Preliminary Design Checklist* (**Appendix B**) should be completed and submitted to the City as part of the Land Use Application. Refer to **Submittals (Chapter 9)** for additional information. **The Site Assessment and Preliminary Design submittal is required for all development that meet or exceed General Thresholds listed in Section 1.2.1.**

The purpose of the site assessment and preliminary design requirements is to ensure that the physical attributes of the development site are reviewed before placing manmade structures such as streets, parking lots, and buildings. This is meant to optimize site design of stormwater management techniques and sensitive areas protection, and to reduce or eliminate potential conflicts between site development elements and required stormwater management systems. A layout that integrates site attributes to manage stormwater and protect habitat may reduce the number, size, and cost of stormwater facilities required for the site.

2.2 Site Assessment and Preliminary Design Submittal

The Site Assessment and Preliminary Design submittal will include the completed checklist from **Appendix B**, site assessment maps, preliminary site plan, preliminary facility sizing documentation, and supporting materials as described below.

2.2.1 Site Information

Provide the requested site information in the checklist, with reference to supporting documentation and maps as appropriate for the site. The following should be included:

A. Applicant contact Information

B. Project location, including whether the site is located within the Oregon City Municipal Code (OCMC) 17.49, Natural Resource Overlay District, US Geologic Hazard Overlay Zone as defined by OCMC 17.44, and/or the Flood Management Overlay District as defined by OCMC 17.42

C. Project type

D. Size of site and amount of proposed impervious area

2.2.2 Site Assessment

Applicants must inventory conditions on and adjacent to the site to learn how stormwater moves through the site and how natural hydrologic functions may be protected and preserved. The information must be presented on a Site Assessment Map at a standard engineer scale appropriate for analyzing the information.

The site assessment should follow the order depicted in **Figure 2-1**. The required information is detailed below.

A. Topography – Steep slopes greater than 25 percent and setback areas around those steep slopes, as well as landslide zones, are subject to additional requirements and restrictions under OCMC 17.44. Infiltration is not allowed on steep slopes and slide-prone areas. **Infiltrating stormwater on moderate slopes (10 percent or greater) requires a geologist or geotechnical engineering analysis to determine the appropriate strategies.**

B. Soils and Seasonal High Groundwater – Use soil maps, which are available from the Natural Resources Conservation Service Soil Survey to determine the site hydrologic soil type (an indication of soil infiltration capacity). An assessment of the seasonal high water table may be required to ensure the functionality of the system.

C. Infiltration Assessment – Stormwater management facility sizing is based on tested infiltration rates. See **Appendix D** for specific infiltration testing requirements and methods.

D. Hydrology – Site Conditions and Natural Features – Show natural and manmade drainage features including channels, pipes, and outfalls. Identify jurisdictional wetland(s) (per Oregon Department of State Lands and U.S. Army Corps of Engineers) or 100-year floodplain (per Federal Emergency Management Agency [FEMA] mapping) present on the site.

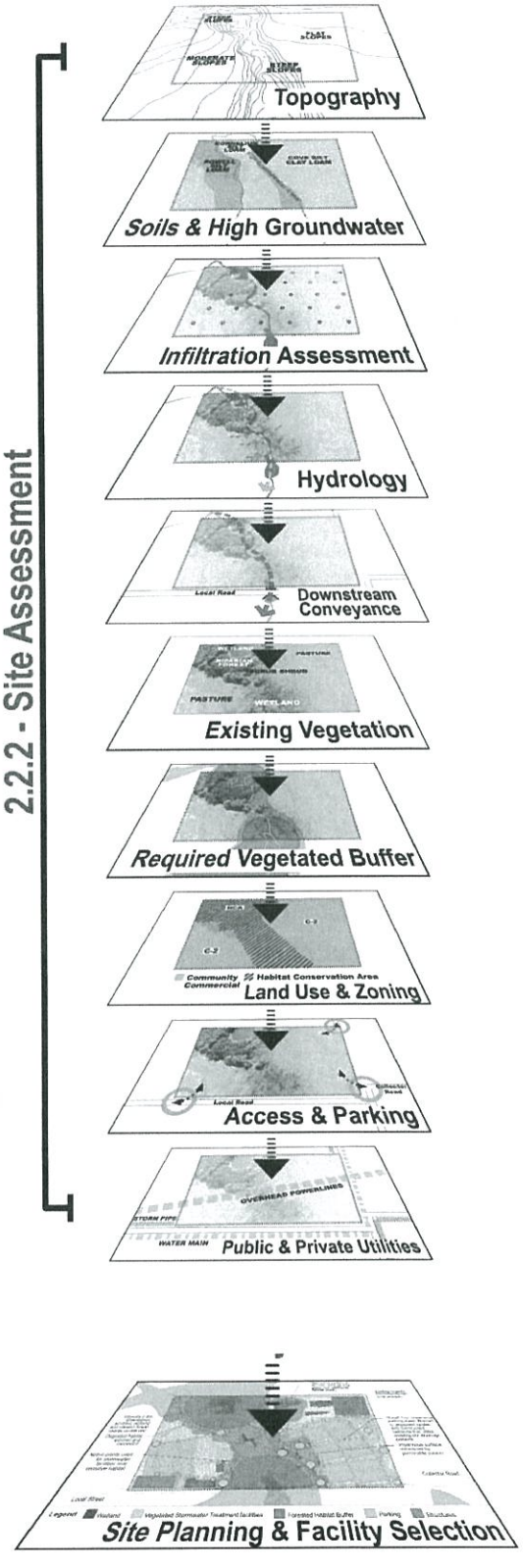


Figure 2-1.
Site Assessment Process

E. Downstream Conveyance – Document the existing and proposed points of discharge for stormwater runoff leaving the site. See **Chapter 5** for downstream analysis requirements and attach the required documentation to this submittal package.

F. Existing Vegetation – Using aerial photos or survey, map all trees and vegetation. Show all existing trees on the site assessment map and mark areas of other vegetation types (e.g., shrubs, pasture). Native trees and vegetation should be protected whenever possible.

G. Required Vegetated Buffers – Document required vegetated buffer areas (per OCMC Title 17). Show required buffer areas on the Site Assessment Map.

H. Land Use and Zoning – Document the existing zoning, including any special overlay zones and/or special districts.

I. Access and Parking – Map proposed access points for all modes of transportation.

J. Public and Private Utilities – Map existing public and private utilities on the site and surrounding areas, including storm, sewer, water, wells, dry wells, onsite septic system, electricity, phone/cable, and gas.

2.2.3 Site Preliminary Design Objectives

Prepare a Preliminary Site Plan at an engineer scale appropriate to review the information that includes proposed grading, clearing areas, stormwater facilities, natural resource areas and required setbacks, buildings, parking areas, streets and other proposed impervious areas. The Preliminary Site Plan must address the four objectives listed below to reduce the impact of stormwater runoff from development, which may reduce the size of stormwater facilities required.

A. Preserve Existing Resources

Required actions: On the Preliminary Site Plan, show sensitive areas and required buffers and setbacks. Show areas that require enhancement. If encroachment into any vegetated buffer area is proposed, show the area of encroachment on the site map and show related proposed mitigation areas. Refer to OCMC Title 17 to identify any other buffer, conservation, or setback requirements.

B. Minimize Site Disturbance

Required actions: Protecting undisturbed, uncompacted areas from construction activities provides more rainfall interception, evapotranspiration and runoff rate attenuation than clearing and replanting, even with soil amendments. On the Preliminary Site Plan, identify areas that will not be cleared during construction.

C. Minimize Soil Compaction

Required actions: Avoid any construction activity that could cause soil compaction in areas designated for stormwater management facilities to preserve filtration and infiltration characteristics of the soil. Also avoid soil compaction in vegetated buffers, and mitigation and/or re-vegetation areas. Delineate these areas on the Preliminary Site Plan and protect during construction with orange construction fencing.

D. Minimize Imperviousness

Required actions: Document the proposed impervious areas for the site. Consider the use of impervious area reduction strategies such as porous pavement and/or

green roofs to reduce the net impervious area proposed for the site. Impervious area reduction strategies will reduce the impervious area requiring stormwater management facilities. Identify proposed impervious area reduction methods and show them on the Preliminary Site Plan.

2.2.4 Stormwater Management Strategy

Given suitable site and soil conditions, the City requires that the stormwater management strategy prioritize infiltration of stormwater runoff to recharge groundwater and mimic pre-development hydrologic conditions. A geotechnical report may be required to document onsite soil conditions in order to determine the appropriate stormwater management strategy.

Stormwater management facilities shall be designed to meet the water quality and flow control standards in **Chapter 4**. Facilities must be sized according to the design requirements in **Chapter 4**, utilizing either the BMP Sizing Tool or the Engineered Method as described in Section 4.3.2.

Figure 2-2 shows the City's Stormwater Management Hierarchy that should be used in selecting the proposed stormwater management strategy. Applicants must demonstrate that the strategies higher on the hierarchy are not feasible before selecting a lower level strategy for stormwater management. **The financial viability of constructing onsite stormwater facilities is not sufficient justification to move to a stormwater management strategy lower on the hierarchy.** The applicant must demonstrate that the proposed development site has one or more of the physical limitations listed in Section 2.2.4.1.

For a development site located entirely within the NROD or the Geologic Hazard area, a stormwater management facility with a surface area equivalent to 10 percent of the total new impervious area of the site will be considered the maximum extent practicable (MEP).

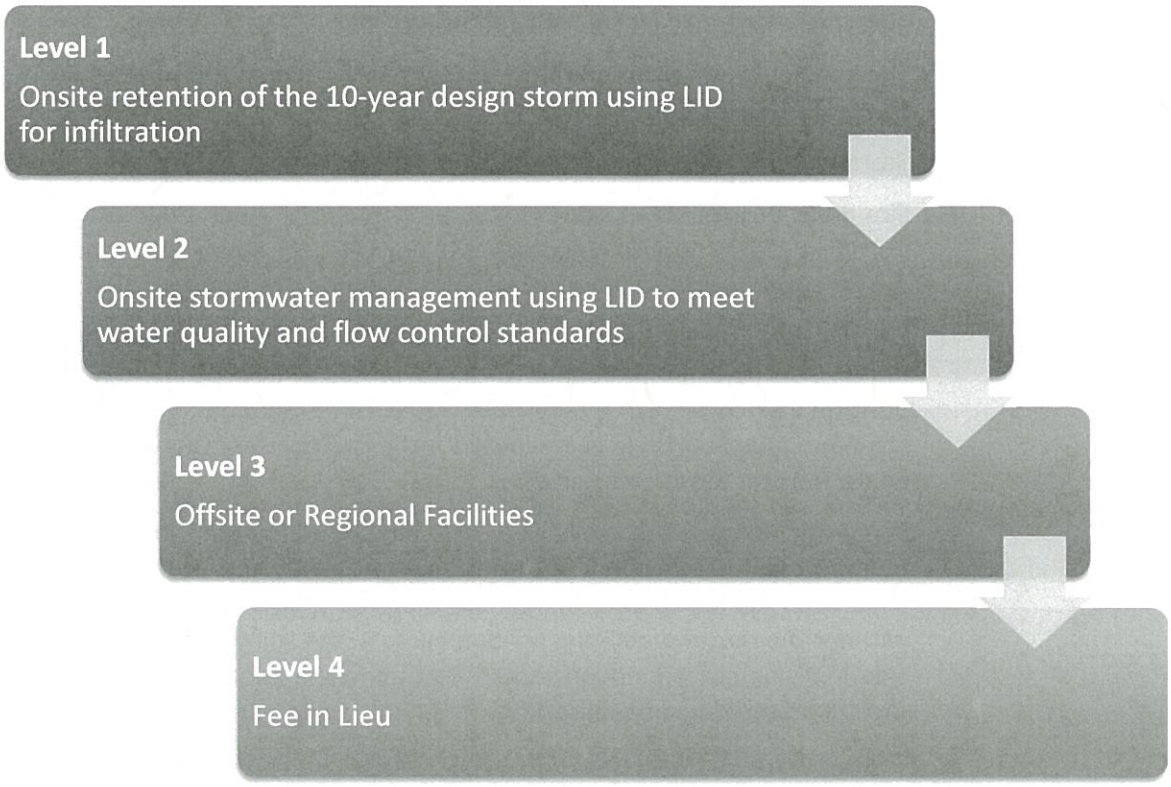


Figure 2-2. Stormwater Management Strategy Heirarchy

After selecting a stormwater management strategy, applicants should indicate which stormwater management facilities are proposed for the site based on the results of the site assessment and preliminary design process. The BMP Sizing Tool should be used to determine preliminary sizes for stormwater management facilities and the BMP Sizing Tool report should be included as part of the application. All proposed stormwater management facilities should be shown on the Preliminary Site Plan.

2.2.4.1 Level 1 – Onsite retention of the 10-year design storm

Given suitable site and soil conditions, the City requires that the stormwater management strategy prioritize infiltration of stormwater runoff to recharge groundwater and mimic pre-development hydrologic conditions. For sites with factored infiltration rates greater than or equal to 2.0 inches per hour, the applicant may provide a stormwater management strategy that will be used to infiltrate to the MEP to meet the water quality and flow control standards in **Chapter 4**.

- Utilization of infiltration stormwater facilities which can infiltrate the full 10-year design storm will be considered the MEP to satisfy both water quality and flow control requirements of **Chapter 4**. Approved LID stormwater management facilities are defined in **Chapter 4**.

When limiting conditions that restrict the use of surface infiltration, the stormwater management strategy may use Level 2 to meet the water quality and flow control standards in **Chapter 4**. Facilities must be sized according to the design requirements in **Chapter 4.**

Limiting conditions may include the following:

A. The site has low infiltration rates of less than 2.0 inches per hour as proven by infiltration testing and/or analysis.

B. Stormwater management facilities would be located on fill.

C. Site areas include steep slopes (>25 percent) and/or geologic hazard zone designations (per OCMC 17.44). A geotechnical engineering or geologist report and City approval is required for infiltration facilities on moderate slopes of 10 to 25 percent.

D. Sites in areas of seasonal high groundwater table. For site preliminary design submittal, sites with jurisdictional wetlands or FEMA floodplains may be required to perform a seasonal high groundwater table assessment and determine that the seasonal groundwater table is at least 12 inches below the proposed bottom elevation of stormwater filtration facilities.

E. Sites with contaminated soils. Sites that have contaminated soils must be evaluated by the Oregon Department of Environmental Quality and/or the U.S. Environmental Protection Agency to determine if areas on the property are suitable for infiltration without the risk of mobilizing contaminants in the soil or groundwater. Documentation showing contamination assessment and determination must be submitted to the City at the time of application.

F. There is a conflict with required source controls for high-risk sites.

The financial viability of constructing onsite infiltration facilities is not sufficient justification to move to a stormwater management strategy lower on the hierarchy. The applicant must demonstrate that the proposed development site has one or more of the physical limitations listed in this section. A geotechnical report or other technical report provided by a licensed professional may be required to document limiting conditions.

2.2.4.2 Level 2 – Onsite stormwater management using LID

When limiting conditions restrict the use of surface infiltration (Level 1), the stormwater management strategy may use onsite LID stormwater management facilities to meet the water quality and flow control standards in **Chapter 4**. Facilities must be sized according to the design requirements in **Chapter 4.** For sites with design infiltration rates between 0.5 and 2.0 inches per hour, the LID facility shall be designed with infiltration as the primary means of flow control. For sites with design infiltration rates less than 0.5 inches per hour, the LID facility will require an underdrain connected to a control structure.

Low-impact development (LID) facilities such as planters, swales, rain gardens, ponds or other vegetated facilities are best management practices (BMPs) and are the preferred strategy to meet the stormwater management requirements for water quality treatment and flow control. A list of accepted LID facilities is provided in **Section 4.1**.

For privately-owned stormwater facilities, applicants may propose stormwater management facilities not listed in **Section 4.1.** See **Section 4.1.1** for additional information on alternate facility proposals. Such a proposal will require the applicant to submit a request for a modification to these standards per **Section 1.6**.

2.2.4.3 Level 3 – Offsite or Regional Facilities

When limiting conditions restrict the use of onsite stormwater management facilities, the applicant may construct an offsite stormwater management facility or utilize offsite regional facilities to provide water quality treatment and flow control. When an offsite facility is proposed, design and construction of the facility shall meet these standards. The applicant shall obtain all permits and agreements with facility property owners to utilize an existing facility prior to project approval. Fees may be charged for the use of existing or future City-owned regional facilities. In such case, the fees shall be proportional to the City's cost to acquire property, design, construct, and maintain the regional facility.

2.2.4.4 Level 4 – Fee in Lieu

When a proposed development is unable to meet the flow control or water quality requirements of these standards through the above strategies, the City may allow applicants to pay a fee in lieu of stormwater management improvements. In such a case, the fee shall be based on the proportional cost for the City to construct an equivalent stormwater management facility, including costs for land acquisition, design, construction, maintenance, and administration. Such facilities shall be sized utilizing the BMP Sizing Tool.

The financial viability of designing and constructing onsite or offsite stormwater management facilities is not sufficient justification to utilize the fee in lieu program. Applicants must demonstrate that the proposed development site has one or more of the physical limitations listed in this **Section 2.2.4.1** and that offsite or regional facilities are not a feasible alternative.

2.2.5 Other Project Requirements

Use the Site Assessment and Preliminary Design Checklist **(Appendix B)** to document the following:

A. Grading permit requirements per OCMC 15.48 and associated grading plans required (see **Chapter 3**).

B. Source control requirements for proposed developments that are categorized as high risk for increased pollutant loading (see **Chapter 6**).

C. Erosion and sediment control requirements for sites that result in 1,000 square feet or more of new or replaced impervious area or sites that disturb more than 1 acre (see **Chapter 7**).

D. Other natural resources-related permits that may be required as part of the proposed development activity. It is the responsibility of the applicant to identify and obtain required permits prior to project approval.

CHAPTER 3

Grading, Fill, and Excavation

CHAPTER 3. GRADING, FILL, AND EXCAVATION

The following grading, fill, and excavation standards are intended as MINIMUM requirements for grading activities in Oregon City. If circumstances create a hazard to life, endanger or adversely affect the use or stability of a public way, adjacent property, critical area, or drainage course, the City of Oregon City (City) may impose additional or more stringent requirements.

3.1 Geotechnical Engineering Report

A Geotechnical Engineering Report, when required, shall include, at a minimum, the following:

A. Data regarding the nature, distribution, and strength of existing soils.

B. Conclusions and recommendations for grading procedures and/or erosion control measures.

C. Design criteria for corrective measures when necessary.

D. Opinions and recommendations covering a site's adequacy for further development, such as cut and fill slopes, existing slope, soil types, settlement, expansive soils, applicable and seismic conditions.

E. Allowable bearing pressure, if applicable. Recommendations in the report shall be incorporated in the proposed plans or specifications.

F. A statement as to whether the proposed work involves soils which may be excessively erodible or which may have limited compaction capability, due to the moisture content or the potential unsuitable nature of the material itself.

3.2 Unstable or Steep Slopes

Any grading activity within the Geologic Hazards Overlay Zone shall comply with the City's engineering policies and OCMC 17.44.

3.3 Natural Resources Overlay District

Any grading activity within the Natural Resources Overlay District (NROD) shall comply with the OCMC 17.49.

3.4 Excavations

Unless otherwise recommended in an approved geotechnical engineering investigation report, all excavated slope faces shall be no steeper than is safe for the intended use and shall not be steeper than two-horizontal to one-vertical (2h:1v). Steeper slopes shall be allowed if supported by geotechnical analysis by a Professional Engineer and approved by the City.

3.5 Fill and Embankments

Unless otherwise recommended in an approved Geotechnical Engineering Report, all fills and embankments must comply with the following minimum requirements listed in the section.

3.5.1 Preparation of Ground

A. Fill slopes shall not be constructed on natural slopes steeper than two-horizontal to one-vertical (2h:1v). The ground surface shall be prepared to receive fill by removing vegetation, non-complying fill, topsoil, and other unsuitable materials. The ground surface shall be scarified to provide a bond with the new fill.

B. The ground surface also shall be benched where natural slopes are steeper than four-horizontal to one-vertical (4h:1v) and the height is greater than 5 feet. This benching shall be into sound bedrock, glacial till, or other competent material as determined by a Geotechnical Engineer. The bench under the toe of fill on a slope steeper than 4h:1v shall be at least 10 feet wide. The area beyond the toe of fill shall be sloped for sheet overflow or a paved drain shall be provided. Refer to the Oregon Department of Transportation Standard Embankment Construction Detail (DET2100) for guidance.

C. When fill steeper than 4h:1v and higher than 5 feet is to be placed over an excavation, the Geotechnical Engineer shall certify that the foundation is suitable for the fill.

3.5.2 Fill Material

Organic material shall not be permitted in fills. No rock or similar irreducible material with a maximum dimension greater than 6 inches shall be buried or placed in fills.

EXCEPTION: The City Engineer may permit placement of larger rock or similar irreducible material (i.e., concrete, etc.) when a Geotechnical Engineer properly devises a method of placement and continuously inspects its placement and approves the fill stability. The following conditions shall also apply:

A. Before issuance of a Fill Permit, potential areas for rock disposal shall be delineated on the grading plan.

B. Rock sizes greater than 6 inches in maximum dimension shall be 5 feet or more below grade, measured vertically.

C. Rocks shall be placed to ensure filling of all voids with well-graded soil.

3.5.3 Compaction

All fills and embankments shall be compacted and tested in accordance with **City standards and the Oregon Structural Specialty Code (OSC), unless otherwise recommended in an approved Geotechnical Engineering Report**. Fills on sites of proposed structures shall be compacted as directed by the City Building Official in accordance with the OSC, **unless otherwise recommended in an approved Geotechnical Engineering Report**.

Testing of compaction shall be at the applicant's expense and shall be conducted by an independent and approved soil testing laboratory. Test frequency shall be per the City's standards, Project Engineer's direction, and/or at a frequency recommended in the Ge-

otechnical Engineering Report. At a minimum, testing shall start at the commencement of fill activities and one test shall be taken for every 500 cubic yards placed. In addition, where the City Engineer requires testing of the compaction of soils outside public right-of-way, compaction shall be tested by an independent soil testing laboratory at the owner's expense.

Minimum compaction values shall comply with City standards and OSC, unless otherwise recommended in an approved Geotechnical Engineering Report. Where a site-specific Geotechnical Engineering Report is approved, the recommendations in the report and values found shall supersede the City's standards as applicable.

Compaction of native soils is prohibited in areas proposed for stormwater management facilities and porous pavements, as compaction can significantly reduce the infiltration capacity of the soil. Refer to the site-specific engineering specifications for additional information.

3.5.4 Structures

Fills that are intended to support structures shall be constructed in conformance with the requirements of the latest edition of the OSC, as adopted by the City. An assignment of allowable soil-bearing pressures will be under the jurisdiction of the City Building Official in accordance with the OSC. If a fill is proposed over an area that the City deems to be a potential building site and the applicant does not state an intent to construct buildings on the fill area at that time, then the City may, at its own discretion, require that a notice be recorded as a public record containing provisions which will include the nature and extent of the grading which has occurred on the parcel.

3.5.5 Stormwater Management Facility Berm Embankments

The following guidelines below shall be considered (or addressed as applicable) in the Geotechnical Engineering Report:

A. Berm embankments shall be constructed on suitable native consolidated soil (or adequately compacted and stable fill soils) which is free of loose surface soil materials, roots, and other organic debris. The embankment soils shall have the following minimum/maximum soil characteristics per the U.S. Department of Agriculture's Textural Triangle: a minimum of 30 percent clay, a maximum of 60 percent sand, a maximum of 60 percent silt, with nominal gravel and cobble content.

B. The berm embankment shall be constructed of compacted soil, (95 percent maximum dry density, per American Society of Testing and Materials (ASTM) D1557) placed in 6- to 8-inch lifts with hand-held equipment and 10- to 12-inch lifts with heavy equipment.

C. Berm embankments shall be constructed by excavating a key equal to 50 percent of the berm embankment's cross-sectional height and width measured through the center of the berm, except in bedrock where the key minimum depth can be reduced to 1 foot of excavation into the till.

D. Anti-seepage collars (and/or pipe anchor wall per City Standards) shall be placed on outflow pipes in berm embankments that impound water greater than 6 feet in depth.

E. Berm embankments 6 feet or less in height, including freeboard and as measured through the center of the berm, shall have a minimum top width of 5 feet. Berm embankments greater than 6 feet in height, as measured through the center of the berm shall be designed by the Geotechnical Engineer.

F. Where maintenance access is provided along the top of berm, the minimum width of the top of berm shall be 12 feet.

3.6 Setbacks

Cut and fill slopes shall be set back from site boundaries in accordance with this section and the **Oregon Structural Specialty Code (OSC)**. Setback dimensions shall be horizontal distances measured perpendicular to the site boundary.

3.6.1 Top of Cut Slopes

The top of cut slopes shall not be made nearer to a site boundary line than one-fifth of the vertical height of cut with a minimum of 2 feet, and a maximum of 10 feet. The setback may need to be increased for any required interceptor drains.

3.6.2 Toe of Fill Slopes

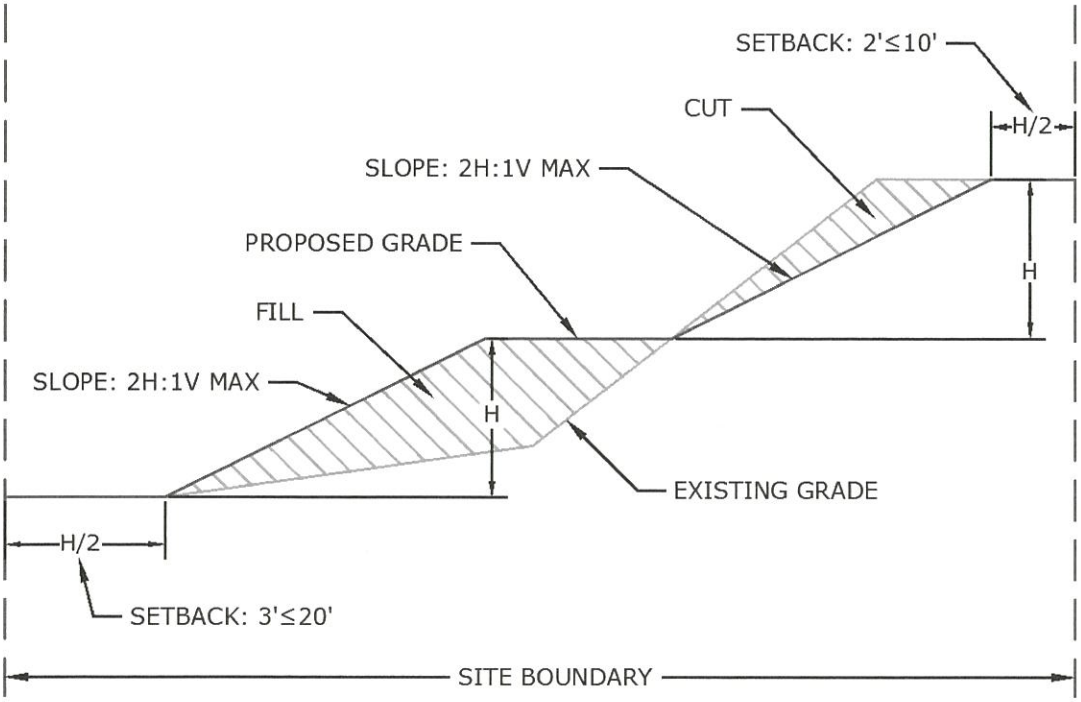
The toe of fill slopes shall not be nearer to the site boundary line than one-half the height of the slope with a minimum distance of 3 feet and a maximum of 20 feet. Where a fill slope is to be located near the site boundary and the adjacent offsite property is developed, special precautions shall be incorporated in the work as the City Engineer deems necessary to protect the adjoining property from damage as a result of such grading. These precautions may include, but are not limited to, the following:

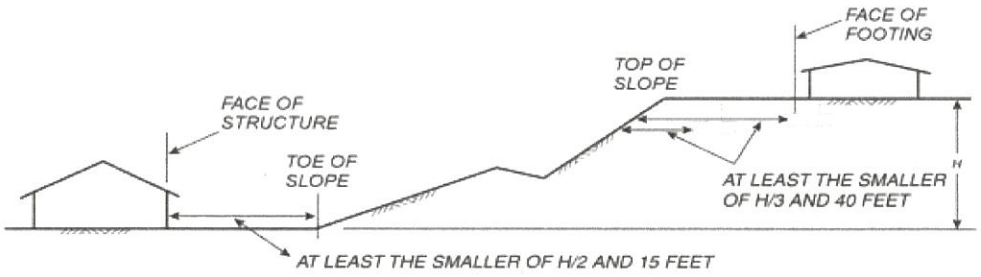
A. Additional setbacks

B. Provision for retaining walls

C. Mechanical or chemical treatment of the fill slope surface to minimize erosion

D. Provisions for the control of surface waters





For SI: 1 foot = 304.8 mm.

FIGURE 1808.7.1
FOUNDATION CLEARANCES FROM SLOPES

Figure 3-6. Grading Setbacks

CHAPTER 4

Stormwater Management Facility Selection and Design

CHAPTER 4. STORMWATER MANAGEMENT FACILITY SELECTION AND DESIGN

This section of the Stormwater and Grading Design Standards describes the methods and criteria for selecting and designing stormwater management facilities for projects that exceed the development thresholds described in **Chapter 1**. Additional structural source controls may be required for certain types of development categorized as high risk for pollutants as described in **Chapter 6**.

4.1 Stormwater Management Facility Selection

Impervious area reduction techniques, such as retaining vegetation and open space, clustering buildings, and constructing pervious pavement and green roofs, may be used as techniques to help mitigate stormwater runoff and reduce the size of the required stormwater management facilities. Impervious area reduction techniques should be identified during the site planning process (See **Chapter 2)**.

Low-impact development (LID) facilities such as planters, swales, rain gardens, ponds, and other vegetated facilities are best management practices (BMPs) and are the preferred strategy to meet the stormwater management requirements for water quality treatment and flow control. The following types of stormwater management facilities can be used to meet these standards.

- Stormwater planters (infiltration and filtration)
- Rain gardens (infiltration and filtration)
- Vegetated swales (infiltration and filtration)
- Detention ponds (infiltration and filtration)

Applicants shall follow the Stormwater Management Strategy in **Section 2.2.4** in selecting the appropriate approach to manage stormwater runoff. **Table 4-1** provides a quick reference to match stormwater management facility types with common design objectives and site constraints.

Table 4-1. Stormwater BMP Selection Guidance for Site Conditions

Facility can be used for	Porous pavement	Green roof	Stormwater planter	Rain garden	Vegetated swale	Detention pond
Impervious area reduction	●	●				
Infiltration facility[a]			●	●	●	●
Flow control	●	●	●	●	●	●
Water quality treatment	●	●	●	●	●	●
Private property	●	●	●	●	●	●
Public property or right-of-way		●	●	●	●	●
Steep slopes		●	●			

[a] *Facilities that include impermeable liners do not satisfy the requirements for surface infiltration.*

4.1.1 Alternate Facilities

For privately-owned stormwater facilities, applicants may propose stormwater management facilities that are not listed in **Table 4-1**. Such a proposal will require the applicant to submit a request for a modification to these standards per **Section 1.6**. Alternate facilities must be sized using the Engineered Method as described in **Section 4.3.4**. Examples of alternate facilities include filter strips for water quality treatment, manufactured water quality treatment devices, infiltration trenches, underground detention storage, dry wells, or other underground injection control (UIC) facilities on private property.

If a proposed facility meets the Oregon Department of Environmental Quality (ODEQ) criteria for a UIC, the applicant shall prepare appropriate registration information for ODEQ and submit a modification request to the City.

4.2 Design Criteria for Stormwater Management Facilities

Stormwater management facility design is based on meeting the City's design criteria to address LID requirements, water quality treatment standards, and flow control requirements.

A. LID Requirement: The goal is to prioritize the use of LID stormwater facilities to the maximum extent practicable (MEP) to mimic the natural stormwater runoff conditions of the pre-developed site and recharge the groundwater. As described in **Chapter 2**, the following strategies meet LID requirements:

- **Onsite retention of the 10-year design storm** – Retain and fully infiltrate the 10-year design storm onsite using surface infiltration facilities for sites with factored infiltration rates greater than or equal to 2.0 inches per hour. This is equivalent to retaining and in-

filtrating runoff from new and replaced impervious surfaces for the 3.5-inch storm over 24 hours. The facility must fully infiltrate within 72 hours following the beginning of the storm event. For sites with design infiltration rates between 0.5 and 2.0 inches per hour, the LID facility shall be designed with infiltration as the primary means of flow control. For sites with design infiltration rates less than 0.5 inches per hour, the LID facility will require an underdrain connected to a control structure. Infiltration of the full 10-year design storm is assumed to satisfy both water quality and flow control requirements listed in the following paragraphs.

- **Onsite stormwater management using LID** – Utilize vegetated stormwater facilities to address the water quality and flow control requirements of the site. Facilities must be sized according to the design requirements of this chapter, utilizing either the BMP Sizing Tool, explained in **Section 4.3.1**, or the Engineered Method.

B. Water Quality Requirement: Water quality facilities shall be designed to capture and treat 80 percent of the average annual runoff volume to the MEP with the goal of 70 percent total suspended solids removal. The treatment volume equates to a **water quality design storm of 1.0 inch over 24 hours**[1]. The BMP Sizing Tool addresses these water quality requirements to size stormwater management facilities.

Hydrodynamic separators, when used as a sole method of stormwater treatment, do not meet the MEP requirement for water quality treatment with regard to these stormwater standards.

C. Flow Control Requirement: Flow control facilities shall be designed so that the **duration of peak flow rates from post-development conditions shall be less than or equal to the duration of peak flow rates from pre-development conditions for all peak flows between 42 percent of the 2-year peak flow rate up to the 10-year peak flow rate** [2]. A hydrologic/hydraulic analytical model capable of performing a continuous simulation of peak flow rates from local long-term rainfall data must be used to determine the peak flow rates, recurrence intervals, and durations. The BMP Sizing Tool addresses these flow control requirements to size stormwater management facilities.

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[1] The water quality design storm rainfall depth as documented in a technical memorandum: *Selection of Representative Rainfall Volume and Rainfall Intensities to result in Capture and Treatment of 80% of the Average Annual Runoff Volume*, Brown and Caldwell, May 11, 2010.

[2] The lower threshold of 42 percent of the 2-year peak flow rate for flow-duration matching is based on a 2008 study by the Oregon Department of Transportation (ODOT) titled, "Water Quantity (Flow Control) Design Storm Performance Standard." ODOT's study found that bed movement in sand-bedded streams occurs at approximately two-thirds of the bank full flow, which is assumed to be roughly equivalent to the 1.2 year discharge. ODOT's flow frequency analysis established that two thirds of the 1.2-year discharge is approximately equivalent to 42 percent of the 2-year discharge.

For sites with conditions that limit the use of infiltration (fill, steep slopes, high groundwater table, wellhead protection areas, and/or contaminated soils), the applicant must submit documentation of limiting conditions. See **Section 2.2.4.1** for additional information regarding limiting conditions. In some cases, utilizing LID facilities may not be feasible and the City may approve the use of alternative stormwater management facilities to meet the water quality and flow control requirements. See **Section 4.1.1** for additional information regarding alternative facilities.

D. **General Conveyance:** Development shall not cause or increase flooding of adjacent or downstream property. An upstream and downstream analysis of the drainage system shall be conducted according to the guidelines in **Chapter 5**. Open channel and closed conduit systems shall be designed to convey the design storms listed in **Table 5-1**.

4.3 Design Methods

This section explains the two methods accepted by the City for designing stormwater management facilities, the BMP Sizing Tool Method and the Engineered Method. To use a different method for sizing a treatment facility type not covered in these standards, applicants must obtain City approval prior to submitting permit applications for review.

The Engineered Method must utilize the continuous runoff model or equivalent if approved by the City Engineer as discussed in section 4.3.4.

Submittal requirements are included in **Chapter 9**.

4.3.1 BMP Sizing Tool Method

A BMP Sizing Tool is available from the City's website to assist with the sizing of stormwater management facilities that meet the requirements of these standards. The following facilities can be sized using the tool:

A. Rain garden – infiltration and filtration

B. Stormwater planter – infiltration and filtration

C. Vegetated swale – infiltration and filtration

D. Detention pond – infiltration and filtration

The detention pond option will allow credit for the utilization of upstream LID facilities, including rain gardens, planters, infiltrators, and swales.

The volume for a manufactured underground stormwater management system shall be modeled as a detention pond in the BMP sizing tool.

The report generated by the BMP Sizing Tool should be included with permit application submittals. The BMP Sizing Tool can be used during the initial site planning and during final design. The soil infiltration rates used during final design must meet the criteria outlined in these standards.

4.3.2 Pre-developed Hydrology

For the purposes of hydrologic modeling, the pre-developed conditions of the site will be modeled as the historical vegetation which existed at the site prior to urban settlement. Most areas of the City will be modeled as forest under pre-developed conditions.

The applicant may use historic photos, reports, or other available sources to document an alternative condition of the site prior to urban settlement.

In the absence of site-specific resources, the City has developed a map of historic vegetation conditions that can be used in determining the appropriate pre-developed conditions land cover (See **Appendix G**). This map is also available for viewing within the City's GIS Public Portal.

4.3.3 Facility Design Adjustments

The BMP Sizing Tool was developed based on specific design requirements for each facility type. Facilities sized using the tool must follow the design details for ponding depth, overflow height, depth of growing media, depth of drain rock, and sizing of orifice controls (where relevant). Applicants who wish to propose alternate facility specifications may use **Table 4-2** to adjust the size of the stormwater facility calculated from the BMP Sizing Tool.

Applicants considering design adjustments different from those included in **Table 4-2** should utilize the Engineered Method to show how the proposed facility size and design specifications will meet the flow control and water quality requirements of these standards.

Table 4-2. Facility Sizing Adjustments*

Facility types	Design modification	Facility size adjustment
Stormwater planter Rain garden Vegetated swale	Increase growing media depth by 12 inches or more	Reduce required facility surface area by 20 percent

**Additional facility size adjustments may be developed at the discretion of the City Engineer. Refer to the City's engineering policies for additional facility sizing adjustments.*

If using a Facility Sizing Adjustment, it must be clearly stated in the report and described and shown on the engineering plans.

4.3.4 Engineered Method

As an alternative to the BMP Sizing Tool, the Engineered Method may be used to calculate the required size of stormwater management facilities for any size or type of development. The Engineered Method provides the developer with flexibility to factor in a wider variety of site data and facility design parameters to determine the size and configuration of stormwater management facilities.

The Engineered Method may be used to do the following:

A. Address unique site conditions
B. Apply a new or emerging design technology
C. Propose alternate facility design specifications

Use of the Engineered Method for flow control requires the use of a continuous simulation hydrologic model that runs a long-term record of historical hourly rainfall data. The model must show that the facility was sized to manage the post-development flows so

that outflow from a facility matched the pre-development flow duration curve for the range of flows considered to have the greatest erosive impact on open-channel systems (42 percent of the 2-year peak flow to the 10-year peak flow). The City must pre-approve the hydrologic/hydraulic analytical model prior to submittal or development of any plans and/or calculations. Regardless of how the stormwater calculations are performed, the report submitted to the City must show how the proposed stormwater management facilities meet the design criteria for LID, water quality, and flow control provided in **Section 4.2.**

Creation of a continuous simulation hydrologic model for a specific development site requires specialized expertise and usually takes additional time and expense to develop and review. The applicant will be required to pay additional fees to the City to review stormwater management plans developed using the Engineered Method. These fees will be used to pay for a third-party peer review of the hydrologic model, stormwater management plan, facilities, details, supporting documentation, and submittals.

The Engineered Method can also be used to document the use of the hydrograph method to size water quality and infiltration facilities when flow control is not required. See **Appendix H** for additional hydrograph method guidance.

4.4 Unmitigated Areas

Due to topographic constraints, runoff from portions of a development site may be permitted to be released at post-development rates (without flow control), provided that all of the following are met:

A. Runoff from the unmitigated area rejoins the pre-development downstream drainage course within one quarter mile downstream of the stormwater management facility.

B. The project engineer has demonstrated in the downstream analysis (see **Section 5.2.4**) and in conveyance capacity calculations (see **Chapter 5**) that the downstream drainage course will not be adversely impacted by the runoff from the unmitigated area. Improvements to the downstream conveyance system may be required to provide adequate conveyance capacity for flows from unmitigated areas.

C. Public easements (as required) are obtained by the applicant from all downstream property owners, through whose property the unmitigated runoff flows, prior to rejoining the detained runoff from the site.

D. The cumulative release rate from all areas of the project site, including the unmitigated area, shall not exceed the cumulative pre-developed rates from the site (in accordance with the flow control requirements in **Section 4.2**). This may be achieved by providing additional storage and flow control in the stormwater management facility to compensate for unmitigated areas.

4.5 Alternative to Infiltration Rate and Testing

To size stormwater management facilities, it is necessary to know the infiltration rate of the soil at the actual facility location. Infiltration testing is not required on development projects which create less than 5,000 square feet of new or replaced impervious surface or when the applicant can justify the lack of a test needed due to historical data assuming no infiltration credit is being requested. When testing is not completed, the facility will be sized using the minimum infiltra-

tion rate as shown in the Natural Resources Conservation Service's soil classification. If using the BMP sizing tool, the required facility infiltration rate will be the minimum infiltration rate for the given soil classification. The City has approved two methods for performing an infiltration test, Basic Test and Professional Test. Specifications for both test procedures are included in **Appendix D**.

4.6 UIC Registration

Subsurface discharging infiltration facilities that are defined by ODEQ as UICs (e.g., infiltration trenches or dry wells) require an approved modification request (see **Section 1.6**). Any UIC for private property shall be designed with an approved pretreatment device and registered with ODEQ as required. The City will not allow new UIC devices which accept stormwater runoff from a public right-of-way or for public ownership or maintenance.

4.7 Detention Pond Design Requirements

The City encourages the use of detention ponds that serve more than one development. A facility that serves more than one development will be referred to as a sub-regional facility. Sub-regional facilities can be more effective in maximizing the development area, reducing the overall maintenance requirement, and minimizing the overall construction cost while enhancing water quality of the stormwater runoff.

The City also encourages applicants to design detention ponds to function as multipurpose facilities (i.e. parks, open space, or recreation facilities), provided that any alternative uses are compatible with the primary stormwater functions and maintenance standards.

The following design requirements apply to all detention pond designs:

4.7.1 Geotechnical Report

Detention ponds shall have a geotechnical report that discusses the site's suitability for the type of stormwater pond being proposed and/or the engineer's recommendations as to how the site shall be improved to make the site suitable for the type of stormwater pond being proposed.

4.7.2 Pond Depth

The maximum active storage depth is 4 feet. An exception from this criterion may be approved on a case-by-case basis if additional safety factors can be shown to address this issue.

When using the BMP Sizing Tool, the total depth measurement reported in the tool includes the active storage depth as well as the depth of growing media, separation layer, and drain rock, as shown in **Figure C-11** in **Appendix C**.

4.7.3 Bottom Width

For ponds with an active storage depth of 3 feet or less, the minimum bottom width shall be 10 feet. For ponds with an active storage depth of over 3 feet, the minimum bottom width shall be 15 feet. An exception from this criterion may be approved on a case-by-case basis if required by topographical or physical boundary constraints. For the

purposes of this bottom width measurement, the width shall be measured at the interior toe of slope.

4.7.4 Interior Side Slopes

Interior side slopes shall be no steeper than three horizontal to one vertical (3h:1v). An exception from this criterion may be approved on a case-by-case basis if required by topographical or physical boundary constraints.

4.7.5 Exterior Side Slopes

Exterior side slopes that have vegetated surfaces that require mowing shall be no steeper than four horizontal to one vertical (4h:1v). Exterior side slopes that have vegetated surfaces that do not require mowing shall be no steeper than two horizontal to one vertical (2h:1v). Exterior slopes shall be landscaped so that there is no exposed soil.

Berm embankments shall meet requirements of **Section 3.5.6.**

4.7.6 Conveyance Outfalls

Pipe outfalls from the conveyance system into the pond shall be flush with interior side slopes. Conveyance outfalls shall be designed with energy dissipation, in accordance with **Section 5.8**.

4.7.7 Outlet Structures

A. **Primary Outlet:** Detention ponds shall have a perforated pipe underdrain system to convey water from the pond to the flow control structure. See **Figure C-11** in **Appendix C** for a graphical depiction showing the underdrain system as the primary outlet.

B. **Secondary Outlet:** Detention ponds shall have a secondary pond outlet structure, such as a catch basin with grated lid located along an interior side slope. This secondary pond outlet will serve as a backup to convey stormwater to the flow control manhole should the primary pond outlet become clogged. The lip elevation of the secondary pond outlet should be set at approximately the ten-year design water surface. See **Figures C-11** and **C-12** in **Appendix C** for a graphical depiction showing a secondary pond outlet.

C. **Flow Control Structure.** Detention ponds shall have a flow control structure with orifice and weir dimensions sized using the BMP Sizing Tool or the Engineered Method. See **Figure C-12** in **Appendix C** for a graphical depiction showing a typical flow control structure. The flow control structure shall be designed to meet the following criteria:

   1. Detention pond control structures may be either weir or orifice structures located in an enclosed manhole and meet City's standards. Locate the outlet control structure(s) outside the open water storage area.

   2. The control structure shall be designed with an internal overflow device, such as an open top riser, to pass the 25-year design storm event (or 100-year design storm for a sub-regional facility) without allowing runoff to discharge through the emergency spillway and without causing upstream or downstream flooding.

The design of the internal overflow shall assume that flow control orifices are plugged during the peak design storm.

3. Flow control manholes shall have solid locking covers. Open grates shall not be permitted in flow control manholes.
4. Locate the flow control structure to allow maintenance access as described in **Section 4.9.1**. The outlet flow control structure shall require little to no attention for normal operation.
5. The construction drawings shall include a separate design detail for each flow control structure.

4.7.8 Emergency Overflow

All ponds shall have an emergency overflow system that will safely pass runoff from a post-developed 100-year design storm through or around the detention pond and direct flows to the downstream conveyance system. The design intent of the emergency overflow system is to protect the integrity of the pond, as well as associated embankments and downstream properties, during large (rare) storm events and/or failure of the flow control structure. Secondary spillway shall meet the following criteria:

A. Locate the spillway to direct overflows safely toward the downstream conveyance system.

B. Locate the spillway in existing soil wherever possible. Protect the spillway with riprap or an approved material that extends to, and is an appropriate distance beyond, the bottom of the berm embankment. Fill the voids of the riprap with soil and vegetate the spillway with grass or ground cover. The selection of the vegetation on the spillway shall consider the required design capacity.

C. The invert elevation of the spillway shall be a minimum of 6 inches above the primary overflow elevation.

D. The minimum spillway depth shall be nine inches from the top of the berm. The free board during the design storm event shall be a minimum of 6 inches.

E. Alternate methods to accomplish the design intent of the secondary overflow system will be acceptable as long as they accomplish the same level of protection and are approved by the City Engineer.

4.7.9 Swales

All vegetated swales shall use rip rap or other methods to minimize and reduce erosion within the swale.

4.7.10 Inspection and Maintenance Access

All manufactured systems shall include inspection and maintenance access.

4.7.11 Signage

All ponds shall have signs placed so that at least one is clearly visible and legible from all adjacent streets, sidewalks, or paths. Applicants may add an indigenous, native wild

bird(s) or wild animal(s) logo or cartoon figure on the sign. Sign spacing shall be approved by the City Engineer. The sign shall read:

D. Please Do Not Disturb the Vegetation or Wildlife
E. Oregon City Stormwater Management Facility
F. For More Information, Call Oregon City Public Works at 503-657-8241

The minimum sign size shall be 12-inches x 18-inches. The maximum sign size shall be 24-inches by 30-inches. The material shall be aluminum with green reflective sheeting and silk screen lettering or equal as approved by the City Engineer. The signs shall be installed on an 8-foot long by 6-inch by 4-inch treated lumber post which is set in concrete and buried 30 inches into the ground. The developer shall install these signs before the City's final acceptance of the pond.

4.7.12 Site Constraints

All publicly-owned detention ponds shall be located in a separate tract dedicated to Oregon City for stormwater facilities. Open ponds shall not be located in dedicated public road right-of-way areas.

4.8 Planting, Irrigation, and Fencing Requirements

Landscaping guidelines for stormwater management facilities are included in the following sections and as described in 9.3.12.

4.8.1 Soil Mixes for Stormwater Management Facilities

Vegetated facilities require a soil/landscape system that simultaneously supports plant growth, soil microbes, water infiltration, nutrient and pollutant adsorption, sediment and pollutant filtration, and pollutant decomposition. Therefore, the soil mix selected for a facility is critical to its success. See the specific facility design criteria in **Appendix C**, and also refer to **Appendix A** for growing media specifications for vegetated facilities.

4.8.2 Planting

Stormwater management facilities with vegetative plantings must meet the following requirements:

A. Establishment procedures, such as control of invasive weeds, animal and vandal damage, mulching, re-staking, watering, and mesh or tube protection replacement, shall be implemented to the extent needed (as determined by the City) to ensure plant survival.

B. Stormwater facilities located in the public street right-of-way are not permitted to use evergreen trees to meet planting requirements.

C. Selected plant materials should be appropriate for soil, hydrologic, and other facility and site conditions (See **Appendix A**).

D. All plants within stormwater management facility areas shall be appropriate native species from the **Appendix A** Plant List (no nuisance, invasive, or prohibited plants).

E. The design for plantings shall minimize the need for herbicides, fertilizers, pesticides, or soil amendments at any time before, during, and after construction and on a long-term basis.

F. Plants shall be selected and planted to minimize the need for mowing, pruning, and irrigation.

G. Certified weed-free native grass or native wildflower seed shall be applied at the rates specified by the suppliers. If plant establishment cannot be achieved with seeding by the time of substantial completion of the stormwater facility portion of the project, the contractor shall plant the area with approved sod, plugs, container plants, or other means to complete the specified plantings and protect against erosion before water is allowed to enter the facility.

H. When any plantings are located within five (5) feet of a perforated pipe, the pipe shall be wrapped in filter fabric. Plantings should be offset from all utilities by a minimum of five (5) feet when possible.

4.8.3 Irrigation

The applicant may choose how to irrigate such as by truck or irrigation system. However, the City recommends onsite irrigation, with appropriate backflow prevention and winterization measures as necessary, to maintain the plant survivability.

When using temporary irrigation onsite using City water, the applicant must obtain a hydrant meter and backflow preventer from Public Works. Once the meter and backflow preventer are returned, the applicant is required to pay the fee for water usage.

Nearby water from a private water source is not allowed for irrigation.

When using temporary irrigation onsite using City water, the applicant shall discuss the irrigation system with the City prior to the completion of the two-year maintenance period. The City may request the irrigation be removed or request the irrigation remain in place for use by the City. In either case, the hydrant meter and backflow preventer will need to be returned and the water fee paid.

Permanent irrigation is desired when the City takes over the maintenance of the stormwater management tracts. Permanent irrigation plans must be submitted to Public Works and approved by Public Works prior to installation.

When using permanent irrigation onsite, the applicant must obtain a hydrant meter and backflow preventer from Public Works. Once the meter and backflow preventer are returned at the end of the two-year maintenance period, the applicant is required to pay the fee for water usage.

Installation of temporary or permanent irrigation requires a water meter installation fee.

Installation of permanent irrigation is considered an additional tap to the water main system and requires a System Development Charge.

4.8.4 Fencing and Handrails

Fences are required for all stormwater facilities with grades 3 feet horizontal to 1 foot vertical (3h: 1 v) or steeper, or any walls/bulkheads greater than 24 inches in height.

Designers are encouraged to **minimize or eliminate the need for fencing** for privately maintained facilities. If fencing is required or used, it shall be black vinyl chainlink or of a material aesthetically related to the building/site architectural style. In some locations, OCMC may only permit fences or walls of a certain type of material or prohibit fencing or require fencing to be screened with plantings. The designer is required to determine what is allowed based on the OCMC. If fencing is prohibited, the designer may have to change the site design to eliminate fencing requirements.

For publicly-maintained facilities, the City may authorize the use of black vinyl coated chain link fencing around city–owned facilities for security and protection including stormwater management facilities with a height ranging from 4 to 8 feet high depending on the location and security need as determined by the City Engineer.

Handrails shall be provided on the pedestrian side of stormwater planters or other stormwater management facilities with vertical sides that exceed 24 inches in depth.

4.9 Operation and Maintenance (O&M) Requirements

Operations and Maintenance requirements apply to all stormwater management facilities and related facility components. Owners are required to provide all-weather access for the City to inspect the facilities regularly to determine maintenance needs. See **Chapter 8** for O&M requirements.

4.9.1 General Maintenance Access

Publicly-maintained stormwater facilities must provide an access road designed and constructed for the intended use and purpose for accessing stormwater facilities. City-maintained facilities should be located on or directly adjacent to the public right-of-way. In locations where access roads are approved by the City, following are the minimum criteria required:

A. A site plan and profile of the access road.

B. Maximum grade: 12 percent.

C. Minimum width of surface: 12 feet.

D. Paved surfaces: 2-inch asphalt concrete (AC) thickness over 6" Aggregate Base OR Grass Pavers.

E. Paved surfaces shall extend to within 10 horizontal feet and 3 vertical feet of openings to all water quality and flow control structures unless otherwise approved by the City.

F. Access roads shall have an approved driveway approach from the public street and meet minimum design standards from Oregon City Municipal Code Title 17, except as modified by this section.

G. Maintenance road access for publicly-maintained facilities shall be shown on the recorded plat map and be situated in a separate tract and identified with the specific and intended use for maintenance access.

4.9.2 Detention Pond Interior Maintenance Access

Detention ponds shall have an access road suitable for maintenance equipment (backhoe, etc.) to safely access the interior bottom of the pond for the purpose of sediment removal. Minimum access road requirements include the following:

A. The interior pond access will begin at the edge of the required pavement and end within 3 vertical feet and 10 horizontal feet of the lowest elevation of the pond.

B. The minimum access road requirement is at least 10 feet wide with slopes no steeper than 15 percent. Curved alignments shall be 15 feet wide to accommodate equipment turning radius.

C. Access roads longer than 300 feet from a public right-of-way shall provide for a truck turn-around area.

D. Bollards shall be installed to limit vehicle access. Bollards shall consist of fixed bollards on each side of the access road and two lockable, removable bollards equally located between the fixed bollards.

E. The pond interior access shall be constructed of a landscape block surface by removing all unsuitable material, laying a geotextile fabric over the native soil, placing landscape blocks, filling the honeycombs with topsoil, and planning appropriate zone grass. Other materials may be reviewed and approved on a case-by-case basis, provided they do not create additional impervious surface and will meet vehicle wheel load requirements.

4.9.3 Private Stormwater Facilities

A. Private stormwater facilities require a recorded maintenance covenant on the property that includes the Operations and Maintenance Plan for the private stormwater feature. See **Appendix C** and **Appendix F**.

B. Manufactured Treatment Technologies and Systems as allowed by **Appendix E** shall be designed with appropriate maintenance access points and systems which could include access roads as described in 4.9.1 and/or multiple access hatches to the systems themselves.

CHAPTER 5

Conveyance System Design

CHAPTER 5. CONVEYANCE SYSTEM DESIGN

Stormwater conveyance system design is an integral component of stormwater management planning. Three considerations largely shape the design of conveyance systems: hazards to life (public safety), hazards to property (flooding), and hazards to habitat (water quality and erosion). Acceptable conveyance system design must maintain compatibility and minimize interference with existing drainage patterns, control onsite and downstream flooding of property, structures and roadways, and minimize the potential degrading environmental impacts of stormwater runoff.

This chapter includes guidelines as well as specific requirements for the design engineer developing the conveyance system for the stormwater management plan. The design requirements cover both open channel and closed conduit stormwater conveyance systems.

5.1 General Conditions

The following are the general conveyance requirements. It is understood that these are general guidelines and that every site will encounter specific issues regarding the overall conveyance system design.

A. The applicant is required to provide an acceptable point of discharge from the developed site. Generally, the point of discharge shall be discussed by the City of Oregon City (City) during pre-application by the City prior to issuing the land use decision.

B. A development that requires connection to the public stormwater system shall provide connection points to allow all adjacent uphill parcels to be served by the stormwater system as the natural drainage patterns and future planning concerns dictate.

C. The City's construction standards and specifications, including acceptable materials, workmanship, fittings, and installation, shall be followed for all aspects of conveyance design.

D. Conveyance systems shall be designed and constructed in compliance with requirements of this chapter. Written authorization of approval from other jurisdictions may be required at the discretion of the City.

E. A stormwater separated conveyance system may be required to accept and convey upstream offsite stormwater runoff through the site. See **Section 5.2.3** for upstream conveyance requirements.

F. Conveyance systems shall be designed and constructed to minimize downstream damage and erosion and to protect existing natural resources to the maximum extent practicable.

G. Conveyance systems shall be designed and constructed in accordance with floodplain management policies and regulations and other National Flood Insurance Program requirements and as determined by the City.

H. The owner is responsible for controlling the flows from springs and groundwater that surface during construction and within the warranty period of the drainage system.

I. Any proposed modification to the approved conveyance system plans shall be submitted to the City for review and approval prior to construction.

5.2 Stormwater Conveyance Requirements

Stormwater conveyance systems are to be designed to intercept and convey stormwater runoff efficiently enough to meet flood protection criteria. The conveyance system should complement the site design and structural stormwater controls to mitigate the major impacts of urban development.

5.2.1 Points of Discharge

The following considerations and/or limitations will be evaluated prior to approving the point of discharge:

A. The applicant will establish one or more acceptable points of discharge. Generally, the points of discharge shall be accepted by the City prior to issuing the land use decision.

B. Runoff from developed portions of the site drainage basin should be discharged at the existing natural drainage outlet or outlets.

C. Runoff shall not be allowed to flow over adjacent public or private property at a rate, volume, or location materially different from that which existed before development occurred.

D. Runoff must be discharged in a manner that will not cause adverse impacts to downstream properties or previously constructed stormwater systems.

E. If the point of discharge is an open channel, then adequate velocity dissipation and/or additional channel protection shall be required to prevent erosion and/or alteration to the existing downstream drainageway.

F. Any connection to a public or private piped downstream stormwater conveyance system shall be approved by the City. The means and methods of connecting or extending a piped conveyance system will be consistent with City standards and/or other standards required by agencies that have the authority to regulate the connection.

G. When private property must be crossed to reach an approved point of discharge, the developer is responsible to acquire a recorded drainage easement from the property owner. The drainage easement must meet City approval.

H. **Approved Discharge Point** – Stormwater from residential impervious surfaces (roofs, driveways, etc.) must be conveyed to an approved stormwater discharge point, which is commonly a stormwater management facility. To accomplish this, roof drains may be connected directly to a public storm drainage system by means of a lateral pipe. Stormwater from roofs may also drain directly to a public street through a curb if the building's top of foundation is at least 2 feet above the curb elevation. (Two feet is the minimum elevation difference considered necessary to allow for positive drainage for the footing drain.) If roof drains cannot be collected and conveyed to a stormwater management facility, other means of disposal such as seepage trenches shall be identified on the plans. These other methods will be reviewed and approved by the City on a case-by-case basis and shall be discussed in the drainage report.

5.2.2 Onsite Conveyance

The following onsite conveyance system requirements shall be incorporated into the design of the stormwater management plan:

A. The site shall be planned and designed to conform generally to onsite natural drainage patterns and discharge to natural drainage paths within a drainage basin. These natural drainage paths should be modified as necessary to contain and safely convey the peak flows generated by the development.

B. Open channel conveyance systems are preferred over closed conduits where feasible, especially where they might provide opportunities for water quality treatment, wildlife habitat improvement, or emergency overland flood relief routes.

C. In establishing the layout of stormwater networks, flows shall not discharge onto neighboring properties, except as under pre-development conditions.

D. It shall be the responsibility of the owner to provide a conveyance drainage system for all stormwater runoff and/or surface water entering the property from offsite. Surface water, springs, and groundwater shall be incorporated into the drainage design.

E. An overland emergency flow path must be identified and/or designed that allows large flow events to discharge without risk of injury or property damage. The emergency overland flow path must be incorporated into the design and show how a 100-year flow event will be accommodated. The emergency flow shall not be allowed to flow through or inundate an existing building. Any emergency overflow structures shall be designed to accommodate the 100-year design storm.

F. The onsite conveyance system shall be designed to reduce blockages and minimize the likelihood of nuisance flooding or damage to neighboring properties.

5.2.3 Upstream Drainage Basins

Developments are required to convey upstream drainage through or around the development using an integrated approach that plans for future development impacts.

A. The upstream offsite stormwater or other nuisance surface water runoff will be conveyed through the development in a separated conveyance system and will not be mixed with the stormwater collected and treated in onsite stormwater management facilities unless the onsite stormwater management facilities are designed to manage the additional flows from the upstream drainage basin(s), assuming full development potential.

B. Upstream drainage basin analysis shall assume ultimate buildout and/or maximum zoning density in determining the size of the separated conveyance system required through the site.

C. Generally, land use zoning adopted by the local planning agency will be used to size the capacity of the separated conveyance system for upstream basins.

5.2.4 Downstream Drainage Conveyance

The following downstream drainage conveyance system requirements shall be incorporated into the design of the stormwater management plan:

A. Stormwater runoff discharges shall not adversely affect the safety and/or flooding potential of adjacent or downstream property owners.

B. If the downstream analysis crosses the jurisdictional boundary of another surface water management agency, that agency must be notified and given the opportunity to review and comment on the analysis.

C. A written downstream analysis shall document existing conditions and demonstrate adequate conveyance capacity of the natural and constructed drainage system downstream of the project site.

D. The downstream analysis shall extend to the distance where the project site contributes less than 15 percent of the cumulative tributary drainage area **or** 1,500 feet downstream of the approved point of discharge, whichever is greater. In capacity constrained areas, the City may extend the distance of the required downstream analysis.

E. When downstream drainage conveyance systems are inadequate or systems are determined to be undersized, or when, in the opinion of the City, property or properties may be adversely affected by the existing and/or proposed stormwater release rates, the applicant may provide additional onsite stormwater flow control measures to reduce contributions to the downstream system, or correct and/or improve downstream drainage conditions so that the proposed stormwater release rates do not have to be restricted further.

F. The applicant is responsible to replace, repair, upsize, construct, or reconstruct the downstream conveyance system to provide the capacity necessary to develop the property. The downstream conveyance system may include any open or closed public or private stormwater conveyance system.

G. The applicant is required to identify all offsite downstream conveyance restrictions and the cost of upsizing/improving these conveyance systems to meet the minimum conveyance requirements established in this chapter.

H. Any offsite improvements will be the requirement and responsibility of the applicant to obtain easements, design approval, and authorization from all owners of any property and/or agency with the authority to regulate the activity. All agreements, easements, authorization, and approvals shall be acquired prior to stormwater management plan approval.

I. Where no conveyance system exists at the adjacent down gradient property line and the discharge was previously un-concentrated or significantly lower concentrated flow, measures must be taken to prevent adverse downstream impacts.

5.3 Stormwater Conveyance Design Methods

The following section describes accepted criteria and methods for analyzing and designing stormwater conveyance systems. It is the responsibility of the project engineer to determine the appropriate method of analysis in determining the capacity of the proposed conveyance system.

5.3.1 Design Event

The design event for sizing each component of the stormwater conveyance system is determined based on the size of the contributing drainage area and the type of convey-

ance system being designed. The design events for conveyance system sizing are listed in **Table 5-1**. Design rainfall intensities and 24-hour storm events are included in **Section 5.3.3 and 5.3.4**.

Table 5-1. Conveyance System Design Storms

Contributing drainage area	Design storm for conveyance system sizing		
	Storm sewer, culverts, and outfall pipes[a]	Creek or stream channels	Bridges
Less than 40 acres	10-year, 24-hour storm	10-year, 24-hour storm	100-year, 24-hour storm
40 to 640 acres	25-year, 24-hour storm	25-year, 24-hour storm	
640 acres or greater	50-year, 24-hour storm	50-year, 24-hour storm	

[a] *When a backwater condition exists, the storm drain system shall be designed to convey and contain at least the peak runoff for the 25-year design storm as described in* ***Section 5.3.6.***

5.3.2 Design Methodology

The following are general design considerations for conveyance sizing requirements:

A. Conveyance systems shall be designed and constructed to carry the design storm flowing full with no pressure flow. Flow conditions in existing pipe systems will be evaluated on a case-by-case basis for adequacy.

B. Conveyance systems in the public right-of-way (ROW) shall be designed as gravity systems, without the use of stormwater pumps. Privately-owned and maintained stormwater pumps may be allowed with City approval as described in **Section 5.13**.

C. The Rational Method for computing peak discharge is preferred by the City. The Rational Method shall be used for all existing and proposed conveyance systems that receive drainage from contributing areas of 25 acres or less and that have a time of concentration (Tc) of less than 100 minutes. For all other conditions, an approved hydrograph method (ex. Santa Barbara Urban Hydrograph (SBUH), Natural Resources Conservation Service (NRCS) Method, or Technical Release 55 (TR-55)), stormwater management model (SWMM), or other standard method as approved by the City shall be used.

D. Manning's equation generally shall be acceptable for determining pipe or open channel capacity for drainageways with a contributing area of 50 acres or less. For larger drainage areas, backwater effects shall be included in determining capacity for a drainageway, typically using HEC RAS or equivalent computer modeling software.

5.3.3 Rational Method

The Rational Method is most applicable for runoff estimates from small drainages with large amounts of impervious area, as is typical within Oregon City. When using the Rational Method, refer to the Oregon Department of Transportation (ODOT) *Hydraulics Manual* for calculation formulas and tables of coefficients.

When using the Rational Method, the following limitations shall apply:

A. Use the Rational Method only for predicting a conservative peak flow rate to be used in determining the required capacity for conveyance elements. The Rational Method shall not be used to size stormwater management facilities.

B. The drainage sub-basin area cannot exceed 25 acres and the time of concentration shall not exceed 100 minutes for a single calculation.

C. The rainfall intensity (I) should be based on the rainfall intensity, duration, and frequency curve shown in **Figure 5-2**.

D. In computing the Time of Concentration (Tc) for smaller basins, the largest and most significant component in the total Tc is the portion of the time devoted to sheet flow. For this reason, extreme care should be given to determining the true travel time for the sheet flow component of the Tc. In calculating the total Tc, the following limitations will apply:

   1. The flow segment used for the sheet flow component shall not extend for more than 300 feet. The use of a distance of less than 200 feet on a pre-developed land use will require supporting documentation, such as photographs that show evidence of shallow concentrated flow at the point of transition.

   2. For segments of the Tc route that flow through closed conveyance facilities such as pipes and culverts, use standard hydraulics formulas for establishing velocity and travel time.

   3. For segments of the Tc route that flow through lakes or submerged wetlands, travel time is normally very short. The travel time can be determined using an appropriate storage routing technique, or it can be assumed to be zero.

   4. The minimum total Tc used in the runoff calculations shall be 5 minutes.

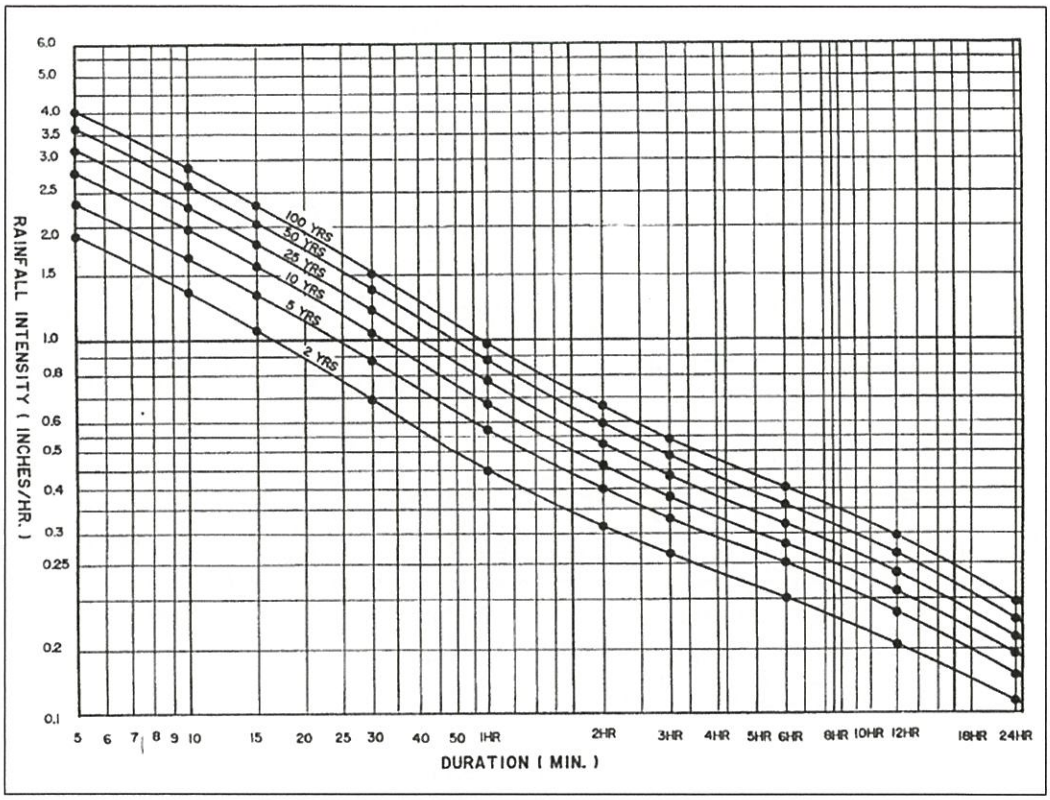


Figure 5-2. Rainfall intensity, duration, and frequency curves for Oregon City

Source: Oregon City Storm Drainage Master Plan, 1988

5.3.4 Hydrograph Method

When storm runoff conveyance design calculations are based on SBUH, TR-55 or the SWMM method, the calculations shall have the following limitations:

A. The rainfall distribution to be used within the city is the design storm of 24-hour duration based on the standard NRCS Type 1A rainfall distribution using the 24-hour precipitation isopluvials in the National Oceanic and Atmospheric Administration Atlas 2, Volume 10, *Precipitation-Frequency Atlas of the Western United States*. The depth of rainfall for the 2 through 100-year 24-hour storm events is shown below in **Table 5-2**.

B. Curve numbers shall be derived from the NRCS runoff curve numbers contained in TR-55 *Urban Hydrology for Small Watersheds*.

C. Soil types shall be derived from the NRCS Soil Survey for Clackamas County.

D. A maximum overland distance for sheet flow used in calculations shall be 300 feet.

E. The minimum time of concentration shall be 5 minutes.

See **Appendix H** for additional guidance on performing hydrograph method calculations.

Table 5-2. 24-hour Rainfall Depths in Oregon City

Recurrence Interval, Years	24-Hour Depth, Inches
2	2.8
10	3.5
25	4.0
50	4.4
100	4.5

Source: NOAA Atlas 2, Volume X

5.3.5 Capacity Analysis: Non-pressure Flow

Storm drains that are designed to operate at full or partially-full conditions during the design storm are called non-pressure flow. The capacity of pipe systems and open channels, for non-pressure flow conditions, can often be estimated using Manning's equation for steady uniform flow as follows:

Manning's Equation

$$Q = \left(\frac{1.486}{n}\right) AR^{2/3}S^{1/2}$$

or

$$V = \left(\frac{1.486}{n}\right) R^{2/3}S^{1/2}$$

where: Q = flow in cubic feet per second (cfs)

n = coefficient of roughness

A = cross sectional area of flow in square feet

V = Velocity, fps

R = hydraulic radius in feet = A/WP

(WP = wetted perimeter = length, in feet, of the wetted contact between a flow of water and its containing channel, measured at right angles to the direction of flow)

S = hydraulic slope (or hydraulic grade line) in feet per foot

The hydraulic slope or hydraulic grade line (HGL) is defined by the elevations to which water will rise in small vertical pipes, located at various locations along the flow. In a non-pressure flow condition, the hydraulic slope can be assumed to be parallel with the flow line slope. The HGL is separated from the energy line by the velocity head. The energy grade line is the sum of the HGL, the velocity head, friction loss, and the incidental losses. Manning's equation does not take into account entrance, exit, bend, and junction losses within catch basins or manholes.

Typical values for the hydraulic roughness coefficient (Manning's n) for conduits and channels can be found in **Tables 5-3 and 5-4**. Refer to the ODOT *Hydraulics Manual* for additional hydraulic roughness values.

This capacity estimate using the Manning equation is acceptable for final design purposes if the conveyance system does not have tailwater influence (such as discharge into a partially full detention basin) or abrupt changes in channel cross-section or slope that might cause non-uniform flow.

Table 5-3. Normal Range Hydraulic Roughness Coefficient (Manning's n) for Conduits

Type of Pipe Material	Manning's n (normal)
Concrete	0.013
Ductile iron	0.012
Corrugated metal (CMP) - annular - 2-2/3" x 1/2"	0.024
CMP - annular – 3" x 1"	0.027
CMP - annular – 6" x 2"	0.032
CMP - helical- 2-2/3" x 1/2"	
12-inch diameter	0.013
18-inch diameter	0.015
24-inch diameter	0.017
36-inch diameter	0.021
48-inch diameter	0.023
60-inch diameter and larger	0.024
Corrugated high-density polyethylene (CPEP) - single wall	0.024
CPEP - smooth wall	0.012
Spiral rib metal	0.011
Poly-vinyl chloride (PVC)	0.011
High density polyethylene (HDPE) - butt fused	0.009

Note: These n values are the "normal" range hydraulic roughness coefficient values for use in the analysis of conduits. Refer to the ODOT Hydraulics Manual *for additional reference values.*

Table 5-4. Normal Range Hydraulic Roughness Coefficient (Manning's n) for Channels

Type of channel	
Constructed	**Natural**
A. Earth, straight and uniform	**A. Minor streams (top width at flood stage less than 100 feet)**
1. Clean, recently completed 0.018	1. Streams on plain
2. Clean, after weathering 0.022	a. Clean, straight, full stage, no rifts or deep pools 0.030
3. Gravel, uniform section, clean 0.025	b. Same as above, but more stones and weeds 0.035
4. With short grass, few weeds 0.027	c. Clean, winding, some pools and shoals 0.040
B. Earth, winding and sluggish	d. Same as above, but some weeds and stones 0.045
1. No vegetation 0.025	e. Same as above, lower stages, irregular slopes and sections with more ineffective flow area 0.048
2. Grass, some weeds 0.030	f. Same as d, but more stones 0.050
3. Dense weeds or aquatic plants in deep channels 0.035	g. Sluggish reaches, weedy, deep pools 0.070
4. Earth bottom and rubble sides 0.030	h. Very weedy reaches, deep pools, or floodways with heavy stand of timber and underbrush 0.100
5. Stony bottom and weedy banks 0.035	2. Mountain streams, no vegetation in channel, banks usually steep, trees and brush along banks submerged at high stages
6. Cobble bottom and clean sides 0.040	a. Bottom: gravels, cobbles, and few boulders 0.040
C. Rock cuts	b. Bottom: cobbles with large boulders 0.050
1. Smooth and uniform 0.035	**B. Floodplains**
2. Jagged and irregular 0.040	1. Pasture, no brush
D. Channels not maintained, weeds and brush uncut	a. Short grass 0.030
1. Dense weeds, high as flow depth 0.080	b. High grass 0.035
2. Clean bottom, brush on sides 0.050	2. Cultivated areas
3. Clean bottom, brush on sides, highest stage of flow 0.070	a. No crop 0.030
4. Dense brush, high stage 0.100	b. Mature row crops 0.035
	3. Brush
	a. Scattered brush, heavy weeds 0.050
	b. Light brush and trees 0.050
	c. Medium to dense brush 0.070
	4. Trees
	a. Dense willows, straight 0.150
	b. Cleared land with tree stumps, no sprouts 0.040
	c. Cleared land with tree stumps, heavy growth of sprouts 0.060
	d. Heavy stand of timber, a few down trees, little undergrowth, flood stage below branches 0.100
	e. Same as above, but with flood stage reaching branches 0.120

Note: The n values listed above are the "normal" range hydraulic coefficient values for use in the analysis of open channels. For conservative design of channel capacity, the "maximum" values listed in the ODOT Hydraulics Manual *should be considered. For channel bank stability calculations, the "minimum" values listed in the ODOT* Hydraulics Manual *should be considered.*

5.3.6 Capacity Analysis: Pressure Flow

A backwater analysis shall be included in the stormwater management plan for the following circumstances:

A. Where uniform flow is not expected or where losses within the system may cause surcharging of water.

B. A discharge into a tailwater condition, such as a partially full stormwater detention pond or into a partially full channel.

C. Culvert entrances.

D. Ditch inlet location where backwater effect could cross a property line.

E. Other locations as determined by the City Engineer.

The backwater analysis shall be to a point where non-pressure flow at the design storm flow rate is re-established.

When a backwater condition exists, the storm drain system shall be designed to convey and contain at least the peak runoff from the 25-year design storm or the design storm identified in **Table 5-1**, whichever is larger.

Structures for proposed pipe systems must be designed to provide a minimum of 1 foot of freeboard between the HGL and the top of the stormwater structure and appurtenances or finish grade above the pipe during the design flow. Surcharge in pipe systems shall not be allowed if it will cause flooding in portions of a structure, including below-floor crawl spaces and basements.

5.3.7 Hydrologic and Hydraulic Calculation Reporting

Design hydrologic and hydraulic data for each reach of a proposed storm drain system shall be included in the stormwater management plan submittal. It is the responsibility of the project engineer to determine the best way to document the design analysis for presentation in the report. Conveyance calculations shall include the following items:

A. Description and sketch of the storm drain system including pipe size, slope, and material for each segment of the system.

B. Description and sketch of the contributing area (curve number value or equivalent, as well as the size).

C. Time of concentration calculations including assumed coefficients, flow path lengths, and slope.

D. Capacity analysis calculations as outlined in **Sections 5.3.5** and **5.3.6**.

E. Design flow calculations, including assumed coefficients and design storm.

F. Design flow rate for each pipe and open channel segment of the onsite conveyance system.

G. HGL and ground surface elevation at each structure and outlet location. It is preferable to show this information on a profile plot on an engineering scale, though spreadsheet tables are acceptable. When spreadsheet tables are used in place of a profile plot, include the distance between the ground surface and the HGL at each structure and outlet location.

H. Flow velocity at outlet structures and in open channels.

5.4 Open Channels

The following section describes accepted criteria and methods for designing open channel conveyance systems such as swales and ditches.

5.4.1 Geometry

Open channel geometry shall meet the following criteria:

A. Constructed open channels shall be sized to pass the design flows listed in **Table 5-1** without causing erosion.

B. Channel side slopes shall be no steeper than two-horizontal to one-vertical (2h:1v) for undisturbed ground (cuts), as well as for disturbed ground (embankments). All constructed channel slopes shall conform to compaction guidelines in **Chapter 3**.

C. A low-flow channel within the main channel, designed to carry 10 percent of the design storm, will be required for channels with a design flow of greater than 20 cubic feet per second (cfs). Side slopes for the low-flow channel shall not exceed 2h:1v and shall be stabilized to the satisfaction of the City Engineer. The minimum stabilization material shall be seeded matting or approved equivalent.

D. Channel design along curves shall be curvilinear with a 100-foot minimum radius. Tighter curves may be used if the City Engineer determines that sufficient erosion control has been incorporated into the design to maintain stable bank conditions following development.

E. Channels shall be designed to provide sufficient freeboard so as not to saturate any adjacent public road base with design storm peak flows. Channels shall have a minimum freeboard of 6 inches when the design discharge is 10 cfs or less and 1 foot when the design discharge is greater than 10 cfs. Extra freeboard may be required for curved segments of an open channel.

5.4.2 Channel Lining and Infiltration

Every opportunity should be taken to design open channels to provide infiltration throughout an entire drainage system. Engineers are also encouraged to consider innovative means of collecting and conveying runoff to incorporate infiltration into the drainage system design.

Protection for open channels shall meet the following criteria:

A. Vegetation-lined channels shall be used whenever practicable. Rock-lined channels shall be used only where a vegetative lining will not provide adequate protection from erosion.

B. If the channel has a flow line slope of 6 percent or greater or a peak design velocity that exceeds 4.0 feet per second (fps), the channel shall incorporate rock lining or riprap energy dissipation devices designed by a qualified Professional Engineer. Channel protection shall be based on the minimum level of protection listed in **Table 5-5**.

C. Where riprap protection is specified, riprap shall be placed over a woven geo-textile fabric.

D. No protruding pipes, culverts, or other structures which reduce or hinder the flow characteristics of the channel will be allowed. Channel connections shall be designed to prevent scouring. All pipe connections shall match side slopes and incorporate a headwall.

E. All channel sides and bottoms shall be seeded, sodded, or rock-lined immediately following excavation, regardless of mean flow velocity.

Table 5-5. Protection for New Channel Construction

Velocity at design flow, fps		Required protection	Thickness, feet	Minimum height above design water surface, feet
Greater than	Less than or equal to			
0	5	Vegetation lining	Not applicable	0.5
5	8	Bioengineered lining	Not applicable	1
		ODOT Class 50 riprap[a]	1.5	
8	12	ODOT Class 200 riprap	2.5	2
12	20	Slope mattress, etc.	Varies	2
20		Engineer-designed		

[a] *The City may require ODOT Class 100 Riprap on an as-needed basis.*

5.4.3 Open Channel Location

New open channels in residential areas shall be in private or public easements and recorded on plat maps with the following restrictions:

A. Property owner shall not alter the drainageway without approval of the City Engineering Division.

B. Property owner shall not place any structure or fence within the normal high-water area of the open channel.

C. Property owner shall not introduce foreign material such as grass clippings within the high-water area of the open channel.

5.4.4 Check Dams

Check dams are not recommended for use in conveyance channels due to the problems they pose for routine maintenance operations. However, check dams are recommended for use in temporary or permanent channels as an erosion and sedimentation control device (see **Chapter 7**) and for stepping down channels being used for infiltration. Where check dams are proposed, they shall be spaced at maximum 2-foot elevation intervals.

5.4.5 Work Near Existing Natural Channels

All work near natural channels shall be consistent with Oregon City Municipal Code (OCMC Title 17) Natural Resource Overlay District (NROD) requirements.

5.5 Culverts

Culverts, for the purposes of this manual, are single runs of pipe that are open at each end and do not have structures such as catch basins or manholes. Culverts designed for fish passage are governed by the Oregon Department of Fish and Wildlife and often require additional design considerations such as depth of flow and velocity that may differ considerably from the design requirements included herein. When conflicts exist, the applicant shall work with the City and the regulating agency to establish the appropriate design criteria.

5.5.1 Culvert Design Criteria

Stormwater conveyance culverts shall meet the following design criteria:

A. Maximum design headwater depth shall be 1.5 times the diameter of the culvert, with no saturation of roadway subgrade.

B. Minimum culvert diameters are as follows:

   For cross-culverts under public and private roadways: minimum 18 inches.
   For all other roadway culverts, including driveway culverts: minimum 12 inches.

C. No bends shall be permitted in culvert pipes.

D. Minimum cover, as measured from the top of pipe to finished grade:

   1. Under roads classified as collectors or higher: 2 feet.
   2. If Class 52 ductile Iron pipe is used, the cover may be reduced to 1 foot.
   3. PVC and HDPE shall require a 2-foot minimum cover in any public roadway area.
   4. Pipe covers of less than the above stated minimums may be permitted on a case-by-case basis. These may require a designed reinforced concrete cover that will distribute roadway use (traffic) forces to a foundation area to the sides of the pipe.
   5. Reinforced concrete box (RCB) culverts with no cover requirement may be permitted on a case-by-case basis. Signed and sealed structural design calculations shall be submitted for review (this requirement may be waived for pre-cast RCB culverts with covers greater than 2 feet). In culverts with no cover, the clearance from the roadway surface to the reinforcing steel shall be no less than three inches and the 30-day concrete strength shall be no less than 4,500 pounds per square inch.

E. Maximum culvert length without access structures is 300 feet.

F. Minimum separation from other utility pipes and conduits (as measured from the outside edge of pipe) is 6 inches vertical, 3 feet horizontal, unless otherwise specified by the purveyor of the utility in question.

G. Controlled Density Fill (CDF or CLSM) shall be used for any pipes with less than 12" separation.

H. Pipe bedding and backfill shall conform to City's Public Works standards.

I. The entrances and outlets to all culverts shall be stabilized with quarry rock or other energy dissipation methods to minimize scouring of the channel bottom and sides. These shall be designed by a Professional Engineer using published references such as Hydraulic *Design of Energy Dissipaters for Culverts and Channels* (U.S. Department of Transportation, Federal Highway Administration) and other references.

J. Rock protection at culvert entrances should extend upstream a minimum of 5 feet and shall have a minimum height of 1 foot above the design headwater elevation. Rock protection at the culvert outlet shall have the greater of:

   A minimum height of 1 foot above the design tailwater elevation
   1 foot above the crown of the pipe

K. When two parallel pipes are installed, the minimum separation between the exterior pipe walls shall be 3 feet or half the diameter of the larger pipe, whichever is greater. Pipe separations less than the stated minimum may be permitted on a case-by-case basis.

5.5.2 Culvert Materials

The culvert materials listed in **Table 5-6** are approved for use for culverts, subject to the limitations listed in the table or in **Section 5.5.1**.

5.5.3 Headwalls/Endwalls

Concrete headwalls/endwalls or other approved end protection are required where pipe material other than concrete or ductile iron is exposed in the design of an outlet or inlet pipe or where required to stabilize the slope.

Headwalls and endwalls should be built high enough to support the full depth of pipe cover recommended by pipe manufacturer. Headwalls and endwalls built to the proper height improve pipe capacity during extremely high flows and help prevent pipe blockage, road washouts, and compounding damage caused by pipe failure.

No plastic pipes shall be exposed, which may require pipe transitions from underground plastic to exposed ductile iron pipe or mitered pipe end matching the slope with a paved concrete end slope 18-inch minimum around end of pipe.

5.5.4 Location

Culverts located within the structural street section shall be placed as shown on the City's Standard Drawing for utility placement location.

5.6 Pipe Systems

Pipe systems are comprised of more than one run of pipe and include at least one junction type of structure such as a catch basin or manhole. The following section describes accepted criteria and methods for designing pipe systems.

5.6.1 General Pipe Design Criteria

Pipe systems shall meet the following design criteria:

A. **Minimum cover**, as measured from the top of pipe to finished grade:

1. Minimum cover of 2-feet under collector and above roads.
2. If Class 52 ductile iron pipe or Class V concrete pipe is used, the cover may be reduced to 1 foot.
3. PVC and HDPE shall require a 2-foot minimum cover in any public roadway area.
4. In areas of relatively flat terrain, the project engineer must show that sufficient depth is provided at the boundary of the development to properly drain the remainder of the upstream basin area tributary to the site.
5. The Oregon Structural Code (OSC) typically requires 1-foot minimum cover on private property where the system will be privately maintained.
6. Pipe covers of less than the above stated minimums may be permitted on a case-by-case basis, as approved by the City Engineer.

B. **Velocity**

1. Minimum velocity: 3 fps at design flow rate.
2. Maximum velocity: 15 fps at design flow rate.
3. Where velocities greater than 10 fps are attained, special provision shall be required to protect structures against pipe erosion and displacement by shock. Energy dissipaters located on sloping land are of particular concern. This condition shall be studied in each case and the results of the study shall be documented in the drainage report.

C. **Slope**

1. Minimum pipe slope of 0.5 percent. Exceptions may be made for topographic constraints, provided the minimum flow velocity is maintained, if approved by the City Engineer.
2. Storm drains laid on slopes of 20 percent or greater shall be secured by anchor walls. Concrete pipe shall not be used when slopes exceed 25 percent due to the potential for joint displacement from differential settlement.

D. **Pipe Diameter**

1. Minimum of 12-inch pipe diameter for stormwater systems within the right-of-way.
2. Storm lines shall not decrease in size as they move downstream, regardless of the slope provided on the pipe.
3. Engineers shall not specify sewers of sizes which are obviously larger than is necessary for satisfactory carrying capacity, but which are specified in order to meet grade requirements (i.e., a fifteen inch (15") pipe for a twelve inch (12") pipe to acquire a decrease in slope).

E. Maximum pipe length of 400 feet between access structures.

F. Minimum separation of 6 inches vertical, 3 feet horizontal from other utility pipes and conduits, unless otherwise specified by the purveyor of the utility in question. The separation shall be measured from the outside edge of pipe.

G. **Debris grates** shall be installed at all inlets where an open channel discharges to a piped drainage system. Additionally, debris grates are required at all outlets of piped systems where the pipe is 18 inches in diameter or larger.

H. **Pipe trench backfill** – Bedding and backfill shall conform to the City's Public Works standards.

I. **Alignment**

1. Storm drains shall be laid on a straight alignment. Horizontal curves that conform to the street curvature may be approved if joints with rubber gaskets are used for all curved storm drains. Minimum radii shall be 115 percent of the pipe manufacturer's recommendation.

2. Changes of alignment greater than 45 degrees at any main flow structure for the main flow are undesirable. Changes of alignment greater than 90 degrees for the main flow will not be allowed.

3. Side pipes will join in such a manner that all flows enter the manhole point downstream. Side pipes with discharges pointed in an upstream direction will not be allowed.

5.6.2 Pipe Material

The pipe materials listed in **Table 5-6** are approved for use in pipe systems, subject to the limitations listed in the table and **Section 5.6.1**.

Table 5-6. Approved Pipe and Culvert Materials [a]

- Reinforced Concrete Pipe, ASTM C-76, Class III minimum. Watertight joints required.
- Ductile Iron; Class 50 wall thickness for pipe sizes up to 12 inches; Class 51 wall thickness for 14 inch and larger; watertight gaskets required.
- Corrugated high-density polyethylene pipe (HDPE) - smooth interior, maximum 30-inch diameter conforming to American Association of State Highway and Transportation Officials (AASHTO) M-294, Type S) with watertight gaskets. Concrete headwalls are required for any exposed ends.
- PVC seamless pipe with watertight gaskets:
  - ASTM 3034 SDR 35 for pipes up to 15-inch-diameter
  - ASTM F679, for pipes 18 to 27 inches in diameter
  - ASTM C900 DR18 for pipes up to 12-inch-diameter
  - ASTM C905 DR 25 for pipes 14 to 30 inches in diameter
  - ASTM F-794 for pipes up to 30-inch-diameter
  - Concrete headwalls are required for any exposed ends
  - ADS N-12 or equivalent

[a] *These pipe materials are allowed for public storm drainage conveyance systems. The City Engineer may adopt or approve other pipe materials or specifications due to technology developments.*

5.6.3 Connections to Pipe Systems

For all piped public drainage systems, excluding roof and foundation line, connections may only be made at a structure, such as at a catch basin or manhole. Tees, wyes, saddles, or other types of connections to storm drainage pipes for other than roof and foundation line will not be permitted unless approved by the City Engineer.

Lateral connections within the ROW shall not exceed half the diameter of the mainline and cannot exceed 8 inches in diameter. For larger connections, a structure for maintenance access is required.

Private storm drains outside the public ROW shall not be less than 6 inches in diameter and must meet local plumbing authority codes.

Storm pipes serving only roof drain laterals with no expectation for upstream future connections may be 8 inches in diameter. Storm sewer service laterals serving an individual house or small commercial property shall be 6 inches in diameter or as approved by the City.

5.6.4 Location

Where storm drains are being designed for installation parallel to other utility pipe or conduit lines, the vertical location shall be in such a manner that will permit future connections. The design must also avoid conflicts with parallel utilities without abrupt changes in vertical grade.

5.6.5 Storm Drains in Streets or Easements

All public storm drains not located in streets shall be in easements. See City's Standard Drawings for "Typical Utility Placement Detail."

If streets have curved alignments, whenever possible, the storm drain alignment shall be parallel with water and sanitary lines with a minimum separation of 10 feet with sanitary and 6 feet with water. The intent is to prevent conflict with sanitary and water lines while providing the fewest manholes required to traverse on curve and prevent a conflict with survey monuments required by OCMC.

Storm drains in easements will be allowed only after all reasonable attempts to place the drains in the ROW have been exhausted. Provisions shall be made for vehicular access to manholes for preventive maintenance and emergency service. See **Section 5.9** for more discussion on easements.

5.6.6 Relation to Creeks and Drainage Channels

Storm drain lines shall enter a creek or drainage channel at 90 degrees or less to the direction of the flow. The outlet shall have a headwall and scour pad or riprap to prevent erosion of the existing bank or channel bottom. The size of the pipe and channel being entered will govern which protective measures are required.

5.7 Structures

The following are design criteria for conveyance system structures.

5.7.1 Manholes

A. Manholes or curb inlets with manhole-type access shall be installed at all pipe junctions where the depth from rim to invert exceeds 4 feet or where the pipe is 18 inches in diameter or greater.

B. Manholes shall conform to the City's applicable standard drawings.

C. Where minimum vertical distance is proposed between inlet and outlet pipes in a manhole (or inlet structure serving as a junction structure), pipes must be aligned vertically by one of the following criteria, in order of preference:

1. Match pipe crowns
2. Match 80 percent diameter of pipes
3. Perform backwater analysis

D. Manholes shall be required at, but not limited to, the following locations:

1. Changes in vertical grade or horizontal alignment of storm drain pipes
2. Change in size of storm drain pipes
3. Uppermost extent of storm pipe not opened (daylighted) to receive ditch or other open conveyance flows. Cleanouts are not allowed in this situation.

E. Manholes with pipe horizontal alignment changes of more than 30 degrees in angle shall have the outlet pipe invert at least 0.2 foot in elevation lower than all inflow pipe inverts. This is in addition to the normal grade crossing the manhole.

F. In addition, a minimum 3-foot elevation difference between the rim and the top of pipe at all manholes with more than 30 degrees of alignment change is required. This is to allow for containment of turbulence generated during high flows by such abrupt changes of alignment.

G. Standard depth manhole rim frames shall be installed in all paved street locations.

H. Outside drop manholes shall be used where the difference in the flow line elevations between intersecting storm sewers exceeds 24 inches, except in inlet runs and flow control structures. Inside drop manholes are prohibited unless the drop is 4 feet or less.

I. Manhole rims not in pavement areas, and not in the pavement section of a paved road, shall be set 6 inches above finished grade. Covers shall be bolted down with a minimum of two stainless steel bolts when required by the City Engineer.

5.7.2 Inlet Structures

A. Inlet structures are required at the following locations, but in no case shall they be spaced farther apart than 400 feet:

1. At the ends of all dead-end streets with a descending grade.

2. At intermediate locations so that the maximum gutter flow does not exceed the shoulder width plus 2 feet of the travel lane. This maximum flow is for a 5-minute, 10-year design storm, or 3 inches in depth (measured at the curb face), whichever is less.
3. At all sag points (low points) in vertical curves.
4. On the uphill side of handicap ramps within 20 feet.
5. Inlet structures shall not be located where they will interfere with a handicap ramp.

B. Inlet structures located in street sections where there is curb and gutter shall be a curb inlet per City standards, unless otherwise approved by the City Engineer.

C. Inlet structures that have an outlet pipe located lower than 4 feet below the street flow line shall have minimum inside dimensions of 3 feet 3 inches by 2 feet 3 inches.

D. With the City's written approval, inlet structures may be used in lieu of manholes for the junction of pipes 15 inches or less in diameter, where the depth from rim to invert is less than 4 feet. Pipelines 18 inches in diameter may be connected to the larger dimension of the structure (catch basin) when the structure is formed and poured around the pipe during new construction. The minimum size for a catch basin/inlet structure shall be per the City's requirements.

E. Catch basins with connector storm drains shall connect to a receiving conveyance pipe with a manhole, another catch basin, or curb inlet. Connectors shall only be a maximum of one additional.

F. Gutter tapers are required for all catch basins and gutter/curb inlets and shall conform to the City's Standard Drawings.

G. Ditch and/or area inlets shall be required to intercept existing flows and convey to the appropriate outlet.

5.8 Outfalls

Outfalls from drainage facilities shall be designed with adequate energy dissipaters to minimize downstream damage and erosion. All outfalls with exit velocities of more than 4 fps shall be examined with respect to soil type to ensure adequate erosion control. Unless otherwise approved, an outfall elevation shall be submerged by the receiving creek or channel during a 10-year storm event.

Storm drain lines shall enter a creek or drainage channel at 90 degrees or less to the direction of the flow. The outlet shall have a headwall and scour pad or riprap to prevent erosion of the existing bank or channel bottom. The size of the pipe and channel being entered will govern which protective measures are required.

Engineered energy dissipaters, including but not limited to, stilling basins, drop pools, hydraulic jump basins, baffled aprons, and bucket aprons, shall be designed using published references such as *Hydraulic Design of Energy Dissipaters for Culverts and Channels* published by the Federal Highway Administration of the U.S. Department of Transportation, the ODOT *Hydraulics Manual,* and others. The design reference shall be cited in the stormwater management plan submittal.

Rock protection at outfalls shall be designed in accordance with information listed in **Table 5-7**.

Table 5-7. Rock Protection at Outfalls

Discharge velocity at design flow, fps		Minimum required protection dimensions				
Greater than	Less than or equal to	Type	Thickness, feet	Width	Length (use greater of)	Height over crown, feet
0	5	ODOT Class 50 Riprap[a]	1.5	Diameter + 6 feet	8 feet –OR- 4 x diameter	1
5	10	ODOT Class 200 Riprap	2.5	Diameter + 6 feet	12 feet –OR- 4 x diameter	1
10		Engineered energy dissipater required				

[a] *The City may require ODOT Class 100 Riprap in areas with likelihood of vandalism.*

See the latest version of Oregon Department of Transportation Detail "Culvert Embankment Protection and Riprap Pads" (RD317) for more information.

If the outfall is located in an OCMC defined NROD or a FMOD, additional requirements may apply. A permit from the USACE and/or the ODSL may be required. The applicant is responsible for obtaining the proper permits from the regulating agencies.

5.9 Easements and Setbacks

Drainage easements for the stormwater conveyance system must meet the following criteria:

A. Minimum width of 15 feet, with the exception that private roof and yard drain systems may be located within 10-foot private storm easements.

B. All pipes must be located within the easement so that outside edge of pipe, or top edge of channel, is no closer than 5 feet from its adjacent easement boundary (roof and yard drain pipes shall be centered in the easement).

C. Open channels shall be located within the easement so that the water surface elevation at the top of freeboard is no closer than 5 feet from each easement boundary.

D. The City may require wider easements for large trunk sewers, sewers greater than 10-feet deep, and areas with topographic constraints such as steep slopes or sites where maintenance, repair, or replacement would require a wider easement. When wider easements are required, easement widths shall be increased in 5-foot increments.

All easements must be furnished to the City for review and approval prior to recording. The City has standard utility easement document forms and guidelines for preparation of descriptions and sketches that shall be used for City easements.

5.10 Slope Intercept Drains

Slope intercept drains are allowed at the following locations:

A. Along the upper boundaries of a development where the natural ground slope exceeds 10 percent to prevent drainage from the tributary area above the site.

B. Along the top of all cut slopes which exceed two-horizontal to one-vertical (2h:1v) where the tributary drainage area above the cut slope has a drainage path greater than 40 feet as measured horizontally from the hinge point of the cut.

5.11 Subsurface Drainage

Subsurface drains (underdrains) shall be provided at the following locations:

A. For stability on cut and fill slopes, when required by the City Engineer.

B. For all existing springs or springs intercepted during construction activity for other facilities.

C. Where high groundwater exists or when it is necessary to reduce the piezometric surface to an acceptable level to prevent land slippage or under floor flooding of buildings.

D. Where possible, a minimum slope of 0.15 foot per 100 feet should be used. The subsurface drain must be installed below the water flow to function properly. The use of a geotextile fabric to line the trench is recommended.

5.12 Foundation Drains

The following drainage provisions shall be made for foundation drains in a development:

A. For commercial or industrial developments, foundation drains shall be piped directly to a storm drain system other than a street gutter. Provisions must be taken so that the design HGL of the receiving stormwater facility does not back up into the foundation drain.

B. For single-family residential developments, foundation drains may be piped to the street through a plastic pipe, as required by applicable code, and set in the curb under the following circumstances:

1. The building's top of foundation elevation for the first floor is at least 2 feet above the top of the existing street curb, and

2. The existing street section will not permit runoff to flow horizontally more than 2 feet beyond the discharge point. This is to prevent wetting the road surface, especially during freezing events.

3. Otherwise, foundation drains shall be piped directly to a storm drain system other than a street gutter.

C. Should site topography prevent connecting foundation drains directly to a public storm drain system, the drains for one or more lots shall be piped through a private system to the public storm drain system. This private system shall be located in a dedicated private drainage easement and the property owner shall be responsible for the private system maintenance. Any private storm drain piping shall conform to the Oregon Plumbing Code.

5.13 Design Criteria for Private Stormwater Pumps

Private stormwater pumps will be permitted only after approval by the City Engineer. Any stormwater pumps so permitted must, at a minimum, meet the following criteria:

A. The proposed pump system is not intended to circumvent other drainage requirements.

B. The proposed pump system is the only feasible alternative to flooding.

C. The pump system must provide storage for a minimum of 25 percent of the runoff volume from a 2-year, 24-hour storm event. An emergency backup power source may be required, at the discretion of the City Engineer.

D. The pump system must include dual pumps with an external audible and visual alarm system.

E. The pump system must be capable of discharging a 100-year storm event.

F. Applicants may be required to provide reasonable assurance of no downstream impacts from the implementation of a stormwater pump system.

G. Private conveyance systems for the pump system must transition to gravity flow, prior to entering the public ROW and must have a gravity connection to the public stormwater system.

H. All pump systems must be privately operated and maintained. Prior to final approval of the project served by such a pump system, an agreement establishing responsibility for payment of costs resulting from the operation and maintenance of the pump system must be approved by the City and must be legally recorded.

I. An operations and maintenance plan and maintenance covenant, consistent with **Chapter 8** shall be developed for all private stormwater pumps.

CHAPTER 6

Source Controls

CHAPTER 6. SOURCE CONTROLS

This chapter presents the stormwater best management practice (BMP) source control requirements for site uses and characteristics that have the potential to generate higher levels of pollutants than typical stormwater runoff.

Some site characteristics/uses may generate specific pollutants of concern or levels of pollution that are not addressed solely through implementation of the pollution reduction measures identified in **Chapter 4**. The site characteristics/uses in this chapter have been identified as potential sources of chronic loadings or acute releases of pollutants such as oil and grease, toxic hydrocarbons, heavy metals, toxic compounds, solvents, abnormal pH levels, nutrients, organics, bacteria, chemicals, and suspended solids. This chapter presents controls for managing these pollutants at their source.

6.1 Introduction and Applicability

Source control requirements apply to all developments with high-risk characteristics as defined in **Section 6.1.1** including new development, redevelopment, tenant improvements, or those existing sites proposing new offsite discharges.

Source controls shall be applied to the areas of the site with high-risk characteristics as well as any areas hydraulically connected to a high-risk area. With redevelopment projects, only areas that are being disturbed with the redevelopment are required to make structural source control changes.

6.1.1 Source Control Triggers

Projects with the following site uses/characteristics are considered to be high-risk and are subject to source control requirements. Refer to the applicable section of this chapter and follow the requirements to design source controls for the proposed site use.

- Fuel Dispensing Facilities and Surrounding Traffic Areas (**Section 6.3**)
- Above-Ground Storage of Liquid Materials (**Section 6.4**)
- Solid Waste Storage Areas, Containers, and Trash Compactors (**Section 6.5**)
- Exterior Storage of Bulk Materials (**Section 6.6**)
- Material Transfer Areas/Loading Docks (**Section 6.7**)
- Equipment and/or Vehicle Washing Facilities (**Section 6.8**)
- Stormwater and Groundwater Management for Development on Land With Suspected or Known Contamination (**Section 6.9**)
- Covered Vehicle Parking Areas for Industrial or Commercial Uses (**Section 6.10**)
- Industrial and Commercial High Traffic Areas (**Section 6.11**)
- Land Uses Subject to Oregon Department of Environmental Quality (ODEQ) 1200-Z Industrial Stormwater Permit Requirements (**Section 6.12**)

Applicants are required to address all high-risk site characteristics listed above. For example, if a development includes both a fuel dispensing area and a vehicle washing facility, the source controls in both **Sections 6.3 and 6.8** will apply.

The requirements of this chapter are in addition to the applicable requirements as identified in other chapters of these standards. Developments that have existing or proposed offsite stormwater BMP facilities are not exempt from the source control requirements of this section.

6.1.2 Goals and Objectives for Source Control

The specific source control requirements are based on the following goals and objectives:

A. Prevent stormwater pollution by eliminating pathways that may introduce pollutants into stormwater.

B. Protect soil, groundwater, and surface water by capturing pollutants and reducing impacts to the environment.

C. Issue permits for the wastewater discharges and areas with the potential for relatively consistent wastewater discharges (such as vehicle washing facilities) to the sanitary sewer system, excluding non-contaminated stormwater runoff.

D. Direct areas that have the potential for pollutant releases or accidental spills and are not expected to regularly receive flow or require water use (such as covered fuel islands or covered containment areas) to an approved method of containment or disposal.

E. Safely contain spills onsite, avoiding preventable discharges to any storm sewers, sanitary, and/or drainageways.

F. Emphasize structural BMP controls over operational procedures. Structural BMP controls are not operator-dependent and are considered to provide more permanent and reliable source control. Any proposals for operation-based source controls need to describe the long-term viability of the maintenance program.

6.1.3 Request for Alternative Method of Source Control

Applicants may request an alternative method of source control as part of the regular modification request process outlined in **Chapter 1**, though such a request may delay issuance of related site development, building and/or plumbing permits. Alternative methods of source control must be reviewed and approved by the City during the planning process.

6.1.4 Other Applicable Codes or Regulations

Some facilities may be required to obtain a National Pollutant Discharge Elimination System (NPDES) Industrial Stormwater General Permit 1200-Z issued by ODEQ before discharging to the City's storm sewer system or to waters of the state. The 1200-Z permit includes discharge benchmarks for facilities with industrial activities that are exposed to rainfall and stormwater runoff. The state also has water quality standards listed in Oregon Administrative Rules 340 Division 041 for discharges to surface waters.

Applicants may be required to obtain an Industrial Wastewater Discharge Permit from the wastewater service provider for discharges to the sanitary sewer system. Facilities subject to these requirements are generally commercial or industrial. Typical discharges include process wastewater, cooling water, or other discharges generated by some of the sources in this section that drain to a storm or sanitary sewer system.

Conformance with the requirements of this section does not relieve the applicant of other applicable local, state, or federal codes or regulations. Other applicable regulations may include the hazardous substances storage requirements of articles 79 and 80 of the Oregon State Fire Code; the Spill Prevention, Countermeasure, and Containment (SPCC) regulations of the U.S. Environmental Protection Agency's (USEPA) 40 Code of Federal Regulations (CFR) 112; the Resource Conservation and Recovery Act (RCRA); Willamette Basin total maximum daily load programs regulated by the ODEQ; or any other applicable local, state, or federal regulations or permit requirements.

In the event of a conflict, the most stringent local, state, or federal regulations generally apply.

6.2 Requirements for All Sites

The following requirements apply to all sites subject to source control.

6.2.1 Signage Requirements

Informational signage is required for some site uses and activities that have the potential to contaminate stormwater. Proper signage addresses good housekeeping rules and provides emergency response measures in case of an accidental spill.

All signage shall conform to the following requirements:

A. Signs shall be located and plainly visible from all activity areas.

B. More than one sign may be needed to accommodate larger activity areas.

C. Signs shall be water and weather resistant.

D. Signs shall include the following information:
   - Safety precautions
   - Immediate spill response procedures
     (for example: "Turn the valve located at..." or "Use absorbent materials")
   - Emergency contact(s) and telephone number(s)

E. Signs may need to be in more than one language if required to communicate effectively with employees and delivery personnel.

F. Signs may need to meet retro-reflectivity standards dependent on the use and intent of the sign.

G. All signage shall comply with pertinent OCMC requirements.

Additional signage requirements for specific activities are noted in applicable sections.

6.2.2 Spill Control

Spill response supplies, such as absorbent material, containment booms, and protective clothing, shall be available at all potential spill areas. Any applicable spill response supplies need to be clearly marked and located where the signage is posted and near the high-risk activity area. The spill response supplies should be appropriate to the nature of the potential risk present at the site. More than one spill response kit may be necessary to accommodate larger activity areas.

Employees should be familiar with the site's operations and maintenance (O&M) plan; SPCC plan; and/or proper spill cleanup procedures.

6.2.3 Public Sanitary Sewer Discharge Permit

Connection/discharge to the public sanitary sewer system requires prior written approval by the City. A request to discharge to the public sanitary system shall be submitted as part of the permitting process.

6.2.4 Source Control Submittal

Applicants shall show the locations of proposed structural source controls (including spill control manholes and shutoff valves) and include documentation of high-risk site uses and the applicable source controls as part of the Stormwater Management Plan Submittal (**Chapter 9**).

6.3 Fuel Dispensing Facilities and Surrounding Traffic Areas

The requirements in this section apply to all development where vehicles, equipment, or fuel tanks are refueled on the premises, whether a large-sized gas station, a single-pump maintenance yard, or a small-sized fuel tank. A fuel dispensing facility is defined as the area where fuel is transferred from bulk storage tanks to vehicles, equipment, and/or mobile containers (including fuel islands, above- or below-ground fuel tanks, fuel pumps, and the surrounding pad). Propane tanks are exempt from the requirements of this section.

Existing fueling areas are not required to install source controls identified in this section if the scope of work is limited to the following:

- A new canopy installation over an existing fuel pad that is not being upgraded.
- An underground tank replacement for compliance with state regulations.
- The replacement of a fuel pump on an existing fuel pad that is not being upgraded.

6.3.1 Discharge Permit

The applicant shall apply and obtain a permit from the City for any discharge or point of connection to the public stormwater system. Discharges of hydrocarbons are prohibited to the public sanitary and storm sewer systems. When a containment or storage device is utilized, the owner or responsible person shall contact the appropriate authority for authorization prior to opening any valve and discharging to a public sanitary or stormwater sewer system.

6.3.2 Cover

The fuel dispensing area shall be covered with a permanent canopy, roof, or awning so precipitation cannot come in contact with the fueling activity area. Rainfall shall be directed from the cover to a stormwater disposal point that meets all applicable code requirements.

- **Covers 10 feet high or less** shall have a minimum overhang of 3 feet on each side. The overhang shall be measured relative to the perimeter of the hydraulically-isolated fueling activity area it is to cover.
- **Covers higher than 10 feet** shall have a minimum overhang of 5 feet on each side. The overhang shall be measured relative to the perimeter of the hydraulically-isolated fueling activity area it is to cover.

The requirement to cover the fuel dispensing area can be appealed if the fuel dispensing area is generally used to service oversized equipment (e.g., cranes) that cannot maneuver under a roof or canopy. A request for such an exception shall be submitted as part of the land use permit application.

6.3.3 Pavement

A paved fueling pad of asphalt or concrete shall be placed under and around the fueling activity area and shall meet all applicable building code requirements. Sizing of the paved area shall be adequate to cover the activity area, including placement and number of the vehicles or pieces of equipment to be fueled by each pump. Fuel pumps shall be located a minimum of 7 feet from the edge of the fueling pad.

6.3.4 Drainage

The paved area beneath the cover shall be hydraulically isolated from the surrounding area through grading, berms, or drains. This will prevent uncontaminated stormwater from running onto the area and carrying pollutants into the stormwater system. Drainage from the hydraulically-isolated area shall be directed to an approved sanitary sewer service provider or an authorized pretreatment facility. Surrounding runoff shall be directed away from the hydraulically-isolated fueling pad to a stormwater disposal point that meets all stormwater management requirements of this manual and other applicable code requirements.

