South Troutdale Storm Drainage Master Plan 2012

Prepared for
City of Troutdale
Troutdale, Oregon
February 14, 2012

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List of Abbreviations

BMP	best management practice
cfs	cubic feet per second
CIP	capital improvement project
CMP	corrugated metal pipe
CSP	corrugated steel pipe
City	City of Troutdale
DEQ	Oregon Department of Environmental Quality
F	Fahrenheit
GIS	geographic information system
HDPE	high-density polyethylene
HDR	high density residential
I-84	Interstate 84
LDR	low density residential
LID	low impact development
MS4	Municipal Separate Storm Sewer System
MS4 Plan	stormwater management plan
Metro	Portland Area Metropolitan Service District
NPDES	National Pollutant Discharge Elimination System
OS	open space
PVC	poly-vinyl chloride
RCP	reinforced concrete pipe
SDMP	storm drainage master plan
TMDL	total maximum daily load
UGB	urban growth boundary
UIC	underground injection control
WLA	waste load allocation

Executive Summary

Introduction

In 2011, the City of Troutdale (City) initiated development of a storm drainage master plan (SDMP) for the South Troutdale area, to develop a 20-year stormwater capital improvement projects list (CIP). The plan objectives include the following:

- Evaluate the capacity of the storm drainage system.
- Consider future annexations, projected development patterns, and county road projects when evaluating capacity and water quality.
- Comply with Municipal Separate Storm Sewer System (MS4) National Pollutant Discharge Elimination System (NPDES) Permit Renewal Requirements to develop total maximum daily load (TMDL) benchmarks.
- Address drainage from the decommissioning of non-rule authorizable dry wells, in order to move the City away from the need to obtain a Water Pollution Control Facility permit.
- Develop water quality CIPs that address the bacteria TMDL as well as position the City to comply with anticipated future stormwater regulations related to hydromodification, retrofits, design storms, maintenance, low impact development, and potential future TMDLs for other parameters of concern.
- Develop CIPs to address identified hydraulic constraints and capacity deficiencies in the system.
- Develop planning level cost estimates that will allow the City to evaluate its stormwater user fee, rate structure, and system development charges.

Study Area Characteristics

The City is approximately 6 square miles in size with two distinct drainage areas: the North Troutdale area and the South Troutdale area. This SDMP includes analysis for South Troutdale. South Troutdale encompasses the portion of the city draining to the Sandy River and Beaver Creek, south of Interstate 84 (I-84). The North Troutdale Storm Drainage Master Plan was completed in 2007 and encompasses areas of the city generally north of I-84 that drain to the Columbia River and the Sandy River.

The topography in South Troutdale is influenced by the Beaver Creek and Sandy River drainage systems. Beaver Creek flows through Troutdale in a northeasterly direction and through a steep canyon to its confluence with the Sandy River at Depot City Park near the Historic Columbia River Highway. The Sandy River runs near the eastern boundary of the city.

Residential development is the primary land use within the urbanized area of South Troutdale. Vacant areas are scattered throughout the city, but a large portion of vacant area exists on the steep slopes along Beaver Creek and the Sandy River.

Runoff from a large area within the South Troutdale study area discharges into underground injection control (UIC) facilities. Areas draining to UICs were not included in this study's hydrologic or hydraulic model, with the exception of drainage areas for six UICs that were identified for decommissioning (see Section 2.8). Drainage areas associated with the six UICs were delineated and included in the future condition hydrologic model in order to identify runoff flows and volumes for future planning purposes.

The City maintains 28 outfalls within the South Troutdale study area, 14 along Beaver Creek and 14 along the Sandy River. As a result of the multiple outfalls, the majority of the City's stormwater infrastructure is relatively small in size with respect to pipe diameter. Pipes owned by Multnomah County along the main arterials within the South Troutdale study area were included in the master plan effort, but pipe systems owned by the Oregon Department of Transportation (i.e., within the right-of-way of I-84) and private entities were not included in the model because these systems are maintained separately from the City's system.