6.3.5 Signage

Signage shall be provided at the fuel dispensing area and shall be plainly visible from all fueling activity areas. Detailed signage information is located in **Section 6.2.1**.

6.3.6 Pretreatment - Oil/ water separator

An oil/water separator with coalescing plate shall be installed upstream of the spill control manhole. The purpose of the device is to treat runoff that occurs from washing down and cleaning of the fueling area and to prevent small spills from entering the public sanitary sewer system.

Coalescing plate separators shall be designed to achieve 100-parts per million (ppm) non-polar oil and grease in the effluent from the peak flow generated by the washing

activity. Testing information must be submitted by the manufacturer of the unit that supports the 100-ppm effluent standard at the calculated flow rate.

Separator details must be shown on the building plans submitted at the time of building permit application and shall match manufacturer specifications and details, including the unit flow rate, effluent water quality, and maximum process flow rate.

All separators shall be maintained per the manufacturer's specifications and City-approved maintenance plan.

6.3.7 Spill Control Manholes

A spill control manhole shall be installed on the discharge line of the fueling pad before the public sanitary sewer line tie-in. The tee section shall extend 18 inches below the outlet elevation, and 60 cubic feet of dead storage volume shall be provided below the outlet elevation for storage of oil, grease, and solids. The manhole shall be located on private property.

A shutoff valve is required prior to the connection to the public sanitary sewer system.

6.3.8 Shutoff Valves

Shutoff valves are required to protect sewer systems from spill risks that present a danger for widespread contamination, system damages, or risk to the public health. Shutoff valves shall be located on private property and downstream of the exposed area's collection system. All valves shall be installed and maintained as per manufacturer's recommendations. For more information about shutoff valves and associated valve boxes, contact the local plumbing authority.

Shutoff valves are required for any of the following situations:

A. Site or activity areas are exposed to corrosives or oxidizers that can harm conveyance system components (such as, but not limited to, battery acid).

B. Substances that do not settle or remain in one location and are capable of being dissolved in or float on water (such as, but not limited to, oil and grease). These substances can spread rapidly into downstream conveyance and disposal systems, causing widespread impacts and difficult clean-up situations.

C. Substances that are known to infiltrate through soils and contaminate groundwater.

D. Traffic pathways that surround fueling pads are considered high-use/high-risk areas and will require a valve on the storm drainage system. Valves installed on storm drainage systems shall be installed downstream of all applicable private stormwater quality facilities to accommodate spill containment. These valves shall be left open to facilitate stormwater flows during normal conditions, and immediately closed in the event of a spill.

E. **Fueling pads require a valve downstream of the spill control manhole**. Valves installed on sanitary sewer systems shall be installed before the public sanitary sewer system tie-in. **These valves shall be kept closed**, and opened only to allow incidental drainage activities that do not pose a threat or risk to the disposal point system. The valve shall be closed **immediately** after drainage activities are completed.

6.3.9 Additional Requirements for Fuel Dispensing Facilities

Installation, alterations, or removal of above-ground fuel tanks larger than 55 gallons, and any related equipment, are subject to additional building permit requirements. For technical questions and permitting, contact the local building code authority and the City's Development Review Engineer.

6.3.10 Bulk Fuel Terminals

Bulk fuel terminals, also known as tank farms, require the following:

A. **Secondary containment** equal to 110 percent of the product's largest container or 10 percent of the total volume of product stored, whichever is larger.

B. A **separate containment area** for all valves, pumps, and coupling areas, with sub-bermed areas either in front of or inside the main containment areas. These sub-bermed areas shall have rain shields and be directed to a public sanitary sewer system with a valve to control disposal. If no public sanitary sewer is available, drainage shall be directed to a temporary holding facility for proper disposal and may require a Water Pollution Control Facility (WPCF) permit from the Water Quality Division of ODEQ.

C. An **impervious floor** within all containment areas. Floors shall be sealed to prevent spills from contaminating the groundwater.

D. **Truck loading and off-loading areas**. These areas shall follow cover, pavement, drainage, spill control, and shutoff valve requirements identified for fuel dispensing facilities.

E. **Shutoff valves** installed for the drainage of the tank yard. The valves shall be installed downstream of the drainage system of the primary containment area and kept closed. Valves installed for the drainage of the truck pad and sub-bermed containment areas shall be installed on the sanitary waste line downstream of the spill control manhole.

F. Approval from the appropriate authority is required before draining a containment area. The facility's O&M plan should clearly define which agencies should be contacted for approval in the event of a containment issue arising. This approval will determine appropriate disposal methods, identify pretreatment requirements (if applicable), and approval of the discharge. Pretreatment may be required for oil and grease removal, and testing may be required to establish the specific characteristics of the discharge.

G. Underground fuel tanks less than 4,000 gallons in size are subject to additional permitting requirements by ODEQ. Tanks larger than 4,000 gallons are referred to the USEPA. For technical questions and permitting, call ODEQ's Northwest Region Portland office and ask for the underground storage tank permitting department.

6.4 Above-Ground Storage of Liquid Materials

The requirements in this section apply to all development where there is any exterior storage of liquid chemicals, food products, waste oils, solvents, process wastewaters, or petroleum products in above-ground containers, in quantities of 50 gallons or more. This includes both perma-

nent storage and temporary storage areas. Underground storage tanks or installations requiring a WPCF permit are exempt from these **Section 6.4** requirements but must go through ODEQ's WPCF permit process. Sites with underground storage tanks may still be subject to the material transfer area requirements in **Section 6.7**.

6.4.1 Containment

Liquid materials shall be stored and contained in such a manner that if the container is ruptured, the contents will not discharge, flow, or be washed into a receiving system. A containment device and/or structure for accidental spills shall have enough capacity to capture a minimum of 110 percent of the product's largest container, or 10 percent of the total volume of product stored, whichever is larger.

Double-walled containers are generally exempt from these spill containment requirements.

Quantity thresholds of products that are generally exempt from these spill containment measures are as follows:

- Janitorial and cleaning supplies of less than 100 pounds net weight or 15 gallons net volume. These supplies shall be packaged for consumer use in containers of five gallons or less or have a net weight of less than 30 pounds per container. This does not include cleaners or solvents used for cleaning machinery or motor vehicle and machine parts.
- Office and stationery supplies less than 100 pounds net weight. These supplies shall be packaged for consumer use in containers less than 5 gallons in size or 30 pounds in weight.

6.4.2 Cover

Storage containers (other than tanks) shall be completely covered so rainfall cannot come in contact with them. Runoff shall be directed from the cover to a stormwater disposal point that meets all applicable code requirements.

- **Covers 10 feet high or less** shall have a minimum overhang of 3 feet on each side. The overhang shall be measured relative to the perimeter of the hydraulically-isolated activity area.
- **Covers higher than 10 feet** shall have a minimum overhang of 5 feet on each side. The overhang shall be measured relative to the perimeter of the hydraulically-isolated activity area.

6.4.3 Pavement

A paved storage area is required unless otherwise approved by the City. The storage area shall be paved with asphalt or concrete and shall meet all applicable building code requirements. Sizing of the paved areas shall be adequate to cover the area intended for storage.

6.4.4 Drainage

All paved storage areas shall be hydraulically isolated through grading, berms, or drains to prevent stormwater runoff from flowing into a storage area.

Water will accumulate in uncovered storage areas during and after rain. **Any contaminated water cannot simply be drained from the area.** It must be collected, inspected, and possibly tested at the expense of the property owner before proper disposal can be determined and authorized. Frequent draining may be required during the wet season, which may prove costly. Some type of monitoring may also be needed to determine the characteristics and level of contamination of the stormwater.

All discharges to the sanitary sewer shall be, at a minimum, considered batch discharges and shall require written approval from the appropriate authority and pretreatment prior to discharge. In some cases, an industrial discharge permit may be required. Pretreatment requirements shall be set as part of the discharge approval process, based on the types and quantities of material to be discharged. A discharge evaluation shall be performed before connection to a sanitary sewer or storm sewer. Testing may be required to establish characteristics of the wastewater or contaminated stormwater and to verify that local discharge limits are not exceeded. The facility's O&M plan should clearly define which agencies should be contacted for approval of discharging into any sanitary system.

Significant amounts of precipitation are not expected to accumulate in covered storage areas, and drainage facilities ***are not required*** for the contained area beneath the cover. If the applicant elects to install drainage facilities, the drainage from the hydraulically-isolated area shall be directed to an approved sanitary sewer or authorized pretreatment facility.

6.4.5 Shutoff Valves

A shutoff valve shall be installed in the storage area so excess stormwater can be drained out of the activity area and directed either to the storm drainage facilities (if clean) or into the public sanitary sewer or authorized pretreatment facility (if contaminated). Except when excess stormwater is being discharged, **the valve shall be kept closed at all times** so any spills within the activity area can be contained effectively.

A shutoff valve may be required for a covered storage area if the applicant elects to install drainage facilities to an approved public sanitary sewer connection. The appropriate authority will make this determination based on the type of material stored and the proposed system receiving the discharge.

6.4.6 Signage

Signage shall be provided at the liquid storage area and shall be plainly visible from all surrounding activity areas. Detailed information is located in **Section 6.2.1**.

6.4.7 Additional Requirements

Storage of reactive, ignitable, or flammable liquids shall comply with local, state, and federal fire codes, as applicable. Source controls presented in this section are intended to complement, not conflict with, current fire code requirements.

6.5 Solid Waste Storage Areas, Containers, and Trash Compactors

The requirements in this section apply to all commercial and industrial development with facilities that store solid wastes (both food and non-food). A solid waste storage area is a place where solid waste containers are collectively stored. Solid waste containers include compactors, barrels, dumpsters, and garbage cans. Requirements of this section also apply to activity areas used to collect and store refuse or recyclable materials, such as can or bottle return stations, grease containers, and debris collection areas.

This section applies to multi-family residential sites of three or more units if a shared trash collection area is proposed. However, the requirements of this section do not apply to single-family homes or debris collection areas used for the temporary storage of wood pallets or cardboard.

Refer to OCMC 8.2 for additional requirements related to dumpsters and solid waste storage areas.

6.5.1 Cover

A permanent canopy, roof, or awning may be required to cover the solid waste storage activity area. When a permanent cover is required, it shall be constructed to cover the activity area so rainfall cannot come in contact with the waste materials being stored. The cover shall be sized relative to the perimeter of the hydraulically-isolated activity area it is to cover. Runoff shall be directed from the cover to a stormwater disposal point that meets all applicable code requirements.

All containers shall contain lids whether or not the enclosure contains a permanent canopy, roof, or awning,

Storage areas shall be required to contain a permanent canopy, roof, or awning when the land use is for operations as shown in Table 6-1 and labeled as High Risk or as determined by the City Engineer.

Compactors are exempt from the cover requirement.

6.5.2 Pavement

A paved waste storage area is required when a structural cover or trash compactor is used. The area shall be paved with asphalt or concrete and meet all applicable building code requirements. Sizing of the paved area shall adequately cover the activity area intended for refuse storage, or the trash compactors and associated equipment.

6.5.3 Isolation

Hydraulic isolation shall be provided for the solid waste storage activity area and shall be designed to prevent uncontaminated stormwater runoff from entering the area and carrying pollutants away. Runoff occurring outside the hydraulically-isolated area shall be directed to a stormwater disposal point that meets all applicable code requirements. This can be achieved by reverse grading at the perimeter of an activity area, perimeter curbing or berming, or the use of area drains to collect and divert runoff.

6.5.4 Signage

Signage shall be provided at the solid waste storage area and shall be plainly visible from all surrounding activity areas. Detailed information is located in **Section 6.2.1**.

6.5.5 Drainage

Drainage shall be provided for the hydraulically-isolated solid waste storage area and directed to an approved public *sanitary sewer* or authorized pretreatment facility (storm sewer). A sanitary sewer drain is required for those areas that may be subject to refuse or suspected pollutants that pose a risk if the structural integrity of the trash receptacle is damaged or if its contents are exposed to rainfall.

All storage areas that are required to have a permanent canopy, roof, or awning shall drain to a sanitary sewer.

Non-gravity option. Multi-family solid waste storage areas that do not have gravity sanitary sewer service may be allowed to direct the drainage from the hydraulically-isolated area to the development's stormwater management facility.

Commercial and industrial solid waste storage areas that do not have gravity sanitary sewer service may be allowed to install a pressurized system. With these types of installations, the following items shall be provided at the time of building permit application:

- Verification or evidence that gravity service cannot be obtained.
- Details of an electronic sump pump system equipped with a float switch.
- City approval.

Pressurized system installations are considered to be permanent equipment and deemed the property owner's liability in the event of system failure or if the property becomes vacated.

The local building codes authority will review all sump pump or sewage ejector installations for compliance with local and state plumbing codes. The City Engineer will review for compliance with City standards.

6.6 Exterior Storage of Bulk Materials

The requirements of this section apply to developments that stockpile or store materials in outdoor containers that may erode or have negative stormwater impacts. The materials are separated into three categories based on risk assessments for each material stored: high-risk, low-risk, and exempt. These include but are not limited to the materials listed in **Table 6-1**.

Table 6-1. Material Risk Categories

High-Risk	Low-Risk	Exempt
• Recycling materials with potential effluent • Corrosive materials (e.g., lead-acid batteries) • Storage and processing of food items • Chalk/gypsum products • Feedstock/grain • Material by-products with potential effluent • Fertilizer • Pesticides • Lime/lye/soda ash • Animal/human wastes	• Recycling materials without potential effluent • Scrap or salvage goods • Metal • Sawdust/bark chips • Sand/dirt/soil (including contaminated soil piles) • Material by-products without potential effluent • Unwashed gravel/rock • Compost • Asphalt	• Washed gravel/rock • Finished lumber • Rubber and plastic products (hoses, gaskets, pipe, etc.) • Clean concrete products (blocks, pipe, etc.) • Glass products (new, non-recycled) • Inert products

Materials with any of the following characteristics are exempt from the requirements of this section:

- Have no measurable solubility or mobility in water and no hazardous, toxic, or flammable properties.
- Exist in a gaseous form at ambient temperature.
- Are contained in a manner that prevents contact with stormwater (excluding pesticides and fertilizers).

6.6.1 Cover

A. Low-risk materials shall be covered with a temporary plastic film or sheeting at a minimum.

B. High-risk materials shall be covered permanently with a canopy or roof to prevent stormwater contact and minimize the quantity of rainfall entering the storage area. Runoff shall be directed from the cover to an approved disposal point that meets all applicable code requirements as stated in section 6.5.5.

C. Covers 10 feet high or less shall have a minimum overhang of 3 feet on each side. The overhang shall be measured relative to the perimeter of the hydraulically-isolated activity area.

D. Covers higher than 10 feet shall have a minimum overhang of 5 feet on each side. The overhang shall be measured relative to the perimeter of the hydraulically-isolated activity area.

6.6.2 Pavement

A. Low-risk material storage areas are not required to be paved.

B. High-risk material storage areas shall be paved beneath the structural cover. Sizing of the paved area shall adequately cover the activity area intended for storage.

6.6.3 Drainage

A. Low-risk material storage areas are typically allowed in areas served by standard stormwater management systems. However, all erodible materials being stored must be protected from rainfall.

B. If materials are erodible, a structural containment barrier shall be placed on at least three sides of every stockpile. The barrier shall be tall enough to prevent run-on of uncontaminated stormwater into the storage area and migration of the stored materials as a result of being blown or washed away. If the area under the stockpile is paved, the barrier can be constructed of asphalt berms, concrete curbing, or retaining walls. If the area under the stockpile is unpaved, sunken retaining walls or ecology blocks can be used. The applicant shall clearly identify the method of containment on the building plans.

C. For high-risk material storage areas, the paved area beneath the structural cover shall be hydraulically isolated through grading, structural containment berms or walls, or perimeter drains to prevent uncontaminated stormwater from running onto the area and carrying pollutants away. If significant amounts of precipitation are not expected to accumulate in covered storage areas, drainage facilities are not required for the contained area beneath the cover. If the applicant elects to install drainage facilities, the drainage from the hydraulically-isolated area shall be directed to an approved public sanitary sewer or authorized pretreatment facility. In such a case, an evaluation will be done to determine if an NPDES discharge permit is required.

6.6.4 Signage

Signage shall be provided at the storage area if hazardous materials or other materials of concern are stored. Signage shall be located so it is plainly visible from all storage activity areas. More than one sign may be needed to accommodate large storage areas. Detailed information and examples are provided in **Section 6.2.1**.

6.6.5 Shutoff Valves

A shutoff valve may be required for the structurally covered storage area if the applicant elects to install drainage facilities to an approved public sanitary sewer. The City will make this determination based on the type of material stored and the proposed system receiving the discharge.

6.6.6 Monitoring and Sampling

A sampling manhole or other suitable stormwater monitoring access point may be required to monitor stormwater runoff from the storage area. This may apply to certain types of storage activities and materials or if an alternative source control is proposed. The City will review the applicability of this requirement.

6.6.7 Additional Requirements

Storage of pesticides and fertilizers may need to comply with specific regulations outlined by ODEQ. For answers to technical questions, call ODEQ's Northwest Region Portland office.

6.7 Material Transfer Areas/Loading Docks

The requirements in this section apply to all developments that propose the installation of new material transfer areas, or structural alterations to existing material transfer areas (e.g., access ramp regrading, leveler installations).

The requirements apply to all material transfer areas, including loading/unloading docks, bay doors, and any other building access points with the following characteristics:

- The area is designed (size, width, etc.) to accommodate a truck or trailer being backed up to or into it, and
- The area is expected to be used specifically to receive or distribute materials to and from trucks or trailers.

The requirements may not apply to areas that are used only for small- to mid-sized passenger vehicles and that are restricted (by lease agreements or other regulatory requirements) to storing, transporting, or using materials that are classified as domestic use. Examples of domestic uses include primary educational facilities (elementary, middle, or high schools), buildings used for temporary storage (a lease agreement will need to be provided), and churches. Contact the City for help in determining whether requirements apply.

6.7.1 Pavement

A paved material transfer area of asphalt or concrete shall be placed underneath and around the loading and unloading activity area and shall meet all applicable building code requirements. This will reduce the potential for soil contamination with potential impacts on groundwater and will help control any acute or chronic release of materials present in these areas.

6.7.2 Isolation

For loading docks, the first 3 feet of the paved area, measured from the building or dock face, shall be hydraulically isolated through grading, berms, or drains to prevent uncontaminated stormwater from running onto the area and carrying pollutants away.

Bay doors and other interior transfer areas shall be designed so that stormwater runoff does not enter the building. This can be accomplished by grading or drains.

6.7.3 Drainage

Drainage from the hydraulically-isolated loading dock areas shall be directed to an approved public sanitary sewer or authorized pretreatment facility. Surrounding runoff and drainage from the access ramp shall be directed away from the hydraulically-isolated area to the appropriate stormwater management facility.

Non-Gravity Option. Activity areas that cannot achieve gravity sanitary sewer service may be allowed to install a pressurized system. With these types of installations, the following items shall be provided at the time of building permit application:

- Verification or evidence that gravity service cannot be obtained.
- Details of an electronic sump pump system equipped with a float switch.
- City approval.

Pressurized system installations are considered to be permanent equipment and deemed the property owner's liability in the event of system failure or if the property becomes vacated.

The local building codes authority will review all sump pump or sewage ejector installations for compliance with local and state plumbing codes. The City Engineer will review for compliance with City standards.

Bay Doors and Other Interior Transfer Areas. Because interior material transfer areas are not expected to accumulate precipitation, installation of floor drains is not required or recommended. It is preferable to handle these areas with a dry mop or absorbent material. If interior floor drains are installed, they shall be plumbed to an approved public sanitary sewer or authorized pretreatment facility.

6.7.4 Signage

Signage shall be provided at the material transfer area and shall be plainly visible from all surrounding activity areas. Detailed information is located in **Section 6.2.1**.

6.7.5 Shutoff Valves

Shutoff valves are required to protect the public sanitary sewer and drainageway systems from spills of chemicals and other constituents that may provide a danger of widespread contamination, system damage, or risk to public health.

Shutoff valves are required for any of the following situations:

- Site activity areas that are exposed to corrosives or oxidizers that can harm conveyance system components (such as battery acid).
- Transfer of substances (such as oil and grease) that do not settle or remain in one location and are capable of being dissolved in or float on top of water. These substances can spread rapidly into downstream systems, causing widespread impacts and difficult clean-up situations.
- Transfer of substances that are known to infiltrate through soils and contaminate groundwater.

Valves located in material transfer areas are typically left open to facilitate drainage during normal conditions, and immediately closed in the event of a spill.

Prior to transfer activities of harmful substances, the valves shall be closed and reopened only after the transfer is complete. The shutoff valves must be located on private property and downstream of the exposed area's collection system.

All valves shall be installed and maintained in accordance with manufacturer's specifications. For more information about shutoff valves and associated valve boxes, contact the local building codes authority.

6.7.6 Additional Requirements

Bay doors and other interior transfer areas shall provide a 10-foot no obstruction zone beyond the entrance within the building. This will allow the transfer of materials to occur with the truck or trailer end placed at least 5 feet inside the building, with an additional staging area of 5 feet beyond that. The no obstruction zone shall be clearly identified on the stormwater management plan at the time of the building permit application and shall be painted at the facility with bright or fluorescent floor paint.

6.8 Equipment and/or Vehicle Washing Facilities

The requirements in this section apply to all development with a designated equipment and/or vehicle washing or steam cleaning area. This includes smaller activity areas, such as wheel-washing stations. **Single Family Residential sites are exempt.**

6.8.1 Cover

The washing area shall be covered with a permanent canopy or roof so precipitation cannot come in contact with the washing activity area. Precipitation shall be directed from the cover to a stormwater disposal point that meets all applicable code requirements.

- **Covers 10 feet high or less** shall have a minimum overhang of 3 feet on each side. The overhang shall be measured relative to the perimeter of the hydraulically-isolated washing activity area it is to cover.
- **Covers higher than 10 feet** shall have a minimum overhang of 5 feet on each side. The overhang shall be measured relative to the perimeter of the hydraulically-isolated washing activity area it is to cover.

6.8.2 Pavement

A paved wash pad of asphalt or concrete shall be placed under and around the washing activity area and shall meet all applicable building code requirements. The paved area shall be sized to cover the activity area adequately, including the placement of the vehicle or piece of equipment to be cleaned.

6.8.3 Signage

Signage shall be provided at the washing area and shall be plainly visible from all surrounding activity areas. Detailed information is located in **Section 6.2.1**.

6.8.4 Drainage

The paved area beneath the cover shall be hydraulically isolated through grading, berms, or drains to prevent uncontaminated stormwater from running onto the area and carrying pollutants away. Drainage from the hydraulically-isolated area shall be directed to an approved public sanitary sewer or authorized pretreatment facility. If connected to the public sanitary sewer, and, depending on the washing compounds used

(i.e., brighteners), an industrial discharge permit to the public sanitary sewer system may be required. For further questions, contact the City.

Surrounding runoff shall be directed away from the hydraulically-isolated washing pad to a stormwater disposal point that meets all applicable requirements of this manual.

6.8.5 Oil Controls

All vehicle and equipment washing activities will be equipped with an approved oil/water separator system unless otherwise authorized by the City. The system shall comply with the public sanitary sewer discharge limits. The following design criteria are established for oil/water separators discharging to a public sanitary sewer system. For discharge requirements and limitations to the public sanitary sewer system, contact the City.

Onsite wash recycling systems may be used for oil control as long as they can meet effluent discharge limits for the public sanitary sewer system. A detail of the wash recycling system and vendor specifications identifying effluent efficiencies shall be submitted as part of the building plans at the time of stormwater management plan/building permit application.

Washing areas protected with a cover or located inside a structure shall have an oil/water separator that meets the following requirements:

A. Baffled oil/water separators and spill control separators shall not be allowed for use with equipment and/or vehicle washing applications. Activities and processes of a washing facility change over time, and the introduction of heat and surfactants may occur.

B. Coalescing plate separators shall be designed to achieve 100-ppm non-polar oil and grease in the effluent from the peak flow generated by the washing activity. Testing information must be submitted by the manufacturer of the unit that supports the 100-ppm effluent standard at the calculated flow rate.

C. Any pumping devices shall be installed downstream of the separator to prevent oil emulsification.

D. Separator details must be shown on the building plans submitted at the time of building permit application and shall match manufacturer specifications and details, including the unit flow rate, effluent water quality, and maximum process flow rate.

E. All separators shall be maintained per the manufacturer's specifications and City-approved maintenance plan.

6.9 Land with Suspected or Known Contamination

The requirements in this section apply to all development projects that disturb property at risk, suspected, or known to contain pollutants in the soil or groundwater. This includes development that is surrounded by properties found to have trace pollutants. These requirements will be applied to any property that is seeking to make a new connection to a public storm system from a property that is at risk, suspected, or known to contain pollutants in the soil or groundwater. To avoid confusion with references to water quality pollutants throughout this manual, this section refers to pollutants as **contaminants and/or contamination**.

Because of local, state, and federal regulations, special handling and management of site soils, groundwater, and surface drainage may be necessary. As a result of these regulations, sites with suspected or known contamination require a more detailed review process and may delay issuance of related stormwater management plans and building permit approvals. Applicants are advised to contact the City early on in the design process (before plan submittal) if they are aware or suspect the site has contaminants or is adjacent to a contaminated site.

6.9.1 Identifying Contaminated Sites

To research contaminant information, refer to ODEQ's Environmental Cleanup Site Information online database: http://www.deq.state.or.us/lq/ecsi/ecsi.htm.

If records indicate there is a potential of contamination on the site, the applicant must contact ODEQ prior to pre- and post-construction activities to ensure conditions of record are not violated. For technical questions related to site contamination and clean-up, contact the Land Quality Division of ODEQ and/or ODEQ's Northwest Region Portland Office.

If a Phase 1 ODEQ Site Assessment is required, the report shall be submitted to the City for review.

If contamination is discovered subsequent to stormwater management plan approval, the owner shall take steps immediately to protect health and safety and contact the City and ODEQ. Plan approval is suspended until the contamination is resolved.

6.9.2 Review Process

Stormwater discharges from sites suspected of contamination, whether proposed as a temporary construction connection or as a permanent connection to any public storm or sanitary sewer system, will require a special authorization from the City. Contaminants, media, and site conditions are unique to each parcel of land. Sites at risk for contamination shall therefore be reviewed on a case-by-case basis.

After reviewing the proposal and a characterization of the contaminants from the site, the City may make one of the following decisions:

- **Approve discharges to the public storm and/or sanitary sewer system with restrictions** such as those described herein or as is necessary given the nature of the discharge.
- **Require the applicant to obtain an NPDES permit** from ODEQ for the anticipated discharge prior to connection to a public system.
- **Require that the applicant become part of the Industrial Pre-Treatment Program** operated by the applicable wastewater agency.
- **Deny the request to discharge** to the public storm and/or sanitary sewer system.
- **Allow unrestricted connection** to the public storm and/or sanitary sewer system, with a testing point for future monitoring.

6.9.3 Soil Management

Stockpiles of contaminated soils shall be covered with temporary plastic film or sheeting to prevent stormwater from coming into contact with them.

Stockpile perimeters shall have a containment barrier on all four sides of every stockpile to prevent stormwater run-on and material runoff. Barriers can consist of concrete curbing, silt fencing, or other berming material, depending on the activity, size, and resources available.

Areas under stockpiles of contaminated soils are not required to be paved. However, an impervious layer shall be placed beneath the stockpile to protect uncontaminated areas from potential leachate.

6.9.4 Construction Dewatering

All construction dewatering discharges resulting from groundwater or precipitation (rainfall) will be evaluated for contamination before disposal methods can be approved.

Source controls, sampling points (if required), and the disposal point shall be identified on the erosion prevention and sediment control plan (see **Chapter 7**). Source control requirements will be identified as part of the review process of the laboratory analysis reports and the proposed stormwater management plan. Based on the intended method of disposal, the following requirements apply:

- **If onsite infiltration is the proposed method for disposal**, authorizations are required from the City and the Land Quality Division of ODEQ. Private infiltration systems for construction dewatering shall be located and maintained on private property, outside the public rights-of-way (ROWs).
- **If a public sanitary system is the proposed method of disposal**, authorizations are required from the appropriate authorities, and will be allowed only if extensive pretreatment is implemented and the discharge is approved by the appropriate authorities. All groundwater and surface water discharges to a sanitary sewer system shall meet local discharge limits and will be subject to discharge volume charges.
- **If a public stormwater system is the proposed method of disposal**, evaluations of discharge to the public storm system will be based on whether discharges meet, or can be pretreated to meet, requirements of the City, NPDES discharge permit, or other state and federal regulations for the receiving surface water.
- **If a receiving stream is the proposed method for disposal**, authorizations are required from the City and Land Quality and Water Quality Divisions of ODEQ.

6.9.5 Post-Construction Drainage Systems

All discharges from sites with suspected or known contamination shall identify an appropriate stormwater disposal location and obtain discharge permits from the appropriate agencies.

If **onsite infiltration** is the proposed method for disposal, authorizations are required from the City and ODEQ. Private infiltration systems shall be located and maintained on private property, outside the public ROWs.

If **a drainageway** is the proposed method for disposal, authorizations are required from the City, the U.S. Army Corp of Engineers, and ODEQ.

If **an offsite public storm or sanitary sewer system** is the proposed method for disposal, authorization or industrial discharge permitting may be required from the City. A per-

manent monitoring point may be required to ensure compliance with local discharge regulations. If monitoring is necessary, a permanent structure (such as a sampling manhole or flow-through vault) shall be installed on the discharge line of the subsurface drainage system.

6.10 Covered Vehicle Parking Areas for Commercial or Industrial Uses

The requirements in this section apply to commercial or industrial development with a covered vehicle parking area. Existing parking structures are not required to be retrofitted unless the structure is being redeveloped.

Single-level covers (canopies, overhangs, and carports) are exempt from the requirements of this section but may be subject to the requirements of **Section 6.11** if they are located in high-traffic areas.

6.10.1 Drainage

Stormwater runoff from the top floor of a multi-level parking structure shall be directed to a stormwater disposal point that meets all water quality requirements of these standards and any other applicable code requirements.

Significant amounts of precipitation are not expected to accumulate in the lower floors of multi-level parking structures, so drainage facilities ***are not required*** for the lower floors. If the applicant elects to install drainage facilities, the drainage from the lower floors shall be directed to an approved public sanitary sewer system. Prior to discharge all applicable pretreatment requirements shall be met.

The adjacent uncovered portions of the site shall be designed so that stormwater does not enter the covered parking areas. This can be accomplished through grading or drains.

6.11 Industrial and Commercial High Traffic Areas

The requirements in this section apply to all new development with vehicle parking areas for developments zoned industrial or commercial with high-traffic volumes. High-traffic volumes are defined as an average daily traffic (ADT) of 2,500 vehicles, consistent with ODEQ's Industrial Stormwater Best Management Practices Manual (February 2013).

Industrial and commercial high-traffic areas with a drainage area of over 10,000 SF directed to a single stormwater management facility shall have an adequate oil control facility located upstream of the stormwater management facility. Parking areas of over 10,000 SF that are divided into drainage areas of less than 10,000 SF do not require this pretreatment.

6.11.1 Oil Controls

An oil/water separator with coalescing plate shall be installed upstream of the stormwater management facility. The purpose of the device is to treat and prevent hydrocarbons from entering the stormwater BMP facility. This device shall be maintained per the manufacturer's specification and the approved maintenance plan.

Coalescing plate separators shall be designed to achieve 100-ppm non-polar oil and grease in the effluent from the peak flow generated by the expected site activity. Test-

ing information must be submitted by the manufacturer of the unit that supports the 100-ppm effluent standard at the calculated flow rate.

Flow rates will be determined by the drainage area served by the device. The device will be sized to treat the water quality storm event as specified in **Chapter 4**.

Separator details must be shown on the building plans submitted at the time of building permit application and shall match manufacturer's specifications and details, including the unit flow rate, effluent water quality, and maximum process flow rate.

All separators shall be maintained per the manufacturer's specifications and the approved O&M plan.

CHAPTER 7

Erosion Prevention and Sediment Control

CHAPTER 7. EROSION PREVENTION AND SEDIMENT CONTROL

When land is disturbed, the erosion rate accelerates dramatically. Since ground cover on an undisturbed site protects the surface, removal of that cover increases the site's susceptibility to erosion. The major problem associated with erosion is the movement of soil off the site and its impact on water quality. This chapter outlines the requirements for erosion prevention, sediment control, and construction debris management.

7.1 Introduction

Sediment in streams is a contributing factor in the decline of salmonid populations in our region. Many agencies, including the Oregon Department of Environmental Quality (ODEQ), National Marine Fisheries Service (NMFS), and the Oregon Department of Fish and Wildlife (ODFW) require proper erosion controls to protect natural systems. In addition, sediment leaving the site may damage neighboring properties, block drainage systems, and enter roadways. Proper planning and use of erosion prevention measures can reduce these impacts.

Erosion prevention measures are more effective than the reactive control of sediment. Identifying erosion problems at the planning stage and noting highly erodible areas helps in selecting cost effective, environmentally sensitive erosion control measures. Once soil particles become dislodged, it requires greater efforts and costs to contain the sediment on the site.

It is the City's goal to comply with all conditions of the various state and federal regulations and requirements that pertain to erosion and water quality protection. As required by water quality standards set forth in Oregon Administrative Rules, It is the City's policy to prevent erosion and use sediment controls to minimize the amount of sediment and other pollutants that reach the public storm and/or surface water system resulting from development, construction, grading, filling, excavating, clearing, and any other activity which accelerates erosion.

For erosion prevention design specifications and standards, the City has partnered with other regional jurisdictions to develop a manual for erosion prevention and sediment control. The City has adopted that manual as the **City of Oregon City Public Works Erosion and Sediment Control Standards (Erosion Standards)**. The requirements of this chapter are consistent with and should be used in conjunction with the **Erosion Standards.** The **Erosion Standards** and other associated documents and forms can be obtained from the City.

7.2 General Provisions

A. The owner of the property and/or permittee under an approved development activity shall be held responsible for any violation of these standards.

B. Visible or measurable erosion from a project site which enters, or is likely to enter, the public or private storm and surface water system or other properties, is prohibited, and is a violation of these standards.

C. No person shall create physical erosion by dragging, dropping, tracking, or otherwise placing or depositing, or permitting to be deposited, mud, dirt, rock or other such debris upon a public street or into any part of the public storm and surface water system, or any part of a private storm and surface water system which drains or connects to the public storm and

surface water system. Any such deposit of material shall be removed immediately using hand labor or mechanical means. No material shall be washed or flushed into any part of the storm and surface water system until all mechanical means to remove the debris have been exhausted and preventative sediment filtration is in place.

D. The City requires temporary and permanent measures for all construction projects to lessen the adverse effects of site alteration on the environment. The owner or his/her agent, contractor, or employee, shall properly install, operate, and maintain both temporary and permanent measures to protect the environment during the useful life of the project.

E. Approval of an **Erosion and Sediment Control Plan (ESCP)** plan by the permitting authority does not relieve the applicant's responsibility to ensure that ESCP measures are constructed and maintained on the construction site.

F. Nothing in this section shall relieve any person of the obligation to comply with the regulations or permits of any local, state, or federal authority.

G. These erosion prevention and sediment control rules apply to all properties within the city boundary, regardless of whether that property is involved in a construction or development activity.

7.3 Applicability

Within the boundaries of the city, any grading or soil disturbance associated with a development activity that disturbs 1,000 square feet or greater is required to obtain an erosion and sediment control (ESC) permit from the City. This requirement is consistent with Metro's Urban Growth Management Plan, Title 3 and the City's National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit.

If any development activity that did not require an ESC permit causes a violation of these standards, the permittee or property owner shall be required to obtain an ESC permit and comply with the associated rules and regulations, including the development of an ESCP, payment of permit fees, and construction site inspection activities.

7.3.1 NPDES 1200-C Permit

In addition to obtaining an ESC permit from the City, development activity that results in 1 or more acres of disturbance is required to obtain an NPDES 1200-C permit from ODEQ and conform to ODEQ's NPDES 1200-C permit requirements. The planning process outlined in the **Erosion Standards** is intended to assist the applicant in meeting the requirements of the NPDES 1200-C permit. However, it is the responsibility of the applicant to review and comply with ODEQ's regulations and permitting process, including paying any applicable fees to reviewing agencies.

7.4 Erosion and Sediment Control Plan (ESCP)

The purpose of the ESCP is to clearly establish control measures that are intended to prevent erosion and off site sediment transport during construction.

7.4.1 General ESCP Principles

When developing an ESCP, the following are important concepts to consider:

A. **Minimize site disturbance**. Plan and locate development activities to minimize land disturbance such as clearing and grading and cut and fill to protect existing vegetation as well as reduce erosion and sediment loss.

B. **Stage construction activities**. Where applicable and appropriate, locate construction pollutant sources (including sediment) away from drainage swales, wetlands, and water bodies.

C. **Schedule work.** Schedule work to minimize overall impacts, addressing critical areas during the dry weather season when practicable. Phase construction activities to minimize the exposed soil area and the duration of exposure.

D. **Prevent erosion.** Emphasize the use of erosion prevention techniques, including proper site planning and construction phasing, ahead of sediment control measures.

E. **Minimize length and steepness of slopes.** Cut and fill slopes should be as flat as practicable and consistent with soil stability. Slopes of two-horizontal to one-vertical (2h:1v) or steeper may require special design.

F. **Control sediment transport.** Sediment removed from sediment control facilities should be placed in non-critical flat areas of the site. In no instances shall the removed sediment be placed in a position that would allow subsequent rainfall to return it to the sediment control devices.

G. **Address wet weather conditions.** Stockpile erosion prevention materials and supplies onsite during the wet weather period (October 1 through May 31). Enhance protections prior to predicted storm events.

H. **Prevent impacts from construction site wastes**. Consider and prevent exposure to stormwater runoff from construction site wastes such as discarded building material, concrete truck washout, chemicals, litter and sanitary waste.

I. **Adjust during construction.** The ESCP shall identify the minimum best management practices (BMPs) to address expected site conditions. Throughout the project duration, it is the responsibility of the applicant to identify appropriate BMPs to prevent erosion and control sediment discharges. In some cases, this will require the applicant to adjust, modify, or add additional BMPs beyond those listed in the ESPC.

J. **Maintain BMPs.** Inspect and maintain ESC BMPs throughout the construction period.

K. **Site stabilization.** Seed and mulch exposed areas as soon as possible after grading is completed. Stabilize the site following construction.

7.4.2 Approved BMPs

ESC BMPs are required for construction areas where ground surfaces will be disturbed by clearing, grading, fills, excavations, and other construction activities. The ESCP shall incorporate construction BMPs which minimize the amount of disturbed land area and avoid or minimize work on steep slopes.

The BMPs prescribed in the **Erosion Standards** are the approved BMPs that shall be used to develop the ESCP. Use of other BMPs shall require approval from the City.

7.4.3 Wet Weather Measures

On sites where vegetation and ground cover are removed, vegetative ground cover shall be planted and established by October 1 and continue to function through May 31 of the following year, or as approved by the City. If ground cover is not established by October 1, the open areas shall be protected through May 31 of the following year with straw mulch, erosion blankets, or other methods approved by the City.

7.4.4 Maintenance and Removal of BMPs

The permittee shall inspect (see **Section 7.5.3**) and maintain the facilities according to the approved ESCP during the construction phase, the post construction phase, establishment of permanent vegetation, or any other permitted activity. If the facilities and techniques approved in an ESCP are not effective or sufficient as determined by the City, the permittee shall submit a revised plan within 3 working days of written notification by the City. Upon approval of the revised plan by the City, the permittee shall implement the additional facilities and techniques included in the revised plan immediately. In cases where erosion is likely to occur, the City may require the applicant to install interim control measures prior to submittal of the revised ESCP.

Temporary BMPs, such as sediment fences, shall be removed after permanent vegetation is established.

Sediment control BMPs will accumulate sediment during the construction process. The applicant shall remove and properly dispose of accumulated sediment in accordance with the **Erosion Standards**.

7.4.5 Contaminated Soils

If the construction process reveals soils contaminated with hazardous materials or chemicals, the contractor shall stop work immediately, ensure that no contaminated material is improperly hauled from the site, and immediately notify the City, ODEQ, and other applicable agencies.

7.5 Plan Review, Permitting and Approval Processes

The City reviews and approves many types of development activities such as single-family residential, multi-family, commercial, industrial, partitions, and subdivisions. All development activity, regardless of the nature of development activity, is subject to the ESC permitting process. Activities that exceed the thresholds outlined earlier will require additional permitting requirements.

7.5.1 ESC Permitting Process

For single-family development permit applications, the applicant shall apply for the erosion control permit along with the building permit application. For non single-family development permit applications, the applicant shall apply for the ESC permit and any other public works permits, in conjunction with the land use application.

7.5.2 ESCP Submittal Requirements

The applicant shall submit an ESCP incorporating the appropriate BMPs for the anticipated site conditions.

The ESCP shall include written documentation and construction plans that show the locations of proposed minimum measures. The ESCP shall be included as part of the overall submittal of the stormwater management plan. For specific guidelines, see the **Erosion Manual**. ODEQ's NPDES 1200-C permit templates may be used for developing the ESCP.

7.5.3 Inspection Process

Inspections shall be conducted by the applicant and/or site operator according to the requirements in the **Erosion Standards**. ESC inspections include:

- Pre-construction: Initial site inspection with City representatives prior to starting any development, site ground disturbance or grading activity excluding the installation of the ESCP BMPs.
- Active Period: Daily site inspections during active construction when stormwater runoff, including snowmelt, is occurring.
- Prior to Inactivity: Inspection to ensure that ESCP measures are in working order. Any necessary repairs must be made prior to leaving the site.
- Inactive Periods (greater than 7 calendar days): Inspections once every two weeks.

During periods when the site is inaccessible due to inclement weather, inspections shall occur daily at relevant and accessible downstream discharge points to look for evidence of sediment laden water flowing from the construction site.

Routine inspections shall be conducted by the City throughout construction.

Once the project has been completed, the permittee shall request a final ESC inspection. Prior to a certificate of occupancy being issued, the City inspector must confirm that the ESC permit can be closed.

CHAPTER 8

Operation and Maintenance

CHAPTER 8. OPERATION AND MAINTENANCE

One purpose of the City of Oregon City's (City) operation and maintenance (O&M) program is to manage stormwater runoff from new development and redevelopment within the boundaries of the city and as required in the City's National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit. The program is required to provide a mechanism to ensure long-term functionality of constructed stormwater management facilities.

8.1 Introduction

The O&M requirements in this chapter apply to all stormwater management facilities constructed as a requirement of these standards. Maintenance activities, including routine maintenance, restorative maintenance, and rehabilitation are required to ensure the long-term function and effectiveness of stormwater management facilities and infrastructure. Initial site planning must incorporate provisions for adequate access and space to perform maintenance activities for all stormwater management facilities.

8.2 General Requirements

The City is responsible for ensuring the O&M of stormwater management facilities within the city boundary. All facility designs will be held to the same standards regardless of the organization or entity that has accepted responsibility for the maintenance. There are two categories of maintenance for stormwater management facilities.

- ***Privately-owned and maintained***. These are stormwater management facilities which benefit one owner. They include residential, multi-family, commercial, and industrial types of developments. These stormwater management facilities require a maintenance covenant recorded with the title that describes the types of facilities and necessary maintenance.
- ***Publicly-owned and maintained***. These are regional and sub-regional stormwater management facilities which benefit the public in general and any facility located within the public right-of-way. These stormwater management facilities can be utilized for any type of development if shown to have sufficient capacity. Stormwater management facilities that serve multiple properties (e.g., facilities for residential subdivisions) shall be transferred to public ownership following the 2-year maintenance warranty period.

8.3 O&M Plans

All stormwater management facilities require the applicant to execute and record an O&M plan. The plan shall ensure that owners maintain and operate the stormwater management facility to preserve and continue its function. O&M plans require stormwater management facility owners to properly maintain, repair, modify or reconstruct (if necessary) the facility, and provide a schedule for the maintenance frequency for the facility.

8.3.1 O&M Plan Development

O&M plans shall be required for all permanent stormwater best management practices (BMP) facilities to ensure that they function as designed. The purpose of an O&M plan is to provide guidance to those who are responsible for the long-term inspection and maintenance of the facility.

To ensure functionality of the stormwater BMP facilities, owners are required to inspect facilities regularly per the approved O&M plan to determine maintenance needs. Routine inspection and maintenance can help to keep overall maintenance costs low by detecting problems early and avoiding large repair or replacement costs.

The facility design and maintenance specifications in **Appendix C** can be used to create the O&M plan. If the proposed facility types do not match a stormwater management facility in **Appendix C**, the applicant and design engineer will be responsible for creating any drawings, maintenance specifications, and an inspection checklist to be incorporated into the O&M plan.

O&M plans for privately owned/maintained facilities shall be recorded with the Clackamas County Clerk's office as an exhibit to the maintenance covenant referenced in **Section 8.4.1** before issuance of a building permit or final plat approval.

8.3.2 O&M Plan Elements

The following outline can be used to prepare an O&M plan.

1. Introduction and general information
    a. Facility Information. Facility type and identifying name or number, as applicable.
    b. Contact. Name and contact information for the responsible organization or individual.
    c. Narrative. Written overview describing the site, drainage areas, and intended function of the facility.
2. Operations and Maintenance
    a. Operating Procedures. Normal operating procedures for facility function, including any seasonal modifications or adjustments.
    b. Regular Maintenance. Required maintenance activities and schedule (i.e., landscape maintenance, sediment removal, pipe cleaning).
    c. Inspections. Required inspection frequency to verify facilities are being maintained and functioning as designed.
    d. Maintenance Standards. Minimum standards that are required for the stormwater management facility to produce desired results and maintenance actions when the minimum standards are not met (See **Appendix C**).
    e. Lifespan. Expected lifespan of the facility components (i.e., when should owners expect to replace growing media, plantings, and control structure elements?).
    f. Connected Facilities. List of interrelated or connected stormwater management facilities and description of how each facility works with the next one.
3. O&M Plan Responsibility
    a. Responsible Party. Identify the person(s) or organization(s) responsible for inspections of stormwater management facilities.
    b. Funding. Identify the funding source for maintenance.

4. Attachments

   a. Site Plan. Include a site plan to identify the location of the facility/facilities, sources of runoff entering each facility, and ultimate stormwater disposal point.

   b. Facility Details. Include the stormwater management facility detail sheet(s) and O&M Plan and checklist(s) (when applicable use details in **Appendix C** for reference).

   c. Maintenance Agreement or Covenant. Include a copy of the public maintenance agreement and/or private maintenance covenant that will be used to assign maintenance responsibility and/or to allow access for maintenance or inspection of the stormwater management facilities.

8.3.3 O&M Plan Review and Approval Process

The O&M plan and associated agreements, covenants, and easements will be reviewed as part of the City's overall stormwater management plan review and approval process.

8.4 Privately-Owned and Maintained Facilities

Generally, stormwater BMP facilities that benefit single owners shall be privately-owned and maintained. All stormwater management facilities to be maintained privately require an O&M plan that is reviewed and approved as part of the overall stormwater management plan review process.

8.4.1 Maintenance Covenant for Private Stormwater Facilities

Maintenance of all privately-owned stormwater management facilities shall be ensured through the creation of a formal maintenance covenant that must be approved by the City and recorded into the land record prior to final plan and/or plat approval. A Maintenance Covenant Template is provided in **Appendix F**. The O&M plan, including scheduled inspections and regular maintenance activities, shall be referenced in the maintenance covenant.

8.4.2 Access Easement

Prior to the issuance of any permit that includes a stormwater management facility, the applicant or owner of the site must execute a maintenance covenant that includes access rights for the City, or its contractor or agent, to inspect the facility and ensure that it is maintained in proper working condition. This includes the right to enter a property when the City has a reasonable basis to believe that a violation of City standards and/or rules and regulations is occurring or has occurred, and to enter when necessary for abatement of a public nuisance or correction of a City violation. The access easement shall be included in the maintenance covenant, as approved by the City and recorded at the Clackamas County Clerk's office.

8.4.3 Annual Inspection and Maintenance

Annual inspections are to be conducted by the Responsible Party identified within the O&M Plan and may be reviewed by the City upon request. All stormwater management facilities must undergo an annual inspection to document maintenance and repair needs and ensure compliance with the requirements of these standards. Maintenance

needs may include the following: removal of silt, litter and other debris from all catch basins, inlets and drainage pipes; grass cutting and vegetation removal; and necessary replacement of water quality vegetation. Any maintenance needs identified must be addressed by the Responsible Party in a timely manner. The inspection and maintenance frequency may be increased as deemed necessary to ensure proper functioning of the stormwater management facility.

8.4.4 Records of Maintenance Activity

Facility owners shall keep records of all maintenance and repairs and shall retain the records for at least 3 years. These records shall be made available to the City during inspection of the facility and at other reasonable times upon request. The owner shall submit a copy of the stormwater management facility maintenance and inspection records to the City annually as required.

8.4.5 City Inspection of Stormwater Management Facilities

Inspections may be conducted by the City at any time, including but not limited to, routine inspections, random inspections, inspections based on complaints or other notice of possible violations, inspections related to the City's NPDES stormwater permit, and joint inspections with other agencies done under environmental or safety laws. Inspections may include, but are not limited to, review of maintenance and repair records; sampling discharges, surface water, groundwater, or material/water in stormwater management facilities; and facility condition evaluations.

8.4.6 Failure to Comply with the O&M Plan

In the event that the stormwater management facility becomes a danger to public safety or public health, the City shall notify in writing the party responsible for maintenance of the stormwater management facility. Upon receipt of the written notice, the responsible person shall have 7 days (in accordance with the maintenance covenant) to effect maintenance and repair of the facility in an approved manner. If a responsible party fails or refuses to meet the requirements of the maintenance covenant, the City, after reasonable notice, may correct a violation of the design standards or maintenance needs by performing all necessary work to return the facility to proper working condition. After proper notice, the City shall assess the owner of the facility for the cost of repair work and any penalties.

8.4.7 Modifications to the O&M Plan

If it is determined that the O&M plan requires modification to maintain the functionality of the facility, then modifications to the O&M plan shall be submitted to the City for review and approval. Written approval from the City is required prior to modifying the O&M plan. The approved modified plan shall be recorded at the Clackamas County Clerk's Office.

8.5 Publicly-Owned and Maintained Facilities

Generally, publicly-owned and maintained stormwater management facilities are facilities that serve multiple property owners or the general public. Publicly-owned stormwater management facilities can serve any type of development (residential, multi-family, commercial, industrial). Publicly-owned facilities may be constructed by the City, or they may be constructed as part of a private development's stormwater management plan, with maintenance responsibilities transferred to the City following the 2-year maintenance warranty period.

8.5.1 O&M Plan

All stormwater management facilities to be maintained by the City require an O&M plan that is reviewed and approved as part of the overall stormwater management plan review process. The O&M plan is prepared by the applicant, identifying the City as the responsible party for inspection and maintenance following the 2-year warranty period (see **Chapter 9**).

During the 2-year warranty period, the applicant is responsible for all maintenance and documentation requirements outlined within the O&M plan. Prior to the completion of the warranty period, the City will require all maintenance records and documents be reviewed and deficiencies addressed prior to the transfer of maintenance responsibilities.

The applicant shall enter into a maintenance agreement with the City establishing bonding, surety, or payment for maintenance of the facility during the 2-year warranty period.

8.5.2 Modifications to the O&M Plan

Following the 2-year warranty period, at the City's discretion, the applicant may be required to prepare a modified O&M plan for public stormwater management facilities. If it is determined that the O&M plan requires modification to maintain the functionality of the facility, then modifications to the O&M plan shall be submitted to the City for review and approval prior to the release of the warranty surety.

8.5.3 Maintenance Fees

The City may establish maintenance fees for publicly-owned stormwater management facilities that serve multiple private owners. When separate maintenance fees are established, they will be distributed proportionally among the owners that utilize the facility for stormwater management.

CHAPTER 9

Submittal Requirements

CHAPTER 9. SUBMITTAL REQUIREMENTS

This chapter outlines the submittals required by the City of Oregon City (City) for stormwater and grading plans and other documents for review by the City's Community Development and Public Works Departments. This section is intended to standardize the submittals and clearly outline the minimum requirements. The requirement for a complete submittal package is intended to reduce the overall plan approval processing time. Refer to the City's engineering policies for additional information regarding plan submittals, as-built drawings, and the development approval process.

9.1 Submittal Requirements and Specifications

All applicants proposing development activities governed by these standards shall submit the plans, reports, studies, and information as required herein. The submittals shall be reviewed and approved by the City.

- The City may assist the applicant with submittal requirements by providing development review checklists and written and/or verbal direction of the minimum submittal requirements necessary to complete a comprehensive review of the plans.
- Submittals must be complete with minimum fees paid before they will be accepted by the City for review.
- Submittals will not be reviewed until a complete package has been submitted, including all the requirements listed in the applicable sections of this chapter.
- The City may require additional fees as applicable to be paid prior to review of any submittal.

9.1.1 Submittal for Land Use Application

When proposed development plans exceed the minimum thresholds listed in **Chapter 1**, applicants must submit the completed Site Assessment and Preliminary Design Checklist (see **Chapter 2),** including the following attachments, for City review and approval as part of the land use application process. These elements shall constitute a preliminary drainage report and form the basis for developing the stormwater management plan described in **Section 9.1.2**.

- Vicinity map
- Site assessment map (Existing Conditions)
- Preliminary site plan (Proposed Conditions)
- Infiltration test results, as required (see **Appendix D**)
- Downstream analysis, as required (see **Chapter 5**)
- Seasonal groundwater depth evaluation, as required
- Print-out results from the BMP Sizing Tool, or equivalent calculations (see **Chapter 4**)
- Documentation of potential high-risk site uses (see **Chapter 6**)
- Other supporting documentation required to evaluate the feasibility of the project

9.1.2 Submittal for Stormwater Management Plan Approval

A stormwater management plan shall be submitted as part of the development review and approval process. The applicant shall submit sufficient supporting information to justify that the proposed stormwater management design meets all the provisions within these standards and the land use conditions of approval.

The information shall include the following as required:

A. Engineered drainage plans (see **Section 9.3**).

B. Drainage report (see **Section 9.4**).

C. Stormwater best management practices (BMP) sizing calculations from the BMP Sizing Tool Method or the Engineered Method (see **Chapter 4**).

D. Geotechnical engineering report/geologist report with required supporting information, such as infiltration testing, soils data, and design/construction recommendations (see **Section 3.1 and Appendix D**).

E. Engineer's cost estimate.

F. Public/private stormwater easements and conservation easements.

G. Spill prevention, containment and countermeasure plan (see **Chapter 6**).

H. Erosion prevention and sediment control (EPSC) plan (see **Chapter 7**).

I. Operations and maintenance (O&M) plan (see **Chapter 8**).

J. Private facility maintenance covenant (see **Appendix F**).

9.2 Grading Plan Submittals

Plan submittals must be in accordance with the City's engineering policies. This section contains guidelines for three types of grading plan submittals made to the City: engineered grading plans (**Section 9.2.1**), abbreviated grading plans (**Section 9.2.2**), and residential lot grading plans (**Section 9.2.3**). Refer to Oregon City Municipal Code (OCMC) 13.12 and 15.48 to determine which type of grading plan submittal is required.

9.2.1 Engineered Grading Plans

All engineered grading plans shall be prepared, stamped with the seal of, and signed by a Professional Engineer registered in the State of Oregon. Engineered grading plans shall include at least the following information:

9.2.1.1 Scale

The plan view shall be no smaller than a scale of 1 inch equals 100 feet. Recommended scale is 1 inch equals 50 feet.

9.2.1.2 Cover sheet Requirements

The first sheet, or cover sheet if one is provided, shall include the following:

A. North arrow.

B. Vicinity map showing project boundaries, streets with street names, streams and rivers, city limit boundaries, and section-township-range.

C. Legal description of the project site.

D. Name, address and telephone of owner of the project.

E. Name, address, and telephone of the Project Engineer.

F. Vertical and horizontal datum for the project.

G. Legend for symbols used in the plans.

H. City planning and public works file number, as applicable.

9.2.1.3 Test Locations

Show locations of soil test pits, infiltration tests, and other environmental evaluations conducted on the site.

9.2.1.4 Existing Topography

Show existing topography, as per the requirements for a topographic map for engineered drainage plans (see **Section 9.3.3**). Show existing slopes steeper than two-horizontal to one-vertical (2h:1v), with the slopes indicated.

9.2.1.5 Finished grade contours

Show finished grade contours. Show locations of top and toe of cut and fill slopes. Indicate the slope for any proposed slope steeper than 2h:1v.

9.2.1.6 Information on Site Water Resources

Show information concerning wetlands, environmentally-sensitive areas, water courses, natural buffer areas, and similar applicable information. Also show the boundaries of mapped Flood Management Areas and Natural Resource Overlay Districts (Reference: OCMC 17.42 and 17.49).

9.2.1.7 Locations of Disturbed Areas

Show clearing and grubbing limits. Show areas to be graded, filled, excavated, or otherwise disturbed. The location of tops and toes of graded slopes shall be indicated, together with the proposed steepness and height of these slopes. The location of stockpiles, haul roads, and disposal sites shall also be indicated.

9.2.1.8 Quantities of Cut/Fill

Show quantities, in cubic yards, of excavation and/or fill throughout the project site.

9.2.1.9 Locations of Stormwater Features

Show existing channels, swales, and drainage pipes that either convey offsite stormwater through the project site, or collect and discharge site runoff from the project site.

9.2.1.10 Locations of Drainage Structures

Show locations of pipes, pipe information (size, materials, and slopes), manholes, catch basins, and inlet structures which are to be constructed as a part of the grading plan.

9.2.1.11 Construction information

Show information concerning construction methods, fill material specifications, source of fill material, compaction specifications, haul routes, and other construction information when known and applicable.

9.2.1.12 Standard grading notes

Engineered grading plans shall include, at a minimum, the standard grading notes per the City's Public Works standards.

9.2.2 Abbreviated Grading Plans

Abbreviated grading plans shall be prepared, stamped with the seal of, and signed by a Professional Engineer registered in the State of Oregon. Abbreviated grading plans shall include the following information:

9.2.2.1 Narrative

Applicants shall submit a narrative describing the project's parameters for grading the site to include the total square footage of new impervious surface. Describe what the project will accomplish and how the project will be executed. Describe how the grading will affect surface water drainage and what is being proposed to ensure that the new drainage pattern will direct the surface water to an approved outfall.

9.2.2.2 Drawings

Provide a simple sketch depicting the topographical lines of the site. Show the project's boundaries and the final desired grading lines versus the existing pre-grading lines. Show drainage patterns with the final outfall. Show a north arrow and at least one street for reference. Drawings shall be printed on paper no smaller than 8.5 by 11 inches, provided sufficient scale can be shown on this size. Otherwise, the drawing shall be printed on 11- by 17-inch paper.

9.2.2.3 Scale

The plan view shall be no smaller than a scale of 1 inch equals 100 feet. Recommended scale is 1 inch equals 50 feet.

9.2.3 Residential Lot Grading Plans

Residential lot grading plans shall be prepared, stamped with the seal of, and signed by a Professional Engineer registered in the State of Oregon. Residential lot grading plans shall include at least the following information:

9.2.3.1 Purpose

A residential lot grading plan illustrates that the storm drainage system is designed to accommodate the drainage patterns of the final graded project. It also provides protective slopes away from all sides of a building.

9.2.3.2 Approved discharge point

Stormwater from residential impervious surfaces (roofs, driveways, etc.) must be conveyed to an approved stormwater discharge point, which is commonly a stormwater management facility. The discharge point shall be labeled on the plan set and discussed in the report.

9.2.3.3 Protective slopes

Protective slopes away from all sides of all buildings are essential elements of all lot grading plans. The purpose of the protective slopes is to drain surface water away from all building walls and backfill areas. Where such a protective slope meets a slope that drains toward a building, a drainage swale of adequate width, depth, and longitudinal gradient is necessary to carry away surface water without flooding against buildings or ponding any lot areas.

9.2.3.4 Basic lot grading types

The Federal Housing Administration has established basic lot grading types. Others may exist depending on the uniqueness of the topography. The three basic lot types are as follows:

- Lot Grading Type A – all drainage to street.
- Lot Grading Type B – drainage to both street and rear of lot.
- Lot Grading Type C – all drainage to rear lot line.

See exhibits of lot grading types in the City's Public Works standards.

If Lot Grading Type B or C is selected, flows may not be channeled or concentrated onto adjacent properties without the creation of a private drainage easement to convey the water to a natural location or public stormwater system. See **Chapters 5 and 8** of these standards for additional discussions regarding drainage easements.

9.2.3.5 Relationship to Street Elevation

The single most important grade relationship for proper lot grading and drainage is top of foundation elevation in relation to street elevation. If the floor elevation is too low in relation to adjoining street grades, adequate protective slopes and drainage swales cannot be provided to drain the site satisfactorily.

Proper top of foundation elevation and lot grades for any lot can be obtained by establishing a lot grading control line on the plans and on the ground appropriate for the spe-

cific property. The line is located differently for each lot grading type as shown by the circles lettered A, B, C, etc., in the exhibit shown in the City's Public Works standards. Each control line starts at the top of the street curb near the indicated high or low lot corner and ends up at the top of the building foundation. Specific design criteria for the grading control line can be found in the residential lot grading notes in the City's current Public Works standards. The grading control line must be checked for each lot or parcel.

9.2.3.6 Rough Grading

Residential lot grading plans shall be based on final rough grading as-built conditions which are certified by the Project Engineer to $\pm$ 0.1 foot.

9.2.3.7 Scale

The plan view of detailed drainage plans shall be drawn at an appropriate engineering scale no smaller than 1 inch equals 50 feet; when more detail is required, a scale of 1 inch equals 20 feet is preferred.

9.2.3.8 Cover Sheet Requirements

The first sheet, or cover sheet if one is provided, shall include the following:

A. North arrow, vicinity map, project boundaries, streets with street names, streams and rivers, city limit boundaries, and section-township-range.

B. Legal description of project site.

C. Name, address, and telephone of the owner of the project.

D. Name, address, and telephone of the Project Engineer.

E. Datum for the project.

F. Legend for symbols used in the plans.

G. City planning and public works file number, as applicable.

H. Basis of bearing.

I. Onsite temporary benchmark.

9.2.3.9 Other Plan Sheet Requirements

A. Standard residential lot grading notes.

B. Standard detail for typical grading patterns.

C. Existing and proposed lot/parcel lines including intersecting adjoining properties.

D. Lot/parcel dimensions.

E. Lot/parcel identification.

F. Street centerlines.

G. Estimated building envelope (show a building envelope size, based on underlying zone setbacks that may be considered typical for the type of development and its location).

H. Existing or proposed curb; if no curb, centerline and edge of street pavement.

I. Top of curb elevations at intersection of curb and property line extensions (at ends of curb returns on corner lots); if no curb, centerline and edge of pavement elevations at intersection with property line extensions; elevations to hundredths of feet.

J. Existing contour lines (minimum 2-foot interval) including adjacent property within 50 feet.

K. Finished grade elevations to the nearest tenth of a foot[1].

L. Lot grading type for each lot or parcel.

M. Top of foundation elevations to the nearest tenth of a foot.

N. Flow arrows shown in street gutter.

O. Flow arrows shown in swales per typical lot grading type detail.

P. Existing and/or proposed storm system.

9.3 Engineered Drainage Plans

All engineered drainage plans shall be prepared, stamped with the seal of, and signed by a Professional Engineer, registered in the State of Oregon. Landscape plans for public stormwater management facilities shall be prepared, stamped with the seal of, and signed by a Landscape Architect, registered in the State of Oregon. The engineered drainage plans shall contain the following information.

9.3.1 Cover Sheet

The first sheet, or cover sheet if one is provided, shall include the following:

A. North arrow, vicinity map, project boundaries, streets with street names, shorelines, if any, city limit boundaries, if any, and section-township-range.

B. Legal description of project site.

C. Name, address, and telephone of owner of project.

D. Name, address, and telephone of Project Engineer.

E. Datum for project.

F. Legend, in the event that symbols are used in plans.

G. City planning and public works file number, as applicable.

H. Basis of bearing.

9.3.2 Index

At least one sheet shall contain a plan view of the entire project site. For large sites, the sheet containing the plan view of the entire site shall serve as an index to subsequent detailed plan sheets.

[1] When the average slope on a proposed lot in the likely location of the structure is greater than 5 percent, it is not necessary to show finished grade elevations to the nearest tenth of a foot on the residential lot grading plan. For these cases, identify a discharge location for roof drainage. (The average slope on a proposed lot shall be calculated by using the average of the three slopes at the two edges of the structure and the middle of the structure.)

9.3.3 Scale

The plan view of detailed drainage plans shall be drawn at an appropriate engineering scale no smaller than 1 inch equals 50 feet; when more detail is required, a scale of 1 inch equals 20 feet is preferred.

9.3.4 Topographic Plan

Plans shall include a topographic map showing existing conditions for the site, including:

A. Current topography for the site and extending 250 feet beyond project boundaries, where practicable. Existing topography for adjacent rights-of-way (ROWs) must be included for the full width of the ROW. Slopes steeper than 25 percent shall be identified.

B. Contours extending at least 250 feet beyond project boundaries, where practicable, and including the full width of adjacent ROWs. Contours shall be at maximum 5-foot vertical elevation intervals for steep locations (greater than 20 percent) and maximum 2-foot vertical elevation intervals for other locations. Locations and elevations of at least two benchmarks in the project vicinity must be shown.

C. Existing structures, including all structures within 250 feet of project boundaries, where practicable.

D. Existing access locations for the project site.

E. Existing project boundaries, ROWs, easements, jurisdictional boundaries, and sectional boundaries. All shall be clearly identified by note or symbol and key. Project boundaries shall include bearings and dimensions as referenced on existing documentation.

F. Adjacent streets, including street names, centerline, and ROW boundaries. Widths of adjacent ROW shall be noted.

G. Existing utilities, including franchised utilities located above or below ground and drainage facilities that transport surface water onto, across, or from the project site. The existing drainage pipes, culverts, and channels shall include the invert or flow line elevations.

H. Existing environmentally-sensitive areas (e.g., gullies, ravines, swales, wetlands, steep slopes, estuaries, springs, wetlands, creeks, lakes, etc.). For natural drainage features, show direction of flow and 100-year flood plain boundary (if applicable). Also, show the boundaries of mapped Water Quality Resource Areas and Flood Management Areas. (Reference: OCMC 17.49).

I. Existing wells, sanitary sewer systems, septic tanks, and drainfields within the project's boundaries. Show all known existing wells, sanitary sewer systems, septic tanks, and drainfields within 250 feet of project boundaries, to the extent possible with the adjacent property owner's cooperation. Describe abandonment procedure.

J. Existing fuel storage tanks.

9.3.5 Drainage Improvement Plans

Plans for proposed drainage improvements shall include the following:

A. Finished grades. Show the extent of cuts and fills by existing and proposed contours, profiles, and/or other explicit designations.

B. Existing structures to be removed.

C. Proposed developed areas and structures including roads and road improvements, parking surfaces, building footprints, walkways, landscape areas, etc. Depict all lines, grades, and gradients to the nearest 0.1 foot of proposed public roadways.

D. Proposed lot boundaries, tracts, and easements. Also, proposed changes to project boundaries, jurisdictional boundaries, and ROW boundaries.

E. Proposed sanitary sewers, water systems, and other related utilities, showing line and grade to the nearest 0.1 foot of all proposed utilities at crossings with the proposed drainage system.

F. Proposed fuel storage tanks. (see **Chapter 6.3**)

G. Locations of proposed structural source controls to address high pollutant potential site uses, if applicable (see **Chapter 6**).

H. Setbacks from existing environmentally sensitive areas.

I. Proposed drainage structures, including pipes, open channels, culverts, ponds, vaults, biofiltration swales, infiltration facilities, outfalls, riprap treatment, energy dissipaters, etc. All projects must identify conveyance including the emergency overflow path as described in **Chapter 5.**

J. Plan views of drainage conveyance facilities for which there is no accompanying profile view. These shall include the following information: pipe sizes, pipe types and materials, lengths of runs, gradients, and locations to the nearest 0.1 foot of pipes or channels, structure identifier (e.g., catch basin/manhole number), type of structure (e.g., Type 2 CB), exact location of structures (e.g., station and offset mainline stationing and/or street centerline stationing, or dimensioning to the nearest 0.1 foot), invert elevations in/out of structures to the nearest 0.1 foot, and top elevations of structures to the nearest 0.1 foot. Notes shall be included referencing details, cross-sections, profiles, etc.

K. Locations of all gutter or ditch flowlines, including flow arrows indicating direction of flow.

L. Profiles for roadway systems with curbs. If a roadway system with curbs is to be constructed in a proposed or existing public ROW, profiles to the nearest 0.1 foot for the following items will be a part of the plan set:

- Curb returns with elevations shown for the beginning of curb (PC), end of curb (PT), quarter points, and low points. Should the roadway section be warped in the vicinity of the PC or PT to manipulate the low point location (sometimes done to move a catch basin location away from a handicap ramp), this area of warping will also be shown in this profile. Straight-line segment between data point profiles will be allowed, as they should communicate the design intent.

Station equations relative to street centerline stationing shall be shown for the PC and PT.

- Cul-de-sacs and knuckles with elevations shown for the PC, PT, low points, and 25-foot intervals along the curve. Station equations relative to street centerline stationing shall be shown for the PC and PT.
- Pavement spot elevations within some major intersections may be necessary.
- Alignment data for proposed roadways (centerline bearings and distances, curve data, and other pertinent data).
- See the City's engineering policies for additional requirements.

M. Proposed construction phasing.

9.3.6 Plan and Profile

In existing and proposed ROWs and storm easements, drainage conveyance facilities shall be shown in profile view. Where practicable, the stationing of the plan view should line up vertically with the stationing of the profile view.

Profile views shall be located below the plan view on the same sheet and include the following:

A. Existing and finish grades.

B. Proposed drainage pipes, channels, and structures.

C. Existing underground utilities where such utilities cross proposed drainage facilities.

D. Pipe sizes.

E. Pipe types and materials.

F. Lengths of runs, gradients, and exact locations of pipes or channels to the nearest 0. 1 foot.

G. Structure identifier (e.g., catch basin/manhole number).

H. Type of structure (e.g., Type 4A Inlet).

I. Exact location of structures (e.g., station and offset mainline stationing and/or street centerline stationing, or dimensioning to the nearest 0.1 foot).

J. Invert elevations in/out of structures, and top elevations of structures.

K. See the City's engineering policies and standard drawings for additional requirements.

9.3.7 Construction Notes

Construction notes shall appear on drainage plans. These notes shall include, at a minimum, the drainage notes included in the City's engineering policies and standard drawings.

9.3.8 Cross Sections

Cross sections shall be provided for the following:

A. Roadways, including access roads.

B. Stormwater management facilities, including rain gardens, stormwater planters, pervious pavements, and detention ponds. The cross sections shall graphically illustrate the following elevations to the nearest 0.1 foot:

- The maximum water surface elevation for the 10-year design storm
- The proposed dead storage water surface elevation (as applicable)
- Amended soil section or porous pavement section (as applicable)

C. Proposed ditches and swales.

9.3.9 Drainage Structure Details

Separate detail sheets shall be provided for all proposed drainage structures and stormwater management facility control structures for which there is insufficient information in the plan view.

9.3.10 Erosion Prevention and Sediment Control Plan

Include detailed erosion prevention and sediment control plans, following the requirements of **Chapter 7** and the City's **Erosion Standards**.

9.3.11 Stormwater Management Facility Grading Plan

A detailed grading plan at a scale of 1 inch equals 20 feet shall be provided for all landscaped stormwater management facilities. This plan shall include the following:

A. Current ground contours (screened) and proposed ground contours at a minimum of a 2-foot contour interval. Slopes steeper than 6h:1v shall be identified.

B. Location of top and toe of slope.

C. Limits of embankment designed to impound water.

D. Location of all drainage structures as well as any other piped utilities in the vicinity.

E. Flow route of the secondary/emergency overflow system.

F. Maintenance access, as applicable.

9.3.12 Landscape Plan

Landscape plans for publicly-maintained stormwater management facilities shall be prepared, stamped with the seal of, and signed by, a Landscape Architect, registered in the State of Oregon. Plans for privately-maintained stormwater management facilities do not require the involvement of a Landscape Architect.

A detailed landscape plan, at a scale of 1 inch equals 20 feet shall be provided for each landscaped stormwater management facility. This plan may be combined with the stormwater management facility grading plan (**Section 9.3.10**). See **Appendix A** for further guidance. The landscape plan shall include the following:

A. Existing vegetation to be preserved and protective construction fencing.

B. Areas of stormwater management facilities to be designated with construction fencing to protect from construction traffic and compaction.

C. Final ground contours at a minimum of a 2-foot contour interval.

D. Location of top and toe of slope.

E. Limits of embankment designed to impound water.

F. Location of all drainage structures as well as any other piped utilities in the vicinity.

G. Limits of areas to receive amended topsoil and growing medium.

H. A plant list or table, including botanic and common names, size at time of planting, quantity, spacing, type of container, evergreen or deciduous, and other information related to the facility-specific planting, in accordance with landscape industry standards.

I. Location of stockpiles (erosion protection measures must be shown on the EPSC plan).

J. Method of temporary irrigation to be used for the establishment period.

K. Location of maintenance access, as applicable.

9.4 Drainage Report

The drainage report shall accompany the drainage improvement plans to complete documentation of the design and design intent. The drainage report shall be prepared by and bear the seal and original signature of a Professional Engineer registered in the State of Oregon. The Professional Engineer shall ensure that the drainage report matches and accounts for the design displayed on the grading and drainage construction plans.

9.4.1 Drainage Report Contents

The drainage report shall contain the following information:

A. **Cover sheet**, including the project name, City's planning and public works file number (as applicable), Project Engineer's name, address and telephone number, Applicant's name, and date of submittal.

B. **Table of contents**, showing the page numbers for each section of the report, including exhibits, appendices, and attachments.

C. **Vicinity map**.

D. **Basin maps** that show the following:

- Project boundaries
- Offsite contributing drainage basins
- Onsite drainage basins
- Approximate locations of all major drainage structures
- The course of stormwater originating from the subject property and extending all the way to the closest receiving body of water
- Reference to the source of the topographic base map (e.g., U.S. Geological Survey [USGS])
- Map scale
- North arrow

E. **Project Description**. Describe the project, including the size and location of the project site, address or parcel number and legal description of the property, property zoning, proposed land use, proposed site improvements, proposed construction of impervious surfaces and proposed landscaping.

F. **Required Permits**. Describe other permits required (e.g., Joint Oregon Division of State Lands/U.S. Army Corps of Engineers 404 fill permit, National Pollutant Discharge Elimination System 1200-C permit, Oregon Department of Environmental Quality permits, etc.) and submit application summaries.

G. **References to relevant reports**. Identify basin plans, flood studies, groundwater studies, wetland designation, water quality resource areas designation, sensitive area designation, environmental impact statements, lake restoration plans, water quality reports, etc. Where such reports impose additional conditions on the project, those conditions shall be included in the report.

H. **Existing Conditions**. Describe existing site conditions, including the following:

- Site topography, land cover, and land use on the project site and abutting properties (i.e. spot grades and contours)
- Hydrologic conditions including natural and constructed channels, creeks, lakes, ponds, wetlands, ravines, gullies, steep slopes, springs, and other environmentally-sensitive areas on or adjacent to the project site
- Points of discharge for existing drainage from the project site
- Offsite drainage to the property, based on a field investigation, and any identified drainage and/or erosion problems
- Boundaries of mapped Natural Resource Overlay Districts and Flood Management Overlay Districts, and groundwater sensitive areas (reference maps and reports as applicable)
- Locations of known /recorded wells on the project site and on adjacent property within 250 feet of the project boundaries
- Locations of existing fuel tanks, in-use or abandoned, within the project boundaries
- General soils conditions present within the project site

I. **Drainage Basin Description.** Describe the drainage basins to which the project site contributes runoff and identify the receiving waters for each of these drainage basins.

J. **Developed Site Drainage Conditions**: Describe the land cover resulting from the proposed project. Describe the proposal for the collection and conveyance of site runoff and offsite drainage areas. Describe proposed stormwater management facilities.

K. **Downstream Analysis**: Conduct and document the downstream analysis that encompasses the entire tributary drainage area that drains to the project site and extends downstream as required in **Chapter 5**. The downstream analysis shall include a map (minimum USGS 1:24000 Quadrangle Topographic Map) to delineate the study area. Describe in narrative form observations regarding the makeup and general condition of the drainage system. Include such information as pipe sizes, channel characteristics, and stormwater facilities.

L. **Contributing Areas**: Define and quantify the area and land use draining to each proposed stormwater management facility.

M. **Hydraulic Design Computations**. Document the methodology, assumptions, and results of calculations to support the design of all proposed stormwater management facilities and existing and proposed conveyance systems. Include a description of how the stormwater system will function during the water quality storm and peak flow events. Printouts from the BMP Sizing tool or equivalent calculations to document the Engineered Method shall be included in an appendix. Include capacity and backwater analyses when required either as part of the proposed drainage design or as a part of the downstream analysis. Other flow routing computations may be needed for wetland impact analysis or for flood plain analysis.

N. **Emergency Overflow**. Provide a narrative description of the 100-year overflow path from each stormwater management facility and storage capacity of all stormwater management facilities during the 100-year event.

O. **Erosion Prevention and Sediment Control**. Describe proposed strategy to address erosion prevention and sediment control (see **Chapter 7**).

P. **Maintenance Strategy.** Provide a narrative discussion that addresses the O&M needs of the proposed stormwater management facilities (see **Chapter 8**).

Q. **Landscape Plan.** Provide a narrative discussion about plant material selection and design objectives, such as shading, aesthetics, and/or temperature control (see **Appendix A**).

9.4.2 Drainage Report Appendices

Appendices to the drainage report shall include technical information including, but not limited to the following:

A. Site planning checklist (see **Chapter 2**).

B. Soils report and/or geotechnical report, where applicable (see **Section 3.1**).

C. BMP Sizing Tool or Engineered Method design calculations for all proposed stormwater management facilities (see **Chapter 4**).

D. Runoff calculations, including time of concentration calculations (see **Chapter 5**).

E. Conveyance system capacity calculations (See **Chapter 5**).

F. Curb and catch basin inlet sizing and spacing to meet the requirements of **Section 5.7.2** (street flooded width calculations as required).

G. Energy dissipater calculations.

H. Downstream analysis.

I. O&M manual: Required for stormwater management facilities.

- For privately owned and maintained facilities: two copies of the O&M manual shall be attached to the Maintenance Covenant and submitted to the City for review prior to recording.
- For publicly owned and maintained facilities two: copies shall be sent to Public Works prior to acceptance.
- See the City's engineering policies for quantity and format of required documents.

9.5 Standard Drawings and Details

The City's standard drawings shall be used for public and private development projects and cannot be modified by designers on a project-by-project basis. It is the responsibility of the project engineer of record to incorporate these drawings as originally intended.

9.6 Plan Review and Approval Processes

The City's plan review and approval requirements are outlined in OCMC Title 17. The process may vary from one application, submittal, and building permit to another. To obtain further information on a specific plan review or permit process, contact the City.

9.7 Construction Considerations

If required, the engineer, contractor, applicant, City, and/or other related agency representatives will hold a pre-construction meeting to share information and requirements as specified in the stormwater management plan. Upon final completion of the construction, the Engineer of Record will certify that the construction as-built drawings are complete in all respects and built per the approved construction documents. At a minimum the following shall be done prior to requesting the final inspection of the stormwater facilities:

A. Clean all stormwater management facilities of sediment and debris.

B. Submit a Certification of Completion to certify that the project was constructed in accordance with the approved plans and City standards.

C. Submit a Vegetated Planting Certification to certify that water quality plantings were constructed in accordance with the approved plans and these standards.

D. Submit as-built drawings according to **Section 9.9**.

E. Submit storm video testing and reports for all public storm system construction.

F. Submit engineer inspection reports.

9.8 Warranty Surety

The City may require the applicant to submit a financial surety in a form acceptable to the city to guarantee performance or warranty of the requirements of these standards. In general, the warranty surety ensures that the owner/ applicant agrees to maintain, repair, replace, and be responsible for damage to the storm sewer for a warranty period of 2 years following the date

the City deems the improvements to be complete. Upon default, the City may perform the remaining work or remedy violations and draw upon the surety or available funds.

9.9 As-built Submittals

All drainage plans shall be as-built prior to the acceptance of the project. As-built drawings are necessary to ensure that the project was constructed per the approved plans. As-builts may be required in paper, Mylar, and/or electronic AutoCAD files, as determined by the City. The Engineer of Record is responsible for record keeping, inspection and preparation of the as-built drawings. As-built drawings shall contain, at a minimum, the following information:

A. Each page shall be stamped by the Professional Engineer and stated in writing that it is an as-built drawing.

B. Show final storm pipe material type in profile view.

C. Show alignment changes, slope changes, pipe size changes and changes in construction materials.

D. Indicate areas of rock removal not completed by standard backhoe (i.e., splitter or blasting).

E. Show storm service connections for each building lot with a callout showing the mainline stationing, pipe size, length, and depth at the property line.

F. Street stationing and other related information is allowed on the construction plans; however, this must be removed on the accepted as-built drawings.

G. Remove all hatching associated with material type.

H. Paper and electronic as-built drawings shall become the unencumbered property of the City and are public records that may be distributed as the City deems necessary.

I. The timely submittal of as-built plans is the responsibility of the Engineer of Record. The City requires all as-built drawings to be submitted within 60 days of completion of the project.

J. See the City's engineering policies for current as-built requirements.

APPENDIX A

Facility Planting Guidance

APPENDIX A. FACILITY PLANTING GUIDANCE

A.1 Introduction

This appendix provides information on plant selection and design guidance for a variety of stormwater management facilities. The role of plants in facilities is critical. The success or failure of a facility can depend on the proper selection and location of plants. The main purpose of vegetation in facilities is to provide the maximum amount of water quality benefit for stormwater management.

A complex combination of physical and biological processes work in tandem to maximize water quality within stormwater management facilities. In addition, there are a range of considerations for plant selection and design, including the site context, protection of native biodiversity, creation of habitat, limitation of noxious invasive species, site context, and aesthetics. The following sections provide guidance for the proper selection of plants.

This section provides guidance for preparing planting plans for stormwater management facilities including developing the plan, specifying growing media material, and selecting plant species. The guidance shall be incorporated into the landscape plan for each vegetated stormwater management facility proposed on a project.

> *"The surface area of a typical stormwater facility allows runoff to pond and evaporate while sediments settle into a layer of mulch. The organic mulch layer prevents soil bed erosion and retains moisture for plant roots. It also provides a medium for biological growth and the decomposition or decay of organic matter. The soil stores water and nutrients to support plant life. Worms and other soil organisms are very good at degrading organic pollutants, like petroleum-based compounds. They also help mix organic material, increase aeration, and improve water infiltration and water holding capacity. Bacteria and other beneficial soil microbes process the majority of pollutants, including most of the nitrogen. The stiff structure of plants such as rushes and sedges slows water passage and traps sediments within the surface area of the facility."*
>
> --City of Portland, BES
> *Stormwater Management Manual*, 2008

A.2 General

All vegetated stormwater management facilities proposed for City maintenance shall have a Landscape Plan prepared, stamped, and signed by a Landscape Architect or Professional Engineer.

A.2.1 Native and Adapted Plants

Plants approved for stormwater management facilities can be grouped into three categories: natives, native cultivars, and non-native adapted plants.

Native plants are plants that are indigenous to our specific region. They typically require minimal care once they are planted because they have evolved and adapted to the growing conditions and climate of the region. Because of their place in the local ecology, native plants also provide habitat value for birds and other local species. For these reasons, native plants and/or native cultivars are required for stormwater management facilities and should be used to the maximum extent practicable. In designated vegetated buffers and sensitive areas only native plants are allowed in stormwater management facilities.

Native cultivars are cultivated varieties of native plants produced by horticultural techniques and are not normally found in wild populations. Cultivars are bred for certain desired characteristics that make them different from their native counterparts. Native cultivars may be selected over a native plant if it is more suitable for certain conditions, such as densely urbanized applications. For example Kelsey Dogwood (*Cornus sericea 'Kelseyi*) is a cultivar of the native Red Twig Dogwood (*Cornus sericea*). Kelsey Dogwood has been selectively bred to be much smaller at maturity than red twig dogwood, which can be advantageous in small-scaled urban stormwater planters. In such instances, the native cultivar is preferred because it will not outgrow the facility or require frequent pruning maintenance, while still offering the same vegetative advantages as its native counterpart.

Non-native adapted plants are plants that are not native to our region, but have certain characteristics that make them very useful and well adapted to stormwater management facilities. The City prefers that native and native cultivars be used whenever practical, but will allow non-native adapted plants where appropriate.

A.2.2 Vegetated Facilities and Habitat

Vegetated stormwater management facilities can be designed to mimic the natural habitats, processes, and hydrology of a particular site.

The environmental benefits of these facilities include:

- Less disturbance to sites than conventional stormwater management methods
- Reduced and delayed peak stormwater flows
- Reduced discharge of pollutants
- Increased planted space and habitat
- Creation of a multifunctional landscape that enhances visual and functional amenities

Nearly all vegetated stormwater management facilities have the potential to create and improve habitat on and near the site through planting and vegetation. Each vegetated stormwater management facility has planting design guidelines such as required plant spacing and plant types, but there is flexibility to maximize habitat for a variety of organisms such as invertebrates, amphibians, small mammals, and birds. Created habitat can also enhance conditions for predators that feed on mosquitoes. These on-site benefits generate off-site benefits by reducing the negative environmental effects associated with urban development.

A.2.3 Climate and Microclimate

All stormwater management facility vegetation should be well-adapted to both the northwest regional climate and the facility's microclimate. Although regional climate dictates average seasonal temperatures, amount of rainfall and available daylight, site-specific microclimates can vary considerably and should be factored into the planting design, particularly in an urbanized environment. For example, sword fern is a plant native to woodlands of the Pacific Northwest that likely would not survive if placed in a south facing flow-through planter with direct sun exposure most of the day and heat radiating off the building. Sword fern placed in a flow-through planter on the north side of the building likely would thrive.

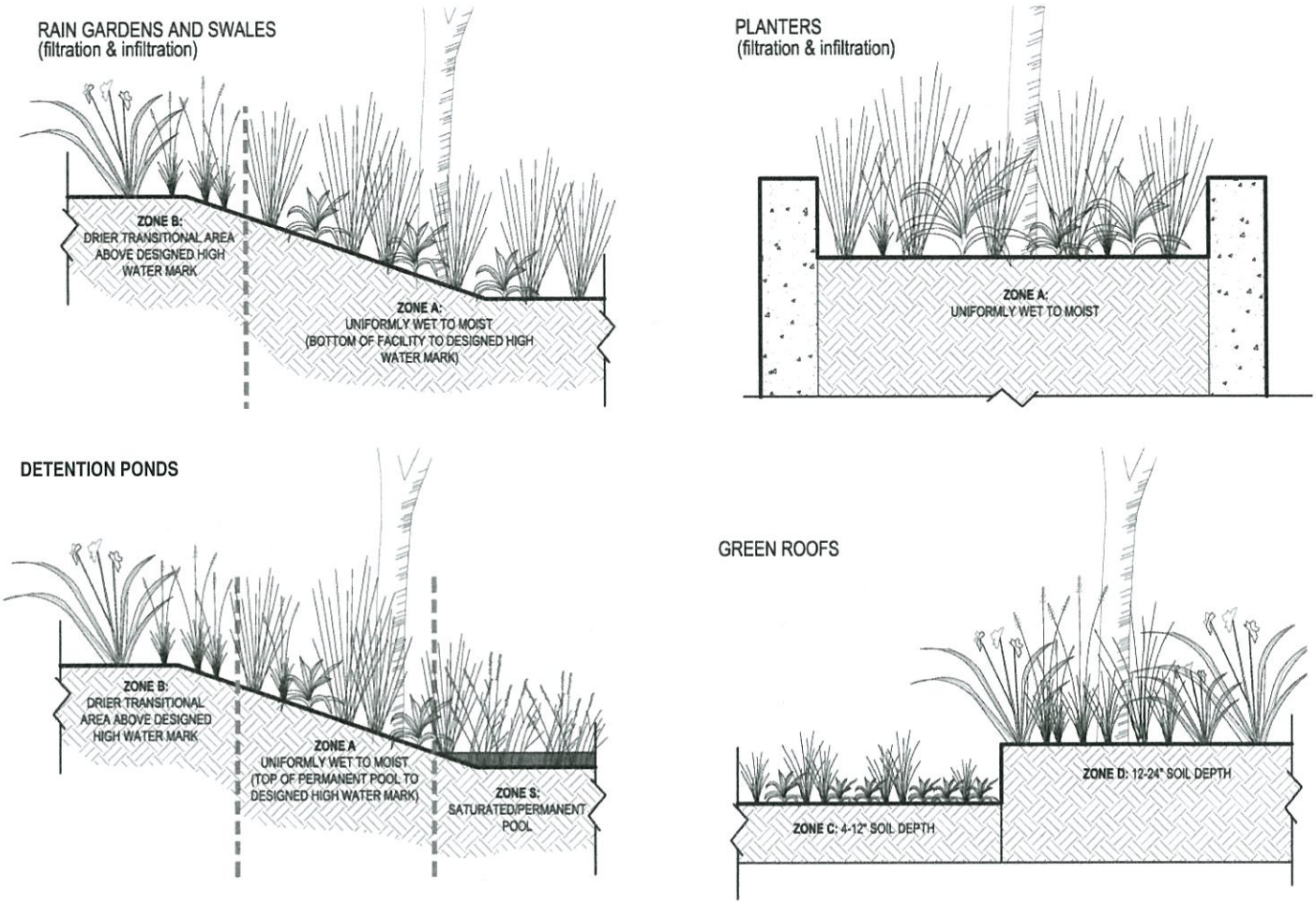
A.2.4 Habitat Diversity and Layering of Plants

Natural environments in the Pacific Northwest are characterized by diverse, layered plant habitats. A range of habitats can be created in vegetated stormwater management facilities by selecting complementary vegetation to plant together, such as groundcovers, perennials, shrubs, and trees. The structural variety of a diversified planting design can also improve site aesthetics. Plant selection should reflect this natural ordering of plantings, as well as mimicking a mixture of deciduous and evergreen materials.

A.2.5 Planting Zones by Facility Type

Vegetation for stormwater management facilities is categorized according to the degree of soil moisture that will be encountered in the facility. Planting conditions for sloped, basin-like stormwater management facilities such as swales, rain gardens and detention ponds have a moisture gradient which varies with the designed maximum water depth, the time it takes for a facility to drain after a storm event, and the steepness of the side slopes. Planting conditions are more uniform for planters and vegetated filter strips because of the relatively uniform and flat surface. For green roofs, the critical planting factor is the depth of the planting soil.

Consideration of these zones will enhance the success of a facility's planting design. The zone from the bottom of the facility to the designed high water line or top of freeboard should be planted with plants that tolerate occasional standing water and wet-to-moist conditions. Above the designed high water line vegetation is not affected by stormwater entering the facility and should be planted with species well-suited to the local climate and site-specific conditions. **Figure A-1** shows the planting zones for typical facility types.



A.2.6 Maintenance

Water efficient irrigation shall be applied for at least the first 2 years after construction of the facility, particularly during the dry summer months, while plantings become established. The applicant may choose the irrigation method such as by truck or irrigation system. When practicable, the on-site irrigation is recommended to maintain the plant survivability. Temporary irrigation will require its own service meter and backflow prevention device. Temporary irrigation systems must be fully removed before the City releases the warranty surety bond.

Additional maintenance practices include:

- Check regularly for weeds. Remove weeds or invasive plants such as blackberries and ivy, and implement a weed control program as needed.
- Check mulch regularly to maintain uniform coverage. Many vegetated stormwater management facilities specify a mulch cover such as river rock to prevent erosion and moisture loss during dry periods.
- Replant bare patches as necessary to comply with the facility's coverage requirements and maintenance plan.
- For a full list of maintenance practices for each type of stormwater management facility, see **Appendix C**.

A.2.7 Fencing

In some locations, OCMC Zoning Code may prohibit fencing or require screening. The designer is required to determine what sections of OCMC Zoning Code apply to the project. If fencing is prohibited, the designer may have to change the facility design to eliminate fencing requirements.

Where fences are required, height may range from 4 to 8 feet high depending on the location and security need as determined by the City Engineer. Fencing materials and colors shall be complementary to the site design.

Public Facilities: Fences are required for all ponds with slopes 3 feet horizontal to 1 foot vertical (3h: 1 v) or steeper, or any walls/bulkheads greater than 24 inches in height. However, a pond with gently sloping sides (less than 3h:v1) and a 10-foot-wide safety earth bench around the facility at the point of slope transition would not require a fence. For publicly maintained facilities, the City may authorize the use of chain link fencing for security and protection.When fencing is required around a pond, a minimum of one locking access gate shall be provided that is 16 feet wide, consisting of two swinging sections each 8 feet in width. At least one pedestrian gate must be provided, with a minimum 4-foot width. Fence material shall be No. 11 gauge galvanized steel fabric with bonded vinyl coating. Vinyl coating shall be a color designed to blend with the surrounding area (likely green, brown, or preferably black). Fence posts shall be galvanized steel, with top caps, and set a minimum of three feet deep in concrete. Crossbars shall connect adjacent fence posts, with diagonal braces at corners and ends. All posts, cross bars and gates shall be painted or coated the same color as the vinyl clad fence.

Private Facilities: Fencing for privately owned facilities is at the discretion of the owner. However, private owners are encouraged to follow the above criteria for public facilities when determining private facility requirements. When any fencing is used, it must be consistent with the City's fencing requirements. In some locations OCMC Zoning Code may prohibit or restrict the type of fencing or require screening. If fencing is prohibited, the designer may have to change the facility design to eliminate fencing requirements.

A.3 Planting Plan Methods

Planting plans shall be required for each vegetated stormwater management facility. Planting plans should address four major components: hydrology, soils, plant materials, and maintenance. When developing planting plans, the following steps should be used:

Step 1: Assess Hydrologic and Hydraulic Conditions

Use the hydrologic and hydraulic analysis for the facility to determine water levels for various storm events. Use the cross sections in **Figure A-1** to assign appropriate hydrologic zones to the facility and identify the hydrologic zones on the plan. Most facilities include one or more of the following planting zones with respect to hydrology during the growing season:

- Wet (Zone S): standing or flowing water/nearly constant saturation; anaerobic soils
- Moist (Zone A): periodically saturated; anaerobic and/or aerobic soils
- Dry (Zones B, C, and D): infrequent inundation/saturation, if any; aerobic soils

Step 2: Plant Selection

Identify plants to be preserved, select plant materials, designate quantities, placement and planting zones.

A. *Preservation:* Every effort shall be made to protect a site's existing native vegetation. Native vegetation along Sensitive Areas and Vegetated Buffers shall be retained to the maximum extent practicable.

B. *Selection:* Plant selection shall be from the plant lists found in **Tables A-1** through **A-4**. Unless approved by City staff, planting restrictions are as follows:

- Deep rooting trees and shrubs (e.g., willow) shall not be planted on top of concrete pipes, or within 10 feet of retaining walls, inlet/outlet structures or other culverts.
- Large trees or shrubs shall not be planted on berms over 4 feet tall that impound water. Small trees or shrubs with fibrous root systems may be installed on berms that impound water and are less than 4 feet tall.

C. *Quantities:* Plant quantities are calculated per 100 square foot of facility area. Plant quantities can be calculated as follows:

- Moisture Zone (S): 115 herbaceous plants
- Moisture Zone (A): 3 large shrubs/small trees, 4 small shrubs, and 115 groundcover plants
- Moisture Zone (B): 1 tree, 3 large shrubs/small trees, 4 small shrubs, and 115 groundcover plants
- Moisture Zone (C & D): 115 sedums, succulents, and herbaceous plants

- One tree is required for every 250 square feet of facility area. No trees, with the exception of street trees, are required for facilities less than 250 square feet or are narrower than 4 feet.

D. *Minimum Sizes:*

- Herbaceous plants: SP #4 container
- Small shrubs/groundcover: # 1 container
- Large shrubs/small trees: 30" Height
- Deciduous trees: 1" caliper
- Evergreen trees: 6' height

E. *Design:* All planting plans must have a minimum of 50 percent evergreen plants and at least two species from the herbaceous and small shrubs/groundcover plant communities. However, trees are not required or recommended in fully lined facilities.

Step 3: Installation

Determine plant installation requirements and assign specifications to plans.

A. *Timing:* Recommended installation timeframes are as follows. Planting or seeding outside these times may require additional measures to ensure survival which shall be specified on the plans and require City approval.

- Containerized stock: February 1 through May 1 and October 1 through November 15
- Bare root stock: December 15 through April 15

- Seeding: March 15 through October 15

B. *Erosion Control:* Grading, soil preparation, and seeding shall be performed during optimal weather conditions and at low flow levels to minimize sediment impacts. Site disturbance shall be minimized and desirable vegetation retained, where possible. Slopes shall be graded to support the establishment of vegetation. Where seeding is used for erosion control, an appropriate native grass, *Regreen* (or its equivalent), or sterile wheat shall be used to stabilize slopes until permanent vegetation is established. Biodegradable fabrics such as coir, coconut or approved jute matting (minimum ¼ inch square holes), may be used to stabilize slopes and channels. Fabrics such as burlap may be used to secure plant plugs in place and to discourage floating upon inundation. No plastic mesh that can entangle wildlife is permitted. Consult **Chapter 7** for additional information.

C. *Mulching:* Mulching for stormwater management facilities shall be per **Section A.4.7**.

D. *Plant Protection from Wildlife:* Depending on site conditions, appropriate measures shall be taken to limit wildlife-related damage.

E. *Irrigation:* Appropriate plant selection, along with adequate site preparation and maintenance, reduces the need for irrigation. However, unless site hydrology is currently adequate, a City approved irrigation system or equivalent shall be used during the 2-year plant establishment period. Watering shall be at a rate to maintain all plantings in a healthy thriving condition during establishment. Other irrigation techniques, such as deep watering, may be allowed with prior approval by City staff.

F. *Access:* Maintenance access requirements are provided in **Chapter 4.**

Step 4: Monitoring and Maintenance

Determine plant monitoring and maintenance requirements.

A. *Monitoring:* Site visits are necessary throughout the growing season to assess the status of the plantings, irrigation, mulching, etc. and ensure successful plant establishment. The determination of a successful plant establishment period will be made by periodic plant establishment inspections. A successful planting establishment for each inspection is defined as:

- All plants are surviving and have vigorous growth.
- Plants are free of insects and disease.
- Plants show signs of continuing health.
- Plants have not reached permanent wilting point.

B. *Weed Control:* The removal of non-native, invasive weeds shall be necessary throughout the maintenance period, or until a healthy stand of desirable vegetation is established.

C. *Plant Replacement and Preservation:* At the end of the maintenance period all plants not in a healthy growing condition will be noted and as soon as seasonal conditions permit shall be removed from the site and replaced with plants of the same species and size as originally specified. Prior to replacement, the cause of loss

(wildlife damage, poor plant stock, etc.) shall be documented with a description of the corrective actions taken.

Step 5: Construction Documents and Specifications

The construction documents and specifications shall include:

A. If applicable, *Sensitive Area* boundaries. Orange construction fencing shall be noted at buffer boundaries as well as at encroachment limits during construction.

B. Site preparation plan and specifications, including limits of clearing, existing plants and trees to be preserved, and methods for removal and control of invasive, non-native species, and location and depth of topsoil and/or compost to be added to planting area.

C. Planting plan and specifications, including all of the following:

- Planting table that documents the common name, scientific name, distribution (zone and spacing), condition and size of plantings
- Installation methods for plant materials
- Mulching
- Plant tagging for identification
- Plant protection
- Seeding mix, methods, rates, and areas

D. Irrigation plan and specifications, including identification of water source, and, maintenance of the system.

E. Maintenance schedule; including responsible party and contact information, dates of inspection (minimum three per growing season and one prior to onset of growing season) and estimated maintenance schedule (as necessary) over the 2-year monitoring period.

F. Access points for installation and maintenance including vehicle access if required.

G. Standard drawing details (north arrow, scale bar, property boundaries, project name, drawing date, name of designer and Property Owner).

A.4 Stormwater Management Facility Growing Medium

A soil analysis is required for the stormwater management facility growing medium for all public facilities and private facilities. A soil analysis is not required for single-family residential sites. The source of the growing medium must be identified in the construction documents.

Growing media specifications shall conform to the following:

A.4.1 Standard Blend for Public and Private Facilities

Use this blend for all vegetated stormwater management facilities.

A. *General Composition*: The medium shall be a blend of loamy soil, sand, and compost that is 30 to 40 percent compost (by volume) and meets the criteria in this specification.

B. *Analysis Requirements for Blended Material:* A particle gradation analysis of the blended material, including compost, shall be conducted in conformance with ASTM C1 17/C136 (AASHTO T1 1/T27). The analysis shall include the following sieve sizes: 1 inch, 3/8 inch, #4, #10, #20, #40, #60, #100, and #200. The gradation of the blend shall meet the following gradation criteria.

Sieve size	Percent passing
1 inch	100
# 4	60 -100
# 10	40-100
# 40	15-50
# 100	5-25
# 200	5-15

The blend shall have a Coefficient of Uniformity (D60/D10) equal to or greater than 6 to ensure that it is well graded (has a broad range of particle sizes). The coefficient is the ratio of two particle diameters on a grain-size distribution curve; it is the particle diameter at 60 percent passing divided by the particle diameter at 10 percent passing.

C. *Organic Matter Content:* An analysis of soil organic matter content shall be conducted in conformance with ASTM D2974 (loss on ignition test). The soil organic matter content shall be a minimum of 10 percent, as reported by that test.

D. *pH:* The blended material shall be tested and have a pH of 5.5 to 7.

A.4.2 General Requirements for Blended Material

The applicant will be responsible for assuring that all of the following general requirements for the blended material are met and providing documentation when requested:

A. The material shall be loose and friable.

B. It shall be well mixed and homogenous.

C. It shall be free of wood pieces, plastic, screened and free of stones 1 inch (25 mm) or larger in any dimension; free of roots, plants, sod, clods, clay lumps, pockets of coarse sand, paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials harmful to plant growth; free of weeds and invasive plants including but not limited to:

1. *Cirsium arvense* (Canadian Thistle)
2. *Convolvulus spp.* (Morning Glory)
3. *Cytisus scoparus* (Scotch Broom)
4. *Dipsacus sylvestris* (Common Teasel)
5. *Festuca arundinaceae* (Tall Fescue)
6. *Hedera helix* (English Ivy)
7. *Holcus canatus* (Velvet Grass)
8. *Lolium spp.* (Rye Grasses)

9. *Lotus corniculatus* (Bird's Foot Trefoil)
10. *Lythrium salicaria* (Purple Loose Strife)
11. *Melilotus spp.* (Sweet Clover)
12. *Myriophyllum spicatum* (Eurasian Milfoil)
13. *Phalaris arundinaceae* (Reed Canary Grass)
14. *Rubus discolor* (Himalayan Blackberry)
15. *Solanum spp.* (Nightshade)
16. *Trifolium spp.* (Clovers), and

D. It shall not be infested with nematodes, grubs, other pests, pest eggs, or other undesirable organisms and disease-causing plant pathogens; friable and with sufficient structure to give good tilth and aeration.

E. Continuous, air-filled, pore-space content on a volume/volume basis shall be at least 15 percent when moisture is present at field capacity. Soil shall have a field capacity of at least 15 percent on a dry weight basis.

F. It shall have no visible free water.

G. It shall be obtained from naturally well drained construction or mining sites where topsoil occurs at least 4 inches deep; it shall not be obtained from bogs, wetlands, or marshes.

A.4.3 Compost

The compost shall be derived from plant material and provided by a member of the U.S. Composting Council Seal of Testing Assurance (STA) program. A list of local providers can be accessed at www.compostingcouncil.org.

The compost shall be the result of the biological degradation and transformation of plant- derived materials under conditions designed to promote aerobic decomposition. The material shall be well composted, free of viable weed seeds, and stable with regard to oxygen consumption and carbon dioxide generation. The compost shall have no visible free water and produce no dust when handled. It shall meet the following criteria, as reported by the U.S. Composting Council STA Compost Technical Data Sheet provided by the vendor.

A. 100 percent of the material must pass through a 1/2-inch screen.

B. The pH of the material shall be between 6 and 8.

C. Manufactured inert material (plastic, concrete, ceramics, metal, etc.) shall be less than 1.0 percent by weight.

D. The organic matter content shall be between 35 and 65 percent.

E. The soluble salt content shall be less than 6.0 mmhos/cm.

F. Germination (an indicator of maturity) shall be greater than 80 percent.

G. The stability shall be between classes 5-7.

H. The carbon/nitrogen ratio shall be less than 25:1.

I. The trace metals test result = "pass."

A.4.4 Documentation

The City requires the applicant to review and retain the following documentation for stormwater management facility growing medium. This documentation shall be submitted upon request.

A. Documentation for the analysis described in **Section A.4.1.B** of this specification (particle gradation with calculated coefficient of uniformity; organic matter content; pH). The analysis shall be performed by an accredited laboratory with certification maintained current. The date of the analysis shall be no more than 90 calendar days prior to the date of the submittal. The report shall include the following information:
   - Name and address of the laboratory
   - Phone contact and e-mail address for the laboratory
   - Test data, including the date and name of the test procedure

B. A compost technical data sheet from the vendor of the compost. The analysis and report must be consistent with the sampling and reporting requirements of the U.S. Composting Council STA program. The analysis shall be performed and reported by an approved independent STA program laboratory.
   - The date of the analysis shall be no more than 90 calendar days prior to the date of the submittal.
   - A description of the location, equipment, and method proposed to mix the material.

A.4.5 Growing Medium Installation

A. *Protection of the Growing Medium:* The growing medium shall be protected from all sources of contamination, including weed seeds, while at the supplier, in conveyance, and at the project site.

B. *Placement of the Growing Medium:* The medium shall be placed in loose lifts, not to exceed 8 inches each and each lift shall be compacted with a water-filled landscape roller. The material shall not otherwise be mechanically compacted.

C. *Timing of Plant Installation:* Weather permitting, plants shall be installed as soon as possible after placing and grading the growing medium in order to minimize erosion and further compaction.

D. *Erosion Control:* Temporary erosion control measures are required until permanent stabilization measures are functional, including protection of overflow structures.

E. *Protection of the Facility:* In all cases, the facility must be protected from foot or equipment traffic that is unrelated to the construction of the facility. Temporary fencing or walkways should be installed as needed to keep workers, pedestrians, and equipment out of the facility. Under no circumstances should materials and equipment be stored in the facility.

F. *Wet and Winter Conditions:* Placement of the growing medium will not be allowed when the ground is frozen or saturated or when the weather is determined to be too wet.

A.4.6 Watering, Fertilizing, and Mulching

A. Water all plants during establishment to maintain all plantings in a healthy thriving condition.

B. Fertilizers should generally be avoided in stormwater management facilities. Fertilize all plants during establishment as needed with slow release, organic (low yield) material.

C. The purpose of mulching soils is to conserve moisture, hold plantings and topsoil in place, limit weed establishment and moderate soil temperatures.

D. Mulch for Vegetated Stormwater Management Facilities: The use of mulch in frequently inundated areas shall be limited, to avoid any possible water quality impacts including the leaching of tannins and nutrients, and the migration of mulch into waterways. Mulches to be used are a stable and inert (non-leaching) matter of sufficient mass and density that it will not float in standard flows. Mulch cover should be maintained throughout the life of the stormwater management facility with minimum thickness of 2 inches in depth.

A.5 Stormwater Management Facility Plant Lists

A.5.1 Selecting Plants

The plant lists provided in the following tables are separated by stormwater management facility type. Each facility list includes a suitability matrix for limiting contextual factors (such as moisture zones and width of facility) as well as a listing of specific characteristics for each species and the recommended on-center spacing. The species listed are representative examples and are not to be considered exclusive or exhaustive for these facility types. A comprehensive Native Plant Species List for planting within Oregon City can be found at the City's website. When a conflict exists between the representative species outlined within this publication and the Native Plant Species List, the Native Plant List will prevail.

An alternate plant selection will be allowed if proposed by a landscape architect or certified arborist.

No species adopted within the Oregon City Nuisance Plant List will be permitted.

The Native Plant List contains several native plants that are suggested as suitable for planting in and around stormwater management facilities. Select plant species suited to the expected hydrological conditions. Consider the maximum depth and duration of inundation, duration of saturation. Also, consider whether the site will dry out completely in the summer. The list includes the typical range of hydrological conditions under which the plants normally grow.

The following characteristics are included in plant matrices to aid in plant selection:

- **Botanical name, Common Name:** Plants are listed by their botanical name first, in italics, followed by a generally accepted common name. Note that common names vary, so use of the botanical name is recommended to ensure proper plant selection.
- **Zone:** Denotes the planting moisture zone as noted in the facility diagrams in **Figure A-1.** Some plants work in multiple moisture zones, and others only in a particular dry, moist, or wet condition.

- **Origin:** As described in **Section A.2.1**, the distinction between Northwest native plants, cultivated varieties of Northwest Natives, and plants that are non-native but adapted to our specific climate.
- **Type/Size**: A range of factors to aid in plant selection showing individual plant characteristics:
  - *(E)vergreen/(D)ecidious:* Identifies the characteristic of a plant to keep foliage during winter months. Planting placement and selection should maintain a balance of evergreen and deciduous materials.
  - *Potential Height:* Maximum size at maturity to use as a design guideline.
  - *On-Center Spacing:* Optimum spacing for new plantings. This is to be used as a guideline and may vary slightly depending on site conditions.
- Context Factors
  - *Facilities less than 3 feet wide:* Narrow conditions require plants that are not too large and will outgrow or have potential for roots to damage narrow planters.
  - *Fully Lined Facility:* Limit larger material or plants with aggressive roots
  - *Parking Area:* Use plant materials that do not limit necessary line of sight visibility.
  - *Streets:* Use plant materials that do not limit necessary line of sight visibility.
  - *Adjacent to Buildings:* Limit plants that are too large for areas next to buildings and would not be compatible with building footings, windows or other systems.

TABLE A-1: Representative Plant Lists: Stormwater Planters (Infiltration and Filtration)

Stormwater Planters (infiltration and filtration)		Zone	Origin			Type/Size			Context Factors					
Plant Name ***Botanical*, Common**	*Photo*	Moisture zone (A) Uniformly wet to moist	NW native	NW native cultivar	Non-native adapted	(E)vergreen /(D)eciduous	Potential height	Typical on center spacing	Facilities < 3 feet wide	Fully-lined facility	Parking areas	Streets	Adjacent to buildings	In buffer area
Herbaceous Plants														
Carex densa, Dense sedge		•	•			E	24"	12"	•	•	•	•	•	•
Carex rupestris, Curly sedge	x	•			•	D	14"	12"	•	•	•	•	•	
Carex testacea, New Zealand orange sedge		•			•	E	24"	12"	•	•	•	•	•	
Eleocharis ovata, Ovate spike rush		•	•			E	30"	12"	•	•	•	•	•	•
Juncus ensifolius, Dagger-leaf rush		•			•	D	10"	12"	•	•	•	•	•	
Juncus patens, Spreading rush	x	•	•			E	36"	12"	•	•	•	•	•	•
Shrubs/Groundcover														
Cornus sericea, Red twig dogwood		•	•			D	6'	4'			•		•	•
Cornus sericea 'Kelseyi', Kelsey dogwood		•		•		D	24"	24"	•	•	•	•	•	
Mahonia aquifolium, Oregon grape		•	•			E	5'	3'		•	•	•	•	•
Fragaria chiloensis, Coastal strawberry		•	•			E	6"	12"	•	•	•	•	•	•
Physocarpus capitatus, Pacific ninebark		•	•			D	10'	3'		•				•
Polystichum munitum, Sword fern	x	•	•			E	2'	2'	•	•	•	•	•	•
Rosa pisocarpa, Swamp rose		•	•			D	8'	3'		•			•	•
Large Shrubs/Small Trees														
Rubus spectabilis, Salmonberry		•	•			D	10'	4'		•			•	•
Salix lucida var. 'Lasiandra', Pacific willow		•		•		D	13'	6'						
Salix purpurea nana, Blue arctic willow		•			•	D	8'	6'			•			
Salix sitchensis, Sitka willow		•	•			D	20'	6'						•
Spirea douglasii, Douglas spiraea		•	•			D	7'	4'		•			•	•
Viburnum edule, Highbush cranberry		•	•			D	6'	4'		•	•	•		•
Trees														
Acer circinatum, Vine maple		•	•			D	15'	10'	•	•	•		•	•
Acer rubrum, Red maple		•			•	D	40'	25'		•	•	•		
Alnus rubra, Red alder		•	•			D	80'	15'			•			•
Crataegus douglasii, Black hawthorn		•	•			D	40'	10'		•	•			•
Fraxinus latifolia, Oregon ash		•	•			D	30'	20'			•			•
Malus fusca, Pacific crabapple		•	•			D	30'	10'	•	•	•			•
Nyssa sylvatica, Black tupelo		•			•	D	25'	20'			•	•		
Salix hookeriana, Hooker's willow		•	•			D	15'	10'			•			•
Thuja plicata, Western red cedar		•	•			E	150'	25'			•			•

TABLE A-2: Representative Plant Lists: Rain Gardens and Swales (Infiltration and Filtration)

Rain Gardens and Swales (infiltration and filtration)	Zone		Origin				Type/Size		Context Factors					
Plant Name ***Botanical*, common**	Moisture zone (A) Uniformly wet to moist	Moisture zone (B) Drier transitional area	NW native	NW native cultivar	Non-native adapted	Evergreen/Deciduous	Potential height	Typical on center spacing	Facilities < 3 feet wide	Fully-lined facility	Parking areas	Streets	Adjacent to buildings	In buffer area
Herbaceous Plants														
Carex obnupta, Slough sedge	•		•			E	48"	12"		•	•	•	•	•
Carex testacea, New Zealand orange sedge	•				•	D	24"	12"		•	•	•	•	
Deschampsia cespitosa, Tufted hair grass	•		•			D	36"	12"	•	•	•	•	•	•
Elymus glaucus, Blue wild rye	•	•	•			E	24"	12"	•	•	•	•	•	•
Juncus ensifolius, Dagger-leaf rush	•				•	D	10"	12"	•	•	•	•	•	
Juncus patens, Spreading rush	•	•			•	E	36"	12"	•	•	•	•	•	
Scirpus microcarpus, Small fruited bulrush	•		•			E	24"	12"	•	•	•	•	•	•
Small Shrubs/Groundcover														
Arctostaphylos uva-ursi, Kinnickinnick		•	•			E	6"	12"	•	•	•	•	•	•
Cornus sericea 'Kelseyi', Kelsey dogwood	•	•		•		D	2'	12"	•	•	•	•	•	
Fragaria chiloensis, Coastal strawberry		•	•			E	6"	12"	•	•	•	•	•	•
Mahonia aquifolium, Oregon grape	•	•	•			E	5'	3'		•	•	•	•	•
Physocarpus capitatus, Pacific ninebark	•		•			D	6'	3'		•				•
Polystichum munitum, Sword fern	•	•	•			E	2'	2'	•	•	•	•	•	•
Spirea betulifolia, Birchleaf spiraea	•	•	•			D	2'	2'	•	•	•	•	•	•
Symphoricarpus alba, Snowberry	•	•	•			D	3'	3'	•	•	•	•	•	•
Large Shrubs/Small Trees														
Cornus sericea, Red-Twig dogwood	•	•	•			D	6'	4'						•
Holodiscus discolor, Western serviceberry	•	•	•			D	6'	4'		•	•	•		•
Rosa nutkana, Nootka rose	•	•	•			D	8'	4'		•		•		•
Omleria cerasiformis, Indian plum	•		•			D	6'	4'		•	•	•		•
Ribes sanguimeum, Red flowering currant	•	•	•			D	8'	4'		•	•	•	•	•
Salix sitchensis, Sitka willow	•		•			D	15'	5'						•
Spirea douglasii, Douglas spiraea		•	•			D	7'	4'		•	•	•	•	•
Trees														
Acer circinatum, Vine maple	•	•	•			D	15'	8'	•	•	•	•	•	•
Alnus rubra, Red alder	•	•	•			D	80'	20'					•	•
Cornus nuttalii, Pacific dogwood	•	•	•			D	20'	10'	•	•	•	•	•	•
Fraxinus latifolia, Oregon ash	•		•			D	30'	25'						•
Malus fusca, Pacific crabapple	•		•			D	30'	10'	•	•			•	•
Pseudotsuga menziesii, Douglas fir	•	•	•			E	200'	30'						•
Thuja plicata, Western red cedar	•	•	•			E	150'	20'			•			•

TABLE A-3: Representative Plant Lists: Ponds

Ponds	Zone			Origin				Type/Size		Context Factors					
Plant Name ***Botanical*, common**	Moisture zone (S) Saturated/permanent pool	Moisture zone (A) Uniformly wet to moist	Moisture Zone (B) Drier transitional area	NW native	NW native cultivar	Non-native adapted	(E)vergreen/(D)eciduous	Potential height	Typical on center spacing	Facilities < 3 feet wide	Fully -lined facility	Parking areas	Streets	Adjacent to buildings	In buffer area
Herbaceous Plants															
Alisma plantago-aquatica, Water plantain	•			•			D	24"	12"	•	•				•
Camassia quamash, Camas lily		•	•	•			D	24"	12"	•	•	•	•	•	•
Carex obnupta, Slough sedge	•	•		•			E	48"	12"		•	•	•	•	•
Deschampsia cespitosa, Tufted hair grass		•		•			D	36"	12"	•	•	•	•	•	•
Eleocharis ovata, Ovate spike rush	•			•			E	30"	12"	•	•				•
Elymus glaucus, Blue wild rye		•	•	•			E	24"	12"	•	•	•	•	•	•
Juncus ensifolius, Dagger-leaf rush	•	•				•	D	10"	12"	•	•	•	•	•	
Juncus patens, Spreading rush	•	•	•			•	E	36"	12"	•	•	•	•	•	
Sagittaria latifolia, Wapato	•			•			D	24"	12"	•	•				•
Scirpus acutus, Hardstem bulrush	•					•	D	10"	12"	•	•				
Scirpus microcarpus, Small fruited bulrush	•	•		•			E	24"	12"	•	•	•	•	•	•
Veronica liwanensis, Speedwell		•				•	D	2"	12"	•	•	•	•	•	
Small Shrubs/Groundcover															
Cornus sericea 'Kelseyi', Kelsey dogwood	•	•	•		•		D	2'	1'	•	•	•	•	•	•
Mahonia aquifolium, Oregon grape		•	•	•			E	5'	3'		•	•	•	•	•
Physocarpus capitatus, Pacific ninebark	•	•		•			D	6'	3'		•				•
Polystichum munitum, Sword fern		•	•	•			E	2'	2'	•	•	•	•	•	•
Spirea betulifolia, Birchleaf spiraea		•	•	•			D	2'	2'	•	•	•	•	•	•
Smphoricarpus alba, Snowberry		•	•	•			D	3'	3'	•	•	•	•	•	•
Large Shrubs/Small Trees															
Cornus sericea, Red-Twig Dogwood	•	•	•	•			D	6'	4'						•
Holodiscus discolor, Western serviceberry		•	•	•			D	6'	4'		•	•	•		•
Rosa nutkana, Nootka rose		•	•	•			D	8'	4'		•		•		•
Omleria cerasiformis, Indian plum		•		•			D	6'	4'		•	•	•		•
Ribes sanguimeum, Red flowering currant		•	•	•			D	8'	4'		•	•	•	•	•
Salix sitchensis, Sitka willow	•	•		•			D	15'	5'						•
Spirea douglasii, Douglas Spiraea			•	•			D	7'	4'		•	•	•	•	•
Ceanothus velutinus, Snowbrush		•	•	•			E	6'	3'		•	•	•	•	•

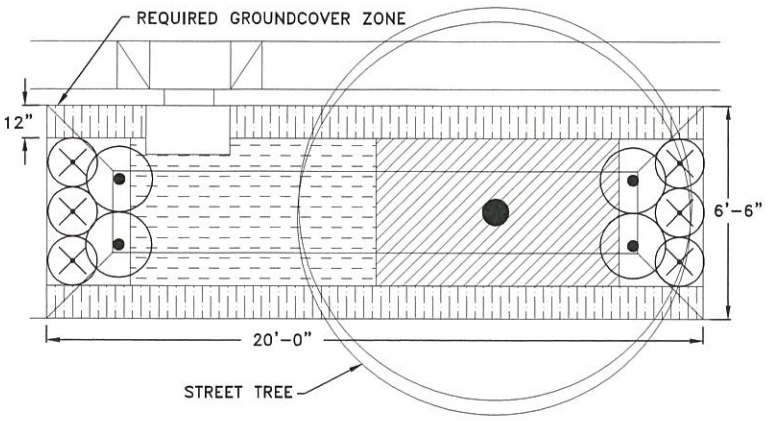
TABLE A-3: Representative Plant Lists: Ponds

Ponds	Zone			Origin				Type/Size		Context Factors					
Plant Name ***Botanical*, common**	Moisture zone (S) Saturated/permanent pool	Moisture zone (A) Uniformly wet to moist	Moisture Zone (B) Drier transitional area	NW native	NW native cultivar	Non-native adapted	(E)vergreen/(D)eciduous	Potential height	Typical on center spacing	Facilities < 3 feet wide	Fully -lined facility	Parking areas	Streets	Adjacent to buildings	In buffer area
Trees															
Acer circinatum, Vine maple		•	•	•			D	15'	8'	•	•	•	•	•	•
Acer rubrum, Red Maple	•	•	•			•	D	40'	25'		•	•	•		
Alnus rubra, Red alder	•			•			D	80'	20'					•	•
Cornus nuttalii, Pacific Dogwood		•	•	•			D	20'	10'	•	•	•	•	•	•
Fraxinus latifolia, Oregon Ash	•	•		•			D	30'	25'						•
Malus fusca, Pacific Crabapple	•	•		•			D	30'	10'	•	•			•	•
Pseudotsuga menziesii, Douglas fir		•	•	•			E	200'	30'						•
Thuja plicata, Western red cedar	•	•	•	•			E	150'	20'			•			•

TABLE A-4: Representative Plant Lists: Green Roofs

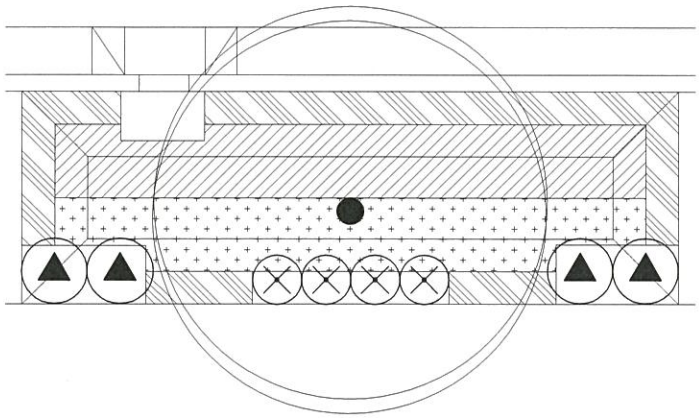
Green Roofs	Zone		Origin				Type/Size	
Plant Name ***Botanical*, common**	Moisture Zone (C) Extensive Ecoroof	Moisture zone (D) Intensive Roof Garden	NW native	NW native cultivar	Non-native adapted	(E)vergreen/(D)eciduous	Potential height	Typical on center spacing
Sedums and Succulents								
Delosperma ssp., Ice plant	•	•			•	E	4"	6-12"
Malephora crocea v. purpureo, Coppery mesemb	•	•			•	E	10"	6-12"
Sedum acre, Biting stonecrop	•				•	E	2"	6-12"
Sedum album, White stonecrop	•				•	E	3"	6-12"
Sedum divergens, Pacific stonecrop	•				•	E	3"	6-12"
Sedum hispanicum, Spanish stonecrop	•				•	E	3"	6-12"
Sedum kamtschaticum, Kirin-so	•	•			•	D	6"	6-12"
Sedum oreganum, Oregon stonecrop	•	•	•			E	4"	6-12"
Sedum sexangulare, Tasteless stonecrop	•	•			•	E	4"	6-12"
Sedum spathufolium, Stonecrop	•	•			•	E	4"	6-12"
Sedum spurium, Two-row stonecrop	•	•			•	E	6"	6-12"
Sempervivum tectorum, Hens and chicks	•				•	E	3"	6-12"
Herbaceous Plants								
Achillea millefolium, Common yarrow	•	•			•	D	24"	24"
Artemesia 'Silver Mound', Artemesia	•	•			•	D	12"	12"
Castilleja foliosa, Indian paintbrush	•	•	•			D	10"	12"
Dianthus ssp., Dianthus	•				•	D	12"	12"
Erigeron discoideus, Fleabane	•				•	D	12"	12"
Festuca glauca 'Elijah's Blue', Elijah's blue fescue	•	•			•	E	12"	12"
Fragaria chiloensis, Coastal strawberry	•	•	•			E	6"	12"
Gilia capitata, Blue thimble flower	•		•			D	12"	12"
Lobularia maritima, Sweet alyssum	•				•	D	12"	12"
Polystichum munitum, Sword fern	•	•	•			E	24"	24"
Thymus serphyllum, Creeping thyme	•				•	D	3"	6"
Veronica liwanensis, Speedwell	•				•	D	2"	6"

PLANT DIAGRAM AND LEGEND 1



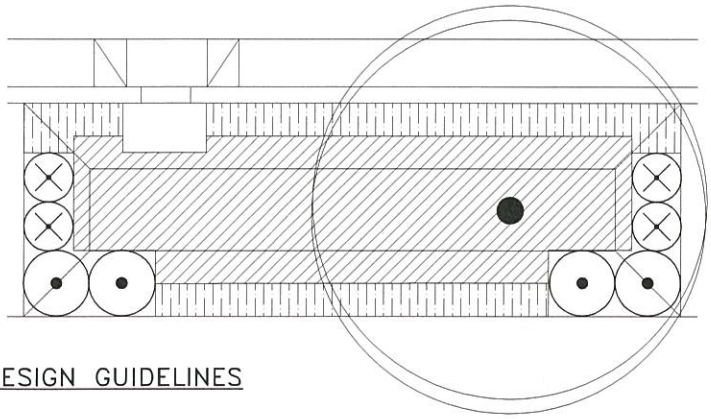
Symbol	Botanical name COMMON NAME	E/D	O.C.	QTY
ZONE A				
	Carex rupestris CURLY SEDGE	E	12"	32
	Juncus patens SPREADING RUSH	E	12"	33
	Spirea douglasii DOUGLAS SPIRAEA	D	24"	4
ZONE B				
	Fragaria chiloensis COASTAL STRAWBERRY	E	12"	37
	Mahonia aquifolium OREGON GRAPE	E	18"	6

PLANT DIAGRAM AND LEGEND 2



Symbol	Botanical name COMMON NAME	E/D	O.C.	QTY
ZONE A				
	Carex densa DENSE SEDGE	E	12"	36
	Juncus patens SPREADING RUSH	E	12"	39
ZONE B				
	Rubus spectabilis SALMONBERRY	E	18"	31
	Mahonia aquifolium OREGON GRAPE	E	18"	4
	Rosa pisocarpa SWAMP ROSE	D	24"	4

PLANT DIAGRAM AND LEGEND 3



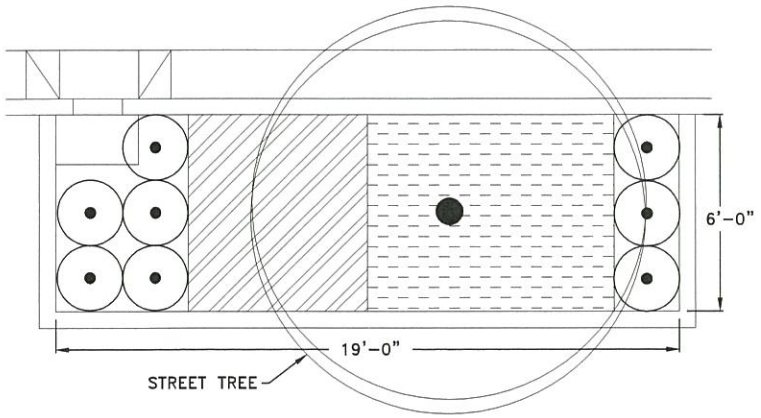
Symbol	Botanical name COMMON NAME	E/D	O.C.	QTY
ZONE A				
	Juncus patens SPREADING RUSH	E	12"	38
ZONE B				
	Fragaria chiloensis COASTAL STRAWBERRY	E	12"	19
	Mahonia aquifolium OREGON GRAPE	E	18"	4
	Spirea douglasii DOUGLAS SPIRAEA	D	24"	4

DESIGN GUIDELINES

1. These are example planting diagrams provided by the City of Oregon City. Choose a planting diagram and alter it to your design. Other planting designs may be approved.
2. See Table A–1 for typical plant spacing and design considerations.
3. Planting legends shown here do not include all required information for landscape plans.

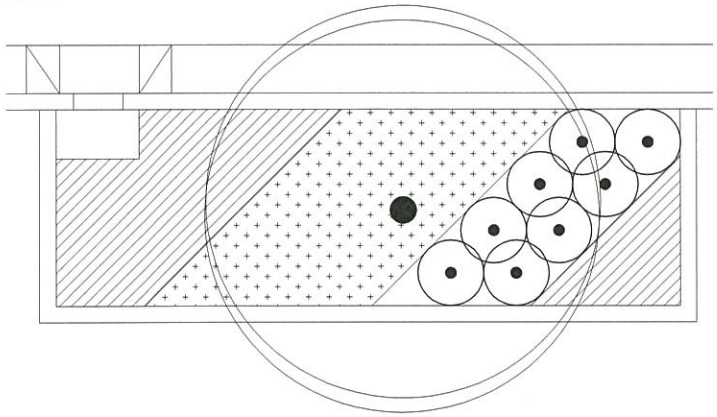
Rain Garden Example Planting Diagram
Figure A–1

PLANT DIAGRAM AND LEGEND 1



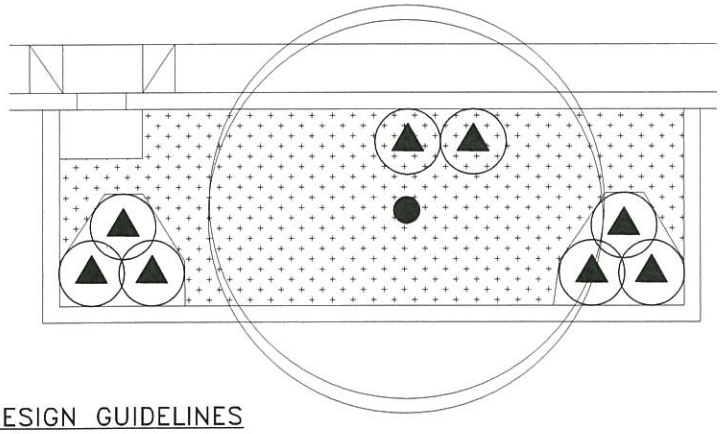
Symbol	Botanical name COMMON NAME	E/D	O.C.	QTY
	Carex ruperstris CURLY SEDGE	E	12"	45
	Juncus ensifolius DAGGER-LEAF RUSH	D	12"	33
	Cornus sericea 'Kelseyi' KELSEY DOGWOOD	D	24"	8

PLANT DIAGRAM AND LEGEND 2



Symbol	Botanical name COMMON NAME	E/D	O.C.	QTY
	Carex densa DENSE SEDGE	E	12"	43
	Juncus patens SPREADING RUSH	D	12"	40
	Cornus sericea 'Kelseyi' KELSEY DOGWOOD	D	24"	8

PLANT DIAGRAM AND LEGEND 3

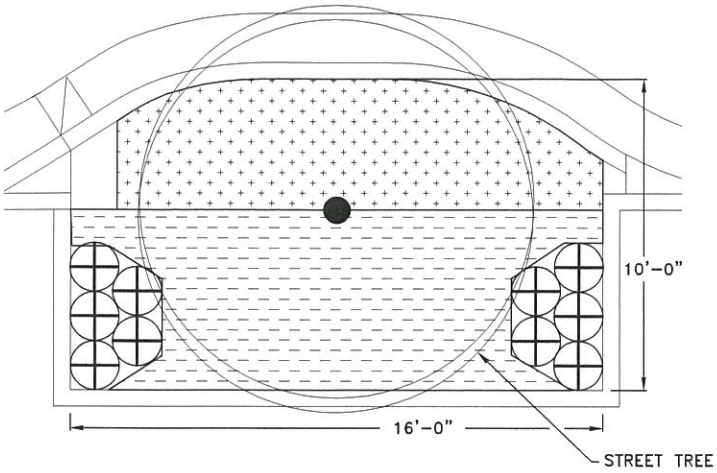


Symbol	Botanical name COMMON NAME	E/D	O.C.	QTY
	Carex densa DENSE SEDGE	E	12"	56
	Rosa pisocarpa SWAMP ROSE	D	24"	8

DESIGN GUIDELINES

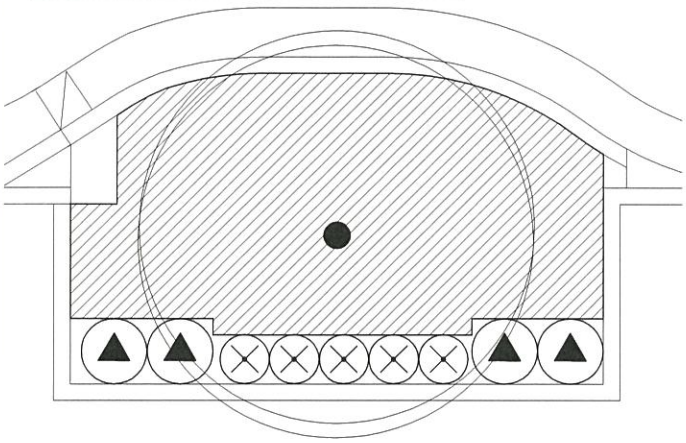
1. These are example planting diagrams provided by the City of Oregon City. Choose a planting diagram and alter it to your design. Other planting designs may be approved.
2. See Table A-1 for typical plant spacing and design considerations.
3. Planting legends shown here do not include all required information for landscape plans.

PLANT DIAGRAM AND LEGEND 1



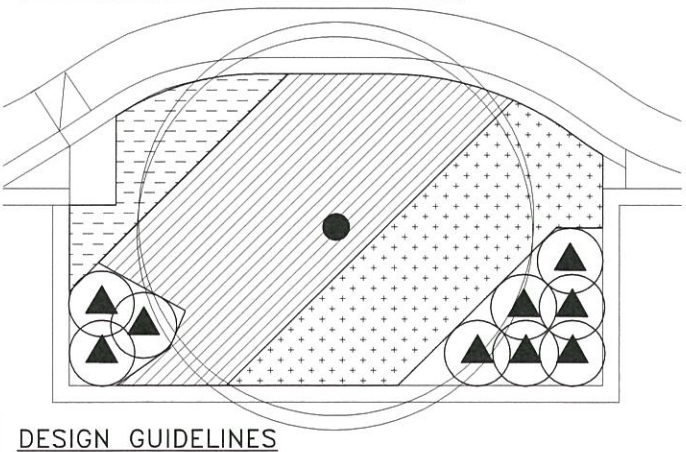
Symbol	Botanical name COMMON NAME	E/D	O.C.	QTY
	Carex rupestris CURLY SEDGE	E	12"	68
	Carex densa DENSE SEDGE	D	12"	52
	Spirea douglasii DOUGLAS SPIRAEA	D	18"	10

PLANT DIAGRAM AND LEGEND 2



Symbol	Botanical name COMMON NAME	E/D	O.C.	QTY
	Juncus patens SPREADING RUSH	E	12"	68
	Mahonia aquifolium OREGON GRAPE	E	18"	5
	Rosa pisocarpa SWAMP ROSE	D	24"	4

PLANT DIAGRAM AND LEGEND 3



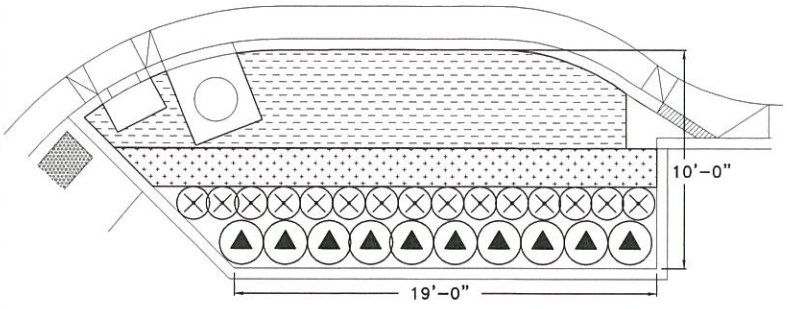
Symbol	Botanical name COMMON NAME	E/D	O.C.	QTY
	Carex rupestris CURLY SEDGE	E	12"	15
	Carex densa DENSE SEDGE	E	12"	41
	Juncus patens SPREADING RUSH	E	12"	59
	Rosa pisocarpa SWAMP ROSE	D	24"	9

DESIGN GUIDELINES

1. These are example planting diagrams provided by the City of Oregon City. Choose a planting diagram and alter it to your design. Other planting designs may be approved.
2. See Table A-1 for typical plant spacing and design considerations.
3. Planting legends shown here do not include all required information for landscape plans.

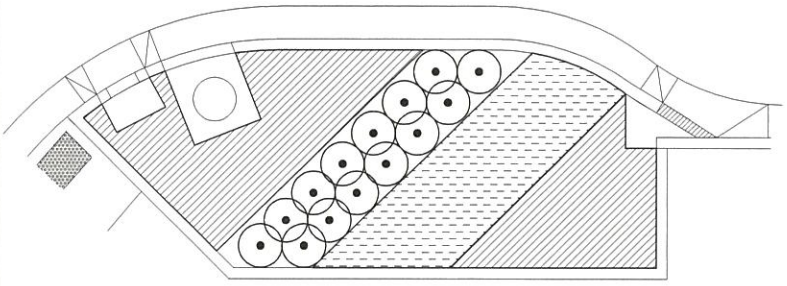
Stormwater Planter (Midblock Curb) Example Planting Diagram
Figure A-3

PLANT DIAGRAM AND LEGEND 1



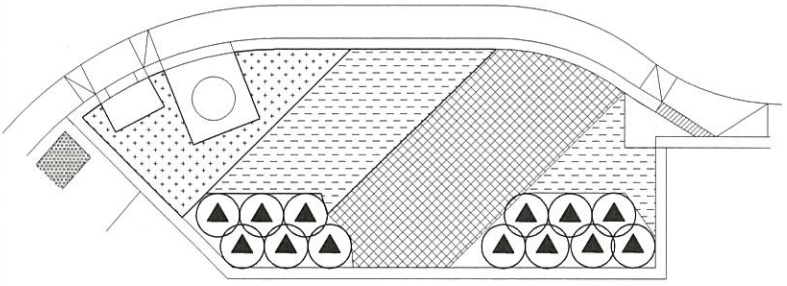
Symbol	Botanical name COMMON NAME	E/D	O.C.	QTY
	Carex rupestris CURLY SEDGE	E	12"	82
	Carex densa DENSE SEDGE	E	12"	42
⊗	Mahonia aquifolium OREGON GRAPE	E	18"	15
▲	Rosa pisocarpa SWAMP ROSE	D	24"	10

PLANT DIAGRAM AND LEGEND 2



Symbol	Botanical name COMMON NAME	E/D	O.C.	QTY
	Carex rupestris CURLY SEDGE	E	12"	56
	Juncus patens SPREADING RUSH	E	12"	96
⊙	Cornus sericea 'Kelseyi' KELSEY DOGWOOD	D	24"	14

PLANT DIAGRAM AND LEGEND 3



Symbol	Botanical name COMMON NAME	E/D	O.C.	QTY
	Carex rupestris CURLY SEDGE	E	12"	58
	Carex densa DENSE SEDGE	E	12"	30
	Carex testacea NEW ZEALAND ORANGE SEDGE	E	12"	68
▲	Rosa pisocarpa SWAMP ROSE	D	24"	13

DESIGN GUIDELINES

1. These are example planting diagrams provided by the City of Oregon City. Choose a planting diagram and alter it to your design. Other planting designs may be approved.
2. See Table A–1 for typical plant spacing and design considerations.
3. Planting legends shown here do not include all required information for landscape plans.

Stormwater Planter (Intersection Curb)
Example Planting Diagram
Figure A–4

APPENDIX B

Site Assessment and Planning Checklist

SITE ASSESSMENT AND PRELIMINARY DESIGN CHECKLIST		
✓	**Information needed**	**Attach supporting materials as needed**
2.2.1 Site Information		
	Applicant contact information	Applicant name: _____ Business name: _____ Contact address, phone number, and e-mail: _____ _____ _____
	Project location	Site address: _____ Site description: _____ _____ _____ Major drainage basin: _____ Is the project site located with the NROD as defined in OCMC 17.49? _____ (Y/N) *Include a vicinity map of the site (including location of property in relation to adjacent properties, roads, and pedestrian/bike facilities).*
	Project type	Identify types of development planned for the site such as commercial, industrial, single-family residential, multi-family residential, or other (describe):
	Size of site	Size of site: _____ (acres) Number of existing/proposed tax lots: _____ Amount of new and replaced impervious area: _____ (SF)
2.2.2 Site Assessment *Note: Site assessment information may be available from the OCMaps online tool available through the City's website.*		
	Site Assessment Map	*Attach engineered scale Site Assessment Map, showing items below.*
	Topography Evaluate site and map slopes: *Flat: 0-10%* *Moderate: 10-25%* *Steep: 25% and greater*	*Surveyed or aerial-based mapping with 2-foot intervals for slopes 0-25% slope and 10-foot intervals for steeper. Indicate Geologic Hazard Areas as defined by OCMC 17.04.510 and Geologic Hazards Overlay Zone as defined by OCMC 17.04.515.*
	Soils and Groundwater Research and map site soil hydrologic group, depth to groundwater	NRCS Hydrologic Soil Type (show on map if more than one type present): *Attach seasonal groundwater depth evaluation if available or required (site has floodplain and/or wetland). Groundwater depth information is available from the City.*
	Infiltration Assessment Determine soil capacity for onsite infiltration	If an infiltration test is performed, attach the documentation. Report the test type (Basic/Professional) performed and results. See **Appendix D** for the approved infiltration testing methods. Test type: _____ _____ (inches/hour)

SITE ASSESSMENT AND PRELIMINARY DESIGN CHECKLIST		
	Hydrology – Conditions and Natural Features Map site floodplains, wetlands, streams, and location of outfalls	Clearly label on map all intermittent and perennial creeks/streams/rivers and wetlands, FEMA floodplains, and existing drainage systems (pipes, ditches, outfalls). Check here if present on site: _____ Sensitive area(s) _____ Floodplain _____
	Downstream Conveyance	Indicate the proposed point of discharge on the site plan. *Prepare and attach a Downstream Analysis as required by* ***Chapter 5****.* Check here to verify that adequate downstream capacity is available: _____
	Existing Vegetation Map trees and vegetation	Using aerial photos or survey, map all trees and vegetation. Note all existing trees 6-inch caliper and greater (DBH) on map. Delineate and identify other areas and types of existing vegetation. The local planning authority may require a formal tree survey.
	Required Vegetated Buffers and Setbacks Assess and map buffers	Identify required vegetated buffer areas and other setback limits as defined by OCMC Title 17.
	Land Use and Zoning	Existing Land Use Zoning designation(s): _____
	Access and Parking	Delineate proposed access points for all transportation modes on map. Indicate amount and area of required parking onsite if applicable, *attach documentation as needed.*
	Utilities to Site and Surrounding Area	Map existing utilities including stormwater facilities, storm conveyance, sewer, water, electricity, phone/cable, gas, and any public storm system/facility downstream.
2.2.3 Site Preliminary Design Objectives *(attach engineered scale Preliminary Site Plan)*		
	1. Preserve existing resources	**Required:** Show sensitive areas and buffers on site plan. Denote buffer areas that require enhancement. Show any proposed areas of encroachment and associated buffer mitigation areas.
	2. Minimize site disturbance	**Required:** Delineate protection areas on site plan for areas to remain undisturbed during construction.
	3. Minimize soil compaction	**Required:** Delineate and note temporary fencing on site plan for proposed infiltration facilities, vegetated stormwater management facilities, and re-vegetation areas.
	4. Minimize imperviousness	**Required:** Delineate proposed impervious areas and proposed impervious area reduction methods on the site plan. A. Total proposed new/replaced impervious area: _____ (SF) B. Area of proposed Green Roofs: _____ (SF) C. Area of proposed pervious pavements: _____ (SF) D. Describe type of pavers or pavement proposed: _____ _____ E. Impervious area requiring management [A-(B+C)]: _____ (SF)

SITE ASSESSMENT AND PRELIMINARY DESIGN CHECKLIST

2.2.4 Proposed Stormwater Management Strategy

	Proposed Stormwater Management Strategy	_____ Level 1 – Onsite retention of the 10-year design storm _____ Full onsite retention/infiltration of the 10-year storm event using LID _____ Infiltration facilities are limited by the following conditions *(include documentation to demonstrate the limiting condition and choose an alternate strategy below):* _____ Low infiltration rates of less than 2.0 inches per hour _____ Stormwater management facility to be located on fill _____ Steep slopes _____ High groundwater _____ Contaminated soils _____ Conflict with required Source Controls (**Chapter 6**) _____ Level 2 – Onsite stormwater management using LID (indicate below) _____ Level 3 - Offsite stormwater management facilities/regional facilities _____ Level 4 - Fee in Lieu, as determined by the City
	Preliminary Facility Selection	Check all that apply, *attach output from BMP Sizing Tool*, and show proposed Stormwater Management Facilities on Preliminary Site Plan. LID facilities: _____ Stormwater Planter (infiltration or filtration) _____ Rain Garden (infiltration or filtration) _____ Vegetated Swale (infiltration or filtration) _____ Detention Pond (infiltration or filtration) _____ Other* _____ **Modifications must be approved by City per Section 1.6*
	Minimum Facility Size	A. Level 1 - Required surface area of onsite surface infiltration facilities: As determined by BMP sizing tool or engineered method: _____ (SF) B. Level 2 - Calculate required surface area of onsite LID facilities: As determined by BMP sizing tool or engineered method: _____ (SF) C. Calculate required surface area of offsite/regional facilities: As determined by BMP sizing tool or engineered method: _____ (SF) D. Level 4 - Fee in Lieu, as determined by the City _____ 10% of total impervious area*: _____ (SF) **10 % sizing factor only applicable for sites entirely within the NROD or Geologic Hazard Area (Section 2.2.4)*

SITE ASSESSMENT AND PRELIMINARY DESIGN CHECKLIST		
2.2.5 Other Project Requirements		
	Grading Permit	Review OCMC 15.48 to determine whether a grading permit will be required. Grading permit required? _____ (Y/N) Type of Grading Plan proposed (see **Chapter 3**): _____
	Erosion Prevention and Sediment Control	Identify the required permits: _____ ESC Permit from the City *(sites that include 1,000+ SF new or replaced impervious area)* _____ 1200-C Permit from DEQ *(sites that disturb 1 acre or more land surface)*
	Source Control for High Use Sites	Identify whether the proposed development will include any of the following: _____ Fuel Dispensing Facilities and Surrounding Traffic Areas _____ Above-Ground Storage of Liquid Materials _____ Solid Waste Storage Areas, Containers, and Trash Compactors _____ Exterior Storage of Bulk Materials _____ Material Transfer Areas/Loading Docks _____ Equipment and/or Vehicle Washing Facilities _____ Development on Land With Suspected or Known Contamination _____ Covered Vehicle Parking Areas _____ Industrial and Commercial High Traffic Areas _____ Other land uses subject to the ODEQ 1200-Z Industrial Stormwater Permit
	Other Permits	Identify other natural resources related permits from local, state, or federal agencies that may be required as part of the proposed development activity. It is the responsibility of the applicant to identify and obtain required permits prior to project approval. List other anticipated permits:

APPENDIX C

Stormwater Facility Design and Maintenance

APPENDIX C. STORMWATER FACILITY DESIGN AND MAINTENANCE

This appendix includes fact sheets, design guideline drawings, and operation and maintenance (O&M) plans for the stormwater management facilities accepted by the City of Oregon City (City). Fact sheets include example photos and concept sketches to illustrate the general appearance and potential use for the stormwater management facilities. The images have been excerpted from the 2009 Clean Water Services LIDA Handbook and are intended to help in the selection of appropriate facilities for preliminary site design.

The facility drawings show minimum facility dimensions, cross sections, and design criteria. These drawings are for reference only. The project engineer must provide facility-specific construction documents with plan views, cross sections, and control structure details for each proposed stormwater management facility. Refer to the City's standard drawings and engineering policy for standard details, applicable for use in construction documents.

This appendix also includes sample O&M plans for typical stormwater management facilities. The O&M plans should be modified as necessary to reflect specific site conditions and facility design before inclusion in the stormwater management plan.

The following figures are included in this appendix:

- Figure C-1. Stormwater Planter – Filtration
- Figure C-2. Stormwater Planter – Infiltration
- Figure C-3. Stormwater Planter O&M Plan
- Figure C-4. Rain Garden – Filtration
- Figure C-5. Rain Garden – Infiltration
- Figure C-6. Rain Garden O&M Plan
- Figure C-7. Vegetated Swale – Filtration
- Figure C-8. Vegetated Swale – Infiltration
- Figure C-9. Vegetated Swale O&M Plan
- Figure C-10. Planter, Rain Garden, and Swale Flow Control Structure
- Figure C-11. Detention Pond
- Figure C-12. Detention Pond Flow Control Structure
- Figure C-13. Detention Pond O&M Plan
- Figure C-14. Roof Infiltration System
- Figure C-15. Roof Infiltration System O&M Plan
- Figure C-16. Pervious Pavement
- Figure C-17. Pervious Pavement O&M Plan
- Figure C-18. Green Roof
- Figure C-19. Green Roof O&M Plan
- Figure C-20. Stormwater Facilities O&M Checklist

Rain Gardens and Stormwater Planters

Rain gardens and Stormwater Planters have similar design guidelines and potential benefits. Stormwater Planters are rain gardens with vertical walls, which may be more appropriate in urban site design or for facilities located adjacent to sidewalks, roadways, or buildings.



RAIN GARDENS

Rain gardens are planted open depressions designed to accept runoff from adjacent impervious surfaces. Rain gardens trap and treat pollutants by filtering it through topsoil as the water infiltrates into native soils or underlying drain pipes. Most rain gardens must be designed to infiltrate the stormwater they receive. An underdrain and overflow device may be required to accomodate flows greater that the infiltration capacity of the underlying soils, or if a liner is required.

Benefits

- Rain gardens may help fulfill a site's landscaping area requirement and can be used to treat stormwater from all types of impervious surfaces including private property and the public right-of-way, rooftops, parking lots, and streets.
- Rain gardens reduce stormwater flow rates, volume, and temperature, and improve water quality. Pollutants are removed as the runoff passes through the soil layer and is collected in an underlying layer of gravel or drain rock.
- Detention storage volume can be built into the underlying drain rock layer.

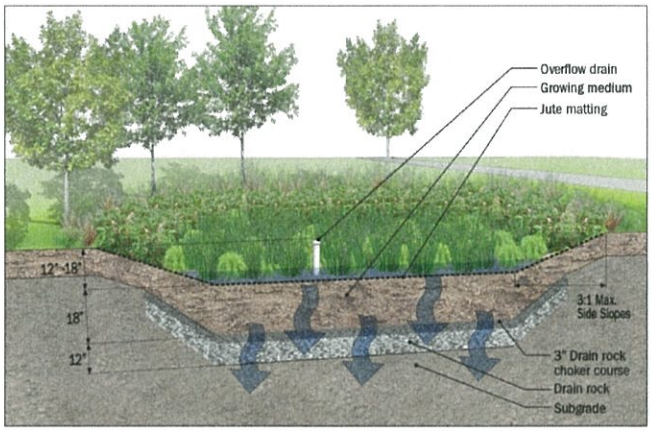


Image from Clean Water Services LIDA Handbook



Buckman Terrace Apartments, Portland



Beaumont Village Lofts, NE Portland

Vegetated Swales

Vegetated Swales function similar to rain gardens, but include a sloped bottom to allow transport of stormwater runoff to a downstream outlet. In this way, vegetated swales can be utilized for stormwater treatment and conveyance.



VEGETATED SWALES

A vegetated swale is a gently sloping landscaped depression that collects and conveys stormwater runoff. The densely planted swale filters stormwater as it flows the length of the swale and allows infiltration of water through topsoil and into the ground. The vegetated swale may discharge to a storm sewer or other approved discharge point where soils do not drain well, or if liner is required.

Benefits

- Vegetated swales may help fulfill a site's landscaping area requirement and can be used to treat stormwater from all types of impervious surfaces including private property and the public right-of-way, rooftops, parking lots, and streets.
- Vegetated swales reduce stormwater flow rates, volume, and temperature, and improve water quality. Pollutants are removed as the runoff passes through the vegetation and soil layer and is collected in an underlying layer of gravel or drain rock.
- Where soils do not drain well, swales can overflow to an approved discharge point.

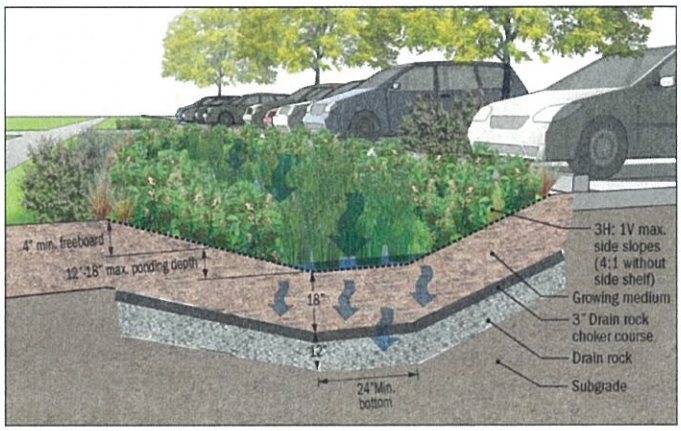


Image from Clean Water Services LIDA Handbook



New Seasons, SE Division St, Portland



Boeckman Road, Wilsonville

Detention Ponds

The principles of detention pond design are the same as those for constructed wet ponds, though the outlet control structure presented in this example from Clean Water Services should be replaced by an outlet control system that matches the design principles from the BMP Sizing Tool (See facility details in Appendix C for more information).



CONSTRUCTED WET PONDS

A constructed wet pond is a landscaped depression that collects and holds stormwater runoff and allows pollutants to settle and filter out during storm events. Constructed wet ponds have a permanent pool of water and also an extended detention area above that fills during storm events and releases water slowly over a number of hours. The permanent pool is sized to reduce pollution by settling and biological processes. The extended detention area is sized to meet flow control requirements.

Benefits

- Constructed Wet Ponds can be used to treat stormwater from all types of impervious surfaces including private property and the public right-of-way, rooftops, parking lots, and streets.
- Constructed Wet Ponds reduce stormwater flow rates, volume, and temperature, and improve water quality. Pollutants are removed through settling and biofiltration through vegetation and soils.
- Constructed Wet Ponds can be designed as multi purpose site amenities and can significantly contribute to urban habitat for birds and other organisms.
- Detention storage volume can be included in wetland sizing, or a detention pond can be designed for detention only without a permanent pool, if water quality requirements are met separately on site.

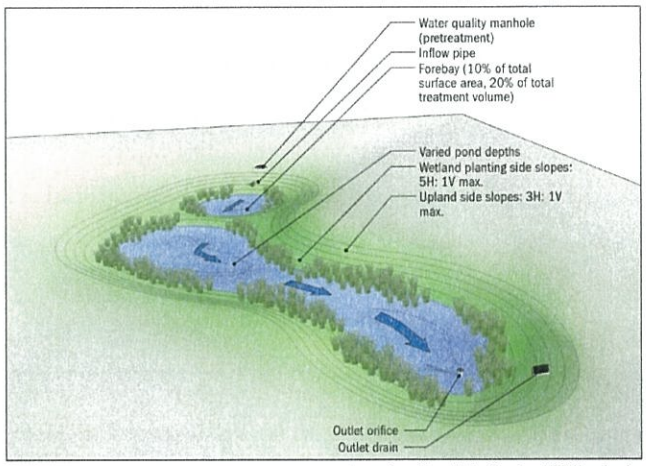


Image from Clean Water Services LIDA Handbook



Washington County

Porous Pavement



POROUS PAVEMENT

Porous pavement is a water permeable structural groundcover that infiltrates precipitation, attenuates stormwater runoff flows and volumes, and reduces temperatures. Porous pavement provides a stable load-bearing surface without increasing a project's total impervious area. The two main categories of porous pavements approved are 1) pervious concrete and 2) permeable pavers. Pervious concrete is poured in place and resembles its solid counterpart. Permeable pavers are solid, discrete units typically made of pre-cast concrete, brick, stone, or cobbles and set to allow water to flow between them.

Benefits

- Porous pavement reduce site impervious area, reducing the required size of stormwater facilities. The area of a porous pavement may be directly substracted from site impervious area
- Porous pavement reduces stormwater flow rates, volume, and temperatures by temporarily storing stormwater and allowing infiltration of stormwater into underlying soils.
- Pervious concrete and permeable pavers can be used in most pedestrian areas, residential driveways, public sidewalks, and parking lots. Local jurisdictions may approve pervious concrete for non-travel lane sections of private streets and public roadways on a case-by-case basis.
- Detention storage volume may be built into the drain rock layer as approved.



Image from Clean Water Services LIDA Handbook

Green Roofs



GREEN ROOFS

A green roof is a thin lightweight vegetated roof system used in place of a conventional roof. Greenroofs typically consist of a waterproof membrane, drainage material, a lightweight layer of soil, and a cover of plants. Species are chosen appropriate for a rooftop environment - dry and hot in summer, wet in winter. Extensive greenroofs are not intended to be accessed except for maintenance.

Benefits

- Green roofs reduce site impervious area, reducing the required size of stormwater facilities. The area of a green roof may be directly substracted from site impervious area in the District's Impervious Reduction Form.
- Green roofs can capture and retain 60% of annual precipitation.
- Green roofs reduce runoff flow rate, volume and temperature of roof runoff.
- Green roofs outlasts conventional roofs by twenty years or more. Average green roof lifespan is 40 years.
- Green roofs slow down peak flow rates during heavy storm events which helps prevent on-site erosion and flooding especially in urban areas where soils are heavily compacted and have a low infiltration rate.
- Green roofs filter air pollutants and absorb carbon dioxide.
- A Greenroof reduces the heat island effect within an urban area by absorbing thermal UV rays from the sun. PV panels have been found to be 6% more efficient when installed over an ecoroof.

Note: Green roof information compiled from City of Portland's Bureau of Environmental Services. See http://www.portlandonline.com/BES/ for more information.

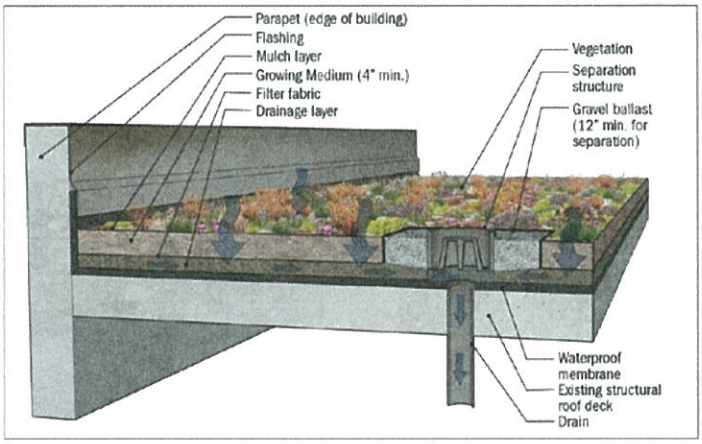
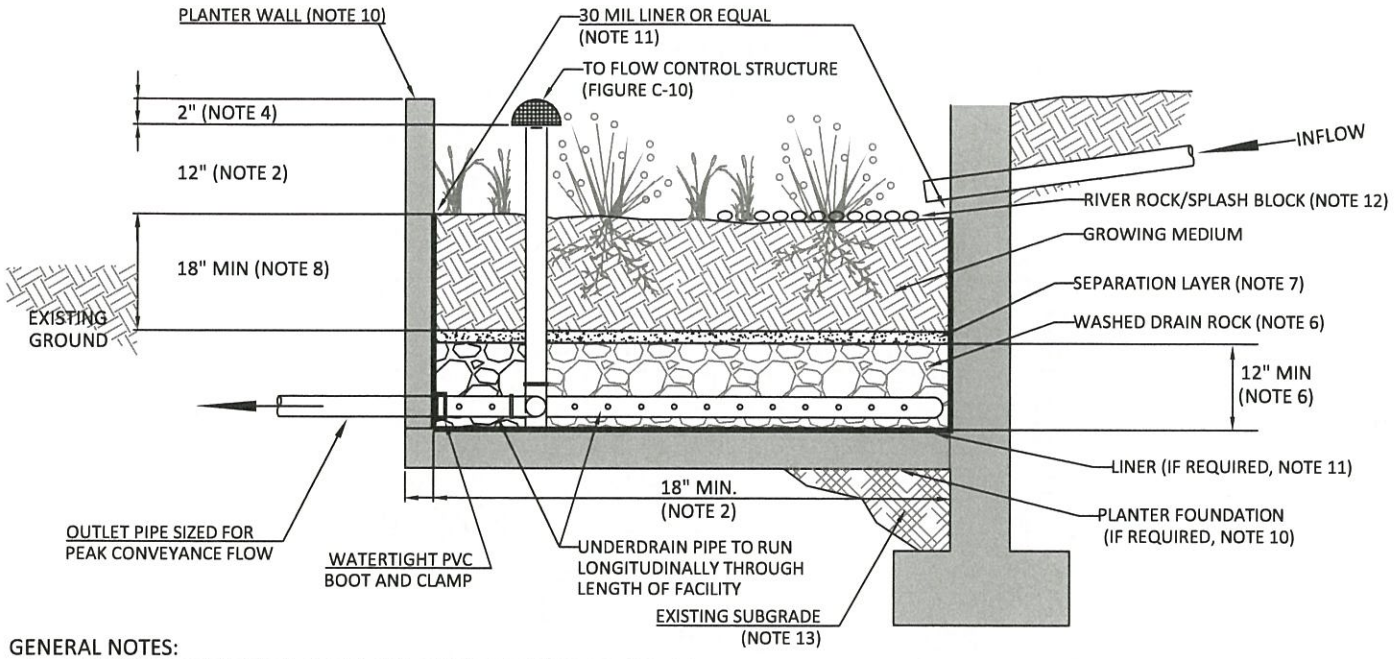


Image from Clean Water Services LIDA Handbook

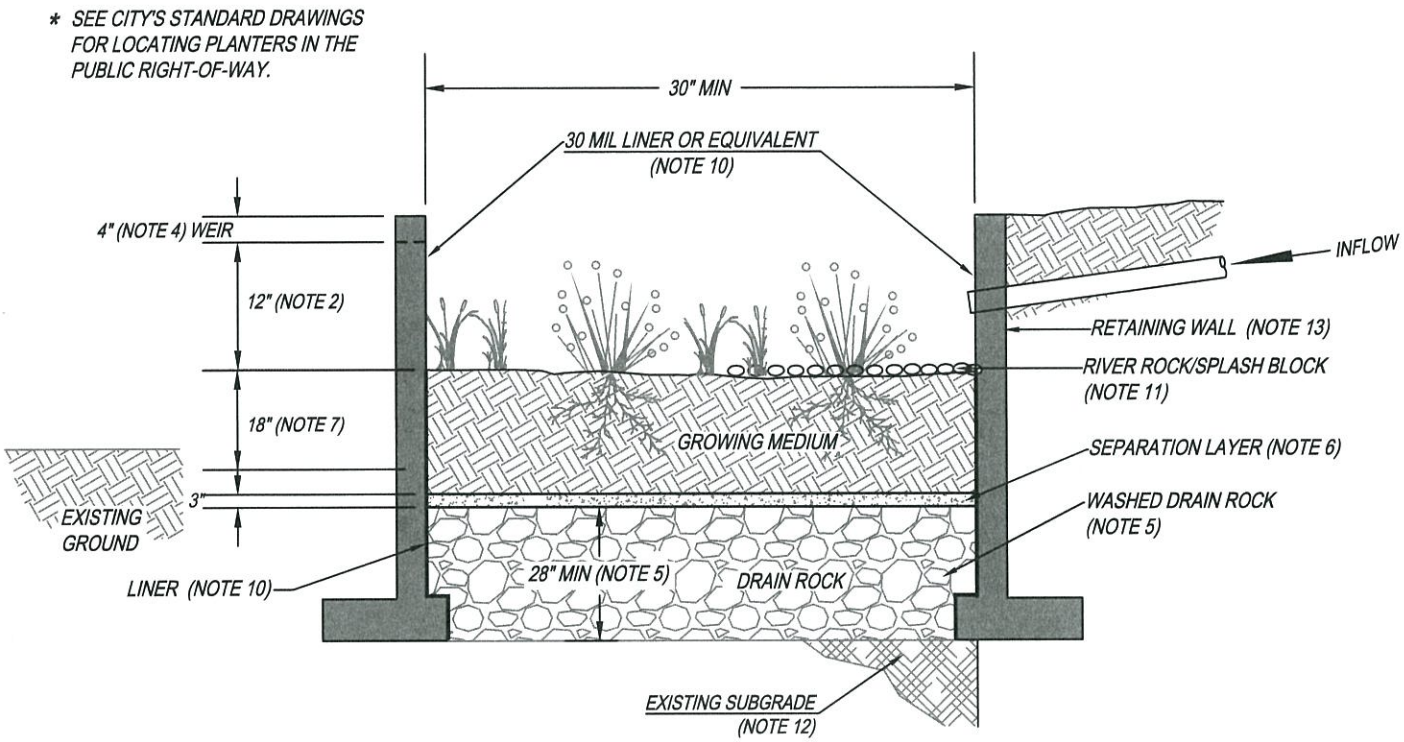
* SEE CITY'S STANDARD DRAWINGS FOR LOCATING PLANTERS IN THE PUBLIC RIGHT-OF-WAY.



GENERAL NOTES:

1. **PROVIDE PROTECTION** FROM ALL VEHICLE TRAFFIC, EQUIPMENT STAGING, AND FOOT TRAFFIC IN PROPOSED INFILTRATION AREAS PRIOR TO, DURING AND AFTER CONSTRUCTION.
2. **DIMENSIONS:**
   -WIDTH: 18" MINIMUM
   -DEPTH OF PLANTER (FROM TOP OF GROWING MEDIUM TO OVERFLOW ELEVATION): 12"
   -SLOPE OF PLANTER: 0.5% OR LESS
3. **SETBACKS**
   -PLANTERS MUST BE MINIMUM OF 5 FEET FROM PROPERTY LINE.
4. **OVERFLOW:**
   -INLET ELEVATION MUST ALLOW FOR 2" OF FREEBOARD, MINIMUM. PROTECT FROM DEBRIS AND SEDIMENT WITH STRAINER OR GRATE.
   -IDENTIFY EMERGENCY OVERFLOW ROUTE ON THE STORMWATER MANAGEMENT PLAN.
5. **PIPING:**
   -PERFORATED UNDERDRAIN PIPING: SHALL BE ABS SCH. 40, DUCTILE IRON, OR PVC SCH.40, 6" MINIMUM DIAMETER. PIPING MUST HAVE 1% GRADE AND FOLLOW THE UNIFORM PLUMBING CODE. PVC NOT ALLOWED ABOVE GROUND.
   -OVERFLOW PIPING: SHALL BE ABS SCH.40, DUCTILE IRON, OR PVC SCH.40 AND SHALL NOT BE PERFORATED. MIMIMUM DIAMETER IS 6". PIPING MUST HAVE 1% GRADE AND FOLLOW THE UNIFORM PLUMBING CODE. PVC NOT ALLOWED ABOVE GROUND.
6. **DRAIN ROCK:**
   -SIZE FOR FLOW-THROUGH PLANTER: 1 1/2" - 3/4" WASHED
   -DEPTH: 12" MINIMUM
7. **SEPARATION** BETWEEN DRAIN ROCK AND GROWING MEDIUM: SHALL BE A 3" LAYER OF 3/4" - 1/4" OPEN GRADED AGGREGATE.
8. **GROWING MEDIUM:**
   -DEPTH: 18" MINIMUM
   -SEE APPENDIX A FOR SPECIFICATION OR USE SAND/LOAM/COMPOST 3-WAY MIX.
   -FACILITY SURFACE AREA MAY BE REDUCED BY 20% WHEN GROWING MEDIA DEPTH IS INCREASED TO 30" OR MORE.
9. **VEGETATION:** FOLLOW LANDSCAPE PLANS OR REFER TO PLANTING REQUIREMENTS IN APPENDIX A.
10. **PLANTER FOUNDATION AND WALLS:**
    -MATERIALS SHALL BE 4" REINFORCED CONCRETE, STONE, BRICK, OR OTHER DURABLE MATERIAL.
    -CONCRETE, BRICK, OR STONE WALLS SHALL BE INCLUDED ON FOUNDATION PLANS.
    -INSTALL INVERTED CURB AS NEEDED BETWEEN PLANTER AND ROAD SUBGRADE.
    -WALL HEIGHTS GREATER THAN 24" ABOVE GRADE REQUIRE HANDRAIL.
11. **WATERPROOF LINER (IF REQUIRED):**
    -LINER SHALL BE 30 MIL PVC OR EQUIVALENT, FOR FLOW THROUGH FACILITIES.
    -A WATERPROOF LINER IS NOT REQUIRED IF THE FOUNDATION OR WALL MATERIAL IS WATERPROOF REINFORCED CONCRETE OR APPROVED EQUAL.
12. **INSTALL RIVER ROCK** SPLASH PAD TO TRANSITION FROM INLET TO GROWING MEDIUM. SIZE OF ROCK SHALL BE 1" - 3".
13. **SEASONAL HIGH GROUNDWATER SEPARATION:**
    -SEPARATION DISTANCE AS REQUIRED BY THE CITY.
14. **SUBMIT RETAINING WALL DESIGN** IN ACCORDANCE WITH APPLICABLE STRUCTURAL CODES FOR REVIEW AND APPROVAL.

Stormwater Planter - Filtration
Figure C-1



GENERAL NOTES:

1. **PROVIDE PROTECTION** FROM ALL VEHICLE TRAFFIC, EQUIPMENT STAGING, AND FOOT TRAFFIC IN PROPOSED INFILTRATION AREAS PRIOR TO, DURING AND AFTER CONSTRUCTION.
2. **DIMENSIONS:**
   -WIDTH: 30" MINIMUM
   -DEPTH OF PLANTER (FROM TOP OF GROWING MEDIUM TO OVERFLOW WEIR ELEVATION): 12"
   -SLOPE OF PLANTER: 0.5% OR LESS
3. **SETBACKS:**
   -PLANTERS MUST BE MINIMUM OF 5 FEET FROM PROPERTY LINE.
4. **OVERFLOW:**
   -WEIR ELEVATION MUST ALLOW FOR 4" OF FREEBOARD, MINIMUM.
   -SIZE OVERFLOW WEIR FOR THE 100 YEAR DESIGN STORM. IDENTIFY EMERGENCY OVERFLOW ROUTE ON THE STORMWATER MANAGEMENT PLAN.
5. **DRAIN ROCK:**
   -SIZE: 1 1/2" - 3/4" WASHED
   -DEPTH: 28" MINIMUM
6. **SEPARATION** BETWEEN DRAIN ROCK AND GROWING MEDIUM: SHALL BE A 3" LAYER OF 3/4" - 1/4" OPEN GRADED AGGREGATE.
7. **GROWING MEDIUM:**
   -DEPTH: 18" MIMIMUM
   -SEE APPENDIX A FOR SPECIFICATION OR USE SAND/LOAM/COMPOST 3-WAY MIX.
   -FACILITY SURFACE AREA MAY BE REDUCED BY 20% WHEN GROWING MEDIA DEPTH IS INCREASED TO 30" OR MORE.
8. **VEGETATION:** FOLLOW LANDSCAPE PLANS OR REFER TO PLANTING REQUIREMENTS IN APPENDIX A.
9. **PLANTER WALLS:**
   -MATERIALS SHALL BE STONE, BRICK, CONCRETE OR OTHER DURABLE MATERIAL.
   -CONCRETE, BRICK, OR STONE WALLS SHALL BE INCLUDED ON FOUNDATION PLANS.
   -INSTALL INVERTED CURB AS NEEDED BETWEEN PLANTERS AND ROAD SUBGRADE.
   -WALL HEIGHTS GREATER THAN 24" ABOVE GRADE REQUIRE HANDRAIL.
10. **WATERPROOF LINER:**
    -LINER SHALL BE 30 MIL PVC OR EQUIVALENT.
    -A WATERPROOF LINER IS NOT REQUIRED IF THE WALL MATERIAL IS WATERPROOF REINFORCED CONCRETE OR APPROVED EQUAL.
11. **INSTALL RIVER ROCK** SPLASH PAD TO TRANSITION FROM INLET TO GROWING MEDIUM. SIZE OF ROCK SHALL BE 1" - 3".
12. **SEASONAL HIGH GROUNDWATER SEPARATION:**
    -SEPARATION DISTANCE AS REQUIRED BY THE CITY.
13. **SUBMIT RETAINING WALL DESIGN** IN ACCORDANCE WITH APPLICABLE STRUCTURAL CODES FOR REVIEW AND APPROVAL.

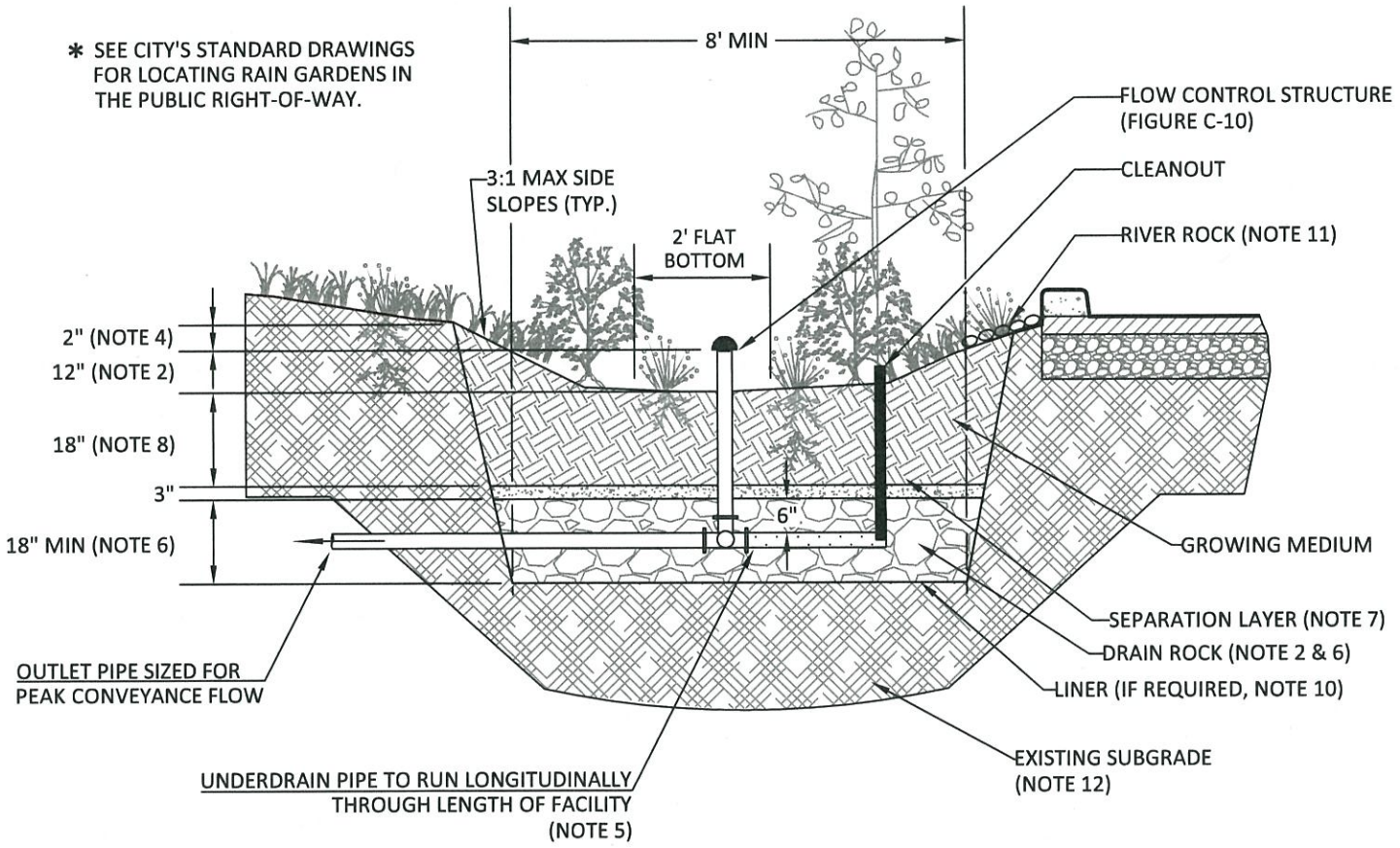
Stormwater Planter - Infiltration
Figure C-2

Stormwater Planters
Operations & Maintenance Plan

What to Look For	What to Do
Structural Components, including inlets and outlets/overflows, shall freely convey stormwater.	
Clogged inlets or outlets	-Remove sediment and debris from catch basins, trench drains and curb inlets and pipes to maintain at least 50% conveyance capacity at all times.
Cracked Drain Pipes	-Repair/seal cracks. Replace when repair is insufficient.
Check Dams	-Maintain 4 to 10 inch deep rock check dams at design intervals.
Vegetation	
Dead or strained vegetation	-Replant per original planting plan, or substitute from Appendix A. -Irrigate as needed. Mulch banks annually. DO NOT apply fertilizers, herbicides, or pesticides.
Tall Grass and Vegetation	-Cut back grass and prune overgrowth 1-2 times per year. Remove cuttings.
Weeds	-Manually remove weeds. Remove all plant debris.
Growing/Filter Medium, including soil and gravels, shall sustain healthy plant cover and infiltrate within 72 hours.	
Gullies	-Fill, lightly compact, and plant vegetation to disperse flow.
Erosion	-Replace splash blocks or inlet gravel/rock.
Slope Slippage	-Stabilize 3:1 slopes/banks with plantings from Appendix A.
Ponding	-Rake, till, or amend to restore infiltration rate.

Annual Maintenance Schedule:

Summer. Make any structural repairs. Improve filter medium as needed. Clear drain. Irrigate as needed.
Fall. Replant exposed soil and replace dead plants. Remove sediment and plant debris.
Winter. Monitor infiltration/flow-through rates. Clear inlets and outlets/overflows to maintain conveyance.
Spring. Remove sediment and plant debris. Replant exposed soil and replace dead plants. Mulch.
All seasons. Weed as necessary. Clean scuppers or curb inlets as needed.
Maintenance Records: Record date, description, and contractor (if applicable) for all structural repairs, landscape maintenance, and facility cleanout activities. Keep work orders and invoices on file and make available upon request of the inspector.
Access: Maintain ingress/egress to design standards.
Infiltration/Flow Control: All facilities shall drain within 72 hours. Record time/date, weather, and site conditions when ponding occurs.
Pollution Prevention: All sites shall implement best management practices to prevent hazardous or solid wastes or excessive oil and sediment from contaminating stormwater. Contact emergency response agencies for immediate assistance responding to spills. Record time/date, weather, and site conditions if site activities contaminate stormwater.
Vectors (Mosquitoes & Rodents): Stormwater facilities shall not harbor mosquito larvae or rats that pose a threat to public health or that undermine the facility structure. Monitor standing water for small wiggling sticks perpendicular to the water's surface. Note holes/burrows in and around facilities. Call Clackamas County Vector Control for immediate assistance to eradicate vectors. Record time/date, weather, and site conditions when vector activity observed.



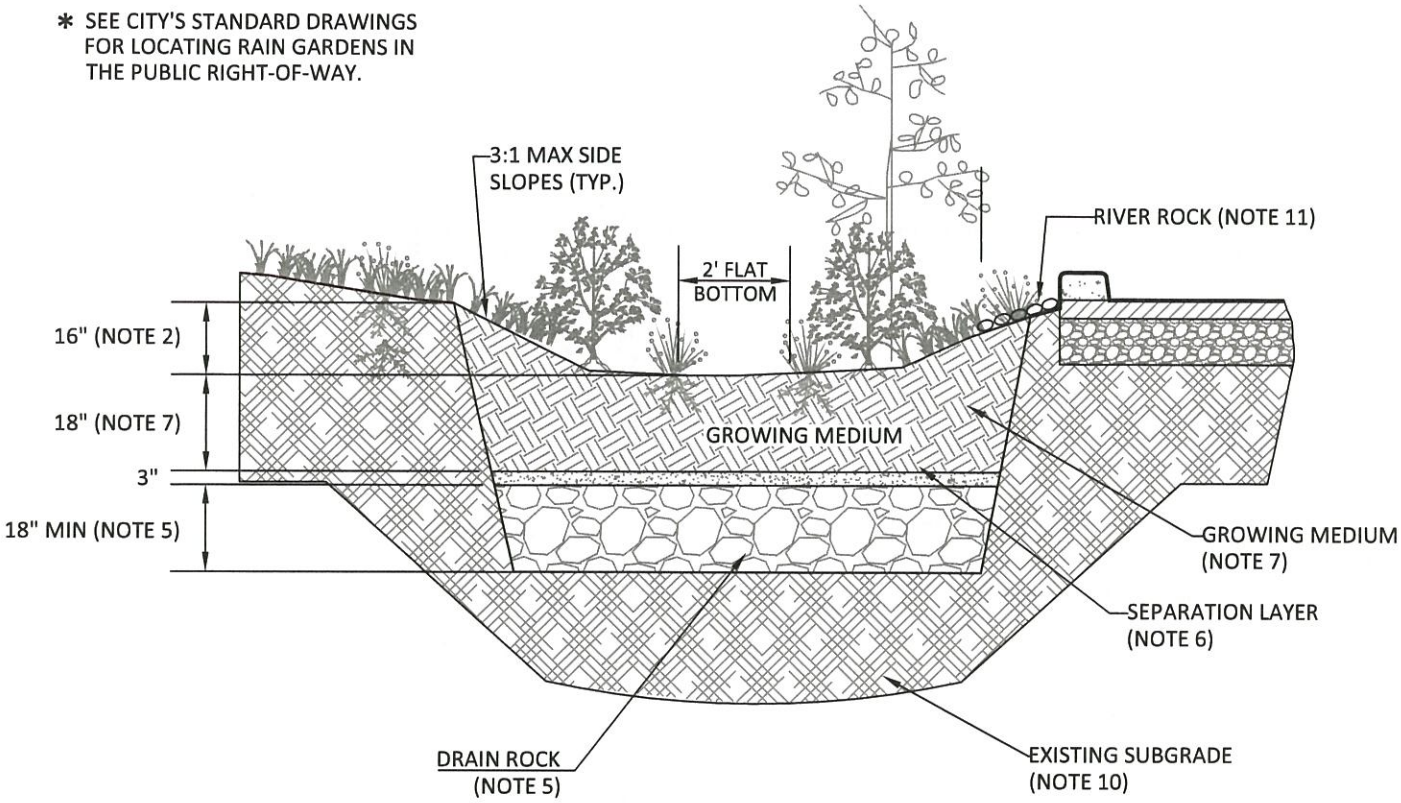
GENERAL NOTES:

1. **PROVIDE PROTECTION** FROM ALL VEHICLE TRAFFIC, EQUIPMENT STAGING, AND FOOT TRAFFIC IN PROPOSED INFILTRATION AREAS PRIOR TO, DURING AND AFTER CONSTRUCTION. UNLESS REQUIRED BY SITE CONDITIONS, UNLINED RAIN GARDENS ARE PREFERRED TO MAXIMIZE ONSITE INFILTRATION.
2. **DIMENSIONS:**
   -DEPTH OF BASIN (FROM TOP OF GROWING MEDIUM TO OVERFLOW ELEVATION): 12"
   -FLAT BOTTOM WIDTH: 2' MINIMUM
   -SIDE SLOPES OF BASIN: 3:1 MAXIMUM
   -SLOPE OF RAIN GARDEN: 0.5% OR LESS
   -FACILITY AREA SHALL BE MEASURED AT THE DEEPEST SECTION (DRAIN ROCK) OF FACILITY
3. **SETBACKS:**
   -FILTRATION RAIN GARDEN MUST BE 10' FROM FOUNDATIONS AND 5' FROM PROPERTY LINES UNLESS APPROVED BY BUILDING OFFICIAL.
4. **OVERFLOW:**
   -INLET ELEVATION MUST ALLOW FOR 2" OF FREEBOARD, MINIMUM. PROTECT FROM DEBRIS AND SEDIMENT WITH STRAINER OR GRATE.
   -IDENTIFY EMERGENCY OVERFLOW ROUTE ON THE STORMWATER MANAGEMENT PLAN.
5. **PIPING:**
   -PERFORATED UNDERDRAIN PIPING: SHALL BE ABS SCH. 40, DUCTILE IRON, OR PVC SCH.40. MINIMUM DIAMETER IS 6". PIPING MUST HAVE 1% GRADE AND FOLLOW THE UNIFORM PLUMBING CODE. PVC NOT ALLOWED ABOVE GROUND.
   -OVERFLOW PIPING: SHALL BE ABS SCH. 40, DUCTILE IRON, OR PVC SCH. 40 AND SHALL NOT BE PERFORATED. MINIMUM DIAMETER IS 6". PIPING MUST HAVE 1% GRADE AND FOLLOW THE UNIFORM PLUMBING CODE. PVC NOT ALLOWED ABOVE GROUND.
6. **DRAIN ROCK:**
   -SIZE: 1 1/2" to 3/4"-0 WASHED
   -DEPTH: 18" MINIMUM
7. **SEPARATION** BETWEEN DRAIN ROCK AND GROWING MEDIUM: SHALL BE A 3" LAYER OF 3/4" - 1/4" OPEN GRADED AGGREGATE OR FILTER FABRIC WITH 3" OF ADDITIONAL DRAIN ROCK MAY BE UTILIZED IN LIEU OF OPEN GRATED AGGREGATE IF APPROVED BY CITY ENGINEER.
8. **GROWING MEDIUM:**
   -DEPTH: 18" MINIMUM
   -SEE APPENDIX A FOR SPECIFICATION OR USE SAND/LOAM/COMPOST 3-WAY MIX.
   -FACILITY SURFACE AREA MAY BE REDUCED BY 20% WHEN GROWING MEDIA DEPTH IS INCREASED TO 30" OR MORE.
9. **VEGETATION:** FOLLOW LANDSCAPE PLANS OR REFER TO PLANTING REQUIREMENTS IN APPENDIX A.
10. **WATERPROOF LINER (IF REQUIRED):** SHALL BE 30 MIL PVC OR EQUIVALENT.
11. **INSTALL RIVER ROCK** OR SPLASH PAD TO TRANSITION FROM INLETS TO GROWING MEDIUM. SIZE OF ROCK SHALL BE 1" - 3".
12. **SEASONAL HIGH GROUNDWATER SEPARATION:**
    -SEPARATION DISTANCE AS REQUIRED BY CITY.

Rain Garden - Filtration
Figure C-4

OREGON CITY
STORMWATER AND GRADING DESIGN STANDARDS

* SEE CITY'S STANDARD DRAWINGS FOR LOCATING RAIN GARDENS IN THE PUBLIC RIGHT-OF-WAY.



GENERAL NOTES:

1. **PROVIDE PROTECTION** FROM ALL VEHICLE TRAFFIC, EQUIPMENT STAGING, AND FOOT TRAFFIC IN PROPOSED INFILTRATION AREAS PRIOR TO, DURING AND AFTER CONSTRUCTION.
2. **DIMENSIONS:**
   -DEPTH OF BASIN (FROM TOP OF GROWING MEDIUM TO OVERFLOW ELEVATION): 16"
   -FLAT BOTTOM WIDTH: 2' MINIMUM
   -SIDE SLOPES OF BASIN: 3:1 MAXIMUM
   -SLOPE OF RAIN GARDEN: 0.5% OR LESS
3. **SETBACKS:**
   -INFILTRATION RAIN GARDEN MUST BE 10' FROM FOUNDATIONS AND 5' FROM PROPERTY LINES.
4. **OVERFLOW:**
   -INLET ELEVATION MUST ALLOW FOR 4" OF FREEBOARD, MINIMUM. PROTECT FROM DEBRIS AND SEDIMENT WITH STRAINER OR GRATE.
   -EMERGENCY OVERFLOW PATH FOR THE 100 YEAR DESIGN STORM SHALL BE IDENTIFIED IN THE STORMWATER MANAGEMENT PLAN.
5. **DRAIN ROCK:**
   -SIZE: 1 1/2" TO 3/4"- WASHED
   -DEPTH: 18"
6. **SEPARATION** BETWEEN DRAIN ROCK AND GROWING MEDIUM: SHALL BE A 3" LAYER OF 3/4" - 1/4" OPEN GRADED AGGREGATE.
7. **GROWING MEDIUM:**
   -DEPTH: 18" MINIMUM
   -SEE APPENDIX A FOR SPECIFICATION OR USE SAND/LOAM/COMPOST 3-WAY MIX.
   -FACILITY SURFACE AREA MAY BE REDUCED BY 20% WHEN GROWING MEDIA DEPTH IS INCREASED TO 30" OR MORE.
8. **VEGETATION:** FOLLOW LANDSCAPE PLANS OR REFER TO PLANTING REQUIREMENTS IN APPENDIX A.
9. **INSTALL RIVER ROCK** SPLASH PAD TO TRANSITION FROM INLET TO GROWING MEDIUM. SIZE OF ROCK SHALL BE 1" TO 3".
10. **SEASONAL HIGH GROUNDWATER SEPARATION:**
    -SEPARATION DISTANCE AS REQUIRED BY THE CITY.

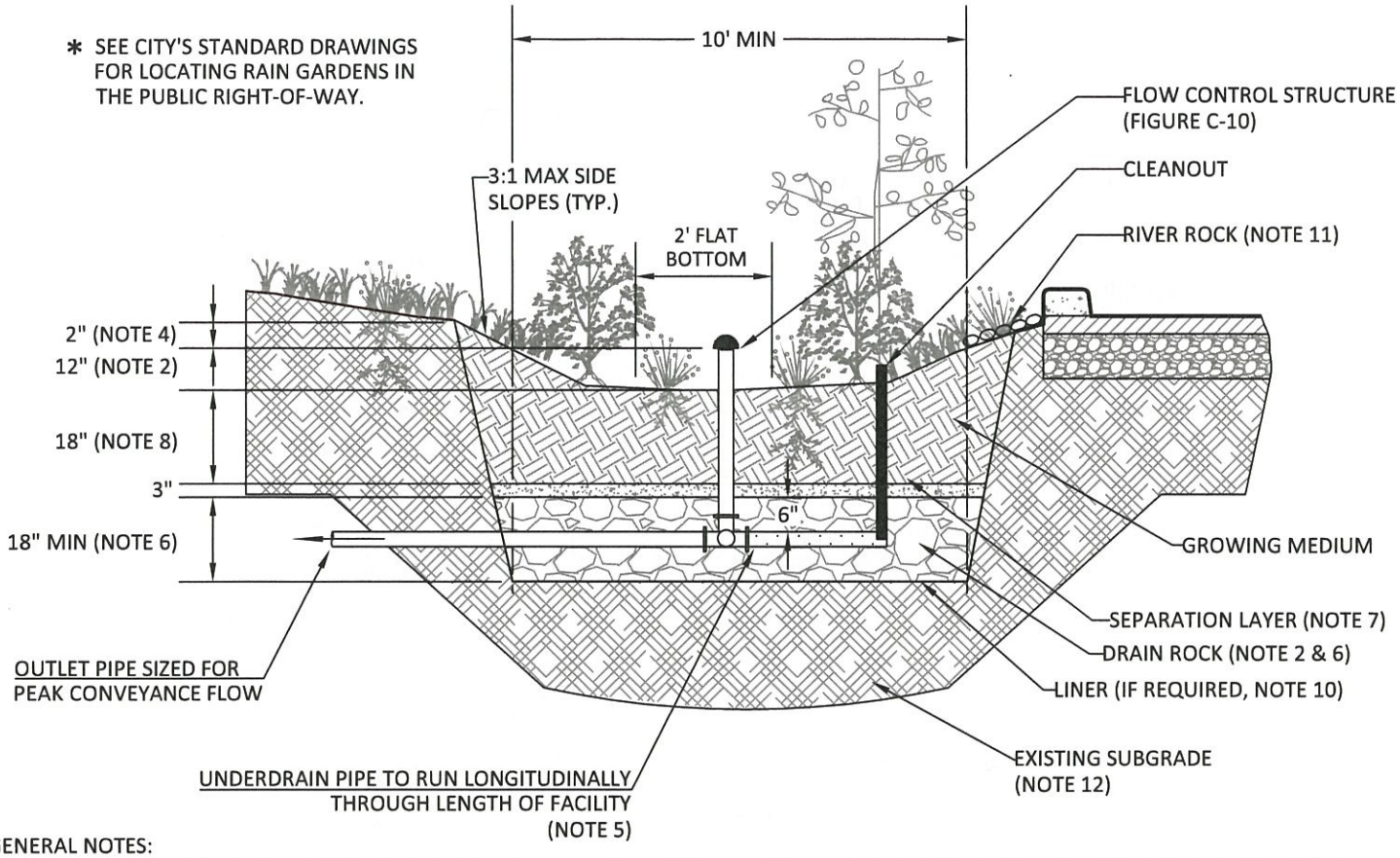
Rain Garden - Infiltration
Figure C-5

Rain Gardens
Operations & Maintenance Plan

What to Look For	What to Do
Structural Components, including inlets and outlets/overflows, shall freely convey stormwater.	
Clogged inlets or outlets	-Remove sediment and debris from catch basins, trench drains and curb inlets and pipes to maintain at least 50% conveyance capacity at all times.
Cracked Drain Pipes	-Repair/seal cracks. Replace when repair is insufficient.
Check Dams	-Maintain 4 to 10 inch deep rock check dams at design intervals.
Vegetation	
Dead or strained vegetation	-Replant per original planting plan, or substitute from Appendix A. -Irrigate as needed. Mulch banks annually. DO NOT apply fertilizers, herbicides, or pesticides.
Tall Grass and Vegetation	-Cut back grass and prune overgrowth 1-2 times per year. Remove cuttings.
Weeds	-Manually remove weeds. Remove all plant debris.
Growing/Filter Medium, including soil and gravels, shall sustain healthy plant cover and infiltrate within 72 hours.	
Gullies	-Fill, lightly compact, and plant vegetation to disperse flow.
Erosion	-Replace splash blocks or inlet gravel/rock.
Slope Slippage	-Stabilize 3:1 slopes/banks with plantings from Appendix A.
Ponding	-Rake, till, or amend to restore infiltration rate.

Annual Maintenance Schedule:

Summer. Make any structural repairs. Improve filter medium as needed. Clear drain. Irrigate as needed.
Fall. Replant exposed soil and replace dead plants. Remove sediment and plant debris.
Winter. Monitor infiltration/flow-through rates. Clear inlets and outlets/overflows to maintain conveyance.
Spring. Remove sediment and plant debris. Replant exposed soil and replace dead plants. Mulch.
All seasons. Weed as necessary. Clean scuppers or curb cuts as needed.
Maintenance Records: Record date, description, and contractor (if applicable) for all structural repairs, landscape maintenance, and facility cleanout activities. Keep work orders and invoices on file and make available upon request of the inspector.
Access: Maintain ingress/egress to design standards.
Infiltration/Flow Control: All facilities shall drain within 72 hours. Record time/date, weather, and site conditions when ponding occurs.
Pollution Prevention: All sites shall implement best management practices to prevent hazardous or solid wastes or excessive oil and sediment from contaminating stormwater. Contact emergency response agencies for immediate assistance responding to spills. Record time/date, weather, and site conditions if site activities contaminate stormwater.
Vectors (Mosquitoes & Rodents): Stormwater facilities shall not harbor mosquito larvae or rats that pose a threat to public health or that undermine the facility structure. Monitor standing water for small wiggling sticks perpendicular to the water's surface. Note holes/burrows in and around facilities. Call Clackamas County Vector Control for immediate assistance to eradicate vectors. Record time/date, weather, and site conditions when vector activity observed.

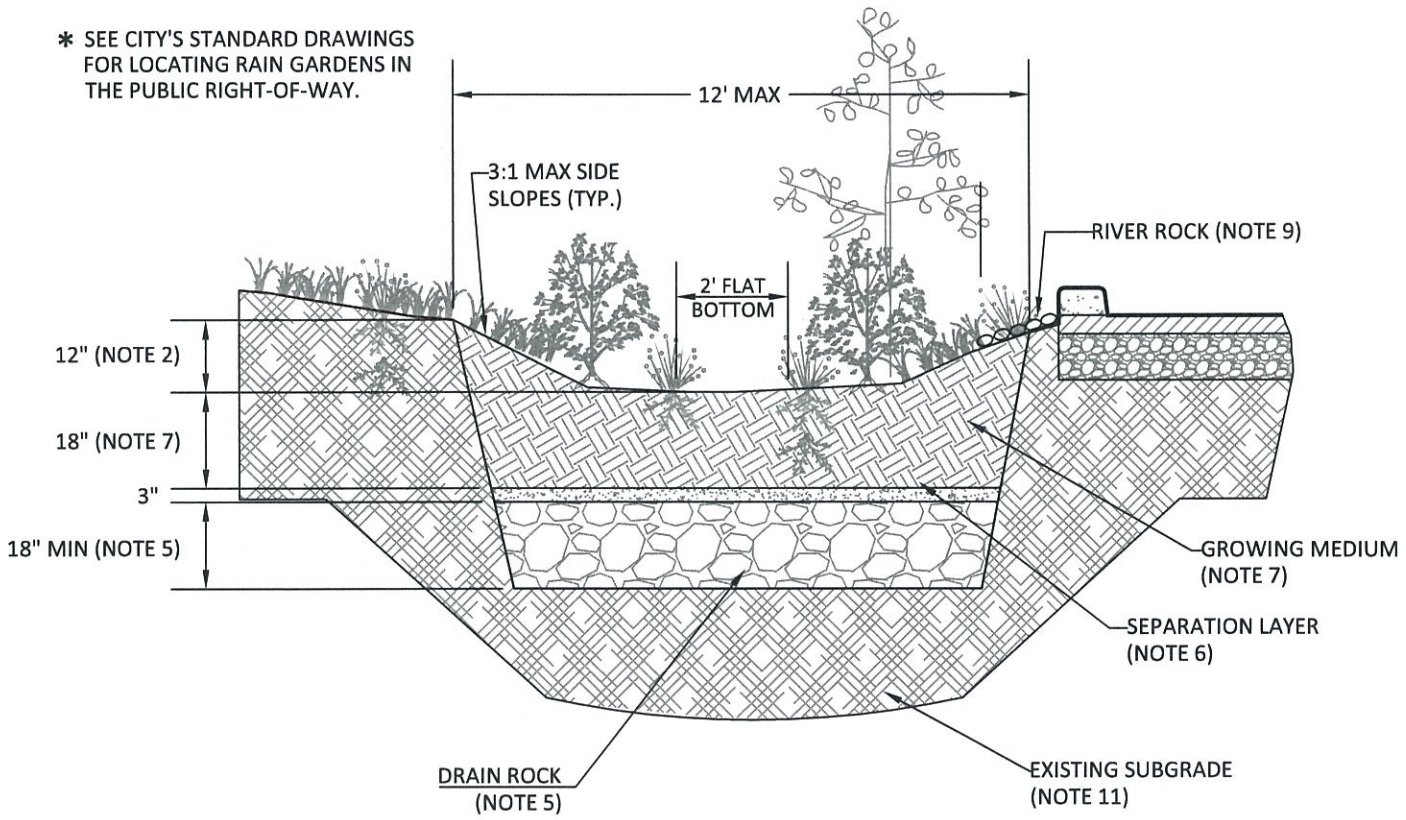


GENERAL NOTES:

1. **PROVIDE PROTECTION** FROM ALL VEHICLE TRAFFIC, EQUIPMENT STAGING, AND FOOT TRAFFIC IN PROPOSED INFILTRATION AREAS PRIOR TO, DURING AND AFTER CONSTRUCTION. UNLESS REQUIRED BY SITE CONDITIONS, UNLINED SWALES ARE PREFERRED TO ALLOW MAXIMUM INFILTRATION.
2. **DIMENSIONS:**
   -DEPTH OF SWALE (FROM TOP OF GROWING MEDIUM TO OVERFLOW ELEVATION): 12"
   -LONGITUDINAL SLOPE OF SWALE: 6.0% OR LESS
   -FLAT BOTTOM WIDTH: 2' MINIMUM
   -SIDE SLOPES OF SWALE: 3:1 MAXIMUM
   -FACILITY AREA SHALL BE MEASURED AT THE DEEPEST SECTION (DRAIN ROCK) OF FACILITY
3. **SETBACKS:**
   -FILTRATION SWALES MUST BE 10' FROM FOUNDATIONS AND 5' FROM PROPERTY LINES UNLESS APPROVED BY BUILDING OFFICIAL.
4. **OVERFLOW:**
   -INLET ELEVATION MUST ALLOW FOR 2" OF FREEBOARD, MINIMUM. PROTECT FROM DEBRIS AND SEDIMENT WITH STRAINER OR GRATE.
   -IDENTIFY EMERGENCY OVERFLOW ROUTE ON THE STORMWATER MANAGEMENT PLAN.
5. **PIPING:**
   -PERFORATED UNDERDRAIN PIPING: SHALL BE ABS SCH. 40, DUCTILE IRON, OR PVC SCH.40. MINIMUM DIAMETER IS 6". PIPING MUST HAVE 1% GRADE AND FOLLOW THE UNIFORM PLUMBING CODE. PVC NOT ALLOWED ABOVE GROUND.
   -OVERFLOW PIPING: SHALL BE ABS SCH. 40, DUCTILE IRON, OR PVC SCH. 40 AND SHALL NOT BE PERFORATED. MINIMUM DIAMETER IS 6". PIPING MUST HAVE 1% GRADE AND FOLLOW THE UNIFORM PLUMBING CODE. PVC NOT ALLOWED ABOVE GROUND.
6. **DRAIN ROCK:**
   -SIZE: 1 1/2" - 3/4" WASHED
   -DEPTH: 12"
7. **SEPARATION** BETWEEN DRAIN ROCK AND GROWING MEDIUM: SHALL BE A 3" LAYER OF 3/4" - 1/4" OPEN GRADED AGGREGATE.
8. **GROWING MEDIUM:**
   -18" MINIMUM
   -SEE APPENDIX A FOR SPECIFICATION OR USE SAND/LOAM/COMPOST 3-WAY MIX.
   -FACILITY SURFACE AREA MAY BE REDUCED BY 20% WHEN GROWING MEDIA DEPTH IS INCREASED TO 30" OR MORE.
9. **VEGETATION:** FOLLOW LANDSCAPE PLANS OR REFER TO PLANTING REQUIREMENTS IN APPENDIX A.
10. **WATERPROOF LINER (IF REQUIRED):** SHALL BE 30 MIL PVC OR EQUIVALENT.
11. **INSTALL RIVER ROCK** OR SPLASH PAD TO TRANSITION FROM INLETS TO GROWING MEDIUM. SIZE OF ROCK SHALL BE 1" TO 3".
12. **SEASONAL HIGH GROUNDWATER SEPARATION:**
    -SEPARATION DISTANCE AS REQUIRED BY CITY.
13. **CHECK DAMS:** SHALL BE PLACED ACCORDING TO FACILITY DESIGN.

Vegetated Swale - Filtration
Figure C-7

OREGON CITY
STORMWATER AND GRADING DESIGN STANDARDS



GENERAL NOTES:

1. **PROVIDE PROTECTION** FROM ALL VEHICLE TRAFFIC, EQUIPMENT STAGING, AND FOOT TRAFFIC IN PROPOSED INFILTRATION AREAS PRIOR TO, DURING AND AFTER CONSTRUCTION.
2. **DIMENSIONS:**
   -DEPTH OF SWALE (FROM TOP OF GROWING MEDIUM TO OVERFLOW ELEVATION): 12"
   -LONGITUDINAL SLOPE OF SWALE: 6.0% OR LESS
   -FLAT BOTTOM WIDTH: 2'
   -SIDE SLOPES OF SWALE: 3:1 MAXIMUM
3. **SETBACKS:**
   -INFILTRATION VEGETATED SWALES MUST BE 10' FROM FOUNDATIONS AND 5' FROM PROPERTY LINES.
4. **OVERFLOW:**
   -EMERGENCY OVERFLOW PATH FOR THE 100 YEAR DESIGN STORM SHALL BE IDENTIFIED ON THE STORMWATER MANAGEMENT PLAN.
5. **DRAIN ROCK:**
   -SIZE: 1 1/2" - 3/4"- WASHED
   -DEPTH: 18"
6. **SEPARATION** BETWEEN DRAIN ROCK AND GROWING MEDIUM: SHALL BE A 3" LAYER OF 3/4" - 1/4" OPEN GRADED AGGREGATE.
7. **GROWING MEDIUM:**
   -18" MINIMUM
   -SEE APPENDIX A FOR SPECIFICATION OR USE SAND/LOAM/COMPOST 3-WAY MIX.
   -FACILITY SURFACE AREA MAY BE REDUCED BY 20% WHEN GROWING MEDIA DEPTH IS INCREASED TO 30" OR MORE.
8. **VEGETATION:** FOLLOW LANDSCAPE PLANS OR REFER TO PLANTING REQUIREMENTS IN APPENDIX A.
9. **INSTALL RIVER ROCK** OR SPLASH PAD TO TRANSITION FROM INLETS TO GROWING MEDIUM. SIZE OF ROCK SHALL BE 1" TO 3".
10. **CHECK DAMS:** SHALL BE PLACED ACCORDING TO FACILITY DESIGN.
11. **SEASONAL HIGH GROUNDWATER SEPARATION:**
    -SEPARATION DISTANCE AS REQUIRED BY CITY.

Vegetated Swale - Infiltration
Figure C-8

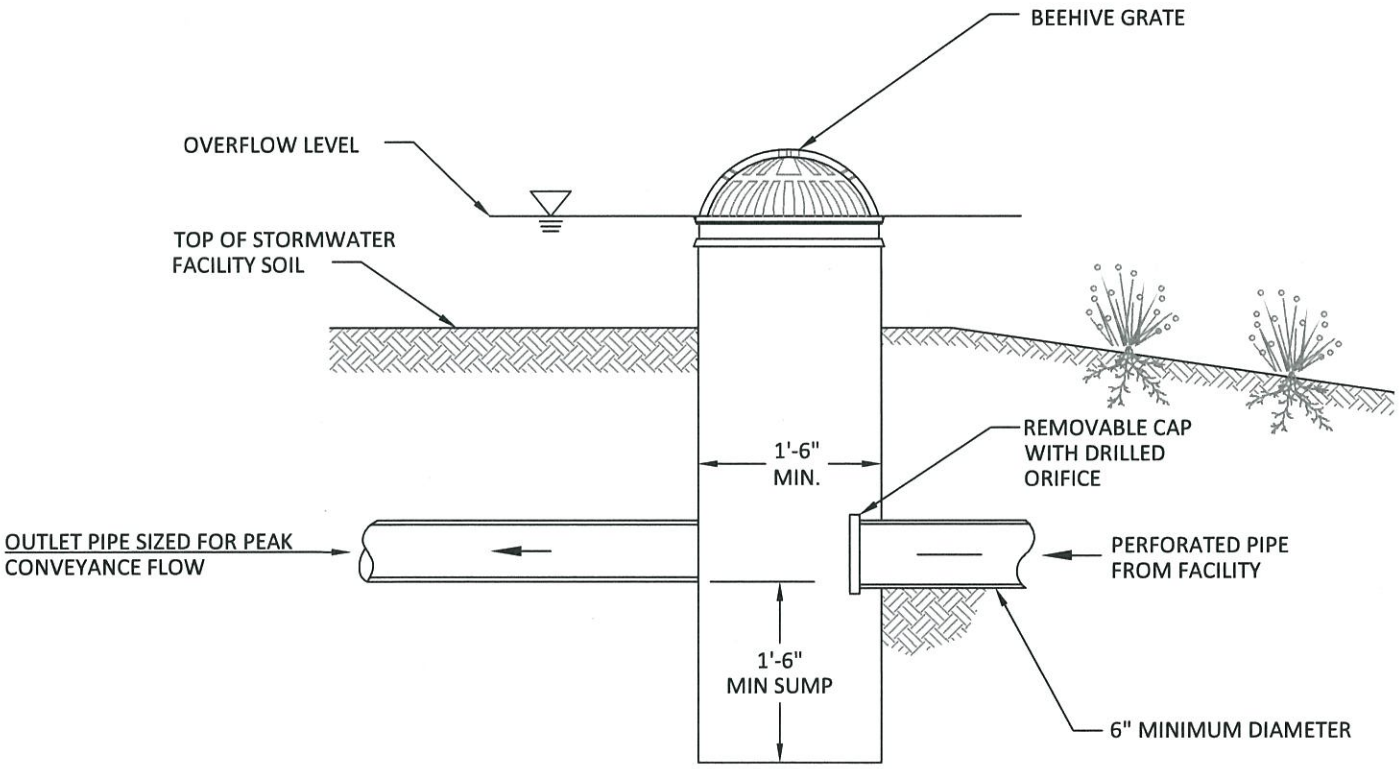
Vegetated Swales
Operations & Maintenance Plan

What to Look For	What to Do
Structural Components, including inlets and outlets/overflows, shall freely convey stormwater.	
Clogged inlets or outlets	-Remove sediment and debris from catch basins, trench drains, curb inlets and pipes to maintain at least 50% conveyance capacity at all times.
Cracked Drain Pipes	-Replace/seal cracks. Replace when repair is insufficient.
Check Dams	-Maintain 4 - 10 inch deep rock check dams at design intervals.
Vegetation	
Dead or strained vegetation	-Replant per original planting plan, or substitute from Appendix A. -Irrigate as needed. Mulch banks annually. DO NOT apply fertilizers, herbicides, or pesticides.
Tall Grass and Vegetation	-Cut back to 4-6 inches, 1-2 times per year. Remove cuttings.
Weeds	-Manually remove weeds. Remove all plant debris.
Growing/Filter Medium, including soil and gravels, shall sustain healthy plant cover and infiltrate within 72 hours.	
Gullies	-Fill, lightly compact, and plant vegetation to disperse flow.
Erosion	-Restore or create outfalls, check dams, or splash blocks where necessary.
Slope Slippage	-Stabilize slope.
Ponding	-Rake, till, or amend to restore infiltration rate.

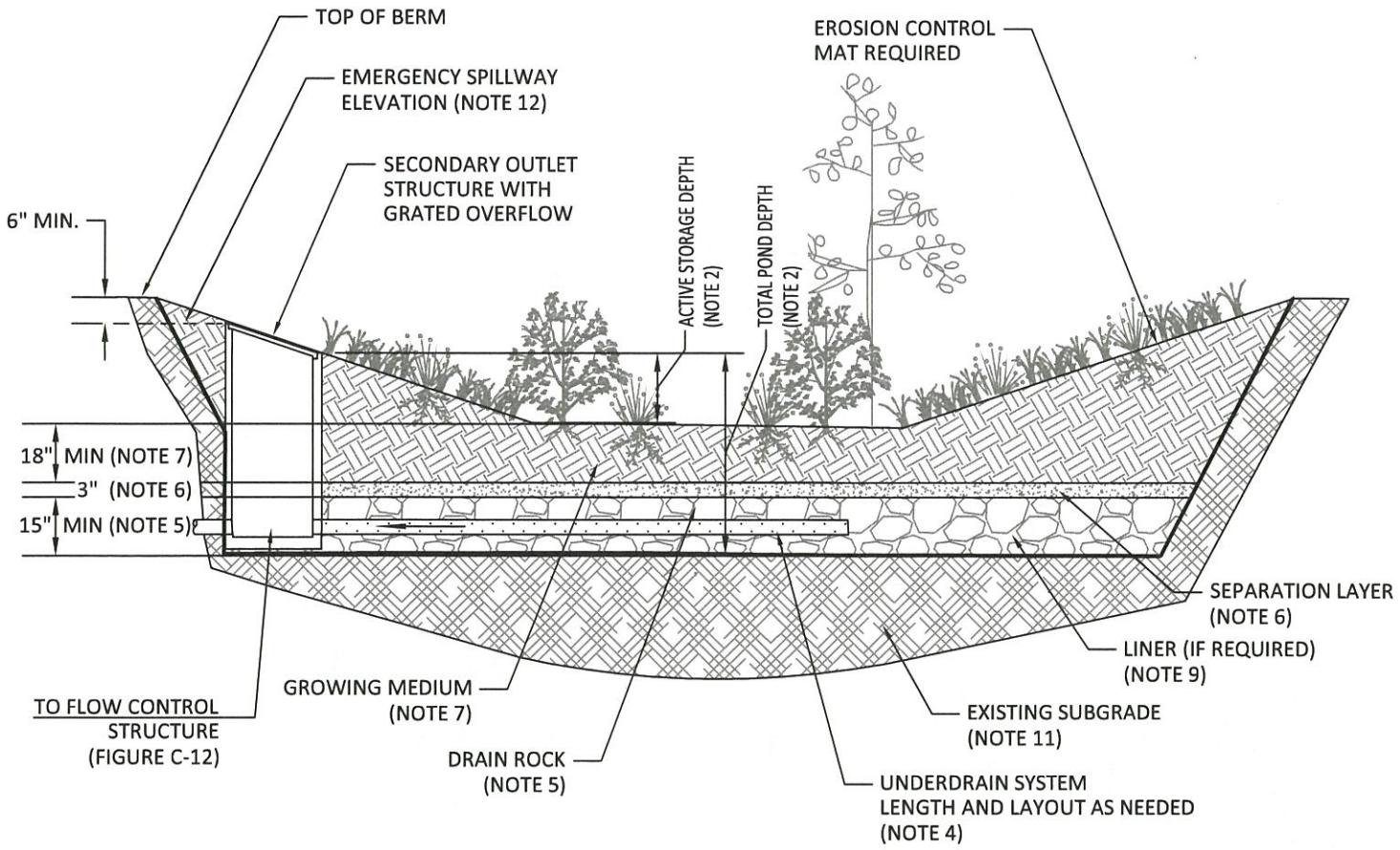
Annual Maintenance Schedule:

Summer. Make any structural repairs. Improve filter medium as needed. Clear drain. Irrigate as needed.
Fall. Replant exposed soil and replace dead plants. Remove sediment and plant debris.
Winter. Monitor infiltration/flow-through rates. Clear inlets and outlets/overflows to maintain conveyance.
Spring. Remove sediment and plant debris. Replant exposed soil and replace dead plants. Mulch.
All seasons. Weed as necessary. Clean scuppers or curb cuts as needed.
Maintenance Records: Record date, description, and contractor (if applicable) for all structural repairs, landscape maintenance, and facility cleanout activities. Keep work orders and invoices on file and make available upon request of the inspector.
Access: Maintain ingress/egress to design standards.
Infiltration/Flow Control: All facilities shall drain within 72 hours. Record time/date, weather, and site conditions when ponding occurs.
Pollution Prevention: All sites shall implement best management practices to prevent hazardous or solid wastes or excessive oil and sediment from contaminating stormwater. Contact emergency response agencies for immediate assistance responding to spills. Record time/date, weather, and site conditions if site activities contaminate stormwater.
Vectors (Mosquitoes & Rodents): Stormwater facilities shall not harbor mosquito larvae or rats that pose a threat to public health or that undermine the facility structure. Monitor standing water for small wiggling sticks perpendicular to the water's surface. Note holes/burrows in and around facilities. Call Clackamas County Vector Control for immediate assistance to eradicate vectors. Record time/date, weather, and site conditions when vector activity observed.

PLANTER, RAIN GARDEN, SWALE FLOW CONTROL STRUCTURE



Planter, Rain Garden, Swale Flow Control Structure
Figure C-10

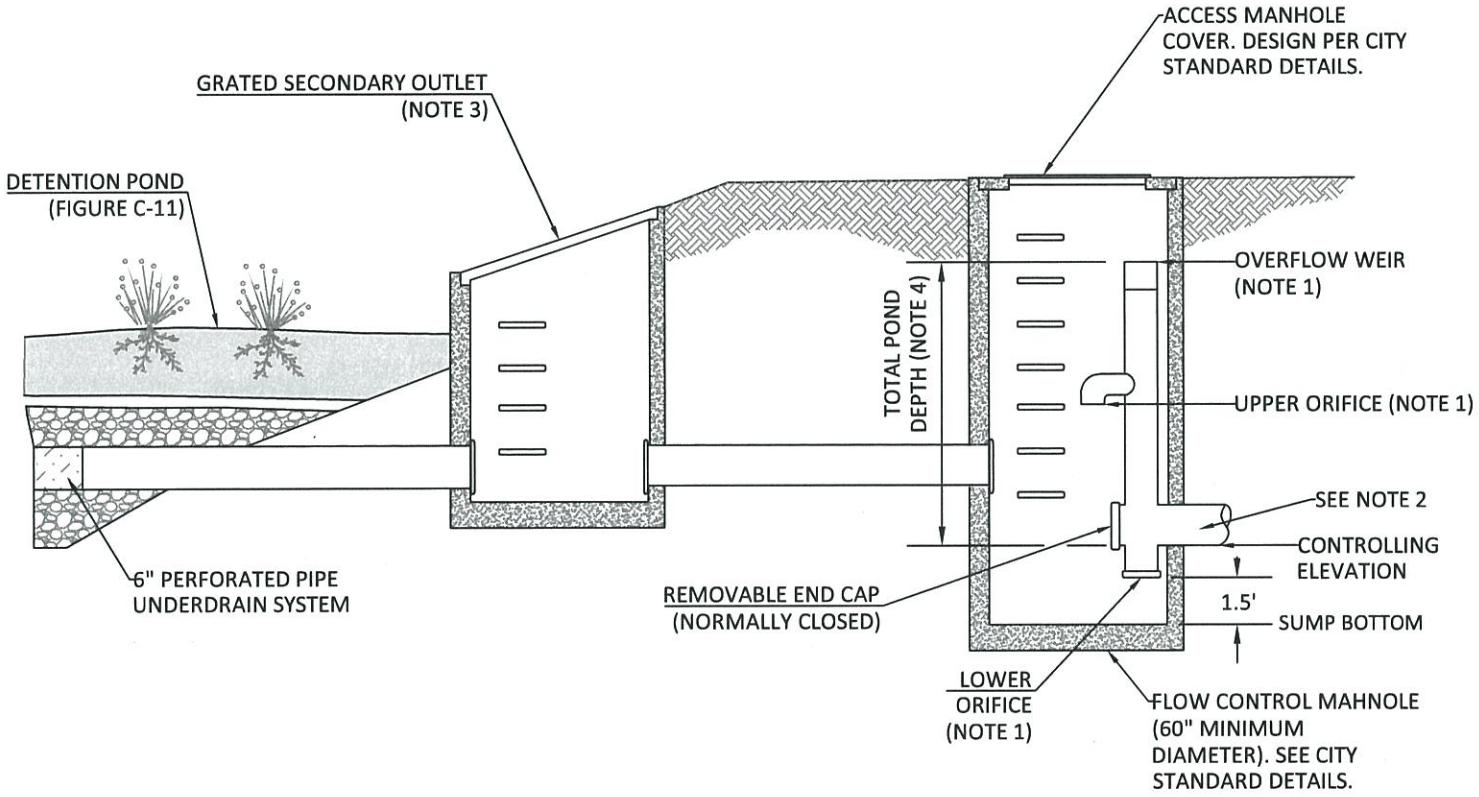


GENERAL NOTES:

1. **PROVIDE PROTECTION** FROM ALL VEHICLE TRAFFIC, EQUIPMENT STAGING, AND FOOT TRAFFIC IN PROPOSED INFILTRATION AREAS PRIOR TO, DURING AND AFTER CONSTRUCTION. UNLESS REQUIRED BY SITE CONDITIONS, UNLINED PONDS ARE PREFERRED TO ALLOW MAXIMUM INFILTRATION.
2. **DIMENSIONS:**
   -ACTIVE STORAGE DEPTH (FROM TOP OF GROWING MEDIUM TO OVERFLOW ELEVATION): PER FACILITY SIZING MODEL
   -FACILITY AREA SHALL BE MEASURED AT THE DEEPEST SECTION (DRAIN ROCK) OF FACILITY.
   -TOTAL POND DEPTH: 4' MINIMUM, PER FACILITY SIZING MODEL
   -BOTTOM SLOPE: 2.0% OR LESS
   -SIDE SLOPES OF DETENTION POND: 3:1 MAXIMUM
3. **SETBACKS:**
   -DETENTION POND MUST BE 10' FROM FOUNDATIONS AND 5' FROM PROPERTY LINES UNLESS APPROVED BY BUILDING OFFICIAL.
4. **PIPING:**
   -PERFORATED UNDERDRAIN PIPING: SHALL BE ABS SCH. 40, DUCTILE IRON OR PVC SCH. 40. 6" MINIMUM DIAMETER. PIPING MUST HAVE 1% GRADE AND FOLLOW THE UNIFORM PLUMBING CODE. PVC NOT ALLOWED ABOVE GROUND.
5. **DRAIN ROCK:**
   -SIZE: 1 1/2" - 3/4" WASHED
   -DEPTH: 15" MINIMUM
6. **SEPARATION** BETWEEN DRAIN ROCK AND GROWING MEDIUM: SHALL BE A 3" LAYER OF 3/4" - 1/4" OPEN GRADED AGGREGATE.
7. **GROWING MEDIUM:**
   -18" MINIMUM
   -SEE APPENDIX A FOR SPECIFICATION OR USE SAND/LOAM/COMPOST 3-WAY MIX.
8. **VEGETATION:** FOLLOW LANDSCAPE PLANS OR REFER TO PLANTING REQUIREMENTS IN APPENDIX A.
9. **WATERPROOF LINER (IF REQUIRED):** SHALL BE 30 MIL PVC OR EQUIVALENT FOR DETENTION POND.
10. **INSTALL RIVER ROCK** OR SPLASH PAD TO TRANSITION FROM INLETS TO GROWING MEDIUM. SIZE OF ROCK SHALL BE 1" TO 3".
11. **SEASONAL HIGH GROUNDWATER SEPARATION:**
    -SEPARATION DISTANCE AS REQUIRED BY CITY.
12. **EMERGENCY SPILLWAY** SIZED TO CONVEY THE 100 - YEAR DESIGN STORM. PROVIDE 6" MINIMUM FREEBOARD ABOVE THE 100 - YEAR DESIGN STORM.