The City operates under a Phase II MS4 NPDES permit, which requires it to implement stormwater management strategies for reducing pollutants discharged from the City's stormwater systems. The City implements its MS4 Plan which includes a variety of programmatic, non-structural, and source control activities that the City conducts in order to improve stormwater quality and reduce pollutant discharges in stormwater. As a result of this SDMP, structural stormwater facilities as capital improvement projects have been identified.

Study Methods

Development of the South Troutdale SDMP involved evaluation of the capacity of the South Troutdale stormwater drainage system and evaluation of opportunities to implement stormwater water quality facilities within the study area.

To evaluate the capacity of the South Troutdale stormwater drainage system, a computer model was developed to simulate the hydrologic/hydraulic conditions of the public system for pipes 12 inches in diameter and greater. The storm system was evaluated under both existing and anticipated future development conditions. XP Software's XP SWMM v2010 model software was selected to conduct this analysis.

In order to develop the hydrologic and hydraulic computer model of the existing storm pipe system, the South Troutdale study area was subdivided into subbasins for modeling purposes. The subbasin boundaries were delineated based on topographic information and the locations of the existing drainage system in the geographic information system (GIS). A total of 200 subbasins are reflected in the hydrologic model.

Information on the South Troutdale drainage (conveyance) system was provided in GIS by the City. As part of this SDMP, elements of the stormwater conveyance system including nodes (manholes) and links (pipes or open channel conveyances) were named.

Once the model was developed, it was validated using anecdotal field observations from a large storm event. The model validation storm event occurred on August 29, 2005. The City reported flooding of the manholes in 257th Avenue near the intersection of the Historic Columbia River Highway. Results of the validation exercise were deemed to be reasonable and no adjustments to the model were made.

Following the model validation, the water quality, 2-year, 5-year, 10-year, and 25-year storm events were simulated for current and future development conditions. Initial model results indicated a total of ten pipe segments with some degree of flooding in either the existing or future development condition. Each flooding location was reviewed in the XP-SWMM model to evaluate the source of the identified capacity deficiency. Additional review of the model assumptions and methods resulted in a refined number of locations that require CIP development for flood control. A total of six pipe capacity issues were identified for CIP development.

In conjunction with the hydraulic evaluation of the City's stormwater system, water quality CIP opportunity areas were identified by reviewing system information including locations of existing water quality facilities, existing vacant areas, publically-owned lands, existing and future condition land uses, storm system layout, topography, and drainage areas. Initial opportunity areas were identified and reviewed with City staff who further commented on feasibility and practicability of water quality facility installations in the identified areas. A total of ten water quality CIP opportunity areas were identified for potential CIP development.

In order to integrate development of the flood control and water quality CIPs, the flood control and water quality opportunity areas were reviewed together to determine whether a water quality facility (to address a specific water quality opportunity area) could be sized, designed, and/or located in such a way that it will also address an identified system capacity deficiency.

Study Results

Analysis of the stormwater drainage system in the South Troutdale drainage area resulted in the identification of 16 potential CIPs. Through the CIP development process, one integrated water quality and flood control CIP was identified; four flood control CIPs were identified; and eleven water quality CIPs were identified. Table ES-1 summarizes the identified CIPs and Figure ES-1 provides the general vicinity of each of these CIP locations.