Detention Pond
Figure C-11

DETENTION POND FLOW CONTROL STRUCTURE



NOTES:

1. ORIFICE AND WEIR DIMENSIONS AND ELEVATION DETERMINED THROUGH FACILITY SIZING MODEL.
2. PIPE SIZING DETERMINED BY ENGINEER.
3. SECONDARY OUTLET SIZED FOR PEAK DESIGN STORM.
4. TOTAL POND DEPTH, PER FACILITY SIZING MODEL, INCLUDES GROWING MEDIA, SEPARATION LAYER, AND DRAIN ROCK AS SHOWN ON FIGURE C-11.

Detention Pond
Operations & Maintenance Plan

Detention Ponds remove pollutants through several processes: sedimentation, filtration, and biological processes. The facility owner must keep a log, recording all inspection dates, observations, and maintenance activities. The following items shall be inspected and maintained as stated:

What to Look For	What to Do
Structural Components, including inlets and outlets/overflows, shall freely convey stormwater.	
Clogged inlets or outlets	-Remove sediment and debris from catch basins, trench drains, curb inlets and pipes to maintain at least 50% conveyance capacity at all times.
Cracked Drain Pipes	-Repair/seal cracks. Replace when repair is insufficient.
Clogged Control Structures	-Remove accumulated sediment and debris.
Vegetation shall cover 90% of the facility.	
Dead or strained vegetation	-Replant per original planting plan, or substitute from Appendix A. -Irrigate as needed. Mulch banks annually. DO NOT apply fertilizers, herbicides, or pesticides.
Tall Grass and Vegetation	-Cut back grass and prune overgrowth 1-2 times per year. Remove cuttings.
Weeds	-Manually remove weeds. Remove all plant debris.
Growing/Filter Medium, including soil and gravels, shall sustain healthy plant cover and infiltrate within 72 hours.	
Gullies	-Fill, lightly compact, and plant vegetation to disperse flow.
Erosion	-Replace splash blocks or inlet gravel/rock.
Slope Slippage	-Stabilize 3:1 Slopes/banks with plantings from Appendix A.
Ponding	-Rake, till, or amend to restore infiltration rate.

Annual Maintenance Schedule:

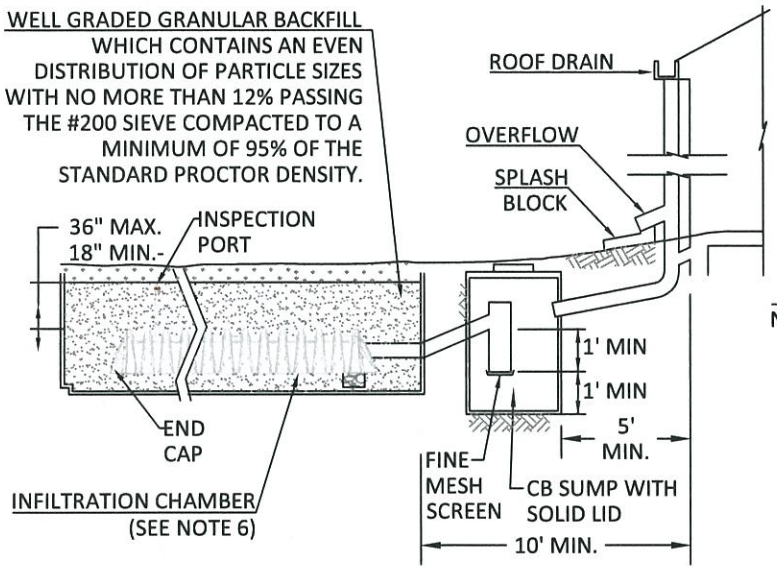
All facility components, vegetation, and source controls shall be inspected for proper operations and structural stability. These inspections shall occur, at a minimum, quarterly for the first 2 years from the date of installation, and 2 times per year thereafter, and within 48 hours after each major storm event.

Access: Maintain ingress/egress to design standards.

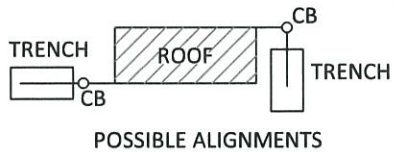
Infiltration/Flow Control: All facilities shall drain within 72 hours. Record time/date, weather, and site conditions when ponding occurs.

Pollution Prevention: All sites shall implement best management practices to prevent hazardous or solid wastes or excessive oil and sediment from contaminating stormwater. Contact emergency response agencies for immediate assistance responding to spills. Record time/date, weather, and site conditions if site activities contaminate stormwater.

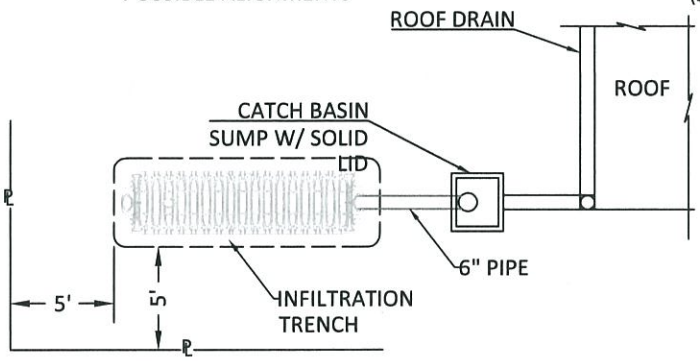
Vectors (Mosquitoes & Rodents): Stormwater facilities shall not harbor mosquito larvae or rats that pose a threat to public health or that undermine the facility structure. Monitor standing water for small wiggling sticks perpendicular to the water's surface. Note holes/burrows in and around facilities. Call Clackamas County Vector Control for immediate assistance to eradicate vectors. Record time/date, weather, and site conditions when vector activity observed.



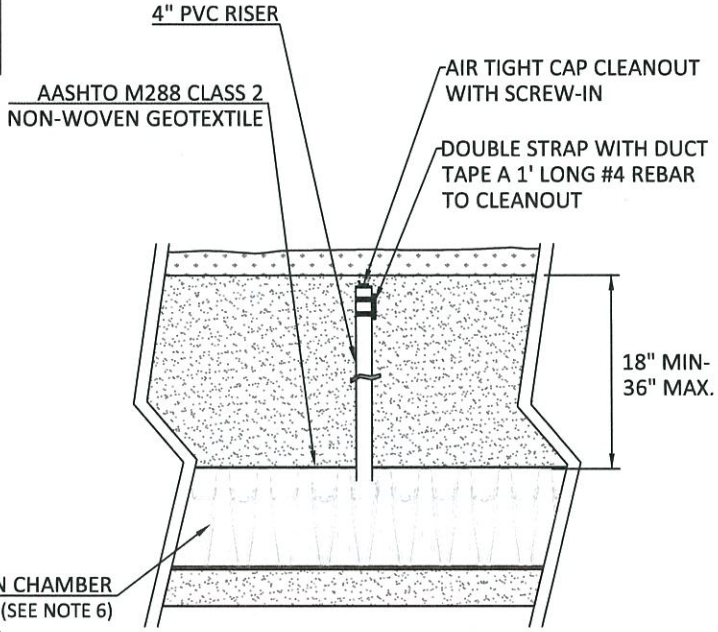
PROFILE VIEW
NOT TO SCALE



POSSIBLE ALIGNMENTS



PLAN VIEW
NOT TO SCALE



INSPECTION PORT DETAIL
NOT TO SCALE

GENERAL NOTES

1. USE OF INFILTRATION SYSTEMS ONLY ALLOWED FOR SITES WITH FACTORED INFILTRATION TEST RESULTS OF AT LEAST 2 IN/HR OR FACILITY IS PLACED ENTIRELY WITHIN AN AREA WITH HYDROLOGIC SOIL GROUP A.
2. FOR SIZING OF FACILITY THE MINIMUM STORAGE VOLUME (CF) = 0.2 x TOTAL IMPERVIOUS AREA (SF).
3. INFILTRATION CHAMBERS ARE TO BE ENTIRELY WRAPPED BY AASHTO M288 CLASS 2 NON-WOVEN GEOTEXTILE.
4. VOLUME OF CHAMBER VARIES WITH EACH CHAMBER MANUFACTURER AND MODEL.
5. PROVIDE AN ADEQUATE NUMBER OF CHAMBERS TO MEET OR EXCEED THE MINIMUM REQUIRED CHAMBER VOLUME.
6. INFILTRATION CHAMBERS SHALL BE MANUFACTURED BY ONE OF THE FOLLOWING OR APPROVED EQUAL:

STORMTECH	CULTEC INC.	INFILTRATOR SYSTEMS INC.
(WWW.STORMTECH.COM)	(WWW.CULTEC.COM)	(WWW.INFILTRATORSYSTEMS.COM)
1-888-892-2694	1-800-4-CULTEC	1-800-718-2754

7. SOIL CLASSIFICATION MAP IS AVAILABLE FOR VIEWING AT WWW.ORCITY.ORG.

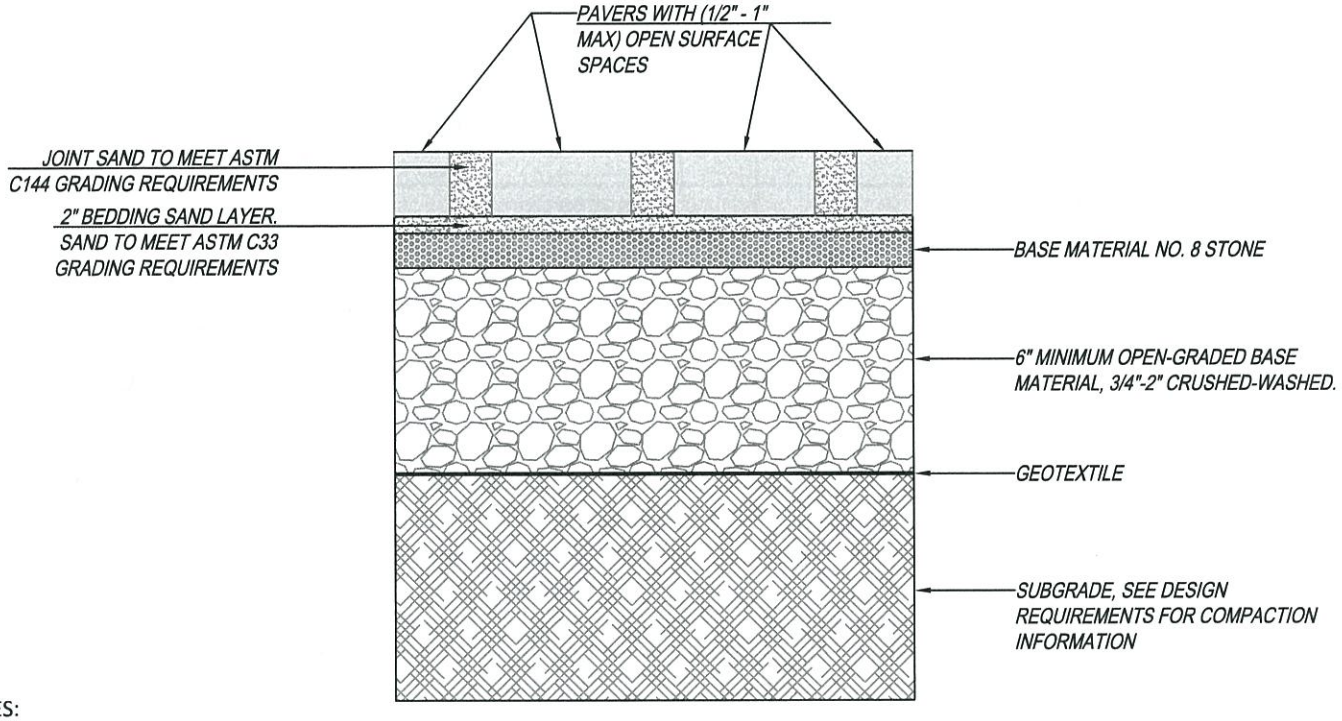
Roof Infiltration System
Figure C-14

Roof Infiltration System
Operations & Maintenance Plan

What to Look For	What to Do
Structural Components, include pipes, manholes, rock/sand reservoirs, storm chambers and silt traps.	
Clogged inlets or outlets	-Clean gutters, rain drains, and silt traps twice a year. -Clear piping to facility when blockage occurs.
Cracked Drain Pipes	-Repair/seal cracks. Replace when repair is insufficient.
Catch Basin	-Remove accumulated sediment annually.
Vegetation includes surface cover and nearby plantings.	
Large Shrubs and Trees	-Prevent large root systems from damaging subsurface structural components.
Filter Layer, includes rock/gravel bed.	
Ponding Water	-Clear piping through facility when ponding occurs. -Replace rock/sand reservoirs as necessary. -Tilling of subgrade below reservoir may be necessary (for trenches) prior to backfill. -May require decommissioning and replacement (for infiltrators or trenches).

Annual Maintenance Schedule:

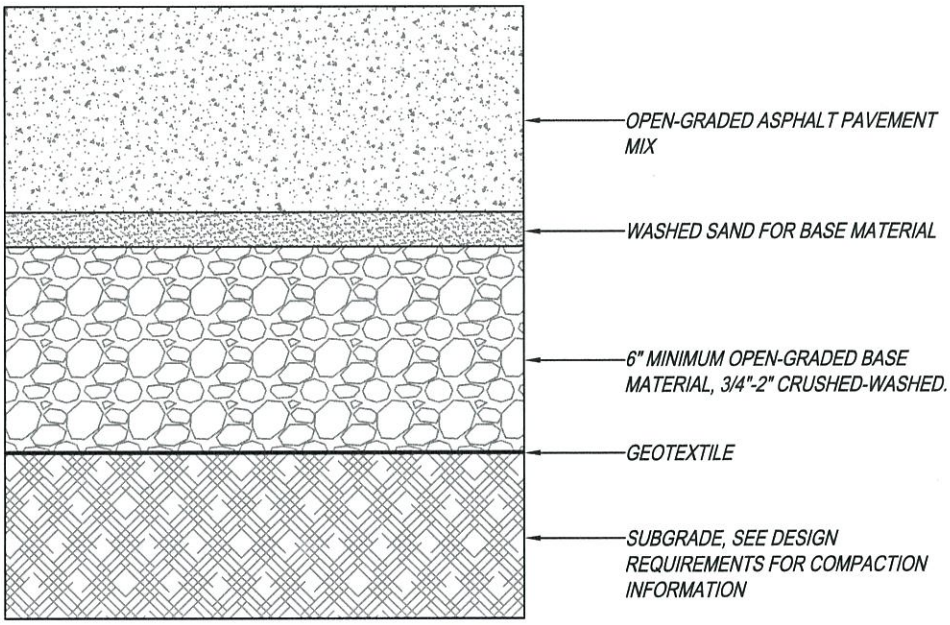
Summer. Make necessary structural repairs. Clean silt traps.
Fall. Clean gutters and rain drains.
Winter. Monitor infiltration rates.
Spring. Clean gutters and rain drains.
Maintenance Records: Record date, description, and contractor (if applicable) for all structural repairs, landscape maintenance, and facility cleanout activities. Keep work orders and invoices on file and make available upon request of the inspector.
Access: Maintain ingress/egress to design standards.
Infiltration/Flow Control: All facilities shall drain within 72 hours. Record time/date, weather, and site conditions when ponding occurs.
Pollution Prevention: All sites shall implement best management practices to prevent hazardous or solid wastes or excessive oil and sediment from contaminating stormwater. Contact emergency response agencies for immediate assistance responding to spills. Record time/date, weather, and site conditions if site activities contaminate stormwater.
Vectors (Mosquitoes & Rodents): Stormwater facilities shall not harbor mosquito larvae or rats that pose a threat to public health or that undermine the facility structure. Monitor standing water for small wiggling sticks perpendicular to the water's surface. Note holes/burrows in and around facilities. Call Clackamas County Vector Control for immediate assistance to eradicate vectors. Record time/date, weather, and site conditions when vector activity observed.



PERVIOUS CONCRETE BLOCK OR "PAVER" SYSTEMS

NOTES:

1. THE DESIGN ENGINEER SHALL SUBMIT PERVIOUS PAVEMENT DESIGN AND SPECIFICATIONS IN CONFORMANCE WITH INDUSTRY STANDARDS.
2. PAVERS AVERAGE COMPRESSIVE STRENGTH OF 8,000 PSI. NO INDIVIDUAL UNIT LESS THAN 7,200 PSI. MINIMUM 80 MM THICKNESS.
3. BANDED BY CONCRETE EDGE RESTRAINTS.
4. MANHOLE COLLARS PER CITY STANDARD DETAIL.



PERVIOUS (OPEN GRADED) CONCRETE SYSTEMS

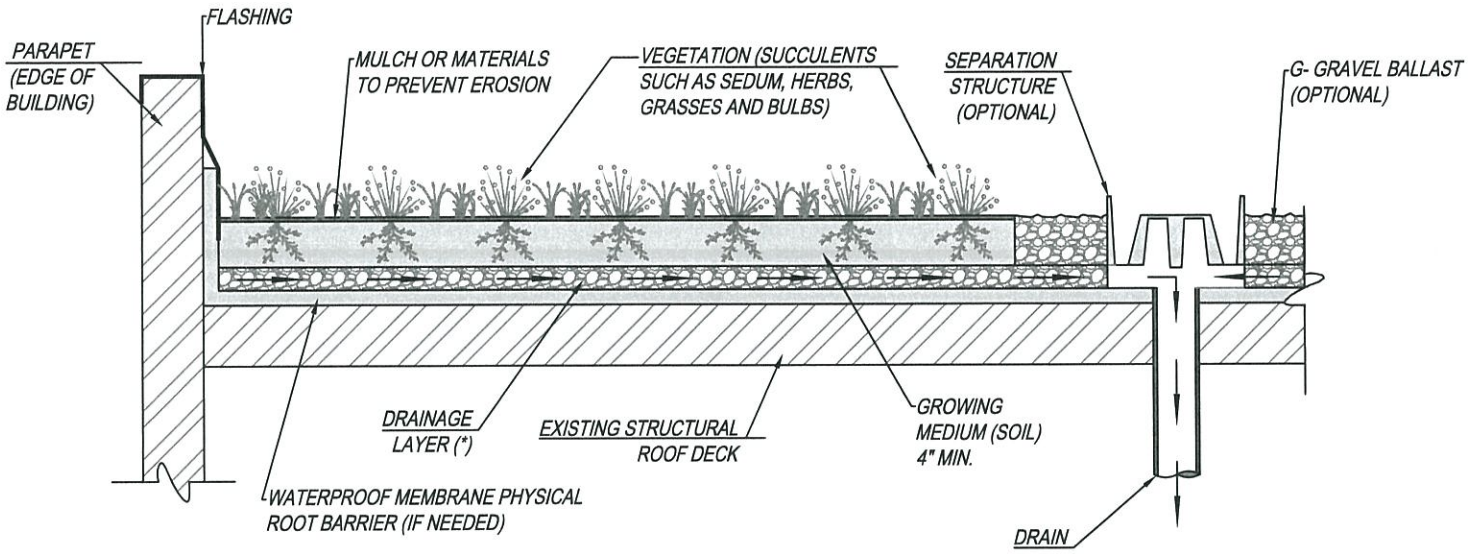
Pervious Pavement
Operations & Maintenance Plan

Pervious pavement is a permeable pavement surface with an underlying stone reservoir that temporarily stores surface runoff before infiltrating into the subsoil or being collected in underlying drain pipes and being discharged off-site. There are many types of pervious pavement including plastic rings planted with grass, stone or concrete blocks with pore spaces backfilled with gravel or sand, porous asphalt, and porous concrete. Pervious pavement accepts only precipitation, not stormwater runoff. The following items shall be inspected and maintained as stated:

What to Look For	What to Do
Structural Components, including surface materials, shall evenly infiltrate stormwater.	
Clogged surface	-Vacuum sweep at least twice a year. -Powerwash annually or as needed. Do not use surfactants.
Cracked or moving edge restraints	-Repair per manufacturer's recommendations.
Cracked or loose pavement	-Repair per manufacturer's recommendations.
Vegetation includes surface cover and nearby plantings.	
Large Shrubs and Trees	-Sweep leaf litter and sediment to prevent surface clogging and ponding. -Prevent large root systems from damaging pavement. -Manually remove weeds. Remove all plant debris.
Filter Medium	
Aggregate loss in pavers from settling and from power washing.	-Replace paver pore space with aggregate from original design.

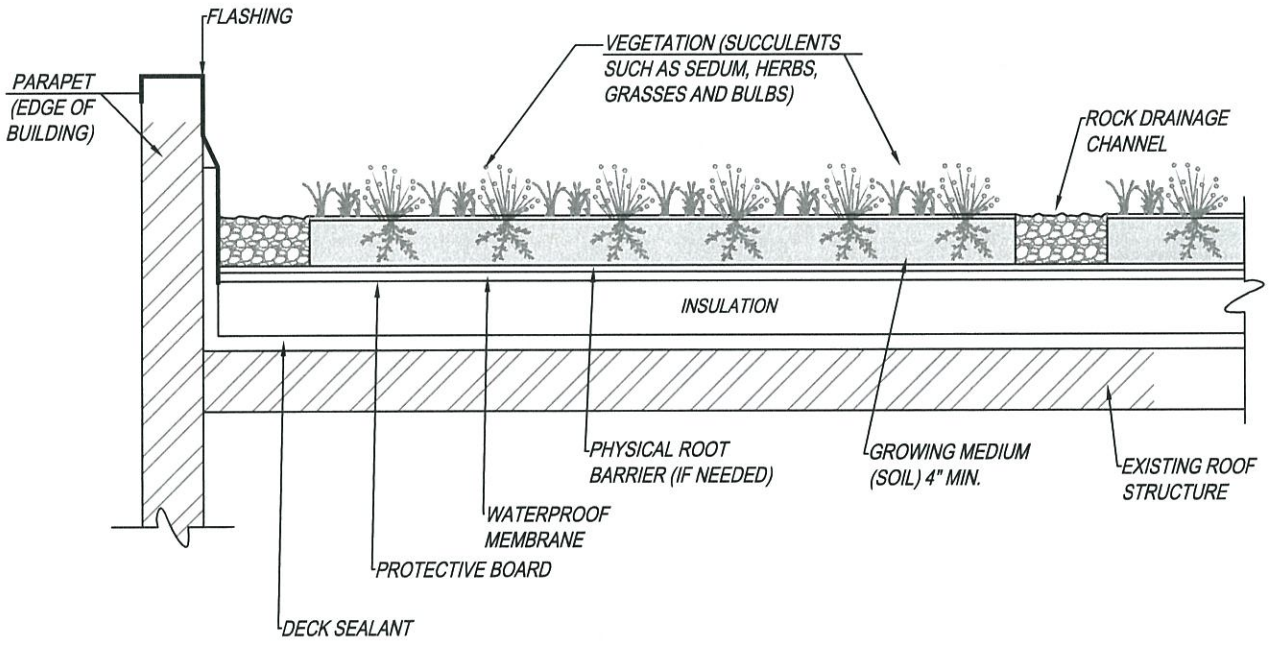
Maintenance Schedule:

Summer. Make necessary structural repairs.
Fall. Vacuum sweep.
Winter. Monitor infiltration rates.
Spring. Power wash with proper disposal. Vacuum sweep.
All Seasons: Weed as necessary.
Maintenance Records: Record date, description, and contractor (if applicable) for all structural repairs, landscape maintenance, and facility cleanout activities. Keep work orders and invoices on file and make available upon request of the inspector.
Access: Maintain ingress/egress to design standards.
Infiltration/Flow Control: All facilities shall not retain standing water during dry weather. Record time/date, weather, and site conditions when ponding occurs.
Pollution Prevention: All sites shall implement best management practices to prevent hazardous or solid wastes or excessive oil and sediment from contaminating stormwater. Contact emergency response agencies for immediate assistance responding to spills. Record time/date, weather, and site conditions if site activities contaminate stormwater.
Vectors (Mosquitoes & Rodents): Stormwater facilities shall not harbor mosquito larvae or rats that pose a threat to public health or that undermine the facility structure. Monitor standing water for small wiggling sticks perpendicular to the water's surface. Note holes/burrows in and around facilities. Call Clackamas County Vector Control for immediate assistance to eradicate vectors. Record time/date, weather, and site conditions when vector activity observed.



* SEE DETAIL BELOW FOR OPTION

GREEN ROOF WITH DRAINAGE LAYER



GREEN ROOF WITH DRAINAGE CHANNELS

GENERAL NOTES:

1. **THE DESIGN ENGINEER** SHALL SUBMIT GREEN ROOF DESIGN AND SPECIFICATIONS IN CONFORMANCE WITH INDUSTRY STANDARDS.

Green Roof
Operations & Maintenance Plan

Green Roofs are vegetated roof systems that retain and filter stormwater and provide aesthetic and energy conservation benefits. All facility components, including soil substrate or growth medium, vegetation, drains, irrigation systems (if applicable), membranes, and roof structure shall be inspected for proper operations, integrity of the waterproofing, and structural stability throughout the life of the green roof. The facility owner must keep a log, recording all inspection dates, observations, and maintenance activities. The following items shall be inspected and maintained as stated:

What to Look For	What to Do
Structural Components, including waterproof membrane, shall be operated and maintained in accordance with the manufacturer's and design specifications.	
Clogged drains	-Repair any leaks or structural deficiencies. -Remove sediment and debris if necessary.
Tears or perforated membrane	-Contact manufacturer for repair or replacement.
Vegetation shall cover 90% of facility.	
Dead or strained vegetation	-Replant per original planting plan, or substitute from Appendix A.
Dry Grass or other Plants	-Prune tall, dry grasses and remove clippings.
Weeds	-Manually remove weeds. Do not use pesticides. Remove all plant debris.
Growing/Filter Medium including soil and gravels, shall sustain healthy plant cover and infiltrate within 48 hours.	
Exposed soil	-Cover with plants and mulch as needed.
Eroded soils and gullies	-Fill, hand tamp or lightly compact, and plant vegetation to disperse flow.
Crusting, dry or shrinking medium	-Rake or amend to restore filtration or flow.
Ponding or excessive moisture	-Amend soils and clear drains.

Maintenance Schedule:

Summer. Make necessary structural repairs. Improve growing medium as needed. Clear drains. Irrigate as needed.
Fall. Replant exposed soil and dead plants. Remove sediment and debris from drains. Provide erosion control for bare soil if neccessary.
Winter. Monitor infiltration rates. Clear drains as needed.
Spring. Replant exposed soil and dead plants. Remove sediment and debris from drains.
All Seasons: Weed as necessary.
Maintenance Records: Record date, description, and contractor (if applicable) for all structural repairs, landscape maintenance, and facility cleanout activities. Keep work orders and invoices on file and make available upon request of the inspector.
Access: Maintain ingress/egress to design standards.
Irrigation: Adjust irrigation program or consult professional to set system at correct watering system.
Infiltration/Flow Control: All facilities shall drain within 48 hours. Record time/date, weather, and site conditions when ponding occurs.
Pollution Prevention: All sites shall implement best management practices to prevent hazardous wastes from contaminating stormwater. Record time/date, weather, and site conditions if site activities contaminate stormwater.
Vectors (Mosquitoes & Rodents): Green Roof shall not harbor mosquito larvae or rodents that pose a threat to public health or that undermine the facility structure. Contact Clackamas County Vector Control for assistance. Record time/date, weather, and site conditions when vector activity observed. Record when vector abatement started and ended.

STORMWATER FACILITIES
OPERATIONS AND MAINTENANCE CHECKLIST

Problem	Recommended / Required	Trigger	Preferred Condition
Sediment Accumulation in Treatment Area	Monthly from November through April / Annually Required	Sediment depth exceeds 3 inches	Sediment removed from vegetated treatment area: level side to side and drains freely toward outlet; no standing water within 24 hours of any major storm (1" in 24 hours)
Erosion Scouring	Monthly from November through April / Annually Required	Exposed earth or rutted soil	Repair ruts or bare areas by filling with topsoil during dry season; regrade and replant large bare areas
Standing Water	Monthly from November through April and after any major storm event (1 inch in 24 hours)	Standing water in the planter between storms that does not drain freely	Remove sediment or trash blockages; improve end to end grade so there is no standing water 24 hours after any major storm (1 inch in 24 hours)
Flow not Distributed Evenly	Monthly from November through April / Annually Required	Flows unevenly distributed through planter width due to uneven or clogged flow spreader	Level the spreader and clean so that flows spread evenly over entire planter width
Settlement/ Misalignment	Annually Required	Failure of planters has created safety, function, or design problem	Planter replaced or repaired to design standards
Constant Baseflow	Monthly from November through April / Annually Required	Small, continual flow of water through the planter even after weeks without rain; planter bottom has an eroded, muddy channel	Add a low-flow pea gravel drain the length of the planter or bypass the baseflow around the planter
Vegetation	Monthly from November through April / Annually Required	Vegetation blocking more than 10% of the inlet pipe opening	No vegetation blocking the inlet pipe opening
Poor Vegetation Coverage	Monthly / Annually Required	Grass or other vegetation is sparse, or bare in more than 10% of the planter area	Determine cause of poor growth and correct the condition; replant with plants (per Appendix A) as needed to meet facility standards
Invasive Vegetation	Monthly / Annually Required	No invasive vegetation is planted or permitted to remain	No invasive vegetation present; remove excessive weeds. Control if complete eradication is not feasible
Rodents	Monthly / Annually Required	Evidence of rodents or rodent damage	No rodents; functioning facility
Insects	Annually Required	Insects such as wasps and hornets that interfere with maintenance activities	Harmful Insects removed
Trash and Debris	Monthly and after any major storm event (1 inch in 24 hours) / Annually Required	Visual evidence of trash, debris or dumping	Trash and Debris removed from facility
Contamination and Pollution	Monthly from November through April / Annually Required	Any evidence of oil, gasoline, contamination or other pollutants	No contaminants or pollutants present; coordinate removal/cleanup with local water quality response agency
Obstructed Inlet/Outlet	Monthly and after any major storm event (1 inch in 24 hours) / Annually Required	Inlet/outlet areas clogged with sediment, vegetation or debris	Clear inlet and outlet; obstructions removed
Excessive Shading	Monthly from November through April / Annually Required	Vegetation growth is poor because sunlight does not reach planter	Trim over-hanging limbs and/or remove brushy vegetation as needed
Vegetation	Monthly from November through April / Annually Required	Specified or approved grass grows so tall that it competes with shrubs and/or becomes a fire danger	String trim non-wetland grasses to 4 to 6 inches and remove clippings; protect woody vegetation

APPENDIX D

Infiltration Testing

APPENDIX D. INFILTRATION TESTING

D.1 General

To properly size and locate stormwater management facilities, it is necessary to characterize the soil infiltration conditions at the location of the proposed facility. All projects that require a stormwater management facility shall evaluate existing site conditions and determine if the site's infiltration rate is adequate to support the proposed stormwater management facility. The following sections provide the approved methods for testing infiltration and setting the design infiltration rate. City staff may require additional testing on a case-by-case basis.

D.2 Basic Method - Open Pit Test

The Basic Method – Open Pit Test (Basic Method) is applicable only to projects on private property with less than 10,000 square feet of new or redeveloped impervious area. The results of infiltration testing shall be documented on the Basic Method Form. The Basic Method cannot be used for projects that have known downstream conveyance problems.

The intent of the Basic Method is to determine whether or not the local infiltration rate is adequate to support an infiltration facility. The Basic Method infiltration test does not need to be conducted by a licensed professional, but it is recommended.

D.2.1 Basic Method Instructions

1. Conduct one test for each proposed stormwater management facility. The test should be where the facility is proposed or within the direct vicinity.
2. Excavate a test hole to the depth of the bottom of the infiltration system, or otherwise to 4 feet. The test hole can be excavated with small excavation equipment or by hand using a shovel, auger, or posthole digger.
3. If a layer hard enough to prevent further excavation is encountered, or if noticeable moisture/water is encountered in the soil, stop, measure, and record this depth from the surface. Proceed with the test at this depth.
4. Fill the hole with water to a height of about 6 inches from the bottom of the hole (or to one-half the maximum depth of the proposed facility), and record the exact time. Check the water level at regular intervals (every 1 minute for fast-draining soils to every 10 minutes for slower-draining soils) for a minimum of 1 hour or until all of the water has infiltrated. Record the distance the water has dropped from the top edge of the hole.
5. Repeat this process two more times, for a total of three rounds of testing. These tests should be performed as close together as possible to portray the soil's ability to infiltrate at different levels of saturation accurately. The third test provides the best measure of the saturated infiltration rate.
6. For each test pit required, submit all three testing results with the date, duration, drop in water height, and conversion into inches per hour.

If the applicant would like to use an infiltration rate for design purposes, a Professional Method Infiltration Test shall be conducted.

D.3 Professional Method

The Professional Method shall be used for all public and private developments with more than 10,000 square feet of new or redeveloped impervious area. The Professional Method shall also be used for all public and private developments with known downstream conveyance problems.

Three infiltration testing methods are available, as outlined in **Sections D.3.5 through D.3.7**. The qualified professional shall exercise judgment in the selection of the infiltration test method.

D.3.1 Testing Criteria

1. Testing shall be conducted or observed by a qualified professional. This professional shall be a Professional Engineer (PE), Registered Geologist (RG), or Certified Engineering Geologist (CEG) licensed in the state of Oregon.
2. The location and depth of the test shall correspond to the facility location and depth.
3. Infiltration testing should not be conducted in engineered or undocumented fill.
4. Boring logs shall be provided as supporting information with infiltration and depth to groundwater tests.
5. All testing data shall be documented in the project submittals. The submittals shall demonstrate that the proposed facilities are sized appropriately for the tested infiltration rates.

D.3.2 Depth and Location of Required Tests

Infiltration tests shall be performed at the base of the proposed facility.

If a confining layer, or soil with a greater percentage of fines, is observed during the subsurface investigation to be within 4 feet of the bottom of the planned infiltration system, the testing shall be conducted within that confining layer.

Tests shall be performed in the immediate vicinity of the proposed facility. Exceptions can be made to the test location provided the qualified professional can support that the strata are consistent from the proposed facility to the test location.

For relatively deep stormwater facilities, a hollow stem auger with an electronic measuring tape can be used, provided there is an adequate seal between the auger and the native soil.

D.3.3 Minimum Number of Required Tests

The total number of infiltration tests is at the discretion of the qualified professional assessing the site and the City Engineer, provided the following minimums are met:

- At least one test for any proposed street facility.
- One test for every 100 lineal feet or 1,000 square feet of proposed infiltration facility.

- Where multiple types of facilities are used, it is likely that multiple tests will be necessary, since an infiltration test can test only a single soil stratum. It is highly recommended to conduct an infiltration test at each stratum used.

D.3.4 Factors of Safety

Table D-1 lists the recommended factors of safety to be applied to field obtained infiltration rates for use in stormwater system design. To obtain the infiltration rate used in design, divide the infiltration rate measured in the field by the factor of safety. The factor of safety used in design should be chosen by collaboration between the geotechnical engineer or geologist overseeing the infiltration testing and the civil engineer designing the stormwater management system. Determination of the factor of safety shall include consideration of project specific conditions such as soil variability, testing methods, consequences of system failure, complexity of proposed construction, and other pertinent conditions. The maximum design infiltration rate is 20 inches per hour.

Table D-1. Infiltration Rate Safety Factors

Test Method	Recommended Correction Factors
Encased Falling Head	3
Open Pit Falling Head	2
Double-Ring Infiltrometer	Public Facilities: 1 Private Facilities: 2

D.3.5 Open Pit Falling Head Procedure

The open pit falling head procedure is based on the Environmental Protection Agency (EPA) Falling Head Percolation Test Procedure (*Onsite Wastewater Treatment and Disposal Systems Design Manual,* EPA/625/1-80-012, 1980). The test is performed in an open excavation and therefore is a test of the combination of vertical and lateral infiltration.

1. Excavate an approximately 2-foot by 2-foot-wide hole into the native soil to the elevation of the proposed facility bottom. The test can be conducted in a machine-excavated pit or a hand-dug pit using a shovel, posthole digger, or hand auger. If smooth auguring tools or a smooth excavation bucket is used, scratch the sides and bottom of the hole with a sharp-pointed instrument, and remove the loose material from the bottom of the test hole.
2. A 2-inch layer of coarse sand or fine gravel may be placed to protect the bottom from scour and sloughing.
3. Fill the hole with clean water a minimum of 1 foot above the soil to be tested, and maintain this depth of water for at least 4 hours (or overnight if clay soils are present) to presoak the native material.

4. Percolation rate measurements shall be made after 15 hours and no more than 30 hours after the soaking period begins. It is important that the soil be allowed to soak for a sufficiently long period of time to allow the soil to swell if accurate results are to be obtained. Any soil that sloughed into the hole during the soaking period shall be removed and the water level shall be adjusted to 6 inches above the added gravel (or 8 inches above the bottom of the hole).
5. In sandy soils with little or no clay, soaking is not necessary. If after filling the hole twice with 12 inches of water, the water seeps completely away in less than 10 minutes, the test can proceed immediately.
6. The measurements should be made with reference to a fixed point. A lath placed in the test pit prior to filling or a sturdy beam across the top of the pit are convenient reference points. The tester and excavator should conduct all testing in accordance with OSHA regulations.
7. Measure the water level to the nearest 0.01 foot (1/8 inch) at 10-minute intervals for a total period of 1 hour (or 20-minute intervals for 2 hours in slower soils) or until all of the water has drained. At no time during the test is the water level allowed to rise more than 6 inches above the gravel.
8. Successive trials shall be run until the measured infiltration rate between two successive trials does not vary by more than 5 percent. At least three trials shall be conducted. After each trial, the water level is readjusted to the 12-inch level. Enter results into the **Infiltration Test Data Table** provided at the end of this section.
9. The results of the last water level drop are used to calculate the tested infiltration rate. The final rate shall be reported in inches per hour. See the calculation following the **Infiltration Test Data Table** provided at the end of this section.
10. For very rapidly draining soils, it may not be possible to maintain a water head above the bottom of the test pit. If the infiltration rate meets or exceeds the flow of water into the test pit, conduct the test in the following manner:
    a. Approximate the area over which the water is infiltrating.
    b. Using a water meter, bucket, or other device, measure the rate of water discharging into the test pit.
    c. Calculate the infiltration rate by dividing the rate of discharge (cubic inches per hour) by the area over which it is infiltrating (square inches).
11. Upon completion of the testing, the excavation shall be backfilled.

D.3.6 Encased Falling Head Test Procedure

The encased falling head procedure is based on a modification of the EPA Falling Head Percolation Test Procedure (*Onsite Wastewater Treatment and Disposal Systems Design Manual,* EPA/625/1-80-012, 1980). The most significant modification is that this test is performed with a 6-inch casing that is embedded approximately 6 inches into the native soil. The goal of this field test is to evaluate the vertical infiltration rate through a 6-inch plug of soil, without allowing any lateral infiltration. The test is not appropriate in gravelly soils or in other soils where a good seal with the casing cannot be established.

1. Embed a solid 6-inch-diameter casing into the native soil at the elevation of the proposed facility bottom (see **Figure D-1**). Ensure that the embedment provides a good seal around the pipe casing so that percolation will be limited to the 6-inch plug of the material within the casing. This method can also be applied to testing within hollow stem augers, provided the driller and tester are reasonably certain that a good seal has been achieved between the soil and auger.
2. A 2-inch layer of coarse sand or fine gravel may be placed to protect the bottom from scour and sloughing.
3. Fill the pipe with clean water a minimum of 1 foot above the soil to be tested, and maintain this depth for at least 4 hours (or overnight if clay soils are present) to presoak the native material.

   Percolation rate measurements shall be made after 15 hours and no more than 30 hours after the soaking period begins. It is important that the soil be allowed to soak for a sufficiently long period of time to allow the soil to swell if accurate results are to be obtained. Any soil that sloughed into the hole during the soaking period shall be removed and the water level shall be adjusted to 6 inches above the added gravel (or 8 inches above the bottom of the hole).

   In sandy soils with little or no clay, soaking is not necessary. If after filling the hole twice with 12 inches of water, the water seeps completely away in less than 10 minutes, the test can proceed immediately.
4. To conduct the first trial of the test, fill the pipe to approximately 6 inches above the soil and measure the water level to the nearest 0.01 foot (1/8 inch). The level should be measured with a tape or other device with reference to a fixed point. The top of the pipe is often a convenient reference point. Record the exact time.
5. Measure the water level to the nearest 0.01 foot (1/8 inch) at 10-minute intervals for a total period of 1 hour (or 20-minute intervals for 2 hours in slower soils) or until all of the water has drained. The infiltration test is continued until the measured infiltration rate between two successive trials does not vary by more than 5 percent. At least three trials shall be conducted. After each trial, the water level is readjusted to the 6-inch level. Enter results into the **Infiltration Test Data Table** provided at the end of this section. At no time during the test is the water level allowed to rise more than 6 inches above the gravel.
6. The result of the last water level drop is used to calculate the tested infiltration rate. The final rate shall be reported in inches per hour.
7. Upon completion of the testing, the casings shall be immediately pulled, and the test pit shall be backfilled.

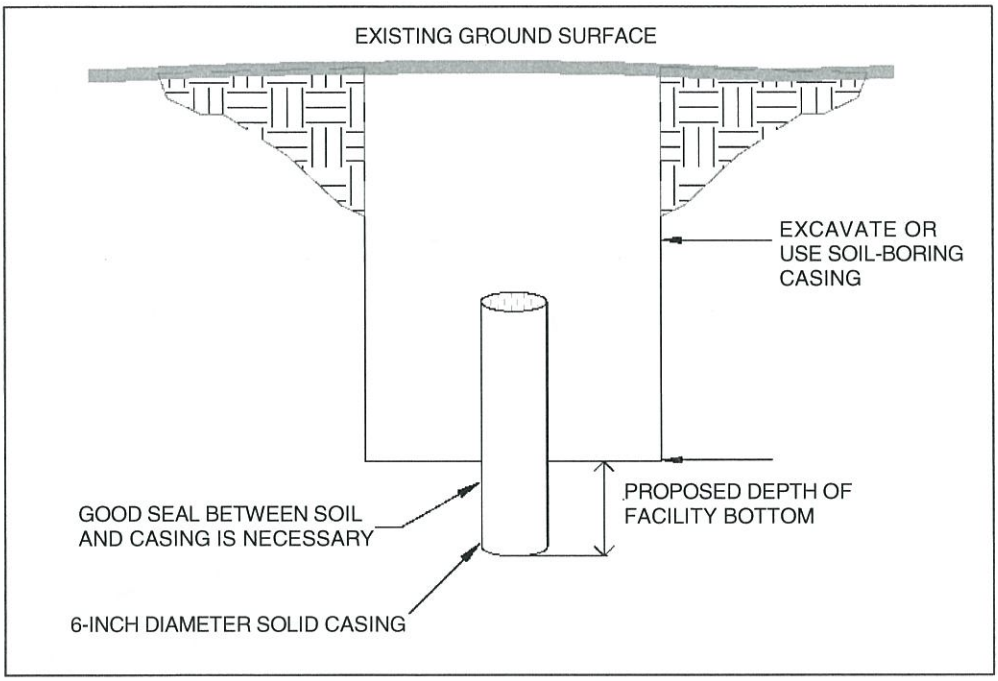


Figure D-1. Encased falling head procedure

D.3.7 Double Ring Infiltrometer Test

The double-ring infiltrometer test procedure shall conform with ASTM 3385-94. The test is performed within two concentric casings embedded and sealed to the native soils. The outer ring maintains a volume of water to diminish the potential of lateral infiltration through the center casing. The volume of water added to the center ring to maintain a static water level is used to calculate the infiltration rate. The double-ring infiltrometer is appropriate only in soils where an adequate seal can be established.

This test may be difficult to perform where the tested soil strata are in a pit, since careful regulation of the static volumes is necessary.

D.4. Reporting Requirements

In addition to the information required by the state for a signed and stamped Geotechnical Engineering Report, the following information should be included in the project's submittals.

1. Infiltration results in inches per hour.
2. Location and depth of excavation. The excavation should be deep enough to verify that there is a 5-foot separation between the final depth of the facility (rock gallery) and the seasonal high groundwater or soil layer that could reduce the infiltration rate.
3. Summary and discussion of infiltration testing, including number of tests, amounts of water used in each test (inches, gallons, etc.), and time of each test. Testing is required to show that an accurate rate was achieved.

4. Discussion of how the test was performed:
   - Open pit (size of area)
   - Encased falling head
     - Pipe type
     - Embedment depth
     - Size of pipe
   - Double ring infiltrometer
     - Pipe type
     - Embedment depth
     - Size of pipe
5. **Infiltration Test Data Table** provided at the end of this appendix.
6. Soil types with depth.
7. Groundwater observations–seasonal high groundwater level estimation.

Infiltration Test Data Table		
Location:	**Date:**	**Test Hole Number:**
Depth to bottom of hole:	**Diameter of hole:**	**Test Method:**
Tester's Name: **Tester's Company:**	**Tester's Contact Number:**	

Depth, feet	Soil Texture

Time	Time interval, minutes	Measurement, feet	Drop in water level, feet	Percolation rate, inches per hour	Remarks

Infiltration Test Data Table Example		
Location: Lot 105, Low Point Heights Subdivision	**Date:** 6/28/2010	**Test Hole Number:** 3
Depth to bottom of hole: 57 inches	**Diameter of hole:** 0.5 feet	**Test Method:** Encased falling head
Tester's Name: C.J. Tester **Tester's Company:** Tester Company		**Tester's Contact Number:** 555-1212

Depth, feet	Soil Texture
0-0.5	Black Top Soil
0.5-1.0	Brown SM
1.0-2.2	Brown ML
2.2-5.1	Brown CL

Time	Time interval, minutes	Measurement, feet	Drop in water level, feet	Percolation rate, inches per hour	Remarks
9:00	0	3.75	-		Filled with 6"
9:20	20	3.83	0.08		
9:40	20	3.91	0.08	2.88	
10:00	20	3.98	0.07	2.52	
10:20	20	4.04	0.06	2.16	
10:40	20	4.11	0.07	2.52	
11:00	20	4.17	0.06	2.16	
11:20	20	4.225	0.055	1.98	
					Adjusted to 6" level for Trial #2

Calculation is performed for each water level drop

= (Drop in water level/Time interval) x conversion

= 0.055ft/20min x (12in/ft) x (60min/hr)

= 1.98 inches per hour

The design infiltration rate of two successive trials shall have a difference of 5% or less.

APPENDIX E

Manufactured Treatment Technologies

APPENDIX E. MANUFACTURED TREATMENT TECHNOLOGIES

Manufactured treatment technologies are proprietary systems, developed to serve specific stormwater management needs. New technologies are always under development to meet the standards of urban stormwater pollutant control. Some manufactured treatment technologies are stand-alone systems and others must be used in conjunction with additional facilities (a "treatment train") in order to accomplish pollutant removal goals.

Oregon City relies on the City of Portland's submission and review protocols to establish a list of approved manufactured stormwater treatment technologies. Engineers wishing to use a manufactured treatment technology for proprietary treatment device for stormwater management should refer to the current version of the City of Portland's Stormwater Management Manual for a list of approved technologies. New technologies must gain approval from the City of Portland before being proposed for use in Oregon City.

APPENDIX F

Maintenance Covenant and Access Easement

After recording return to:

CITY RECORDER
PO BOX 3040
Oregon City, OR 97045
City Planning No.: fill in

Tax Map/Lot: _____
Drainage Area Served: _____

MAINTENANCE COVENANT AND ACCESS EASEMENT

THIS MAINTENANCE COVENANT AND ACCESS EASEMENT ("Agreement") is made this ___day of _____, 20___, between [FILL IN OWNERSHIP INFO] an [FILL IN COMPANY STATUS SUCH AS LLC] ("Developer"), and the CITY OF OREGON CITY, a municipal corporation of the State of Oregon formed pursuant to ORS Chapter 457 (the "City").

RECITALS

A. Developer is the owner and developer of certain real property located in the City of Oregon City, Clackamas County, Oregon, legally described on Exhibit A attached hereto and commonly known as [FILL IN PROPERTY INFO], OREGON CITY, OR 97045 (the "Development").

B. Developer has developed or will develop at the Development a stormwater management facility as further described below:

List the Type, Quantity, and Location of all stormwater management facilities proposed and constructed within the development.

C. The City has approved construction plans submitted by Developer for the Development, including the on-site stormwater facilities as described above (together with any other stormwater facilities that may hereafter be constructed on the Development, the "Stormwater Facilities").

D. To protect future lot owners in the Development, as well as owners of neighboring property, the City requires Developer to enter into this Agreement as a condition to the City's approval of construction plans, building permit(s), if applicable, and the final plat, if applicable, for the Development.

E. The Stormwater Facilities enable development of property while mitigating the impacts of additional surface water and pollutants associated with stormwater runoff prior to discharge from the property to the public stormwater system. The consideration for this Agreement is connection to the City's stormwater system.

F. The Stormwater Facilities are designed by a registered professional engineer to accommodate the anticipated volume of runoff and to detain and treat runoff in accordance with City's Stormwater and Grading Design Standards and its amendments.

G. Failure to inspect and maintain the Stormwater Facilities can result in an unacceptable impact to the public stormwater system.

AGREEMENT

NOW, THEREFORE, for good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, the City and Developer agree as follows:

1. **Covenant to Maintain and Repair**. Developer shall, at its sole expense, itself or through qualified independent contractors, at all times maintain the Stormwater Facilities in good working order, condition and repair, clear of all debris, and in compliance with all applicable state and local rules, regulations, and guidelines (including those adopted from time to time by the City and including the City's Stormwater and Grading Design Standards).

2. **Covenant to Inspect.** Developer shall perform annual inspections of all Stormwater Facilities covered by this agreement. The annual inspection required by this Agreement shall identify any work necessary to repair or maintain facilities in good working order. Developer shall provide Oregon City Public Works with annual maintenance inspection forms, including an identification of the corrective actions the Developer has taken in response to the annual inspection. See the City's Public Works Department Engineering Policies for appropriate inspection forms.

3. **Easement.** Developer hereby grants the City, its employees, independent contractors and designees, a nonexclusive easement for ingress and egress over, across and under the Development from time to time at the City's sole discretion to inspect, sample, and monitor components of the Stormwater Facilities and discharges therefrom, as well as allow the City to take the actions described in Sections 4 and 5 of this Agreement. Developer understands and agrees that this easement limits the ability of Developer, its successors and assigns from constructing any permanent buildings, structures, landscaping or other improvements that would interfere with the functioning of the Stormwater Facilities or the City's access to perform the inspection and maintenance required under this Agreement.

4. **Failure to Perform Covenant.** If the City, in its sole discretion, determines that Developer is not in compliance with the covenant described in Sections 1 and 2, except in the case of an emergency, the City or its designee shall give the Developer written notice to perform the maintenance and/or repair work specified in the notice. If such work is not performed to the City's satisfaction within seven (7) days after the date of such notice, or such other time as the City may, in its sole discretion, determine, the City, its employees, independent contractors and

designees may exercise their right under the Easement described in Section 3 of this Agreement to enter the Development to perform any and all work required bringing the Stormwater Facilities into compliance with this Agreement.

5. **Emergency**. If the City, in its sole discretion, determines that there exists or will likely exist an emergency on or about the Development with respect to the Stormwater Facilities, the City, its employees, independent contractors and designees may immediately exercise their rights under the Easement described in Section 3 of this Agreement to immediately enter the Development to perform any and all work required to bring the Stormwater Facilities into compliance with this Agreement, and in such case the City shall use reasonable efforts to notify the Developer prior to entering the Development. Notwithstanding the above, the work performed may consist only of avoiding or mitigating the emergency and/or cleaning and repairing the Stormwater Facilities to their original condition and standards.

6. **City Under No Obligation.** Developer, for itself and its successors and assigns (including all owners of lots in the Development), agrees that the City, as well as its departments, employees, independent contractors and/or designees shall have no obligation to exercise its rights under this Agreement, including the right under Sections 4 and 5 of this Agreement to perform the work required of the Developer, or to perform any other maintenance or repair of the stormwater facilities. Developer also agrees that none of the City, as well as its departments, employees, independent contractors and/or designees shall have any liability to Developer or any of Developer's successors or assigns (including owners of lots in the Development) in connection with the exercise or nonexercise of such rights, the maintenance or repair of the stormwater facilities, or the failure to perform the same.

7. **D eveloper Obligations**. In addition to the covenants and easement described above, Developer agrees to the following additional obligations.

a. Prior to the sale of any portion of the Development, Developer shall provide to the City's Public Works Department, a copy of the Operations and Maintenance Manual for the Stormwater Facilities, which shall include detailed diagrams and descriptions identifying the components and operations of the Stormwater Facilities.

b. Prior to final approval of the Development, developer shall record this document in the deed records of Clackamas County and provide a copy of the recorded document to the City.

c. Developer shall notify the City's Public Works Director in writing of the person responsible for compliance with Developer's obligations under this covenant ("Developer Designee"), and of any change in the Developer Designee. Developer expressly agrees that the Developer Designee shall have the authority to bind Developer, its successors and assigns with respect to the matters described in this Agreement.

d. Upon sale or transfer of the Development, or any portion thereof, including any lots in a subdivision, the Developer shall inform the purchaser of the obligations required under this Agreement.

8. **Reimbursement**. If the City exercises its right to enter the Development pursuant to the Easement described in Section 3 of this Agreement, Developer shall reimburse the City for all of its costs and expenses incurred in connection therewith within thirty (30) days after receipt of an invoice. If Developer fails to pay the invoiced amount within such period, such amount shall thereafter accrue interest at the statutory rate. Such amount, together with interest, shall be a lien on the Development (and each of the lots contained therein) which may be foreclosed in accordance with ORS Chapter 88. If the Development is owned by more than one person (i.e., multiple lot owners), each such owner shall be jointly and severally liable for payment of the amounts provided for in Section 3.

9. **Indemnification**. Developer agrees to indemnify, defend (with legal counsel reasonably acceptable to the City), and hold harmless the City, its employees, independent contractors and designees harmless from and against any liability, losses, costs, expenses (including reasonable attorney fees), claims or suits arising from Developer's failure to perform its obligations under this Agreements or the exercise of the City's rights under this Agreement.

10. **Run with the Land**. The parties' rights and obligations contained herein shall run with the land and shall be binding upon Developer and its successors and assigns (including, without limitation, subsequent owners of lots in the Development and any homeowner's association owning common areas in the Development). Those rights and obligations shall inure to the benefit of the City, as well as its successors and assigns.

11. **Attorney Fees.** If legal action is commenced in connection with this Agreement, the prevailing party in such action shall be entitled to recover its reasonable attorney fees and costs incurred in the trial court and in the appeal therefrom. The term "action" shall be deemed to include action commenced in the bankruptcy courts of the United States and any other court of general or limited jurisdiction.

12. **Assignment**. The obligations of Developer (and subsequent owners of lots in the Development) under this Agreement may not be assigned except (a) in connection with the sale of the property owned by such person (in which case the transferee will be deemed to assume such obligations), and (b) with the prior written consent of the City, to a homeowner's association that owns and maintains the common areas of the Development.

13. **Authority.** If Developer is an entity, the individual executing this Agreement on behalf of Developer represents and warrants to the City that he or she has the full power and authority to do so and that Developer has full right and authority to enter into this Agreement and perform its obligations under this Agreement.

IN WITNESS WHEREOF, Developer and the City have executed this instrument on the date first written above.

[Signature Page Follows]

DEVELOPER:	**CITY OF OREGON CITY**
_____	_____
By:_____ [FILL IN NAME, TITLE AND ENTITY OF SIGNER, e.g., by John Smith, Member of Smith Family, LLC]	By:_____ City Manager By: _____ Public Works Director

CITY

STATE OF OREGON)
) ss.
County of Clackamas)

This instrument was acknowledged before me on _____, by _____, as_____ of the City of Oregon City.

_____
Notary Public for Oregon
My Commission Expires _____

DEVELOPER

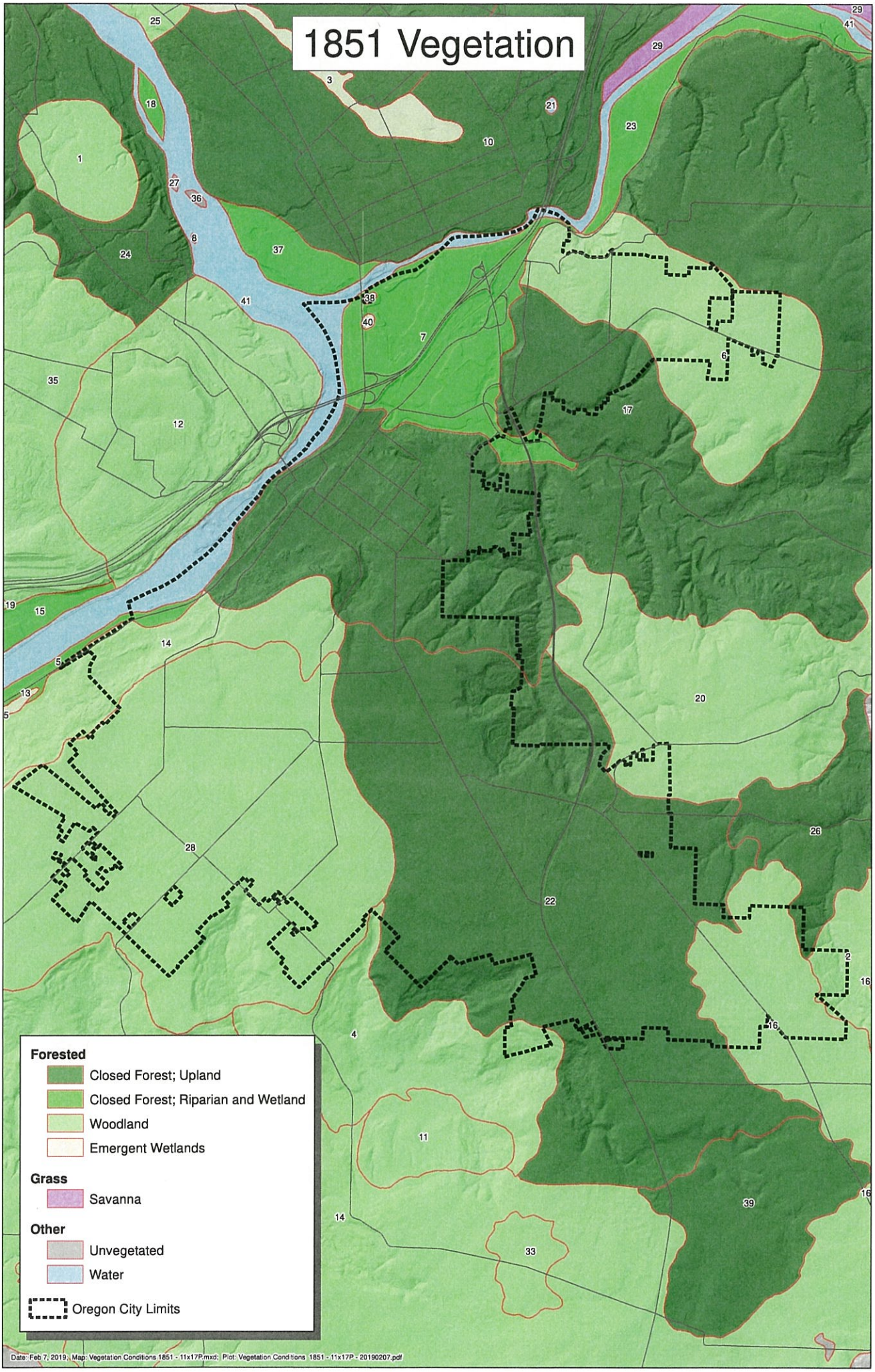
STATE OF OREGON)
) ss.
County of Clackamas)

This instrument was acknowledged before me on _____, by _____.

_____
Notary Public for Oregon
My Commission Expires _____

APPENDIX G

1851 Vegetation Conditions


1851 Vegetation
Forested
Closed Forest; Upland
Closed Forest; Riparian and Wetland
Woodland
Emergent Wetlands
Grass
Savanna
Other
Unvegetated
Water
Oregon City Limits
Date: Feb 7, 2019 , Map: Vegetation Conditions 1851 - 11x17P.mxd; Plot: Vegetation Conditions 1851 - 11x17P - 20190207.pdf

APPENDIX H

Hydrograph Method Guidelines

APPENDIX H. HYDROGRAPH METHOD GUIDELINES

The Santa Barbara Urban Hydrograph (SBUH) method was developed by the Santa Barbara County Flood Control and Water Conservation District to determine a runoff hydrograph for an urbanized area. It is a simpler method than some other approaches, as it computes a hydrograph directly without going through intermediate steps (i.e., a unit hydrograph) to determine the runoff hydrograph.

The SBUH method is a popular method for calculating runoff, since it can be done with a spreadsheet or by hand relatively easily. The SBUH method can be used to calculate peak flows and runoff volumes for sizing conveyance systems or stormwater management facilities when flow-duration matching is not required.

Elements of the SBUH Method

The SBUH method depends on several variables:

- Design storm
- Pervious (A_p) and impervious (A_{imp}) land areas
- Time of concentration (Tc) calculations
- Runoff curve numbers (CN) applicable to the site

These elements shall all be presented as part of the submittal process. In addition, maps showing the pre-development and post-development conditions shall be presented to help in the review.

Design Storm

The SBUH method also requires a design storm to perform the runoff calculations. Oregon City uses a NRCS Type 1A 24-hour storm distribution. This storm is shown in **Figure H-1** at the end of this appendix. The depth of rainfall for the water quality design storm shall be 1.0 inches[1] in 24 hours. The depth of rainfall for the 2 through 100-year 24-hour storm events is shown below in **Table H-1.**

Table H-1. 24-hour Rainfall Depths in Oregon City

Recurrence Interval, Years	24-Hour Depth, Inches
2	2.8
10	3.5
25	4.0
50	4.4
100	4.5

Source: NOAA Atlas 2, Volume X

[1] The water quality design storm rainfall depth as documented in a technical memorandum: *Selection of Representative Rainfall Volume and Rainfall Intensities to result in Capture and Treatment of 80% of the Average Annual Runoff Volume*, Brown and Caldwell, May 11, 2010.

Land Area

The total area, including the pervious and impervious areas within a drainage basin, shall be quantified in order to evaluate critical contributing areas and the resulting site runoff. Each area within a basin shall be analyzed separately and their hydrographs combined to determine the total basin hydrograph. Areas shall be selected to represent homogenous land use/development units.

Time of Concentration

Time of concentration, Tc, is the time for a theoretical drop of water to travel from the furthest point in the drainage basin to the facility being designed. (In this case, Tc is derived by calculating the overland flow time of concentration and the channelized flow time of concentration.) Tc depends on several factors, including ground slope, ground roughness, and distance of flow. The following formula may be used for determining Tc.

$Tc = Tt_1 + Tc_2 + Tc_3 + \ldots + T_{cn}$

$Tt = L/60V$ (Conversion of velocity to travel time)

$Tt = \frac{0.42\ (nL)^{0.8}}{1.58(s)^{0.4}}$ (Manning's kinematic solution for sheet flow less than 300 feet)

For shallow concentrated flow across slopes less than 0.005 ft/ft:

$V = 16.1345(s)^{0.5}$ (Unpaved surfaces)

$V = 20.3282(s)^{0.5}$ (Paved surfaces)

Where,

T_t = travel time, minutes

T_c = total time of concentration, minutes (minimum T_c = 5 minutes)

L = flow length, feet

V = average velocity of flow, feet per second

n = Manning's roughness coefficient for various surfaces

s = slope of the hydraulic grade line (land or watercourse slope), feet per foot

When calculating T_c, the following limitations apply:

- Overland sheet flow (flow across flat areas that does not form into channels or rivulets) shall not extend for more than 300 feet.
- For flow paths through closed conveyance facilities such as pipes and culverts, standard hydraulic formulas shall be used for establishing velocity and travel time.
- Flow paths through lakes or wetlands may be assumed to be zero (i.e., T_c = 0).

Runoff Curve Numbers

Runoff curve numbers (CNs) were developed by the Natural Resources Conservation Service (NRCS) after studying the runoff characteristics of various types of land. CNs were developed to reduce diverse characteristics such as soil type, land usage, and vegetation into a single variable for doing runoff calculations. The runoff curve numbers approved for stormwater quantity/quality calculations are included as **Tables H-2 and H-3** of this appendix.

The curve numbers presented in **Tables H-2 and H-3** are for wet antecedent moisture conditions. Wet conditions assume previous rainstorms have reduced the capacity of soil to absorb water. Given the frequency of rainstorms in the Portland area, wet conditions are most likely, and give conservative hydrographic values.

Hydrologic Soil Group descriptions, critical to determining the appropriate curve numbers are included in **Table H-4**.

Table H-2. Runoff Curve Numbers for Urban Areas*

Cover Descriptions	Average Percent Impervious Area	Curve Numbers for Hydrologic Soil Group			
Cover Type and Hydrologic Condition		A	B	C	D
Open space (lawns, parks, golf courses, cemeteries, etc.)					
Poor condition (grass cover <50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads					
Paved: curbs and stone sewers (excluding right-of-way)		98	98	98	98
Paved: open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Urban districts					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82

**Soil Conservation Service, Urban Hydrology for Small Watersheds, Technical Release 55, pp. 2.5-2.8, June 1986.*

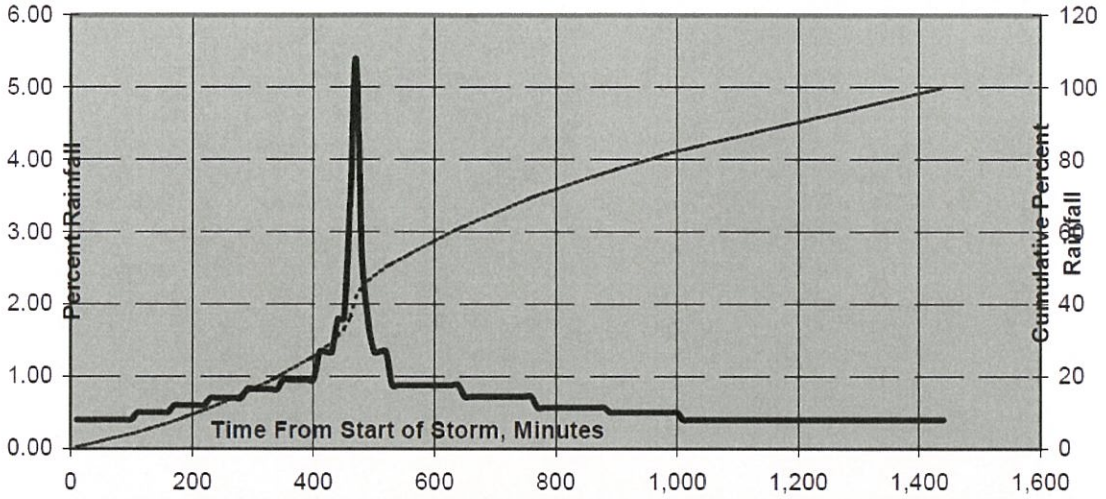
Table H-3. Runoff Curve Numbers for Other Agricultural Areas*

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range-continuous forage for grazing					
<50% ground cover or heavily grazed with no mulch	Poor	68	79	86	89
50 to 75% ground cover and not heavily grazed	Fair	49	69	79	84
>75% ground cover and lightly or only occasionally grazed	Good	39	61	74	80
Meadow-continuous grass, protected from grazing and generally mowed for hay	-	30	58	71	78
Brush--weed-grass mixture with brush as the major element					
<50% ground cover	Poor	48	67	77	83
50 to 75% ground cover	Fair	35	56	70	77
>75% ground cover	Good	30	48	65	73
Woods-grass combination (orchard or tree farm)	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Cover type	Hydrologic condition	A	B	C	D
Woods					
Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.	Poor	45	66	77	83
Woods are grazed but not burned, and some forest litter covers the soil.	Fair	36	60	73	79
Woods are protected from grazing, and litter and brush adequately cover the soil.	Good	30	55	70	77

*Soil Conservation Service, *Urban Hydrology for Small Watersheds*, Technical Release 55, pp. 2.5-2.8, June 1986.

Table H-4. NRCS Hydrologic Soil Group Descriptions

NRCS Hydrologic Soil Group	Description
Group A	Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist chiefly of deep, well drained to excessively drained sands or gravels. These soils have a high rate of water transmission.
Group B	Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.
Group C	Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils that have a layer that impedes the downward movement of water or soils that have moderately fine texture or fine texture. These soils have a slow rate of water transmission.
Group D	Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clay soils that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a fragipan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.



Time From Start of Storm, Minutes	% Rainfall	Cumulative % Rainfall
0 - 10	0.40	0.40
10 - 20	0.40	0.80
20 - 30	0.40	1.20
30 - 40	0.40	1.60
40 - 50	0.40	2.00
50 - 60	0.40	2.40
60 - 70	0.40	2.80
70 - 80	0.40	3.20
80 - 90	0.40	3.60
90 - 100	0.40	4.00
100 - 110	0.50	4.50
110 - 120	0.50	5.00
120 - 130	0.50	5.50
130 - 140	0.50	6.00
140 - 150	0.50	6.50
150 - 160	0.50	7.00
160 - 170	0.60	7.60
170 - 180	0.60	8.20
180 - 190	0.60	8.80
190 - 200	0.60	9.40
200 - 210	0.60	10.00
210 - 220	0.60	10.60
220 - 230	0.70	11.30
230 - 240	0.70	12.00
240 - 250	0.70	12.70
250 - 260	0.70	13.40
260 - 270	0.70	14.10
270 - 280	0.70	14.80
280 - 290	0.82	15.62
290 - 300	0.82	16.44
300 - 310	0.82	17.26
310 - 320	0.82	18.08
320 - 330	0.82	18.90
330 - 340	0.82	19.72
340 - 350	0.95	20.67
350 - 360	0.95	21.62
360 - 370	0.95	22.57
370 - 380	0.95	23.52
380 - 390	0.95	24.47
390 - 400	0.95	25.42
400 - 410	1.34	26.76
410 - 420	1.34	28.10
420 - 430	1.34	29.44
430 - 440	1.80	31.24
440 - 450	1.80	33.04
450 - 460	3.40	36.44
460 - 470	5.40	41.84
470 - 480	2.70	44.54
480 - 490	1.80	46.34
490 - 500	1.34	47.68
500 - 510	1.34	49.02
510 - 520	1.34	50.36
520 - 530	0.88	51.24
530 - 540	0.88	52.12
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610 - 620	0.88	59.16
620 - 630	0.88	60.04
630 - 640	0.88	60.92
640 - 650	0.72	61.64
650 - 660	0.72	62.36
660 - 670	0.72	63.08
670 - 680	0.72	63.80
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690 - 700	0.72	65.24
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710 - 720	0.72	66.68
720 - 730	0.72	67.40
730 - 740	0.72	68.12
740 - 750	0.72	68.84
750 - 760	0.72	69.56
760 - 770	0.57	70.13
770 - 780	0.57	70.70
780 - 790	0.57	71.27
790 - 800	0.57	71.84
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810 - 820	0.57	72.98
820 - 830	0.57	73.55
830 - 840	0.57	74.12
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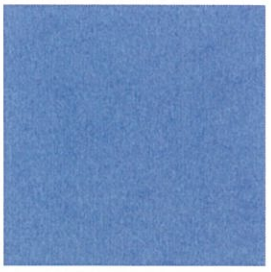
Figure H-1. NRCS 24-Hour Type 1A Hyetograph

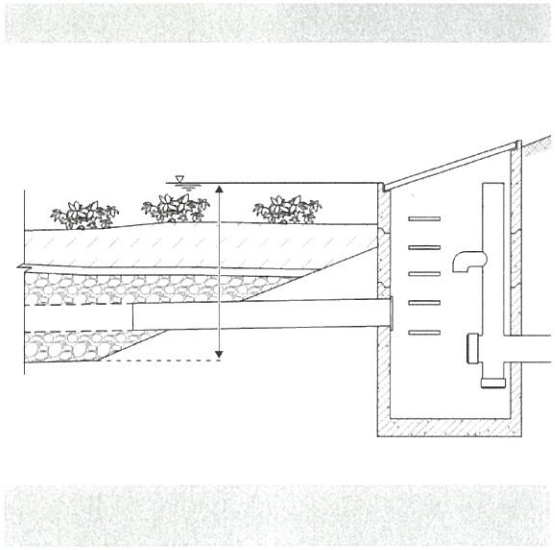



NO DUMPING
¡NO CONTAMINE!
CITY OF OREGON CITY
DRAINS TO
WATERWAY





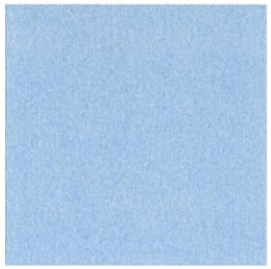


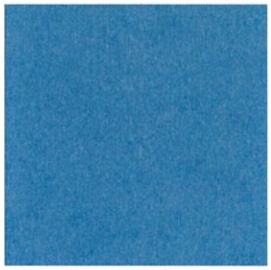















OREGON
CITY

July 2019

ORDINANCE NO. 15-1006

AN ORDINANCE ADOPTING AMENDMENTS TO OREGON CITY MUNICIPAL CODE CHAPTER 13.12, STORMWATER MANAGEMENT.

WHEREAS, the City of Oregon City needs a legal mechanism to require the provision of adequate drainage facilities and adequate grading and land clearing practices in the development and use of property in conformation with current accepted standards for the design of drainage facilities and grading operations; and

WHEREAS, an expanded population and increased development of land in the City of Oregon City, coupled with inadequate drainage controls, has led to problems related to land clearing, grading, and stormwater runoff impacts; and

WHEREAS, these problems include increased sedimentation in ponds, creeks, and streams, water quality degrading and deterioration of existing stream channels; and

WHEREAS, inadequate surface and subsurface drainage planning and practice can lead to erosion and property damage and risk to life; and

WHEREAS, future problems will be reduced if land developments, both public and private, provide for adequate drainage of property, and adequate grading of slopes; and

WHEREAS, Statewide Planning Goal 11 requires local jurisdictions to plan and develop a timely, orderly and efficient arrangement of public facilities and services to serve as a framework for urban and rural development, and are necessary for an effective level of future urban development within the City Limits; and

WHEREAS, the proposed amendments meet federal and state National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permitting requirements; and

WHEREAS, the proposed amendments will minimize the introduction of pollutants and provide water quality treatment of stormwater runoff to preserve the beneficial uses of drainageways, lakes, ponds, wetlands, and other sensitive areas; and

WHEREAS, the proposed amendments protect the health, safety and welfare of persons and property by safely conveying all stormwater runoff from site development and preventing the uncontrolled or irresponsible discharge of stormwater onto adjoining public or private property.

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

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

Section 1. The City hereby replaces the existing Oregon City Municipal Code Chapter 13.12, entitled Stormwater Management, and replaces it with the amended Chapter 13.12, attached hereto as Exhibit 'A.'

Section 2. Severability. If any provision of this Ordinance or its application to any person or circumstance is held invalid, the invalidity does not affect other provisions or applications of this Ordinance that can be given effect without the invalid provision or application, and to this end the provisions of this Ordinance are severable.

Section 3. Effectiveness. This Ordinance shall take effect 90 days from the date of adoption.

Read for the first time at a regular meeting of the City Commission held on the 6th day of May, and the City Commission finally enacted the foregoing ordinance this 20th day of May, 2015.

DAN HOLLADAY, Mayor

Attested to this 20th day of May 2015:

Kattie Riggs

Kattie Riggs, City Recorder

Approved as to legal sufficiency:

City Attorney

Exhibits:
Exhibit A – Amended Chapter 13.12, entitled Stormwater Management

GSB:7008052.1

Chapter 13.12 STORMWATER MANAGEMENT

Sections:

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13.12.020 Adoption of standards.

13.12.030 Superseding Oregon City Drainage Master Plan Appendix A.

13.12.040 Definitions.

13.12.050 Applicability and exemptions.

13.12.060 Abrogation and greater restrictions.

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13.12.090 Approval criteria for engineered drainage plans and drainage report.

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13.12.110 Transfer of engineering responsibility.

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13.12.130 Administrative provisions.

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13.12.150 Penalties and enforcement.

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13.12.010 Purpose.

The purpose of this chapter is to define policies, minimum requirements, minimum standards and design procedures and permits for the construction and maintenance of stormwater conveyance and quantity and quality control facilities in order to:

A. Minimize increased stormwater runoff rates from any development so as to minimize the impact upon any downstream natural channel that may exist between the subject area and the Willamette or Clackamas Rivers;

B. Prevent water runoff generated by development from exceeding the capacity of downstream stormwater facilities;

C. Reduce stormwater runoff rates and volumes, soil erosion and pollution, wherever possible, from developed and developing lands;

D. Prevent the uncontrolled or irresponsible discharge of stormwater from new development onto adjoining public or private property;

E. Maintain the integrity of stream channels for their biological functions, as well as for drainage and other purposes;

F. Have stormwater conveyance facilities of adequate design to manage all volumes of water generated in the contributing drainage area, for both the existing condition and the anticipated future condition;

G. Have all stormwater facilities:

1. Designed to mimic natural hydrologic conditions, to the maximum extent practicable,

2. Designed in a manner to allow economical future maintenance,

2. If city owned or maintained, designed for maintenance with city owned equipment,

3. Designed using materials that will ensure a minimum practical design life of seventy-five years, and

4. Designed to have sufficient structural strength to resist erosion and all external loads (construction, traffic, seismic) which may be imposed;

H. Establish maintenance easements with the owners of privately owned/maintained stormwater facilities to ensure an appropriate level of maintenance and to help minimize public safety hazards;

I. Have all new stormwater facilities comply with applicable National Pollutant Discharge Elimination System (NPDES) requirements;

J. Minimize the deterioration of existing watercourses, culverts, bridges, dams and other structures;

K. Minimize increases in stormwater pollution; and

L. Allow for periodic inspections of both private and public stormwater quantity control and quality control facilities to verify that they are functioning in substantial conformance with the approved design intent.

M. Allow issuance of engineering permits for stormwater work in the right-of-way or public easements either as a separate Public Works permit or as part of overall issued public infrastructure construction plans. The various fees for these permits are approved and modified from time to time by the city commission. Failure to meet the conditions of the issued permit shall constitute a violation of the Municipal Code. (Ord. 99-1029 §2 (part), 1999)

(Ord. No. 10-1003, § 1(Exh. 1), 7-7-2010)

13.12.020 Adoption of standards.

The city commission may establish and modify from time to time by resolution Public Works Stormwater and Grading Design Standards to implement the requirements of this chapter.

(Ord. 99-1029 §2 (part), 1999)

13.12.030 Superseding Oregon City Drainage Master Plan Appendix A.

The policies and standards of this chapter are intended to be consistent with the applicable sections of the Oregon City Drainage Master Plan dated January 1988, and applicable basin master plans, for land drainage and flood control within the Oregon City urban growth area, as adopted by the city. Appendix A of the Oregon City Drainage Master Plan dated January 1988 is superseded by the Public Works Stormwater and Grading Design Standards adopted by resolution and as periodically amended.

(Ord. 99-1029 §2 (part), 1999)

13.12.040 Definitions.

Unless specifically defined below, words and phases used in this chapter shall be interpreted so as to give them the meaning they have in common usage and to give this chapter its most reasonable application.

"Applicant" means a person, party, firm, corporation or other legal entity that has applied for a development permit or approval.

"Bulk petroleum storage" means storage of any type of bulk liquid petroleum or petroleum waste materials stored outside in multiple above ground storage tanks (AST). Multiple ASTs include two or more tanks that are either within the same secondary containment structure or within twenty feet of each other.

"Catch basin" means a structure, normally with a sump, for receiving drainage from a gutter or median and discharging the water through a conduit.

"City" means the City of Oregon City.

"City engineer" means the city engineering manager, their duly authorized representative(s), or the city's duly authorized representative(s) as designated by the city manager.

"Clearing" means surface removal of vegetation.

"Constructed wetlands" means wetlands developed as a water quality or quantity facility, subject to maintenance and modification as such. These areas must be clearly defined and/or separated from naturally occurring wetlands or wetlands created for mitigation purposes.

"Contributing drainage area" means the subject property together with the land area contributing runoff to it.

"Conveyance" means a channel or conduit to move water from one point to another point.

"Culvert" means a hydraulically short conduit that conveys surface drainage in artificial or natural watercourses through a roadway embankment or past some other type of flow obstruction.

"Dam" means a water storage structure that may or may not meet Oregon Revised Statute (ORS) requirements for height and storage capacity. All such structures require professional engineer design. If the water storage structure exceeds the ORS criteria for height or storage capacity, then the Oregon State Water Resources Commission shall have approval authority.

"DEQ" means the Oregon Department of Environmental Quality.

"Development" means any manmade change to improved or unimproved real estate, including but not limited to, the construction of building or other structures, utility infrastructure, grading, streets or other structures or facilities, mining, dredging, paving, filling or excavation. Development does not include the following: (1) stream enhancement or restoration projects approved by the city; (2) farming practices as defined in ORS 30.930 and farm use as defined in ORS 215.203, except that buildings associated with farm practices and farm uses are subject to the requirements of this chapter.

"Disturb" means man-made changes to the existing physical status of the land that are made in connection with development.

"Drainage feature" means any natural or man-made structure, facility, conveyance or topographic feature which has the potential to concentrate, convey, detain, retain, infiltrate or affect the flow rate of stormwater runoff.

"DSL" means the Oregon Division of State Lands.

"Easement" means the legal right to use a parcel of land for a particular purpose. It does not include fee ownership, but may restrict the owner's use of the land.

"Embankment" means a raised structure of earth, gravel or similar material above the surrounding grade.

"Engineer" means a registered professional engineer licensed by the state of Oregon.

"Enhancement" means the process of improving upon the natural functions and/or values of an area or feature that has been degraded by human activity. Enhancement activities may or may not return the site to a predisturbance condition, but create/recreate processes and features that occur naturally.

"Erosion" means the movement of soil particles resulting from actions of water, wind or mechanical means.

"Excavation" means the mechanical removal of earth material.

"Fill" means any material such as, but not limited to, sand, gravel, soil, rock or gravel that is placed for the purposes of development or redevelopment.

"Floodplain" means the land area identified and designated by the United States Army Corps of Engineers, the Oregon Division of State Lands, the Federal Emergency Management Agency or City of Oregon City that has been or may be covered temporarily by water as a result of a storm event of identified frequency. It is usually the flat area of land adjacent to a stream or river formed by floods.

"Fuel dispensing facilities" means the area (including fuel islands, above ground fuel tanks, fuel pumps, and the surrounding pad) where fuel is transferred from bulk storage tanks to vehicles, equipment, and/or mobile containers.

"Grading" means any excavating, filling, embanking or altering contours of earth material.

"Grubbing" means the removal of vegetative matter from below the surface of the ground, such as sod, stumps, roots, buried logs or other debris, and shall include the incidental removal of topsoil to a depth not exceeding twelve inches.

"Impervious surfaces" means a hard surface area which prevents or retards the entry of water into the soil mantle and/or causes water to run off the surface in greater than natural quantities or at an increased rate. Impervious surfaces include, but are not limited to, rooftops, walkways, patios, driveways, parking lots, concrete or asphalt paving, gravel surfaces with compacted subgrade, packed earthen materials and oiled macadam or other surfaces which similarly impede the infiltration of stormwater. Open, uncovered stormwater management facilities shall not be considered impervious surfaces.

"Inlet" means a connection between the surface of the ground and a drain or sewer for the admission of surface and stormwater runoff.

"Maintenance" means any activity that is necessary to keep an existing stormwater facility in good working order so as to function as designed. Maintenance includes complete reconstruction of a stormwater facility, if needed to return the facility to good working order. Maintenance also includes the correction of any problem on the site property that may directly impact the function of the stormwater facilities.

"Maintenance easement" means a binding agreement between the city and the person or persons holding title to a property served by a stormwater facility where the property owner promises to maintain certain stormwater facilities; grants the city the right to enter the subject property to inspect and make certain repairs, or perform certain maintenance procedures on the stormwater control facilities when such repairs or maintenance have not been performed by the property owner; and promises to reimburse the city for the cost should the city perform such repairs or maintenance.

"NPDES" means the National Pollutant Discharge Elimination System. A national permit system that covers discharges to waters of the United States and is enforced under the Federal Water Pollution Control Act, commonly known as the Clean Water Act.

"Owner or property owner" means the person who is the legal record owner of the land, or where there is a recorded land sale contract, the purchaser thereunder.

"Parcel" means a single unit of land that is created by a partitioning of land (ORS 92.010(7)).

"Plans" mean the construction documents and specifications, including system site plans, storm drain plans and profiles, cross sections, detailed drawings, etc. or reproductions thereof, approved or to be approved by the city, county, or state. They will show the location, character, dimensions and details for the work to be done.

"Private stormwater facility" means a stormwater facility located on private property and maintained by private property owners.

"Professional engineer" means a registered professional engineer licensed by the state of Oregon..

"Project engineer" means the professional engineer responsible for the project, who will affix his/her seal on the project drainage plans and drainage analysis and supervise construction of the stormwater facilities. The project engineer shall be licensed in the state of Oregon and qualified by experience or examination.

"Public stormwater facility" means any stormwater facility in the public right-of-way or easement operated and maintained by the city, county or state.

"Record drawings" means a set of engineering or site drawings that show how the project was constructed and what materials were used. Record drawings are signed and dated by the project engineer.

"Restoration" means the process of returning a disturbed or altered area or feature to a previously existing natural condition. Restoration activities reestablish the structure, function, and/or diversity to that which occurred prior to impacts caused by human activity.

"Right-of-way" means all land, or interest therein, which by deed, conveyance, agreement, easement, dedication, usage or process of law is reserved for, or dedicated to, the use of the general public.

"Sedimentation" means the process of gravity deposition of water suspended matter; the process of depositing soil particles, clays, sands and other sediment that were picked up by stormwater runoff.

"Solid waste storage area" means a place where solid waste containers are stored. Solid waste containers include trash compactors, solid waste dumpsters and garbage cans.

"Stormwater" means the surface water runoff that results from all natural forms of precipitation.

"Stormwater facility" means a component of a man-made drainage feature, or features designed or constructed to perform a particular function or multiple functions related to stormwater management. Includes, but is not limited to, pipes, swales, ditches, culverts, street gutters, rain gardens, pervious pavements, green roofs, ponds, constructed wetlands, infiltration devices, catch basins, oil/water separators and sediment basins. Stormwater facilities shall not include building gutters, downspouts, and drains serving one single-family residence.

"Stormwater management" means a program to provide surface water quality and quantity controls through structural and non-structural methods and capital improvement projects. Nonstructural controls include, but are not limited to, maintenance of stormwater facilities, public education, water quality monitoring, and preparation of agreements, ordinances, and regulations.

"Stormwater quality control" means the control of the introduction of pollutants into stormwater and the process of separating pollutants from stormwater.

"Stormwater quantity control" means the control of the rate and/or volume of stormwater released from a development site.

"Stream" means a body of running water moving over the earth's surface in a channel or bed, such as a creek, rivulet or river. It flows at least part of the year, including perennial and intermittent streams. Streams are dynamic in nature and their structure is maintained through build-up and loss of sediment.

"Structure(s)" means a building or other major improvement that is built, constructed or installed, and it also means manmade improvements to land that are used, or expected to be used, in the operation of a utility. It includes buildings, utility lines, manholes, catch basins, driveways and sidewalks. It does not include minor improvements, such as fences, utility poles, flagpoles or irrigation system components that are not customarily regulated through zoning codes.

"Watercourse" means a channel in which a flow of water occurs, either continuously or intermittently, and if the latter with some degree of regularity. Such flow must be in a definite direction.

"Wetlands" means those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas. Wetlands are those areas identified and delineated by a qualified wetland specialist as set forth in the 1987 Corps of Engineers Wetland Delineation Manual.

(Ord. 99-1029 §2 (part), 1999)

13.12.50 Applicability and exemptions.

This chapter establishes performance standards for stormwater conveyance, quantity and quality. Additional performance standards for erosion prevention and sediment control are established in OCMC 17.47.

A. Stormwater Conveyance. The stormwater conveyance requirements of this chapter shall apply to all stormwater systems constructed with any development activity, except as follows:

1. The conveyance facilities are located entirely on one privately owned parcel; and
2. The conveyance facilities are privately maintained; and
3. The conveyance facilities receive no stormwater runoff from outside the parcel's property limits.

Those facilities exempted from the stormwater conveyance requirements by the above subsection will remain subject to the requirements of the Oregon Uniform Plumbing Code. Those exempted facilities shall be reviewed by the building official.

B. Water Quality and Flow Control. The water quality and flow control requirements of this chapter shall apply to the following proposed uses or developments, unless exempted under subsection C:

1. Activities located wholly or partially within water quality resource areas pursuant to Chapter 17.49 that will result in the creation of more than five hundred square feet of impervious surface within the WQRA or will disturb more than one thousand square feet of existing impervious surface within the WQRA as part of a commercial or industrial redevelopment project. These square footage measurements will be considered cumulative for any given five-year period; or
2. Activities that create or replace more than five thousand square feet of impervious surface per parcel or lot, cumulated over any given five year period.

C. Exemptions. The following exemptions to 13.12.050(B) apply:

1. An exemption to the flow control requirements of this chapter will be granted when the development site discharges to the Willamette River, Clackamas River or Abernethy Creek;

and either lies within the one hundred year floodplain or is up to ten feet above the design flood elevation as defined in Chapter 17.42, provided that the following conditions are met:

a. The project site is drained by a conveyance system that is comprised entirely of manmade elements (e.g. pipes, ditches, culverts outfalls, outfall protection, etc) and extends to the ordinary high water line of the exempt receiving water; and

b. The conveyance system between the project site and the exempt receiving water has sufficient hydraulic capacity and erosion stabilization measures to convey discharges from the proposed conditions of the project site and the existing conditions from non-project areas from which runoff is collected.

2. Projects in the following categories are generally exempt from the water quality and flow control requirements:

a. Stream enhancement or restoration projects approved by the city;

b. Farming practices as defined by ORS 30.960 and farm use as defined in ORS 214.000; except that buildings associated with farm practices and farm use are subject to the requirements of this chapter,

c. Actions by a public utility or any other governmental agency to remove or alleviate an emergency condition,

d. Road and parking area preservation/maintenance projects such as pothole and square cut patching, surface sealing, replacing or overlaying of existing asphalt or concrete pavement, provided the preservation/maintenance activity does not expand the existing area of impervious coverage above the thresholds in 13.12.050(B).

e. Pedestrian and bicycle improvements (sidewalks, trails, pathways, and bicycle paths/lands) where no other impervious surfaces are created or replaced, built to direct stormwater runoff to adjacent vegetated areas.

f. Underground utility projects that replace the ground surface with in-kind material or materials with similar runoff characteristics.

g. Maintenance or repair of existing utilities.

D. Uses Requiring Additional Management Practices. In addition to any other applicable requirements of this chapter, the following uses are subject to additional management practices, as defined in the Public Works Stormwater and Grading Design Standards:

a. Bulk Petroleum Storage facilities;

b. Above ground storage of liquid materials;

c. Solid waste storage areas, containers, and trash compactors for commercial, industrial, or multi-family uses;

d. Exterior storage of bulk construction materials;

e. Material transfer areas and loading docks;

f. Equipment and/or vehicle washing facilities;

g. Development on land with suspected or known contamination;

h. Covered vehicle parking for commercial or industrial uses.

i. Industrial or commercial uses locating in high traffic areas, defined as average daily count trip of 2,500 or more trips per day, and

j. Land uses subject to DEQ 1200-Z Industrial Stormwater Permit Requirements.

(Ord. 99-1029 §2 (part), 1999)

13.12.060 Abrogation and greater restrictions.

Where the provisions of this chapter are less restrictive or conflict with comparable provisions of other portions of this code, regional, state or federal law, the provisions that are more restrictive shall govern. Where this chapter imposes restrictions that are more stringent than regional, state or federal law, the provisions of this chapter shall govern. However, nothing in this chapter shall relieve any party from the obligation to comply with any applicable federal, state or local regulations or permit requirements.

Compliance with this chapter and the minimum requirements, minimum standards, and design procedures as set forth in the city's adopted Public Works Stormwater and Grading Design Standards does not relieve the designer, owner, or developer of the responsibility to apply conservative and sound professional judgment to protect the health, safety and welfare of the public. It is not the intent of this chapter to make the city a guarantor or protector of public or private property in regard to land development activity.

(Ord. 99-1029 §2 (part), 1999)

13.12.070 Severability.

The provisions of this chapter are severable. If any section, clause, or phrase of this chapter is adjudged invalid by a court of competent jurisdiction, the decision of that court shall not affect the validity of the remaining portions of this ordinance.

(Ord. 99-1029 §2 (part), 1999)

13.12.080 Submittal requirements.

A. Applications subject to stormwater conveyance, water quality, and/or flow control requirements of this chapter shall prepare engineered drainage plans, drainage reports, and design flow calculation reports in compliance with the submittal requirements of the Public Works Stormwater and Grading Design Standards.

B. Each project site, which may be composed of one or more contiguous parcels of land, shall have a separate valid city approved plan and report before proceeding with construction.

(Ord. 99-1029 §2 (part), 1999)

13.12.90 Approval criteria for engineered drainage plans and drainage report.

An engineered drainage plan and/or drainage report shall be approved only upon making the following findings:

A. The plan and report demonstrate how the proposed development and stormwater facilities will accomplish the purpose statements of this chapter;

B. The plan and report meet the requirements of the Public Works Stormwater and Grading Design Standards adopted by resolution under Section 13.12.020

C. The storm drainage design within the proposed development includes provisions to adequately control runoff from all public and private streets and roof, footing, and area drains and ensures future extension of the current drainage system.

D. Streambank erosion protection is provided where stormwater, directly or indirectly, discharges to open channels or streams.

E. Specific operation and maintenance measures are proposed that ensure that the proposed stormwater quantity control facilities will be properly operated and maintained.

(Ord. 99-1029 §2 (part), 1999)

13.12.100 Alternative materials, alternative design and methods of construction.

The provisions of this chapter are not intended to prevent the use of any material, alternate design or method of construction not specifically prescribed by this chapter or the Public Works Stormwater and Grading Design Standards, provided any alternate has been approved and its use authorized by the city engineer. The city engineer may approve any such alternate, provided that the city engineer finds that the proposed design is satisfactory and complies with the intent of this chapter and that the material, method, or work offered is, for the purpose intended, at least the equivalent of that prescribed by this chapter in effectiveness, suitability, strength, durability and safety. The city engineer shall require that sufficient evidence or proof be submitted to substantiate any claims that may be made regarding its use. The details of any action granting approval of an alternate shall be recorded and entered in the city files.

(Ord. 99-1029 §2 (part), 1999)

13.12.110 Transfer of engineering responsibility.

Project drainage plans shall always have a project engineer. If the project engineer is changed during the course of the work, the city shall be notified in writing and the work shall be stopped until the replacement engineer has agreed to accept the responsibilities of the project engineer. The new project engineer shall provide written notice of accepting project responsibility to the city within seventy-two hours of accepting the position as project engineer.

(Ord. 99-1029 §2 (part), 1999)

13.12.120 Standard Construction Specifications.

The workmanship and materials shall be in accordance with the edition of the "Standard Specifications for Public Works Construction," as prepared by the Oregon Chapter of American Public Works Association (APWA) and as modified and adopted by the city, in effect at the time of application. The exception to this requirement is where this chapter and the Public Works Stormwater and Grading Design Standards provide other design details, in which case the requirements of this chapter and the Public Works Stormwater and Grading Design Standards shall be complied with.

(Ord. 99-1029 §2 (part), 1999)

13.12.130 Administrative provisions.

An applicant shall submit the following additional items to the city and complete the following tasks prior to proceeding with construction of proposed development plans. These items include the following:

A. Engineer's cost estimate (also may be known as engineer's opinion of probable construction cost);

B. Plan check and inspection fees (as set by city resolution);

C. Certificate of liability insurance for city funded public projects contracted by the city (not less than one million dollars single incident and two million dollars aggregate);

D. Preconstruction meeting (if required by some other provision of this code);

E. Performance Assurance(s). Applicant must submit a letter of commitment, cash deposit or other form of assurance in form and substance satisfactory to the city engineer and city attorney, to cover the engineer's cost estimate for the construction of the stormwater facility. This is required to assure that the following are accomplished to the satisfaction of the city engineer:

1. Work shown on the development plans is accomplished,
2. Appropriate as-built/record drawings and electronic files are delivered to the city. (As-built drawings, or record drawings, will be on four-mil Mylar.) Electronic files shall be submitted per city engineer format requirements,
3. Compliance with the criteria in this chapter and the Public Works Stormwater and Grading Design Standards, as well as with other city standards, ordinances, resolutions or rules,
4. Permanent stabilization and/or restoration of the impact from the development,
5. Fulfillment of all conditions of approval,
6. Payment of all outstanding fees,
7. Submittal of any required maintenance guarantee(s);

F. Developer/engineer agreement for public works improvements;

G. Land division compliance agreement (if applicable);

H. Project engineer's certificate of completion;

I. Operation and maintenance easement (if applicable);

J. Details on individual items required by this subsection can be obtained by contacting the city's engineering division. Many items, such as the engineer's cost estimate and plan check and inspection fee, maybe be submitted in conjunction with documentation for other infrastructure improvements that are done with the development (such as street, sanitary sewer, and water).

(Ord. 99-1029 § 2 (part), 1999)

13.12.140 Maintenance of public stormwater facilities.

A. A stormwater facility that receives stormwater runoff from a public right-of-way shall be a public facility. Upon expiration of the warranty period and acceptance by the city as described below, the city shall be responsible for maintenance of those public stormwater facilities. Access for maintenance of the stormwater facilities shall be provided to the city through the granting of a stormwater easement or other means acceptable to the city.

B. Responsibility for maintenance of stormwater facilities including all landscaping, irrigation systems, structures and appurtenances shall remain with the property owner/developer for two years (known as the warranty period). The owner/developer shall provide the city a separate two-year landscaping maintenance bond for one hundred ten percent of the landscaping cost. Transfer of maintenance of stormwater conveyance systems shall occur when the city accepts the stormwater conveyance system.

C. The city will perform an inspection of the development's entire publicly maintained stormwater system approximately forty-five days before the two-year warranty period expires. The stormwater system must be found to be in a clean, functional condition by the city engineer before acceptance of maintenance responsibility by the city.

(Ord. 07-1011, 2007; Ord. 99-1029 § 2(part), 1999)

13.12.145 Maintenance of private stormwater facilities.

A. An applicant shall submit an operation and maintenance plan for each proposed stormwater facilities, unless exempted in the Public Works Stormwater and Grading Design Standards. The information in the operation and maintenance plan shall satisfy the requirements of the Public Works Stormwater and Grading Design Standards.

B. Private owners are required to inspect and maintain stormwater facilities on their property in accordance with an approved operation and maintenance plan. A maintenance log Is required to document facility inspections and specific maintenance activities. The log shall be available to city inspection staff upon request.

C. Failure to operate or maintain a stormwater facility according to the operation and maintenance plan may result in an enforcement action under Section 13.12.150.

13.12.150 Penalties and enforcement.

A. The city is authorized to make inspections and take such actions as required to enforce the provisions of this chapter. The city has the authority to enter onto land for the purpose of inspecting site development activities or resulting improvements. City staff will make an effort to contact the property owner before entering onto that property.

B. If the city engineer determines a site has any unpermitted or illegal facilities placed, constructed or installed on the site, then the city engineer shall notify the owner in writing directing the owner to submit a written plan (with construction drawings completed by a professional engineer, if otherwise required by this chapter) within ten calendar days. This plan (and drawings, if required) shall depict the restoration or stabilization of the site or correct the work that has adversely impacted adjacent or downstream property owners. The city engineer shall review the plan (and drawings, if required) for compliance with city standards and issue comments for correction, if necessary, or issue an approval to the owner. The city shall establish a fee by resolution for such review, with all costs borne by the owner. If the required corrective work constitutes a grading permit, then the city shall collect the appropriate grading permit fee.

C. Any person, firm, corporation or entity violating any of the provisions of this chapter, whether they be the property owner, the applicant, the contractor or any other person acting with or without the authorization of the property owner or applicant, shall be subject to the code enforcement procedures of Chapters 1.16, 1.20 and 1.24

(Ord. 99-1029 § 2 (part), 1999)

13.12.160 Hazardous conditions.

A. Determination and Notification. If the city engineer determines that any excavation, embankment, erosion/sedimentation control or drainage facility is a safety hazard; endangers property; or adversely affects the safety, use or stability of a public way, water quality resource areas (pursuant to Section 17.49) or drainage course, the owner(s) of the subject property and/or the person or agent in control of the property shall be required to repair or eliminate the hazard in conformance with the requirements of this chapter and the Public Works Stormwater and Grading Design Standards. At the time that the city engineer makes the determination that a hazardous condition exists, the property owner and/or person or agent in control of the property will be notified in writing that the hazard exists.

B. Order to Correct. The city engineer will order the specific work to be undertaken or will order that an engineering design be submitted for review and approval by the city engineer, and will specify the time periods within which the hazardous conditions be repaired or eliminated. In the event that the

owner and/or the person or agent in control of the property fails to comply with this order, that person shall be subject to the code enforcement procedures of Chapters 1.16, 1.20, and 1.24

(Ord. 99-1029 §2 (part), 1999)

13.12.170 Permits from other jurisdictions.

A. The Oregon State Department of Environmental Quality (DEQ) currently issues NPDES 1200-C permits for projects that cover areas of one acre or greater. No permit shall be issued for projects of this size (or any other size as modified by DEQ) without a copy of said DEQ permit being on file with Oregon City. DEQ is responsible for policing its own permits, however, if city personnel observe conditions that are believed to be in violation of any such permit, and cannot get corrections made, the city will bring such conditions to the attention of the appropriate DEQ representatives.

B. Projects may require Oregon State Division of State Lands (DSL) and/or United States Army Corps of Engineers (USACE) permits. If such permits are required, no permission to construct will be granted until such a time as a copy of such permit is on file with the city or notice is received from those agencies that a permit is not required. DSL/USACE is responsible for enforcing its own permits, however, if city personnel observe conditions that are believed to be in violation of any such permit, and cannot get corrections made, the city will bring such conditions to the attention of the appropriate DSL/USACE representatives.

C. Projects may require Oregon State Department of Fish and Wildlife (ODFW) permits. When ODFW permits are required, no work will be authorized until the receipt of a copy of the ODFW permit. ODFW is responsible for policing its own permits, however, if city personnel observe conditions that are believed to be in violation of any such permit, and cannot get corrections made, the city will bring such conditions to the attention of the appropriate ODFW representatives.

(Ord. 99-1029 §2 (part), 1999)

13.12.180 Violation—Penalty.

Any act or omission in violation of this chapter shall be deemed a nuisance. Violation of any provision of this chapter is subject to the code enforcement procedures of Chapters 1.16, 1.20 and 1.24.

(Ord. No. 10-1003, § 1(Exh. 1), 7-7-2010)

GSB:7047664.1

City of Oregon City

625 Center Street
Oregon City, OR 97045
503-657-0891

Staff Report

File Number: PC 19-108

Agenda Date: 10/14/2019

Status: Agenda Ready

To: Planning Commission

Agenda #: 3c.

From: Sr. Planner Christina Robertson-Gardiner

File Type: Planning Item

SUBJECT:
Planning Files: LEG 19-00003 - Beavercreek Road Concept Plan- Code and Zoning Amendments- (Parks, Enhanced Home Occupation/Cottage Industry, Concept Plan Renaming)

RECOMMENDED ACTION (Motion):
Continuance of file LEG 19-00003 to the October 28, 2019 Planning Commission Hearing.

BACKGROUND:
The Planning Commission is reviewing the zoning and code amendments for the Beavercreek Road Concept Plan (BRCP) over multiple meetings during the late summer and fall of 2019.

Each meeting will be broken into 1-3 topics to allow the Planning Commission, staff and the public time to focus their energy. Planning Commission comments and direction as well as public comments will be tracked throughout the hearings and topics may be added to future meetings if new items are identified or issues have not been resolved. Please refer to the updated calendar attached to each Planning Commission packet for meeting topics. Please note that public comment at any meeting is not limited to the identified topic and may be on any issue related to LEG 19-0003.

The following topics were identified either by public comment or the Planning Commission for the September 23, 2019 Hearing. Staff will provide background on the following issues and will provide a recommendation if warranted.

1. Parks Acquisition Code Amendments
2. Enhanced Home Occupation/Cottage Industry (follow-up from September 9, 2019 PC Meeting)
3. Concept Plan Renaming

Tentative Schedule
The dates and topics may change as the process moves forward.

August 12, 2019 Background on Project, Open Record
August 26, 2019: Introduce Tracking Matrices, An Overview Of 8.13.19 City Commission Work Session, Identify Future Topics /Calendar
September 9, 2019: Beavercreek Zones & Maps, Home Occupation
September 23, 2019: Master Planning Requirement, Upland Habitat, Geologic Hazards

October 14, 2019: Parks, Renaming Concept Plan, Home Occupation/Cottage Industry
October 28, 2019: TBD
November 11, 2019 PC Meeting Canceled.
November 25, 2019: Transportation Roadway Width, Roundabout, Holly Lane, Local Street Speed)- Please note: moved to November.
December 9, 2019: Tentative Planning Commission Recommendation

Other Meetings
November 12, 2019 - City Commission Beavercreek Road Design Work Session-
August 29, 2019 Parks and Recreation Advisory Committee (PRAC)- Initial Presentation
October 9, 2019 Natural Resource Committee (Upland Habitat
October 24, 2019 Parks and Recreation Advisory Committee (PRAC) Recommendation To The Planning Commission
October 2019 - Additional Public Outreach on Transportation Questions

BUDGET IMPACT:
Amount:
FY(s):
Funding Source:

OREGON CITY

Community Development – Planning

698 Warner Parrott Road | Oregon City OR 97045
Ph (503) 722-3789 | Fax (503) 722-3880

To: Planning Commission
From: Christina Robertson-Gardiner, Senior Planner
RE: LEG 19-0003-Beavercreek Road Concept Plan Zoning and Code Amendments
Date: October 7, 2019

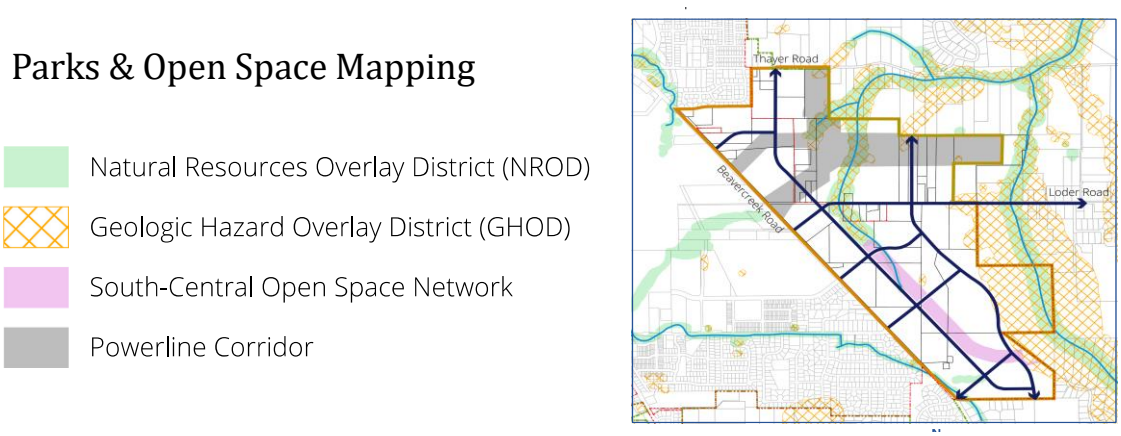
Background

The Planning Commission is reviewing the zoning and code amendments for the Beavercreek Road Concept Plan (BRCP)over multiple meetings during the late summer and fall of 2019. Each meeting will be broken into 2-3 topics to allow the Planning Commission, staff, and the public time to focus their energy. Planning Commission comments and direction, as well as public comments, will be tracked throughout the hearings, and topics may be added to future meetings if new items are identified or issues have not been resolved. Please refer to the updated calendar attached to each Planning Commission packet for meeting topics.

The following topics were identified either by public comment or the Planning Commission for the October 14, 2019 Hearing. Staff will provide background on the issue and offer a recommendation if warranted.

1. Parks Acquisition Code Amendments

The BRCP prioritizes an open space network that preserves identified environmental resource areas, parks, trails, and viewpoints, including the South-Central Open Space Network and the Low Impact Conservation Area upslope of Thimble Creek on the eastern edge of the district. The proposed code amendments will create the South-Central Open Space Network and Low Impact Conservation Area through required parkland dedication at the time of development and protect trail corridors throughout the district's open space system by also requiring dedication of easements at the time of development. This code is not for the construction of these elements, only for the dedication of land. System Developments fees would be used for construction of parkland acquired by this code.



The dedication of park property happens at the time of development based on a specific proportional calculation. Please note, the draft code below refers to the "neighborhood park" and will be amended before the Planning Commission sends their formal recommendations to the City Commission to also include the Thimble Creek Conservation Area. The Parks and Recreation Advisory Committee and staff also recommends that the Conservation area also be acquired as a city park during development review.

16.08.042 (&17.62.058) - Additional Public Park Requirements in Beavercreek Road Concept Plan area.

- *A. Each development within the Beavercreek Road Concept Plan area that includes residential development must provide for land for neighborhood parks which meets the requirements of this section.*
- *B. The minimum amount of land in acres dedicated for a park shall be calculated according to the following calculation: (2.6 persons per dwelling units) x (total number of dwelling units proposed in the development) x (8.0 acres) / (1,000 persons).*
- *C. The entire acreage must be dedicated prior to approval or as part of the final plat or site plan development approval for the first phase of development.*
- *D. If a larger area for a neighborhood park is proposed than is required based on the per-unit calculation described in subsection (A), the City must reimburse the applicant for the value of the amount of land that exceeds the required dedication based on the fee-in-lieu formula expressed in subsection (E)(1).*
- *E. The City may accept a fee-in-lieu as an alternative to this dedication at its discretion or may require a fee-in-lieu if a suitable site meeting the criteria described in subsection (F) of these provisions is not available with the development site. The calculation of the fee-in-lieu or other monetary contribution must meet the following standards.*
  1. *The amount of the fee in lieu or other monetary contribution is set in dollars per acre of required dedication and is equivalent to the appraised cost of land within the development, as provided by a certified appraiser chosen by the City and with the assumption that zoning and other land use entitlement are in place.*
  2. *The fee-in-lieu or other monetary contribution must be paid prior to approval of the final plat or development approval for each phase of development.*

Along with the draft code, the two new parks and trail map will need to be added to the Parks Master Plan and Trails Master Plan with some descriptive information to provide guidance to future developers and city staff. The Parks and Recreation Advisory Committee (PRAC) will be adopting recommended exhibits to be added to the Parks Master Plan as part of this adoption process. They will be reviewing the draft exhibits at the October PRAC meeting. Staff will include these exhibits into the record at a future Planning Commission Meeting. If the Planning Commission has any specific recommendations for required park elements that will be adopted in the Parks Master Plan, staff will pass them onto the Parks and Recreation Advisory Committee for their meeting on October 24, 2019.

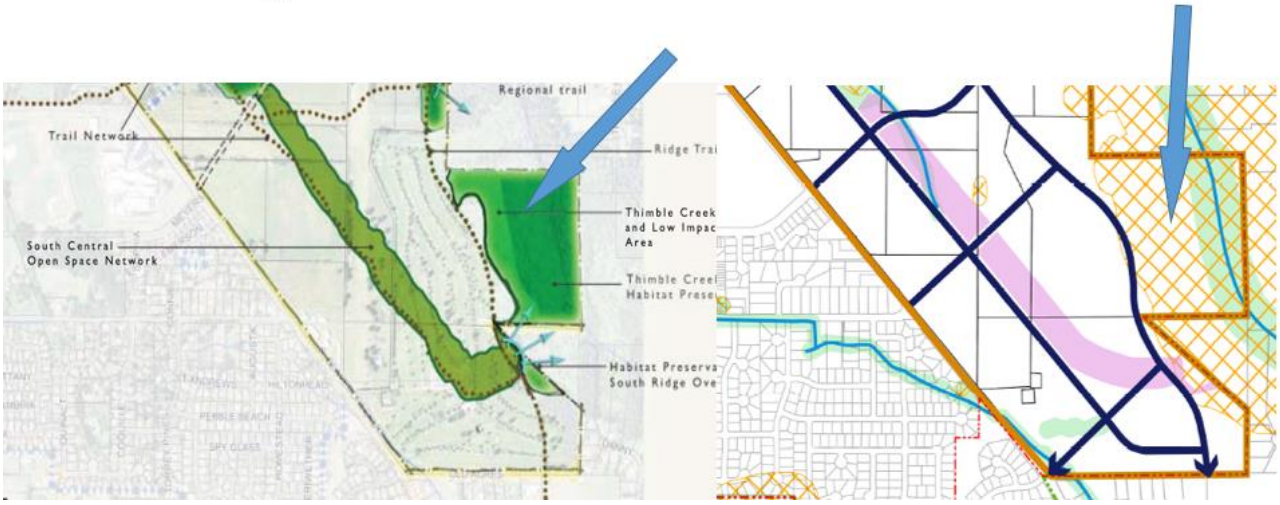
Linear Park: Pearl and String Approach



Linear Park Elements

- 30 foot ped/bikeway string along the east side of Holly Lane extension to be located in the right of way and will not be considered part of a pearl.
- 3-4 pearls of various sizes spread along the open space network
- Min and maximum sizes pearls: TBD
- Min combined size of all pearls: 8 acres
- Min average width: TBD
- Min average depth: TBD
- At least 5 acres to be developed with active recreation components

East Ridge – Thimble Creek Conservation Area



Thimble Creek Conservation Area Elements

- Two public viewpoints: size TBD
- ½ of area between the Thimble Creek stream buffer and the 490-foot elevation ridgeline to be open space
- 700-foot non-interrupted view corridor along open space
- Provide a forest trail from one view-point to another along the Ridge Parkway
- Staff and Parks and Recreation Advisory Board recommendation is to indicate that this area is a public open space amendment to Parks Master Plan

Beavercreek Road Concept Plan Trails in Power Line Corridor

Natural Resources Overlay District (NROD)

Geologic Hazard Overlay District (GHOD)

South-Central Open Space Network

Powerline Corridor



Trail Elements

- 30-foot trail width
- Ten-foot wide path

Staff recommendation: Staff recommends the draft code that refers to the "neighborhood park" and be amended before the Planning Commission sends their formal recommendations to the City Commission to also include the Thimble Creek Conservation Area. If the Planning Commission has any specific recommendations for required park elements that will be adopted in the Parks Master Plan, staff will pass them onto the Parks and Recreation Advisory Committee for their meeting on October 24, 2019.

2. Enhanced Home Occupation/Cottage Industry (follow-up from September 9, 2019 PC Meeting)

At the September 9, 2019 Planning Commission Hearing, the Planning Commission directed staff to look at options to increase employment opportunities in the Residential Districts of the Beavercreek Road Concept Plan. An initial survey was sent out to over 200 people participating in the Beavercreek Road Concept Plan email listserve, and the combined response can be found attached to the memo.

The survey looks at different ways the home occupation license could be enhanced within the Beavercreek Road Concept Plan area to allow more intense employment options. Survey results show

that there are varied opinions for these options and staff will be requesting further direction on the following items at the October 14, 2014 PC Hearing:

- Retail (picking up goods for sale)
- Outdoor storage associated with a business (landscaping equipment, construction materials)
- Parking commercial vehicles (landscape trucks, 5th wheel cabs)
- Work performed outdoors (welding, outdoor yoga)
- Offsite employees working at the residence (1-3 employees checking in at residence or working at the house)
- Using a majority of a residence for business (more than 50% of the residence devoted to business use)

Once further direction is given, staff will return at a future hearing with proposed code amendments. Broader public engagement will occur once draft code amendments have been created for this topic.

As previously discussed at the September 9, 2019 Planning Commission Hearing, as part of the 2016 re-adoption of the plan, the Planning Commission recommended that as part creating the implementing zoning for the BRCP, the City Commission direct staff to further analyze the issue of allowing expanded home occupation uses, also known as cottage manufacturing/industry within the mixed-use and residential areas.

> "In 2008, the City Commission specifically considered amending the plan to include cottage manufacturing within the mixed-use area, consistent with the instructions on remand, and decided the details of cottage housing are more appropriately addressed when the code language was created "Additionally, live-work units and home occupations, that may include cottage industries, are supported by the mixed-use approach. Adoption of the BRCP does not preclude the provision of cottage manufacturing or a greater variety of home occupations within the mixed use and residential areas. The proposed land use mix, combined with the improved transportation network, will guide the future development of the area in a manner that supports this policy. Finally, as part of creating the implementing zoning for the BRCP, the City Commission directs staff to further analyze the issue of allowing expanded home occupation uses, also known as cottage manufacturing, within the mixed use and residential areas." Cottage industry was not added to the text of the Beavercreek Road Concept Plan in 2008 or in 2016. [1]

As the term cottage industry or cottage manufacturing was not incorporated into the adopted plan, it is neither encouraged nor discouraged. As part of the code implementation process, the Planning Commission should make findings relating to this issue and how it was addressed as part of the adoption process.

The Merriam Webster Dictionary definition defines cottage industry as:

> 1**:** an industry whose labor force consists of family units or individuals working at home with their own equipment
> 2**:** a small and often informally organized industry
> 3**:** a limited but enthusiastically pursued activity or subject

[1] Response Brief of Respondent City of Oregon City -LUBA No. 2016-044 Page 8

In Oregon City, a home occupation is a business carried on by the resident of a dwelling as a secondary use, with the activity conducted so that there is no audible, visual, or other appearance of a business. The primary use must continue to be a residence. Partners or employees are not allowed onsite for business purposes. This means that the business must be conducted by the resident(s) and family members who live at the dwelling. In order to renew your business license, your home occupation statement must be reviewed annually. All of this is shorthand for – do your work inside a building and make sure it is not adversely affecting your neighbors.

17.04.580 -Home occupation. "Home occupation" means an occupation carried on solely by the resident or residents of a dwelling unit as a secondary use in accordance with 17.54.120.

17.54.120 -Home Occupations
Home occupations shall comply with all of the following:
A. No employees reporting to work onsite who are not residents unless otherwise required by State law. The business may have off-site employees or partners provided that they do not report for work at the subject residence;
B. All business conducted on sites hall be conducted within the home or accessory structure;
C. No outdoor storage of materials or commercial vehicles associated with the business shall occur on-site; and
D. Not more than one-half of the square footage of the primary dwelling is devoted to such use

*Please note that restriction of retail sales onsite was left off the definition that was adopted on August 2, 2019. A revised definition, which includes the prohibition of retail sales onsite is part of the *Amendments to the Recently Adopted Code for Clarifications, Corrections of Errors, or Improvements* that is also being heard tonight. Once adopted, the retail restriction component will once again be part of the home occupation definition.

Public Comment
The following question was discussed at the April 9, 2019 BRCP Meeting #2, which was also available through an online survey.

11. East Mixed-Use Neighborhood- Should home occupations and/or live/work units be broadened to allow "cottage industries" that manufacture and sell goods? What additional compatibility standards should apply, such as use limitations, impacts, size, storage, or customer visits? Are there other ideas to integrate live-work opportunities in these neighborhoods, and the district generally?

There was very little feedback on this question from either in person comments or through online comments. At the April 9, 2019 meeting, the question asked to those assembled if there should be additional allowances for offsite employees, retail customers, outside storage, or outside activities in the R-2 or R-5 residential zones within the BRCP. Very little people expressed support for adding additional elements to the home occupation definition.

Staff recommendation: Once further direction is given on the specifics of the enhanced employment options; staff will return at a future hearing with proposed code amendments. Broader public engagement will occur once draft code amendments have been created for this topic.

3. Concept Plan Renaming

One issue that came up over and over again in public outreach conversations and public comments this winter and spring was a concern that the name of the concept plan area was geographically confusing and was being confused with the Hamlet of Beavercreek. One way to lessen this concern is to potentially begin referring to the area with a new name as part of the code amendment project. Ideally, the new name should not be geographically confusing.

Historic References: Most of the property is on the Andrew Hood Donation Land Claim. Until the golf course was built, the area was mainly farm fields for people who lived at Maple Lane or lived in the city and kept farms nearby. When the golf course was established, the newspaper reported it going in at "Maple Lane." According to Karin Morey, local history enthusiast, a survey map for "Skypark" which was the airfield was identified west of the golf course. Google maps show it today as Fairways Airfield. None of the references above create a unique geographic name.

Additional names provided during the public outreach during the spring of 2019 were: Thimble Creek, East Caufield, Loder Road, SE Industrial (Oregon City), Two Creeks, and Thayer Greens.
As Thimble Creek runs through the site, is not very long and empties into Abernethy Creek soon after it leaves the site, staff finds it to be the best alternative name option.

Staff recommendation: Staff recommends that if the Planning Commission wishes to rename the Concept Plan as part of this process, Thimble Creek Concept Plan is the best option.

Beavercreek Road Concept Plan- Cottage Industry- Expanded Home Occupation Options

This page shows analysis of submitted data as of October 7, 2019

Do you support allowing the following uses in subdivison areas (houses) in the Beavercreek Road Concept Plan Area?

	I SUPPORT this within subdivision developments (houses)	I SUPPORT this within subdivision developments (houses) with additional restrictions	I DO NOT support this within subdivision (houses) developments
Retail (picking up goods for sale)	0	6	12
Outdoor storage associated with a business (landscaping equipment, construction materials)	0	5	13
Parking commercial vehicles (landscape trucks, 5th wheel cabs)	0	3	15
Work performed outdoors (welding, outdoor yoga)	0	5	13
Offsite employees working at the residence (1-3 employees checking in at residence or working at the house)	1	8	9
Using a majority of a residence for business (more than 50% of the residence devoted to business use)	0	5	13

Do you support allowing the following uses in multifamly areas in the Beavercreek Road Concept Plan Area?

	I SUPPORT this within multi-family development (apartments)	I SUPPORT this within multi-family development (apartments) with additional restrictions	I DO NOT support this within multi-family development (apartments)
Retail (picking up goods for sale)	0	4	14
Outdoor storage associated with a business (landscaping equipment, construction materials)	0	1	17
Parking commercial vehicles (landscape trucks, 5th wheel cabs)	0	0	18
Work performed outdoors (welding, outdoor yoga)	0	2	16
Offsite employees working at the residence (1-3 employees checking in at residence or working at the house)	1	6	11
Using a majority of a residence for business (more than 50% of the residence devoted to business use)	0	4	14

Even if allowed in the Beavercreek Road Concept Plan area, should developers and home owner associations (HOAs) be allowed to create private covenants that restrict these expanded uses?

Yes 9

No 5

Tell us some information about you (click all that apply).

I am a resident of Oregon City	8
I am a resident of Clackamas County	13
I am a resident of the Caulfield Neighborhood	2
I started my business in my home but moved it to another location as it grew	1
I have experience in commercial or residential real-estate	5
I build residential buildings	3
I would move to the Beavercreek Road Concept Plan area to take advantage of the new allowed uses	1

Specific Comments

Do you any have additional concerns about allowing expanded uses in residential areas within the Beavercreek Road Concept Plan?

Yes, anything outside the already defined and approved uses will bring in additional traffic congestion, noise and crime.

Too much traffic on Beavercreek Road

Do not allow businesses that may produce airborne particulate/pollution or effluent into water systems

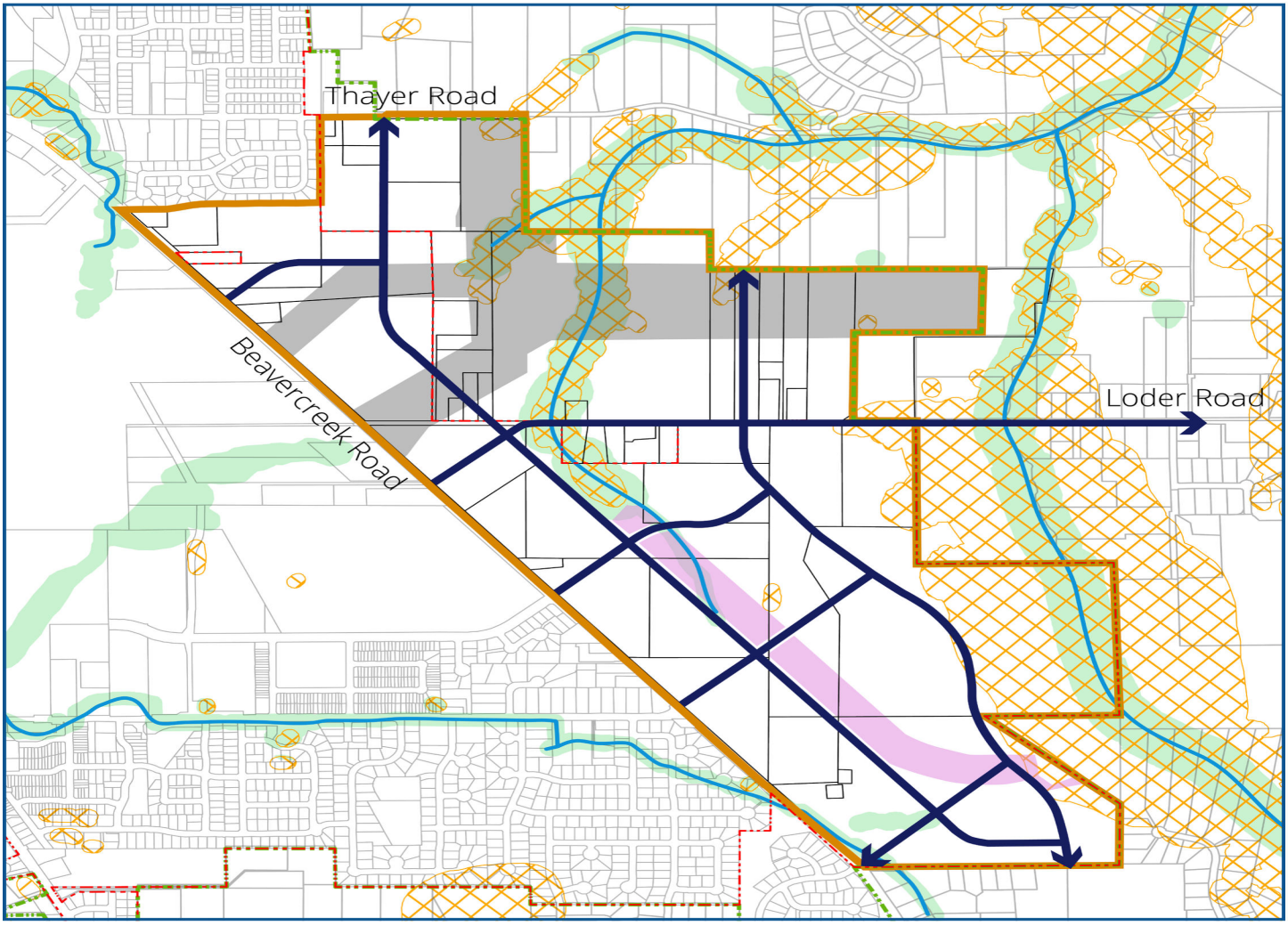
POTENTIALLY VERY HIGH ROAD TRAFFIC WITH THE ABOVE. TRAFFIC PLANNING WILL BE NEEDED IN ADVANCE

There should be a way to address nuisance complaints quickly

Noise and traffic congestion

Oregon City bullying their way into building where infrastructure doesn't exist and isn't wanted by rural residence.

Traffic is going to be a nightmare if all the planned multifamily units are built - last thing needed is commercial traffic too



0' 1,200' 2,400'

Legend

Natural Resources Overlay District (NROD)

Geologic Hazard Overlay District (GHOD)

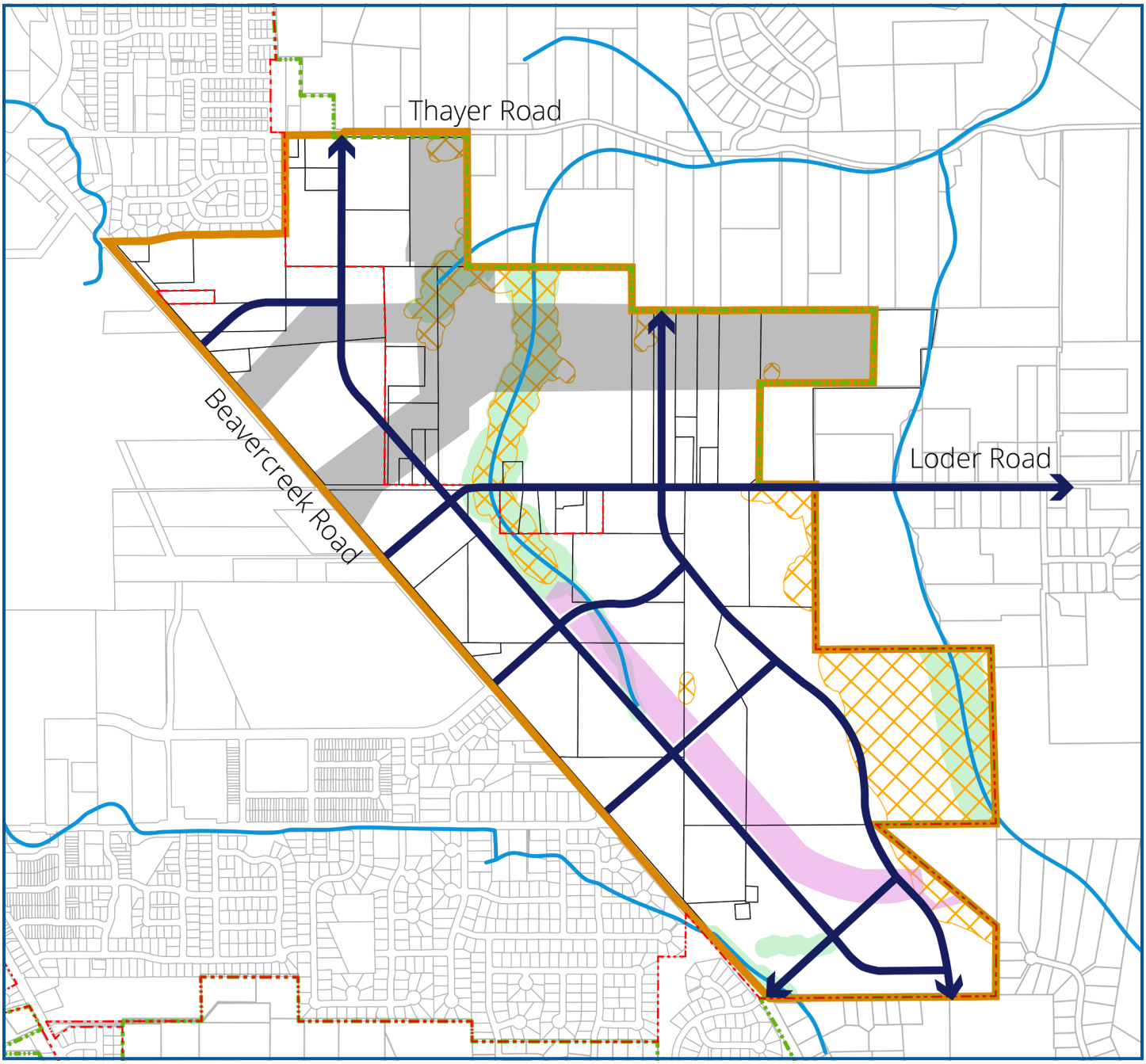
BRCP Boundary

Urban Growth Boundary

City Limits

Beavercreek Road Concept Plan

Development Constraints



Legend

- Natural Resources Overlay District (NROD)
- Geologic Hazard Overlay District (GHOD)
- South-Central Open Space Network
- Powerline Corridor

N

0′ 1,200′ 2,400′

- BRCP Boundary
- Urban Growth Boundary
- City Limits
- Conceptual Road Network
- Streams

Meeting #2 - April 9, 2019

Date	Question/Comment	Topic	Staff Response / Recommendation	Planning Commission Action/Recommendation
8.12.19 Mike Mitchell	Provide more background on the decision to have a 20 foot setback at the north boundary of the concept plan areas and a 40 foot setback at the south boundary	Zones	Will be addressed at the September 9, 2019 Planning Commission Meeting.	Keep northern setback as written. Add accessory buildings and roads as permitted in the southern boundary.
8.12.19 Mike Mitchell	Concern that the definition of warehousing is not specific enough to allow ancillary use by permitted uses	Zones	Will be addressed at the September 9, 2019 Planning Commission Meeting.	Oregon City views the storage and distribution of materials that are constructed or assembled onsite to be part of the permitted use. No changes to the code are recommended.
8.12 19 Patti Gage	Provide additional background on the Geologic Hazard code- how does it affect development in the BRCP area and Holly Lane area?	Hazards/Natural Resources	Geologic Hazard Review within the city is subject to OCMC 17.44 Geologic Hazard Review. Areas near the Thimble Creek Conservation Area are subject to the Geologic Hazard code at time of Development Will be further addressed at the September 23, 2019 Planning Commission Meeting.	Planning Commission did provide staff with any direction on amendments to the existing 17.44 Geologic Hazards Overlay District
9.9.19 Planning Commission	Provide additional information on options for including additional job opportunities in the southern part of the Concept Plan area.	Cottage Industry/Home Occupation	This topic will be further addressed at the October 14, 2019 Planning Commission Meeting	

Date	Question/Comment	Topic	Staff Response / Recommendation	Planning Commission Action/Recommendation
8.12.19 Dirk Schlagenhaufer	Provide additional information on the pros and cons of roundabouts and crash statistics for the corridor.	Transportation	Additional information about intersection control measures (Roundabouts and signals) will be shared in October and through the additional public outreach occurring in September 2019. See calendar in Commission report for details	
8.12.19 Dirk Schlagenhaufer	Please expand on Comprehensive Plan Policy 9.8.7 as it relates to bicycles	Transportation	*Policy 9.8.7* *Assess methods to integrate the pedestrian, bicycle and elevator transportation modes into the mass transit system.* Additional information about intersection control measures (Roundabouts and signals) will be shared in October and through the additional public outreach occurring in September 2019. See calendar in Commission report for details	
8.12.19 Tom Geil Vern Johnson	If the transportation study horizon is only 20-25 years how do we know we are sizing Beavercreek Road correctly?	Transportation	Additional information about traffic studies and planning for capacity will be shared in October and through the additional public outreach occurring in September 2019. See calendar in Commission report for details	
8.12.19 Mike Mitchell	Concern about categorizing shared and separated bike lines with at grade bike lanes in terms of safety and likeliness of being utilized	Transportation	Additional information about will be shared in October and through the additional public outreach occurring in September 2019. See calendar in Commission report for details	
8.12.19 Tom Geil	Provide more information on the creation of the Beavercreek Blue Ribbon Committee	Other/Economic Development	Lori Bell, Economic Development Coordinator will provide a brief email explaining purposed of organization, which will be attached to public comments.	Non anticipated

Date	Topic	Issue / Comment / Concern	Staff Comment	Has this been Addressed? How?
7.3.19 Written Comment to Planning Commission Wendy Black	Natural Resources	Concerned that the area where home is located was in a protected natural area according to the first map they were sent, but now seems to be included in the industrial area. Concern about project impact to farm use.		This topic will be addressed at the September 23, 2019 Planning Commission Meeting
7.12.19 Written Comment to Planning Commission Clackamas River Water (CRW)	Infrastructure	Territory that is annexed to the City must be withdrawn from CRW and served by Oregon City services to the extent practicable. CRW assumes that future development will, in large part, be guided and coordinated consistent with the concepts provided in the Joint Engineering Study, June 11, 2018, by Murraysmith.	This is consistent with Staff's understanding. New development within the concept plana area (except for the previously approved Villages of Beavercreek) will utilize city water.	No response needed for this comment
7.15.19 Written Comment to Planning Commission Wes Rogers Oregon City School District	Infrastructure	Assuming that the BRCP is developed in stages over the next 5-10 years, the District currently believes that it has the current capacity and/or will be able to have time to add capacity to meet the long-term enrollment generated by the Beavercreek Road Concept Plan development.	The school property to the south of the Concept Plan area will have vehicular access to the Concept Plan and can connect to local streets when it is constructed.	No response needed for this comment
8.12.19 Testimony to Planning Commission Paul Edgar Entered into the record- Title 4 Map	Zoning Map	Request that the Planning Commission work with Metro to revise the Title 4 Industrial maps to remove a parcel owned by Terry Emmert to allow construction of housing for homeless veterans onsite.	https://www.oregonmetro.gov/industrial-and-employment-land Portions of the CI area in the BRCP are identified as Title 4 Industrial areas. Any change to the title 4 Map must be adopted by Metro and would need to be completed before the Code amendments are adopted by the City to remain consistent with Title 4.	This will be addressed at the September 9, 2019 Planning Commision Hearing

Date	Topic	Issue / Comment / Concern	Staff Comment	Has this been Addressed? How?
8.12.19 Testimony to Planning Commission Christine Kosinski	Geologic Hazards	Concerned about development in the Beavercreek concept Plan areas affecting homes on Holly Lane as Holly lane is in a historic landslide area. Does not support any connection of the concept plan area to Holly Lane-	Geologic Hazard Review within the city is subject to OCMC 17.44 Geologic Hazard Review. Areas near the Thimble Creek Conservation Area are subject to the Geologic Hazard code at time of Development.	This topic will be addressed at the September 23, 2019 Planning Commission Meeting
9.9.19 Jim Nicita	Cottage Industry	2011 City Commision Meeting voted to have additional job opportunities at the south of the concept plan. Encouraged PC to look at a hybrid district rather than a residential district with home occupation uses. Encourage implementing cottage industry.	Planning Commission requested staff to return at a future meeting with additional opportunities for jobs in the southern part of the Concept Plan area above and beyond the existing home occupation licence.	This topic will be further addressed at the October 14, 2019 Planning Commission Meeting
9.9.19 Elizabeth Grazer Lindsey	Cottage Industry	This area was brought into the Urban Growth Boundary for jobs. There are many businesses that are currently in the county that would want to be involved in this use. Encouage allowing cottage industry as a way to promote incubator spaces.	Planning Commission requested staff to return at a future meeting with additional opportunities for jobs in the southern part of the Concept Plan area above and beyond the existing home occupation licence.	This topic will be further addressed at the October 14, 2019 Planning Commission Meeting

Date	Topic	Issue / Comment / Concern	Staff Comment	Has this been Addressed? How?
9.23.19 Christine Kosinki Handouts	Geologic Hazards	Holly Lane Connection is not suitable for road connection to I-205 No insurance coverage is readable available for property owners If near a landslide area you cannot get landslide insurance. The City should provide additional information on landslides and protection people can take to protect their land. State Law requires people to educate about landslides. Oregon City has been derelict in educating the public.	Josh Wheeler, Assistant Engineer presented a background on the OCMC 17.44 Geologic Hazard Overlay District. He also recommended people attend the October 8, 2019 City Commission Worksession about Geologic Hazards.	Planning Commission did provide staff with any direction on amended the existing 17.44 Geologic Hazards Overlay District.

From: Lori Bell
To: Christina Robertson-Gardiner
Subject: Beavercreek Employment Area
Date: Monday, August 26, 2019 10:09:39 AM
Attachments: image001.png

Thank you for reaching out Christina. The Blue Ribbon Committee, created in 2016, is a community group working to increase awareness around available sites around Clackamas Community College.

Below are the answers to your questions.

1. Why was it created? – to attract targeted industry to the existing and zoned Industrial sites in the Beavercreek Employment Area, near and around Clackamas Community College area by leveraging the education and training resources at Clackamas Community College.
2. Steering Committee -Lori Hall, CCC PIO, Lisa Davidson Executive Director of CCC Center for Business and Industry, Lori Bell Economic Development City of Oregon City, Current Executive Director Oregon City Chamber of Commerce Victoria, Jon Legarza – or other representative from Clackamas County Ec Dev Department, Kent Ziegler, OCBA representative.
3. Eric Underwood and Amber Holvek, previous Chamber Director, created the ad hoc committee.
4. It is not a public body and interested parties are welcome to attend. The group meets on an ad-hoc bases. Contact Lori Bell for more information.

Please let me know if you need anything else.

Lori Bell
Economic Development
lbell@orcity.org



City of Oregon City
PO Box 3040
625 Center Street
Oregon City, Oregon 97045
503-974-5517 x 1588 Direct
503-657-0891 City Hall

From:	Wendy Black
To:	Christina Robertson-Gardiner
Subject:	Beavercreek Road Concept Plan - Loder Rd Residents
Date:	Wednesday, July 3, 2019 2:39:07 PM

Hello,

I live on Loder Road in the area that now seems to be planned for a Campus Industrial Zoning. Currently we are Rural Residential Farm/Forest 5 and we have a small farm that does include animals. This is significant source of food for our family. We also live on the ridge above the creek. I am concerned how the rezoning would impact our land use. Are you able to provide me further information? I've read through much of the information on the website. I am very concerned that the area where our home is was in a protected natural area according to the first map we were sent, but now seems to be included in the industrial area. I had trouble telling from all the other maps and information what was happening.

Thank you for your assistance in this matter. Kind regards,
Wendy Black
15060 S Loder Rd, Oregon City, OR 97045

Oregon City School District No. 62

Learning to be our Best

PO Box 2110 (1417 12th St.), Oregon City, Oregon 97045-5010

July 15, 2019

Community Development Department
City of Oregon City
698 Warner Parrott Road
Oregon City, OR 97045

RE: Beavercreek Road Concept Plan - BRCP

The District has been asked to provide comments concerning the BRCP and the current proposal for zoning designations and code amendments. Comments are to address the ability of Oregon City School District to adequately provide public educational services to the area. Current impacted school enrollment areas are Gaffney Lane and Beavercreek Elementary Schools, Ogden Middle School and Oregon City High School.

The District has limited short-term capacity available at both Gaffney Lane and Beavercreek Elementary Schools, capacity available at Ogden Middle School and capacity at our three high schools. Recent residential developments in the District have yielded significantly less than one student per household across all grade levels. The District currently is in design and construction to replace/expand and update middle schools and add safety and security features to all District schools. Current enrollment projections show a gradually increasing elementary enrollment, a middle school enrollment that decreases in the short term and then gradually increases and high school enrollment that slightly decreases. Assuming that the BRCP is developed in stages over the next 5-10 years, the District currently believes that it has the current capacity and/or will be able to have time to add capacity to meet the long-term enrollment generated by the Beavercreek Road Concept Plan development.

Sincerely,

Wes Rogers
Bond Program Manager
503-785-8531, wes.rogers@orecity.k12.or.us

Oregon City Planning Commission
Hearing of September 23rd, 2019

RE: Testimony of Christine Kosinski, unincorporated Clackamas County

Agenda Item 3b – LEG19-0003 Beavercreek Rd Concept Plan – Geology

Oregon City is comprised of some of the most difficult and dangerous topography in the State. I continue to be shocked that the City would even consider using Holly Lane as a freeway for motorists to reach the I-205. This is being done to preserve Beavercreek Road, since it is at capacity, and the City has failed in the past to construct a grade separated intersection at Hwy 213 and Beavercreek Rd which would have been the solution to its capacity issues at this intersection. Because the City failed, they pulled out Plan B from their pocket and decided to use Holly Lane which is a small 2 land road that is riddled on both sides with landslides. The homeowners on Holly Lane have suffered previous landslides which demolished two homes and severely damaged four others. Their was NO insurance coverage when the slides occurred in 1996 and the homeowners had to pay hundreds of thousands of dollars to fix and re-build their homes.

Case in point, the City has failed to fulfill it's obligations to their people in providing adequate transportation infrastructure to support the large build out they are proposing, however using Holly Ln to carry some 70,000 plus vehicles per day is simply ludicrous. To make the people of Holly Lane pay for the errors of the City should never be done, rather the City must now go back to plan their way out of this difficult situation that they themselves have created.

Following are several Exhibits I am entering into the City record for the Beavercreek Rd Concept Plan. These exhibits show that poor planning on the part of the City has created these traffic problems.

EXHIBIT ONE – One page of a new article where Scott Burns, Professor of Geology, PSU, was being interviewed after the OSO, WA Landslide Disaster. This is the statement he had about the poor people losing everything, **and there's no insurance covering them.**

EXHIBIT TWO – This is the first sheet of an application for Landslide Insurance, NOTE the question "Is the building in a known landslide area or have there been any incidents of landslide within ONE MILE of the property? It doesn't matter if you answer yes or no since the insurance company will look up your address on lidar landslide maps. If there has been a previous landslide within one mile of your property you will not get insured.

EXHIBIT THREE – There are extensive exclusions, in fact so many, that even if you could get landslide insurance, it would virtually never pay out.

EXHIBIT FOUR – Here is a copy of the denial my Husband and I received when we tried to obtain landslide insurance in 2015.

EXHIBIT FIVE – An e-mail from Professor Scott Burns speaking to the concerns of the Thayer Road landslides and that the road will not take large amounts of traffic.

EXHIBIT SIX – Oregon City's Comprehensive Plan for Landslides. If the City approves the use of Holly Lane, as well as the approving both the North and South extensions of Holly, they will be going against their own Comprehensive Plan, as well as the requirements of the State and LCDC.

EXHIBIT SEVEN – Oregon City "Trail News

EXHIBIT EIGHT - DOGAMI's Lidar Landslide Map. The location of the BRCP is highlighted. I want you to note that this map includes an extensive area of Oregon City because NO ONE in this entire area will be able to obtain Landslide Insurance. Many of them will not know this when they are purchasing homes and/or property. They need to be told the truth if they are moving into a landslide area, they need to know there will be no insurance coverage if a landslide hits their property. **This is STATE LAW – Property Disclosure Law.**

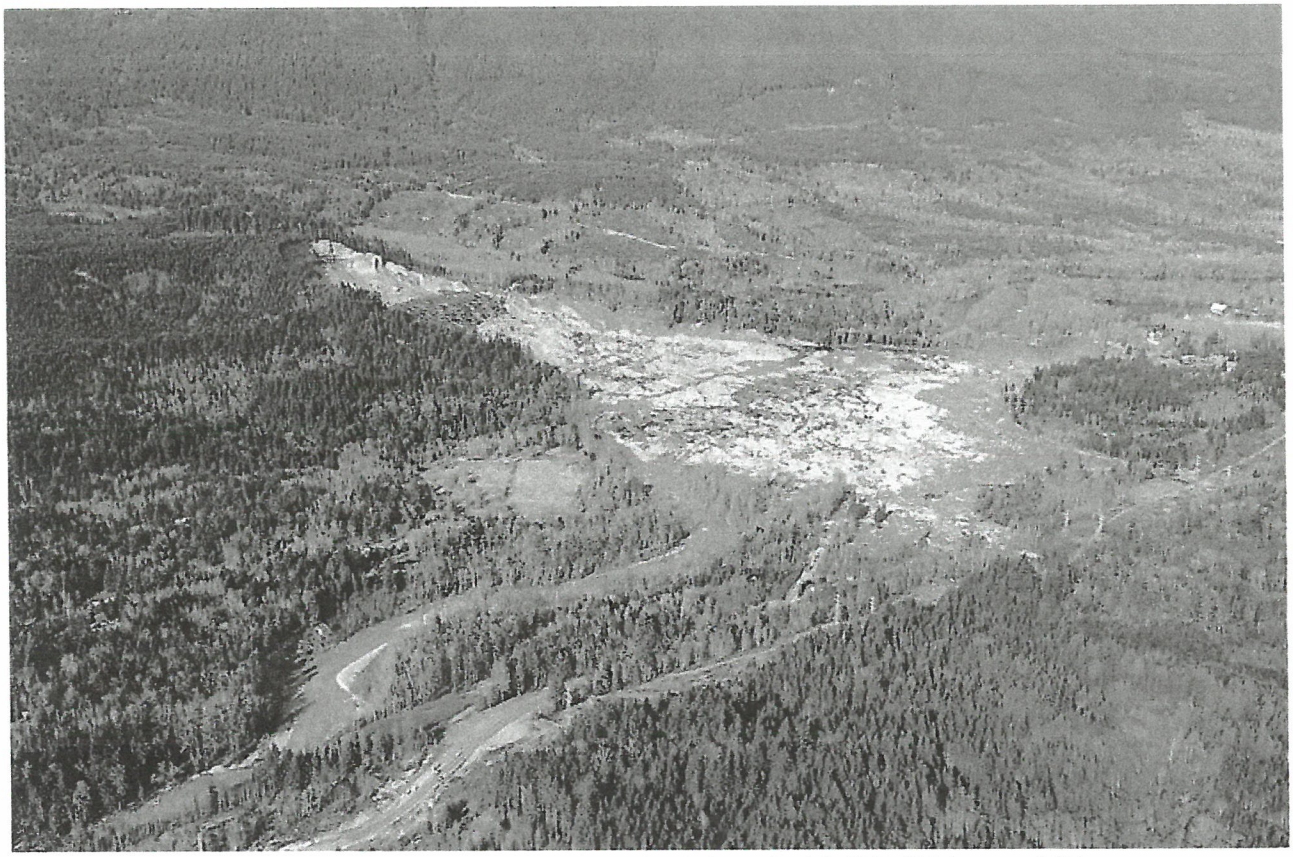
The City should not be using the people of Holly Lane to try and fix it's planning problem where the grade separated intersection, which should have been built way back before three very large concept plans were proposed. The City was wrong in doing this, and now must, once again, re-consider the grade separated intersection which is what should have happened years ago. We ask and ask again and again, take Holly Lane out of your TSP. It is a dangerous street with high susceptibility to future landslides. A City should NEVER compromise the SAFETY of the people!

A Call For Landslide Insurance For Homeowners

Scott Burns

By DAVID HYDE (/PEOPLE/DAVID-HYDE) & MARCIE SILLMAN (/PEOPLE/MARCIE-SILLMAN) •
MAR 26, 2014

Twitter (http://twitter.com/intent/tweet?url=http%3A%2F%2Fwww.tinyurl.com%2Fk9hh9uk&text=A%20Call%



(http://mediad.publicbroadcasting.net/p/kuow/files/styles/x_large/public/201403/osomudslide-GovInsleeaerial1.jpg)

All those people who lost their houses in the Oso landslide have lost everything, and there's no insurance covering them. We lost lives. That is the worst thing. But then property is the second thing. Hopefully, this will be enough of an impetus to take us to the next level and put more pressure on insurance companies to possibly come forward with landslide insurance.

#1

NCIP

NATURAL CATASTROPHE INSURANCE PROGRAM

Coverage Underwritten by Certain Underwriters at Lloyd's, London B1180D150591

Earthquake, Landslide Application
Application No. NCIP435439

Building Information

Foundation Type:	Crawl Space
Dwelling Type:	Owner Occupied Primary Residence
Year Built:	1971
Roof Update:	1998
Construction Type:	Wood Frame
Dwelling Value Declared at 100% Replacement Cost:	$200,000.00
Total Square Footage:	1,410
Do you own this property?	Yes
Select the option that best describes the building:	Single-Family
Is this a split level home?	No

General Questions

Does the building have additions or extensions supported by posts, piers, or beams?	No
Is there existing cracking of wall or foundation?	No
Is there a garage attached to the building?	Yes
Is the sill plate permanently bolted to the foundation of the building?	No
What year was the roof last updated?	1998

Earthquake Questions

Have any buildings or personal property located on the premises been damaged from an incident of Earthquake Shock?	No

Landslide Questions

Is the building in a known landslide area or have there been any incidents of landslide within 1 mile of the property?	Yes
Have any buildings or personal property located on the premises been damaged from an incident of landslide, earth movement, or land subsidence?	No

#2

POULTON ASSOCIATES, INC. | State License Number: 230392
3785 South 700 East, Second Floor, Salt Lake City, Utah 84106
Phone: 801-268-2600 Opt# 2 | Fax: 801-268-2674 | icservice@poulton.com

H.Premises means the real property at the address shown on the Coverage Declarations.

I. **Sinkhole** collapse means the settlement or systematic weakening of the land supporting the **building(s)**, when such settlement or systematic weakening results from movement or ravelling of soils, sediments, or rock materials into subterranean voids created by the effect of water on a limestone or similar rock formation.

III. Losses Excluded

A. This Policy does not insure against:

1. Loss or damage arising directly or indirectly out of nuclear reaction, nuclear radiation or radioactive contamination, however such nuclear reaction, nuclear radiation or radioactive contamination may have been caused.
2. Loss or damage arising directly or indirectly out of war, invasion, acts of foreign enemies, hostilities (whether war be declared or not) civil war, rebellion, revolution, insurrection, military or usurped power or martial law or confiscation or nationalization or requisition or destruction of or damage to property by or under the order of any government or public or local authority.
3. Loss, damage or increased cost arising directly or indirectly out of enforcement of any ordinance or law regulating the use, reconstruction, repair or demolition of any **building(s)** insured hereunder, nor any loss, damage, cost, expense, fine or penalty which is incurred, or sustained by or imposed on you at the order of any governmental agency, court or other authority arising from any cause whatsoever.
4. Loss or damage arising out of acts or decisions, including the failure to act or decide, of any person, group, organization or governmental body relating to faulty, inadequate or defective:
   a. Planning, zoning, development, surveying, siting;
   b. Design, specifications, workmanship, repair, construction, renovation, remodelling, grading, compaction;
   c. Materials used in repair, construction, renovation or remodelling; or
   d. Maintenance of all or part of any property on or off the **premises**.
5. Loss or damage arising out of normal settling, shrinking or expansion of land, **buildings**, structures or foundations; or erosion, gradual subsidence or the processes of erosion that take place over time, or any other gradually occurring loss or damage whether caused by **earthquake shock**, **flood** or **landslide** or not, or any loss or damage which commenced prior to the inception of this Policy.
6. Loss or damage arising out of fire regardless of any other event which contributes concurrently or in any sequence to the loss or damage.
7. Loss or damage arising out of exposure to weather conditions where any **personal property** is left in the open or not contained in **buildings** which are on permanent foundations and capable of secure storage.
8. Mysterious disappearance or inventory shortage, theft, fraud, or any kind of wrongful conversion or abstraction.
9. The costs for reconstruction of electronic data or other data.
10. Loss or damage arising out of cessation, fluctuation or variation in, or insufficiency of, water, gas or electricity supplies, or other public utility service supplying the **premises**.
11. Reduction in rental value, reduction in market value or the saleability of property insured by this Policy, or any costs or expenses related thereto.

B. Notwithstanding any provision in this Policy to the contrary (or within any Endorsement which forms part of this Policy), this Policy does not insure:

1. Any loss, damage, costs or expense, or
2. Any increase in insured loss, damage, cost or expense, or
3. Any loss, damage, cost, expense, fine or penalty, which is incurred, sustained or imposed by order, direction, instruction or request of, or by any agreement with, any court, government agency or any public, civil or military authority, or threat thereof, (and whether or not as a result of public or private litigation) which arises from "any kind of seepage or any kind or pollution and/or contamination," or threat thereof, whether or not caused by or resulting from a peril insured, or from

SPECIMEN

#3

This exclusion applies regardless whether there is (i) any physical loss or damage to insured property; (ii) any insured peril or cause, whether or not contributing concurrently or in any sequence; (iii) any loss of use, occupancy, or functionality; or (iv) any action required, including but not limited to repair, replacement, removal, clean-up, abatement, disposal, relocation, or steps taken to address medical or legal concerns.

This exclusion replaces and supersedes any provision in the Policy that provides insurance, in whole or in part, for these matters.

I. This Policy does not cover any costs and expenses, whether preventative, remedial or otherwise, arising out of or relating to change, alteration or modification of any computer system, hardware, program or software and/or any microchip, integrated circuit or similar device in computer equipment or non-computer equipment, whether the property of the insured or not.

J. Notwithstanding any provision to the contrary within this insurance or any endorsement thereto it is agreed that this insurance excludes loss, damage, cost or expense of whatsoever nature directly or indirectly caused by, resulting from or in connection with any act of terrorism regardless of any other cause or event contributing concurrently or in any other sequence to the loss.

For the purpose of this Policy an act of terrorism means an act, including but not limited to the use of force or violence and/or the threat thereof, of any person or group(s) of persons, whether acting alone or on behalf of or in connection with any organization(s) or government(s), committed for political, religious, ideological or similar purposes including the intention to influence any government and/or to put the public, or any section of the public, in fear.

This also excludes loss, damage, cost or expense of whatsoever nature directly or indirectly caused by, resulting from or in connection with any action taken in controlling, preventing, suppressing or in any way relating to any act of terrorism.

If the underwriters allege that by reason of this exclusion, any loss, damage, cost or expense is not covered by this insurance the burden of proving the contrary shall be upon the insured.

In the event any portion of this endorsement is found to be invalid or unenforceable, the remainder shall remain in full force and effect.

IV. Property Excluded

A. This Policy does not cover:

1. Land, land values, soil, water, air, or any interest or right therein.
2. **Building(s)** and other structures used in whole or in part for any commercial, farming or manufacturing purposes, other than residences on the **premises** held for rental.
3. Mobile homes; but this exclusion does not apply to modular or manufactured housing permanently attached to foundations.
4. Paved areas, including but not limited to parking lots, terraces, driveways, walkways, sidewalks, pavements, paths, curbing and swimming pools.
5. Bridges, steps and stairs; wharves, piers and jetties, unless physically attached to any **building(s)**.
6. Retaining walls whether or not necessary for the continuing stability of any part of the **premises**, and whether or not attached to any **building(s)**.
7. Fences; embankments and earthen structures, tanks, wells, ponds, dams, and dikes.
8. Trees, shrubs, lawns, plants, landscaping costs, animals, birds or fish.
9. Any aircraft or other aerial device, watercraft and their trailers, motorized and non-motorized vehicles other than motorized equipment used to maintain the **premises**.
10. Accounts, bills, currency, money, medals, notes, credit cards, securities, deeds, bullion, books of account, evidences of debt or title, manuscripts, passports, tickets, stamps and valuable papers.
11. Jewellery, watches, precious stones, precious metals, silverware, silver-plated ware, gold-ware, gold-plated ware, and pewter ware, fine art, objects d'art, firearms, sculpture and statuary, furs and garments trimmed with fur.
12. Loss or damage to the basement and/or real property and **personal property** suffering loss or damage within the basement where the basement has not been declared within the Policy Application for this insurance.

#3

SPECIMEN

From: Jackie Goodman <jackie@huggins.com>
To: britenshin <britenshin@aol.com>
Subject: RE: Landslide and earthquake quote
Date: Wed, Oct 28, 2015 11:20 am

Hello Christine and John,

I received a response from the Underwriter and I am sorry to tell you that your application has been denied. Unfortunately you are ineligible for landslide coverage at this time. The comments from the Underwriter indicate the risk is surrounded by 6 large landslides and a recent fan of debris. The Catcoverage.com market is the only market that we have available for this type of coverage.

I am so sorry that I am unable to assist you. If you have any questions or concerns, please let me know.

Kindly,

Jackie Goodman
Account Manager
Huggins Insurance Services
jackie@huggins.com

#4

Subj: **Re: Thayer Road in Oregon City**
Date: 11/19/2007 6:20:35 A.M. Pacific Standard Time
From:
To:

Christine - great to hear from you!! Keep working at getting the county to change - it takes time! The Thayer Road problem is a big one - that slide keeps creeping. The road will not take large amounts of traffic and they definitely should not build on the site! Thanks for keeping me up on these things! Good luck,

Scott Burns, PSU Geology

Quoting Britenshin@aol.com:

> Dr. Burns: I was speaking with Sha Spady last week regarding the large
> landslide area on Thayer Road which sinks every year. Sha told me that you
> were recently here to inspect this part of the road and that I should
> contact you
> for your thoughts and concerns about this area.
>

#5

areas of concern are shown on other city, county, state and federal maps. These publications are available at the Oregon City Planning Department.

Development and construction in areas with unstable soils require that special development standards be met on a site-specific basis to prevent or minimize damage caused by unstable soils. Maintaining existing vegetation or revegetating may be required for excavation and road slopes in areas designated as landslide-prone.

Landslides. Landslides include rockslides, mudslides, debris flows, earthflows, and slumping. These phenomena are natural geologic processes that occur principally when soils and rock in steep areas become saturated with water, increasing weight and lubricating the mass. Gravity pulls the affected areas downhill. Landslides can be exacerbated by adding fill material to a slope, removing vegetation, altering drainage and runoff patterns, and undercutting a slope. Landslides can be triggered by heavy rains, groundshaking from earthquakes and heavy traffic, and undercutting the lower edge of a slope, which can be caused by erosion along stream banks, and by development, such as cuts in road construction.

Areas most susceptible to landslides in Oregon City are those with slopes of greater than 25 percent. These areas have been mapped by DOGAMI and are shown in the *Oregon City Hazard Mitigation Plan* (1998). The Unstable Soils and Hillside Constraint Overlay District requires geotechnical surveys of other potential hazard areas and provides standards that are used to determine the potential risk of landslides on slopes with various degrees of steepness in relation to the development.

Seismic Activity

Although predicting seismic events is extremely difficult, some prediction is possible by looking at the history of a particular region. Oregon is in a region with a history of intense seismic activity, generated by the subduction of the Juan de Fuca Plate under the North American Plate and by the collision of the Pacific Plate with the North American Plate along the San Andreas Fault and associated faults in California. Known catastrophic subduction-zone seismic events in the Pacific Northwest, which have occurred every 300 to 800 years, have caused a down-drop of land, generated enormous tsunamis along the coast, and triggered major landslides throughout the region. The last such event took place in 1700.

Tectonic uplift of the entire Pacific Northwest region, driven by subduction of the Juan de Fuca Plate far offshore, has spawned many faults throughout the region, including the West Hills Fault along the axis of the toe of Portland's West Hills. An earthquake in March of 1993 near Molalla just south of Oregon City, dubbed the "Spring Break Quake," had a magnitude of 5.6 on the Richter

#6

Oregon City Planning Commission hearing of September 23rd, 2019

OREGON CITY TRAIL NEWS

Since April of 1996 until the Fall issue of this year, 2019 – There have been many articles in the Trail News on.....

City Sewers
City Streets
National Night Out
City Heritage Day
Water Safety
Stormwater Master Plan Update
Construction Projects
Many articles on living in the flood plain
Many articles on flood insurance
Many articles on the BRCP
The Pioneer Center

BUT
NEVER ONE ARTICLE EVER IN THE PAST 23 YEARS
ABOUT LANDSLIDES!!!!!!

Both Land Use Goals 7 and 2, as well as Oregon Statutes Chapter 195 – Local Government Planning Coordination – Section 195.260. All of these State laws call for local governments to educate their people about the risks of Landslides.

The people of Oregon City must know who to call, where to go for help when noticing things like cracks in their foundations, windows that won't go up or down due to shifting, cracks appearing in their ceilings, floors that begin to tilt and become unlevel. The people of Oregon City must be educated in reading the DOGAMI Lidar Landslide Maps, if they have questions, the City must be ready with answers and with help.

This is simply awful that Oregon City, with some of the worst topography in the State, has not reached out to their people through the Trail News, through newspaper articles, through mailers, through classes held within the community on the dangers of Landslides, Earthquakes and they must know about Emergency preparedness and the fact that Landslide Insurance does not exist at this time in the U.S. and that the Homeowner is responsible for all damages.

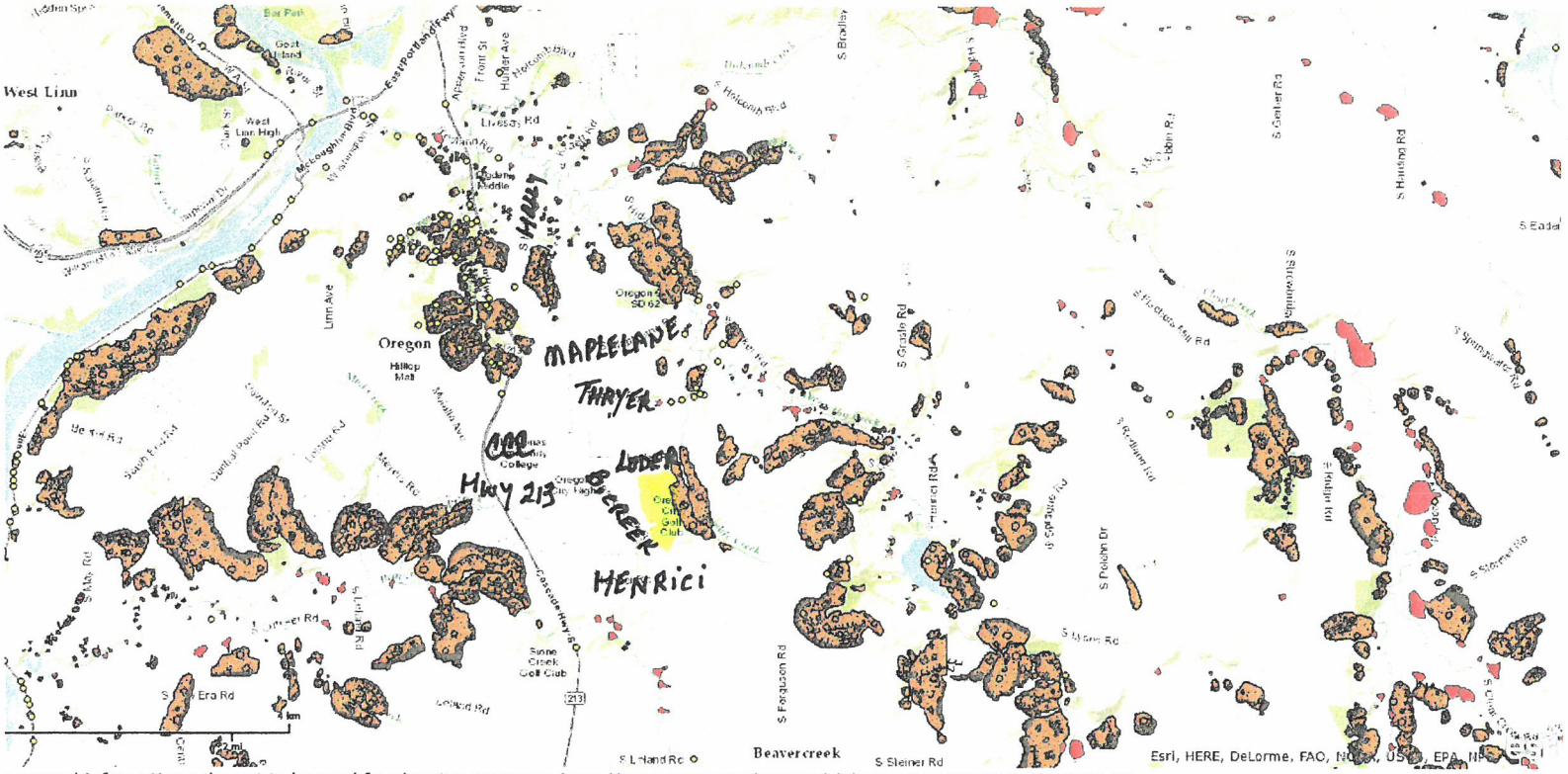
Oregon City has been derelict in it's duties to protect the lives and property of it's people, and must, by State law, begin an intensive plan to educate their people into the dangers and hazards of living in a landslide area, of which Oregon City is highly comprised of – difficult topography.

Christine Kosinski

#7

Map from DOGAMI's SLIDO Viewer

olly Ln & Hwy 213 Landslides



- general information only; not to be used for planning purposes. http://www.oregongeology.org/slido Sat Aug 27 2016 09:53:25 PM.

#8

Clackamas River Water

MEMO

To: Laura Terway, Community Development Director, Oregon City

cc: files

From: Joseph D. Eskew, Engineering Manager

Date: 7/12/2019

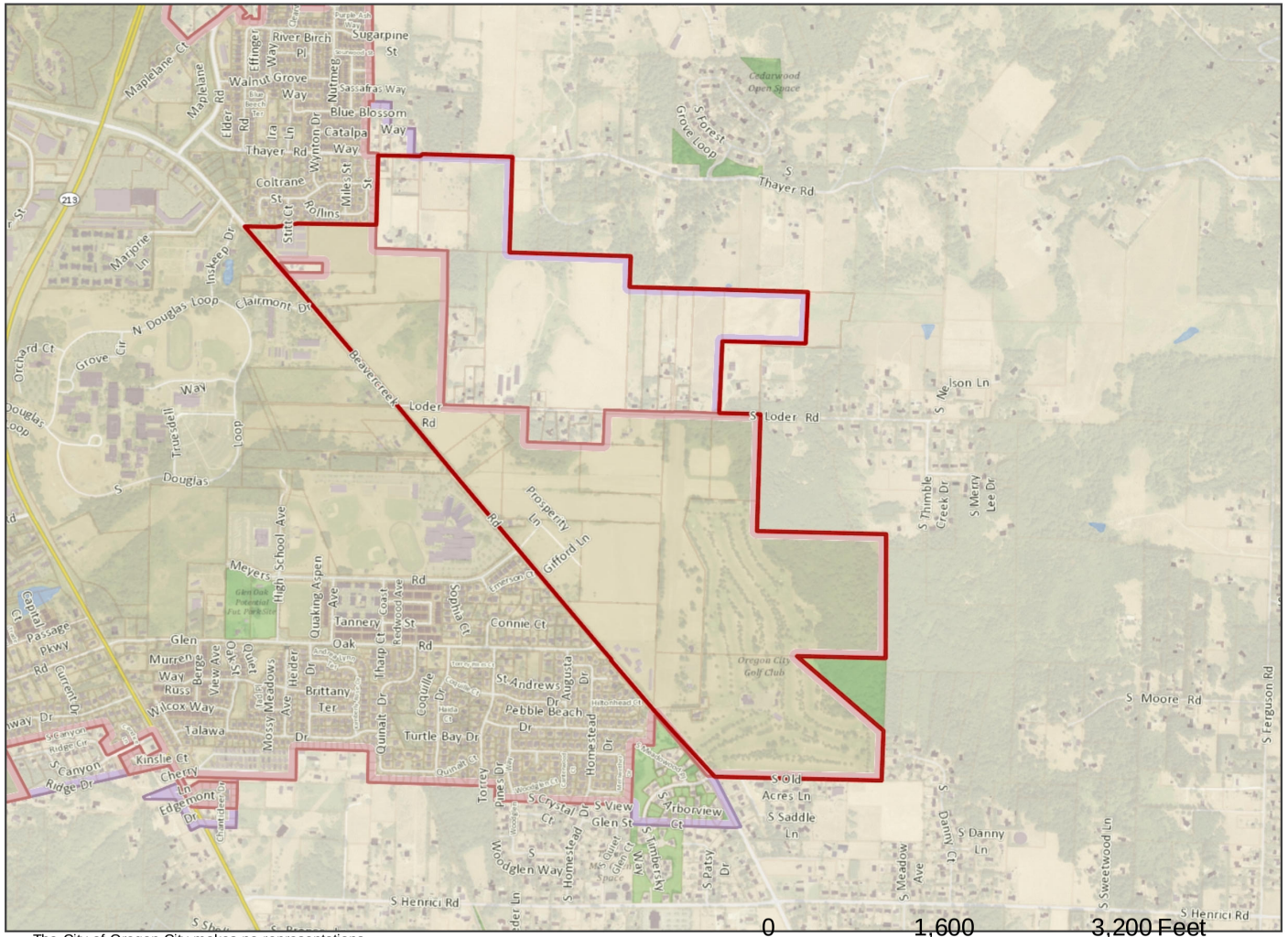
RE: *Beavercreek Road Concept Plan – CRW Comments*

Thank you for this opportunity to provide comments regarding the Beavercreek Road Concept Plan and how Clackamas River Water (CRW) will be affected.

The area of interest (the Area) is located east of Beavercreek Rd, south of Thayer Rd and north of Henrici Rd. The area lies wholly within the Urban Growth Boundary (UGB) and partially within City limits.

Portions of the Area extend into current CRW jurisdictional territory that is served by CRW. Regarding these portions of the Area, CRW provides the following summary comments:

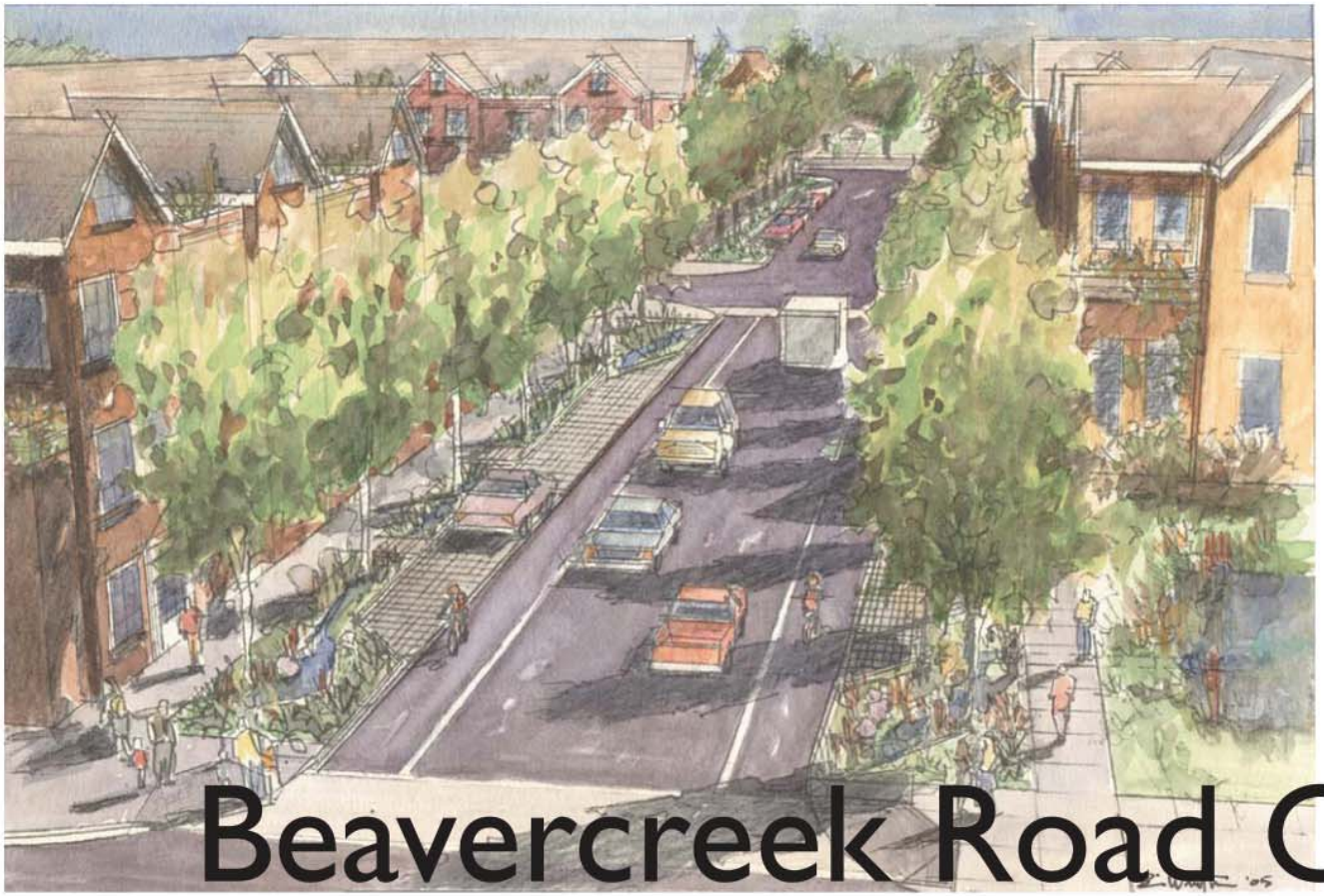
1. Existing CRW customers within the UGB and/or City limits, will remain customers until such time that the City has infrastructure and can provide water service.
2. CRW owns service mains that traverse through the Area to territory outside the UGB. Water mains must remain in service to provide water to customers outside the UGB. CRW is open to discussions regarding alternatives for maintaining service to customers outside the UGB.
3. Territory that is annexed to the City must be withdrawn from CRW and served by Oregon City services to the extent practicable.
4. An Intergovernmental Agreement between CRW and Oregon City, dated October, 13 2016 provides a mechanism to serve CRW water within Oregon City limits, on a limited basis, through a master meter for water sales to Oregon City. The IGA is focused specifically to provide interim water service for the proposed "Villages at Beavercreek" development. This agreement is in force and will be honored.
5. CRW lacks required storage and infrastructure to increase the amount of water sales for additional development over the flow rate designated in the IGA.
6. CRW assumes that future development will, in large part, be guided and coordinated consistent with the concepts provided in the Joint Engineering Study, June 11, 2018, by Murraysmith.



The City of Oregon City makes no representations, express or implied, as to the accuracy, completeness and timeliness of the information displayed. This map is not suitable for legal, engineering, surveying or navigation purposes. Notification of any errors is appreciated.

Map created 6/21/2019

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Beavercreek Road Concept Plan

Envisioning a Complete and Sustainable Community

Concept Plan Report, Summary and Recommendations

Final Plan August 2008





This project is partially funded by a grant from the Transportation and Growth Management (TGM) Program, a joint program of the Oregon Department of Transportation and the Oregon Department of Land Conservation and Development. This TGM grant is financed, in part, by Federal Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU), local government, and State of Oregon funds. The contents of this document do not necessarily reflect views or policies of the State of Oregon.

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Lower, right – illustration by Jim Longstreth

Beavercreek Road Concept Plan

Summary and Recommendations

Final Plan - August 2008

Funding provided by:

City of Oregon City

Oregon Department of Transportation -
Transportation and Growth Management Program

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Environmental Sciences Associates, Inc.

Jeanne Lawson Associates

Kittelson and Associates

Otak Project No. 13599

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Bill Leach	Clackamas Community College
Lynda Orzen	Resident, Caufield Neighborhood
Ron Estes	Resident, Caufield Neighborhood
Rose Holden	Property Owner, Oregon City Golf Course
Ken Allen	Development Interest, Representing Hall family
Richard Mudgett/ Patty Jacobs (alt)	Representing Hall family
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Appendix

1. Project Goals with Objectives, March 13, 2007
2. Concept Plan Alternatives
3. GIS Analysis Map
4. Job and Housing Estimates

Technical Appendix (Under Separate Cover)

A. Public Involvement Plan
B. Goals and Evaluation Criteria
C. Existing Conditions, Opportunities and Constraints Reports
    1. Land use
    2. Transportation
    3. Sustainability
    4. Market
    5. Natural resources
    6. Infrastructure
D. Focus Group Summaries
E. Summaries of Community Events
    1. Open House No. 1
    2. Design Workshop
    3. Open House No. 2
F. Alternatives Evaluation Report
G. Final Transportation Evaluation
H. Infrastructure Reports
    1. Water
    2. Sewer
    3. Storm Water/Water Quality
I. Fiscal Impact Analysis
J. Draft Code

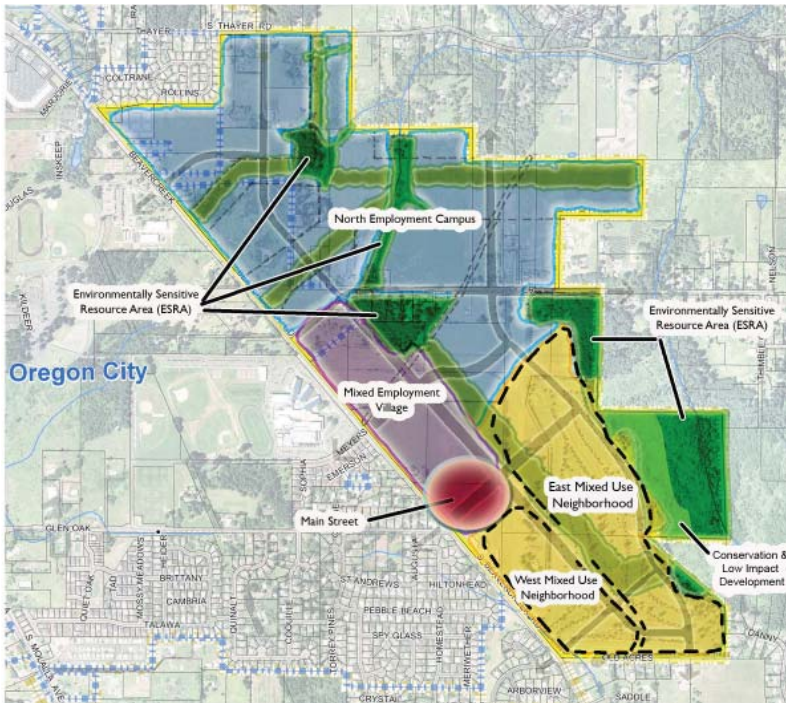
I. Introduction

Summary

The Beavercreek Road Concept Plan is a guide to the creation of a complete and sustainable community in southeast Oregon City. Most of the 453 acre site along Beavercreek Road was added to the regional urban growth boundary by Metro in 2002 and 2004. The plan envisions a diverse mix of uses (an employment campus north of Loder Road, mixed use districts along Beavercreek Road, and two mixed use neighborhoods) all woven together by open space, trails, a network of green streets, and sustainable development practices. Transit-oriented land uses have been strategically located to increase the feasibility of transit service in the future. The plan has been carefully crafted to create a multi-use community that has synergistic relationships with Clackamas Community College, Oregon City High School, and adjacent neighborhoods.

Key features of the Concept Plan are:

- *A complete mix of land uses, including:*
  - A North Employment Campus for tech flex and campus industrial uses, consistent with Metro requirements for industrial and employment areas.
  - A Mixed Employment Village along Beavercreek Road, between Meyers Road and Glen Oak Road, located as a center for transit-oriented densities, mixed use, 3-5 story building scale, and active street life.
  - A 10-acre Main Street area at Beavercreek Road and Glen Oak Road, located to provide local shops and services adjacent neighborhoods and Beavercreek sub-districts.
  - A West Mixed Use Neighborhood along Beavercreek Road, intended for medium to high density (R-2) housing and mixed use.
  - An East Mixed Use Neighborhood, intended for low density residential (R-5) and appropriate mixed use. The East Neighborhood has strong green edges and the potential for a fine grain of open space and walking routes throughout.



Proposed Land Use Sub-districts

- *Policy support for employment and program connections with Clackamas Community College.*
- *Sustainability strategies, including:*
  - Mixed and transit supportive land uses.
  - A sustainable stormwater management plan that supports low impact development, open conveyance systems, regional detention, and adequate sizing to avoid downstream flooding.
  - Green street design for all streets, including the three lane boulevard design for Beavercreek Road.
  - A preliminary recommendation supporting LEED certification or equivalent for all commercial and multi-family buildings, with Earth Advantage or equivalent certification for single family buildings. This recommendation includes establishment of a Green Building Work Group to work collaboratively with the private sector to establish standards.
  - Open spaces and natural areas throughout the plan. North of Loder Road, these include the power line corridors, the tributary to Thimble Creek, and a mature tree grove. South of Loder Road, these include an 18-acre Central Park, the east ridge area, and two scenic view points along the east ridge.
- *A trail framework that traverses all sub-districts and connects to city and regional trails.*
- *A street framework that provides for a logical and connected street pattern, parallel routes to Beavercreek Road, and connections at Clairmont, Meyers, Glen Oak, and the southern entrance to the site.*
- *A draft Beavercreek Road Zone development code to implement the plan.*

Purpose of this Report and Location of Additional Information

This report is a summary of the Plan, with emphasis on describing key elements and recommendations. Many of the recommendation are based on technical reports and other information that is available in the Technical Appendix to this report.



Beavercreek Road Concept Plan Area - Existing Conditions

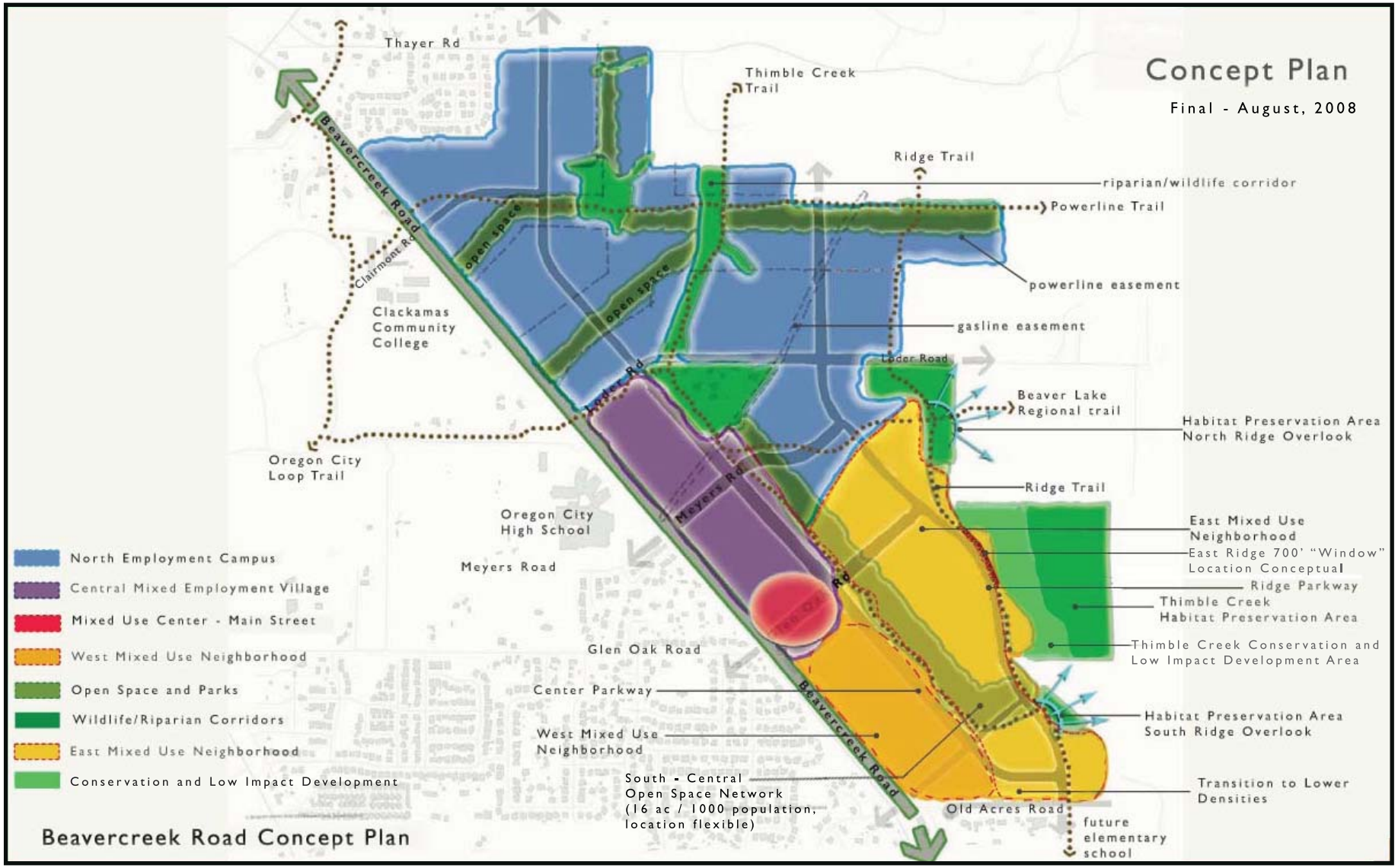


Figure 1 - Composite Concept Plan

II. Purpose and Process

The purpose of the Beavercreek Road Concept Plan is to provide a conceptual master plan to be adopted as an ancillary document to the City of Oregon City's Comprehensive Plan. As such, it provides a comprehensive and cohesive guide to future development, in three parts:

- Framework plan maps, goals and policies – These elements will be adopted as part of the Oregon City Comprehensive Plan. Compliance will be required for all land use permits and development.
- Ancillary report materials – The descriptive text, graphics and technical appendix of this report will be adopted as an "ancillary document" to the Comprehensive Plan, which provides "operational guidance to city departments in planning and carrying out city services" (Oregon City Comprehensive Plan, page 4). These documents include information for updating the City's utility master plans and Transportation System Plan.
- Draft development code – A working draft development code was prepared as part of the Concept Plan. Once final, it will be adopted as part of the Oregon City Code. Compliance will be required for all land use permits and development. The Beavercreek Zone code relies on master planning to implement the concepts in the Plan.

The Concept Plan was developed by a 15-member Citizen Advisory Committee (CAC) and 9-member Technical Advisory Committee (TAC) (see Project Participants list at the beginning of this report). The committees met twelve times between June 2006 and July 2007.



Design Workshop Participants

In addition to the Committee meetings, additional process steps and community involvement included:

- Study area tour for CAC and TAC members
- Two public open houses
- Market focus group
- Sustainability focus group
- Employment lands coordination with Metro
- Community design workshop
- Website
- Project posters, site sign, email notice, and extensive mailing prior to each public event

The major steps in the process were:

- Inventory of base conditions, opportunities, constraints for land use, transportation, natural resources, market conditions, infrastructure and sustainability.
- Establishment of project goals.
- Extensive discussion of employment lands questions: how much, what type and where?
- Following the community workshop, preparation of three alternative concept plans (sketch level), addition of a fourth plan, prepared by a CAC member, and narrowing of the alternatives to two for further analysis.
- Evaluation of the alternatives (including transportation modeling) and preparation of a hybrid Concept Plan (framework level).
- Preparation of detailed plans for water, sewer, storm water, and transportation facilities.
- Preparation of a draft development code.
- Committee action to forward the Concept Plan package to the Planning Commission and City Commission.

For additional information please see Technical Appendix, Sections A, D, E, and F.



Design Workshop Plan

III. Vision, Goals and Principles

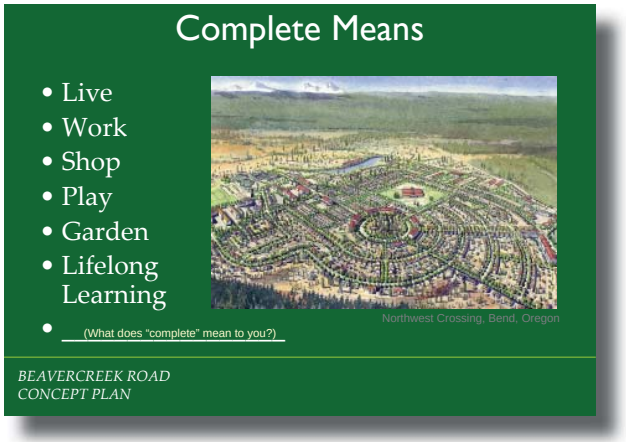
The overall vision for the Beavercreek Concept Plan is to create "A Complete and Sustainable Community". The images shown on this page were displayed throughout the process to convey the project's intent for this vision statement.

Regarding the meaning of sustainability, the vision statement is based in part on the definition of sustainability originally developed by the United Nations Brandtland Commission: "A sustainable society meets the needs of the present without sacrificing the ability of future generations to meet their own needs".

The following project goals were developed by the Citizen Advisory Committee. The Committee also added objectives to each of the goals – please see Appendix 1 for the objectives.

The Beavercreek Road Concept Plan Area will:

- Create a complete and sustainable community, in conjunction with the adjacent land uses, that integrates a diverse mix of uses, including housing, services, and public spaces that are necessary to support a thriving employment center;
- Be a model of sustainable design, development practices, planning, and innovative thinking;
- Attract "green" jobs that pay a living wage;
- Maximize opportunities for sustainable industries that serve markets beyond the Portland region and are compatible with the site's unique characteristics;
- Incorporate the area's natural beauty into an ecologically compatible built environment;
- Provide multi-modal transportation links (such as bus routes, trails, bike-ways, etc.) that are connected within the site as well as to the surrounding areas;



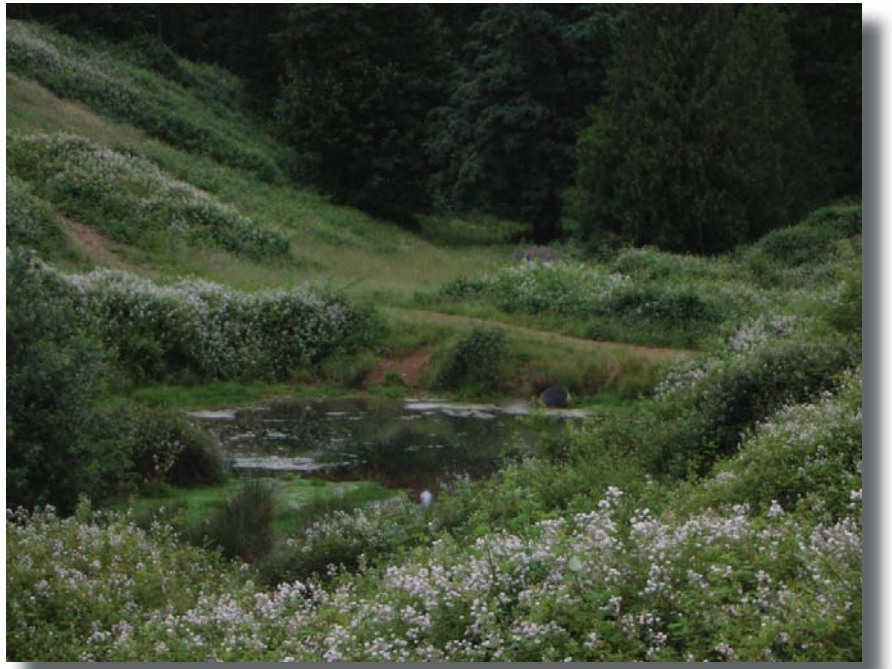




- Implement design solutions along Beavercreek Road that promote pedestrian safety, control traffic speeds and access, and accommodate projected vehicular demand;
- Promote connections and relationships with Oregon City High School and Clackamas Community College;
- Have a unique sense of place created by the mix of uses, human scale design, and commitment to sustainability; and
- Ecological Health – Manage water resources on site to eliminate pollution to watersheds and lesson impact on municipal infrastructure by integrating ecological and man-made systems to maximize function, efficiency and health.

The following 10 Principles of Sustainable Community Design were submitted by a CAC member, supported by the committee, and used throughout the development of the Concept Plan:

1. Mix Land Uses - Promote a mix of land uses that support living wage jobs and a variety of services.
2. Housing Types - Create a range of housing choices for all ages and incomes.
3. Walk-ability - Make the Neighborhood "walkable" and make services "walk-to-able."
4. Transportation - Provide a range of transportation options using a connected network of streets and paths.
5. Open Space - Protect and maintain a functioning green space network for a variety of uses.
6. Integrate Systems - Integrate ecological and man-made systems to maximize function, efficiency and health.
7. Watershed Health - Manage water resources on site to eliminate pollution to watershed and lesson impact on municipal infrastructures.
8. Reuse, Recycle, Regenerate - Reuse existing resources, regenerate existing development areas
9. Green Buildings - Build compact, innovative structures that use less energy and materials
10. Work Together - Work with community members and neighbors to design and develop.



Thimble Creek Tributary

gional and Local Context

ercreek Road Concept Plan area is 453 acres of land located
theast edge of Oregon City and the Urban Growth Boundary
marks a transition point between the City's current edge of
on and rural and resource lands to the south and east.

ity of the site (245 acres) was added to the Metro UGB in
2002 and an additional 63 acres were added to the UGB in
remaining site acreage was in the UGB and/or the Oregon
prior to 2002. The Concept Plan area carries Metro design type
ns of Employment, Industrial, and Outer Neighborhood on
n 2040 Growth Concept Map. The properties with the Outer
hood designation have been in the UGB since 1980. Employment
e areas, as defined by Metro, allow various types of employment
residential development and limited commercial uses. Industrial
e areas are set aside by Metro primarily for industrial activities
ed supporting uses.

e update of Oregon City's Comprehensive Plan, a policy was
cknowledging the jobs-related importance of the site to Oregon
he region, while also allowing some flexibility in the project area's
Comprehensive Plan policy 2.6.8 states:

ands east of Clackamas Community College that are designated
Urban Holding to be the subject of concept plans, which is
as an amendment to the Comprehensive Plan, would guide
signations. The majority of these lands should be designated in
that encourages family-wage jobs in order to generate new jobs
towards meeting the City's employment goals."

There are relatively limited employment centers within this area of Oregon City and Clackamas County. This imbalance of jobs and hous contributes to Clackamas County's pattern of approximately 60% of t work force traveling outside of the County to work.

The site is surrounded by residential and undeveloped properties with the city limits, including the Hamlet of Beavercreek, and rural Clacka County. The nearest commercial area is the Berry Hill Shopping Cente the intersection of Beavercreek Road and Highway 213. Clackamas Co College (CCC) and Oregon City High School are across Beavercreek R adjacent to the site. These institutional uses offer a unique opportunity plan synergistic land uses that connect the properties, reinforce an ide for the area, and help localize trips. A Tri-Met transit hub is located on CCC property.

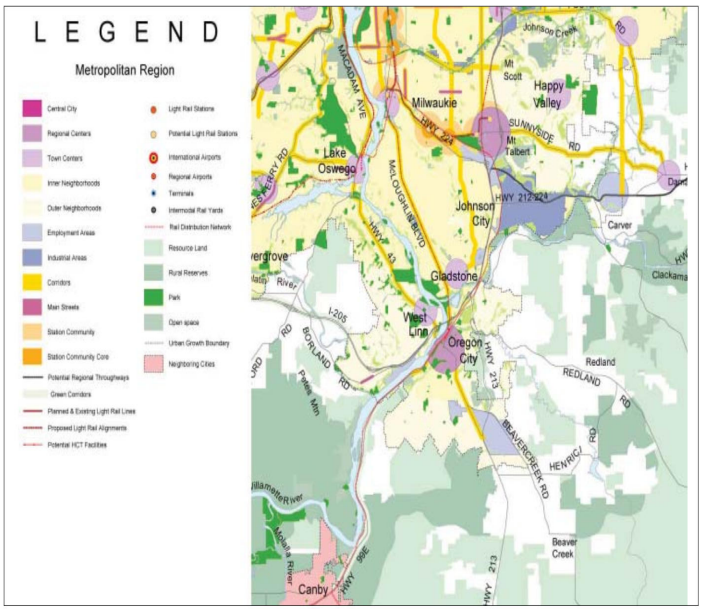


Figure 2 - Regional C

Like all additions to the Portland Metropolitan Area Urban Growth Boundary, the Beavercreek Road area is inextricably tied to it's place in the region and its place within Oregon City. The Concept Plan responds to this context in multiple ways.

From a regional perspective, the Beavercreek Road area is currently a transition point from urban to rural use. Whether this "hard line" of transition will remain in the future cannot be established with certainty. The CAC openly acknowledged this issue in its discussions and sought to balance the needs of creating a great urban addition to Oregon City with sensitivity to adjacent areas. Examples of this balance include:

- The plan has land use and transportation connections that support future transit. This will link the Beavercreek Road area, via alternative transportations, to Clackamas Community College (CCC), the Oregon City Regional Center (downtown and adjacent areas) and the rest of the region.
- Trails and green spaces have been crafted to link into the broader regional network.
- The plan recommends lower densities and buffer treatments along Old Acres Road.
- The north south collector roads are coalesced to one route that could (if needed) be extended south of Old Acres Road.
- The recommended street framework provides for a street that parallels Beavercreek Road, connecting Thayer Road to Old Acres Road, and potentially north and south in the future. This keeps options open: if the UGB extends south, the beginning of a street network is in place. If it does not, the connection is available for rural to urban connectivity if desired.
- As with the street network described above, the East Ridge trail is extended all the way to Old Acres Road, and therefore, potentially beyond.

This will provide a connection from rural areas to the open spaces and trail network of Beavercreek Road area and the rest of the region.

From a City and local neighborhood perspective, the Beavercreek Road area offers an opportunity to establish a new complete and sustainable community within Oregon City. Specific linkages include the following:

- Oregon City needs employment land. The Beavercreek Concept Plan provides 156 net acres of it in two forms: 127 net acres of tech flex campus industrial land, 29 acres of more vertical mixed use village and main street. Additional employment will be available on the Main Street and as mixed use in the two southern neighborhoods.
- The street framework connects to all of the logical adjacent streets. This includes Thayer, Clairmont, Meyers, Glen Oak, and Old Acres Roads. This connectivity will disperse traffic to many routes, but equally important, make Beavercreek Road connected to, rather than isolated from, adjacent neighborhoods, districts and corridors.
- The plan provides for a complete community: jobs, varied housing, open space, trails, mixed use, focal points of activity, trails, and access to nature.
- The plan provides for a sustainable community, in line with the City's

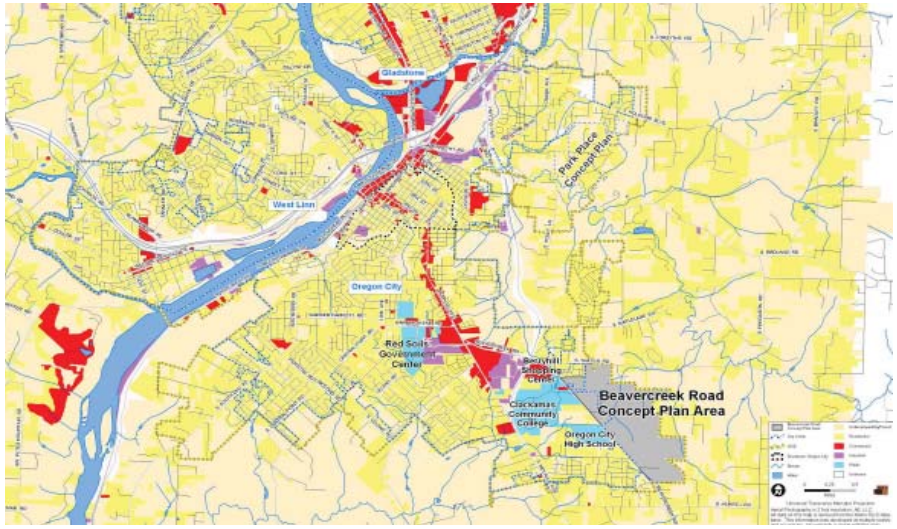


Figure 3 - Oregon City Context

Comprehensive Plan support for sustainability. This takes the form of mixed land uses, transportation options, green streets, sustainable storm water systems, and LEED or equivalent certification for buildings. Much more can certainly be done – the Concept Plan offers an initial platform to work from.

- Physical linkages have been provided to Oregon City High School and Clackamas Community College. These take the form of the planned 3-lane green street design for Beavercreek Road and the intersections and trails at Clairmont, Loder and Meyers Roads. The physical linkages are only the beginning – the City, School District and College need to work together to promote land uses on the east side of Beavercreek Road that truly create an institutional connection.

For additional information, see Existing Conditions, Opportunities and Constraints Reports, Technical Appendix C.

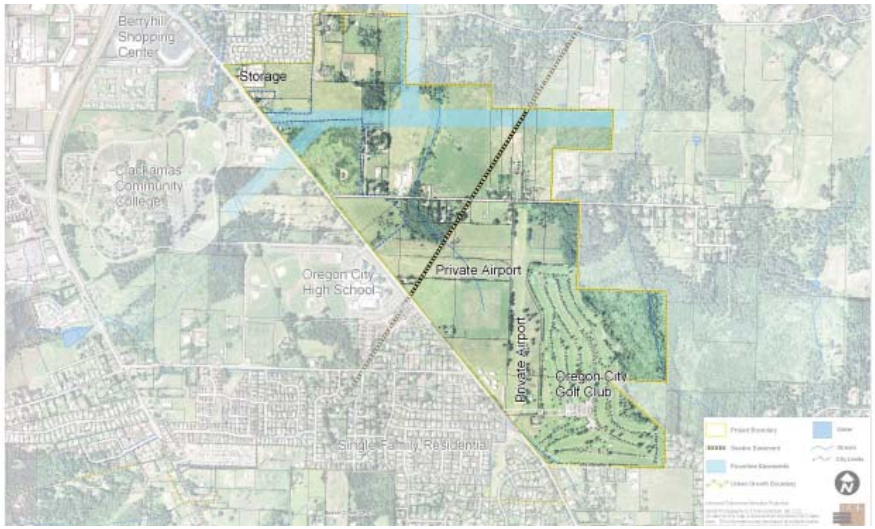


Figure 4 - Existing Conditions

Site Conditions and Buildable Lands

A portion of the study area (approximately 50 acres) is currently within the existing city limits and zoned Campus Industrial (CI). The study area's northern boundary is Thayer Road and the southern boundary is Old Acres Lane. Loder Road is the only existing road that runs through the project area.

Currently, the project area is largely undeveloped, which has allowed the site to retain its natural beauty. There are 448 gross acres in the project area, not including the right-of-way for Loder Road (approximately five acres). The existing land uses are primarily large-lot residential with agricultural and undeveloped rural lands occupying approximately 226 acres of the project area. The Oregon City Golf Club (OCGC) and private airport occupy the remaining 222 acres.

There are several large power line and natural gas utility easements within the project boundaries. These major utility easements crisscross the northern and central areas of the site. The utility easements comprise approximately 97 acres or 20% of the project area.

There are 51 total properties ranging in size from 0.25 acres to 63.2 acres. Many of these properties are under single ownership, resulting in only 42 unique property owner names (Source: Clackamas County Assessor). There are several existing homes and many of the properties have outbuildings such as, sheds, greenhouses, barns, etc. , which result in 127 existing structures on the site (Source: Clackamas County Assessor).

A key step in the concept planning process is the development of a Buildable Lands Map. The Buildable Lands Map was the base map from which the concept plan alternatives and the final recommended plan were. "Buildable" lands, for the purpose of the Beavercreek Road Concept Plan, are defined as the gross site area minus wetlands, steep slopes, other Goal 5 resources, public utility easements, road rights-of-way, and committed properties (developed properties with an assessed improvement value

greater than $350,000). Properties with an assessed improvement value of less than$350,000 (based on County assessment data) are considered redevelopable over the long-term as the existing structures are converted to higher value uses. The OCGC has an improvement value over $350,000, but has been included as buildable lands (minus the clubhouse) because the owners may wish to redevelop the property in coordination with the recommended concept plan over time. The private airport has also been included as buildable over the long-term, recognizing that the owners may choose to continue the airport's use for many years.

When land for power lines, the natural gas line, natural resources, and committed structures are removed the net draft buildable acreage is approximately 292 acres. The CAC reviewed the Preliminary Buildable Lands map and approved a three-tier system to define the buildable lands. Tier A or "Unconstrained" has approximately 292 acres, Tier B or "Low Impact Development Allowed with Review" has approximately 28 acres, and Tier C "Constrained" has approximately 131 acres. The "Low Impact" area was later further evaluated and recommended for conservation under a Environmentally Sensitive and Resource Area designation on the plan.

The Buildable Lands Map was reviewed at the July 20th and August 17th Citizen and Technical Advisory Committee (CAC/TAC) meetings, as well as at the August 24th, 2006 Open House. The draft buildable land boundaries and acreages shown in Figure 6 reflect the input received from the advisory committee members, property owners, and citizen input.

For additional information, see Existing Conditions, Opportunities and Constraints Reports, Technical Appendix C.

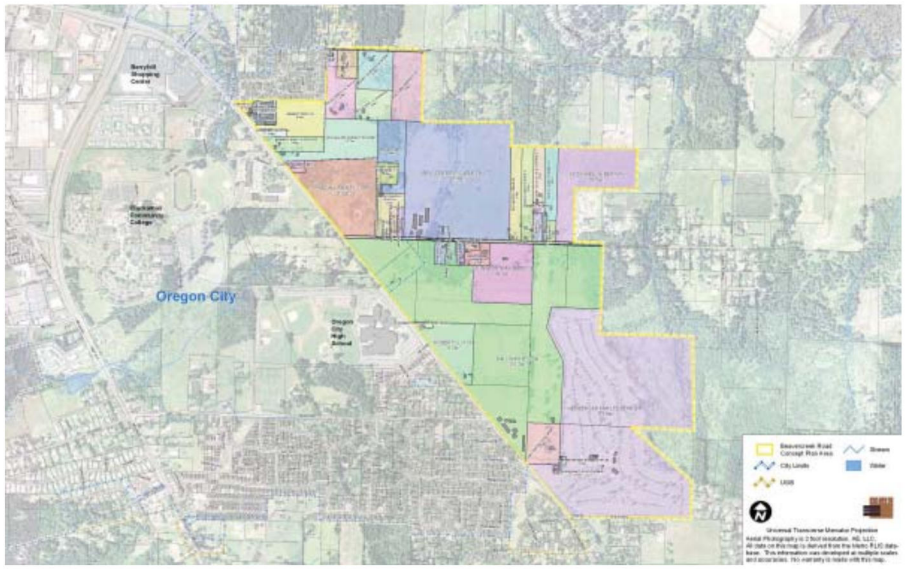


Figure 5 - Ownerships

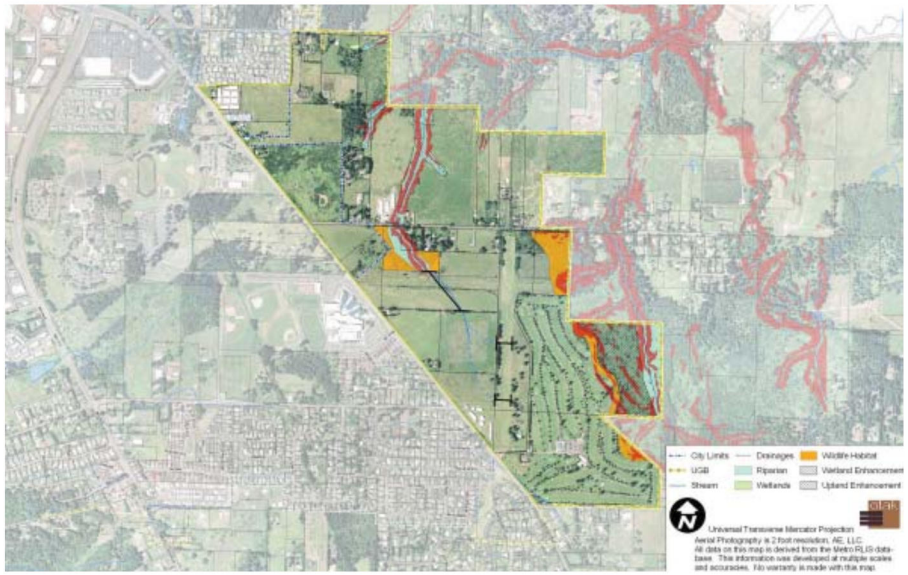


Figure 6 - Natural Resource Inventory

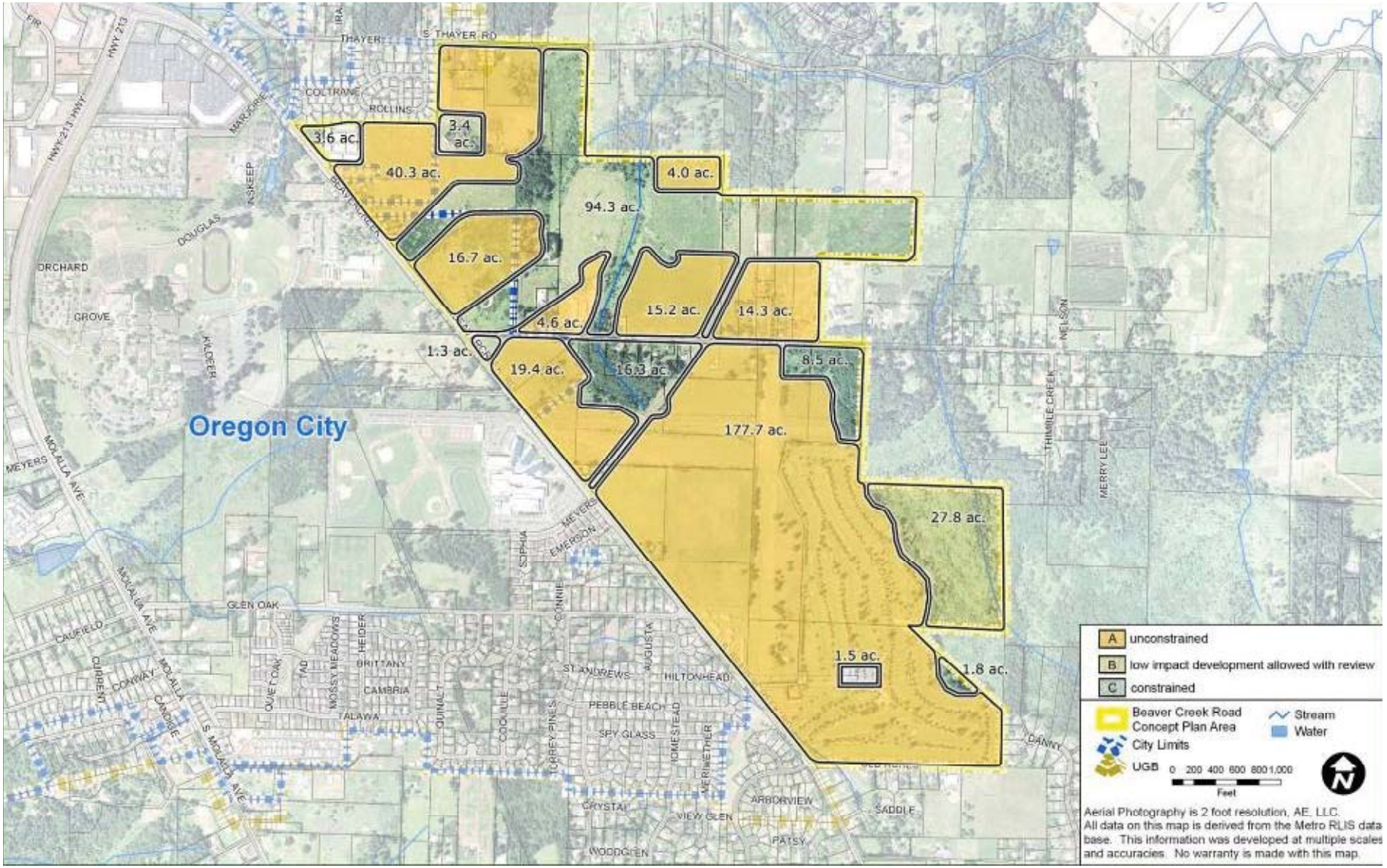


Figure 7 - Buildable Lands

Employment – A Key Issue

How much employment? What type? And where? These questions were extensively discussed during the development of the Concept Plan. Three perspectives emerged as part of the discussion:

Oregon City Perspective

Prior to initiating the Concept Plan process, the City adopted a comprehensive plan policy which emphasizes family wage employment on the site. The policy reads: "Require lands east of Clackamas Community College that are designated as Future Urban Holding to be the subject of concept plans, which is approved as an amendment to the Comprehensive Plan, [and will] guide zoning designations. The majority of these lands should be designated in a manner that encourages family-wage jobs in order to generate new jobs and move towards meeting the City's employment goals." Oregon City Comprehensive Plan, Policy 2.6.8.

Metro Perspective

Metro brought the majority of the concept plan area (245 gross acres) into the UGB in 2002 and 2004 to fulfill regional industrial employment needs. These areas (308 gross acres) are designated as the Industrial Design Type on Metro's 2040 Growth Concept Map. As part of its land need metrics reported to the region and state, Metro estimated 120 net acres of the Beavercreek Road Concept Plan's land would be used for employment uses. Metro representatives met with the Concept Plan CAC and emphasized: (1) it was important to Metro for the Concept Plan to fulfill their original intent for providing Industrial land; and, (2) that there was flexibility, from Metro's perspective, for the local process to evaluate creative ways to meet that intent.

Citizen Advisory Committee Perspective

The CAC discussed extensively the issues and options for employment lands. Many sources of information were consulted: a market analysis by ECONorthwest (See Appendix __), a developer focus group, land inventory and expert testimony submitted by property owners, the Metro perspective cited above, and concerns of neighbors. The advice ranged from qualified optimism about long term employment growth to strong opposition based on shorter term market factors and location considerations. Some members of the CAC advocated for a jobs target (as opposed to an acreage target) to be the basis for employment planning.

At it's meeting on September 14th, 2006, the CAC developed a set of "bookends" for the project team to use while creating the plan alternatives.

a. At least one plan alternative will be consistent with the Metro Regional Growth Concept.

b. At least one plan alternative (may be the same as above) would be designed consistent with Policy 2.6.8.

c. Other alternatives would have the freedom to vary from "a" and "b" above, but would also include employment.

d. No alternative would have heavy industrial, regional warehousing or similar employment uses".

After evaluating alternatives, the CAC ultimately chose a hybrid employment strategy. The recommended Concept Plan includes: (1) about 127 net acres of land as North Employment Campus, which is consistent with Metro's intent and similar to Oregon City's Campus Industrial designation; (2) about 29 acres as Mixed Employment Village and Main Street, which allows a variety of uses in a village-oriented transit hub; and, (3) mixed use neighborhoods to the south that also provide for jobs tailored to their neighborhood setting.

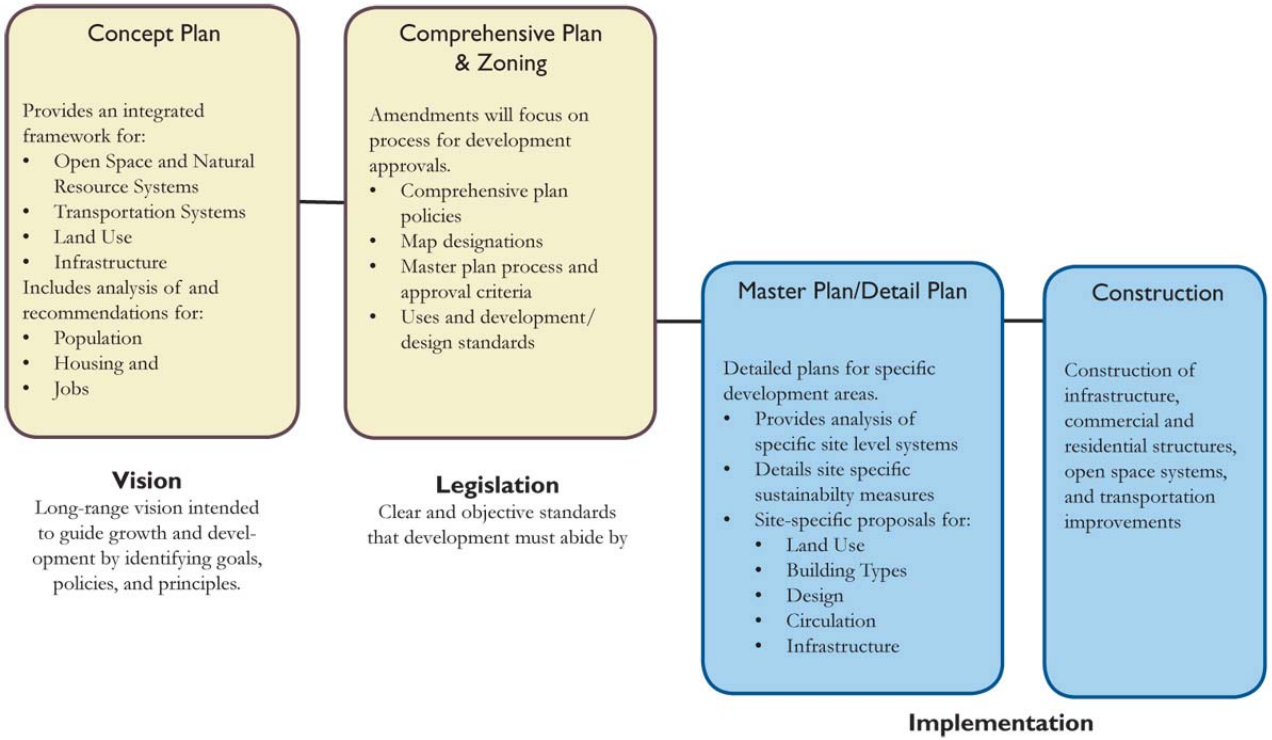
V. Concept Plan Summary

The Framework Plan Approach

The Beavercreek Road Concept Plan is a framework for a new, urban community. The plan is comprised of generalized maps and policies that integrate land use, transportation, open space, and green infrastructure. The framework maps and policies are supported by detailed code and requirements for master planning and design review. The approach here is to set the broad framework and intent on the figures and text in this Plan. Detailed development plans demonstrating compliance with the Concept Plan are required in the implementing code.

The framework plan approach is intended to:

- Ensure the vision, goals and standards are requirements in all land use decisions
- Provide for flexibility in site specific design and implementation of the Plan and code
- Allow for phased development over a long period of time (20+ years)



The code describes many detailed requirements such as street connectivity, block configuration, pocket parks, building scale, pedestrian connections, low impact development features, tree preservation, and sustainable buildings. These design elements will be essential to the success of the area as a walkable, mixed use community. The expectation of this Plan is that the flexibility is coupled with a high standard for sustainable and pedestrian-oriented design.

Land Use Sub-Districts

Figure 8 illustrates the five land-use "sub-districts" of the concept plan area. Each has a specific focus of land use and intended relationship to its setting and the plan's transportation and open space systems. Each is briefly described below and illustrated on Figures 9 through 12.

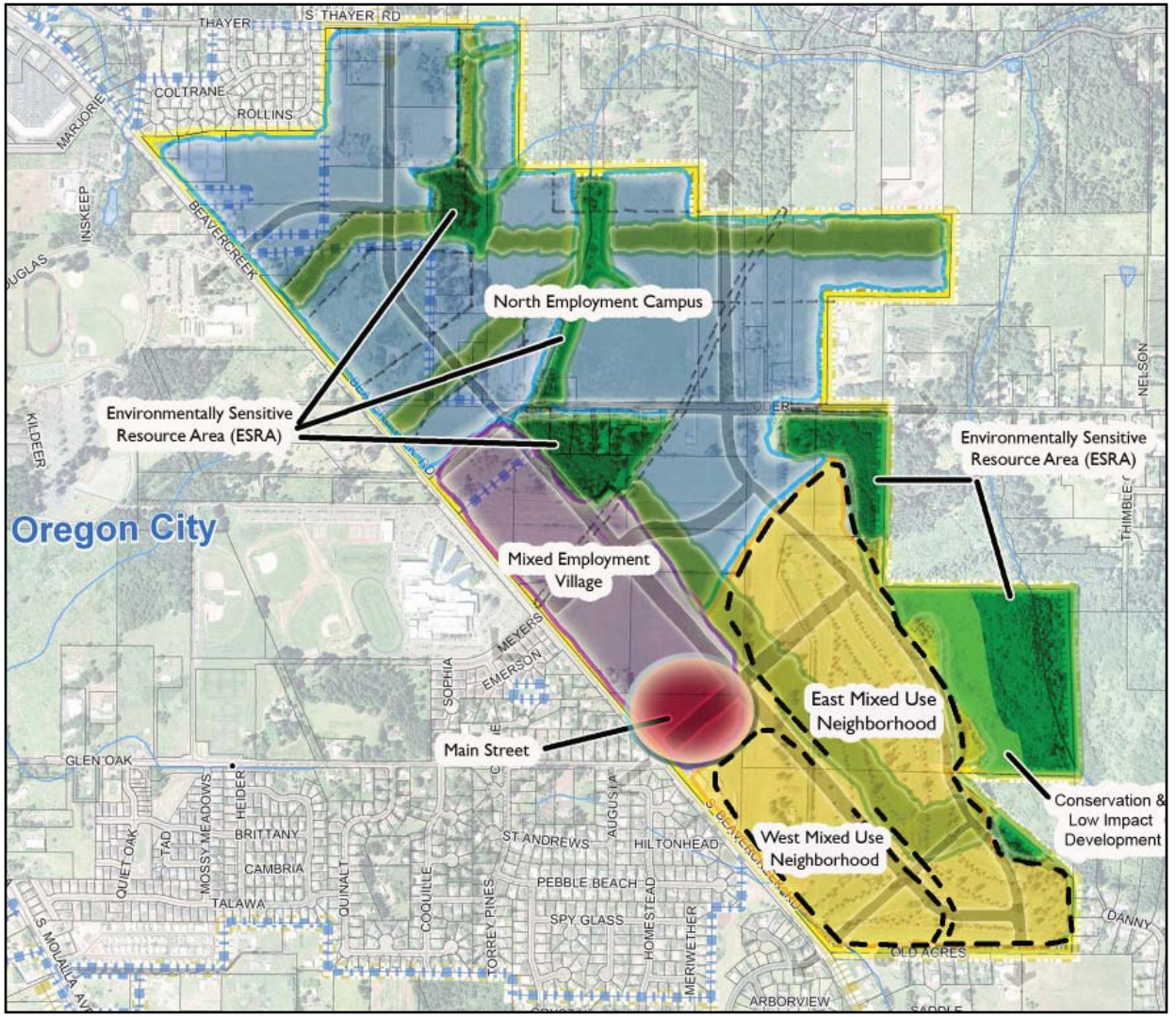


Figure 8 - Land Use Sub-districts

North Employment Campus – NEC

The purpose of the North Employment Campus is to provide for the location of family wage employment that strengthens and diversifies the economy. The NEC allows a mix of clean industries, offices serving industrial needs, light industrial uses, research and development and large corporate headquarters. The uses permitted are intended to improve the region's economic climate, promote sustainable and traded sector businesses, and protect the supply of sites for employment by limiting incompatible uses. The sub-district is intended to comply with Metro's Title 4 regulations. Site and building design will create pedestrian-friendly areas and utilize cost effective green development practices. Business and program connections to Clackamas Community College (CCC) are encouraged to help establish a positive identity for the area and support synergistic activity between CCC and NEC properties. Businesses making sustainable products and utilizing sustainable materials and practices are encouraged to reinforce the identity of the area and promote the overall vision for the Beavercreek Road area.

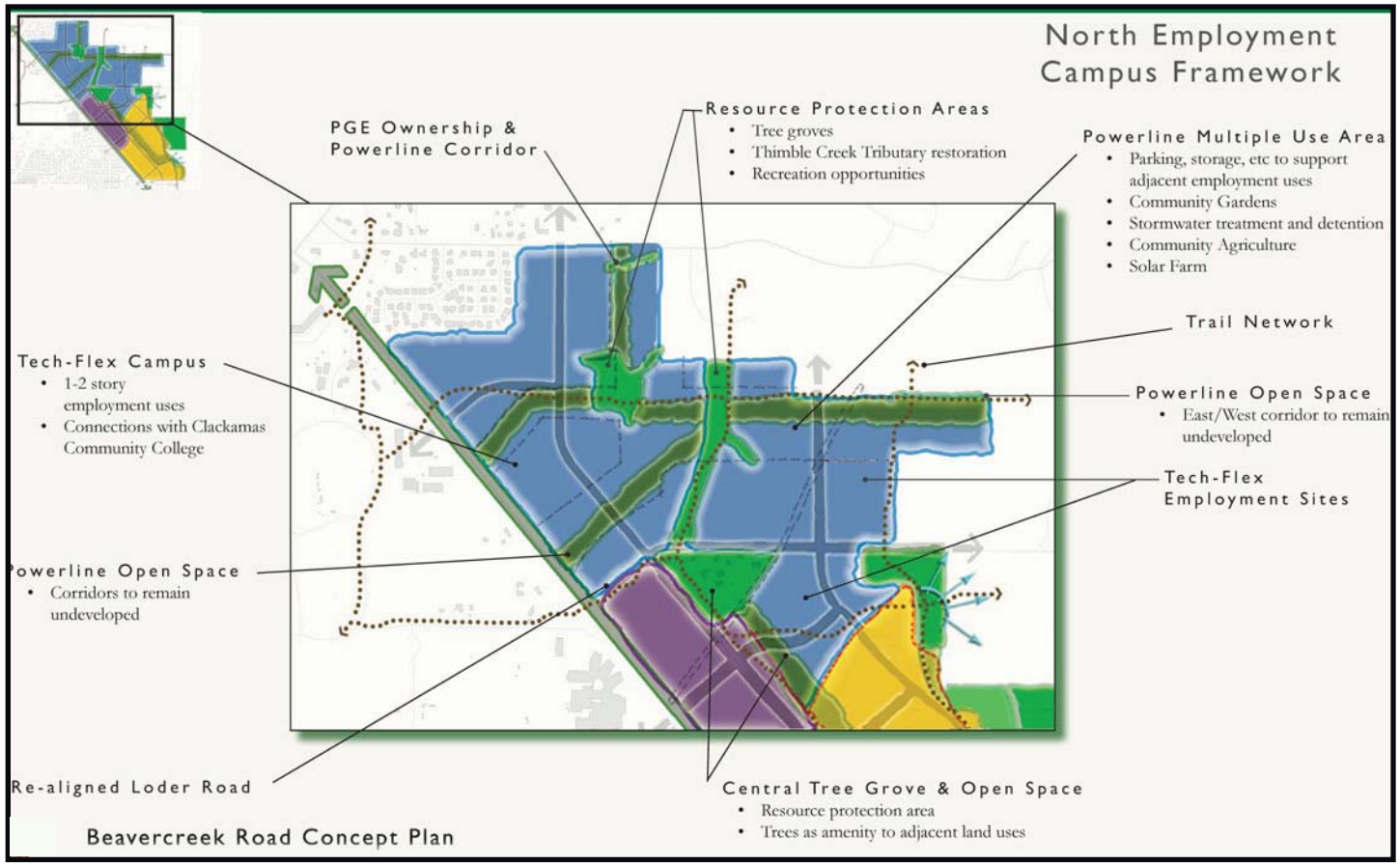


Figure 9 - North Employment Campus Framework

Mixed Employment Village – MEV

The purpose of the Mixed Employment Village is to provide employment opportunities in an urban, pedestrian friendly, and mixed use setting. The MEV is intended to be transit supportive in its use mix, density, and design so that transit remains an attractive and feasible option. The MEV allows a mix of retail, office, civic and residential uses that make up an active urban district and serve the daily needs of adjacent neighborhoods and Beavercreek Road sub-districts. Site and building design will create pedestrian-friendly areas and utilize cost effective green development practices. Business and program connections to Clackamas Community College and Oregon City High School are encouraged. Businesses making sustainable products and utilizing sustainable materials and practices are encouraged to reinforce the identity of the area and promote the overall vision for the Beavercreek Road area.

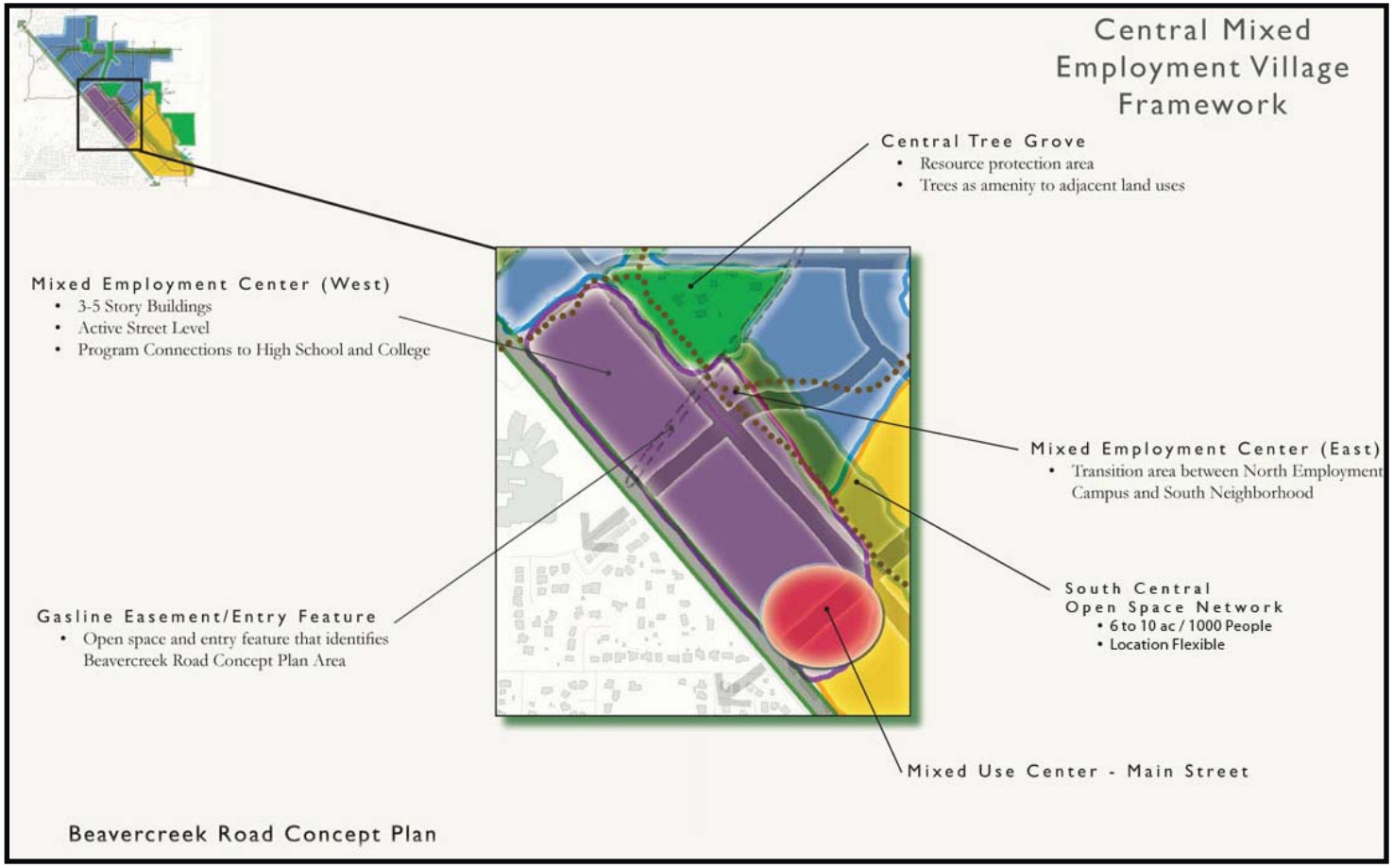


Figure 10 - Central Mixed Employment Village Framework

Main Street – MS

The purpose of this small mixed-use center is to provide a focal point of pedestrian activity. The MS allows small scale commercial, mixed use and services that serve the daily needs of the surrounding area. "Main Street" design will include buildings oriented to the street, an minimum of 2 story building scale, attractive streetscape, active ground floor uses and other elements that reinforce pedestrian oriented character and vitality of the area.



Figure 11 - Main Street Framework

West Mixed Use Neighborhood – WMU

The West Mixed Use Neighborhood will be a walkable, transit-oriented neighborhood. This area allows a transit supportive mix of housing, live/work units, mixed use buildings and limited commercial uses. A variety of housing and building forms is required, with the overall average of residential uses not exceeding 22 dwelling units per acre. The WMU area's uses, density and design will support the multi-modal transportation system and provide good access for pedestrians, bicycles, transit and vehicles. Site and building design will create a walkable area and utilize cost effective green development practices.

East Mixed Use Neighborhood – EMU

The East Mixed Use Neighborhood will be a walkable and tree-lined neighborhood with a variety of housing types. The EMU allows for a variety of housing types while maintaining a low density residential average not exceeding densities permitted in the R-5 zone. Limited non-residential uses are permitted to encourage a unique identity, sustainable community, and in-home work options. The neighborhood's design will celebrate open space, trees, and relationships to public open spaces. The central open space, ridge open space scenic viewpoints, and a linked system of open spaces and trails are key features of the EMU. Residential developments will provide housing for a range of income levels, sustainable building design, and green development practices.

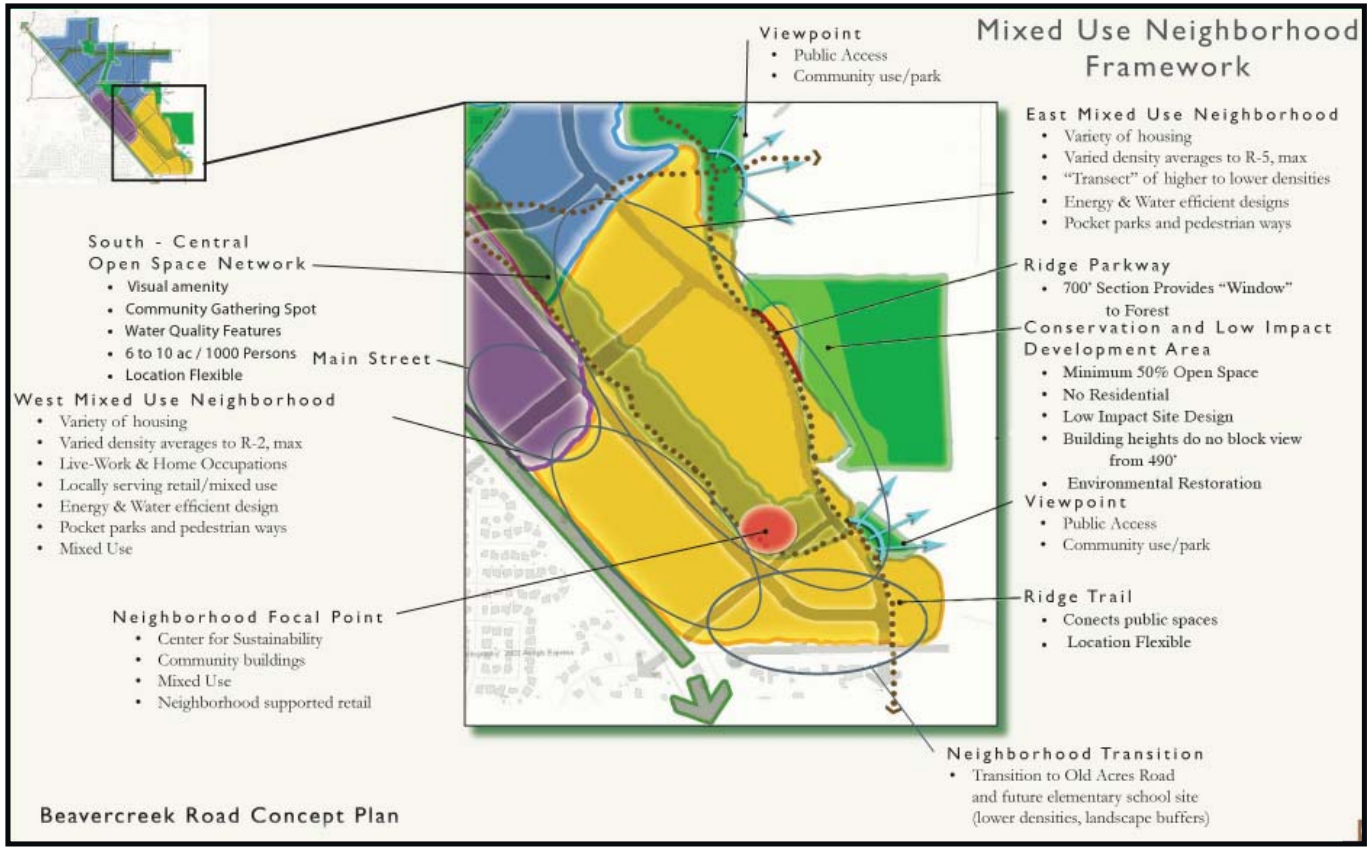


Figure 12 - West and East Mixed Use Neighborhoods

Open Space

The Open Space Framework illustrated on Figure 13 provides a network of green spaces intended to provide:

- A connected system of parks, open spaces and natural areas that link together and link to the Environmentally Sensitive Resource Areas.
- Scenic and open space amenities and community gathering places
- Access to nature
- Tree and natural area preservation
- Locations where storm water and water quality facilities can be combined with open space amenities, and opportunities to implement sustainable development and infrastructure
- Green spaces near the system of trails and pedestrian connections
- Open spaces which complement buildings and the urban, built environment

Power Line Open Spaces

The power line corridors and gas line corridor comprise 97 acres of land. The power line corridors north of Loder Road are a dominant feature. They are a dominant feature because they define open corridors and have a significant visual impact related to the towers. They also have a influence on the pattern of land use and transportation connections. In response to these conditions, the Concept Plan includes four main strategies for the use of the power line corridors:

- Provide publicly accessible open spaces. The implementing code includes a minimum 100 foot-wide open space and public access easement would be required at the time of development reviews, or, obtained through cooperative agreements with the utilities and property owners.
- Provide trails. A new east-west trail is shown on Figure 13 that follows the main east-west corridor. This corridor has outstanding views of Mt. Hood.
- Allow a broad array of uses. Ideas generated by the CAC, and permitted by the code, include: community gardens, urban agriculture, environmental science uses by CCC, storage and other "non-building" uses by adjacent industries, storm water and water quality features, plant nurseries, and solar farms.
- Link to the broader open space network. The power line corridors are linked to the open spaces and trail network in the central and southern areas of the plan.

South-Central Open Space Network

Park spaces in the central and southern areas of the plan will be important to the livability and sustainability goals for the plan. The basic concept is to assure parks are provided, provide certainty for the total park acreage, guide park planning to integrate with other elements, and provide flexibility for the design and distribution of parks.

The following provisions will apply during master planning and other land use reviews:

- Park space will be provided consistent with the City's Park and Recreation Master Plan standard of 6 to 10 acres per 1000 population.
- The required acreage may be proposed to be distributed to a multiple park spaces, consistent with proposed land uses and master plan design.
- A central park will be provided. The location and linearity of the park was first indicated by Metro's Goal 5 mapping. It was illustrated by several citizen groups during the design workshop held in October, 2006. This open space feature is intended as a connected, continuous and central green space that links the districts and neighborhoods south of Loder Road. The code provides for flexibility in its width and shape, provided there remains a clearly identifiable and continuous open space. It may be designed as a series of smaller spaces that are clearly connected by open space. It may be designed

as a series of smaller spaces that are clearly connected by open space. If buildings are incorporated as part of the central park, they must include primary uses which are open to the public. Civic buildings are encouraged adjacent to the central park. Streets may cross the park as needed. The park is an opportunity to locate and design low impact storm water facilities as an amenity for adjacent urban uses.

East Ridge

The East Ridge is a beautiful edge to the site that should be planned as a publicly accessible amenity and protected resource area. The natural resource inventory identified important resources and opportunities for habitat restoration in the riparian areas of Thimble Creek. In addition, Lidar mapping and slope analysis identified steeper slopes (greater than 15%) that are more difficult to develop than adjacent flat areas of the concept plan. The sanitary sewer analysis noted that lower areas on the east

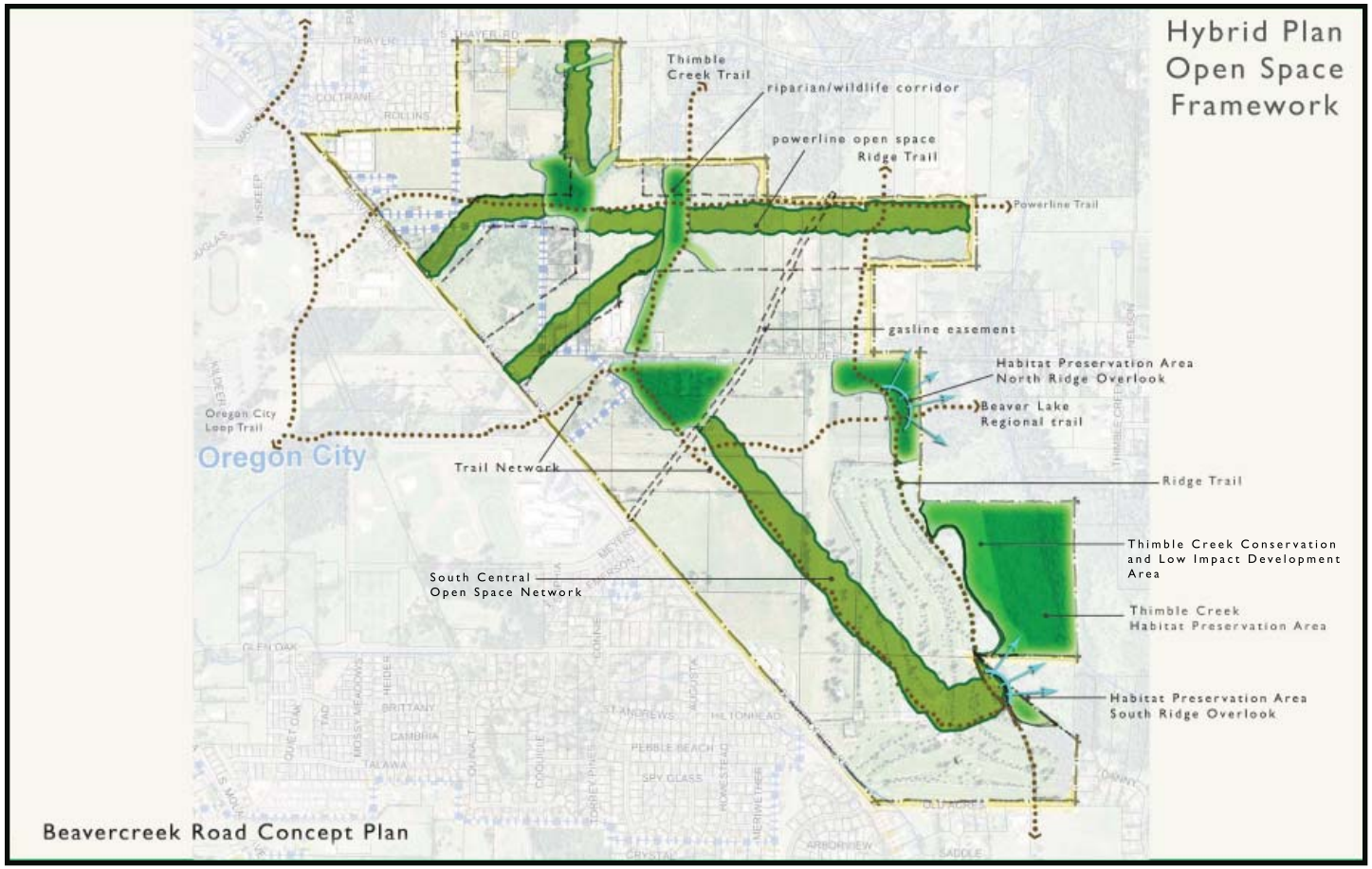


Figure 13 - Open Space Framework

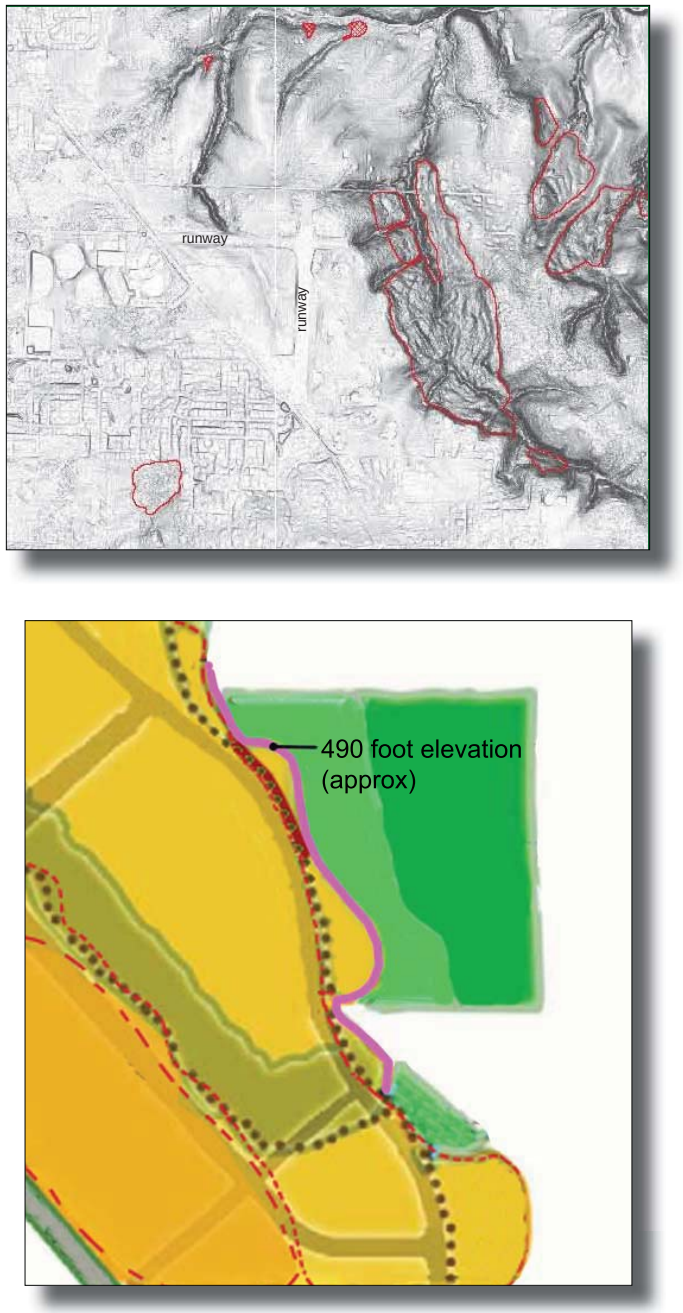


Figure 13A - East Ridge Lidar and 490 foot elevation

ridge could not be readily served with gravity systems - they would require private pump facilities. For all of these reasons, it is recommended here that an East Ridge open space and conservation area be designated.

The plan and code call for:

- Establishing the Class I and II Riparian area (per Metro mapping) plus 200 feet as a protected open space area. No development is permitted, except for very limited uses such as trails.
- Between the west edge of the above referenced protected open space area and the 490 foot elevation (MSL), establish a conservation area within which the following provisions apply:

  a. A minimum of 50% of the conservation area must be open space. No residential uses are permitted.

  b. All development must be low impact with respect to grading, site design, storm water management, energy management, and habitat.

  c. Building heights must not obscure views from the 490 foot elevation of the ridge.

  d. Open space areas must be environmentally improved and restored.

- Establishing a limit of development that demarks the clear edge of urban uses and a "window" to adjacent natural areas. In the central area of the est ridge, the "window" must be a minimum of 700 feet of continuous area and publicly accessible. The specific location of the "window" is flexible and will be establishing as part of a master plan.
- Creating two scenic view points that are small public parks, located north and south of the central area.
- Creating an East Ridge Trail - the location of the trail is flexible and will be established during master planning. It will be located so as to be safe, visible, and connect the public areas along the ridge. Along the "window" area described above, it will be coordinated with the location of the adjacent East Ridge Parkway.

Transportation

In summary, the key elements of the Concept Plan transportation strategy are to:

- Plan a mixed use community that provides viable options for internal trip making (i.e. many daily needs provided on-site), transit use, maximized walking and biking, and re-routed trips within the Oregon City area.
- Improve Beavercreek Road as a green street boulevard.
- Create a framework of collector streets that serve the Beavercreek Road Concept Plan area.
- Require local street and pedestrian way connectivity.
- Require a multimodal network of facilities that connect the Beavercreek Road Concept Plan area with adjacent areas and surrounding transportation facilities.
- Provide an interconnected street system of trails and bikeways.
- Provide transit-attractive destinations.
- Provide a logical network of roadways that support the extension of transit services into the Beavercreek Road Concept Plan area.
- Use green street designs throughout the plan.
- Update the Oregon City Transportation System Plan to include the projects identified in the Beavercreek Road Concept Plan, provide necessary off-site improvements, and, assure continued compliance with Oregon's Transportation Planning Rule.

Streets

Figure 14 illustrates the street plan. Highlights of the plan include:

- *Beavercreek as a green boulevard.* The cross-section will be a 5 lane arterial to Clairmont, then a 3 lane arterial (green street boulevard) from Clairmont to UGB. The signalization of key intersections is illustrated on the Street Plan.
- *Center Parkway as a parallel route to Beavercreek Road.* This new north-south route provides the opportunity to completely avoid use of Beavercreek Road for trips between Old Acres and Thayer Road. This provides a much-needed separation of local and through trips, as well as an attractive east-side walking and biking route. Major cross-street intersections, such as Loder, Meyers and Glen Oak may be treated with roundabouts or other treatments to help manage average speeds on this street. Minor intersections are likely to be stop-controlled on the side street approaches. The alignment of Center Parkway along the central open space is intended to provide an open edge to the park. The cross-section for Center Parkway includes a multi-use path on the east side and green street swale. Center Parkway is illustrated as a three-lane facility. Depending on land uses and block configurations, it may be able to function well with a two lane section and left turn pockets at selected locations.
- *Ridge Parkway as a parallel route to Center Parkway and Beavercreek Road.* The section of Ridge Parkway south of the Glen Oak extension is intended as the green edge of the neighborhood. This will provide a community "window" and public walkway adjacent to the undeveloped natural areas east of the parkway. Ridge Parkway should be two lanes except where left turn pockets are needed. Major intersections south of Loder are likely to only require stop control of the side street, if configured as "tee" intersections. Mini roundabouts could serve as a suitable option, particularly if a fourth leg is added.
- *Ridge Parkway.* Ridge Parkway was chosen to extend as the through-connection south of the planning area to Henrici Road. Center Parkway and Ridge Parkway are both recommended for extension to the north as long-term consideration for Oregon City and Clackamas County during the update of respective Transportation System Plans. It is beyond the scope of this study to identify and determine each route and the feasibility of such extensions. Fatal flaws to one or both may be discovered during subsequent planning. Nonetheless, it is prudent at this level of study, in this area of the community, to identify opportunities to efficiently and systematically expand the transportation system to meet existing and future needs.

- *Extensions of Clairmont, Meyers, Glen Oak Roads and the south entrance through to the Ridge Parkway.* These connections help complete the network and tie all parts of the community to adjacent streets and neighborhoods.
- *Realignment of Loder Road at its west end. Loder is recommended for re-configuration to create a safer "T" intersection.* The specific location of the intersection is conceptual and subject to more site specific planning.

The streets of the Concept Plan area are recommended to be green streets. This is an integral part of the storm water plan and overall identity and vision planned for the area. The green street cross-sections utilize a combination of designs: vegetated swales, planter islands, curb extensions, and porous pavement. Figures 15 – 19 illustrate the recommended green street cross-sections. These are intended as a starting point for more detailed design.

Trails

Figure 14 also illustrates the trail network. The City's existing Thimble Creek Trail and Metro's Beaver Lake Regional Trail have been incorporated into the plan. New trails include the Powerline Corridor Trail, multi-use path along Center Parkway, and the Ridge Trail.

Transit

The Concept Plan sets the stage for future transit, recognizing that how that service is delivered will play out over time. Specifics of transit service will depend on the actual rate and type of development built, Tri-Met resources and policies, and, consideration of local options. Three options have been identified:

1. A route modification is made to existing bus service to Clackamas Community College (CCC) that extends the route through CCC to Beavercreek Road via Clairmont, then south to Meyers or Glen Oak, back to HWY 213, and back onto Molalla to complete the normal route down to the Oregon City Transit Center. To date, CCC has identified Meyers Road as a future transit connection to the college.
2. A new local loop route that connects to the CCC transit center and serves the Beavercreek Road Concept Planning area, the High School, the residential areas between Beavercreek and HWY 213, and the residential areas west of HWY 213 (south of Warner Milne).
3. A new "express" route is created from the Oregon City Transit Center, up/down HWY 213 to major destinations (CCC, the Beavercreek Road Employment area, Red Soils, Hilltop Shopping Center, etc.).

It is the recommendation of this Plan that the transit-oriented (and Use mix), density, and design of the Beavercreek Road area be implemented so that transit remains a viable option over the long term. The City should work with Tri-Met, CCC, Oregon City High School, and developers within the Concept Plan area to facilitate transit.

Connectivity

The street network described above will be supplemented by a connected local street network. Consistent with the framework plan approach, connectivity is required by policy and by the standards in the code. The specific design for the local street system is flexible and subject to master plan and design review. Figure 20 illustrates different ways to organize the street and pedestrian systems. These are just three examples, and are not intended to suggest additional access to Beavercreek Road beyond what is recommended in Figure 14. The Plan supports innovative ways to configure the streets that are consistent with the goals and vision for the Beavercreek Concept Plan area.

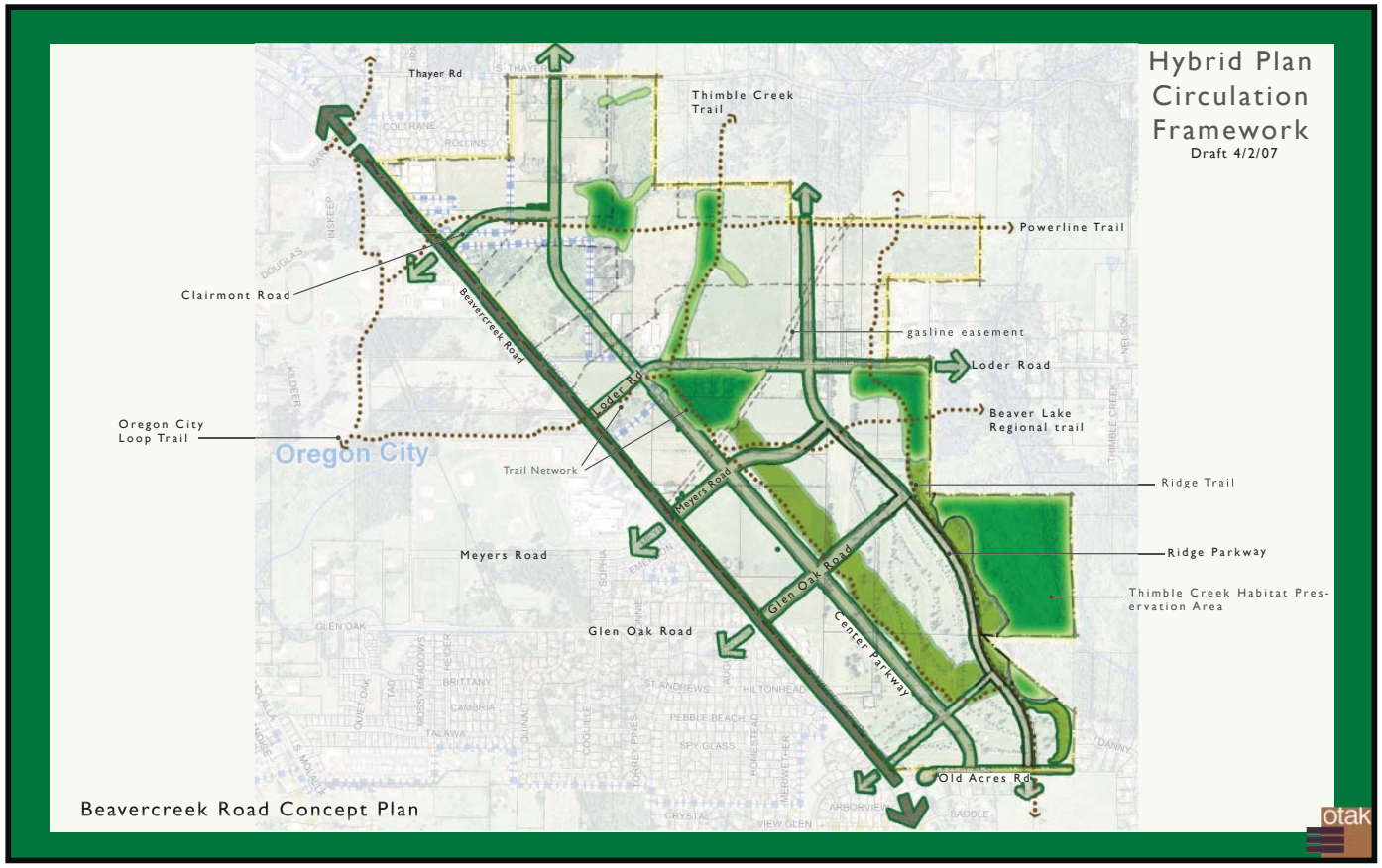


Figure 14 - Circulation Framework

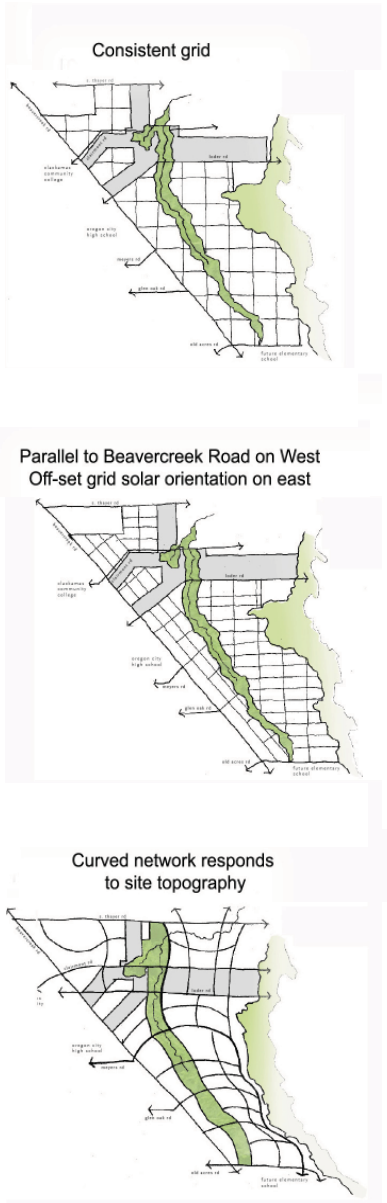


Figure 20 - Connectivity Diagrams

Conceptual only - See Figure 14 for recommended access points to Beavercreek Road.

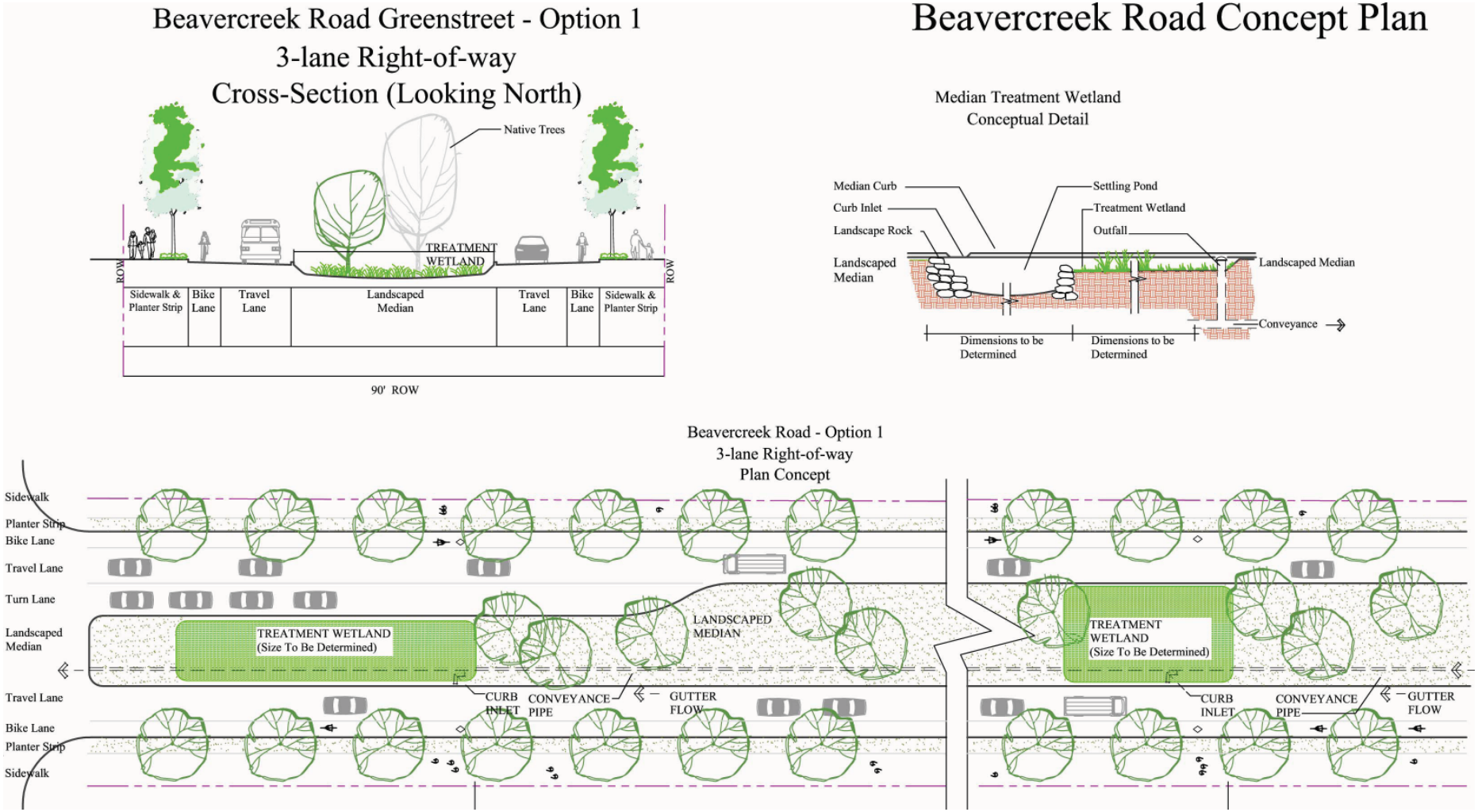


Figure 15 - Beavercreek Road Green Street

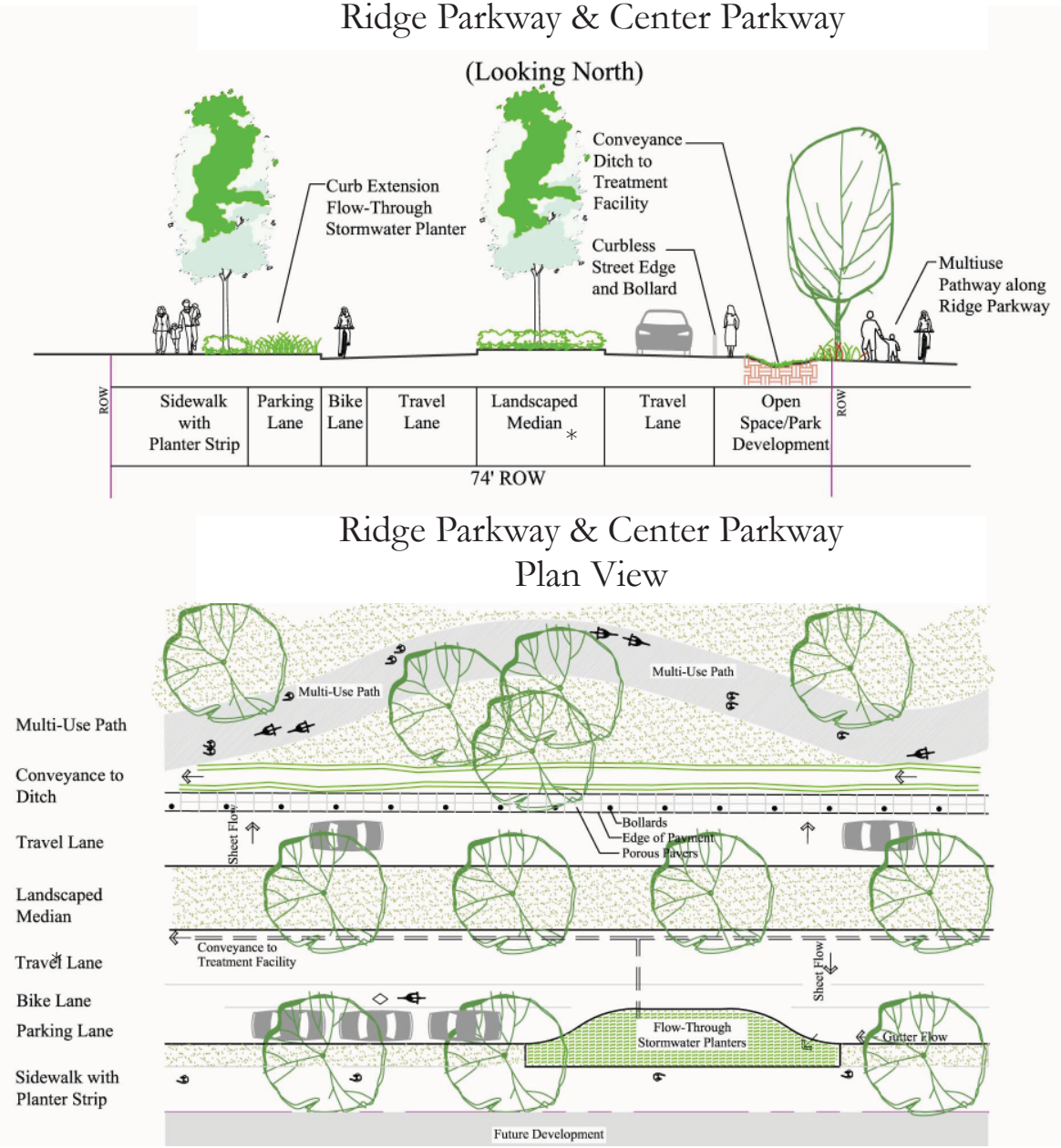


Figure 16 - Ridge Parkway and Central Parkway Green Streets

*Center median is optional for Ridge Parkway.

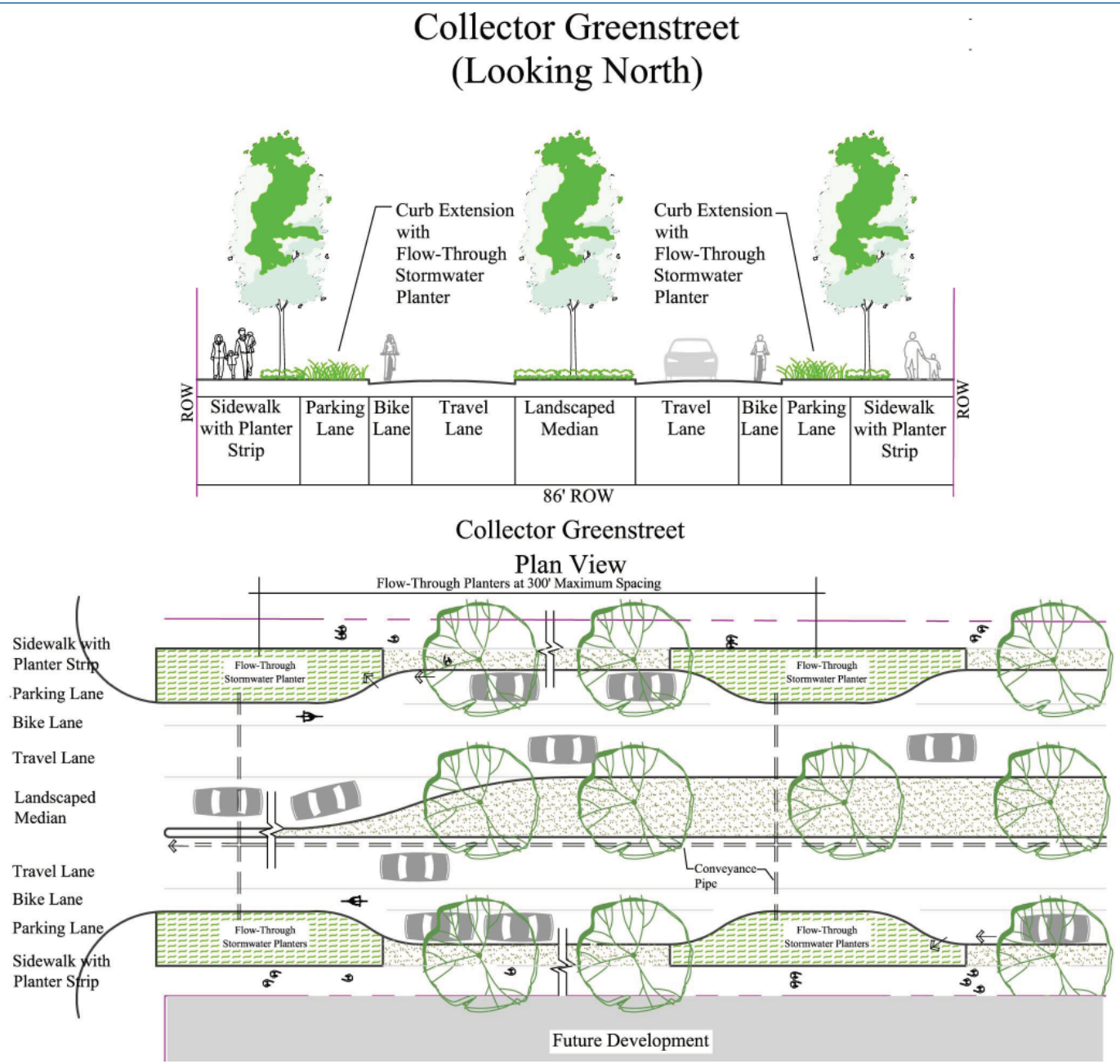


Figure 17 - Collector Green Street

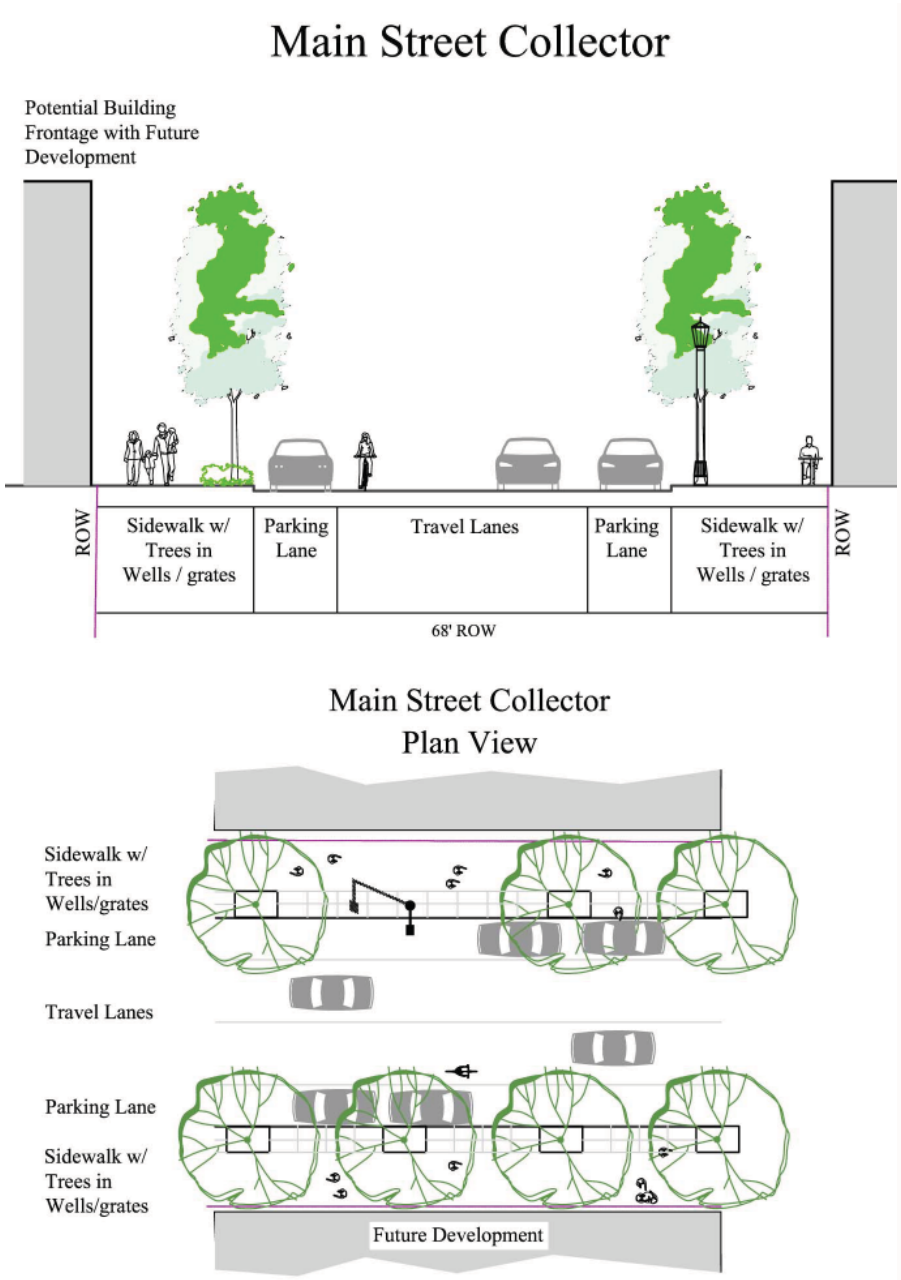


Figure 18 - Main Street Green Street

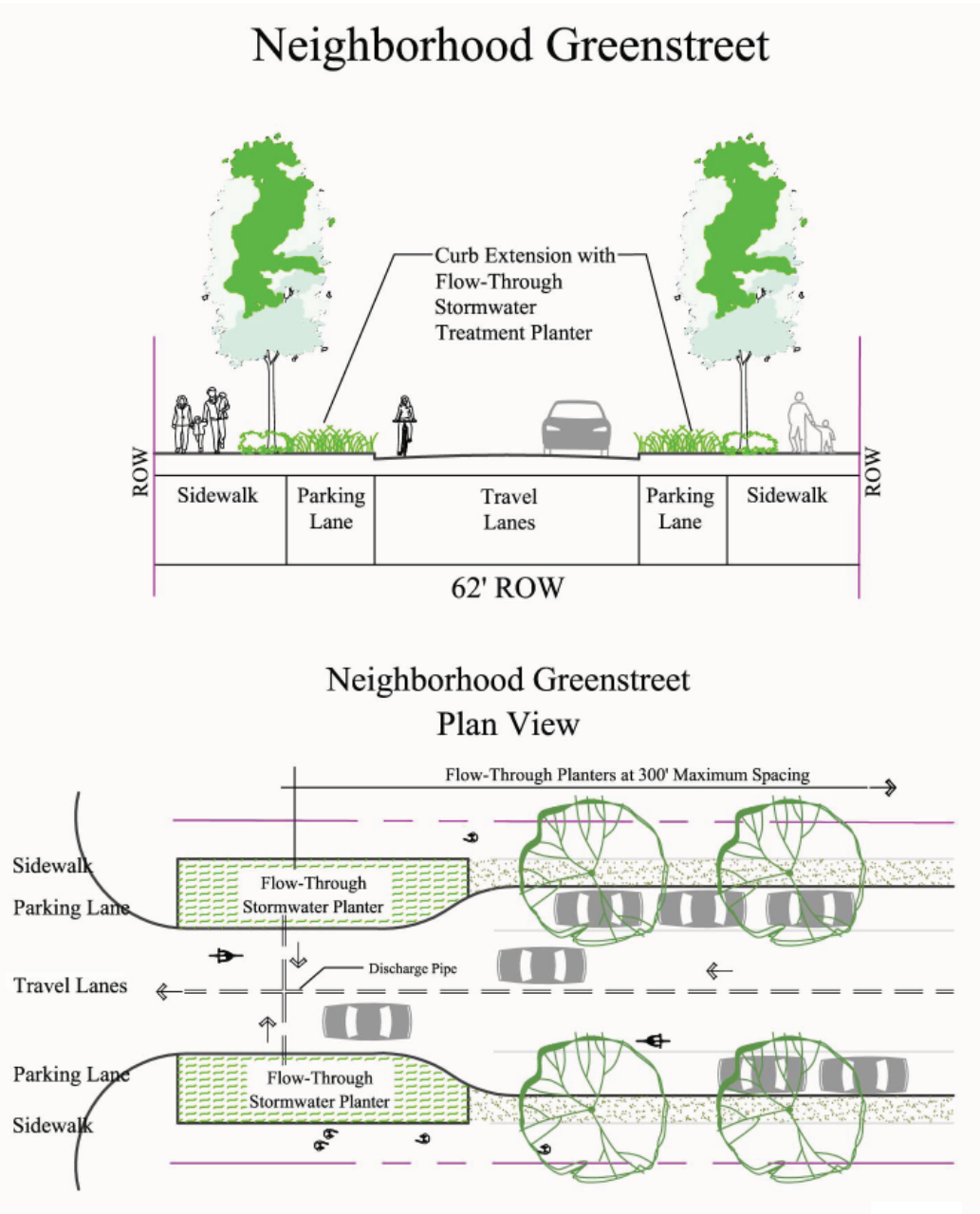


Figure 19 - Neighborhood Green Street

Cost Estimate

A planning-level cost estimate analysis was conducted in order to approximate the amount of funding that will be needed to construct the needed improvements to the local roadway system, with the build-out of the Beavercreek Road Concept Plan. The table below lists these improvements and their estimated costs. These generalized cost estimates include assumptions for right-of-way, design, and construction.

For additional information, please see Technical Appendix, Sections C2 and G.

Roadway Improvements	**Improvement**	**Estimated Cost**
Beavercreek Road: Marjorie Lane to Clairmont Drive	Construct 5-lane cross-section to City standards	$6,300,000
Beavercreek Road: Clairmont Drive to Henrici Road	Construct 3-lane cross-section to City standards	$12,300,000
Clairmont Drive: Beavercreek Road – Center Parkway	Construct new 3-lane collector to City standards and modify signal at Beavercreek Road	$2,400,000
Loder Road: Beavercreek Road to Center Parkway	Construct 3-lane cross-section to City standards and signalize Beavercreek Road intersection	$1,400,000
Loder Road: Center Parkway – East Site Boundary	Construct 3-lane cross-section to City standards	$4,200,000
Meyers Road: Beavercreek Road – Ridge Parkway	Construct new 3-lane collector to City standards and modify signal at Beavercreek Road	$3,500,000
Glean Oak Road: Beavercreek Road – Ridge Parkway	Construct new 3-lane collector to City standards and modify signal at Beavercreek Road	$3,400,000
Center Parkway	Construct new 3-lane collector with 12' multi-use path	$17,700,000
Ridge Parkway	Construct new 3-lane collector	$9,800,000
Total Roadway Improvements		**$61,000,000**
Intersection Only Improvements	**Improvement**	**Estimated Cost**
Beavercreek Road/Maplelane	Road Construct new WB right-turn lane	$250,000
Beavercreek Road/ Meyers Road	Construct new NB and SB through lanes	$5,000,000
Total Intersection Improvements		**$5,250,000**
TOTAL IMPROVEMENTS		***$66,250,000***

Transportation Cost Estimate



Figure 21 - Sustainable Stormwater Plan

Storm Water and Water Quality

This Beavercreek Road stormwater infrastructure plan embraces the application of low-impact development practices that mimic natural hydrologic processes and minimize impacts to existing natural resources. It outlines and describes a stormwater hierarchy focused on managing stormwater in a naturalistic manner at three separate scales: site, street, and neighborhood.

Tier 1 – Site Specific Stormwater Management Facilities (Site)

All property within the study area will have to utilize on-site best management practices (BMPs) to reduce the transport of pollutants from their site. Non-structural BMPs, such as source control (e.g. using less water) are the best at eliminating pollution. Low-impact structural BMPs such as rain gardens, vegetated swales, pervious surface treatments, etc. can be designed to treat stormwater runoff and reduce the quantity (flow and volume) by encouraging retention/infiltration. They can also provide beneficial habitat for wildlife and aesthetic enhancements to a neighborhood. These low-impact BMP's are preferred over other structural solutions such as underground tanks and filtration systems. Most of these facilities will be privately maintained.

Tier 2 – Green Street Stormwater Management Facilities (Street)

Green Streets are recommended for the entire Beavercreek Concept Plan area. The recommended green street design in Figures 15 - 19 use a combination of vegetated swales or bioretention facilities adjacent to the street with curb cuts that allow runoff to enter. Bioretention facilities confined within a container are recommended in higher density locations where space is limited or is needed for other urban design features, such as on-street parking or wide sidewalks. The majority of the site is underlain with silt loam and silty clay loam. Both soils are categorized as Hydrologic Soil Group C and have relatively slow infiltration rates.

The recommended green streets will operate as a collection and conveyance system to transport stormwater from both private property and streets to regional stormwater facilities. The conveyance facilities need to be capable of managing large storm events that exceed the capacity of the swales. For this reason, the storm water plan's conveyance system is a combination of open channels, pipes, and culverts. Open channels should be used wherever feasible to increase the opportunity for stormwater to infiltrate and reduce the need for piped conveyance.

Tier 3 – Regional Stormwater Management Facilities (Neighborhood)

Regional stormwater management facilities are recommended to manage stormwater from larger storms that pass through the Tier 1 and Tier 2 facilities. Figure 21 illustrates seven regional detention pond locations. Coordinating the use of these for multiple properties will require land owner cooperation during development reviews, and/or, City initiative in advance of development.

The regional facilities should be incorporated into the open space areas wherever possible to reduce land costs, and reduce impacts to the buildable land area. Regional stormwater facilities should be designed to blend with the other uses of the open space area, and can be designed as a water feature that offers educational or recreational opportunities. Stormwater runoff should be considered as a resource, rather than a waste stream. The collection and conveyance of stormwater runoff to regional facilities can offer an opportunity to collect the water for re-use.

rge Locations

evelopment stormwater runoff rates from the Beavercreek Road
pt Plan Area will need to match pre-development rates at the existing
ge locations, per City Stormwater Design Standards. Since there are
small discharge locations to Thimble Creek, flow control facilities
t be feasible at all discharge locations. In this situation, over-
on is needed at some discharge locations to compensate for the un-
d areas so that flows in Thimble Creek at the downstream point of
ance meet City Stormwater Design Standards for flow control.

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Water

The proposed water infrastructure plan creates a network of wat
pipelines as the "backbone" system. In addition, as individual pa
developed, a local service network of water mains will be needed
individual lots.

Since there are two pressure zones in the concept plan area, there
to be a network of pipes for each of the two zones. These syster
illustrated on Figure 22. The Fairway Downs Pressure Zone will
south one-third of the concept plan area. This zone receives wat

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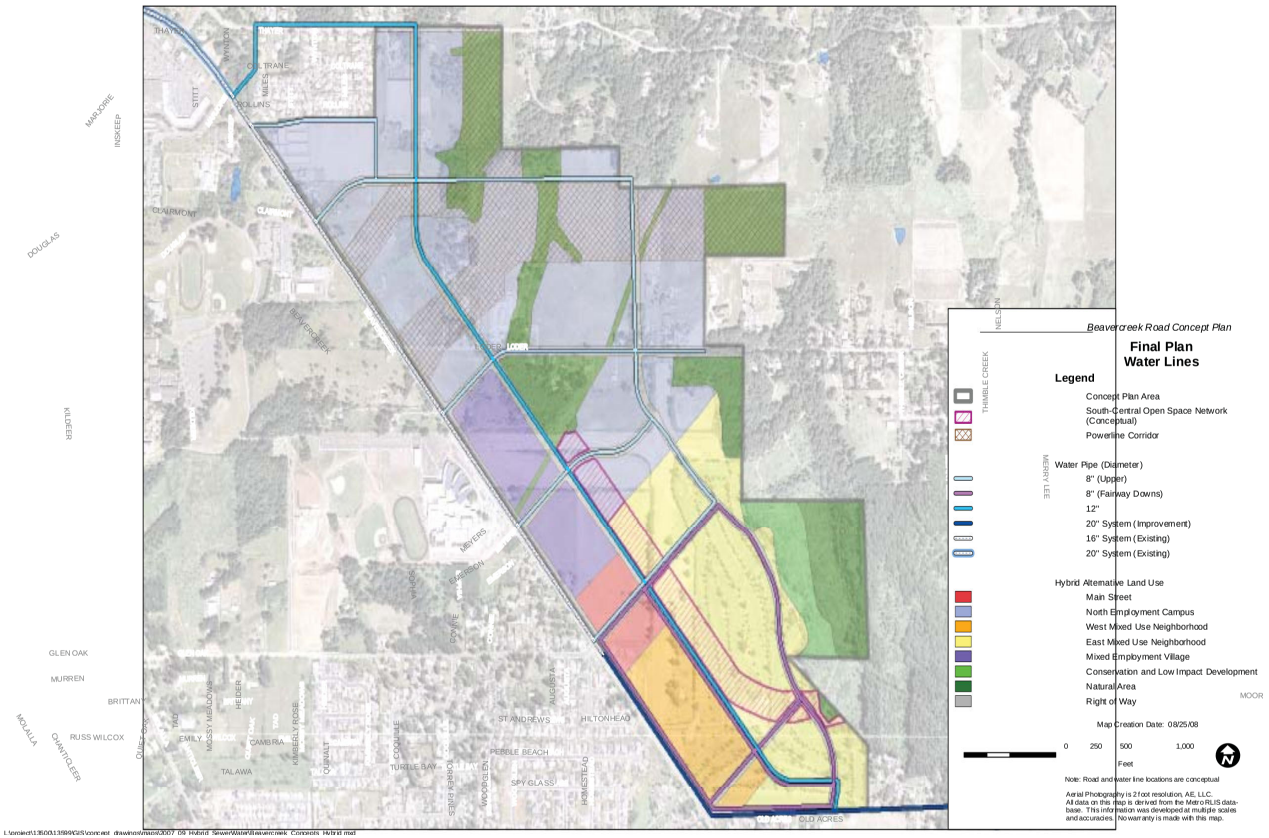


Figure 22 - Water Plan

In the Fairway Downs Pressure Zone, the majority of the water mains will be installed in the proposed public rights-of-way. However, a small portion of the system may need to be in strip easements along the perimeter of the zone at the far southeast corner of the concept plan area. The system layout shown is preliminary and largely dependent on future development and the final system of internal (local) streets. Additional mains may be needed or some of the water mains shown may need to be removed. For instance, if the development of the residential area located at the southeast end of the site, adjacent to Old Acres Road, includes internal streets, the water mains shown along the perimeter of the site may be deleted because service will be provided from pipes that will be installed in the internal street system.

Some of the planned streets in the Fairway Downs Pressure Zone will contain two water mains. One water main will provide direct water service to the area from the booster pump system. The other water main will carry water to the lower elevation areas in the Upper Pressure Zone.

The Upper Pressure Zone will serve the north two-thirds of the concept plan area. The "backbone" network for the Upper Pressure Zone will have water mains that are pressured from the Henrici and Boynton reservoirs. A single 12-inch water main will run parallel with Beavercreek Road through the middle of concept plan area. This water conduit will serve as the "spine" for the Upper Pressure Zone. A network of 8-inch water pipes will be located in the public rights-of-way and will provide water to the parcels that are identified for development. The system can be extended easterly on Loder Road, if needed.

The preliminary design ensures that the system is looped so that there are no dead-end pipes in the system. Along a portion of the north perimeter, approximately 1,600 feet of water pipe will be needed to complete a system loop and provide water service to adjacent lots. This pipe will share a utility easement with a gravity sanitary sewer and a pressure sewer. There may also be stormwater facilities in this same alignment.

In the Water Master Plan, under pipeline project P-201, there is a system connection in a strip easement between Thayer Road and Beavercreek Road at the intersection with Marjorie Lane. Consideration should be given to routing this connection along Thayer Road to Maplelane Road and then onto Beavercreek Road. This will keep this proposed 12-inch main in the public street area where it can be better accessed.

The estimated total capital cost for the "backbone" network within the concept plan area will be in the area of $5,400,000. This estimate is based the one derived for Alternative D, which for concept planning purposes, is representative of the plan and costs for the final Concept Plan. This is in addition to the $6.9 million of programmed capital improvement projects that will extend the water system to the concept plan area. All estimates are based on year 2003 dollars. Before the SDC can be established, the estimates will need to be adjusted for the actual programmed year of construction.

For additional information, please see Technical Appendix, Sections C6 and H3.

ary Sewer

orthern half of the concept area drains generally to the north and s the natural land contours formed by the uppermost portion of le Creek. The proposed sanitary sewer system in the vicinity of Road will follow the north-south street rights-of-way. This part of tem will terminate at the low point of the concept plan area in a l. A sanitary lift station over the wetwell will pump the wastewater n a westerly direction to a point that it can be discharged into a sewer that will flow west to the trunk sewer in Beavercreek Road. t station and pressure sewer project has been identified in the y Sewer Master Plan as projects BC-COL-5 and 6. A utility bridge ll carry the pressure pipe and gravity sewer pipe over Thimble is anticipated.

t road access to mp station that llel to Thimble will also be l.

The majority of the southern half of the concept area will have a sanitary sewer system that will convey waste water to the existing foot long trunk sewer in Beavercreek Road, which currently exte Highway 213 to approximately 800 feet south of Marjorie Lane. portion of the system can be built in the planned roadways and in existing Beavercreek Road right-of-way. This portion of the syste built in the planned roadways. A portion of the system, approxim feet long, will need to be built in the current alignment of Loder that the gravity sewer can be connected to the trunk sewer in Bea Road. The circulation plan includes a realignment of Loder Road. Therefore, a sewer easement will need to be retained across the fu parcel that now includes the current Loder Road alignment.

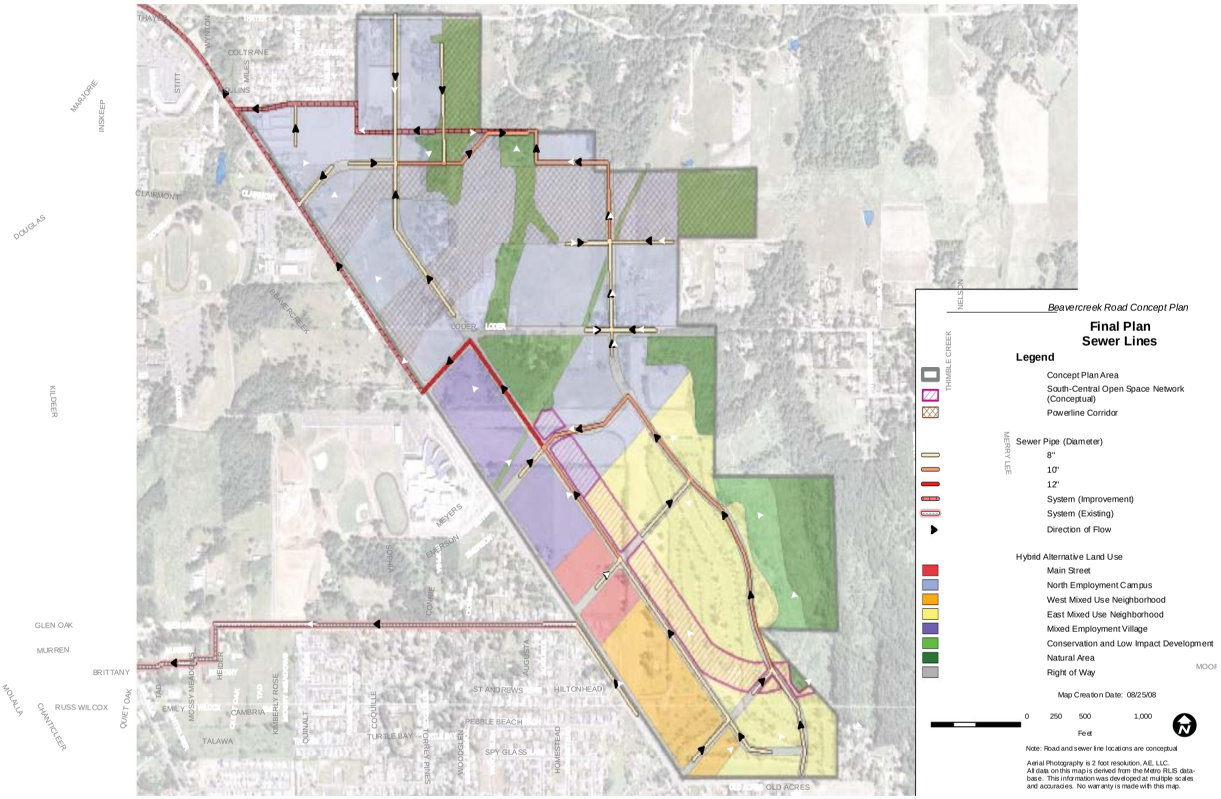


Figure 23 - Sewer Plan

The approxima elevation of 49 (MSL) is impor the southern ha the concept pla relative to gravi service. Roadw and developme constructed abo 490 ft will mos allow for gravit service. If land requiring sanita service (or roac with sewer und are located low 490 ft, individu stations and pr services may be required.

The estimated total capital cost will be in the vicinity of $4,400,000. This estimate is based on the cost analysis for Alternative D, which is comparable. This is in addition to the $2.3 million in sanitary sewer master plan capital costs that needed to bring the sanitary sewers to the concept plan area. These estimates are based on year 2003 dollars. The estimates will need to be adjusted for the programmed year of construction.

For additional information, please see Technical Appendix, Sections C6 and H2.

Funding strategies

For water, sewer, storm water and parks, there are five primary funding sources and strategies that can be used:

- *System development charges (SDCs)*– Oregon City requires developers to pay SDCs for new development. Developers pay these charges up front based on the predicted impact of the new development on the existing infrastructure and the requirements it creates for new improvements. Although the charges are paid by the developer, the developer may pass on some of these costs to buyers of newly developed property. Thus, SDCs allocate costs of development to the developer and buyers of the new homes or new commercial or industrial buildings.
- *Urban renewal/tax increment financing* - Tax increment financing is the primary funding vehicle used within urban renewal areas (URA). The tax increment revenue is generated within a URA when a designated area is established and the normal property taxes within that area are 'frozen' (often called the frozen base). Any new taxes generated within that area through either property appreciation or new investment becomes the increment. Taxing jurisdictions continue to collect income from the frozen base but agree to release assessed value above the base to the URA. The URA then can issue bonds to pay for identified public improvements. The tax increment is used to pay off the bonds.

Oregon City has the authority to establish an URA. The Beavercreek Road Concept Plan Area would have to meet the definition of 'blight' as defined in ORS 457. It is likely to meet 'blight' standards because its existing ratios of improvement-to-land values are likely low enough to meet that standard.

- *Local Improvement Districts* - Local Improvement Districts (LIDs) are formed for the purpose of assessing local property owners an amount sufficient to pay for a project deemed to be of local benefit. LIDs are a specific type of special assessment district, which more broadly includes any district that is formed within an existing taxing district to assess specific property owners for some service that is not available throughout the larger district. The revenues from the LID assessments are used to pay the debt payments on a special assessment bond or a note payable issued for the capital improvements.

LID assessments increase costs for property owners. Under a LID the improvements must increase the value of the taxed properties by more than the properties are taxed. LIDs are typically used to fund improvements that primarily benefit residents and property owners within the LID.

- *Bonds* - Bonds provide a financing mechanism for local governments to raise millions of dollars for parks and other capital projects. The City could back a bond with revenue from a LID, the Urban Renewal Districts, or property taxes citywide. General obligation (GO) bonds issued by local governments are secured by a pledge of the issuer's power to levy real and personal property taxes. Property taxes necessary to repay GO bonds are not subject to limitation imposed by recent property tax initiatives. Oregon law requires GO bonds to be authorized by popular vote.

Bond levies are used to pay principal and interest for voter-approved bonded debt for capital improvements. Bond levies typically are approved in terms of dollars, and the tax rate is calculated as the total levy divided by the assessed value in the district.

- Developer funded infrastructure – The City conditions land use approvals and permits to include required infrastructure. Beyond

the sources cited above, developers cover the remaining costs for the infrastructure required for their development.

Additional funding tools that could be investigated and implemented within the Concept Plan area include a Road District, a County Service District, Intergovernmental Agreements, an Advance Finance District, a Certificate of Participation, and a Utility Fee. There are benefits and limitations associated with each of the funding options that should be reviewed carefully before implementing.

For transportation infrastructure, the same sources as cited above are available. For larger facilities, such as Beavercreek Road, additional funds may be available. They include Metro-administered federal STP and CMAQ funding, and, regional Metro Transportation Improvement Plan funding. These sources are limited and extremely competitive. County funding via County SCSs should also be considered a potential source for Beavercreek Road. Facilities like Beavercreek Road are often funded with a combination of sources, where one source leverages the availability of another.

Sustainability

One of the adopted goals is: The Beavercreek Road Concept Plan Area will be a model of sustainable design, development practices, planning, and innovative thinking.

Throughout the development of the concept plan, sustainability has been paramount in guiding the CAC, the City, and the consultant team. The final plan assumes that sustainable practices will be a combination of private initiatives (such as LEED certified buildings), public requirements (green streets and low impact development policies), and public-private partnerships. It is recommended that City use incentives, education and policy support as much as possible for promoting sustainability at Beavercreek Road. Some initiatives will require regulation and City mandates, but caution and balance should be used. At the end of the day, it is up to the private sector to invest in sustainable development. The Beavercreek Road's site's legacy as a model of sustainable design will depend, in large part on the built projects that are successful in the marketplace and help generate the type of reputation that the community desires and deserves.

The key to fulfilling the above-listed goal will be in the implementation. For the City's part, implementation strategies that support sustainable design will be included within the Oregon City Comprehensive Plan policies and Code provisions. They will be applied during master plan and design review permitting. Some of these strategies will be "required" while other are appropriate to "encourage." These sustainability strategies include:

- Energy efficiency
- Water conservation
- Compact development
- Solar orientation
- Green streets/infrastructure
- Adaptive reuse of existing buildings/infrastructure
- Alternative transportation
- Pedestrian/Cyclist friendly developments
- Natural drainage systems
- Tree preservation and planting to "re-establish" a tree canopy
- Minimizing impervious surfaces
- Sustainability education (builder, residents, businesses and visitors)
- Collaboration with "local" institutional and economic partners, particularly Clackamas Community College and Oregon City High School
- Community-based sustainable programs and activities

Principles for Sustainable Community Design

The CAC discussed Principles for Sustainable Community Design that were offered by one of the members. These provide a good framework for how the Concept Plan is addressing sustainability.

Mix Land Uses - Promote a mix of land uses that support living wage jobs and a variety of services.

All of the sub-districts are, to some degree, mixed use districts. The Mixed Use Village, Main Street and West Mixed Use Neighborhood allow a rich mix of employment, housing, and services. Taken together, the entire 453 acre area will be a complete community.

Housing Types - Create a range of housing choices for all ages and incomes.

The concept plan includes housing in many forms: mixed use formats in the 3-5 story buildings, high density apartments and condominiums, live-work units, townhomes, small cottage lots, and low density single family homes.

Walk-ability - Make the Neighborhood "walkable" and make services "walk-to-able."

The plan provides a street and trail framework. The code will require a high level of connectivity and maximum block sizes for most sub-districts. Services are provided throughout the plan as part of mixed use areas and a broad range of permitted uses.

Transportation - Provide a range of transportation options using a connected network of streets and paths.

The plan provides for all modes: walking, biking, driving and transit. Transit-supportive land use is specifically required in the Mixed Employment Village, Main Street and West Mixed Use Neighborhoods. The framework of connected streets and paths will be supplemented by a further-connected system of local streets and walking routes.

Open Space - Protect and maintain a functioning green space network for a variety of uses.

Open space is distributed throughout the plan. New green spaces are connected with existing higher-value natural areas.

Integrate Systems - Integrate ecological and man-made systems to maximize function, efficiency and health.

Infrastructure systems (green storm water, multi-modal transportation) are highly integrated with the open space network and array of land uses. It will be important for the implementation of the plan to further integrate heating, cooling, irrigation and other man-made systems with the Concept Plan framework.

Ecological Health - Manage natural resources to eliminate pollution to watersheds and lesson impact on habitat and green infrastructure.

Methods to achieve this principle are identified in the Stormwater Infrastructure Report. Additionally, the code requires measures to preserve natural resources and eliminate pollution to watersheds necessary to achieve this principle.

Reuse, Recycle, Regenerate - Reuse existing resources, regenerate existing development areas.

The principle will be applied primarily at time of development and beyond.

Green Buildings - Build compact, innovative structures that use less energy and materials.

The draft code includes provisions for green buildings. This is a new area for the City to regulate, so a public-private Green Building Work Group is recommend to explore issues, build consensus, and develop specific code recommendations.

Work Together - Work with community members and neighbors to design and develop.

The development of the alternatives and the recommended plan has been a collaborative process with all project partners. The concept plan process through implementation and subsequent project area developments will continue to be a collaborative process where all stakeholders are invited to participate.

For additional information, please see Technical Appendix, Sections C3, D, and F.

Metrics

Land Use

The following table summarizes the acreages for major land uses on the Concept Plan.

Land Use Category (acres)	Hybrid
North Employment Campus (adjusted gross acreage)*	149
Mixed Employment Village	26
Main Street	10
West Mixed Use Neighborhood	22
East Mixed Use Neighborhood	77
Total Acres of "built" land use	**284**
Other Land Uses (not "built")	
Parks/Open Space/Natural Areas (Total)**	113
Major ROW+	56
Existing Uses (unbuildable)	0
Total Project Area Gross Acres	**453**

***Adjusted gross acreage** is the sum of 50% of the employment land use shown under the powerline easement plus all other unconstrained employment land use areas. Calculations shown below:

Land Use Category (acres)	Hybrid
Total North Employment Campus	175
Unconstrained NEC	**123**
Employment with powerline overlay	52
Useable portion of powerline overlay (50%)	**26**
North Employment Campus (adjusted gross acreage)*	**149**

Housing and Employment Estimates

The Concept Plan has an estimated capacity for approximately 5000 jobs and 1000 dwellings. The following table displays the estimates and assumptions used to estimate jobs and housing. On a net acreage, these averages are 33 jobs/ net developable acre and 10.3 dwellings/ net developable acre.

Land Use Category	Hybrid Gross Acres	Hybrid Net Acres*	FAR/Acre**	SF/Job**	# of Jobs***	Avg. Units/Acre	# of Units+
North Employment Campus (adjusted gross acreage)	149	127	0.3	450	3,678		
Mixed Employment Village	26	21	0.44	350	1,139		
Main Street****	10	8	0.44	350	219	25	100
West Mixed Use Neighborhood	22	18			15	22	387
East Mixed Use Neighborhood	77	62			21	8.7	536
Total # of Jobs					**5,073**		
Total # of Housing Units							**1,023**
Total Acres of Developed Land++	**284**	**235**					

***For Hybrid -** Net acres equals gross acres minus 15% for local roads and easements in Employment. Mixed Employment, Mixed Use, and residential areas assume 20% for local roads and easements

* *Based on Metro 2002-2022 Urban Growth Report: An Employment Land Need Analysis. Includes total on site employment (full and part time). Mixed Employment FAR and job density reflects a mix of office, tech/flex, and ground floor retail.

***Number of Jobs in Employment, Mixed Employment, Mixed Use calculated by multiplying total acres by the FAR; Converting to square feet; and dividing by number of jobs/square foot. Jobs in residential areas (Work at Home Jobs) estimated at 4% (potential could be as high as 15%).

**** Mixed Use land use assumes 50% of acreage devoted to commercial uses and the remaining 50% devoted to vertical mixed use.

+Number of units calculated by multiplying total net acres of residential land use by average units per acre

++Includes 50% of useable power line corridor (26 acres total) as part of developed land (included in Employment land area)

+++Does not include powerline corridor acreage as part of developed land

VI. Goals and Policies

The following goals and policies are recommended for adoption into the Oregon City Comprehensive Plan. The goal statements are those developed by the Citizen Advisory Committee as goals for the plan.

Goal 1 Complete and Sustainable Community

Create a complete and sustainable community, in conjunction with the adjacent land uses, that integrates a diverse mix of uses, including housing, services, and public spaces that are necessary to support a thriving employment center.

Policy 1.1

Adopt new comprehensive plan and zone designations, and development code, that implement the Beavercreek Concept Plan. Require all development to be consistent with the Concept Plan and implementing code.

Policy 1.2

Establish sub-districts to implement the Concept Plan. The sub-districts are:

North Employment Campus – NEC

The purpose of the North Employment Campus is to provide for the location of family wage employment that strengthens and diversifies the economy. The NEC allows a mix of clean industries, offices serving industrial needs, light industrial uses, research and development and large corporate headquarters. The uses permitted are intended to improve the region's economic climate, promote sustainable and traded sector businesses, and protect the supply of sites for employment by limiting incompatible uses. The sub-district is intended to comply with Metro's Title 4 regulations. Site and building design will create pedestrian-friendly areas and utilize cost effective green development practices. Business and program connections to Clackamas Community College (CCC) are encouraged to help establish a positive identity for the area and support synergistic activity between CCC and NEC properties. Businesses making sustainable products and utilizing sustainable materials and practices are encouraged to reinforce the identity of the area and promote the overall vision for the Beavercreek Road area.

Mixed Employment Village – MEV

The purpose of the Mixed Employment Village is to provide employment opportunities in an urban, pedestrian friendly, and mixed use setting. The MEV is intended to be transit supportive in its use mix, density, and design so that transit remains an attractive and feasible option. The MEV allows a mix of retail, office, civic and residential uses that make up an active urban district and serve the daily needs of adjacent neighborhoods and Beavercreek Road sub-districts. Site and building design will create pedestrian-friendly areas and utilize cost effective green development practices. Business and program connections to Clackamas Community College and Oregon City High School are encouraged. Businesses making sustainable products and utilizing sustainable materials and practices are encouraged to reinforce the identity of the area and promote the overall vision for the Beavercreek Road area.

Main Street – MS

The purpose of this small mixed-use center is to provide a focal point of pedestrian activity. The MS allows small scale commercial, mixed use and services that serve the daily needs of the surrounding area. "Main Street" design will include buildings oriented to the street, and minimum of 2 story building scale, attractive streetscape, active ground floor uses and other elements that reinforce pedestrian oriented character and vitality of the area.

West Mixed Use Neighborhood – WMU

The West Mixed Use Neighborhood will be a walkable, transit-oriented neighborhood. This area allows a transit supportive mix of housing, live/work units, mixed use buildings and limited commercial uses. A variety of housing and building forms is required, with the overall average of residential uses not exceeding 22 dwelling units per acre. The WMU area's uses, density and design will support the multi-modal transportation system and provide good access for pedestrians, bicycles, transit and vehicles. Site and building design will create a walkable area and utilize cost effective green development practices.

East Mixed Use Neighborhood – EMU

The East Mixed Use Neighborhood will be a walkable and tree-lined neighborhood with a variety of housing types. The EMU allows for a variety of housing types while maintaining a low density residential average not exceeding the densities permitted in the R-5 zone. Limited non-residential uses are permitted to encourage a unique identity, sustainable community, and in-home work options. The neighborhood's design will celebrate open space, trees, and relationships to public open spaces. The central open space, ridge open space scenic viewpoints, and a linked system of open spaces and trails are key features of the EMU. Residential developments will provide housing for a range of income levels, sustainable building design, and green development practices.

Policy 1.3

Within the Northern Employment Campus sub-district, support the attraction of family wage jobs and connections with Clackamas Community College.

Policy 1.4

Within the Mixed Employment Village and Main Street sub-districts, promote job creation, mixed use and transit oriented development. Adopt minimum densities, limitations on stand-alone residential developments, and other standards that implement this policy.

Policy 1.5

The Main Street sub-district may be located along the extension of Glen Oak Road and not exceed 10 gross acres. The specific configuration of the MS sub-district may be established as part of a master plan.

Policy 1.6

Within the West and East Mixed Use Neighborhoods, require a variety of housing types. Allow lot size averaging and other techniques that help create housing variety while maintaining overall average density.

Policy 1.7

Within the MEV, MS, WMU and EMU sub-districts, require master plans to ensure coordinated planning and excellent design for relatively large areas (e.g. 40 acres per master plan). Master plans are optional in the NEC due to the larger lot and campus industrial nature of the area.

Goal 2 Model of Sustainable Design

Be a model of sustainable design, development practices, planning, and innovative thinking.

Policy 2.1

Implement the Sustainable Storm Water plan recommended in the Concept Plan. During site specific design, encourage innovative system design and require low impact development practices that manage water at the site, street and neighborhood scales.

Policy 2.2

Storm water facilities will be designed so they are amenities and integrated into the overall community design.

Policy 2.3

Support public and private sector initiatives to promote sustainable design, development practices and programs, including but not limited to:

- Energy efficiency
- Water conservation
- Compact development
- Solar orientation
- Green streets/infrastructure
- Adaptive reuse of existing buildings/infrastructure
- Alternative transportation
- Pedestrian/Cyclist friendly developments
- Natural drainage systems
- Tree preservation and planting to "re-establish" a tree canopy
- Minimizing impervious surfaces
- Sustainability education (builder, residents, businesses and visitors)
- Collaboration with "local" institutional and economic partners, particularly Clackamas Community College and Oregon City High School
- Community based sustainable programs and activities

Policy 2.4

Work with stakeholders and the community to develop LEED or equivalent green building standards and guidelines to apply in the Concept Plan area.

Goal 3 Green Jobs

Attract "green" jobs that pay a living wage.

Policy 3.1

Coordinate with county, regional and state economic development representatives to recruit green industry to the Concept Plan area.

Policy 3.2

Promote the Concept Plan area as a place for green industry.

Policy 3.3

Work with Clackamas Community College to establish programs and education that will promote green development within the Concept Plan area.

Goal 4 Sustainable Industries

Maximize opportunities for sustainable industries that serve markets beyond the Portland region and are compatible with the site's unique characteristics.

Policy 4.1

As master plans are approved, ensure there is no net loss of land designated North Employment Campus.

Policy 4.2

Coordinate with County, regional and state economic development representatives to recruit sustainable industries that serve markets beyond the Portland region.

Goal 5 Natural Beauty

Incorporate the area's natural beauty into an ecologically compatible built environment.

Policy 5.1

Incorporate significant trees into master plans and site specific designs. Plant new trees to establish an extensive tree canopy as part of the creation of an urban community.

Policy 5.2

Provide scenic viewpoints and public access along the east ridge.

Policy 5.3

Protect views of Mt Hood and locate trails and public areas so Mt Hood can be viewed within the community

Policy 5.4

Establish open space throughout the community consistent with the Open Space Framework Plan. Allow flexibility in site specific design of open space, with no net loss of total open space area.

Policy 5.5

Protect steeply sloped and geologically sensitive areas along the east ridge from development.

Goal 6 Multi-modal Transportation

Provide multi-modal transportation links (such as bus routes, trails, bike-ways, etc.) that are connected within the site as well as to the surrounding areas.

Policy 6.1

Work with Tri-Met and stakeholders to provide bus service and other alternatives to the Concept Plan area.

Policy 6.2

As land use reviews and development occur prior to extension of bus service, ensure that the mix of land uses, density and design help retain transit as an attractive and feasible option in the future.

Policy 6.3

Ensure that local street connectivity and off-street pedestrian routes link together into a highly connected pedestrian system that is safe, direct, convenient, and attractive to walking.

Policy 6.4

The "walkability" of the Concept Plan area will be one of its distinctive qualities. The density of walking routes and connectivity should mirror

the urban form – the higher the density and larger the building form, the "finer" the network of pedestrian connections.

Policy 6.5
Require trails to be provided consistent with the Concept Plan Circulation Framework.

Policy 6.6
Provide bike lanes on Beavercreek Road and all collector streets, except for Main Street. The City may consider off-street multi-use paths and similar measures in meeting this policy. Bike routes will be coordinated with the trails shown on the Circulation Framework.

Goal 7 Safety Along Beavercreek Road
Implement design solutions along Beavercreek Road that promote pedestrian safety, control traffic speeds and access, and accommodate projected vehicular demand.

Policy 7.1
Design Beavercreek Road to be a green street boulevard that maximizes pedestrian safety.

Policy 7.2
Work with the County and State to establish posted speeds that are safe for pedestrians and reinforce the pedestrian-oriented character of the area.

Policy 7.3
Control access along the east side of Beavercreek Road so that full access points are limited to the intersections shown on the Circulation Framework. Right in-Right-out access points may be considered as part of master plans or design review.

Goal 8 Oregon City High School and Clackamas Community College

Promote connections and relationships with Oregon City High School and Clackamas Community College.

Policy 8.1
Coordinate with OCHS and CCC when recruiting businesses and promoting sustainability. Within one year of adoption of the Concept Plan, the City will convene dialogue with OCHS, CCC and other relevant partners to identify target industries and economic development strategies that are compatible with the vision for the Concept Plan. Encourage curricula that are synergistic with employment and sustainability in the Concept Plan area.

Policy 8.2
Prior to application submittal, require applicants to contact OCHS and CCC to inform them and obtain early comment for master plans and design review applications.

Policy 8.3
Improving the level-of-service and investing in the Highway 213 corridor improves the freight mobility along Highway 213, which provides access to Beavercreek Road and the Concept Plan area. Protecting the corridor and intersections for freight furthers the City goal of providing living-wage employment opportunities in the educational, and research opportunities to be created with CCC and OCHS.

Goal 9 Unique Sense of Place

Have a unique sense of place created by the mix of uses, human scale design, and commitment to sustainability.

Policy 9.1

Utilize master plans and design review to ensure detailed and coordinated design. Allow flexibility in development standards and the configuration of land uses when they are consistent with the comprehensive plan, development code, and vision to create a complete and sustainable community.

Policy 9.2

Implement human scale design through building orientation, attractive streetscapes, building form/architecture that is matched to the purpose of the sub-district, location of parking, and other techniques. The design qualities of the community should mirror the urban form – the higher the density and larger the buildings, the higher the expectation for urban amenities and architectural details.

Policy 9.3

Density should generally transition from highest on the west to lowest in the eastern part of the site.

Policy 9.4

Promote compatibility with existing residential areas at the north and south end of the Concept Plan area. Transition to lower densities, setbacks, buffers and other techniques shall be used.

Goal 10 Ecological Health

Manage water resources on site to eliminate pollution to watersheds and lesson impact on municipal infrastructure by integrating ecological and man-made systems to maximize function, efficiency and health.

Policy 10.1

Utilize low impact development practices and stormwater system designs that mimic natural hydrologic processes, minimize impacts to natural resources and eliminate pollution to watersheds.

Policy 10.2

Prepare the Environmentally Sensitive Resource Area overlay to protect, conserve and enhance natural areas identified on the Concept Plan. Apply low-density base zoning that allows property owners to cluster density outside the ESRA and transfer to other sites.

Appendix

1. Project Goals

2. Concept Plan Alternatives

3. GIS Analysis Map

4. Job and Housing Estimates

Appendix I

	To: Beavercreek Road Concept Plan Citizens and Technical Advisory Committees From: Tony Konkol Date: March 13, 2007 Subject: Project Goals with Objectives

The following project goals and supplemental objectives were prepared using the *Ideas we Like, Principles of Sustainable Development,* and the Advisory Committees' long-term vision for the project area. This update reflects input by the Citizens and Technical Advisory Committees at their March 8th, 2007 meeting.

The Beavercreek Road Concept Plan Area will:

Goal

1. Create a **complete community**, in conjunction with the adjacent land uses, that integrates a diverse mix of uses, including housing, services, and public spaces that are necessary to support a thriving employment center;

   Objective 1.1
   Allow a variety of employment uses that may integrate and utilize the surrounding city and rural economies.
   Objective 1.2
   Develop plans that consider the existing rural lands and uses around the Urban Growth Boundary.
   Objective 1.3
   Continue to coordinate with the Oregon City School District and Clackamas Community College to identify partnerships, land needs and programs that would be beneficial to all parties and contribute to the community.
   Objective 1.4
   Encourage neighborhood-oriented and scaled mixed-use centers that provide goods, services, and housing for local workers and residents of all ages and incomes.
   Objective 1.5
   Become a model of sustainability that may be implemented throughout the City.
   Objective 1.6
   Allow the integration of housing and employment uses where practicable.
   Objective 1.7
   Work with Metro to ensure that there is enough land available within the Beavercreek Road Study Area to meet the need for employment/industrial development and reduce the jobs to housing imbalance in the sub-region.

2. Be a **model of sustainable design**, development practices, planning, and innovative thinking;

   Objective 2.1
   Allow a variety of employment uses that may integrate and utilize the surrounding city and rural economies.
   Objective 2.2
   Develop plans that consider the existing rural lands and uses around the Urban Growth Boundary.
   Objective 2.3
   Encourage neighborhood-oriented and scaled mixed-use centers that provide goods, services and housing for local workers and residents of all ages and incomes.
   Objective 2.4
   Encourage environmentally responsible developments that are economically feasible, enhance livability of neighborhoods and enhance the natural environment.
   Objective 2.5
   Investigate development standards that offer incentives for developments that exceed energy efficiency standards and meets green development requirements and goals.

3. Attract **"green" jobs** that pay a living wage;
   Objective 3.1
   Allow a variety of employment uses that may integrate and utilize the surrounding city and rural economies.
   Objective 3.2
   Develop plans that consider the existing rural lands and uses around the Urban Growth Boundary.
   Objective 3.3
   Encourage neighborhood-oriented and scaled mixed-use centers that provide goods, services and housing for local workers and residents of all ages and incomes.
   Objective 3.4
   Allow the integration of housing and employment uses where practicable.
   Objective 3.5
   Work with Metro to ensure that there is enough land available within the Beavercreek Road Study Area to meet the need for employment/industrial development and reduce the jobs to housing imbalance in the sub-region.
   Objective 3.6
   Create a "brand" for the area that reflects the desire for sustainable development that will serve as the theme to attract and recruit businesses and developers as well as guide the design standards and build-out of the area.

4. Maximize opportunities for **sustainable industries that serve markets beyond the Portland region** and are compatible with the site's unique characteristics;

   Objective 4.1

Create a "brand" for the area that reflects the desire for sustainable development that will serve as the theme to attract and recruit businesses and developers as well as guide the design standards and build-out of the area.

Objective 4.2

Work with Metro to ensure that there is enough land available within the Beavercreek Road Study Area to meet the need for employment/industrial development and reduce the jobs to housing imbalance in the sub-region.

Objective 4.3

Support locally based and founded employers that provide living wages jobs.

Objective 4.4

Support the development of sustainable industries that utilize green design standards and development practices.

5. Incorporate the area's **natural beauty** into an ecologically compatible built environment;

Objective 5.1

Design the adjacent land-uses to Beavercreek Road in such a manner to ensure that the pedestrian experience is not diminished through the development of fences, parking lots, backs of buildings, or other impediments to pedestrian access and circulation.

Objective 5.2

Allow a variety of employment uses that may integrate and utilize the surrounding city and rural economies.

Objective 5.3

Develop plans that consider the existing rural lands and uses around the Urban Growth Boundary.

Objective 5.4

Work with Metro to ensure that there is enough land available within the Beavercreek Road Study Area to meet the need for employment/industrial development and reduce the jobs to housing imbalance in the sub-region.

6. Provide **multi-modal transportation links** (such as bus routes, trails, bike-ways, etc.) that are connected within the site as well as to the surrounding areas;

Objective 6.1

Provide public connectivity routes for bicycles and pedestrians that encourage non-vehicular trips to employment, retail and recreational areas within the study area and to the communities beyond.

Objective 6.2

Provide an integrated street system that is designed as practicable to minimize the impacts to the environment through the use of green streets, swales and other natural stormwater systems that provide water quality and quantity control and contribute to the natural beauty of the area.

Objective 6.3

Explore local and regional transit opportunities that will increase non-single occupancy vehicle travel.

7. Implement **design solutions along Beavercreek Road** that promote pedestrian safety, control traffic speeds and access, and accommodate projected vehicular demand;

   Objective 7.1
   Develop and maintain a multi-modal transportation system that is safe for all users and will minimize conflict points between different modes of travel, especially across Beavercreek Road to the existing neighborhoods, Clackamas Community College, Oregon City High School and the Berry Hill Shopping Center.
   Objective 7.2
   Design the adjacent land-uses to Beavercreek Road in such a manner to ensure that the pedestrian experience is not diminished through the development of fences, parking lots, backs of buildings, or other impediments to pedestrian access and circulation.

8. Promote connections and relationships with **Oregon City High School and Clackamas Community College**;

   Objective 8.1
   Allow a variety of employment uses that may integrate and utilize the surrounding city and rural economies.
   Objective 8.2
   Develop plans that consider the existing rural lands and uses around the Urban Growth Boundary.
   Objective 8.3
   Continue to coordinate with the Oregon City School District and Clackamas Community College to identify partnerships, land needs and programs that would be beneficial to all parties and contribute to the community.

9. Have a **unique sense of place** created by the mix of uses, human scale design, and commitment to sustainability.

   Objective 9.1
   Provide public connectivity routes for bicycles and pedestrians that encourage non-vehicular trips to employment, retail and recreational areas within the study area and to the communities beyond.
   Objective 9.2
   Provide an integrated street system that is designed as practicable to minimize the impacts to the environment through the use of green streets, swales and other natural stormwater systems that provide water quality and quantity control and contribute to the natural beauty of the area.
   Objective 9.3
   Allow a variety of employment uses that may integrate and utilize the surrounding city and rural economies.
   Objective 9.4
   Develop plans that consider the existing rural lands and uses around the Urban Growth Boundary.

Objective 9.5

Encourage neighborhood-oriented and scaled mixed-use centers that provide goods, services and housing for local workers and residents of all ages and incomes.

Objective 9.6

Allow the integration of housing and employment uses where practicable.

Objective 9.7

Work with Metro to ensure that there is enough land available within the Beavercreek Road Study Area to meet the need for employment/industrial development and reduce the jobs to housing imbalance in the sub-region.

Objective 9.8

Create a "brand" for the area that reflects the desire for sustainable development that will serve as the theme to attract and recruit businesses and developers as well as guide the design standards and build-out of the area.

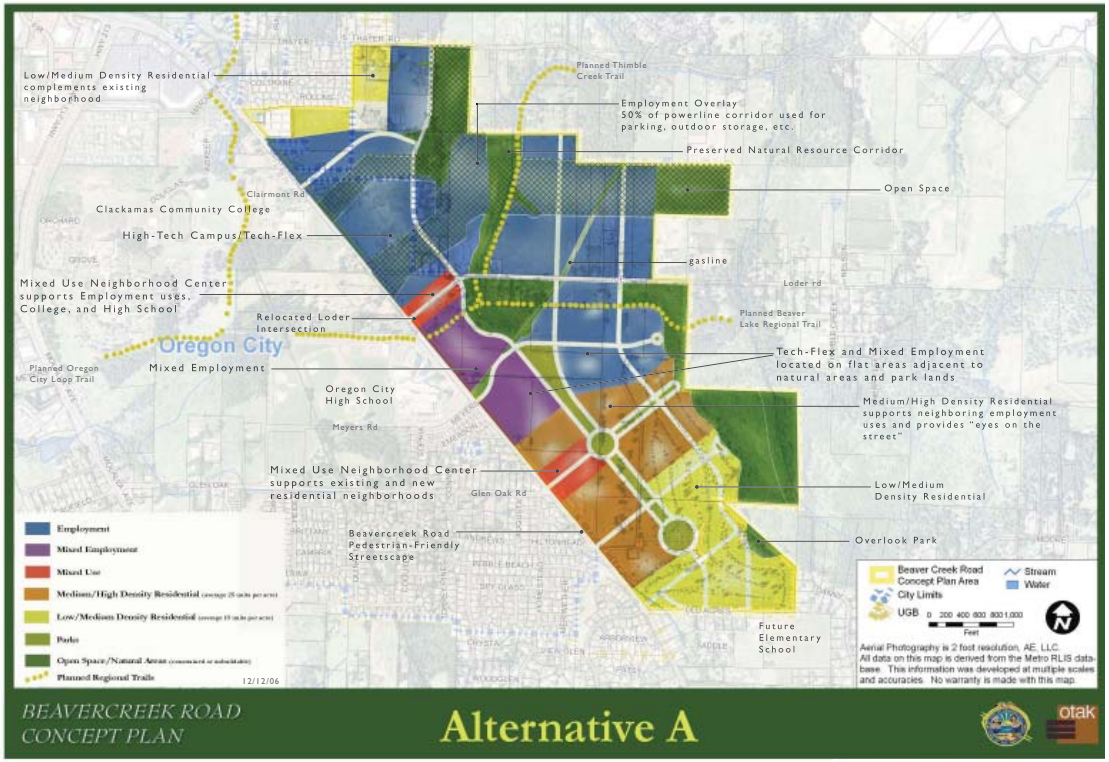
Objective 9.9

Design the adjacent land-uses to Beavercreek Road in such a manner to ensure that the pedestrian experience is not diminished through the development of fences, parking lots, backs of buildings, or other impediments to pedestrian access and circulation.

10. Ecological Health – Manage water resources on site to **eliminate pollution to watersheds** and lesson impact on municipal infrastructure by integrating ecological and man-made systems to maximize function, efficiency and health.

Objective 10.1

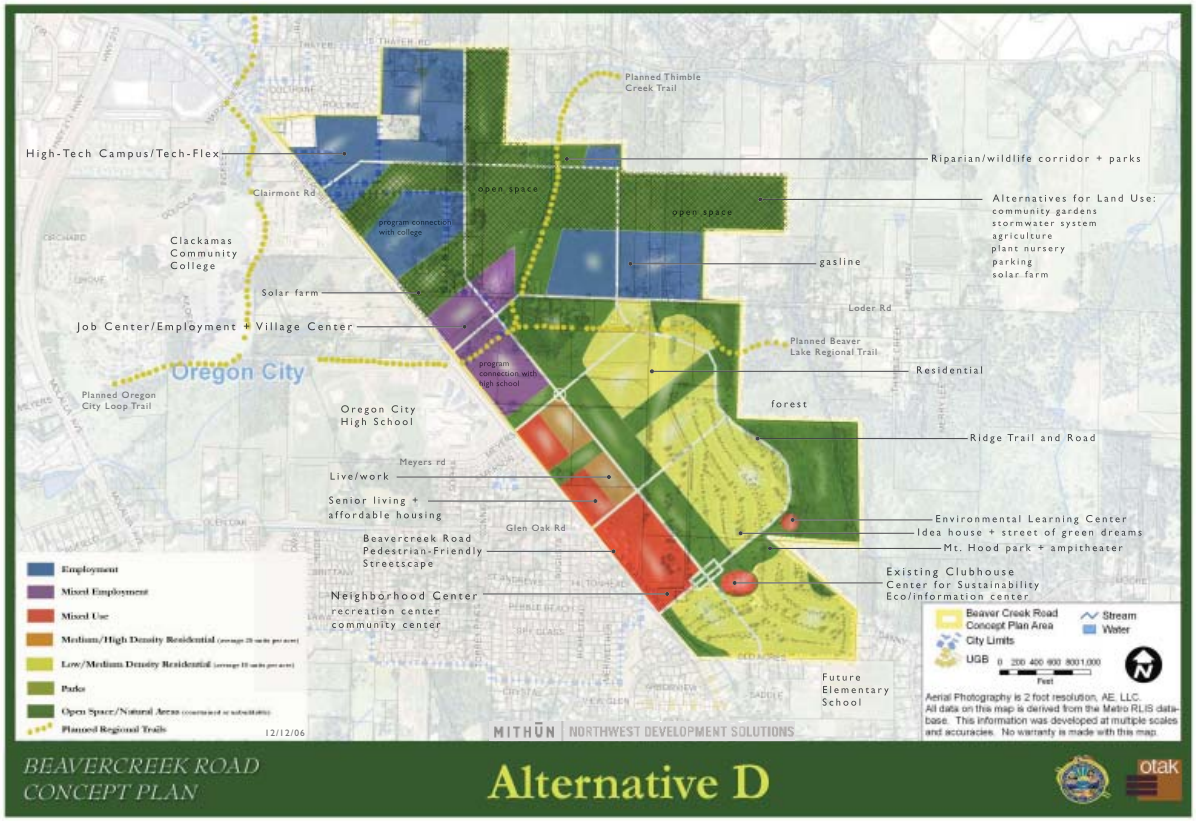
Provide an integrated street system that is designed as practicable to minimize the impacts to the environment through the use of green streets, swales and other natural stormwater systems that provide water quality and quantity control and contribute to the natural beauty of the area.



BEAVERCREEK ROAD CONCEPT PLAN

Alternative A

otak



BEAVERCREEK ROAD CONCEPT PLAN

Alternative D

otak

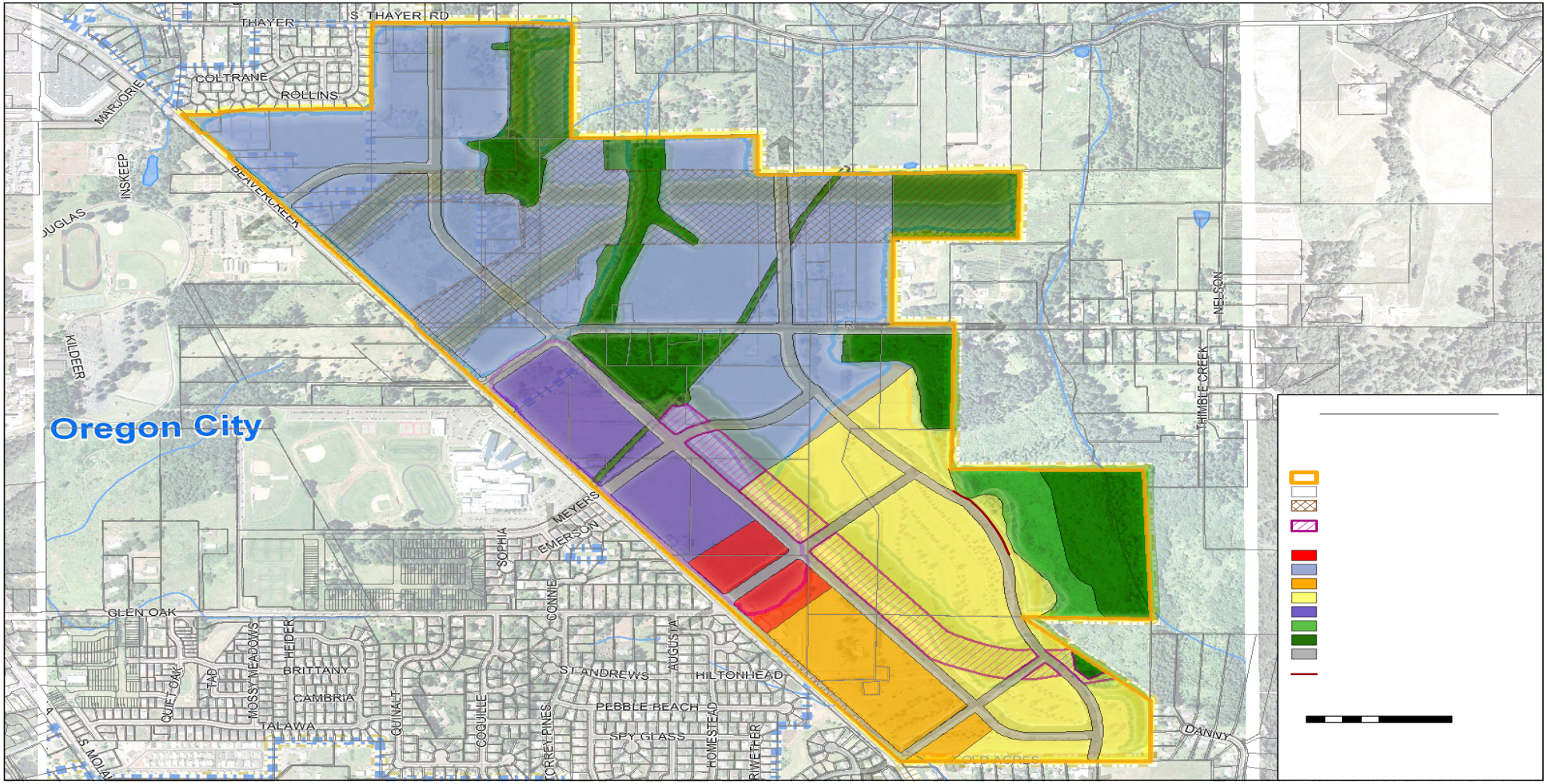

Oregon City
THAYER
S THAYER RD
COLTRANE
ROLLINS
MARJORIE
INSKEEP
BEAVERCREEK
KILDEER
NELSON
THIMBLE CREEK
MEYERS
EMERSON
SOPHIA
CONNIE
GLEN OAK
HEIDER
MOSSY MEADOWS
BRITTANY
QUIET OAK
TAD
CAMBRIA
TALAWA
QUINALT
COQUILLE
CORET PINES
ST ANDREWS
AUGUSTA
HILTONHEAD
PEBBLE BEACH
SPY GLASS
HOMESTEAD
RIVERTHER
DANNY
OLD ACRES

Table 2
Beavercreek Concept Plan Job & Housing Density Assumptions
Revised - 7/10/07

Land Use Category	Hybrid Gross Acres	Hybrid Net Acres*	FAR/Acre**	SF/Job**	# of Jobs***	Avg. Units/Acre	# of Units+
North Employment Campus (adjusted gross acreage)	149	127	0.3	450	3,678		
Mixed Employment Village	26	21	0.44	350	1,139		
Main Street****	10	8	0.44	350	219	25	100
West Mixed Use Neighborhood	22	18			15	22	387
East Mixed Use Neighborhood	77	62			21	8.7	536
Total # of Jobs					**5,073**		
Total # of Housing Units							**1,023**
Total Acres of Developed Land++	**284**	**235**					

Land Use Category	Plan A Gross Acres	Plan A Net Acres*	FAR/Acre**	SF/Job**	# of Jobs***	Avg. Units/Acre	# of Units+
Employment (adjusted gross acreage)	139	118	0.3	450	3,431		
Mixed Employment	24	20	0.44	350	1,117		
Mixed Use****	10	9	0.44	350	233	25	106
Medium/High Density Residential	50	43			43	25	1,063
Low/Medium Density Residential	53	45			18	10	451
Total # of Jobs					**4,841**		
Total # of Housing Units							**1,619**
Total Acres of Developed Land++	**276**	**235**					

Land Use Category	Plan D Gross Acres	Plan D Net Acres*	FAR/Acre**	SF/Job**	# of Jobs***	Avg. Units/Acre	# of Units+
Employment (adjusted gross acreage)	84	71	0.3	450	2,073		
Mixed Employment	25	21	0.44	350	1,164		
Mixed Use****	29	25	0.44	350	675	25	308
Medium/High Density Residential	9	8			8	25	191
Low/Medium Density Residential	99	84			34	10	842
Total # of Jobs					**3,953**		
Total # of Housing Units							**1,341**
Total Acres of Developed Land+++	**246**	**209**					

***For Hybrid -** Net acres equals gross acres minus 15% for local roads and easements in Employment. Mixed Employment, Mixed Use, and residential areas assume 20% for local roads and easements

* *Based on Metro 2002-2022 Urban Growth Report: An Employment Land Need Analysis. Includes total on site employment (full and part time). Mixed Employment FAR and job density reflects a mix of office, tech/flex, and ground floor retail.

***Number of Jobs in Employment, Mixed Employment, Mixed Use calculated by multiplying total acres by the FAR; Converting to square feet; and dividing by number of jobs/square foot. Jobs in residential areas (Work at Home Jobs) estimated at 4% (potential could be as high as 15%).

**** Mixed Use land use assumes 50% of acreage devoted to commercial uses and the remaining 50% devoted to vertical mixed use.

+Number of units calculated by multiplying total net acres of residential land use by average units per acre

++Includes 50% of useable power line corridor (26 acres total) as part of developed land (included in Employment land area)

+++Does not include powerline corridor acreage as part of developed land

Appendix IV

Table 3
Land Use Metrics/Assumptions - HYBRID
Revised - 7/10/07

Land Use Category (acres)	Hybrid	Alt. A	Alt. D
North Employment Campus (adjusted gross acreage)*	149	139	84
Mixed Employment Village	26	24	25
Main Street	10	10	29
West Mixed Use Neighborhood	22	50	9
East Mixed Use Neighborhood	77	53	99
Total Acres of "built" land use	**284**	**276**	**246**
Other Land Uses (not "built")			
Parks/Open Space/Natural Areas (Total)**	113	132	166
Major ROW+	56	36	30
Existing Uses (unbuildable)	0	7	7
Total Project Area Gross Acres	**453**	**~450**	**~450**

***Adjusted gross acreage** is the sum of 50% of the employment land use shown under the powerline easement plus all other unconstrained employment land use areas. Calculations shown below:

Land Use Category (acres)	Hybrid	Alt. A	Alt. D
Total North Employment Campus	175	166	84
Unconstrained NEC	**123**	**111**	**84**
Employment with powerline overlay	52	55	0
Useable portion of powerline overlay (50%)	**26**	**28**	**na**
North Employment Campus (adjusted gross acreage)*	**149**	**139**	**84**

** Open Space/Natural areas is the sum of all "unbuildable lands" as shown on the *Buildable Lands Map* plus two areas under the powerlines. Calculations shown below.

Open Space/Natural Areas Break-Out	Hybrid	Alt. A	Alt. D
Open Space -Gas Overlay	3	4	4
Open Space - Unbuildable Powerlines***	48	49	0
Environmental Resources/*Buildable Lands Map*	61	61	61
Parks	na	12	na
Other Open Space Areas	18	6	101
Open Space/Natural Areas (Total)	**130**	**132**	**166**

***For Hybrid** - Unbuildable Powerlines area includes 12 acres on east edge of site under powerlines plus 50% of employment area under powerlines (~26 acres) and the PGE parcel (10 acres). **For Alt. A** - Unbuildable Powerlines area includes 12 acres on east edge of site under powerlines and 10 acres of the PGE Parcel and 50% of powerline area (27 acres).

+Major ROW are approximate location & acreage (may be shown as crossing natural resource areas. Actual location and size of ROW will be addressed during development review/master planning). Includes 2 acre adjustment for GIS polygon alignment.

MEMO

Date: June 26, 2019

To: Laura Terway & Christina Robertson-Gardiner, City of Oregon City

CC: Steve Faust, 3J Consulting

From: Elizabeth Decker, JET Planning

Subject: Beavercreek Road Concept Plan Map and Code Implementation Project

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I. PROJECT DESCRIPTION AND BACKGROUND

I.a. CONCEPT PLAN SUMMARY

The Beavercreek Road Concept Plan (BRCP) establishes the goal of creating a complete and sustainable community in southeast Oregon City within a 453-acre district along Beavercreek Road. The district is intended to provide for a mix of uses including an employment campus north of Loder Road, mixed-use districts along Beavercreek Road, and two mixed-use neighborhoods woven together by open space, trails, a network of green streets, and sustainable development practices. District development will help to provide 1000 to 1,600 diverse housing options and to realize the City's economic development goals, including creation of up to 5,000 family-wage jobs. The five subdistricts that support these development goals include:

- ***North Employment Campus:*** The largest subdistrict, located north of Loder Road and is intended for tech flex and campus industrial uses.
- ***Mixed Employment Village:*** Located along Beavercreek Road between Meyers Road and Glen Oak Road, and intended for mixed-use, 3-5 story building scale, active street life.
- ***Main Street:*** A node located Beavercreek Road and Glen Oak Road, intended for mixed-use, local shops and services.
- ***West Mixed-Use Neighborhood:*** Located along Beavercreek Road south of Glen Oak Road and the Main Street subdistrict, and intended for medium to high density housing and limited community uses.
- ***East Mixed-Use Neighborhood:*** Located in the southeast end of concept plan area, and is intended for low-density residential and green space throughout.

- ***Parks, Open Spaces and Resource Areas:*** Includes a connected system of parks, open spaces and natural areas that link together and link to the environmentally sensitive areas throughout the district, including the undevelopable portion of the powerline overlay.

The Beavercreek Road Concept Plan was initially adopted in 2008 and re-adopted in 2016, following legal and legislative findings that affirmed the plan's consistency with Metro regional employment goals. (See File No. LE-15-0003.) While approximately half of the district has been annexed to the City, mapping and zoning regulations need to be developed and applied for the annexed areas and the remainder of the district to fully implement the BRCP.

I.b. IMPLEMENTATION PROJECT SUMMARY

Oregon City aims to further implementation of the Beavercreek Road Concept Plan (BRCP) through comprehensive plan designation and zone mapping, and development code amendments. The specific tasks for this project will be to develop comprehensive plan map and zoning map designations to implement the Beavercreek Road Concept Plan map, and supporting development code regulations for each implementing zone. The existing Concept Plan map was the guide for mapping implementation. Existing city zoning, bolstered by recent Amendments to the Oregon City Municipal Code (including the Equitable Housing Project recommendations) code amendments, generally lines up with the desired land use concepts within the plan and will facilitate implementation with minor amendments. Additional plan goals beyond land use implementation are outside the scope of this project, including infrastructure, transportation and economic development measures that have already been completed or planned for the concept plan area. Additional items will be pursued separately from this land use implementation project.

I.c. PROJECT PUBLIC ENGAGEMENT

The BRCP implementation project engaged a range of stakeholders in multiple venues and formats over eight months, with each successive round of engagement used to inform project refinements in subsequent phases.

The first round of engagement consisted of four stakeholder interviews with property owners, economic development representatives, and local educational institutions to understand current conditions and priorities for the implementation project. This initial round also included three presentations to the following community groups to update them on the status of the BRCP concept plan and hear their priorities for the implementation process:

- Caulfield Neighborhood Association- January 22, 2019

- The Hamlet of Beavercreek- January 23, 2019
- Beavercreek Blue Ribbon Committee- January 17, 2019

Three public meetings were held at the Oregon City High School, near the concept plan area, and at City Hall during the course of the project to provide information and discussion opportunities on the evolving maps and code amendments:

- Tuesday, January 29, 2019- Oregon City High School Library- 7:00-8:30 PM
- Tuesday, April 9, 2019- Oregon City High School Library- 7:00-8:30 PM
- Monday, June 10, 2019- City Hall Commission Chambers - 5:00-7:00 PM

For all meetings, materials were also available online including comment forms to allow community members to participate virtually if they were not able to attend the meetings in person.

Additional presentations were held at the following City meetings to detail the implementation project elements:

- Citizen Involvement Committee- January 7, 2019
- Transportation Advisory Committee- March 19, 2019

The proposed map and code amendments were discussed at the two work sessions this spring:

- Planning Commission Work Session- May 13, 2019
- City Commission Work Session- June 11, 2019

Throughout the project, ongoing methods used to engage citizens in the process have included:

- Project website with regular updates (https://www.orcity.org/Beavercreekconceptplan)
- Email Updates announcing upcoming meetings and events
- Mailing List
- Public comment tracker, compiling feedback from all engagements with responses from staff, updated throughout the project
- Online comment forms
- Naming survey for renaming the concept plan area
- Notice board posted within the concept plan area

The following meetings are anticipated as of the date of this report as part of the adoption process.

- 1st Planning Commission Hearing: August 12, 2019- 7:00 PM
- City Commission Work Session (Beavercreek Road Street Design): August 13, 2019
- Additional Planning Commission and City Commission public hearings and work sessions to be scheduled.

All meetings will be properly noticed and advertised through the project's mailing list and website.

II. PROPOSED AMENDMENTS

II.a. AMENDMENT SUMMARY

The implementation project includes map and text amendments consistent with BRCP including:

1. *Comprehensive plan text amendments:* Proposed clarification in the Parks Master Plan (ancillary document to the Comprehensive Plan) as well as amendments to the Transportation System Plan (ancillary document to the Comprehensive Plan) as needed.
2. *Comprehensive plan map amendments:* Proposed amendments to the comprehensive plan map implement the five subdistricts identified in the BRCP consistent with the concept plan maps throughout the concept plan area.
3. *Zoning map amendments:* Proposed amendments to the zoning map implement the five subdistricts consistent with the concept plan and comprehensive plan designations for properties within the concept plan area that have been annexed into the city limits. Zoning for properties within the Concept Plan boundary but not annexed into the City will be applied at the time of annexation, consistent with the adopted comprehensive plan map.
4. *Zoning text amendments:* Code amendments to the Oregon City Municipal Code include geographically specific provisions to supplement the base zoning district provisions to fully implement the concept plan goals for each subdistrict. Limited amendments to subdivision and site plan review standards are also proposed to ensure concept plan standards are implemented at the time of development.

The BRCP subdistricts are proposed to be implemented with existing city comprehensive plan designations and zoning districts for proposed maps, with proposed code amendments building on existing district standards.

Subdistrict	*Comprehensive plan designation*	*Zone*
North Employment Campus	Industrial (I)	Campus Industrial (CI)
Mixed Employment Village	Mixed-Use Corridor (MUC)	Mixed-Use Corridor (MUC-2)
Main Street	Mixed-Use Corridor (MUC)	Neighborhood Commercial (NC)
West Mixed-Use Neighborhood	High-Density Residential (HDR)	High-Density Residential (R-2)
East Mixed-Use Neighborhood	Medium-Density Residential (MDR)	Medium-Density Residential (R-5)
Environmentally Sensitive Restoration Area		Natural Resources Overlay District (NROD) Geological Hazard Overlay District (GHOD)

II.b. SUMMARY OF ZONING TEXT AMENDMENTS

The proposed code amendments specific to each subdistrict are described below, and supplement rather than supplant the base zone standards.

OCMC 16.08, Land Divisions – Process and Standards

- Proposed code amendments include additional public park requirements or fee-in-lieu option for certain properties to ensure land for the South Central Open Space Network is reserved and dedicated to the city at the time of residential subdivisions. This is expected to largely apply to development in the R-5 district.

OCMC 17.10, R-5 Medium Density Residential District (East Mixed-Use Neighborhood subdistrict)

- No changes are proposed to the mix of uses or dimensional standards in the zone beyond those proposed in the Amendments to the Oregon City Municipal Code (including the Equitable Housing Project recommendations).

- Standards for the Low-Impact Conservation Area implement the plan goals for the area upslope of Thimble Creek, on the eastern edge of the Beavercreek Road district. The proposed standards limit development to two units per acre, require open space preservation and restoration, and require view corridors to preserve views.
- A 40-foot perimeter buffer is proposed along the southern edge of the district including landscaping, setbacks and fencing, to manage the transition to lower-density residential development outside City limits along Old Acres Lane to the south.

OCMC 17.12, R-2 High Density Residential District (West Mixed-Use Neighborhood subdistrict)

- Allows additional uses consistent with the Concept Plan include live/work dwellings and limited commercial/mixed-use spaces.
- Provides up to a 20% density bonus for development incorporating sustainability features.
- Additional changes in Site Plan and Design Review standards to add requirement for additional public park dedication or fee-in-lieu, consistent with requirement for new subdivisions.

OCMC 17.24, MC Neighborhood Commercial District (Main Street subdistrict)

- Limits uses to a 10,000 SF building footprint to encourage pedestrian-scale, main street businesses. Limits residential uses to 50% of the project floor area, and prohibits ground-floor residential uses within 150 feet of Glen Oak Road (which will be the "main street.") Adds a new use category for artisan and specialty goods production to allow limited manufacturing type uses.
- Increase dimensional standards to match scale proposed in the Concept Plan, including a five-story height limit and 0.5 FAR minimum.
- Improves building presence and interaction along the street by requiring parking to be located behind building facades.

OCMC 17.29, MUC Mixed-Use Corridor District (Mixed Employment Village subdistrict)

- Light industrial uses are permitted to implement the employment aspect of the vision for this subdistrict. Retail and service uses, including food service, are limited to 20% of a site to maintain the focus on employment uses generating family-wage jobs. Residential uses are limited to upper stories only.

- One parcel with an in-progress residential development is permitted outright, to avoid creating a nonconforming use.
- An additional dimensional standard implements a minimum 0.35 FAR for new development to ensure efficient use of land.

OCMC 17.31, CI Campus Industrial District (North Employment Campus subdistrict)

- Retail and professional service uses are limited consistent with Metro Title 4 requirements to preserve land for industrial uses. Offices are permitted consistent with uses outlined in the Concept Plan, whereas distribution and warehouse uses are prohibited because they create relatively few jobs per acre inconsistent with the plan goals.
- Several parcels with existing single-family residential development are permitted outright, to avoid creating nonconforming uses. (These parcels are outside of Title 4 lands, so there is no conflict with employment requirements.)
- Additional standards require landscaping, berms and fences within the required 25-foot transition area between industrial and residential uses.
- Outdoor storage is limited to a maximum of 25% of the developable area to avoid inefficient use of land that does not support employment plan goals.
- A minimum 30-foot open space and trail corridor is required along the powerline corridor. Additional parks, trails, urban agriculture and community garden uses are permitted consistent with the plan goals for uses within the powerline easement.
- Sustainable development features are required for all development to implement the plan's sustainability goals.

OCMC 17.44, US – Geologic Hazards and OCMC 17.49 – Natural Resources Overlay District

- No changes are proposed to the geologic hazard or natural Resources Overlay District standards for this district; resource areas within the concept plan area will be protected consistent with existing standards.

OCMC 17.62, Site Plan and Design Review

- Proposed code amendments include additional public park requirements or fee-in-lieu option to ensure land for the South Central Open Space Network is reserved and dedicated to the city at the time of residential subdivisions.

This is intended to apply to any residential development in the R-2 or the mixed-use districts that does not get developed through subdivision.

III. COMPLIANCE

III.a. CHAPTER 17.68 ZONING CHANGES AND AMENDMENTS

17.68.010 Initiation of the amendment.

A text amendment to this title or the comprehensive plan, or an amendment to the zoning map or the comprehensive plan map, may be initiated by:

A. A resolution by the commission;

B. An official proposal by the planning commission;

C. An application to the planning division presented on forms and accompanied by information prescribed by the planning commission.

All requests for amendment or change in this title shall be referred to the planning commission.

Response: This request is for amendments to the zoning map, amendments to the comprehensive plan map, and text amendments to the Oregon City Municipal Code and was initiated by the Planning Division.

17.68.020 Criteria.

The criteria for a zone change are set forth as follows:

A. The proposal shall be consistent with the goals and policies of the comprehensive plan.

Response: Consistency with the Oregon City Comprehensive Plan (OCCP) Goals and Policies follow starting on page 11.

B. That public facilities and services (water, sewer, storm drainage, transportation, schools, police and fire protection) are presently capable of supporting the uses allowed by the zone, or can be made available prior to issuing a certificate of occupancy. Service shall be sufficient to support the range of uses and development allowed by the zone.

Response: The capacity of the respective public facilities and services to support the proposal is addressed below.

Water and Sewer Capacity

Please refer to the attached memorandum from 3J Consulting. The memorandum provides an assessment of the water and sanitary sewer system implications of the map and code amendments proposed with the BRCP implementation project.

Wastewater treatment is provided by the Tri-City Sewer District, which the project contacted for comment.

The 3J memorandum concludes that development of 1,105 dwelling units and 5,734 jobs within the BRCP area have been adequately planned for in infrastructure master plans and sufficient capacity will be available to serve development. The Sanitary Sewer (2014) and Water Distribution (2012) Master Plans were all created subsequent to initial adoption of the Beavercreek Road Concept Plan (2008). Each master plan incorporated the BRCP area into future capital improvement projections and will ensure adequate water and sewer capacity is developed.

South Fork Water Board (SFWB), Oregon City's water provider was contacted for comment.

Schools

The proposal was sent to the Oregon City School District (OCSD) for comment.

Police and Fire Protection

Oregon City Police Department and Clackamas Fire District capacity would not be affected by the proposal, since the proposal does not change existing service areas. They have been contacted for comment.

Wastewater Treatment

Tri-City Sewer District was contacted for comment.

Storm Drainage

This proposal does not change the city's adopted policies and technical documents related to storm water management and erosion control. The Draft 2019 Oregon City Stormwater Master Plan includes the BRCP area, which is part of the Newell Creek Basin, but does not identify any capital improvement projects specifically needed to serve the BRCP district. The Plan states that the eventual layout of the stormwater conveyance systems and management facilities will be crafted through the preliminary and final design process for development projects within the BRCP district.

Transportation

Impacts to the transportation system are addressed under (C) below.

Based on the various analyses provided, public facilities and services are presently capable of supporting the uses allowed by the proposal, or can be made available prior to issuing a certificate of occupancy. **This criterion is met.**

C. The land uses authorized by the proposal are consistent with the existing or planned function, capacity and level of service of the transportation system serving the proposed zoning district.

Response: The impacts of the proposal on the transportation system were reviewed by a transportation consultant, DKS. Please refer to the DLS analysis and memorandum which is attached to this narrative. The memorandum provides an assessment of the transportation implications of the project proposal. The memorandum assesses whether the proposed amendments trigger a finding of significant effect that would require further analysis to determine transportation impacts under OAR 660-12-0060 (Transportation Planning Rule or "TPR").

The memo concludes that the proposed map and code amendments do not result in a significant change in the number of trips resulting from the dwelling units and jobs anticipated within the BRCP district compared to the traffic anticipated and planned for in Oregon City's Transportation System Plan (TSP) adopted in 2013. Therefore, the proposed amendments do not have a significant effect on the transportation system and that the city may adopt findings to that effect when adopting the proposed amendments. **This criterion is met.**

D. Statewide planning goals shall by addressed if the comprehensive plan does not contain specific policies or provisions which control the amendment.

Response: The acknowledged Oregon City Comprehensive Plan (OCCP) addresses all of the applicable Statewide Planning goals unless the Statewide Goal is inapplicable. The relevant sections of the OCCP implemented by this proposal, and the applicable Statewide Goals, is indicated below.

Statewide Planning Goal	**OCCP Section / Goal(s) Implemented by this Proposal**
1: Citizen Involvement	1. Citizen Involvement / Goals 1.2, 1.4
2: Land Use Planning	2. Land Use Planning / Goals 2.1, 2.3, 2.4, 2.5, 2.6, 2.7
3: Agricultural Lands	3. Not applicable within UGB
4: Forest Lands	4. Not applicable within UGB
5: Natural Resources, Scenic and Historic Areas, and Open Spaces	5. Open Spaces, Scenic and Historic Areas, and Natural Resources / Goals 5.1, 5.4
6: Air, Water and Land Resources Quality	6. Quality of Air, Water, and Land Resources / Goals 6.1, 6.2
7: Areas Subject to Natural Hazards	7. Natural Hazards / Goal 7.1
8: Recreation Needs	8. Parks and Recreation / Goal 8.1,

9: Economic Development	9. Economic Development / Goals 9.1, 9.3, 9.5, 9.7, 9.8
10: Housing	10. Housing / Goals 10.1, 10.2
11: Public Facilities and Services.	11. Public Facilities / Goals 11.1, 11.6, 11.7
12: Transportation	12: Transportation / Goal 12.1
13: Energy Conservation	13. Energy Conservation / Goal 13.1
14: Urbanization	14. Urbanization / Goal 14.3
15: Willamette River Greenway	Not affected by this proposal.
16: Estuarine Resources	Not applicable.
17: Coastal Shorelands	Not applicable.
18: Beaches and Dunes	Not applicable.
19: Ocean Resources	Not applicable.

Detailed responses to the OCCP goals and policies are provided in Section III.b below.

III.b. OREGON CITY COMPREHENSIVE PLAN GOALS AND POLICIES

Goal 1.2 Community and Comprehensive Planning

Ensure that citizens, neighborhood groups, and affected property owners are involved in all phases of the comprehensive planning program.

Policy 1.2.1

Encourage citizens to participate in appropriate government functions and land-use planning.

Goal 1.4 Community Involvement

Provide complete information for individuals, groups, and communities to participate in public policy planning and implementation of policies.

Policy 1.4.1

Notify citizens about community involvement opportunities when they occur.

Response: **The proposal is consistent with these Goals and Policies**. The project provided numerous opportunities for citizen involvement, including engagement with the Citizen Involvement Committee, the Caufield Neighborhood Association, property owners, and other stakeholders through multiple avenues throughout the eight-month project planning process with multiple notification and participation options provided. See Section I.c for full summary of citizen involvement efforts.

2.1 Efficient Use of Land

Ensure that property planned for residential, commercial, office, and industrial uses is used efficiently and that land is developed following principles of sustainable development.

Response: The proposal maps and supplements existing zoning district standards for the R-5, R-2, NC, MUC-II, and CI zones that have been found to support efficient and sustainable development. The BRCP envisions the area developed with vibrant, walkable, amenity rich neighborhoods with active community centers, as mapped and implemented by this proposal. The proposed code amendments further support efficient land use by providing residential density bonuses, FAR minimums for mixed-use development, and requiring sustainable design features for industrial development. **The proposal is consistent with this Goal.**

Policy 2.1.1

Create incentives for new development to use land more efficiently, such as by having minimum floor area ratios and maximums for parking and setbacks.

Response: The proposed code amendments create additional incentives for efficient land use in the BRCP district beyond the existing code standards, including higher minimum FARs for development in the two mixed-use zones and reduced setbacks and landscaping area for the NC zone applied to the Main Street subdistrict. The OCMC already includes parking maximums in OCMC 17.52.020. **The proposal is consistent with this Policy.**

Policy 2.1.2

Encourage the vertical and horizontal mixing of different land-use types in selected areas of the city where compatible uses can be designed to reduce the overall need for parking, create vibrant urban areas, reduce reliance on private automobiles, create more business opportunities and achieve better places to live.

Response: The proposed map amendments apply two existing mixed-use zones with the BRCP area, the MUC-II and NC zones. In addition to the mix of office, commercial and residential uses allowed in the base zones, the proposed code amendments expand the mix of uses including allowing light manufacturing uses in the MUC-II zone. The proposed code amendments limit the scale and percentages of different categories of uses, including limiting residential uses to upper stories or ground-floor uses set back a minimum distance from the main roadways, to provide for a greater mix of uses. The proposed code amendments also introduce opportunities for small-scale commercial uses in the R-2 zone for additional opportunities for mixed-use development. **The proposal is consistent with this Policy.**

Goal 2.3 Corridors

Focus transit-oriented, higher intensity, mixed-use development along selected transit corridors.

Response: The proposed map amendments apply two existing mixed-use zones with the BRCP area, the MUC-II and NC zones, along Beavercreek Road, which has potential to be a future transit corridor as development increases potential ridership numbers. The higher-intensity residential development zoned R-2 is also located along Beavercreek Road, compared to medium-density residential areas zoned R-5 located further east away from major roads. In addition, the site is near the Clackamas Community College which has a transit center for Tri-Met. **The proposal is consistent with this Goal.**

Policy 2.4.2

Strive to establish facilities and land uses in every neighborhood that help give vibrancy, a sense of place, and a feeling of uniqueness; such as activity centers and points of interest.

Response: The essence of the BRCP is to establish a district with interconnected, vibrant neighborhoods. The proposed map amendments support a mix of uses throughout the district, included a district focal point in the Main Street subdistrict zoned NC that will serve as the hub for the district's neighborhoods. The proposed code amendments also support development of smaller-scale activity centers throughout the district, such as permitting small-scale commercial uses with the East Mixed-Use Neighborhood zoned R-2 and supporting creation of the South-Central Open Space Network through required parkland dedications. **The proposal is consistent with this Policy.**

Policy 2.4.3

Promote connectivity between neighborhoods and neighborhood commercial centers through a variety of transportation modes.

Response: The BRCP plans for multimodal transportation networks throughout the district, as supported by the proposed map and code amendments. The proposed code amendments support creation of the South-Central Open Space Network through required parkland dedications, which will form a linear park and multimodal trail connecting multiple subdistricts. **The proposal is consistent with this Policy.**

Goal 2.5 Retail and Neighborhood Commercial

Encourage the provision of appropriately scaled services to neighborhoods.

Response: The map amendments, consistent with the BRCP map, provide for a Main Street subdistrict zoned NC in close proximity to the residential East and West Mixed-Use Neighborhoods. In addition, the proposed code amendments add opportunities to integrate small-scale commercial uses in the West Mixed-Use Neighborhood zoned R-2. **The proposal is consistent with this Goal.**

Policy 2.5.4

Encourage the development of successful commercial areas organized as centers surrounded by higher density housing and office uses, rather than as commercial strips adjacent to low-density housing.

Response: The map amendments, consistent with the BRCP map, provide for a Main Street subdistrict zoned NC in close proximity to the higher-density West Mixed-Use Neighborhood zoned R-2 and the Mixed Employment Village subdistrict zoned MUC-II that will support office uses. There are no commercial strips proposed adjacent to lower-density housing in the East Mixed-Use Neighborhood zoned R-5. **The proposal is consistent with this Policy.**

Policy 2.5.5

Encourage commercial and industrial development that enhances livability of neighborhoods through the design of attractive LEEDTM-certified buildings and environmentally responsible landscaping that uses native vegetation wherever possible, and by ensuring that development is screened and buffered from adjoining residential neighborhoods and access is provided by a variety of transportation modes.

Response: The proposed code amendments include requirements for sustainable design features for industrial development within the North Employment Campus zoned CI; the menu of features includes LEEDTM-certified buildings and use of native vegetation. The proposed code amendments also provide for an enhanced landscaping buffer incorporating berms and fencing between the industrial subdistrict and adjacent residential development in the East Mixed-Use Neighborhood. The BRCP includes plans for a multimodal transportation network that will be built out as development occurs. **The proposal is consistent with this Policy.**

Goal 2.6 Industrial Land Development

Ensure an adequate supply of land for major industrial employers with family-wage jobs.

Response: The map amendments designate 236.1 gross acres, estimated at 132.1 net acres for Industrial designation and Campus Industrial zoning; the North Employment Campus is the largest of all the BRCP subdistricts. All Metro Title 4

land protected for employment use has been designated and zoned CI. The existing CI zone allows a range of uses that support family-wage jobs, such as light manufacturing; the proposed code amendments further protect job generation potential by limiting the amount of site area that can be used for outdoor storage areas and prohibiting distribution and warehouse uses, which typically do not generate significant job opportunities. **The proposal is consistent with this Goal.**

Policy 2.6.2

Ensure that land zoned or planned for industrial use is used for industrial purposes, and that exceptions are allowed only where some other use supports industrial development. New non-industrial uses should especially be restricted in already developed, active industrial sites.

Response: The map amendments ensure that land planned for industrial use is protected for industrial purposes by zoning it CI. The CI zoning code standards limit non-industrial uses, and the proposed code amendments further limit the size of any supporting retail or office to 5,000 SF per establishment or 20,000 per development. Existing residential uses on a handful parcels within the North Employment Campus are permitted outright, rather than rendered nonconforming uses, but no new residential uses are permitted. **The proposal is consistent with this Policy.**

Policy 2.6.3

Protect the city's supply of undeveloped and underdeveloped land zoned for industrial uses by limiting non-industrial community uses, such as schools, parks, and churches on such properties and by limiting larger commercial uses within those areas.

Response: The CI zoning code standards already prohibit schools and churches; parks, trails and urban agriculture uses are proposed as permitted uses in the code amendments for the North Employment Campus subdistrict, intended to apply within the powerline easement areas that would otherwise be undevelopable for industrial use. The proposed code amendments limit the size of any supporting commercial use to 5,000 SF per establishment or 20,000 per development. **The proposal is consistent with this Policy.**

Policy 2.6.4

Protect existing and planned undeveloped and underdeveloped industrial lands from incompatible land uses, and minimize deterrents to desired industrial development.

Response: Much of the North Employment Campus industrial lands are currently undeveloped. The map amendments applying the CI zone will protect these lands from incompatible development through existing CI use standards. The CI zoning

code standards limit non-industrial uses, and the proposed code amendments further limit the size of any supporting retail or office to 5,000 SF per establishment or 20,000 per development. Existing residential uses on a handful parcels within the North Employment Campus are permitted outright, rather than rendered nonconforming uses, but no new residential uses are permitted. The CI zoning code standards also prohibit schools and churches; parks, trails and urban agriculture uses are proposed as permitted uses in the code amendments for the North Employment Campus subdistrict, intended to apply within the powerline easement areas that would otherwise be undevelopable for industrial use. **The proposal is consistent with this Policy.**

Policy 2.6.5

Ensure that land-use patterns create opportunities for citizens to live closer to their workplace.

Response: A central feature of the BRCP is the integration of residential and employment opportunities to create possibilities to live, work and play in the district. The proposed map amendments will create residential and employment districts in close proximity, including two mixed-use districts with both residential and employment opportunities. **The proposal is consistent with this Policy.**

Policy 2.6.6

Identify industrial uses that could partner with Clackamas Community College as training centers and future employers of students graduating from CCC.

Response: CCC was identified as a stakeholder in the implementation project, and was engaged in the map and code development. The proximity of the North Employment Campus and the CCC campus create an exciting opportunity for future industrial developments in the BRCP area that partner with CCC as training centers and future employers. The existing CI use standards permit a wide range of industrial uses, including light manufacturing and research and development, that could accommodate future industrial uses within the BRCP district. **The proposal is consistent with this Policy.**

Policy 2.6.7

Establish priorities to ensure that adequate public facilities are available to support the desired industrial development.

Response: Public facility master planning has been completed for the district, and planned water, sewer, stormwater, and transportation facilities have been shown to support the full 5,734 jobs projected with this implementation project. See response to approval criteria 17.68.020.B and C in Section III.a. All proposed industrial

development will be reviewed through the Site Plan and Design Review process in OCMC 17.62 that includes a criteria for approval for any new development that public facilities are adequate to support the proposal. **The proposal is consistent with this Policy.**

Policy 2.6.8

Require lands east of Clackamas Community College that are designated as Future Urban Holding to be the subject of concept plans, which if approved as an amendment to the Comprehensive Plan, would guide zoning designations. The majority of these lands should be designated in a manner that encourages family-wage jobs in order to generate new jobs and move towards meeting the city's employment goals.

Response: The lands east of CCC have been incorporated into the BRCP and envisioned for industrial development that encourages family-wage jobs. The proposed map amendments, guided by the approved concept plan, designate this area for Industrial designation and Campus Industrial zoning. The existing CI zone allows a range of uses that support family-wage jobs, such as light manufacturing; the proposed code amendments further protect job generation potential by limiting the amount of site area that can be used for outdoor storage areas and prohibiting distribution and warehouse uses, which typically do not generate significant job opportunities. **The proposal is consistent with this Policy.**

Goal 2.7 Oregon City Comprehensive Plan Land-Use Map

Maintain the Oregon City Comprehensive Plan Land-Use Map as the official long-range planning guide for land-use development of the city by type, density and location.

Response: The proposal includes amendments to the official Comprehensive Plan Land-Use Map as part of on-going maintenance to update designations for the BRCP area. **The proposal is consistent with this Goal.**

Policy 2.7.2

Use the following 11 land-use classifications on the Oregon City Comprehensive Plan Land-Use Map to determine the zoning classifications that may be applied to parcels:

- *Low Density Residential (LR)*
- *Medium Density Residential (MR)*
- *High Density Residential (HR)*
- *Commercial (C)*
- *Mixed Use Corridor (MUC)*
- *Mixed Use Employment (MUE)*

- *Mixed Use Downtown (MUD)*
- *Industrial (I)*
- *Public and Quasi-Public (QP)*
- *Parks (P)*
- *Future Urban Holding (FUH)*

Response: The proposed comprehensive plan map amendments apply the Medium Density Residential, High Density Residential, Mixed Use Corridor, and Industrial designations to the BRCP area, with zoning classifications that are consistent with these designations. **The proposal is consistent with this Policy.**

Goal 5.1 Open Space

Establish an open space system that conserves fish and wildlife habitat and provides recreational opportunities, scenic vistas, access to nature and other community benefits.

Response: The BRCP prioritizes an open space network that preserves identified environmental resource areas, parks, trails, and viewpoints, including the South-Central Open Space Network and the Low Impact Conservation Area upslope of Thimble Creek on the eastern edge of the district. The map amendments will include mapping and applying the Natural Resources Overlay District (NROD)—OCMC 17.49 and Geologic Hazards—OCMC 17.44 to habitat areas. The proposed code amendments will create the South-Central Open Space Network through required parkland dedication at the time of development, protect trail corridors throughout the district's open space system by requiring dedication of easements at the time of development, and protect the Low Impact Conservation Area by limiting development to two units per acre and protecting view corridors. **The proposal is consistent with this Goal.**

Policy 5.1.1

Conserve open space along creeks, urban drainage ways, steep hillsides, and throughout Newell Creek Canyon.

Response: The existing Natural Resources Overlay District (NROD) will be applied to all riparian corridors and the Geologic Hazards standards will be applied to all steep hillsides to conserve those areas. **The proposal is consistent with this Policy.**

Goal 5.4 Natural Resources

Identify and seek strategies to conserve and restore Oregon City's natural resources, including air, surface and subsurface water, geologic features, soils, vegetation, and fish and wildlife, in order to sustain quality of life for current and future citizens and visitors, and the long-term viability of the ecological systems.

Response: The proposed amendments do not include any changes to OCMC 17.44, Natural Resources Overlay District, or to OCMC 17.49 – Geologic Hazards. These acknowledged codes are intended to conserve, protect and restore inventoried natural resources within the City's Urban Growth Boundary. **The proposal is consistent with this policy.**

Policy 5.4.16

Protect surfacewater quality by:

- *providing a vegetated corridor to separate protected water features from development*
- *maintaining or reducing stream temperatures with vegetative shading*
- *minimizing erosion and nutrient and pollutant loading into water*
- *providing infiltration and natural water purification by percolation through soil and vegetation*

Response: The proposed amendments do not include any changes to OCMC 17.44, Natural Resources Overlay District, which provides for a vegetated corridor and shading along street corridors, or to the City's recently adopted stormwater and erosion control standards, design manuals or review processes. **The proposal is consistent with this policy.**

Goal 6.1 Air Quality

Promote the conservation, protection and improvement of the quality of the air in Oregon City.

Response: The proposed amendments will not affect any codes or policies that implement Goal 6. The City's overlay districts, such as the Natural Resource Overlay District, Flood Management Overlay, and Geologic Hazards Overlay will apply regardless of the proposed changes. All engineering standards and building code standards for storm drainage, grading, erosion control, water quality facilities will continue to apply to development. Oregon Dept. of Environmental Quality (DEQ) air and water quality permits are required separately for new development. **The proposal is consistent with this Goal.**

Policy 6.1.2

Ensure that development practices comply with or exceed regional, state, and federal standards for air quality.

Response: Oregon Dept. of Environmental Quality (DEQ) air and water quality permits are required separately for new development. Oregon City planning and

engineering staff are included in the coordination of these permits prior to issuance by DEQ. **The proposal is consistent with this Policy.**

Goal 6.2 Water Quality

Control erosion and sedimentation associated with construction and development activities to protect water quality.

Response: Oregon Dept. of Environmental Quality (DEQ) air and water quality permits are required separately for new development. Oregon City planning and engineering staff are included in the coordination of these permits prior to issuance by DEQ. **The proposal is consistent with this Policy.**

Policy 6.2.1

Prevent erosion and restrict the discharge of sediments into surface- and groundwater by requiring erosion prevention measures and sediment control practices.

Response: All engineering standards and building code standards for storm drainage, grading, erosion control, and water quality facilities will continue to apply to development. **The proposal is consistent with this Policy.**

Policy 6.2.2

Where feasible, use open, naturally vegetated drainage ways to reduce stormwater and improve water quality.

Response: All engineering standards and building code standards for storm drainage, grading, erosion control, and water quality facilities will continue to apply to development. **The proposal is consistent with this policy.**

Goal 7.1

Natural Hazards Protect life and reduce property loss from the destruction associated with natural hazards.

Response: Development within the Natural Resources Overlay District and Geologic Hazards Overlay District (which includes sloped and historic landslide areas) is limited by development standards in the Municipal Code to protect the public.

Policy 7.1.1 Limit loss of life and damage to property from natural hazards by regulating or prohibiting development in areas of known or potential hazards.

Response: Development within the Natural Resources Overlay District and Geologic Hazards Overlay District (which includes sloped and historic landslide areas) is limited by development standards in the Municipal Code to protect the public.

8.1 Developing Oregon City's Park and Recreation System

Maintain and enhance the existing park and recreation system while planning for future expansion to meet residential growth.

Response: The BRCP prioritizes a network of parks, trails, and open spaces, including the South-Central Open Space Network. The proposed code amendments will support creation of the South-Central Open Space Network through required parkland dedication at the time of development and protect trail corridors throughout the district's open space system by requiring dedication of easements at the time of development. **The proposal is consistent with this Goal.**

Policy 8.1.1

Provide an active neighborhood park-type facility and community park-type facility within a reasonable distance from residences, as defined by the Oregon City Park and Recreation Master Plan, to residents of Oregon City.

Response: The South-Central Open Space Network will create park facilities within proposed neighborhoods; all residences will be within approximately 1/4 mile of the network, which will include multiple elements including features similar to a neighborhood park-type facility and a multipurpose trail. The proposed code amendments will create the South-Central Open Space Network through required parkland dedication at the time of development. **The proposal is consistent with this Policy.**

Policy 8.1.2

When property adjacent to an existing neighborhood or community park becomes available, consider adding property to the park and developing it to meet the current needs of existing neighborhoods.

Response: There are no existing parks in the BRCP area, however, future park facilities in the South-Central Open Space Network will be expanded over time as the properties in the district are developed. The proposed code amendments will create the South-Central Open Space Network through required parkland dedication at the time of development, and include provisions for dedication of land within the mapped South-Central Open Space Network to allow the facility to expand and maintain connectivity throughout the district. **The proposal is consistent with this Policy.**

Policy 8.1.5

Identify and construct a network of off-street trails throughout the city for walking and jogging.

Response: The BRCP identifies a network of off-street trails including regional trails throughout the district. The proposed code amendments will protect identified trail corridors by requiring dedication of easements at the time of development. **The proposal is consistent with this Goal.**

Policy 8.1.9

Emphasize retaining natural conditions and the natural environment in proposed passive recreation areas.

Response: Passive recreation areas will include open space areas and environmental resource areas. The Natural Resources Overlay District (NROD)—OCMC 17.49 and Geologic Hazards—OCMC 17.44 will be applied to habitat areas which promote retention of natural conditions. In addition, the proposed code amendments include provisions for the Low Impact Conservation Area that require environmental restoration as a condition of any adjacent development. **The proposal is consistent with this Policy.**

Policy 8.1.12

Identify and protect land for parks and recreation within the Urban Growth Boundary.

Response: The BRCP identifies and prioritizes a network of parks, trails, and open spaces, including the South-Central Open Space Network. The proposed code amendments will support creation of the South-Central Open Space Network through required parkland dedication at the time of development and protect trail corridors throughout the district's open space system by requiring dedication of easements at the time of development. **The proposal is consistent with this Policy.**

Policy 8.1.14

Require or encourage developers to dedicate park sites as part of the subdivision review process. When possible, require or encourage developers to build parks to City standards and give them to the City to operate and maintain.

Response: The proposed code amendments will require parkland dedication to create the South-Central Open Space Network as part of subdivision review process. **The proposal is consistent with this Policy.**

Goal 9.1 Improve Oregon City's Economic Health

Provide a vital, diversified, innovative economy including an adequate supply of goods and services and employment opportunities to work toward an economically reasonable, ecologically sound and socially equitable economy.

Response: A core aspect of the BRCP is to create economic opportunities, and the proposed map and code amendments implement three distinct subdistricts focused on employment opportunities. The North Employment Campus, proposed for CI zoning, will provide family-wage employment opportunities. The two mixed-use subdistricts in the Mixed Employment Village and Main Street will provide goods and services, and additional jobs in those sectors. In total, the proposal is estimated to support up to 5,734 jobs, exceeding the BRCP goal of 5,000 jobs. The proposed code amendments include provisions such as sustainable design elements for industrial development and the inherent efficiencies of mixing uses within the district and individual subdistricts to reduce distances travelled to live, work, shop and eat, which will support ecologically sound economic growth. **The proposal is consistent with this Goal.**

Policy 9.1.1

Attract high-quality commercial and industrial development that provides stable, high-paying jobs in safe and healthy work environments, that contributes to a broad and sufficient tax base, and that does not compromise the quality of the environment.

Response: Three of the BRCP subdistricts, proposed to be implemented through map and code amendments, will support commercial and industrial development. The North Employment Campus, proposed for CI zoning, will support primarily industrial development with family-wage employment opportunities. The Mixed Employment Village subdistrict will provide support high-quality commercial and office employment, with similar opportunities in the Main Street subdistrict. In total, the proposal is estimated to support up to 5,734 jobs, exceeding the BRCP goal of 5,000 jobs. The proposed code amendments include provisions such as sustainable design elements for industrial development and the inherent efficiencies of mixing uses within the district and individual subdistricts to reduce distances travelled to live, work, shop and eat, which will support ecologically sound economic growth. Natural resources will be protected through the Natural Resources Overlay District (NROD)—OCMC 17.49 and Geologic Hazards—OCMC 17.44 to habitat areas to ensure development does not compromise the quality of the environment. As discussed in response to Goals 6.1 and 6.2 above, compliance with existing state and local air and water standards will ensure protection of those resources at the time of future development. **The proposal is consistent with this Policy.**

Policy 9.1.2

Contribute to the health of the regional and state economy by supporting efforts to attract "traded sector industries" such as high technology and production of metals, machinery, and transportation equipment. (Traded sector industries compete in multi-state, national, and international markets and bolster the state's economy by bringing money in from sales of goods and services outside of the state.)

Response: The BRCP prioritizes recruitment of sustainable industries, which could include traded sector industries. The proposed map and code amendments support this goal by creating development opportunities for such industries within the proposed North Employment Campus and Mixed Employment Village subdistrict. Additional recruitment efforts will be led by the City's Economic Development Department. **The proposal is consistent with this Policy.**

Goal 9.3 Retention of Existing Employers

Retain existing employers, both public and private, and encourage them to expand their operations within the City.

Response: The proposed map and code amendments will create significant new acreage for industrial and employment growth, which could be acquired and developed by existing employers looking to expand their operations. **The proposal is consistent with this Policy.**

Policy 9.3.1

Protect existing industries from encroachment by incompatible land uses, and ensure that expansion options are available to them wherever possible.

Response: The proposed map amendments will not create any incompatible land uses near existing industries. The proposed map and code amendments will create significant new acreage for industrial and employment growth, which could be acquired and developed by existing employers looking to expand their operations. **The proposal is consistent with this Policy.**

Goal 9.5 Retail Service

Allow a variety of retail outlets and shopping areas to meet the needs of the community and nearby rural areas.

Response: The proposed map and code amendments will support the creation of the Main Street subdistrict along Glen Oak Road providing retail and shopping opportunities for the immediate BRCP district and nearby areas. The code amendments specifically support retail development by limiting residential uses to upper stories and the rear portion of sites, to ensure commercial development remains the priority. Limited retail outlets are also permitted under the proposed

code amendments for the Mixed Employment Village to support those who work and live in the subdistrict. **The proposal is consistent with this Goal.**

Policy 9.5.1

Develop local neighborhood or specific plans, when appropriate, to blend infill development along linear commercial areas into existing neighborhoods.

Response: The BRCP district is undeveloped and as such, does not have existing commercial or existing neighborhoods; the plan as implemented by the proposed map and code amendments proactively creates opportunities to blend commercial development within neighborhoods. The proposed map and code amendments create opportunities for retail and commercial development primarily within the Main Street subdistrict, which is located along Glen Oak Road interior to the district, rather than strung out as a linear commercial development along Beavercreek Road. The proposed code amendments also allow small-scale retail and commercial development within the West Mixed-Use Neighborhood to the south of the Main Street subdistrict. **The proposal is consistent with this Policy.**

Policy 9.5.2

Develop plans to provide necessary public services to surrounding rural industrial lands for future development.

Response: No changes are proposed to adopted infrastructure master plans for water, sewer and stormwater and the Transportation System Plan (TSP) which will ensure provision of necessary services to industrial lands within and outside of the BRCP district. **The proposal is consistent with this Policy.**

Goal 9.7 Home-Based Businesses

Provide a supportive climate for home-based businesses.

Response: The City has already adopted standards and permitting processes for home occupations, defined by OCMC 17.04.580 and permitted in all residential zones. The City has developed a worksheet to support owners of home occupations to comply with business licensing and zoning requirements. (See https://www.orcity.org/sites/default/files/fileattachments/economic_development/page/4592/2016_home_occupation_worksheet_-_fillable.pdf) Home-based businesses will similarly be allowed and supported within residential areas of the BRCP district. **The proposal is consistent with this Goal.**

Policy 9.7.1

Encourage home-based businesses that are low impact and do not disrupt the residential character of the neighborhoods in which they are located.

Response: No changes are proposed to adopted home occupation standards in OCMC 17.04.580, which limit disruptions to neighborhood residential character by prohibiting non-resident employees, prohibiting retail sales onsite, prohibiting off-site sound impacts, prohibiting outdoor uses, and requiring that uses are secondary to the residential purpose of the dwelling. During the development of the code amendments, a "cottage industry" concept was explored to permit small-scale manufacturing based businesses as home occupations within the BRCP neighborhoods, such as welding or cabinet making. Some small-scale manufacturing could be permitted under the existing home occupations code, provided it was conducted indoors and did not generate off-site sound impacts, however, changes to the home occupation standards to promote such uses or loosen current restrictions are not recommended based on citizen feedback concerning potential disruptions to residential neighborhood character. During the April 9, 2019 public workshop, citizens shared concerns that noise and visual impacts from potential cottage manufacturing uses could be a conflict with residential neighborhoods, as well as concern that the smaller homes and dwelling types proposed in the BRCP neighborhoods would not have sufficient room for such uses or sufficient buffering between residences. Therefore, existing home occupation standards are proposed for BRCP neighborhoods to encourage home-based businesses while limiting disruptions to residential neighborhoods. **The proposal is consistent with this Policy.**

Policy 9.7.2

Encourage the support services that home-based businesses need.

Response: No changes are proposed to adopted home occupation standards in OCMC 17.04.580 or City policies to support business owners. The City will continue to work with business owners to support them in obtaining business licenses. The plan provides nearby mixed use and employment districts to support home based businesses. **The proposal is consistent with this Policy.**

Goal 9.8 Transportation System

Recognize the importance of the land use-transportation link and encourage businesses to locate in areas already served by the type of transportation system they need.

Response: The adopted BRCP transportation strategy includes elements such as planning a mixed-use community that will increase options for internal trip making, developing a framework of collector streets, improving Beavercreek Road itself to accommodate trips within and through the district, and developing off-site transportation connections guided by the Transportation System Plan; the transportation strategy was developed to serve the intended industrial and

commercial development in each subdistrict. The proposed map and code amendments provide for the intended types of development in each subdistrict, that will be served by existing and planned transportation elements. **The proposal is consistent with this Goal.**

Policy 9.8.1

Through coordination with TriMet and local employers, encourage and promote the use of mass transit to travel between residential areas and employment areas.

Response: The adopted BRCP sets the stage for future transit by providing transit-attractive destinations, such as high-density employment and residential nodes, and a logical network of roadways that would support future transit routes. The proposed map and code amendments support future transit improvements by implementing the plan subdistricts that concentrate job and housing densities near Beavercreek Road and the transit center at Clackamas Community College. **The proposal is consistent with this Policy.**

Policy 9.8.4

Promote "shared parking" and transportation demand management techniques such as transit vouchers, car or van pooling, and flexible schedules and telecommuting options to reduce peak hour trips.

Response: The adopted parking standards permit shared parking facilities per OCMC 17.52.020.B.2, and will apply to development within the BRCP area. Additional transportation demand management techniques are more appropriate for individual businesses to develop, and can be implemented at the time of development. **The proposal is consistent with this Policy.**

Policy 9.8.6

Encourage the provision of multi-modal transportation to support major existing employers.

Response: There are no existing employers within the BRCP area that will be affected by the proposed map and code amendments. However, the amendments will support development of a multimodal transportation system throughout the BRCP area consistent with adopted transportation strategies, including transit, sidewalks, bike routes, and off-street trail network that will serve future employers in the North Employment Campus and throughout the district. **The proposal is consistent with this Policy.**

Policy 9.8.7

Assess methods to integrate the pedestrian, bicycle and elevator transportation modes into the mass transit system.

Response: The adopted transportation strategies in the BRCP include development of on and off-street pedestrian and bicycle facilities throughout the district; an elevator mode is not proposed because it is not suitable for the district's topography. The proposed map and code amendments support future development of these facilities by requiring facilities to be constructed at the time of site development. **The proposal is consistent with this Policy.**

Goal 10.1 Diverse Housing Opportunities

Provide for the planning, development and preservation of a variety of housing types and lot sizes.

Response: The BRCP prioritizes a variety of housing types for a range of income levels across the different subdistricts. The proposed map and code amendments support these goals by implementing the West and East Mixed Use Neighborhoods, with additional residential opportunities in the mixed-use Main Street and Mixed Employment Village subdistricts. The proposed zoning districts for the West and East Mixed-Use Neighborhoods are R-2 and R-5, respectively; these districts were significantly revised as part of the Amendments to the Oregon City Municipal Code (including the Equitable Housing Project recommendations) earlier in 2019 to better meet this goal. The housing code amendments allow for a broad range of housing options collectively referred to as "missing middle housing," defined as a range of multi-unit or clustered housing types compatible in scale with single-family homes that help meet the growing demand for housing choices at a variety of scales across a variety of neighborhoods, encouraging a more diverse housing stock in residential zones that are currently dominated by single-family residential homes. The proposed map and code changes with this proposal implement these zones and will guide planning and development of a variety of housing types and lot sizes. **The proposal is consistent with this Goal.**

Policy 10.1.1

Maintain the existing residential housing stock in established older neighborhoods by maintaining existing Comprehensive Plan and zoning designations where appropriate.

Response: There are no established older neighborhoods in the BRCP area, however, there are a handful of existing residences. The proposed code amendments will permit existing homes with proposed CI zoning to remain permitted uses rather than making them nonconforming uses. **The proposal is consistent with this Policy.**

Policy 10.1.2

Ensure active enforcement of the City of Oregon City Municipal Code regulations to ensure maintenance of housing stock in good condition and to protect neighborhood character and livability.

Response: No changes are proposed to the code enforcement standards or policies with this proposal. As neighborhoods are developed in the BRCP area, code enforcement will ensure housing and neighborhoods are maintained in good condition. **The proposal is consistent with this Policy.**

Policy 10.1.3

Designate residential land for a balanced variety of densities and types of housing, such as single-family attached and detached, and a range of multi-family densities and types, including mixed-use development.

Response: The proposed map amendments designate land for a variety of densities and types of housing as follows: 25.1 gross acres of High Density Residential with R-2 zoning, 136.7 gross acres of Medium Density Residential with R-5 zoning, and 13.5 gross acres of Mixed-Use Corridor with NC zoning for mixed-use residential development. The existing zoning standards for these districts permit a range of densities for different housing types ranging from a minimum of 7.0 units per net acre for single-family detached homes in the R-5 zone to a maximum of 21.8 units per net acre for townhouse and multifamily development in the R-2 zone, or up to 26.2 units per net acre for projects that incorporate sustainability features in the proposed code amendments. **The proposal is consistent with this Policy.**

Policy 10.1.4

Aim to reduce the isolation of income groups within communities by encouraging diversity in housing types within neighborhoods consistent with the Clackamas County Consolidated Plan, while ensuring that needed affordable housing is provided.

Response: The proposed map and code amendments apply the revised R-5 and R-2 zoning district standards that were developed as part of the Equitable Housing Project specifically to provide greater variety of affordable housing options, both regulated, income-restricted housing options and market-rate housing options that are lower priced and thus affordable to housing with lower household incomes. The variety of housing types allowed in both zones will provide opportunities to integrate affordable housing into the BRCP neighborhoods as they are developed. **The proposal is consistent with this Policy.**

Policy 10.1.5

Allow Accessory Dwelling Units under specified conditions in single-family residential designations with the purpose of adding affordable units to the housing inventory and

providing flexibility for homeowners to supplement income and obtain companionship and security.

Response: Accessory Dwelling Units (ADUs) are permitted in both the R-5 and R-2 zoning districts proposed for the BRCP neighborhoods with this proposal; no further changes to the ADU regulations are included with this proposal. Code revisions adopted with the Amendments to the Oregon City Municipal Code (including the Equitable Housing Project recommendations) included a provision in OCMC 16.08.095 that restricts new subdivisions from applying code, covenants, and restrictions (CC&Rs) that prohibit ADUs, which will ensure that new developments within the BRCP are not restricted by public zoning code or private CC&Rs from developing ADUs. **The proposal is consistent with this Policy.**

Policy 10.1.6

Allow site-built manufactured housing on individual lots in single-family residential zones to meet the requirements of state and federal law. (Pursuant to state law, this policy does not apply to land within designated historic districts or residential land immediately adjacent to a historic landmark.)

Response: The Oregon City Municipal Code does not differentiate between manufactured housing and other housing types on individual lots and the proposed code amendments do not propose to change this; an individual manufactured house is permitted on any lot where a single-family detached, site-built house would be permitted in the BRCP neighborhoods under the proposed R-5 and R-2 zoning. **The proposal is consistent with this Policy.**

Policy 10.1.7

Use a combination of incentives and development standards to promote and encourage well-designed single-family subdivisions and multi-family developments that result in neighborhood livability and stability.

Response: The proposed map amendments apply the R-2 and R-5 zoning districts within the BRCP, which already incorporate numerous incentives and development standards to support livability and stability. The proposed code amendments further support livable neighborhoods by requiring parkland dedication or fee-in-lieu for all new subdivisions and multifamily developments, to create the South-Central Open Space Network with park and trail facilities serving the BRCP neighborhoods. The proposed amendments also include a density bonus option as an incentive for multifamily development to incorporate sustainability features. **The proposal is consistent with this Policy.**

Goal 10.2 Supply of Affordable Housing

Provide and maintain an adequate supply of affordable housing.

Response: The proposed map amendments add significant buildable residential land to the City's inventory, including 12.1 net acres of buildable land zoned R-2 in the West Mixed Use Neighborhood and 64.5 net acres of buildable land plus 15.9 acres of constrained land zoned R-5 in the East Mixed Use Neighborhood and additional opportunities in the two mixed-use subdistricts with a combined estimated potential for 1,105 new housing units. Maintaining an adequate supply of buildable land will help keep housing prices affordable by reducing land scarcity. These areas will be developed under the R-5 and R-2 zoning district standards recently amended with the Amendments to the Oregon City Municipal Code (including the Equitable Housing Project recommendations) project that expand the range of housing types permitted, decrease minimum lot sizes for many types, and increase density for some missing middle housing types. Together, these standards create opportunities to build market-rate housing that is more affordable than traditional single-family detached, large-lot subdivisions. **The proposal is consistent with this Policy.**

Policy 10.2.1

Retain affordable housing potential by evaluating and restricting the loss of land reserved or committed to residential use. When considering amendments to the Comprehensive Plan Land-Use Map, ensure that potential loss of affordable housing is replaced.

Response: The proposed map amendments commit a total of 161.8 gross acres of land for residential use, consistent with the BRCP map; no existing residential land or affordable housing will be lost with this proposal. **The proposal is consistent with this Policy.**

Policy 10.2.2

Allow increases in residential density (density bonuses) for housing development that would be affordable to Oregon City residents earning less than 50 percent of the median income for Oregon City.

Response: The proposed map amendments apply the R-2 zone to the West Mixed Use Neighborhood, and existing R-2 code standards provide up to a 20% density bonus for affordable units at 80% AMI for a minimum term of 30 years for apartment projects. No further changes to the affordable housing density bonus is proposed with this project. **The proposal is therefore consistent with this policy.**

Policy 10.2.3

Support the provision of Metro's Title 7 Voluntary Affordable Housing Production Goals.

Response: (From Comprehensive Plan, P. 77):

> *In 2001, Metro adopted amendments to Title 7 of the Urban Growth Management Functional Plan to implement the Regional Affordable Housing Strategy (2000), which identifies measures to provide adequate affordable housing in the Metro region. The amendments require local jurisdictions to consider adopting a number of tools and strategies for promoting the creation and retention of affordable housing. Metro defines an affordable housing unit as one that requires no more than 30 percent of household income for people earning 50 percent of the median household income in their jurisdiction. By that definition, an affordable housing unit in Oregon City in 2000 would cost $570 per month or less. The 2002 housing inventory and analysis showed that the number of lower-cost units in Oregon City was inadequate to meet both the current (2002) and projected housing needs of the city's lower-income residents. Title 7 tools and strategies have been adopted as Goal 10.2 and Policies 10.2.1 through 10.2.4.*

The proposed map and code amendments support affordable housing creation consistent with Title 7 through compliance with Goal 10.2 and Policies 10.2.1 through 10.2.4, as demonstrated in this section. **The proposal is consistent with this Policy.**

Policy 10.2.4

Provide incentives that encourage the location of affordable housing developments near public transportation routes. Incentives could include reduction of development-related fees and/or increases in residential density (density bonuses).

Response: As mentioned in Policy 10.1.4, the West Mixed Use Neighborhood will be zoned R-2 under the proposed map amendments and the R-2 standards include a 20% density bonus for affordable units at 80% AMI for a minimum term of 30 years. The West Mixed Use Neighborhood is located along Beavercreek Road and the future Center Parkway which have been identified as potential future public transportation routes. **The proposal is consistent with this Policy.**

Goal 11.1 Provision of Public Facilities

Serve the health, safety, education, welfare, and recreational needs of all Oregon City residents through the planning and provision of adequate public facilities.

Policy 11.1.1

Ensure adequate public funding for the following public facilities and services,

if feasible:

- *Transportation infrastructure*
- *Wastewater collection*
- *Stormwater management*
- *Police protection*
- *Fire protection*
- *Parks and recreation*
- *Water distribution*

Response: As demonstrated within this report the aforementioned systems can accommodate the impact anticipated in the Concept Plan.

Policy 11.1.7

Develop and maintain a coordinated Capital Improvements Plan that provides a framework, schedule, prioritization, and cost estimate for the provision of public facilities and services within the City of Oregon City and its Urban Growth Boundary

Response: As demonstrated within this report the aforementioned systems can accommodate the impact anticipated in the Concept Plan.

Goal 12.1 Land Use-Transportation Connection

Ensure that the mutually supportive nature of land use and transportation is recognized in planning for the future of Oregon City.

Response: The adopted BRCP includes interconnected land use and transportation elements that ensure appropriately scaled multimodal facilities will serve future development. The plan establishes a variety of interconnected subdistricts with a mix of uses that increase opportunities for local trips while decreasing total trips utilizing the broader transportation network. The proposed map and code amendments implement this vision to balance land use and transportation goals; the proposal is supported by a transportation memo prepared by DKS that concludes that development associated with the proposal can be served by the planned City-wide transportation system. **The proposal is consistent with this Goal.**

Policy 12.1.1

Maintain and enhance citywide transportation functionality by emphasizing multi-modal travel options for all types of land uses.

Response: The adopted BRCP includes multimodal transportation provisions. As development occurs, on-street and off-street pedestrian and bicycle facilities will be required to be constructed as outlined in the plan. The proposed map and code amendments are consistent with the BRCP and will support expanded multimodal facilities throughout the district serving all the different land uses from industrial to residential. **The proposal is consistent with this Policy.**

Policy 12.1.3

Support mixed uses with higher residential densities in transportation corridors and include a consideration of financial and regulatory incentives to upgrade existing buildings and transportation systems.

Response: The proposed map and code amendments create mixed-use subdistricts including the NC-zoned Main Street and MUC-II-zoned Mixed Employment Village that permit high-density residential development, as well as a mix of uses within the district as a whole across the five subdistricts. The map and code amendments will facilitate a mix of uses at higher residential densities along Beavercreek Road, including the two aforementioned mixed-use districts and the R-2-zoned West mixed Use Neighborhood. There are no significant existing buildings within the BRCP area affected by this policy. **The proposal is consistent with this Policy.**

Policy 12.1.4

Provide walkable neighborhoods. They are desirable places to live, work, learn and play, and therefore a key component of smart growth.

Response: Walkability is a central goal of all the BRCP neighborhoods, and is supported by the proposed map and code amendments. Neighborhoods will built around blocks with a maximum block length of 530 feet, except for the industrial areas in the North Employment Campus, consistent with zoning standards in OCMC 16.12.030 for implementing districts that create easily walkable neighborhoods that minimize out-of-direction travel by pedestrians. On-street pedestrian facilities will be required consistent with green street cross-sections which create a desirable walking environment, in addition to an off-street trail network. The proposed code amendments support a compelling, walkable Main Street subdistrict along Glen Oak road by requiring building presence along a minimum percentage of the site and limiting parking areas to the rear of the site. **The proposal is consistent with this Policy.**

Goal 13.1 Energy Sources

Conserve energy in all forms through efficient land-use patterns, public transportation, building siting and construction standards, and city programs, facilities, and activities.

Response: The Concept Plan includes an efficient mix of uses to allow those that leave in or near the site to also obtain amenities and employment nearby.

Goal 14.3 Orderly Provision of Services to Growth Areas

Plan for public services to lands within the Urban Growth Boundary through adoption of a concept plan and related Capital Improvement Program, as amendments to the Comprehensive Plan.

Response: The proposed map and code amendments implement an adopted concept plan for Beavercreek Road. The Sanitary Sewer Master Plan (2014), Water Distribution Master Plan (2012), Stormwater Master Plan (2019 Draft), and Transportation System Plan (2013) were all created subsequent to initial adoption of the BRCP in 2008 and plan for public services to serve residential and employment growth forecasted for the concept plan area. The proposed map and code amendments are estimated to support 1,105 dwellings and 5,734 jobs, consistent with demand forecasted and planned for in adopted capital improvements plans. **The proposal is consistent with this Goal.**

Policy 14.3.1

Maximize new public facilities and services by encouraging new development within the Urban Growth Boundary at maximum densities allowed by the Comprehensive Plan.

Response: The proposed map and code amendments provide for higher densities in the BRCP area to maximize utility of new public facilities developed to serve the area. Residential development will be subject to high and medium-density residential standards in the R-2 and R-5 districts respectively. Both zones have minimum density standards equal to 80% of the maximum allowed density, to ensure higher density development, as well as opportunities for types like cluster housing, duplexes, and 3-4 plexes in the R-5 zone that allow higher densities than would otherwise be permitted for single-family detached residential uses. Employment development in the two mixed-use districts will be subject to FAR minimums under the proposed code amendments to ensure efficient use of land and public facilities. **The proposal is consistent with this Policy.**

Policy 14.3.2

Ensure that the extension of new services does not diminish the delivery of those same services to existing areas and residents in the city.

Response: The adopted Sanitary Sewer Master Plan (2014), Water Distribution Master Plan (2012), Stormwater Master Plan (2019 Draft), and Transportation System Plan (2013) ensure that public facilities are extended to new areas, including the BRCP area and development anticipated through the proposed map and code amendments, without compromising the ability to provide services to existing areas and residents of the city that meet adopted service standards. **The proposal is consistent with this Policy.**

Policy 14.3.3

Oppose the formation of new urban services districts and oppose the formation of new utility districts that may conflict with efficient delivery of city utilities within the Urban Growth Boundary.

Response: The BRCP area is within the future service area of city utility providers and no new urban service districts or utility districts are proposed. **The proposal is consistent with this Policy.**

Policy 14.3.4

Ensure the cost of providing new public services and improvements to existing public services resulting from new development are borne by the entity responsible for the new development to the maximum extent possible.

Response: All development proposed with the BRCP area under the proposed map and code amendments will be subject to development review, which requires that new development provide for on-site and off-site public services needed to serve the development. The City has also adopted System Development Charges (SDCs) that are assessed at the time of development to pay for the costs of expanding public services. **The proposal is consistent with this Policy.**

III.c. BEAVERCREEK ROAD CONCEPT PLAN GOALS AND POLICIES

Goal 1 Complete and Sustainable Community

Create a complete and sustainable community, in conjunction with the adjacent land uses, that integrates a diverse mix of uses, including housing, services, and public spaces that are necessary to support a thriving employment center.

Response: The proposal implements the plan vision for a mix of uses within the district and within individual subdistricts, notably the Mixed Employment Village and the Main Street subdistricts. Housing is provided for in all subdistricts except the North Employment Campus. Services are permitted through proposed zoning standards in all subdistricts except the East Mixed Use Neighborhood. Public spaces

are provided for consistent with the BRCP, including the South Central Open Space Network, powerline corridor and trail network. Many of the zoning standards, particularly the expanded residential zones, support compact development, coupled with resource protection standards for sensitive environmental areas. Much of the sustainable infrastructure planning, including LID stormwater and green street designs, was done with the BRCP and can be implemented at the time of site development. **The proposal is consistent with this Goal.**

Policy 1.1

Adopt new comprehensive plan and zone designations, and development code, that implement the Beavercreek Concept Plan. Require all development to be consistent with the Concept Plan and implementing code.

Response: The proposal applies comprehensive plan and zone designations to implement the BRCP, with development code amendments that supplement existing zoning district standards for each subdistrict to fully implement the BRCP vision for those subdistricts. Development will be reviewed for conformity with the implementing code through the development review process; discretionary development applications, such as master plans, will be required to comply with the Concept Plan as well. **The proposal is consistent with this Policy.**

Policy 1.2

Establish sub-districts to implement the Concept Plan. The sub-districts are:

North Employment Campus – NEC

The purpose of the North Employment Campus is to provide for the location of family wage employment that strengthens and diversifies the economy. The NEC allows a mix of clean industries, offices serving industrial needs, light industrial uses, research and development and large corporate headquarters. The uses permitted are intended to improve the region's economic climate, promote sustainable and traded sector businesses, and protect the supply of sites for employment by limiting incompatible uses. The sub-district is intended to comply with Metro's Title 4 regulations. Site and building design will create pedestrian-friendly areas and utilize cost effective green development practices. Business and program connections to Clackamas Community College (CCC) are encouraged to help establish a positive identity for the area and support synergistic activity between CCC and NEC properties. Businesses making sustainable products and utilizing sustainable materials and practices are encouraged to reinforce the identity of the area and promote the overall vision for the Beavercreek Road area.

Response: The NEC subdistrict will be implemented with the Industrial comprehensive plan designation and the Campus Industrial (CI) zoning district. The permitted uses in OCMC 17.37.020 include a range of industrial, light manufacturing, research and development, and corporate headquarters uses that support family-wage employment. The proposed additional code standards for the NEC include limitations on retail and service uses to 5,000 SF per use or 20,000 SF total per site to limit incompatible uses. The proposed code standards and subdistrict boundaries have been reviewed against Metro Title 4 maps and code requirements. Site and building design for development in the subdistrict will be required to implement green design features from a menu proposed in OCMC 17.37.060.G. Outside of the code and map implementation projects, supporting efforts to build relationships with CCC and to recruit businesses with sustainable practices will be led by the City's Economic Development department. **The proposal is consistent with this Policy.**

Mixed Employment Village – MEV

The purpose of the Mixed Employment Village is to provide employment opportunities in an urban, pedestrian friendly, and mixed use setting. The MEV is intended to be transit supportive in its use mix, density, and design so that transit remains an attractive and feasible option. The MEV allows a mix of retail, office, civic and residential uses that make up an active urban district and serve the daily needs of adjacent neighborhoods and Beavercreek Road sub-districts. Site and building design will create pedestrian-friendly areas and utilize cost effective green development practices. Business and program connections to Clackamas Community College and Oregon City High School are encouraged. Businesses making sustainable products and utilizing sustainable materials and practices are encouraged to reinforce the identity of the area and promote the overall vision for the Beavercreek Road area.

Response: The MEV subdistrict will be implemented with the Mixed Use Corridor comprehensive plan designation and the Mixed Use Corridor-2 (MUC-2) zoning district. The permitted uses in OCMC 17.29.020, with refinements in proposed OCMC 17.29.080.C, include a range of retail, office, civic and residential uses. Proposed use standards also limit the percentage of building area that can be used for retail, service, and residential uses, to ensure that employment uses are also integrated into site development. Minimum FAR standards will support higher intensity development that will support future transit service. Site and building design for development in the subdistrict will be support an urban, pedestrian friendly setting through a height limit of 60 feet to permit multistory construction, maximum setbacks to bring development up to the street, and prohibition on

ground floor residential uses to support active ground floor uses. (See existing OCMC 17.29 and proposed 17.29.080.) Additional building and site development standards in OCMC 17.62.050 will apply at the time of development. Outside of the code and map implementation projects, supporting efforts to build relationships with CCC and to recruit businesses with sustainable practices will be led by the City's Economic Development department. **The proposal is consistent with this Policy.**

Main Street – MS

The purpose of this small mixed-use center is to provide a focal point of pedestrian activity. The MS allows small scale commercial, mixed use and services that serve the daily needs of the surrounding area. "Main Street" design will include buildings oriented to the street, and minimum of 2 story building scale, attractive streetscape, active ground floor uses and other elements that reinforce pedestrian oriented character and vitality of the area.

Response: The MC subdistrict will be implemented with the Mixed Use Corridor comprehensive plan designation and the Neighborhood Commercial (NC) zoning district. The permitted uses in OCMC 17.24.020, with refinements in proposed OCMC 17.24.050.C, include a range of retail, service and residential uses, capped at 10,000 square feet per establishment to create a small-scale character for the subdistrict. Proposed dimensional standards include a minimum height of two stories, maximum five-foot front setbacks to ensure that development engages with the street, minimum FAR of 0.5 to create more intensive development, requirement for parking areas to be located behind buildings, standards for planter boxes and urban plazas as part of required landscaping, and prohibition on ground floor residential uses to support active ground floor uses. (See existing OCMC 17.24 and proposed 17.24.050.) Additional building and site development standards in OCMC 17.62.050 will apply at the time of development. **The proposal is consistent with this Policy.**

West Mixed Use Neighborhood – WMU

The West Mixed Use Neighborhood will be a walkable, transit-oriented neighborhood. This area allows a transit supportive mix of housing, live/ work units, mixed use buildings and limited commercial uses. A variety of housing and building forms is required, with the overall average of residential uses not exceeding 22 dwelling units per acre. The WMU area's uses, density and design will support the multi-modal transportation system and provide good access for pedestrians, bicycles, transit and vehicles. Site and building design will create a walkable area and utilize cost effective green development practices.

Response: The WMU subdistrict will be implemented with the High-Density Residential comprehensive plan designation and the R-2 High-Density Residential (R-2) zoning district. Permitted residential uses, as recently expanded in the Amendments to the Oregon City Municipal Code (including the Equitable Housing Project recommendations), provide for a variety of multifamily residential, single-family attached, cluster housing, duplexes, triplexes and quadplexes. (See OCMC 17.12.020.) The proposed code amendments add live/work units as conditional uses and permit small-scale commercial and mixed-use development as part of a master plan. (See proposed OCMC 17.12.060.C.) The minimum and maximum density permitted in the R-2 district is 17.4 to 21.8 units per acre. (See OCMC 17.12.050) Up to a 20% density bonus can be earned for affordable housing or, in the WMU, for projects incorporating sustainable design features. (See proposed OCMC 17.12.D.) The base density and density bonuses together will not exceed an overall average of 22 units per acre. The density of development will support transit use, and site design will integrate pedestrian and bicycle facilities at the time of development. **The proposal is consistent with this Policy.**

East Mixed Use Neighborhood – EMU

The East Mixed Use Neighborhood will be a walkable and tree-lined neighborhood with a variety of housing types. The EMU allows for a variety of housing types while maintaining a low density residential average not exceeding the densities permitted in the R-5 zone. Limited non- residential uses are permitted to encourage a unique identity, sustainable community, and in-home work options. The neighborhood's design will celebrate open space, trees, and relationships to public open spaces. The central open space, ridge open space scenic viewpoints, and a linked system of open spaces and trails are key features of the EMU. Residential developments will provide housing for a range of income levels, sustainable building design, and green development practices.

Response: The EMU subdistrict will be implemented with the Medium-Density Residential comprehensive plan designation and the R-5 Medium-Density Residential (R-5) zoning district. Streets will be developed with sidewalks and street trees per adopted street standards, and may not exceed a maximum block length of 530 feet to ensure a robust, connected street network supporting walkability. (See OCMC 12.08, Street Trees; OCMC Table 16.12.016 for sidewalk widths; OCMC 16.12.030 for block spacing.) Permitted residential uses, as recently expanded in the Amendments to the Oregon City Municipal Code (including the Equitable Housing Project recommendations), provide for a variety of single-family detached, single-family attached, accessory dwelling units, cluster housing, duplexes, triplexes and quadplexes. (See OCMC 17.10.020.) The R-5 density standards will apply in the

EMU zone. (See OCMC 17.10.050.) The variety of residential uses, including smaller lot sizes for selected types, will support housing for a wider range of income levels. The smaller lot sizes and home sizes will inherently increase the efficiency and sustainability of residential development, for example, reducing heating and cooling needs, and the mix of uses in the BRCP district will support green living by reducing the need for vehicle trips. Home occupations will be permitted to provide in-home work options; see response to OCCP Policy 9.7.1 for further discussion. New development will be required to dedicate parkland for the South-Central Open Space, and view points will be created along the ridgeline through view corridor standards. (See proposed OCMC 16.12.042 and 17.10.070.C, respectively.) Trail corridors will be identified and reserved through the subdivision review process. (See OCMC 16.08.025.E.) **The proposal is consistent with this Policy.**

Policy 1.3

Within the Northern Employment Campus sub-district, support the attraction of family wage jobs and connections with Clackamas Community College.

Response: Under the proposed code amendments, the NEC subdistrict permits a range of industrial, light manufacturing, research and development, and corporate headquarters uses that support family-wage employment. Outside of the code and map implementation projects, supporting efforts to build relationships with CCC and to recruit businesses with family-wage jobs will be led by the City's Economic Development department. **The proposal is consistent with this Policy.**

Policy 1.4

Within the Mixed Employment Village and Main Street sub-districts, promote job creation, mixed use and transit oriented development. Adopt minimum densities, limitations on stand-alone residential developments, and other standards that implement this policy.

Response: Under the proposed code amendments, the MEV and MS subdistricts permit a range of employment opportunities including light manufacturing (MEV only), office, retail and service uses. Proposed code standards require that residential uses be proposed as part of a mixed-use project, rather than stand-alone residential developments, and limit residential uses to upper-stories in both the MS and MEV subdistricts. (See proposed OCMC 17.24.050.E and 17.29.080.E.) In the MS subdistrict, ground-floor residential uses may also be permitted on the rear of sites, set back a minimum of 150 feet from the front property line and not to exceed 50% of the total building site area, with a minimum density of 17.4 units per acre. (See proposed OCMC 17.24.050.E.) **The proposal is consistent with this Policy.**

Policy 1.5

The Main Street sub-district may be located along the extension of Glen Oak Road and not exceed 10 gross acres. The specific configuration of the MS sub-district may be established as part of a master plan.

Response: The proposed map amendments designate the MS subdistrict along Glen Oak Road, totaling 13.5 gross acres or 6.6 net acres. The gross acre numbers that we have include the ROW along Glen Oak and Center/Holly, which may be inflating this figure. **The proposal is consistent with this Policy.**

Policy 1.6

Within the West and East Mixed Use Neighborhoods, require a variety of housing types. Allow lot size averaging and other techniques that help create housing variety while maintaining overall average density.

Response: Permitted residential uses in R-5 and R-2 zoning districts, proposed to implement the EMU and WMU subdistricts, provide for a variety of single-family detached, single-family attached, accessory dwelling units, multifamily, cluster housing, duplexes, triplexes and quadplexes. (See OCMC 17.10.020 and 17.12.020.) Lot size averaging is permitted per OCMC 16.08.065. **The proposal is consistent with this Policy.**

Policy 1.7

Within the MEV, MS, WMU and EMU sub-districts, require master plans to ensure coordinated planning and excellent design for relatively large areas (e.g. 40 acres per master plan). Master plans are optional in the NEC due to the larger lot and campus industrial nature of the area.

Response: Master planning is permitted in all subdistricts as a discretionary review alternative. (OCMC 17.65.) Mandatory master planning is not proposed in light of state standards requiring clear and objective residential development standards and proposed amendments which address concerns generally reserved for Master Plans, such as required park aquisition. Since 2008 when the BRCP was developed, state law has been strengthened to require a clear and objective review option for all residential and mixed-use development to provide greater certainty for housing development. (ORS 197.303, 197.307.) Master planning provisions are generally discretionary, and so should not be made mandatory for residential or mixed-use areas. Many of the concept plan provisions, such as green streets and LID stormwater development, can be implemented by existing or proposed code standards and thereby meet the master planning intent. Master planning can provide an alternative review path, with incentives such as higher densities or modifications to base zone standards like minimum lot sizes. The City could also

require master planning as a condition of annexation or zone change. **The proposal is consistent with this Policy.**

Goal 2 Model of Sustainable Design

Be a model of sustainable design, development practices, planning, and innovative thinking.

Response: The greatest strength of the BRCP, as implemented by the proposed map and code changes, is the mix of uses that will support a vibrant, interconnected district. Much of the sustainable infrastructure planning, including LID stormwater and green street designs, was done with the BRCP and subsequent utility master planning, will can be implemented at the time of site development. Many of the zoning standards, particularly the expanded uses in the residential zones, support compact development, coupled with resource protection standards for sensitive environmental areas. The proposed code amendments include site-specific sustainable design features required in the NEC subdistrict through the implementing CI standards, and incentivized in the WMU subdistrict through the implementing R-2 standards in the form of a density bonus. Future implementation efforts will continue building partnerships with private and institutional stakeholders to further support sustainable development and economic development. **The proposal is consistent with this Goal.**

Policy 2.1

Implement the Sustainable Storm Water plan recommended in the Concept Plan. During site specific design, encourage innovative system design and require low impact development practices that manage water at the site, street and neighborhood scales.

Response: Since the BRCP was initially written in 2008, the City has adopted the Stormwater and Grading Design Standards (2015), emphasize low-impact development (LID) practices, source controls for higher pollutant generating activities, erosion prevention and sediment controls, and operation and maintenance practices designed to properly manage stormwater runoff and protect our water resources. Some of the LID techniques permitted include porous pavement, green roofs, filtration planters, infiltration planters, swales, and rain gardens. (See https://www.orcity.org/publicworks/stormwater-and-grading-design-standards) **The proposal is consistent with this Policy.**

Policy 2.2

Storm water facilities will be designed so they are amenities and integrated into the

overall community design.

Response: LID techniques such as green roofs, filtration planters, infiltration planters, swales, and rain gardens, consistent with the 2015 Stormwater and Grading Design Standards, will serve as amenities integrated into the community. **The proposal is consistent with this Policy.**

Policy 2.3

Support public and private sector initiatives to promote sustainable design, development practices and programs, including but not limited to:

- Energy efficiency
- Water conservation
- Compact development
- Solar orientation
- Green streets/infrastructure
- Adaptive reuse of existing buildings/infrastructure
- Alternative transportation
- Pedestrian/Cyclist friendly developments
- Natural drainage systems
- Tree preservation and planting to "re-establish" a tree canopy
- Minimizing impervious surfaces
- Sustainability education (builder, residents, businesses and visitors)
- Collaboration with "local" institutional and economic partners, particularly Clackamas Community College and Oregon City High School
- Community based sustainable programs and activities

Response: Many of these initiatives are ongoing and involve multiple stakeholders, which the City will continue to support. The proposed map and code amendments will directly and indirectly support a number of them. The proposed residential standards in particular support compact development by allowing a variety of residential units at higher density than permitted density for single-family detached residential uses. The City has adopted green street standards with the 2013 Transportation System Plan and the low impact development stormwater and grading design standards that will be applied to all new development. Sidewalks and bicycle lanes will be built with new roadways at the time of development to

provide alternative transportation infrastructure, as well as off-street trails. Bicycle parking will be required in new developments per OCMC 17.52.040. Tree protection, preservation, removal and replanting is regulated per OCMC 17.41 to support tree preservation. Impervious surfaces can be minimized through application of the low impact development stormwater standards, and supported by recent reductions to off-street parking required for residential uses in OCMC 17.52 with the Amendments to the Oregon City Municipal Code (including the Equitable Housing Project recommendations). **The proposal is consistent with this Policy.**

Policy 2.4

Work with stakeholders and the community to develop LEED or equivalent green building standards and guidelines to apply in the Concept Plan area.

Response: As part of the proposed code amendments, industrial development in the NEC subdistrict will be required to incorporate sustainable design features; one option is to propose a LEED certified building. (See proposed OCMC 17.37.060.G.8.) Similarly, WMU development may elect to build to LEED standards as one option to qualify for a density bonus. (See proposed OCMC 17.12.060.D.12.) The existing site development standards in OCMC 17.62 that apply to all new development except low-density residential already include green building standards and guidelines that supports sustainability. For example, 15% site landscaping is required along with conservation of natural resource areas which, along with adopted LID stormwater standards, minimizes impervious surface and treats stormwater runoff. Mandatory green building standards for all development, beyond the sustainable features for industrial and high-density residential, are not recommended. Requiring compliance with a third-party set of standards, such as LEED, is inherently problematic because it outsources City decision-making to a third party, with standards that are updated more frequently than City code is updated. **The proposal is consistent with this Policy.**

Goal 3 Green Jobs

Attract "green" jobs that pay a living wage.

Response: The proposed map and code amendments lay the foundation for future "green" job and green industry recruitment by designating 135.1 net acres for industrial development under the CI standards, and permitting a wide range of industrial, research and development, and corporate headquarters uses. Further business recruitment efforts will be led by the City's Economic Development department and community partners to promote the BRCP area, building off the existing Beavercreek Employment Area efforts that already include a portion of the

BRCP area. (See https://www.orcity.org/economicdevelopment/beavercreek-employment-area) **The proposal is consistent with this Goal.**

Policy 3.1

Coordinate with county, regional and state economic development representatives to recruit green industry to the Concept Plan area.

Response: The proposed map and code amendments will support business recruitment efforts for the BRCP area that will be led by the City's Economic Development department and county, regional and state economic development representatives. The City can expand current partnerships such as the Beavercreek Employment Area Blue Ribbon Committee that include city, county and regional representatives. (See https://www.orcity.org/sites/default/files/fileattachments/economic_development/page/11230/beavercreek_employment_area_-_marketing_and_recruitment_strategy.pdf) The Committee was identified as a stakeholder in this implementation project and provided their input at a meeting held January 17, 2019. **The proposal is consistent with this Policy.**

Policy 3.2

Promote the Concept Plan area as a place for green industry.

Response: The proposed map and code amendments will support business promotion efforts for the BRCP area that will be led by the City's Economic Development department. The City can promote the BRCP area, building off the existing Beavercreek Employment Area efforts that already include a portion of the BRCP area. (See https://www.orcity.org/economicdevelopment/beavercreek-employment-area) **The proposal is consistent with this Policy.**

Policy 3.3

Work with Clackamas Community College to establish programs and education that will promote green development within the Concept Plan area.

Response: Clackamas Community College was identified as a stakeholder in this implementation project and interviewed early in the process to incorporate their ideas into the map and code amendments. The College has participated in the Beavercreek Employment Area efforts to date as a member of the Blue Ribbon Committee and the City will continue working with the College. **The proposal is consistent with this Policy.**

Goal 4 Sustainable Industries

Maximize opportunities for sustainable industries that serve markets beyond the

Portland region and are compatible with the site's unique characteristics.

Response: The proposed map and code amendments lay the foundation for sustainable industries by designating 135.1 net acres for industrial development under the CI standards, and permitting a wide range of industrial, research and development, and corporate headquarters uses. Further business recruitment efforts will be led by the City's Economic Development department and community partners to promote the BRCP area, building off the existing Beavercreek Employment Area efforts that already include a portion of the BRCP area. (See https://www.orcity.org/economicdevelopment/beavercreek-employment-area) **The proposal is consistent with this Goal.**

Policy 4.1

As master plans are approved, ensure there is no net loss of land designated North Employment Campus.

Response: The proposed map amendments designate 236.1 gross acres with an estimated 135.1 net acres with the Industrial comprehensive plan designation and CI zoning district. Any rezoning proposal will have to show compliance with the BRCP, including this policy, which will prevent any net loss of NEC land. Much of the NEC land is designated Industrial land consistent with Metro Title 4 regulations, and is further protected from conversion to non-industrial uses by Metro standards. (See https://www.orcity.org/sites/default/files/fileattachments/planning/page/12700/title_4_map_-_employment_and_industrial_land.pdf) **The proposal is consistent with this Policy.**

Policy 4.2

Coordinate with County, regional and state economic development representatives to recruit sustainable industries that serve markets beyond the Portland region.

Response: The proposed map and code amendments will support business recruitment efforts for the BRCP area that will be led by the City's Economic Development department and county, regional and state economic development representatives. The City can expand current partnerships such as the Beavercreek Employment Area Blue Ribbon Committee that include city, county and regional representatives. (See https://www.orcity.org/sites/default/files/fileattachments/economic_development/page/11230/beavercreek_employment_area_-_marketing_and_recruitment_strategy.pdf) The Committee was identified as a stakeholder in this implementation project and provided their input at a meeting held January 17, 2019. **The proposal is consistent with this Policy.**

Goal 5 Natural Beauty

Incorporate the area's natural beauty into an ecologically compatible built environment.

Response: The proposed map and code amendments will protect natural resources within the future built environment of the district by requiring dedication of parkland to create the South-Central Open Space Network, requiring dedication of trail corridors identified in the BRCP, protecting trees per OCMC 17.41, and protecting riparian habitat and geologic hazard areas from development through application of the Natural Resources Overlay District in OCMC 17.49 and the Geologic Hazards Overlay Zone in OCMC 17.44. **The proposal is consistent with this Goal.**

Policy 5.1

Incorporate significant trees into master plans and site specific designs. Plant new trees to establish an extensive tree canopy as part of the creation of an urban community.

Response: All future development in the areas affected by this proposal will be required to comply with tree protection standards in OCMC 17.41, which include replanting standards with development. **The proposal is consistent with this Policy.**

Policy 5.2

Provide scenic viewpoints and public access along the east ridge.

Response: Under the proposed map and code amendment, the east ridge area will be zoned R-5. Proposed R-5 standards for the BRCP area in proposed OCMC 17.10.070 include view protection standards along the ridgeline requiring view corridors. (See proposed OCMC 17.10.070.C.) An additional viewpoint is incorporated in the South Central Open Space extent; those parklands will be required to be dedicated at the time of residential development. (See proposed OCMC 16.12.042.) The east ridge trail corridor as identified in the Trails Master Plan will be identified and reserved through the subdivision review process, ensuring public access. (See OCMC 16.08.025.E.) **The proposal is consistent with this Policy.**

Policy 5.3

Protect views of Mt Hood and locate trails and public areas so Mt Hood can be viewed within the community.

Response: Under the proposed map and code amendment, trails and public areas identified in the BRCP will be acquired by the City and protected from

development, which will protect views of Mt Hood from those facilities. Parkland within the South Central Open Space Network will be required to be dedicated at the time of residential development. (See proposed OCMC 16.12.042 and 17.62.058.) Trail corridors as identified in the Trails Master Plan will be identified and reserved through the development review process, including a 30-foot corridor through the powerline easement area identified in the BRCP as providing Mt Hood views. (See OCMC 16.08.025.E and proposed 17.37.060.F.) **The proposal is consistent with this Policy.**

Policy 5.4

Establish open space throughout the community consistent with the Open Space Framework Plan. Allow flexibility in site specific design of open space, with no net loss of total open space area.

Response: Under the proposed map and code amendment, open spaces identified in the BRCP will be protected from development and/or acquired by the City. Parkland within the South Central Open Space Network will be required to be dedicated at the time of residential development. (See proposed OCMC 16.12.042 and 17.62.058.) Trail corridors as identified in the Trails Master Plan will be identified and reserved through the development review process. (See OCMC 16.08.025.E.) Additional natural, undeveloped open space will be protected through application of the Natural Resources Overlay District in OCMC 17.49 and the Geologic Hazards Overlay Zone in OCMC 17.44 which restrict development in sensitive areas. **The proposal is consistent with this Policy.**

Policy 5.5

Protect steeply sloped and geologically sensitive areas along the east ridge from development.

Response: Through the proposed code amendments, the steeply sloped areas along the east ridge will be protected through the application of the Geologic Hazards Overlay Zone in OCMC 17.44, which limits development on slopes 25 to 35% and prohibits all development on slopes over 35%. The east ridge will be further protected through application of the proposed Low Impact Conservation Area standards, which limit development density and development area and require mitigation. (See proposed OCMC 17.10.070.C.) **The proposal is consistent with this Policy.**

Goal 6 Multi-modal Transportation

Provide multi-modal transportation links (such as bus routes, trails, bike- ways, etc.)

that are connected within the site as well as to the surrounding areas.

Response: The proposed map and code amendments will support the provision of multi-modal transportation links within the site and to surrounding areas at the time of development. The transportation network of major arterials and collectors within the BRCP area have been adopted in the City's Transportation System Plan (2013); the projects must be complete or completed by the developer at the time of development. Improvement of these major rights-of-way will meet green street standards with multimodal elements. The trails network, as part of the Trails Master Plan, will be required to be built prior to or as a condition of development as well. Bus routes will be planned with Tri-Met as part of ongoing coordination efforts. **The proposal is consistent with this Goal.**

Policy 6.1

Work with Tri-Met and stakeholders to provide bus service and other alternatives to the Concept Plan area.

Response: Bus service will be planned with Tri-Met as part of ongoing coordination efforts outside of the proposed map and code amendments. **The proposal is consistent with this Policy.**

Policy 6.2

As land use reviews and development occur prior to extension of bus service, ensure that the mix of land uses, density and design help retain transit as an attractive and feasible option in the future.

Response: The proposed map and code amendments support development of a mix of uses both across the district and within individual subdistricts that include employment, commercial and residential uses that can support future transit service. Minimum densities will be applied to residential development in the EMU and WMU subdistricts, at 7.0 units per acre and 17.4 units per acre respectively; any ground-floor residential uses in the MS subdistrict will also be required to meet a minimum density of 17.4 units per acre. Minimum FARs are also proposed for the MEV and MS subdistricts to guide intensive design supportive of future transit options. **The proposal is consistent with this Policy.**

Policy 6.3

Ensure that local street connectivity and off-street pedestrian routes link together into a highly connected pedestrian system that is safe, direct, convenient, and attractive to walking.

Response: The proposed map and code amendments will require local street connectivity and off-street pedestrian routes to be developed with all new development. OCMC 16.12, which applies to new subdivisions and site plan reviews, requires a maximum block length of 530 feet to maintain connectivity except in the CI zone, discourages cul-de-sacs and dead ends, and requires public off-street pedestrian and bicycle accessways when through streets cannot be provided; together these provisions provide for a highly connected pedestrian system. (See OCMC 16.12.025, 16.12.030, 16.12.032.) Additionally, development under the proposed map and code amendments will be required to reserve trail corridors supporting completion of the off-street trails network established in the Trails Master Plan. **The proposal is consistent with this Policy.**

Policy 6.4

The "walkability" of the Concept Plan area will be one of its distinctive qualities. The density of walking routes and connectivity should mirror the urban form – the higher the density and larger the building form, the "finer" the network of pedestrian connections.

Response: The proposed map and code amendments will require pedestrian connectivity that mirrors the urban form. A maximum block length of 530 feet applies in all proposed zones except the CI-zoned NEC subdistrict, where greater spacing between streets is appropriate for industrial campus development. (See OCMC 16.12.030.) Within the "finer" grained residential and mixed-use subdistricts, code standards to be applied through these proposed map amendments will also require provision of a well-marked, continuous and protected on-site pedestrian circulation system within development sites per OCMC 17.62.050.C. **The proposal is consistent with this Policy.**

Policy 6.5

Require trails to be provided consistent with the Concept Plan Circulation Framework.

Response: Development under the proposed map and code amendments will be required to reserve trail corridors supporting completion of the off-street trails network established in the Trails Master Plan. **The proposal is consistent with this Policy.**

Policy 6.6

Provide bike lanes on Beavercreek Road and all collector streets, except for Main Street. The City may consider off-street multi-use paths and similar measures in meeting this policy. Bike routes will be coordinated with the trails shown on the

Circulation Framework.

Response: Streets, including Beavercreek Road, will be built prior to or as a condition of development, and will be required to be constructed to the City's adopted green street standards that include bike lanes except on Glen Oak Road which will serve as the Main Street. Off-street multiuse paths may be developed along Center Parkway (Holly) within an expanded right-of-way as part of the South Central Open Space Network. **The proposal is consistent with this Policy.**

Goal 7 Safety Along Beavercreek Road

Implement design solutions along Beavercreek Road that promote pedestrian safety, control traffic speeds and access, and accommodate projected vehicular demand.

Response: The proposed map and code amendments will not affect the design of Beavercreek Road, which will be built as planned in the BRCP and the adopted TSP. **The proposal is consistent with this Goal.**

Policy 7.1

Design Beavercreek Road to be a green street boulevard that maximizes pedestrian safety.

Response: The proposed map and code amendments will not affect the design of Beavercreek Road, which will be built as planned in the BRCP and the adopted TSP as a green street boulevard. **The proposal is consistent with this Policy.**

Policy 7.2

Work with the County and State to establish posted speeds that are safe for pedestrians and reinforce the pedestrian-oriented character of the area.

Response: Future coordination with the County and the State about the posted speeds is outside of the scope of the proposed map and code amendments. **The proposal is consistent with this Policy.**

Policy 7.3

Control access along the east side of Beavercreek Road so that full access points are limited to the intersections shown on the Circulation Framework. Right in-Right-out access points may be considered as part of master plans or design review.

Response: The proposed map and code amendments will support limited access along the east side of Beavercreek Road. At the time of development, driveway spacing and access limitations will be applied to individual lots including standards that require a minimum of 175 feet per driveway along an arterial like Beavercreek Road, that limit access to one driveway per frontage, and that require access to be

provided from the lowest classification street. (See OCMC 16.12.035.) Requirements to develop an alley network in all subdistricts except the NEC will also limit access needs for individual lots. (See OCMC 16.12.025.) The City may adopt additional access limitations specific to Beavercreek Road. **The proposal is consistent with this Policy.**

Goal 8 Oregon City High School and Clackamas Community College

Promote connections and relationships with Oregon City High School and Clackamas Community College.

Response: Both OCHS and CCC were identified as stakeholders in this implementation project, and engaged through initial interviews and invitations to all public meetings throughout the project; OCHS hosted two public open houses on January 29 and April 9, 2019. Future implementation efforts will continue to engage OCHS and CCC. **The proposal is consistent with this Goal.**

Policy 8.1

Coordinate with OCHS and CCC when recruiting businesses and promoting sustainability. Within one year of adoption of the Concept Plan, the City will convene dialogue with OCHS, CCC and other relevant partners to identify target industries and economic development strategies that are compatible with the vision for the Concept Plan. Encourage curricula that are synergistic with employment and sustainability in the Concept Plan area.

Response: Both OCHS and CCC are members of the Beavercreek Employment Area Blue Ribbon Committee that includes city, county and regional representatives to discuss economic development strategies for the area incorporating the two institutions and portions of the BRCP area. (See https://www.orcity.org/sites/default/files/fileattachments/economic_development/page/11230/beavercreek_employment_area_-_marketing _and_recruitment_strategy.pdf) Future implementation efforts will continue to engage OCHS and CCC. **The proposal is consistent with this Policy.**

Policy 8.2

Prior to application submittal, require applicants to contact OCHS and CCC to inform them and obtain early comment for master plans and design review applications.

Response: The City will develop internal policies to ensure that OCHS and CCC are engaged at the time of pre-application conferences required before all subdivision,

master plan, and site plan review applications are submitted, to inform OCHS and CCC and provide opportunity for early comment. **The proposal is consistent with this Policy.**

Policy 8.3

Improving the level-of-service and investing in the Highway 213 corridor improves the freight mobility along Highway 213, which provides access to Beavercreek Road and the Concept Plan area. Protecting the corridor and intersections for freight furthers the City goal of providing living-wage employment opportunities in the educational, and research opportunities to be created with CCC and OCHS.

Response: Alternative Mobility Targets were adopted for Highway 213 in 2018, including the Highway 213 and Beavercreek Road intersection, which will support freight mobility along Highway 213 to support employment opportunities in the BRCP area. OCHS and CC are encouraged to continue to implement TDM strategies. **The proposal is consistent with this Policy.**

Goal 9 Unique Sense of Place

Have a unique sense of place created by the mix of uses, human scale design, and commitment to sustainability.

Response: The essence of the BRCP area is the mix of uses both across the district as a whole and within individual subdistricts, which will be fully implemented by the proposed map and code amendments to create the five subdistricts including mixed-use zoning for the MEV and MS subdistricts. Design elements implemented through the proposed code amendments include maximum square footages for individual business establishments, minimum FARs, and maximum setbacks in the MS and MEV subdistricts; pedestrian connectivity within sites, subdistricts, the district and beyond; and building design standards, as discussed elsewhere in this narrative. Sustainability will be integrated into the fabric of the district as discussed in response to Goal 2 and related policies, including sustainable infrastructure, mix of uses, natural resources protection, and sustainable building and site design elements for industrial development and multifamily development in the R-2 zoned WMU zone. **The proposal is consistent with this Goal.**

Policy 9.1

Utilize master plans and design review to ensure detailed and coordinated design. Allow flexibility in development standards and the configuration of land uses when they are consistent with the comprehensive plan, development code, and vision to create a complete and sustainable community.

Response: Under the proposed map and code amendments, new development will be reviewed through site plan design review, subdivision, and/or master plans. Development standards can be modified through minor and major variances if they are consistent with the comprehensive plan including the BRCP vision. (See OCMC 17.60.) The configuration of land uses will be established by the proposed map amendments and can be modified through future map amendments consistent with OCMC 17.68, though the range of uses allowed in each subdistrict through the proposed code amendments is intended to be flexible and potentially reduce the need for map amendments, such as the R-2 standards for small-scale commercial and mixed-use in the primarily residential EMU subdistrict. **The proposal is consistent with this Policy.**

Policy 9.2

Implement human scale design through building orientation, attractive streetscapes, building form/architecture that is matched to the purpose of the sub-district, location of parking, and other techniques. The design qualities of the community should mirror the urban form – the higher the density and larger the buildings, the higher the expectation for urban amenities and architectural details.

Response: Design elements implemented through the proposed code amendments that support human-scale design include maximum square footages for individual business establishments, minimum FARs, and maximum setbacks in the MS and MEV subdistricts; pedestrian connectivity within sites, subdistricts, the district and beyond; and requirements for parking to be located at the rear of sites served by alley access. The proposed code amendments also apply the building design standards in OCMC 17.62.055 for all development, except industrial development, requiring quality building materials, siting of structures along the front property line, buildings oriented towards the street, entryways, façade modulation and articulation, and fenestration. The proposed code amendments will support attractive streetscapes through both design standards for private development along the street, such as maximum setbacks and provisions for pedestrian plazas and outdoor café seating within the setbacks, and the green street standards for the public right-of-way development. **The proposal is consistent with this Policy.**

Policy 9.3

Density should generally transition from highest on the west to lowest in the eastern part of the site.

Response: Generally, the proposed map and code amendments support graduated density across the district from west to east. Density transitions from highest in the west along Beavercreek Road, with the R-2 zoning for the WMU subdistrict that

allows development up to 21.8 units an acre, transitioning to medium density at a maximum density of 8.7 units per acre for single-family detached homes in the east with the R-5 zoning for the EMU subdistrict. The density transitions to very low density on the eastern edge of the site within the Low Impact Conservation Area, limited to two units per acre. (See proposed OCMC 17.10.070.C.) **The proposal is consistent with this Policy.**

Policy 9.4

Promote compatibility with existing residential areas at the north and south end of the Concept Plan area. Transition to lower densities, setbacks, buffers and other techniques shall be used.

Response: The proposed code amendments support compatibility with existing residential areas to the north and south of the BRCP area by requiring buffers and setbacks. Under the proposed map and code amendments, the northern edge of the district is zoned CI and industrial development within the zone that is adjacent to residential is required to provide a 25-foot-wide buffer including landscaping, trees, berms, and fencing. (See proposed OCMC 17.37.060.D.) At the southern edge of the district, the proposed code requires a perimeter transition requiring larger 6,000 square foot lots restricted to single-family detached uses, a 40-foot setback from the edge of the district, and a combination of landscaping, trees and fencing. (See proposed OCMC 17.10.070.D.) **The proposal is consistent with this Policy.**

Goal 10 Ecological Health

Manage water resources on site to eliminate pollution to watersheds and lesson impact on municipal infrastructure by integrating ecological and man-made systems to maximize function, efficiency and health.

Response: The City has adopted the Stormwater and Grading Design Standards (2015) that emphasize low-impact development (LID) practices, which will be applied to new development within the BRCP area under the proposed map and code amendments. The Natural Resources Overlay District (NROD) in OCMC 17.49 will also be applied to stream corridors and riparian habitat through the proposed map and code amendments to protect water resources on site. **The proposal is consistent with this Goal.**

Policy 10.1

Utilize low impact development practices and stormwater system designs that mimic natural hydrologic processes, minimize impacts to natural resources and eliminate pollution to watersheds.

Response: Since the BRCP was initially written in 2008, the City has adopted the Stormwater and Grading Design Standards (2015), emphasize low-impact development (LID) practices, source controls for higher pollutant generating activities, erosion prevention and sediment controls, and operation and maintenance practices designed to properly manage stormwater runoff and protect our water resources. Some of the permitted LID techniques, some of which mimic natural hydrologic processes, include porous pavement, green roofs, filtration planters, infiltration planters, swales, and rain gardens. (See https://www.orcity.org/publicworks/stormwater-and-grading-design-standards) **The proposal is consistent with this Policy.**

Policy 10.2

Prepare the Environmentally Sensitive Resource Area overlay to protect, conserve and enhance natural areas identified on the Concept Plan. Apply low-density base zoning that allows property owners to cluster density outside the ESRA and transfer to other sites.

Response: Areas identified within the Environmentally Sensitive Resource Area will be protected by a variety of strategies through the proposed map and code amendments. Most importantly, the Natural Resources Overlay District (NROD) in OCMC 17.49 will be applied to stream corridors and riparian habitat, including Thimble Creek on the eastern edge of the site. The Geologic Hazards Overlay District will be applied to steep slopes per OCMC 17.44, limiting development on slopes 25 to 35% to two units per acre and prohibiting development on slopes above 35%. The key ESRAs identified on page 1 of the BRCP are generally protected through the combination of these two overlays, however, there are minor discrepancies in the extent of individual nodes. In 2008 when the BRCP was being drafted, there was discussion that upland habitat areas could be protected through the NROD as well, however, subsequent development of the NROD standards elected to exclude upland habitat areas because there is no mechanism for such in Metro's Title 13. The exclusion of the upland habitat areas slightly reduces the extent of some of the identified ESRA nodes, but the NROD and geologic hazard overlays together protect the core of each resource area. The NROD includes density transfer provisions in OCMC 17.49.240. **The proposal is consistent with this Policy.**

OREGON CITY

Community Development – Planning

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Oregon City Municipal Code
Beavercreek Road Concept Plan Implementing Code
June 7, 2019 Draft

Chapter 16.08, Land Divisions - Process and Standards

16.08.025 - Preliminary plat—Required information.

A. Site Plan. A detailed site development plan drawn to scale by a licensed professional based on an existing conditions plan drawn by a licensed surveyor. The site plan shall include the location and dimensions of lots, streets, existing and proposed street names, pedestrian ways, transit stops, common areas, parks, trails and open space, building envelopes and setbacks, all existing and proposed utilities and improvements including sanitary sewer, stormwater and water facilities, total impervious surface created (including streets, sidewalks, etc.), all areas designated as being within an overlay district and an indication of existing and proposed land uses for the site. (…)

16.08.040 – Park and open space requirements.

Where a proposed park, open space, playground, public facility, or other public use shown in a plan adopted by the city is located in whole or in part in a land division, the City may require the dedication or reservation of this area on the final plat for the partition or subdivision.

16.08.042 - Additional Public Park Requirements in Beavercreek Road Concept Plan area.

A. Each development within the Beavercreek Road Concept Plan area that includes residential development must provide for land for neighborhood parks which meets the requirements of this section.

B. The minimum amount of land in acres dedicated for a park shall be calculated according to the following calculation: (2.6 persons per dwelling units) x (total number of dwelling units proposed in the development) x (8.0 acres) / (1,000 persons).

C. The entire acreage must be dedicated prior to approval or as part of the final plat or site plan development approval for the first phase of development.

D. If a larger area for a neighborhood park is proposed than is required based on the per-unit calculation described in subsection (A), the City must reimburse the applicant for the value of the amount of land that exceeds the required dedication based on the fee-in-lieu formula expressed in subsection (E)(1).

E. The City may accept a fee-in-lieu as an alternative to this dedication at its discretion or may require a fee-in-lieu if a suitable site meeting the criteria described in subsection (F) of these provisions is not available with the development site. The calculation of the fee-in-lieu or other monetary contribution must meet the following standards.

1. The amount of the fee in lieu or other monetary contribution is set in dollars per acre of required dedication and is equivalent to the appraised cost of land within the development, as provided by a certified appraiser chosen by the City and with the assumption that zoning and other land use entitlement are in place.
2. The fee-in-lieu or other monetary contribution must be paid prior to approval of the final plat or development approval for each phase of development.

F. Neighborhood park sites proposed for dedication must meet the following criteria.

1. Located within the South Central Open Space Network as shown in Figure 16.08.042-1.

   Figure 16.08.042-1 (To be provided, will show the South Central Open Space Network as mapped on the Development Constraints Map.)

2. Met either of the following standards:

   a. Pearl standard. (*To be developed with Parks input.)*

   b. String standard. (*To be developed with Parks input.)*

Chapter 17.10, R-5 Medium Density Residential District (East Mixed-Use Neighborhood subdistrict)

17.10.070 – Additional Standards for Beavercreek Road Concept Plan Area

A. Applicability. This section applies to all development in the R-5 district within the Beavercreek Road Concept Plan area.

B. Relationship of Standards. These standards apply in addition to and supersede the standards of the R-5 zone within the Beavercreek Road Concept Plan area. In the event of a conflict, the standards of this section control.

C. Low-Impact Conservation Area. Between the west edge of the designated Natural Resources Overlay District extent required along Thimble Creek extending east to the 490-foot elevation (MSL), additional standards apply to create a low-impact conservation area as depicted in Figure 17.10.070-1 and preserve views to adjacent natural areas.

Figure 17.10.070-1 Extent of Low-Impact Conservation Area (To be provided based on Concept Plan.)

1. The standards of this section apply in addition to the requirements of OCMC 17.44, US—Geologic Hazards, if applicable. In the event of a conflict, the more restrictive shall apply.
2. Development intensity shall be limited as follows:

   a. The maximum residential density shall be limited to two dwelling units per acre;

b. An individual lot or parcel shall have a disturbance area of no more than fifty percent or three thousand square feet of the surface area, whichever is smaller, graded or stripped of vegetation or covered with structures or impermeable surfaces; and

c. No cut into a slope for the placement of a housing unit shall exceed a maximum vertical height of fifteen feet for the individual lot or parcel.

3. Views shall be preserved through one of the following methods:

a. Individual lots shall have minimum 25-foot side yard setbacks on both sides to create view corridors a minimum of 50 feet wide between houses. Nothing shall be placed within the side yard setback that exceeds the 490-foot elevation with the exception of trees and vegetation that are existing or planted as part of mitigation required in subsection (4).

b. Alternatively, residential lots may be arranged so that a minimum 700-foot wide view corridor is created along the 490-foot elevation line extending in the direction of Thimble Creek. Nothing shall be placed in the view corridor that exceeds the 490-foot elevation with the exception of trees and vegetation that are existing or planted as part of mitigation required in subsection (4). Residential lots outside of this view corridor shall be subject to the side yard setbacks in the R-5 zone.

4. Open space restoration shall be required to mitigate development impacts. Restoration shall occur at a one-to-one ratio of restoration area to proposed disturbance area, and shall meet all of the following standards:

a. All trees, shrubs and ground cover shall be selected from the Oregon City Native Plant List.

b. All invasive species shall be removed to the extent practicable.

c. The restoration requirement shall be calculated based on the size of the disturbance area. Native trees and shrubs are required to be planted at a rate of one tree and five shrubs per every one hundred square feet of disturbance area, rounded to the nearest whole number of trees and shrubs. Bare ground must be planted or seeded with native grasses or herbs. Non-native sterile wheat grass may also be planted or seeded, in equal or lesser proportion to the native grasses or herbs.

d. No initial plantings may be shorter than twelve inches in height.

e. Trees shall be planted at average intervals of seven feet on center. Shrubs may be planted in single-species groups of no more than four plants, with clusters planted on average between eight and ten feet on center.

f. Shrubs shall consist of at least three different species. If twenty trees or more are planted, no more than one-third of the trees may be of the same genus.

5. Alternative standards for the low-impact conservation area may be proposed as part of a Master Plan per OCMC 17.65, provided it is consistent with the goals of the adopted Beavercreek Road Concept Plan.

D. Southern Perimeter Transition. Along the southern boundary of the Beavercreek Road Concept Plan area between Beavercreek Road and the eastern-most point of Tax Lot 00316, located on Clackamas County Map #32E15A, additional standards apply to create a perimeter transition.

1. For all lots adjacent to the southern boundary and within 20 feet of the southern boundary, uses shall be limited to single-family detached residential and parks, trails and open space.
2. For all lots adjacent to the southern boundary and within 20 feet of the southern boundary, minimum lot size for residential uses shall be 6,000 square feet.
3. All structures shall be set back a minimum of 40 feet from the southern boundary for all lots adjacent to the southern boundary and within 20 feet of the southern boundary.
4. Within the 40-foot wide setback, a combination of landscaping and screening shall be provided to buffer the perimeter. The landscaping and screening shall meet one of the two standards:
    a. Utilize existing vegetation in compliance with OCMC 17.41 resulting in preservation or replanting of a minimum of 12 inches of tree diameter inches per lot with trees spaced an average of one tree for every 30 linear feet along the southern property line. These trees may be located on the residential lots or an abutting tract created for tree preservation consistent with OCMC 17.41.050.B or other similar landscaping or open space purpose.
    b. Provide a combination of landscaping and screening to include:
        (i) A minimum of 12 inches of tree diameter inches per lot, or a minimum of an average of one tree with minimum caliper of two inches DBH for every 30 linear feet along the southern property line, whichever is greater; and
        (ii) A minimum six-foot tall, decorative, sight-obscuring fence or wall running parallel to the southern boundary. The fence or wall shall be constructed of wood, stone, rock, or brick. Other durable materials may be substituted with Planning Director's approval. Chainlink fencing with slats shall be not allowed to satisfy this standard.
5. An alternative southern perimeter transition may be proposed as part of a Master Plan per OCMC 17.65, provided it is consistent with the goals of the adopted Beavercreek Road Concept Plan.

Chapter 17.12, R-2 High Density Residential District (West Mixed-Use Neighborhood subdistrict)

17.12.060 – Additional Standards for Beavercreek Road Concept Plan Area

A. Applicability. This section applies to all development in the R-2 district within the Beavercreek Road Concept Plan area.

B. Relationship of Standards. These standards apply in addition to and supersede the standards of the R-2 zone within the Beavercreek Road Concept Plan area. In the event of a conflict, the standards of this section control.

C. Uses.

1. Live/work dwellings are a permitted use.
2. As part of a master plan when authorized by and in accordance with the standards contained in OCMC 17.65, up to five thousand square feet of commercial space as a stand-alone building or part of a larger mixed-use building, to be used for:
    a. Restaurants, eating and drinking establishments without a drive through;

b. Services, including personal, professional, educational and financial services; laundry and dry-cleaning; or

c. Retail trade, including grocery, hardware and gift shops, bakeries, delicatessens, florists, pharmacies, specialty stores, and similar.

D. Sustainability density bonus. The maximum net density allowed in 17.12.050.B may be increased by up to twenty percent, or a maximum net density of 26.2 du/acre, for projects incorporating the following sustainability features. For every feature provided below, net density may be increased by up to five percent, with a maximum twenty percent bonus available.

1. A vegetated ecoroof for a minimum of thirty percent of the total roof surface.
2. For a minimum of seventy-five percent of the total roof surface, a white roof with a Solar Reflectance Index (SRI) of 78 or higher if the roof has a 3/12 roof pitch or less, or SRI of 29 or higher if the roof has a roof pitch greater than 3/12.
3. A system that collects rainwater for reuse on-site (e.g., site irrigation) designed to capture an amount of rainwater equivalent to the amount of stormwater anticipated to be generated by 50% of the total roof surface.
4. An integrated solar panel system for a minimum of thirty percent of the total roof or building surface.
5. Orientation of the long axis of the building within thirty degrees of the true east-west axis, with unobstructed solar access to the south wall and roof.
6. Windows located to take advantage of passive solar collection and include architectural shading devices (such as window overhangs) that reduce summer heat gain while encouraging passive solar heating in the winter.
7. Fifty percent or more of landscaped area covered by native plant species selected from the Oregon City Native Plant List.
8. Provision of pedestal or wall-mounted Level 2, two hundred forty-volt electric vehicle chargers, or similar alternative fueling stations as approved by the planning director, at a minimum ratio of one station per fifty vehicle parking spaces up to a maximum of five such stations.
9. Building energy efficiency measures that will reduce energy consumption by thirty percent based on HERS rating for building, including efficient lighting and appliances, efficient hot water systems, solar orientation or solar water heating, solar photovoltaic panels, geothermal, and offsetting energy consumption with alternative energy.
10. Use of Forest Stewardship Council certified wood Reclaimed Wood for a minimum of thirty percent of wood products used in the site development.
11. Permeable paving, which may include porous concrete, permeable pavers, or other pervious materials as approved by the city engineer, for a minimum of thirty percent of all paved surfaces.
12. Buildings LEED-certified by the U.S. Green Building Council at any level shall be allowed to increase net density by the full twenty percent.
13. Or an alternative the meets or exceeds the intent of the above code as approved by the Community Development Director through a Type II review.

Chapter 17.24, NC Neighborhood Commercial District (Main Street subdistrict)

17.24.050 – Additional Standards for Beavercreek Road Concept Plan Area

A. Applicability. This section applies to all development in the NC district within the Beavercreek Road Concept Plan area.

B. Relationship of Standards. These standards apply in addition to and supersede the standards of the NC zone within the Beavercreek Road Concept Plan area. In the event of a conflict, the standards of this section control.

C. Uses.

1. All uses permitted per OCMC 17.24.020.A and B, including grocery stores, are limited to a maximum footprint for a stand alone building with a single store or multiple buildings with the same business not to exceed ten thousand square feet, unless otherwise restricted in this chapter.
2. Residential uses are permitted subject to limitations in OCMC 17.24.050.E, and are not subject to OCMC 17.29.020.M, OCMC 17.29.020.N, and OCMC 17.24.020.D.
3. Artisan and specialty goods production is permitted, constituting small-scale businesses that manufacture artisan goods or specialty foods and makes them available for purchase and/or consumption onsite, with an emphasis on direct sales rather than the wholesale market. Examples include: candy, fruit and vegetable preserving and specialty foods, bakeries and tortilla manufacturing; artisan leather, glass, cutlery, hand tools, wood, paper, ceramic, textile and yarn products; microbreweries, microdistilleries, and wineries. All uses shall provide either:
    a. A public viewing area that includes windows or glass doors covering at least twenty-five percent of the front of the building face abutting the street or indoor wall, allowing direct views of manufacturing; or
    b. A customer service space that includes a showroom, tasting room, restaurant, or retail space.
4. Drive-throughs are prohibited.
5. Gas stations are prohibited.

D. Dimensional standards.

1. Maximum building height shall be sixty feet or five stories, whichever is less.
2. Minimum building height shall be twenty-five feet or two stories, whichever is less, except for accessory structures or buildings under one thousand square feet.
3. Maximum corner side yard setback abutting a street shall be five feet.
4. Minimum floor area ratio (FAR) shall be 0.5.
    a. Required minimum FARs shall be calculated on a project-by-project basis and may include multiple contiguous blocks. In mixed-use developments, residential floor space will be included in the calculations of floor area ratio to determine conformance with minimum FAR.

b. An individual phase of a project shall be permitted to develop below the required minimum FAR provided the applicant demonstrates, through covenants applied to the remainder of the site or project or through other binding legal mechanism, that the required FAR for the project will be achieved at project build out.

5. Minimum required landscaping: Ten percent. Required landscaping areas may include:

a. Landscaping within a parking lot.

b. Planter boxes.

c. Ecoroofs.

d. Paved courtyard or plaza with at least twenty-five percent of the area used for landscaping, planter boxes, and/or water features including shade trees planted at the ratio of one tree for every 500 square feet of urban plaza area.

E. Residential Uses. Residential uses, excluding live/work dwellings, are subject to the following additional standards:

1. All residential uses shall be proposed along with any nonresidential use allowed in the NC district in a single development application.

2. All ground-floor residential uses, with the exception of entrances for upper-story residential uses, shall be set back a minimum of 150 feet from the property line along Glen Oak Road.

3. Ground-floor residential building square footage shall not exceed fifty percent of the ground-floor nonresidential building square footage onsite.

4. Ground-floor residential uses shall achieve a minimum net density of 17.4 units per acre, with no maximum net density.

5. Any new lots proposed for exclusive residential use shall meet the minimum lot size and setbacks for the R-2 zone for the proposed residential use type.

6. Upper-story residential uses are permitted with no limitations.

F. Site design standards.

1. In lieu of complying with OCMC 17.62.050.B.1, parking areas shall be located behind the building façade that is closest to the street or below buildings and shall not be located on the sides of buildings or between the street and the building façade that is closest to the street.

Chapter 17.29, MUC Mixed-Use Corridor District (Mixed Employment Village subdistrict)

17.29.080 – Additional Standards for Beavercreek Road Concept Plan Area

A. Applicability. This section applies to all development in the MUC-2 district within the Beavercreek Road Concept Plan area.

B. Relationship of Standards. These standards apply in addition to and supersede the standards of the MUC-2 zone within the Beavercreek Road Concept Plan area. In the event of a conflict, the standards of this section control.

C. Uses.

1. Light industrial uses limited to the design, light manufacturing, processing, assembly, packaging, fabrication and treatment of products made from previously prepared or semi-finished materials are permitted.
2. The following permitted uses, alone or in combination, shall not exceed twenty percent of the total gross floor area of all of the other permitted and conditional uses within the development site. The total gross floor area of two or more buildings may be used, even if the buildings are not all on the same parcel or owned by the same property owner, as long as they are part of the same development site, as determined by the community development director.
    a. Restaurants, eating and drinking establishments;
    b. Services, including personal, professional, educational and financial services; laundry and dry-cleaning;
    c. Retail trade, including grocery, hardware and gift shops, bakeries, delicatessens, florists, pharmacies, specialty stores, marijuana, and similar, provided the maximum footprint for a stand-alone building with a single store does not exceed twenty thousand square feet; and
    d. Grocery stores provided the maximum footprint for a stand-alone building does not exceed forty thousand square feet.
3. Drive-throughs are prohibited.
4. Gas stations are prohibited.
5. Bed and breakfast and other lodging facilities for up to ten guests per night are a conditional use.
6. Tax Lot 00800, located on Clackamas County Map #32E10C has a special provision to allow the multifamily residential use permitted as of (Ordinance effective date) as a permitted use. This property may only maintain and expand the current use.

D. Dimensional standards.
1. Minimum floor area ratio (FAR) shall be 0.35.
2. Maximum allowed setback for corner side yard abutting street shall be five feet.

E. Residential uses. All residential uses, except live/work units, are limited to upper stories only, and may only be proposed as part of a single development application incorporating nonresidential uses allowed in the MUC-2 district on the ground floor.

Chapter 17.37, CI Campus Institutional District (North Employment Campus subdistrict)

17.37.060 – Additional Standards for Beavercreek Road Concept Plan Area

A. Applicability. This section applies to all development in the CI district within the Beavercreek Road Concept Plan area.

B. Relationship of Standards. These standards apply in addition to and supersede the standards of the CI zone within the Beavercreek Road Concept Plan area. In the event of a conflict, the standards of this section control.

C. Uses.

1. The following permitted use supersedes the use allowed in OCMC 17.37.020.L. Retail sales and services, including but not limited to eating establishments for employees (i.e. a cafe or sandwich shop) or retail sales of marijuana pursuant to OCMC 17.54.110, located in a single building or in multiple buildings that are part of the same development shall be limited to a maximum of five thousand square feet in a single outlet or twenty thousand square feet in multiple outlets that are part of the same development project.
2. The following permitted use supersedes the use allowed in OCMC 17.37.020.M. Retail and professional services including but not limited to financial, insurance, real estate and legal offices limited to a maximum of five thousand square feet in a single outlet or twenty thousand square feet in multiple outlets that are part of the same development project. Financial institutions shall primarily serve the needs of businesses and employees within the development, and drive-throughs are prohibited.
3. Offices as an accessory to a permitted use are permitted.
4. Parks, trails, urban agriculture and community garden uses are permitted.
5. Distribution and warehousing are prohibited.
6. Tax Lots 00300, 00301, 00302, 00303, 00400 and 00401, located on Clackamas County Map #32E10C have a special provision to allow single-family detached residential use as a permitted use. This property may only maintain and expand the current use.

D. Buffer zone treatment required in OCMC 17.37.040.D shall include:

1. Landscaping shall be installed to provide screening of views of parking, loading and vehicle maneuvering areas, refuse/recycling collection areas, outdoor storage, and building façades. Buffer zone treatment may substitute for perimeter parking lot landscaping required per OCMC 17.52.060.C. Landscaping shall include:
   a Trees a minimum of two caliper inches dbh planted on average 30 feet on center. Existing mature vegetation may be used to meet this standard if it achieves a similar level of screening as determined by the Planning Director.
   b An evergreen hedge screen of thirty to forty-two inches high or shrubs spaced no more than 4 four feet apart on average.
   c Ground cover plants, which includes grasses covering all landscaping areas. Mulch (as a ground cover) shall only be allowed underneath plants at full growth and within two feet of the base of a tree and is not a substitute for ground cover.
2. Buffer shall incorporate a berm no less than three feet in height above the existing grade, constructed with a slope no steeper than 3:1 on all sides. The berm shall be planted with plant materials to prevent erosion.
3. A minimum six-foot tall, decorative, sight-obscuring fence or wall. The fence or wall shall be constructed of materials commonly used in the construction of fences and walls, such as wood, stone, rock, brick, or other durable materials. Chainlink fencing with slats shall be not allowed to satisfy this standard.

E. Outdoor storage permitted per OCMC 17.37.050.D shall be limited to a maximum of twenty-five percent of the net developable area.

F. Power line corridors. A distinct feature of this district is the power line corridors north of Loder Road that define open corridors.

1. Within the power line corridors, a minimum 30-foot wide open space and public access easement shall be granted to the City. The easement shall run parallel to the power line corridor and align with easements on abutting properties to create a continuous corridor.
2. The easement may be shown on the final plat or recorded as a separate easement document. In either case, the easement must be recorded prior to issuance of a certificate of occupancy.
3. Open spaces within the power line corridors, including the open space easements, may be counted as landscaping satisfying the requirements of OCMC 17.62.050.A.
4. Additional uses encouraged in the power line corridors include community gardens, urban agriculture, stormwater and water quality features, plant nurseries, and solar farms.

G. Sustainability features. Each development must incorporate six of the following sustainability features.

1. A vegetated ecoroof for stormwater management. An ecoroof covering twenty to forty percent of the total roof area shall count as one feature, and a roof covering more than forty percent of the total roof area shall count as two features.
2. A white roof with a Solar Reflectance Index (SRI) of 78 or higher if the roof has a 3/12 roof pitch or less, or SRI of 29 or higher if the roof has a roof pitch greater than 3/12 covering a minimum of seventy-five percent of the total roof area.
3. A system that collects rainwater for reuse on-site (e.g., site irrigation) designed to capture an amount of rainwater equivalent to the amount of stormwater anticipated to be generated by 50% of the total roof surface.
4. An integrated solar panel system mounted on the roof or anywhere on site. A solar system with surface area equivalent to a minimum of twenty to forty percent of the total roof area shall count as one feature, and a solar system with surface area equivalent to forty percent or more of the total roof area shall count as two features.
5. Use of native plant species selected from the Oregon City Native Plant List. Native plantings that cover twenty to thirty percent of the total landscaped area shall count as one feature, and plantings that cover thirty percent or more of the total landscaped area shall count as two features.
6. Provision of pedestal or wall-mounted Level 2, two hundred forty-volt electric vehicle chargers, or similar alternative fueling stations as approved by the planning director, at a minimum ratio of one station per fifty vehicle parking spaces up to a maximum of five such stations.
7. Permeable paving, which may include porous concrete, permeable pavers, or other pervious materials as approved by the city engineer. Permeable paving totaling twenty to forty percent of all paved surfaces shall count as one feature, and permeable paving of forty percent or more of all paved surfaces shall count as two features.
8. Buildings LEED-certified by the U.S. Green Building Council at any level shall be counted as three features.
9. Or an alternative the meets or exceeds the intent of the above code as approved by the Community Development Director through a Type II review.

Chapter 17.62 Site Plan and Design Review

17.62.058 - Additional Public Park Requirements in Beavercreek Road Concept Plan area.

A. Each development within the Beavercreek Road Concept Plan area that includes residential development must provide for land for neighborhood parks which meets the requirements of this section.

B. The amount of land in acres dedicated for a park shall equal at least the following calculation: (2.6 persons per dwelling units) x (total number of dwelling units proposed in the development) x (8.0 acres) / (1,000 persons).

C. The entire acreage must be dedicated prior to approval or as part of the site plan development approval for the first phase of development.

D. If a larger area for a neighborhood park is proposed than is required based on the per-unit calculation described in subsection (A), the City must reimburse the applicant for the value of the amount of land that exceeds the required dedication based on the fee-in-lieu formula expressed in subsection (E)(1).

E. The Planning Director may accept a fee-in-lieu as an alternative to this dedication at its discretion or may require a fee-in-lieu if a suitable site meeting the criteria described in subsection (F) of these provisions is not available with the development site. The calculation of the fee-in-lieu or other monetary contribution must meet the following standards.

1. The amount of the fee in lieu or other monetary contribution is set in dollars per acre of required dedication and is equivalent to the appraised cost of land within the development site, as provided by a certified appraiser chosen by the City and with the assumption that zoning and other land use entitlement are in place.
2. The fee-in-lieu or other monetary contribution must be paid prior to approval of the final development approval for each phase of development.

F. Neighborhood park sites proposed for dedication must meet the following criteria.

1. Located within the South Central Open Space Network as shown in Figure 16.08.042-1.

   Figure 17.62.058-1 (Same as proposed in OCMC 16.08.042.)

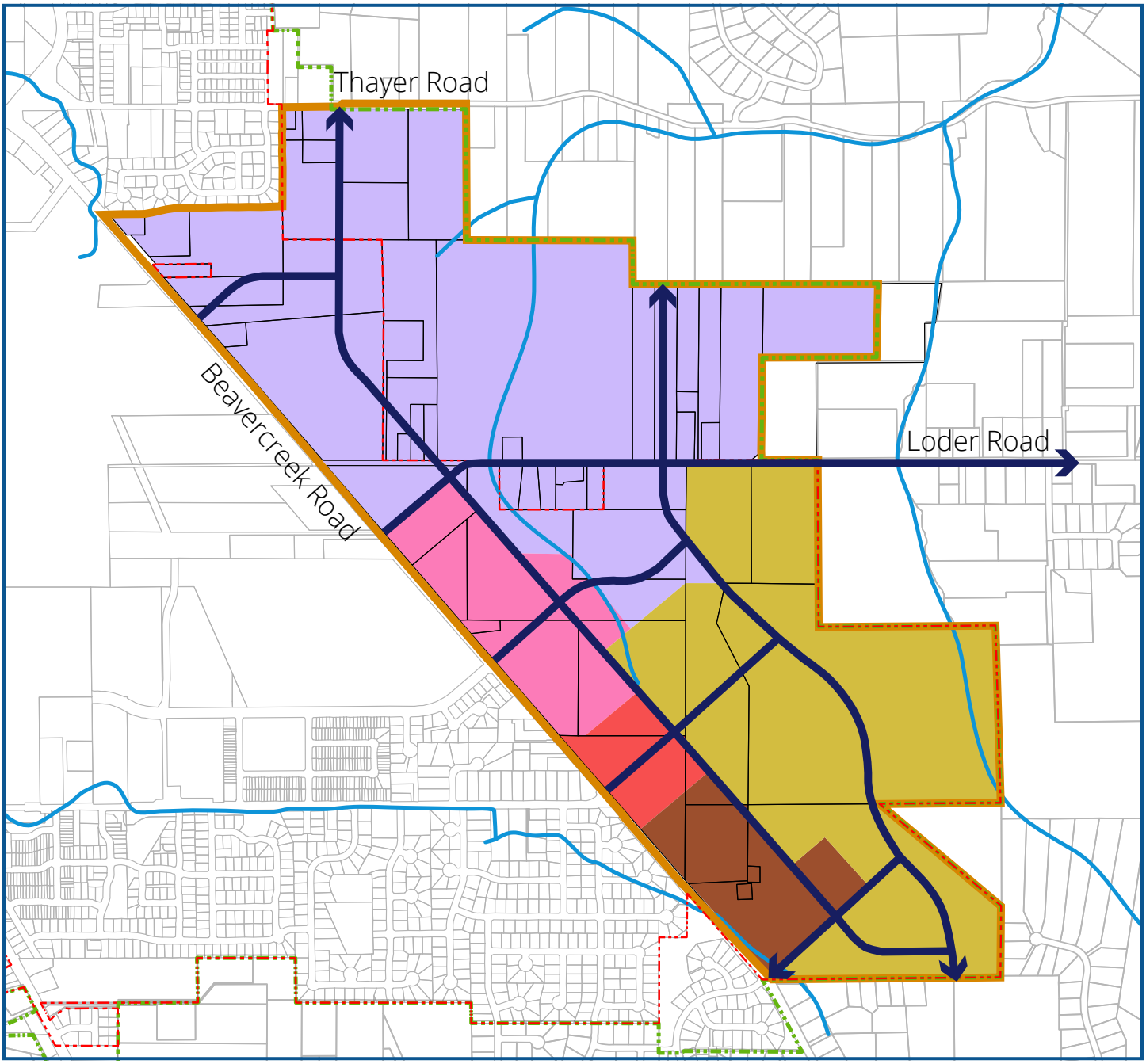
2. Met either of the following standards:

   a. Pearl standard. (*To be developed.)*

   b. String standard. *(To be developed.)*

Beavercreek Road Concept Plan

Proposed Zoning and Comprehensive Plan Designations



Legend

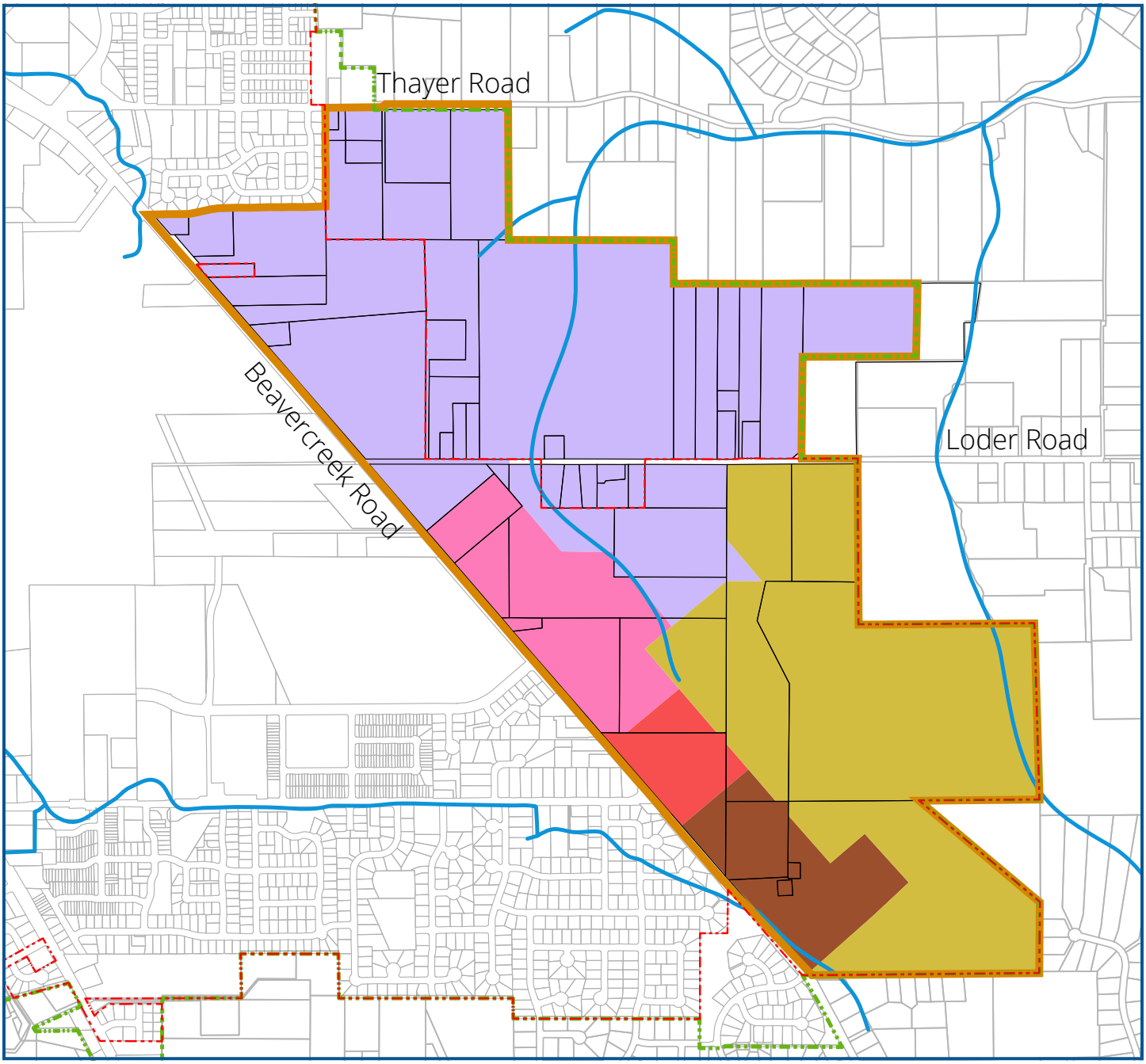
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0′ 1,200′ 2,400′

BRCP Subdistrict	Comp Plan Designation	Zoning Designation		
West Mixed Use Neighborhood	High Density Residential	High Density Residential	R-2	BRCP Boundary
East Mixed Use Neighborhood	Medium Density Residential	Medium Density Residential	R-5	Urban Growth Boundary
Main Street	Mixed Use Corridor	Neighborhood Commercial	NC	City Limits
Mixed Employment Village	Mixed Use Corridor	Mixed Use Corridor	MUC-2	Future Road Connections
North Employment Campus	Industrial	Campus Industrial	CI	Streams

Beavercreek Road Concept Plan

Proposed Zoning and Comprehensive Plan Designations



Legend

N

0′ 1,200′ 2,400′

BRCP Subdistrict	Comp Plan Designation	Zoning Designation		
West Mixed Use Neighborhood	High Density Residential	High Density Residential	R-2	BRCP Boundary
East Mixed Use Neighborhood	Medium Density Residential	Medium Density Residential	R-5	Urban Growth Boundary
Main Street	Mixed Use Corridor	Neighborhood Commercial	NC	City Limits
Mixed Employment Village	Mixed Use Corridor	Mixed Use Corridor	MUC-2	Future Road Connections
North Employment Campus	Industrial	Campus Industrial	CI	Streams

MEMO

Date: June 7, 2019

To: Laura Terway & Christina Robertson-Gardiner, City of Oregon City

From: Elizabeth Decker, JET Planning

Subject: Beavercreek Road Concept Plan Implementing Zoning Code

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Overview: Oregon City aims to further implementation of the Beavercreek Road Concept Plan (BRCP) through comprehensive plan designation and zone mapping, and development code amendments, to complement the public vision, infrastructure, and economic development measures that have already been completed or planned east of Beavercreek Road generally between Thayer Road and Old Acres Lane. Development of the 453-acre BRCP area is intended to create around 1,000 housing units and up to 5,000 family-wage jobs as part of a complete and sustainable community.

The overall strategy for implementing code is to use existing zones, rather than create a Beavercreek Road area-specific overlay. The practice has been used to implement the City's other two concept plans. Several of the implementing zones proposed here were developed for concept plan areas, including the Neighborhood Commercial and the Residential Medium Density R-5 zone. Proposed zoning districts for each concept plan subdistrict include:

Concept Plan Subdistrict	*Zone*
North Employment Campus	Campus Institutional (CI)
Mixed Employment Village	Mixed-Use Corridor (MUC-2)
Main Street	Neighborhood Commercial (NC)
West Mixed-Use Neighborhood	High-Density Residential (R-2)
East Mixed-Use Neighborhood	Medium-Density Residential (R-5)
Environmentally Sensitive Restoration Area	Natural Resources Overlay District (NROD) Geological Hazard Overlay District (GHOD)

This memo provides a short introduction to the draft code amendments to implement the Concept Plan provisions. All of the base zone standards apply, in addition to the proposed code standards specific to each subdistrict described

below. Note that the proposed amendments incorporate the most recent code language from the Equitable Housing and other development code amendments currently under review by the City Commission.

OCMC 16.08, Land Divisions – Process and Standards

- Proposed code amendments include additional public park requirements or fee-in-lieu option to ensure land for the South Central Open Space Network is reserved and dedicated to the city at the time of residential subdivisions. This is expected to largely apply to development in the R-5 district.

OCMC 17.10, R-5 Medium Density Residential District (East Mixed-Use Neighborhood subdistrict)

- No changes are proposed to the mix of uses or dimensional standards in the zone beyond those proposed in the Equitable Housing code amendments.
- Standards for the Low-Impact Conservation Area implement the plan goals for the area upslope of Thimble Creek, on the eastern edge of the Beavercreek Road district. The proposed standards limit development to two units per acre, require open space preservation and restoration, and require view corridors to preserve views.
- A 40-foot perimeter buffer is proposed along the southern edge of the district including landscaping, setbacks and fencing, to manage the transition to lower-density residential development outside City limits along Old Acres Lane to the south.

OCMC 17.12, R-2 High Density Residential District (West Mixed-Use Neighborhood subdistrict)

- Allows additional uses consistent with the Concept Plan include live/work dwellings and limited commercial/mixed-use spaces.
- Provides up to a 20% density bonus for development incorporating sustainability features.
- Additional changes in 17.62 add requirement for additional public park dedication or fee-in-lieu, consistent with requirement for new subdivisions.

OCMC 17.24, MC Neighborhood Commercial District (Main Street subdistrict)

- Limits uses to a 10,000 SF building footprint to encourage pedestrian-scale, main street businesses. Limits residential uses to 50% of the project floor area, and prohibits ground-floor residential uses within 150 feet of Glen Oak Road (which will be the "main street.") Adds a new use category for artisan and specialty goods production to allow limited manufacturing type uses.

- Increase dimensional standards to match scale proposed in the Concept Plan, including a five-story height limit and 0.5 FAR minimum.
- Improves building presence and interaction along the street by requiring parking to be located behind building facades.

OCMC 17.29, MUC Mixed-Use Corridor District (Mixed Employment Village subdistrict)

- Light industrial uses are permitted to implement the employment aspect of the vision for this subdistrict. Retail and service uses, including food service, are limited to 20% of a site to maintain the focus on employment uses generating family-wage jobs. Residential uses are limited to upper stories only.
- One parcel with an in-progress residential development is permitted outright, to avoid creating a nonconforming use.
- An additional dimensional standard implements a minimum 0.35 FAR for new development to ensure efficient use of land.

OCMC 17.31, CI Campus Institutional District (North Employment Campus subdistrict)

- Retail and professional service uses are limited consistent with Metro Title 4 requirements to preserve land for industrial uses. Offices are permitted consistent with uses outlined in the Concept Plan, whereas distribution and warehouse uses are prohibited because they create relatively few jobs per acre inconsistent with the plan goals.
- Several parcels with existing single-family residential development are permitted outright, to avoid creating nonconforming uses. (These parcels are outside of Title 4 lands, so there is no conflict with employment requirements.)
- Additional standards require landscaping, berms and fences within the required 25-foot transition area between industrial and residential uses.
- Outdoor storage is limited to a maximum of 25% of the developable area to avoid inefficient use of land that does not support employment plan goals.
- A minimum 30-foot open space and trail corridor is required along the powerline corridor. Additional parks, trails, urban agriculture and community garden uses are permitted consistent with the plan goals for uses within the powerline easement.
- Sustainable development features are required for all development to implement the plan's sustainability goals.

OCMC 17.44, US – Geologic Hazards and OCMC 17.49 – Natural Resources Overlay District

- No changes are proposed to the geologic hazard or NROD standards for this district; resource areas within the concept plan area will be protected consistent with existing standards.

OCMC 17.62, Site Plan and Design Review

- Proposed code amendments include additional public park requirements or fee-in-lieu option to ensure land for the South Central Open Space Network is reserved and dedicated to the city at the time of residential subdivisions. This is intended to apply to any residential development in the R-2 or the mixed-use districts that does not get developed through subdivision.

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MEMORANDUM

To: Christina Robertson Gardiner, AICP
Planner
City of Oregon City
698 Warner Parrott Rd
Oregon City, Oregon 97045

From: Steve Faust, AICP
Project Manager

Date: June 7, 2019

Project Name: Beavercreek Road Concept Plan Implementation
Project No: 18510
RE: BRCP Land Use Map Changes

The City of Oregon City (City) has initiated a project to update the Oregon City Comprehensive Plan Map, Zoning Map and Municipal Code to allow planned housing and mixed-use development to occur in the 2008 Beavercreek Road Concept Plan (BRCP) area. Updates will apply zoning and map designations for properties within the BRCP area. The City, through a grant from the Oregon Department of Land Conservation and Development, has contracted with 3J Consulting to assist with this effort.

As part of the BRCP Implementation project, 3J Consulting has been tasked with applying and mapping zoning districts to implement the land use categories in the Concept Plan Map found on page 3 of the Beavercreek Road Concept Plan (Attachment A).

An initial Land Use Map approximating the lines on the 2008 Concept Plan Map was prepared on April 9, 2019 (Attachment B). This map was used as a starting point for making employment and dwelling unit projections for the BRCP area. Several modifications have been made to the June 7, 2019 Land Use Map to reflect taxlot and development realities while maintaining substantial compliance with the Concept Plan Map and the public comments heard to date. The following is a summary and justification of the changes made to the June 7, 2019 Land Use Map (Attachment C).



1. North of Old Acres Road – In response to concern from property owners about high-density residential development adjacent to Old Acres Road, the map is adjusted such that R-5 single family development is adjacent to that road. Additionally, some lands on the east edge of the R-2 district is extended across the street to allow for a "Neighborhood Focal Point" as identified in the plan.

Figure 1. BRCP Land Use Map Changes between April 9 and June 7, 2019

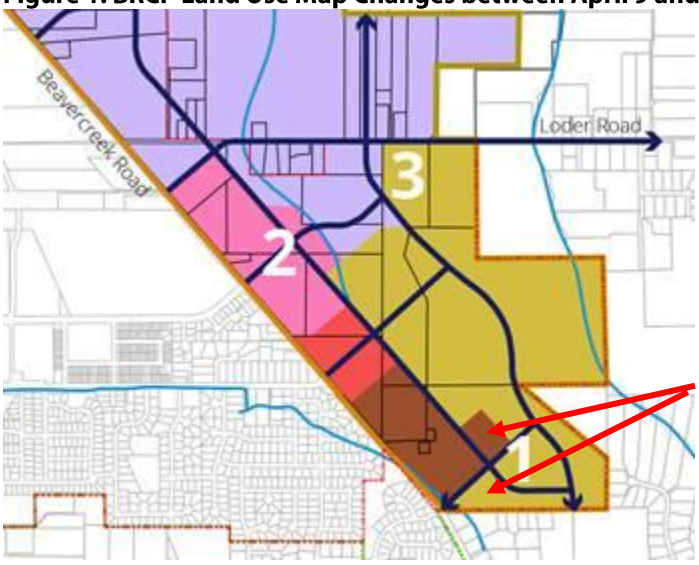
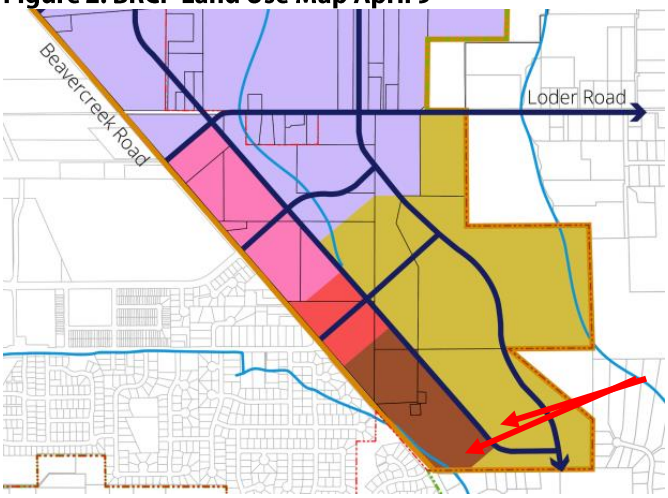


Figure 2. BRCP Land Use Map April 9



2. South of the Natural Resource Overlay District (NROD) in the South Central Open Space – the area north of the road parallel to Beavercreek Road was originally zoned North Employment Campus (CI), but with the NROD and South Central Open Space overlays, there were two remnants that would be too small for industrial uses. The plan identifies this area as part of the Mixed-Employment district (MUC-2), so the boundaries are adjusted to make these remnants part of the MUC-2 district to better conform with the plan and avoid creating unusable lot remnants. Adjusted lines also conform with Title 4 identified lands to avoid conflict.

Figure 3. BRCP Land Use Map Changes between April 9 and June 7, 2019

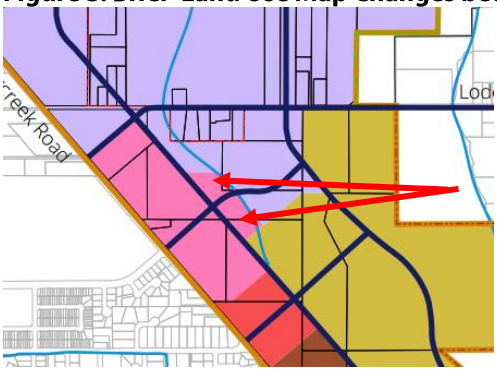
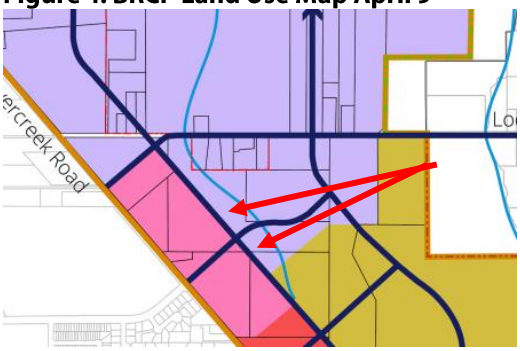


Figure 4. BRCP Land Use Map April 9



3. South of Loder towards the eastern edge of the BRCP area – In response to concern from the public about the prevalence and location of industrial lands near residential areas, lands zoned CI south of Loder Road and northeast of the easternmost north-south connector are adjusted to R-5. There is a small area that is Title 4 identified lands and is not adjusted.

Figure 5. BRCP Land Use Map Changes between April 9 and June 7, 2019

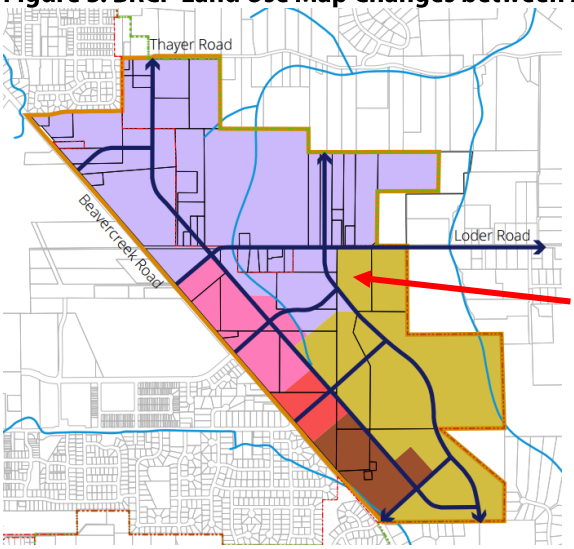
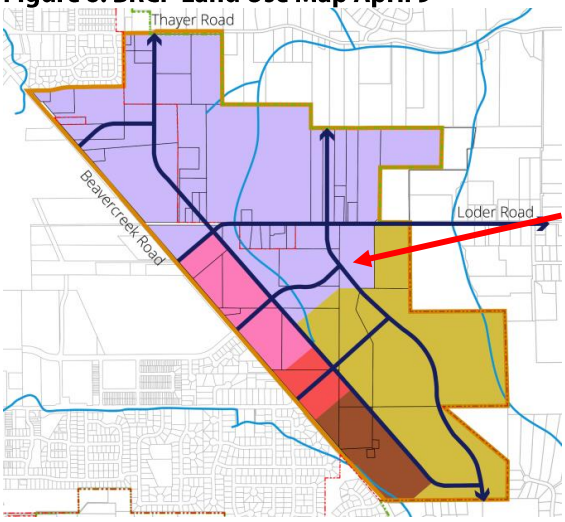


Figure 6. BRCP Land Use Map April 9



At the request of land owners with property north of Loder Road, 3J examined the possibility of changing zoning designations from employment to residential. Lands in the BRCP area north of Loder Road are designated as Metro Title 4 Industrial Lands (https://www.oregonmetro.gov/industrial-and-employment-land) which prohibit residential uses and thus this request could not be considered.

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TECHNICAL MEMORANDUM

To: Christina Robertson-Gardiner, AICP
Oregon City Senior Planner

John M. Lewis
Oregon City Public Works Director

From: Aaron Murphy, P.E.
Steve Faust, AICP

Date: June 19, 2019

Project Name: **Beavercreek Road Concept Plan Implementation – Zoning and Code Amendments**
Project No: **18510.70**
RE: **Infrastructure Memo**

The City of Oregon City (City) has initiated a project to update the Oregon City Comprehensive Plan Map, Zoning Map and Municipal Code to allow planned housing and mixed-use development to occur in the Beavercreek Road Concept Plan (BRCP) area. Updates will apply zoning and map designations for properties within the BRCP area.

As part of the BRCP Implementation project, 3J Consulting has been tasked to review the City's water distribution, sanitary sewer and stormwater master plans and comment on the adequacy of current and planned infrastructure to support the number of new dwelling units and employees that are projected in the BRCP and will be formalized through the zone change.

Beavercreek Road Master Plan
The Beavercreek Road Concept Plan (BRCP) is a guide to the creation of a complete and sustainable neighborhood in southeast Oregon City. The plan, adopted in 2008 and again in 2016, provides a framework for urbanization of 453 acres within the urban growth boundary including a diverse mix of uses (an employment campus north of Loder Road, mixed use districts along Beavercreek Road, and two mixed use neighborhoods), all woven together by open space, trails, a network of green streets, and sustainable development practices. The plan has been carefully crafted to create a multi-use community linking Clackamas Community College, Oregon City High School, and adjacent neighborhoods together.

The BRCP includes Housing and Employment Estimates for the various land use categories:

Land Use Category	Number of Jobs	Number of Dwelling Units
North Employment Campus	3,678	-------
Mixed Employment Village	1,139	-------
Main Street	219	100
West Mixed Use Neighborhood	15	387
East Mixed Use Neighborhood	21	536
Total	**5,073**	**1,023**

Updated projections based on land use maps developed for this project to implement the BRCP estimate the number of dwelling units at 1,105 and jobs at 5,734. We do not consider the change reflected in the revisions to be significant and therefore do not impact the findings of this memorandum.

Zone Change Criteria
The relevant criteria (17.68.020) for a zone change are set forth as follows:

B. That public facilities and services (water, sewer, storm drainage, transportation, schools, police and fire protection) are presently capable of supporting the uses allowed by the zone, or can be made available prior to issuing a certificate of occupancy. Service shall be sufficient to support the range of uses and development allowed by the zone.

This memorandum reflects a first look at the adequacy of current and planned infrastructure to meet the needs of future development. A more detailed look at existing conditions will be needed at the time of development to identify capital improvements needed to show consistency with the Master Plan.

Major Findings
The Sanitary Sewer (2014), Stormwater (2019 Draft) and Water Distribution (2012) Master Plans were all created subsequent to initial adoption of the Beavercreek Road Concept Plan (2008). Each master plan incorporates the BRCP area into future capital improvement projections, but methodologies vary among plans. This conclusion was confirmed through a conversation with Oregon City Public Works Director, John Lewis.

Sanitary Sewer Master Plan (SSMP)
Figure 5-8 on page 5-11 of the 2014 Sanitary Sewer Master Plan refers specifically to the projected Housing and Employment Estimates on page 42 of the BRCP.

Stormwater Master Plan (SWMP)
The Draft 2019 Oregon City Stormwater Master Plan includes the BRCP area, which is part of the Newell Creek Basin, but does not identify any capital improvement projects specifically related to the BRCP. The Plan states that the eventual layout of the stormwater conveyance systems and management facilities will be crafted through the preliminary and final design process for the BRCP area.

Water Distribution Master Plan (WDMP)
The 2019 Technical Memorandum - Oregon City Water Distribution System Capital Improvement Program Update was prepared to provide an update to the 2012 WDMP, including a list of capital improvements. Page 21 of the memo specifically discusses Beavercreek Road development and defines the City's pressure zones that encompass the BRCP.

Economic, Social, Environmental and Energy (ESEE) Analysis
The ESEE consequences that can occur within the proposed MUC, NC, CI, R-5 and R-2 zoning will not result in a greater conflict to the Goal 5 resource mapped on the site over the current FU-10 zoning. The change in zoning from FU-10 to MUC, NC, CI, R-5 and R-2 may result in lesser amounts of environmental and energy consequences; however, MUC, NC, CI, R-5 and R-2 has opportunity to provide increased economic and social benefits. Mixed use centers allow City residents to live near their work, which tends to reduce vehicle use, which minimizes potential air, water and energy quality impacts.

The Goal 5 resources mapped on the site is protected under Chapter 17.49 Natural Resource Overlay District of the City's code of ordinances, regardless of site zoning. Chapter 17.49 of Oregon City code is compliant with Metro's Title 3 and 13 lands and the Statewide Planning Goal 5. Therefore, the potential for increased levels of impervious surfaces and vegetation loss associated with MUC, NC, CI, R-5 and R-2 development activities will be protected and if necessary mitigated through local permitting compliant with Chapter 17.49.

Master Plan Summaries

Sanitary Sewer Master Plan

A Sanitary Sewer Master Plan (SSMP) was prepared by Brown & Caldwell in November 2014. Section 5.2.3.4 of the SSMP focuses on the BRCP area. Table 5-8 of the SSMP references land use designations and the associated gross areas of the BRCP area to calculate sanitary flows to ultimately size pipe diameters and slopes.

Table 5-9 of the SSMP identifies the BRCP area Estimated Improvement Costs for Capital Improvement Plan (CIP) projects is $15,580,000. This amount includes a 50% allowance for construction contingencies.

The CIP list specifically related to the BRCP area includes:

- Gravity Sewer Extensions (8”-15”)
- Two (2) pump stations and associated force mains (BR-1 & BR-2)

Since the SSMP was published, improvements have been completed according to an email provided by Bob Balgos from the City dated March 25, 2019. These improvements include:

- 12” sanitary sewer extension south along Beavercreek Road near the north-end of the Oregon City High School property boundary.

Also identified in the email, City staff have identified construction proposed in 2019-2020:

- 12” sanitary sewer extension in conjunction with the Villages at Beavercreek Development located opposite Meyers Road on the east side of Beavercreek Road. The extension will be completed from the north-end of the Oregon City High School through the entire frontage of Villages at Beavercreek.

Further assessment of the CIP project amount will be necessary to include:

- Completed infrastructure upgrades such as Capital Improvement Projects (CIP), development etc.
- Anticipated infrastructure upgrades such as CIP projects or development such as Villages at Beavercreek
- Inflation and construction cost increases to current dollars.

Stormwater Master Plan

Five (5) Stormwater Master Plans (SWMP) were reviewed:

- Drainage Master Plan, OTAK 1988
- South End Basin Master Plan, Kampe Associates, Inc. 1997
- Caulfield Basin Master Plan, Kampe Associates, Inc. 1997
- Park Place Basin Master Plan, Kampe Associates, Inc. 1997
- Draft Oregon City Stormwater Master Plan. Brown and Caldwell, 2019

The BRCP area largely falls within the Newell Creek Basin. The Draft 2019 SWMP does not specifically reference the BRCP area, but the overall assessment does include recommendations for improvements for the Newell Creek Basin. The City’s stormwater treatment and detention methods apply for all current and future development of the BRCP area.

Page 2-7 references the Beaver Creek Road Concept Plan and states that the concept plan “outlines basic assumptions for the type and quantities of stormwater infrastructure that may be required to develop the planning area. These assumptions are useful for fiscal planning, but the eventual layout of the stormwater conveyance systems and management facilities will be crafted through the preliminary and final design process for [the BRCP] area.”

Low Impact Development (LID) Green Streets are identified for the Beavercreek Road Concept Plan area. The City is currently working on creating green street standards that will be applicable for both the South End and Beavercreek Concept Plan areas. These standards will be based on the identified street sections found in the Concept Plans and are being designed to meet the standards of the draft Storm water Manual. Adoption of these standards will occur in Fall 2019.

Water Distribution Master Plan

A Water Distribution Master Plan (WDMP) was prepared by West Yost Associates in January 2012. Although the WDMP does not specifically reference the BRCP area, the overall assessment does include recommendations for improvements that includes the UGB boundary that encompasses BRCP.

A Technical Memorandum - Oregon City Water Distribution System Capital Improvement Program Update (TM) was prepared by Murraysmith in March 2019. The TM was prepared to provide an update to the WMP produced in 2012, including a list of capital improvements and updated costs from 2009 to 2018 dollars. Page 21 of the memo specifically discusses BRCP area development and defines the City's pressure zones that encompass this area as Upper Zone and Fairway Downs Zone.

Table 17 of the TM identifies the updated CIP list and cost estimate including the improvements required for the City's Upper and Fairway Downs Zones for the BRCP area. The total estimated cost for CIP projects specific to BRCP area total $14,018,000.

The CIP project list includes:

- New Upper Zone distribution
- New Fairway Downs distribution
- New PRV between Fairway Downs and Upper Zone
- New Fairway Downs Reservoir
- New Fairway Downs Pump Station
- New Fairway Downs Transmission
- Transfer existing Henrici transmission to Fairway Downs transmission

The City and Clackamas River Water (CRW) share the need to serve current and future customers at adjoining service area boundaries within the BRCP area.

A Technical Memorandum – Clackamas River Water / City of Oregon City Joint Engineering Analysis Water Service Dual Interest Area Technical Analysis (TM2) was prepared by Murraysmith in June 2018. TM2 identifies opportunities for shared infrastructure partnerships which could ultimately provide a more cost-effective solution to both the City and CRW, see Table 3 of TM2.

The City is preparing a concurrent study to ensure the City can serve the BRCP area in the case that the City and CRW are not able to agree on a partnership to serve the area.

Economic, Social, Environmental and Energy (ESEE) Analysis

As part of a Zone Change analysis, the city requires substantial evidence that the possibility of land use development activities allowed under the new zoning (MUC, NC, CI, R-5 and R-2) will not result in a greater impact on the Goal 5 resources mapped on the site over the existing Future Urban (FU-10) land use development activities.

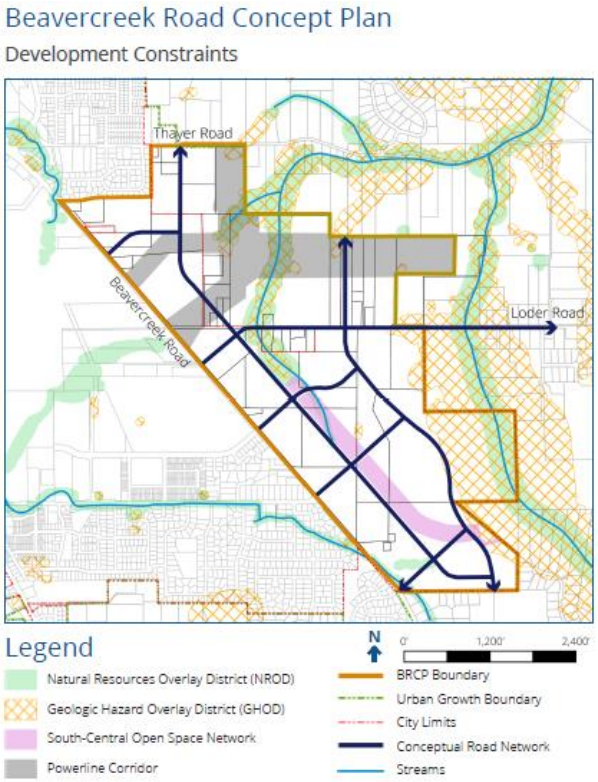
The ESEE analysis involves evaluating the potential tradeoffs associated with different levels of natural resource protection that could be established by the City. As required by the Goal 5 rule (OAR 660-015-0000(5), the evaluation process involves identifying the consequences of allowing, limiting or prohibiting conflicting uses in areas containing significant natural resources. The rule requires that this analysis be completed before actions are taken to protect or not protect natural resources that are identified in inventory and determined to be significant. Specifically, the rule requires the following steps:

1. Identify conflicting uses – A conflicting use is a land use or activity that may negatively impact natural resources.

2. Determine impact area – The impact area represents the extent to which land uses or activities in areas adjacent to natural resources could negatively impact those resources. The impact area identifies the geographic limits within which to conduct the ESEE analysis.

3. Analyze the ESEE consequences – The ESEE analysis considers the consequences of a decision to either fully protect natural resources; fully allow conflicting uses; or limit the conflicting uses. The analysis looks at the consequences of these options for both development and natural resources.

4. Develop a program – The results of the ESEE analysis are used to generate recommendations or an "ESEE decision." The ESEE decision sets the direction for how and under what circumstances the local program will protect significant natural resources.



Based on information provided in Exhibit 3 Economic, Social, Environmental and Energy (ESEE) Phase 1 Analysis of Metro's April 2005 UGB Growth Management Functional Plan ordinance, the section below describes the potential conflicting uses associated with the proposed zone designations could have the greater potential to have an adverse effect on the functions and values of the Goal 5 resource mapped on properties located within the Beavercreek Road Concept Plan area which include Thimble Creek and an unnamed tributary to Thimble Creek. Note the zoning themselves are not conflicting uses.

It is the development activities and other disturbances permitted under the zoning that potentially conflicts with the functions and values associated with the Goal 5 resource. The City of Oregon City developed their Chapter 17.49 Title 13 regulations based on Metro's UGB Management Function Plan. Therefore, the ESEE analysis provided below is consistent with Oregon City's Goal 5 ordinance.

<u>Economic Consequences</u>

FU-10 – May provide increased adjacent property value. Large Lots associated with FU 10 zoning will retain more vegetation and tree cover than the new zones associated with the Beavercreek Road Concept Plan activities; however, does not provide an overall economic value to the community.

R-5 & R-2- These medium density and high density zones can provide a response to the known regional problem of limited housing supply and skyrocketing housing prices affecting the Portland Metro Area and Oregon City. There is a mismatch between supply and demand of housing that is leading to limited availability and affordability challenges for many households. Looking at the latest census data, in Oregon City, 71% of residential units are single-family detached homes, dominating the housing market. All other housing types make up 29% of the housing options, combined, ranging from manufactured homes and floating homes to 20-unit apartment complexes.

Housing prices are increasingly unaffordable, which is typically defined as spending more than 35% of household income on housing. Almost 24% of homeowners with a mortgage have unaffordable costs, and over 40% of renters can't afford housing costs. Overall, one in four households are struggling to pay for housing. Single-family detached homes, a traditional free-standing house with a yard and space for 3.2 children, dominate the supply but comes at a high cost that is increasingly out of reach, leading to homelessness in some cases. With smaller households more and more common, the city's needs don't match the homes available. Additional housing choices that include duplexes, tri-plexes, townhomes, apartments and cluster housing can provide alternatives to the predominate single family housing model found in Oregon City.

MUC, NC and CI – Enhances the potential for local economic development. The zone change supports Metro's Growth Concept Plan underlying goals to provide employment, income, and related tax benefits to local community.

Summary: While FU-10 may result in less vegetation removal, the MUC, ND, CI, R-2 and R-5 land uses provides a greater economic benefit to the community through increased housing options, employment and educational opportunities and reduced transportation facilities and utilities. These zones promote more efficient use of land, minimizing urban sprawl.

Therefore, the conflicting uses associated with MUC, NC, CI, R-5 and R-2 development activities provides a greater economic benefit, outweighing the FU-10 conflicting uses.

Social Consequences

FU-10 –-Goal 5 resource provides natural stress relief to employment occupants. The R-2, R-5, ND, CI and MUC-2 land uses may also provide potential public educational and recreational benefit though passive open space viewing and the ability to dedicate future park space as development occurs within the BRCP area; however, there is a potential to reduce the scenic value.

Summary- Change in conflicting use zoning from FU-10 may provide an increased social benefit to Oregon City.

Environmental Consequences

FU-10–Impacts to Goal 5 resources and associated Impact Area (buffer) for FU-10 development may require: removal of native vegetation; non-native landscaping; pesticide and fertilizer use; and pets which tend to degrade habitat and water quality.

MUC, NC, CI, R-5 and R-2 can create larger building footprints than FU-10 which may result in increased vegetation removal; however, MUC, NC and CII offer decreased VMT (vehicle miles traveled) which reduces overall water quality impacts in the local watershed. Minimal light and glare into Goal 5 resource and buffer. Provides overall moderate to high imperviousness, low infrastructure requirements, and low to moderate overall natural landcover.

Summary: Due to smaller development footprints, disturbance activities associated with FU-10 conflicting uses may provide a lesser degree of impact to the Goal 5 resource and associated buffer than MUC, NC, CI, R-5 and R-2 conflicting use development activities. However, MUC, NC, CI, R-5 and R-2 stricter water quality standards, providing potential for overall lesser amounts of impact to the local watershed.

Energy Consequences

FU-10- Tends to retain more trees than other zoning, reducing air quality and temperature impacts. However, tends to create more infrastructure (utilities and roads) and greater travel distances which can have a negative energy consequence.

MUC, NC, CI, R-5 and R-2 - Energy efficient zoning because it decreases VMT (vehicle miles traveled) and overall infrastructure requirements. Potential to reduces the amount of overall development through shared

parking. Shared parking areas have vegetated islands reducing imperviousness and negative energy consequences associated with temperature regulation.

Summary: MUC, NC, CI, R-5 and R-2 conflicting use development activities for energy consequences may result in lesser impact on the Goal 5 resource and associated buffer over FU-10 development activities.

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ECONorthwest
ECONOMICS • FINANCE • PLANNING

DATE: June 21, 2019
TO: Christina Robertson-Gardner, City of Oregon City; Steve Faust, 3J Consulting
FROM: Bob Parker and Matt Craigie, ECONorthwest
SUBJECT: Beavercreek Road Concept Plan - Zoned Capacity Analysis - REVISED

The City of Oregon City contracted ECONorthwest to review and verify previous analyses conducted for the Beavercreek Road Concept Plan. The purpose of the project is to determine if the Beavercreek Road Planning Area—as planned—will have the future zoned capacity to accommodate the Plan's projected number of jobs. In its simplest terms, this analysis is about fit and capacity. The key question is whether the zoning regulations that are being put in place over the Planning Area will actually allow for the 5,000 estimated jobs to occupy future buildings in the area. This analysis does not account for current or projected future market trends; it is exclusively focused on the examination of land use regulations and their implications for job capacity.

Findings

Our analysis shows that the Beavercreek Road Planning Area will have sufficient zoned capacity to accommodate estimated future employment growth. Under current zoning standards, the Planning Area at full build-out will be able to accommodate between 5,700 and 11,700 jobs (Exhibit 1, Rounded). These capacity levels are 15% to 131% more than the targeted 5,000 jobs for the Planning Area. Economic conditions will determine how the area is eventually built out, but zoned capacity is adequate to allow for a range of future job numbers that are at or above desired employment levels as described in the Beavercreek Road Concept Plan.

Exhibit 1. Beavercreek Planning Area, Zoned Capacity.

Sub-District	Maximum Zoned Job Capacity	Zoned Job Capacity with Market Considerations
Main Street	727	352
Mixed Employment Village	2,827	1,399
North Employment Campus	8,169	3,983
Total	**11,723**	**5,734**

Source: ECONorthwest

Our zoned capacity model was built using Oregon City's current zoning standards. Here we present two capacity estimates:

- First, **the maximum job capacity** for the area shows the total number of jobs that could fit in the area under current regulations.
- Second, the lower estimate—**Job Capacity with Market Considerations**—illustrates another interpretation of Oregon City's zoning regulations. In this second scenario, we have further restricted the scale of allowable development by: (1) modeling an underbuilt of total development as a result of insufficient parking areas, and (2) dedicating a higher percentage of area on individual parcels to internal rights of way,

ingress/egress space, and private streets. This is intended to reflect potential market conditions that would reduce the amount of built space, and as a result, the number of employees.

The maximum zoned capacity scenario is a true maximum; meaning that this estimate is modeling the highest density of employment permissible by zoning regulations and standards, without any consideration for how employment areas generally get developed. For example, the maximum scenario assumes over 8,000 jobs in the North Employment Campus area. To accomplish this scale of development would require the development of acres upon acres of four-story office buildings that have relatively little parking area. Although permissible, this scenario is unlikely to occur and therefore is a poor estimate of the actual zoned capacity of the Planning Area.

The more restrictive scenario presents a situation where development scale is linked to our observations of the density of other similar industrial areas across the Portland region and therefore better reflects what one could expect to happen in the Beavercreek Planning Area. For this scenario, we have adapted parking ratios to those generally demanded in the marketplace and deducted some internal area of parcels for circulation space and other rights of way. The large size of some parcels, especially inside the North Employment Campus (NEC), would warrant these internal spaces dedicated to transportation flow and parking.

For example, many flex-industrial buildings—a desired development type for the NEC—are two story buildings with multiple tenants. These "flex" buildings are built to flexibly adapt to the needs of different tenants. They are built with adaptable internal build-outs (e.g. varying amounts of office and warehouse space) and feature enough parking for employees as well as truck loading/unloading, circulation, and outdoor storage. Therefore, it is common to see flex buildings with not just enough parking and circulation space for employees that are coming and going from work, but to accommodate a wider variety of truck space, outdoor storage space, and general circulation space. In our model, we reflect these common observations by both increasing the parking ratio and reducing the number of stories for buildings in the NEC. These changes bring the potential development scale for the NEC in line with the maximum build-out observed in other industrial areas of the region.

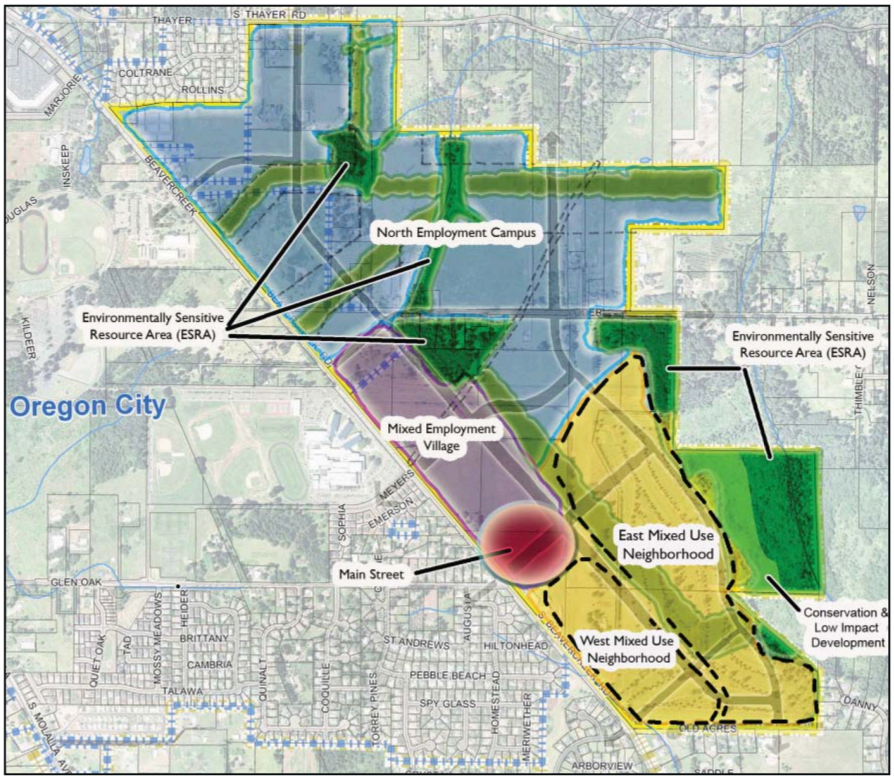
With these changes, the restrictive—and more realistic—scenario shows a zoned capacity of the Planning Area to be reduced from the maximum scenario (11,723 down to 5,734). Despite the reduction, there still is adequate space to accommodate the 5,000 projected jobs.

Economic and market trends will inform the type, scale, and demands of future development of the Beavercreek Planning Area. Whatever development does eventually get built in the area, our analysis shows that zoning regulations and standards will allow for enough developable space for the desired amount of employment.

Background

In 2008, Oregon City contracted the consulting firm Otak, in collaboration with several consultants (including ECONorthwest), to develop a concept plan[1] for a 453-acre site in the southeast area Oregon City. The Plan envisioned a diverse mix of uses, organized by five sub-districts (see Exhibit 2).

Exhibit 2. Land Use Sub-Districts for Beavercreek Road Concept Plan
Source: Beavercreek Road Concept Plan, Envision a Complete and Sustainable Community, 2008.



The five subareas are summarized as follows:

1. **North Employment Campus (NEC)** allows clean industries, offices servicing industrial needs, light industrial uses, research and development, and large corporate headquarters.
2. **Mixed Employment Village (MEV)** allows retail and offices (including civic and residential uses).
3. **Main Street (MS)** allows small scale commercial and mixed-use services.
4. **West Mixed-Use Neighborhood (WMU)** allows live/work units, mixed use buildings, limited commercial uses, and—to a larger extent—housing.

[1] Beavercreek Road Concept Plan, Envision a Complete and Sustainable Community, 2008.

5. **East Mixed-Use Neighborhood (EMU)** primarily allows housing.

At present, Oregon City is revisiting the concept plan as a step toward the Plan's implementation. The City has asked several consultants to review and analyze select parts of the concept plan to verify the veracity of its underlying analyses. A key aspect of this effort is to understand whether the Planning Area will have the zoned capacity to accommodate the Plan's stated number of future jobs. ECONorthwest was assigned this task. To answer this key question of zoned capacity, we reviewed the findings of the 2008 work and conducted additional analyses. Our approach and a description of our analysis is outlined in the next section.

Approach

Our approach to this analysis had a few steps. These included:

- **Collecting and verifying data.** The first step involved gathering applicable data from the Plan, from the City, and other sources. Employment projections come directly from The Plan. The Plan identified an estimated capacity for approximately 5,000 jobs (for reference, the output table from the Plan is presented in Appendix A).

  We also compiled an organized list of Oregon City's development codes, standards, and regulations from the City's current municipal code. These regulatory standards were used to create our zoned capacity model.

- **Developing a zoned capacity model.** Using Oregon City's development code and standards, we generated a catalogue of zoning requirements and limitations for each zoning designation that comprises the five sub-districts of the Planning Area. With this information, we developed a model that calculates the maximum job capacity for each sub-district. To calibrate the model to likely future outcomes, we relied on planning and development assumptions taken from our observations of similar fully built-out areas around the Portland Metropolitan region.[2]

- **Reconciling zoned capacity model output with future employment projections**. This step formed the central part of our analysis. In this step, we used the output of the zoned capacity model—the job capacity for each subarea of the Planning Area—and matched those outputs to future employment projections.

  A more detailed description of our analysis is presented in the next section.

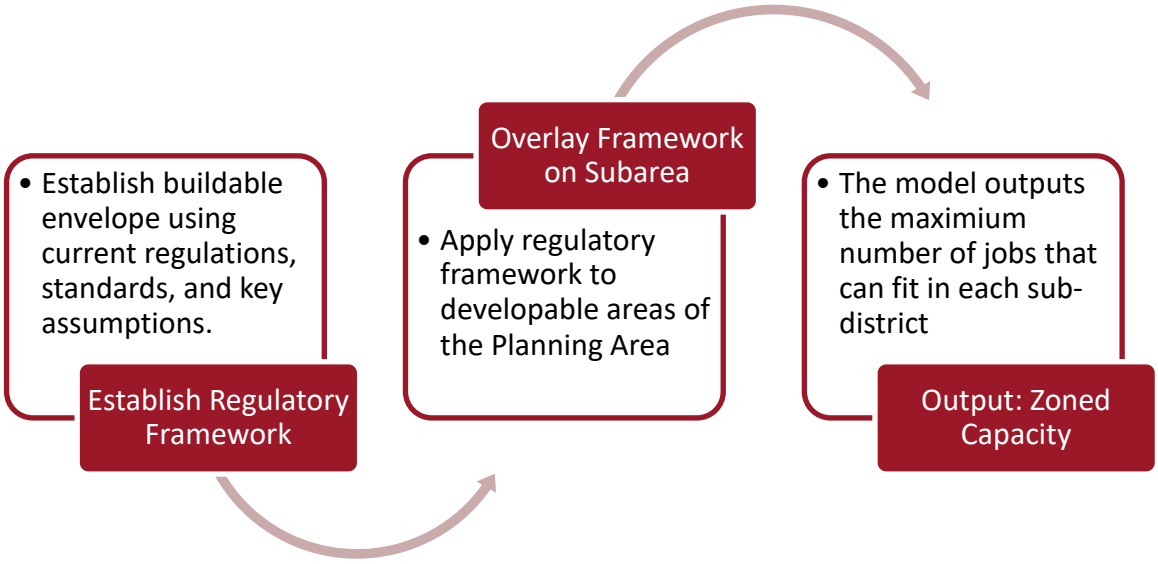
[2] Key assumptions for this analysis, include: actual parking ratios, percent of parcels that achieve full build-out, common building to land ratios, among others.

Description of Zoned Capacity Analysis

The Model

To understand the future capacity of jobs in the Beavercreek Road Planning Area, we built a model that mimics zoning regulations and standards for the expected land use zones to be applied to the Planning Area sub-districts. The model works by taking key inputs and assumptions about the regulatory framework that will govern land uses in the Planning Area and overlaying them across the developable land of the area. The output of the model is the maximum zoned capacity for jobs within the Planning Area (See Exhibit 3).

Exhibit 3: Zoned Capacity Model Process
Source: ECONorthwest.



Key Model Inputs and Assumptions

To arrive at an accurate understanding of the zoned capacity for jobs of any to-be-developed area requires a large set of inputs and assumptions. For this type of analysis, the type of inputs and assumptions are related to regulations and standards that will guide the development of new buildings and their supportive elements (e.g. parking). Some inputs are rigid and unlikely to change, such as maximum building heights or setbacks. Assumptions are more qualitative and require specialized knowledge about aspects of how real estate gets developed. Inputs and assumptions also have a varied impact on the output of the model. Some, like parking ratios, have a strong influence on the model's output. Others have less of an impact. Below we describe inputs and assumptions that have a major impact on the model's output.

- **Dimensional standards.** Dimensional standards define the maximum "box" that a building can fill on a parcel. These standards are determined through setbacks, maximum building heights, landscaping requirements, and other restrictions.

  Source: City of Oregon City Development Code.

- **Employment density.** This assumption describes the relationship between build-area (area inside buildings) and the number of jobs that fill those spaces. This assumption is typically described as jobs per square feet of building area. This is a key metric for this analysis. The smaller the number, the higher the job density. Larger numbers mean fewer jobs per building area, and therefore fewer jobs overall.

  Source: Metro Employment Density Study, ECONorthwest.

- **Parking ratios.** The amount of automobile parking that is available for a new development is a key factor in determining its viability. Whether capped by regulations or demanded by the market, new developments need a certain amount of parking to attract funding and become economically successful land uses. Most cities, Oregon City included, provide regulations about the minimum and maximum amount of parking for new developments. Sometimes these regulations are perceived to be out of sync with what the real estate market demands. This can happen when urban, transit served developments are required to have "too much" parking. Or when suburban areas with little accessibility do not have sufficient land for necessary parking to support new development.

  In our observations of real estate development, one of the primary reasons that development projects get "under-built", or do not achieve the building height or scale otherwise permissible by development regulations, is too little provision of on-site parking. For this analysis, we have used Oregon City's parking regulations as a general guide for the amount of parking that will be required to accompany new developments in the Planning Area.

  Source: City of Oregon City, ECONorthwest.

- **Parcel size and building to land ratios.** The Beavercreek Planning Area of tomorrow is expected to look remarkably different than it does today. As it develops, property owners will sell to developers who, in many cases, will aggregate several parcels of land to create a "developable parcel" for their specific desired land use. To understand what size these future parcels may be and to what extent they will be covered with a building footprint, we observed several areas of the Portland region that contain similar land uses to those proposed for the Planning Area. These observations, combined with our knowledge of specific types of development elsewhere, formed our assumptions for future parcels sizes and building to land ratios.

  Source: ECONorthwest.

- **Maximum build-out and "under-build".** Each developable piece of land has an invisible envelope or "box" that forms the vertical area in space that a building can

occupy. This box is determined by the zoning regulations and standards that govern the land use of that property. Building to full capacity would mean that this box is entirely filled with building area. Many times, developers "under-build" or chose to not fully take advantage of all of the vertical buildable space available to them. In an economic sense, it would be advantageous for a developer to build as much building area as she could lease or sell. If some of this building area does not contribute economically to her pro forma or if it is hard to lease or sell, she may choose to build a smaller building. As stated in the parking ratios description, we commonly observe that developers chose to under-build their properties when they are unable to secure access to a sufficient level of parking.

For this analysis, we have assumed that many of the future developable parcels will under-build for lack of parking or other reasons. This is in-line with our observations of developed areas that are similar to the Planning Area in other parts of the Portland region.

- **Source**: ECONorthwest

Key Data

This analysis is focused on one key question: Will the future regulatory environment of the Beavercreek Planning Area allow enough buildable area to accommodate the projected number of future jobs for this area. To answer this question, we relied upon data from the several sources. Key data to this analysis are as follows:

- **Projected Jobs for the Planning Area.** We have relied on the projected number of jobs for the Beavercreek Planning Area as stated in The Plan. The Plan identified an estimated capacity for approximately 5,000 jobs (for reference, the output table from the Plan is presented in Appendix A).

  This number of jobs—5,000—is a key data point for this work. It is the number of jobs that we are trying to fit into the Beavercreek Planning Area.

- **Planning Area Size and Developable Acres.** The Planning Area is approximately 449 acres in total size (gross size). Per the Plan, of this 449, there are 241 net developable acres. The difference between 449 and 241 includes roads, easements, wetlands, and other undevelopable lands.

Together the (1) projected job numbers, and (2) the developable area within the Planning Area form the two key data points for this analysis. These data can be further divided by sub-district of the Planning Area (See Exhibit 4). This is an important point; each sub-district has its own employment projections and will have its own zoning regulations.

Exhibit 4. Beavercreek Planning Area Sub-Districts: Estimated Jobs and Net Areas (Acres)[3][4]
Source: City of Oregon City, ECONorthwest.

Planning Area Sub-District	Estimated Jobs	Net Developable Acres
North Employment Campus (NEC)	3,678	132
Mixed Employment Village (MEV)	1,139	26
Main Street	219	7
West Mixed-Use Neighborhood	15	12
East Mixed-use Neighborhood	21	65
Totals	**5,073**	**241**

Findings

See the first page of this report for a discussion of our findings.

[3] Rounding of numbers may result in approximate totals. *Note: The acreage estimates do not exactly align with those in Exhibit 6. Acreages in Exhibit 6 have been reevaluated since the time of The Plan. In our analysis, we are using the latest size estimates provided by the City of Oregon City.*

[4] We concentrated our analyses on the three sub-districts with significant employment projections. The mixed-use neighborhoods have been excluded from our analyses.

Appendix A. Employment Estimates, 2008

The Beavercreek Road Concept plan estimated employment capacity at approximately 5,000 jobs (33 jobs per net acre).

Exhibit 5. Employment Estimates, Beavercreek Road Planning Area
Source: Beavercreek Road Concept Plan, Envision a Complete and Sustainable Community (pg. 42), 2008.

Land Use Category	Hybrid Gross Acres	Hybrid Net Acres*	FAR/Acre**	SF/Job**	# of Jobs***	Avg. Units/Acre	# of Units+
North Employment Campus (adjusted gross acreage)	149	127	0.3	450	3,678		
Mixed Employment Village	26	21	0.44	350	1,139		
Main Street****	10	8	0.44	350	219	25	100
West Mixed Use Neighborhood	22	18			15	22	387
East Mixed Use Neighborhood	77	62			21	8.7	536
Total # of Jobs					**5,073**		
Total # of Housing Units							**1,023**
Total Acres of Developed Land++	**284**	**235**					

***For Hybrid -** Net acres equals gross acres minus 15% for local roads and easements in Employment. Mixed Employment, Mixed Use, and residential areas assume 20% for local roads and easements

* *Based on Metro 2002-2022 Urban Growth Report: An Employment Land Need Analysis. Includes total on site employment (full and part time). Mixed Employment FAR and job density reflects a mix of office, tech/flex, and ground floor retail.

***Number of Jobs in Employment, Mixed Employment, Mixed Use calculated by multiplying total acres by the FAR; Converting to square feet; and dividing by number of jobs/square foot. Jobs in residential areas (Work at Home Jobs) estimated at 4% (potential could be as high as 15%).

**** Mixed Use land use assumes 50% of acreage devoted to commercial uses and the remaining 50% devoted to vertical mixed use.

+Number of units calculated by multiplying total net acres of residential land use by average units per acre

++Includes 50% of useable power line corridor (26 acres total) as part of developed land (included in Employment land area)

+++Does not include powerline corridor acreage as part of developed land

DRAFT MEMORANDUM

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DATE: June 21, 2019

TO: Christina Robertson-Gardiner, City of Oregon City

FROM: Kevin Chewuk, DKS Associates
Amanda Deering, DKS Associates

SUBJECT: Oregon City Beavercreek Land Use Review P19082-001

This memorandum summarizes how the requirements of Oregon Administrative Rule (OAR) 660-012-0060, the Transportation Planning Rule (TPR), are met for the Beavercreek Concept Plan area in Oregon City, Oregon. The study area comprises the adopted 2008 Beavercreek Concept Plan area which established land use designations, design guidelines and future transportation infrastructure needs. The Beavercreek Concept Plan area is roughly bounded by the Urban Growth Boundary to the east, Beavercreek Road to the west, Old Acres Road to the south and Thayer Road to the north. The following sections describe the consistency of the Beavercreek Concept Plan with the current Oregon City Transportation System Plan (TSP).

Land Use Assumptions

The Beavercreek Concept Plan area includes about 5,700 new jobs and 1,100 new housing units. Table 1 describes the assumptions that were used. For the Oregon City TSP, vehicle trips within the Beavercreek Concept Plan area were estimated based on around 1,639 new jobs and 355 new households. The Beavercreek Concept Plan was held up in the Oregon Land Use Board of Appeals (LUBA) during the recent update to the Oregon City TSP, thus the zoning in the Beavercreek Concept Plan area did not reflect the rezoned land resulting from the plan.

Land Use and Motor Vehicle Trip Generation Assumptions

The impact of the increased vehicle trip generation on the surrounding transportation system, as a result of the Beavercreek Concept Plan, will be evaluated through the year 2035 (consistent with the horizon year of the current TSP).

For the current Oregon City TSP, vehicle trips were estimated based on the existing land use assumptions (see Table 1). These trips are included in the 2035 TSP Baseline scenario. For the TPR analysis, the Beavercreek Concept Plan was estimated to accommodate 750 more housing units and 4,095 more employees than the current TSP.

Vehicle trips that would be generated by the increased housing units and employees were estimated by applying the Metro Regional Travel Forecast model trip generation rates by land use type. Overall, the Beavercreek Concept Plan is expected to generate about 2,584 motor vehicle trips during the p.m. peak hour, or 925 more than what was assumed in the current TSP.

Table 1: Land Use Assumptions

Scenario	New Housing Units	New Employees	Forecasted Weekday PM Peak Hour Vehicle Trip End Growth
TSP Baseline (without Beavercreek Concept Plan)	355	1,639	1,659
Beavercreek Concept Plan	1,105	5,734	2,584
Change (With Beavercreek Concept Plan – Without Beavercreek Concept Plan)	**+750**	**+4,095**	**+925**

2035 Motor Vehicle Operations

Future p.m. peak hour traffic forecasts were prepared for two land use scenarios, including:

- **TSP Baseline (without Beavercreek Concept Plan) –** This scenario assumes the land use within the Beavercreek Concept Plan will be built out consistent with the prior TSP analysis. It includes the improvement projects listed in the "Baseline Transportation System Improvements" section.
- **Beavercreek Concept Plan –** This scenario assumes full buildout of Beavercreek Concept Plan area. It includes the improvement projects listed in the "Baseline Transportation System Improvements" section.

With each of these two land use scenarios, a sensitivity option was tested that assumed the planned segment of Holly Lane between Maple Lane Road and Thayer Road would not be completed. The forecast will include 2035 volumes to match the TSP horizon year.

Baseline Transportation System Improvements

The starting point for the future operations analysis relied on a list of street system improvement projects contained in the Oregon City TSP. These projects represent only those that are expected to be reasonably funded, and therefore can be included in the Baseline scenario. Many of the projects in the Beavercreek Concept Plan area will be constructed as private development occurs. Others will be

constructed as part of public infrastructure improvements or concurrent with adjacent private developments. The improvements assumed include:

- Roundabout installation at the **Beavercreek Road/Glen Oak Road** intersection (TSP Project D39)
- Roundabout installation at the **Beavercreek Road/Loder Road** intersection (TSP Project D44)
- **Meyers Road** extension from OR 213 to High School Avenue (TSP Project D46)
- **Meyers Road** extension from Beavercreek Road to the Meadow Lane Extension (TSP Project D47)
- **Clairmont Drive** extension from Beavercreek Road to the Holly Lane South Extension (TSP Project D54)
- **Glen Oak Road** extension from Beavercreek Road to the Meadow Lane Extension (TSP Project D55)
- **Timbersky Way** extension from Beavercreek Road to the Meadow Lane Extension (TSP Project D56)
- **Holly Lane** extension from Thayer Road to the Meadow Lane Extension (TSP Projects D58 and D59)
- **Meadow Lane** extension to the Urban Growth Boundary, north of Loder Road (TSP Projects D60 and D61)
- **Loder Road** extension from Beavercreek Road to Glen Oak Road (TSP Project D64)
- **Beavercreek Road** improvements from Clairmont Drive to the Urban Growth Boundary, south of Old Acres Lane (TSP Projects D81 and D82)
- **Loder Road** improvements from Beavercreek Road to the Urban Growth Boundary (TSP Project D85)

Intersection Operations

During the evening peak hour, all study intersections operate within adopted mobility targets under all scenarios after assuming the baseline transportation system improvements from the TSP. The traffic analysis results are summarized in a separate memorandum.

TPR Findings

Overall, the current TSP includes adequate transportation system projects for the Beavercreek Concept Plan area to comply with the Transportation Planning Rule (TPR). All transportation impacts as a result of the additional housing units and employees in the Beavercreek Concept Plan area are

addressed by current TSP projects. This includes the widening of Beavercreek Road through the project area to a 3 or 5-lane cross-section (to be determined in separate memorandum) and intersection control improvements to the Loder Road and Glen Oak Road intersections with Beavercreek Road (roundabout or traffic signals, to be determined in separate memorandum).

Beavercreek Road Concept Plan - Zoning and Code Amendments
Consolidated Comment Tracker January 2019-June 2019

Transportation	
Ensure that traffic flow is efficient and safe around the BRCP area (roundabouts or traffic signals), considering school drop off/pickup, different uses (e.g. Industrial-type traffic near residential areas) and trips generated outside the study area. Concern about emergency access to the area.	Currently preparing an assessment of transportation facilities and will present preliminary findings on road capacity and traffic control at the June 10 public meeting.
If Beavercreek Road is widened, will it be expanded to the east?	Efforts are made to expand equally in each direction from the road center line, assuming street rights-of-way allow for it.
How many road connections will be made to Beavercreek Road?	Currently the only road connections will be at existing intersections (Loder Road, Meyers Road and Glen
Require transportation infrastructure improvements before development begins.	We are considering the timing of infrastructure as development comes online. Development applications are required to build infrastructure to support their development. There are state and local land use requirements that look at the proportionality a project has to the city's infrastructure network both on and offsite of a development proposal. In some cases, development can be required to provide an offsite improvement as a condition of development, other times, they pay system development fees that help pay for larger capital improvement projects. The city is also looking at ways we can apply for grants, or work with developers to create local improvement districts or advance finance districts to better coordinate the timing of infrastructure.
Meyer Road or Glen Oak as the main street? Meyer is the bigger street and closer to CCC and high school.	Will explore Main Street options and provide an opportunity for further discussion at the April 9 public meeting.
Ensure that there is adequate parking to accommodate uses without congestion, especially around residential areas, but this should be balanced with creating pedestrian-friendly environments, especially around the MUC. Will the City pursue or require structured parking in the Main Street or Mixed Use areas?	Oregon City Development Code OCMC 17.52 requires minimum and maximum parking standards per use. It is not anticipated that this project will recommend any revisions to those requirements. All new development in Oregon City requires parking to be located to the side or rear of commercial uses. The project team is currently looking at how to encourage or require parking to be located to the rear of the commercial uses in the Glen Oak Mixed Use Center to better add in the pedestrian feel of the street and strategies for customers to minimize customers using the on-street parking in nearby neighborhoods.
Pursue adequate transit service in the BRCP will require coordination between jurisdictions to properly plan and secure funding.	City participates in ongoing conversations with TriMet, Clackamas County, Clackamas Community College, and Public Works about transit service. Ultimately, mass transit service is driven by population/jobs demand, though shuttle services can be more flexible.
Ensure adequate infrastructure and amenities to support safe bike and pedestrian movement within the BRCP, especially crossings of Beavercreek Road.	Concept Plan includes provisions for multi-modal transportation options which will be implemented through this Zoning and Code Amendments process. Certain streets will contain on-street or off-street bike paths and connect with a larger bicycle system as identified in the Transportation System Plan. Commercial and multi-family uses will also have mike parking requirements.
Parks, Trails and Open Space	
BRCP should ensure safe and aesthetic walking paths and trails to support pedestrians, especially school children.	Concept Plan includes provisions for sidewalks and off-street pathways which will be implemented through the Zoning and Code Amendments process. The design of Beavercreek Road and zoning should consider the proximity to the high school and potentially a future school south of the plan area.
Adequate green spaces, open spaces, and recreational areas, especially in the industrial area, are desirable.	Provisions will be made for open spaces, parks and trails throughout the Concept Plan area. The plan calls for parks and existing requirements in the code identify buffers around streams and wetlands and steep slopes.
When will proposed parks and trails be developed?	Land acquisition for parks will occur as part of development reviews. The construction of the parks is based on the Community Services (Parks Department) Capital Construction timeline/prioritization.
Residential	
Prioritize residential before other types of development.	Once the area had been rezoned, the timing and location of development will be left to the market and property owner to decide when to develop their property. The City will not do any development of homes or businesses. However, any development is required to make sure the proper infrastructure is in place to support proposed development.
Residents would like to see high-quality and well-designed residential units with sufficient open space and street trees and a maximum height of 3 stories.	The design team are looking at design standards, open space, landscaping and building height limits which will be addressed through this Zoning and Code Amendments process.
Support a broad variety of housing types, denser in the West Mixed Use area.	The plan envisions a higher density in the West Mixed Use area. Project staff is looking at code amendments to implement a mix of commercial and residential uses.
Non-residential uses in the residential area should have impacts on the surrounding neighborhood that are consistent with the zone. These impacts are lower in residential-only areas and increase when approaching non-residential zones. Prefer live/work and home occupations.	The design team is looking at identifying an appropriate type of non-residential uses and ways to mitigate their impacts.
Include affordable housing and alternative housing options in the BRCP.	Affordable housing is housing which is deemed affordable to those with a median household income or below as rated by the national or local recognized housing affordability index. Affordable housing development is generally done through cooperation with government and non-profit funding to subsidize the rental or ownership cost of a unit. The zoning code regulates uses and does not regulate the pricing of the housing. What zoning codes can do, is allow multiple types of housing to be allowed in a zone such as duplexes, cluster housing and row housing which can offer more option to the consumer than just a single family house. The City Commission is currently considering adding these types of uses to residential zones citywide. Visit https://www.orcity.org/planning/housing-and-other-development-and-zoning-code-amendments to lean more about this process. The plan will consider a variety of housing types which may have less expensive housing options.
Prefer sidewalks over alleys. Alleys create more burdens than benefits.	In areas where alleys are required by current city code-sidewalk are also required in the front of the properties. The City Commission is currently considering if existing alley requirements should remain.
There should be a gradual tapering of density at the edge of residential areas. Buffers with surrounding areas should primarily be setbacks or open space, not a physical wall or barrier. There should be more than 25 feet between residential and industrial uses. What types of barriers/screening between industrial and residential uses are allowed? Cyclone fencing? Concrete wall? Trees along the wall? A rotating park? Maintain row of trees that run east-west along the edge of the golf course. Consider integrating a bike/pedestrian trail into the landscaping setback along the southern perimeter to make better use of the space and keep it active.	Increased buffering and screening requirements are currently being looked at for development at the edge of the Beavercreek Road Concept Plan boundary when abutting residential uses. Requiring a tapering of density at the edge of a project is often more difficult and initially envisioned through a clear and objective code process and still meet the other required city goals of block length, lot size and street connectivity. The Concept plan zones identify a general tapering of densities.
Concern about compatibility of R-2 development along the BRCP southern boundary. Especially in regards to natural resources/stormwater/flooding.	In response to comments during the public process, the revised June Zoning Map slightly shifted the multi family portions near the south border. The total number of projected housing units remain the same.

Cottage Industries. New homes in BRCP area might be too small to incorporate square footage for cottage industries, like a large shop. Concerns about noise impacts from more industrial-type uses, such as woodworking. Consider whether potential impacts from cottage industries, like on-street parking and traffic are compatible with residential uses. Cottage industry uses might be better located in mixed-use and industrial areas.	Through the public engagement process, we heard from many folks that were concerned about allowing additional uses in the home occupation code for the Beavercreek Concept Plan Area, though there was some support for the concept. The Concept Plan calls for allowing job creation in residential zones. During the 2016 re-adoption of the Concept Plan, the City Commission made a finding that the existing city-wide home occupation code allows for a breath of opportunities for people to start starter businesses in their residences. As part of the hearings process, staff will look for additional guidance from the Planning and City commission on this topic.
Maintain access to Old Acres Lane for existing residents to use. Access should not be shared with BRCP area development.	Old Acre Road is a private driveway that can restrict public access- No part of the Concept Plan area will connect to Old Acres Road.
Mixed Use Center	
The MUC should consist of small, easily accessible shops with residential on the 2nd and 3rd floors if the market allows it.	The MUC zone allows for this type of use, but also allows properties to be developed as exclusively residential or commercial. The project team is currently looking at the balance of how much minimum commercial or residential to require for these area to ensure that the code does not over or underregulate the vision.
Smaller scale development. Do not require retail. Permit ground floor residential.	The MUC zone allows for this type of use, but also allows properties to be developed as exclusively residential or commercial. The project team is currently looking at the balance of how much minimum commercial or residential to require for these area to ensure that the code does not over or underregulate the vision.
Street design in the MUC should use landscaping, lighting, to ensure a pleasant pedestrian environment.	The project team is looking at what type of dimensional standards and enhanced landscape requirements, beyond what is already required city-wide, will be needed to ensure a pedestrian-friendly, walkable commercial node. The concept plan identifies some street design.
10,000 square foot limit seems appropriate for anchor retail spaces or stand-alone buildings. Square footage limit should be large enough to accommodate a non-big box grocery store (Trader Joes, Zupans). Consider a 6,000 to 8,000 square foot range for the other tenant spaces.	The city has generally not prescribed that level of detail between varying permitted uses. The proposed code looks at minimizing the size of each building to ensure that the massing of the neighborhood commercial area is complementary to and compatibly with the neighboring residential uses. The NC zones proposes the following language: All uses permitted per OCMC 17.24.020.A and B, including grocery stores, are limited to a maximum footprint for a standalone building with a single store or multiple buildings with the same business not to exceed ten thousand square feet, unless otherwise restricted in this chapter.
Upper-level residential should be allowed. In addition to traditional apartments, incorporate affordable units for underserved populations (transitional housing, micro housing/dormitory housing.)	Upper level residential is allowed in the MUE and NC Zones when coupled with commerical development.
Provide parking lots near the Main Street area to support local businesses. Ensure parking for a grocery store doesn't occupy all available parking.	Development applications will be required to provide for their own off-street parking per their specific use. The Plan and city encourges shared lots for ease of acess but each use must be accounted for.
People will not walk or take shuttles from the Industrial area to the Main Street area if there is ample parking.	As part of the public engagement process, staff and the project consultant team looked at the possibility of moving the Main Street area to the Meyers Road intersection to bringing it closer to employment locations. However, there was a pre-existing multi-family project located at the intersection of Meyers Road and Beavercreek Road that is currently in the Building Permit review process. This limited the ability to move the Main Street area of the Concept Plan.
Industrial	
Uses in the Industrial area should minimize impacts on adjacent residential areas through uses that are quiet, clean, and minimize pollution. There should be adequate buffers and transitions to other zones.	The project team is looking at ensuring uses with outside components be required to obtain a conditional use permit or be limited in scope and ensure adequate landscape buffering from abutting residential uses.
Focusing residential and mixed-use zoning south of Loder Rd and employment/business zoning north of Loder. There are many physical barriers to development south of Loder Road.	We have heard from some property owners south of Loder Road that this a concern coupled with the location of the existing lot lines and proposed street locations and natural features. There may be an opportunity to slightly tweak the proposed zoning map to address these concerns, but the final proposed zoning map will need to show compliance with the goals of the Concept Plan and projected housing and job targets. We are working with the owners on this issue and will provide more updates at the April 9, 2019 public meeting.
Avoid allowing marijuana-related activity in the industrial area, due to the nearby schools and family housing.	This project does not anticipate revising the existing city-wide marijuana regulation, which can be found at the following link https://www.orcity.org/planning/marijuana-regulation-oregon-city.
Can the areas under the power lines be developed? How many acres of the total are subject to power line restrictions?	No new buildings can be contructed under the powerlines. Outdoor storage, predestrian acessways and parking are all allowed under the easments.
Do not make the area comfortable for transients. Specifically, how to address area behind golf course to back of Thayer and Loder roads.	This is not a concern that can be addressed through the zoning process. Oregon City has, however, created a homeless liaison officer position. This position works with residents, homeowners, and business
What are the goals and restrictions for targeting certain industries? Define targeted jobs clearly; what type of business and give examples. Do not restrict industries yet. Target jobs to high school kids transitioning to the work force.	While the Beavercreek Road Concept Plan envisions green or green technology type of businesses as the optimal tenant, the zoning code is not really the tool to regulate specific sectors of businesses or number of employees. Planning staff and the consultant team worked to create general zoning designation that are consistent with existing city-wide zoning use designations. If the city wants to encourage green
Do not place size limitations. Focus on design. Use clear, easy-to-find and understand design standards.	The project team is looking at proposing a code that touches on uses, sizes and some design aspects. Our goal is to not underregulate nor overregulate the product. Please stay involved and let us know if you think the proposed zoning code amendments achieved this goal or if it should be further amended.
25% is pretty restrictive for what can be stored outside.	One of the major goals of the Concept Plan is to bring jobs to Oregon City. Large outdoor storage areas (not parking lots) can greatly reduce the jobs/acre projections. Utilizing 25% of the building square footage as a ratio for outdoor storage seemed to be a reasonable compromise.
Is trucking allowed? How will freight to the industrial area be accommodated?	Freight needs, freight hours and freight turning radii needs will be included in the final street designs and
Is live/work space allowable in the Industrial area?	
Where will employees park?	Development applications will be required to provide for their own off-street parking per their specific use. The Plan and city encourges shared lots for ease of acess but each use must be accounted for.
Economic Development	
Commercial uses, including professional services and services that allow workers and students to meet their daily needs.	The existing MUE and MUC zones allow professional services.
Desire for small businesses/employment and building footprints, but balance with attracting larger employers. Target local businesses in mixed use area, but anchor stores should be national chains that people are familiar with and that are well-received (Chipotle, Trader Joes, etc.)	We have heard a need for a mix of sizing of commercial and industrial uses. Some of these goals can be minimally achieved by the zoning code. Others, are more aligned with economic development goals and programs that City Commission may employ to work collaboratively with property owners to achieve this mix.

Proactive and effective economic development to ensure vibrant economic activity and growth within the BRCP.	While this is a zoning code amendments process, any comments that relate to a need for larger city involvement in the development of the Concept Plan area will be forwarded to the Planning and City Commission through this comment matrix and any public comments that arise through the public hearing process later this summer. The Economic Development department has been working on a nearby Beavercreek Employment Area with a variety of stakeholders.
Land Use and Infrastructure	
What role do residents have in approving the Concept Plan or future development?	The Concept Plan was adopted as an ancillary document to the city's comprehensive plan by the City Commission at a Public Hearing in 2008 and readopted through a public hearing in 2016. These Beavercreek Road code amendments will need to show consistency with the adopted Concept Plan and will be adopted through a noticed public hearing before the Planning and City Commissions later this year. Once adopted, all new development will be processed through the city's land use process depending on the type of development requested: https://library.municode.com/or/oregon_city/codes/code_of_ordinances?nodeId=TIT17ZO_CH17.50ADPR_17.50.030SUDEKIPR
Use a fast permitting process, ensure infrastructure is readily available to serve development areas, and barriers to development are minimized.	The design team is considering which process development is subject to and the Public Works and Economic Development departments will be working together to consider larger infrastructure. Generally developers installs infrastructure needed to serve their development.
Analyze electricity capacity to serve new development since existing neighborhoods in the area already experience "brown-outs".	Coordination with private utilities occurs during the private development review process. Private utility providers such as power, phone and cable have been sent notice of this application.
Zone designations should be separated by streets, not individual property lines. What do the property owners of those properties think?	Street location provide general direction and are finalized at time of development. Staff tried to find a balance of utilitizing exisiting proeprty lines and antipcated road locations.
The East Mixed Use Neighborhood should be more of a square rather than strung out along Beavercreek Road itself. Move it further north and center it around the mixed-use areas including Main Street and the industrial	While that sounds like an intriguing idea, staff felt that it was too divergent from the adopted plan. Staff's direction was to implement the adopted plan and only amend as needed to implement the intent of the
Education	
The anticipated extension of Clackamas Community College provides significant opportunity for professional training and economic development.	We agree and encourage all property owners to work with Clackamas Community College and the city's Economic Development Department to look for opportunities to partner to help transition students to full time work. The uses allowed in the area will take this into consideration.
Ensure proper siting and ease of permitting for future schools.	In the 2008 Concept Plan process, the Oregon City School District determined that they did not need additional land within the concept plan boundaries. They do have a parcel of land located just south of the concept plan boundary, near Old Acres Road but is not being considered for construction in the short term. Development in the concept plan area will provide an opportunity for future connections with the school property.
Miscellaneous	
Be clear about what is meant by "conceptual" in terms of roadways and district boundaries. Consider changing it from a "plan" to a "guide".	Final roadway design will be addressed at the development application stage and will need to be consistent with the concept plan maps or provide an alternate design that meets or exceeds the intent of the adopted street map. The design team will make an effort to set the correct expectations.
The plan should include a mix of uses and amenities - they would be helpful to reduce traffic and in case of disaster.	We have heard a need for a mix of commercial uses. Some of these goals can be achieved by the zoning code. Others, are more aligned with economic development goals and programs that City Commission may employ to work collaboratively with property owners to achieve this mix.
Like Lake Oswego development.	We assume that this comment translates to "make it look nice". Zoning code and design standards can provide a template for how a private development could look. However, too detailed of standards can stifle creativity and sensitivity to a specific private parcel's market needs. The project team is trying to create a balance of not under or over-regulating the urban layout of the concept plan areas. We are identifying the major design goals of the Concept Plan and are trying to create code that requires these elements. As the draft code is released this spring and through the public hearing process, please let us know if this balance was achieved, or if you think there should be a different balance.
How to limit connections to a private street to the south.	Old Acres Road, located at the southern boundary of the Concept Plan, is a private road and new development in the Concept Plan area will not be able to utilize this connection unless previously allowed by the private property owners.
Manage density.	The density outlined in the Concept Plan is regulated by Title 11 which governs the Urban Growth Boundary process. This code ensures cities efficiently use land brought into the Urban Growth Boundary, which reduces the need to expand the growth boundary earlier than predicted. The density of dwelling units in the approved Beavercreek Road Concept Plan has been set to fall between 1,000 and 1,600 dwelling units. A dwelling unit is defined as one single-family house, a townhouse unit, or an apartment unit in a multi-family building. It does not differentiate between the number of bedrooms. Development of these units will be completed over time through the subdivision (single-family or townhomes) or Site Plan and Design Review process (multi-family) based on the market and property owner direction. The goal of the code amendment process is to adopt zoning codes that can ensure that the area develops dwelling units over time that fall within the adopted 1,200-1,600 threshold. The placement of the densities and design will help create a community people like while minimizing
Include art.	Public art is not a goal or requirement of the concept plan, and therefore does to align with the aims of this zoning amendments project (provide zoning code amendments to allow private development to build within the Concept Plan boundary). However, as development moves forward, there may be opportunities to partner with local art organizations such as the Clackamas County Art Alliance https://clackamasartsalliance.org/ for public art in city open spaces or in private development.

City of Oregon City

625 Center Street
Oregon City, OR 97045
503-657-0891

Meeting Minutes - Draft

Planning Commission

Monday, February 25, 2019 | **7:00 PM** | **Commission Chambers**

1. Call to Order

Chair Mitchell called the meeting to order at 7:00 PM.

Present: 10 - Tom Geil, Robert Mahoney, Vern Johnson, Patti Gage, Mike Mitchell, Dirk Schlagenhaufer, Greg Stoll, Doug Neeley, Dorothy Dahlsrud and Matt Kuhl

Staffers: 3 - Laura Terway, Pete Walter and Diliana Vassileva

2. Public Comments

There were no public comments on non-agenda items.

3. Public Meeting

3a. 19-144 Joint Work Session between the Planning Commission and Natural Resources Committee

Pete Walter, Planner, discussed the bylaws and role of the Natural Resources Committee (NRC) including giving comments and advice on Planning Commission decisions. He reviewed the NRC's accomplishments and work plan priorities.

There was discussion regarding sending to the NRC applications that would make changes to the Natural Resources Overlay District so the NRC could review them and make recommendations. It was suggested that large changes should be required to come to the NRC, while smaller changes should be recommended to come to the NRC.

There was further discussion regarding tree removals before applications were submitted, curving sidewalks and streets around trees to save the trees, how wetlands were treated that were outside of the NROD, changing the requirements for the Heritage Tree program to make it less onerous, mitigation for tree removal, and incentivizing tree protection.

NRC Chair Neeley said the biggest concerns were the NROD changes and Heritage Tree issues.

The NRC members left the meeting.

3b. 19-145 Overview of How the Public May Learn About and Stay Involved with Land Use Decisions

Diliana Vassileva, Planner, gave an overview of the public noticing that the Planning Department did for different levels of land use proposals and the opportunities the

public had to learn about and review applications. These included the development projects website, mailed notices, property signs, emailed notices, neighborhood association/CIC notices, newspaper postings, Planning Commission/City Commission agendas, and email subscriptions.

Commissioner Geil arrived at 8:20 PM.

There was discussion regarding the 300 foot distance for the mailed notice, use of social media, improvements to the development projects website, and how to improve communication with citizens.

4. Communications

19-146

Laura Terway, Community Development Director, discussed items on future meeting agendas. She shared Community Development Department statistics as of December 31, 2018.

There was discussion regarding the funding for the Riverwalk.

5. Adjournment

Chair Mitchell adjourned the meeting at 8:53 PM.

City of Oregon City

625 Center Street
Oregon City, OR 97045
503-657-0891

Meeting Minutes - Draft

Planning Commission

Monday, April 8, 2019 | **7:00 PM** | **Commission Chambers**

1. Call To Order

Chair Mitchell called the meeting to order at 7:00 PM.

Present: 7 - Tom Geil, Vern Johnson, Patti Gage, Mike Mitchell, Dirk Schlagenhaufer, Greg Stoll and Robert Mahoney

Staffers: 4 - Kelly Reid, William Kabeiseman, John Lewis and Laura Terway

2. Public Comments

There were no public comments on non-agenda items.

3. Public Hearing

PC 19-033 GLUA-19-00001 (General Land Use Application), PARK-19-00001 (Parking Adjustment) SP-19-00007 (Site Plan and Design Review), and MP-19-00001 (Minor Partition) for 221 and 202 Molalla Avenue

Chair Mitchell opened the public hearing and read the hearing statement. He asked if any Commissioner had conflicts of interest, ex parte contacts, bias, or statements to declare including a visit to the site.

Commissioner Mahoney drove by the site occasionally. Councilor Johnson drove by the site. Commissioner Stoll drove past the site many times per week. Commissioner Schlagenhaufer had been to the site many times. Commissioner Gage had driven by the site. Chair Mitchell visited the site.

Kelly Reid, Planner, presented the staff report. This was a request for a parking adjustment to exceed the maximum off-street parking allowance for the commercial building at 221 Molalla Avenue, a minor partition to divided 202 Molalla Avenue into two 5,000 square foot parcels, and a new 10-space parking lot on proposed Parcel 1 with access from Myrtle Street. She disclosed that the Planning Department used to be located at this location. There were 101 parking spaces currently allowed based on the current retail and office mix, and the applicant was requesting approval for 107 spaces. Staff did not find that the use was extraordinary in this case, however it could be considered unique because the buliding had mixed uses within it. Staff found the parking adjustment was appropriate as additional spaces could be converted to retail and greater parking would be needed. Staff recommended approval with conditions. She pointed out an error in Condition #2.

Commissioner Geil arrived at 7:20 PM. He had no conflicts of interest, ex parte contacts, bias, or statements to declare and he had not visited the site.

There was discussion regarding the reasons for the maximum number of spaces.

Michael Robinson and Perish Burns, representing the applicant, gave a site context, explained what was being proposed on the site, and discussed how the applications complied with the standards and approval criteria. Public outreach was presented to the Barclay Hills Neighborhood Association and there were no objections. They agreed with the staff report recommendations and conditions with the exception of Conditions #15 and #22. The concern with Condition #15 was that it would require the applicant to underground all of the overhead lines on Molalla Avenue. That had been clarified to only be from the service line from the overhead utility lines to the house. The concern with Condition #22 was the third easement requirement which was a future condition and they did not have an obligation to record that easement now in order to comply. There was also concern about the second easement for vehicluar reciprocal access between proposed Parcel 1 and 2. The easement could preclude the redevelopment of the Parcel 2 since the easement would run with the property, and it needed to be written in a way that allowed modification or termination.

There was discussion regardnig the undergrounding of the power lines.

Mr. Robinson requested removal of Condition #15 as the best time to require the undergrounding would be the redevelopment of the house.

Tracy Hamlet, resident of Oregon City, owned properties around the subject site. She was concerned about people driving through her parking lot to get to the new parking lot. She thought a barrier on the south propety line should be required. She also thought the proposed parking lot should have lights for safety.

Donna Sellman-Pilorget, real estate agent, had an interested buyer for this property, but was told that it could not be purchased right now because of the minor partition process. Parcel 2 would not be used as a residence with her buyer, but for light retail. She asked about the parking for that lot.

Bill Kabeiseman, City Attorney, stated the fact that some people's opinion this would limit the uses of Parcel 2 in the future did not mean the application did not meet the criteria.

Elizabeth Lewis, resident of Oregon City, questioned if there was legally enough room for a car to access Parcel 2 and not trespass on Ms. Hamlet's property. She asked for clarification on the temporary barrier and the required future easement.

Staff clarified these issues.

The Commission took a short break.

Mr. Robinson provided rebuttal. The applicant was comfortable with Condition #22 as it was written. Regarding Condition #15, he suggested changing the condition to say undergrounding the service line was required when the use changed from a single family residential use or the property was redeveloped. The parking lot would be used for employees, not visitors. He did not think there would be a reason for them to drive through someone else's parking lot and they could not put a barrier on the common property line as it would block the access to the driveway. A possible buyer and use for Parcel 2 was not part of the approval criteria. The partition did not change the access to the parcels. If lighting was put in the parking lot, it would encourage people

to use it in the evening who were not employees. Ms. Burns clarified the asphalt paving area that had been utilized for parking for the house would remain with the land division as proposed.

Ms. Terway said staff requested a continuance of the hearing to provide additional information on the cost of the overhead utility lines.

Mr. Robinson clarified the applicant wanted to be able to construct and use the parking lot before the undergrounding was done. If that was allowed, then he would withdraw the objection to Condition #15.

Mr. Kabeiseman clarified the applicant could construct the parking lot and use it and not underground the utilities for up to two years when the final plat was recorded. Parcel 2 could not change use or ownership without the undergrounding.

Ms. Terway said staff withdrew the request for continuance.

Chair Mitchell closed the public hearing.

The Commission deliberated on the merits of the application and how they were in support.

Commissioner Geil was concerned about the lighting and proposed divisions.

A motion was made by Commissioner Mahoney, seconded by Commissioner Gage, to approve GLUA-19-00001 (General Land Use Application), PARK-19-00001 (Parking Adjustment) SP-19-00007 (Site Plan and Design Review), and MP-19-00001 (Minor Partition) for 221 and 202 Molalla Avenue with the conditions as written except the amendment to Condition #2. The motion carried by the following vote:

Aye: 6 - Vern Johnson, Patti Gage, Mike Mitchell, Dirk Schlagenhaufer, Greg Stoll and Robert Mahoney

Abstain: 1 - Tom Geil

4. Adjournment

Chair Mitchell adjourned the meeting at 9:00 PM.

City of Oregon City

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Meeting Minutes - Draft

Planning Commission

Monday, April 8, 2019 | **7:30 PM** | **Commission Chambers**

Work Session

1. Call To Order

Chair Mitchell called the meeting to order at 9:00 PM.

Present: 7 - Tom Geil, Vern Johnson, Patti Gage, Mike Mitchell, Dirk Schlagenhaufer, Greg Stoll and Robert Mahoney

Staffers: 4 - Laura Terway, Kelly Reid, John Lewis and Aleta Froman-Goodrich

2. PC 19-032 Stormwater Master Plan Update

Alissa Maxwell, Brown and Caldwell, and Aleta Froman-Goodrich, City Engineer, gave a presentation on the Stormwater Master Plan update. They explained the background on the stormwater system, development of the Stormwater Master Plan in 1988, planning context, identified problem areas, Master Plan recommendations, and proposed capital projects.

There was discussion regarding state regulations for stormwater, the process for the Master Plan to become part of the Comprehensive Plan, how it would affect the Concept Plan areas, and current stormwater facilities.

Laura Terway, Community Development Director, discussed the Beavercreek Road Concept Plan implementation and proposed Code amendments that had been referred back to the Planning Commission.

3. Adjournment

Chair Mitchell adjourned the meeting at 9:52 PM.