Table ES-1. CIP Summary

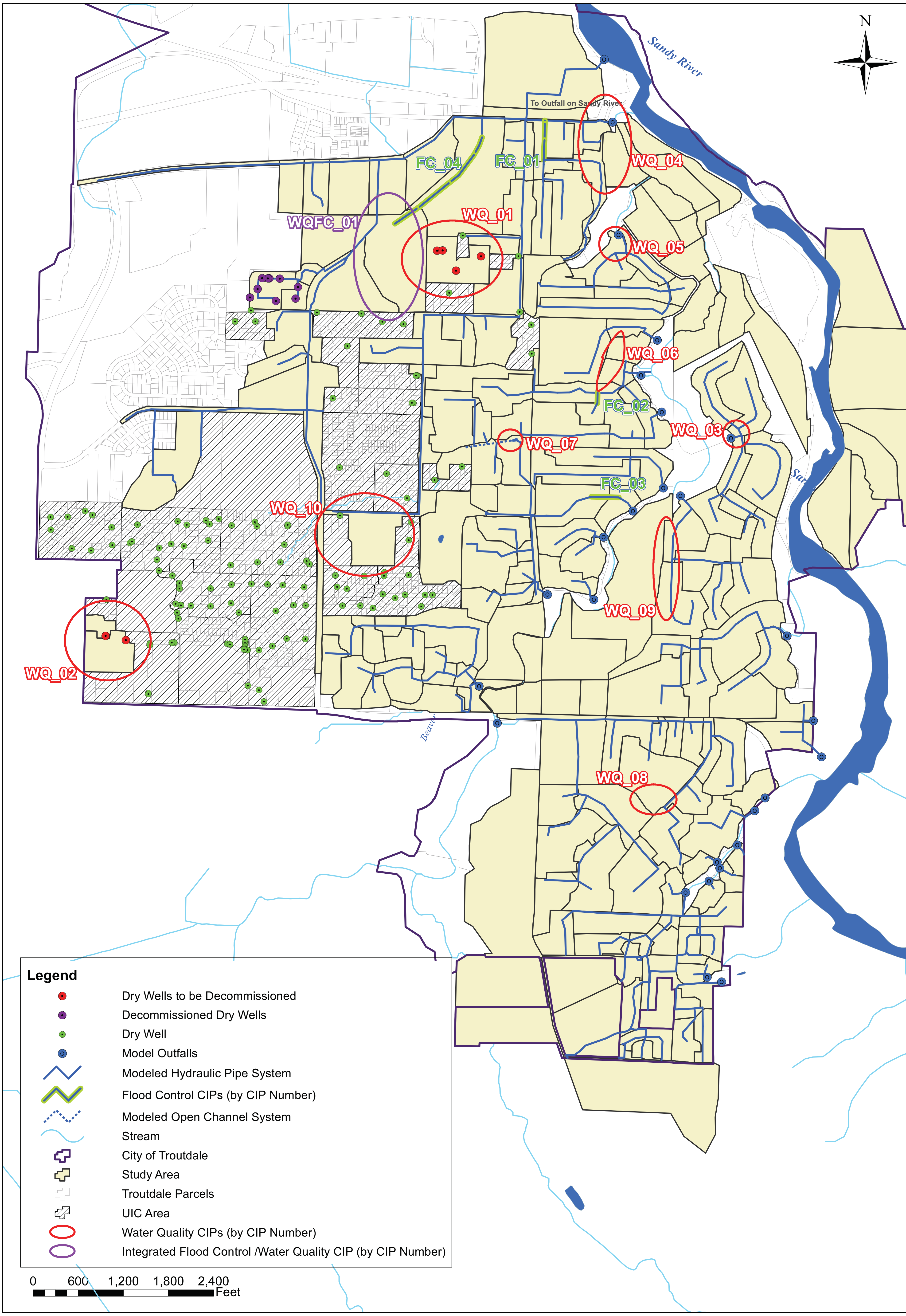
CIP number	CIP type	CIP name	Estimated CIP project cost, dollars	Estimated CIP maintenance cost, dollars (annual)[3]
WQFC_01[1]	Integrated Flood Control/Water Quality	LID Pilot Project	50,000	N/A
FC_01	Flood Control	Pipe Upsizing on S Buxton Road	130,100	N/A
FC_02	Flood Control	Curb Installation	2,500	N/A
FC_03	Flood Control	Pipe Upsizing on SE 21st Street	106,100	N/A
FC_04[1]	Flood Control	Pipe Upsizing on NW 257th Avenue	522,700	N/A
WQ_01a[2]	Water Quality	Stormwater Planter for Northern UIC Decommissioning	717,500	13,000
WQ_1b[2]	Water Quality	Stormwater Planter for Northern UIC Decommissioning	293,400	5,100
WQ_02	Water Quality	Stormwater Planter for Western UIC Decommissioning	1,099,500	20,400
WQ_03	Water Quality	Sandee Palisades Detention Pond Retrofit	153,800	4,600
WQ_04	Water Quality	Vegetated Infiltration Facility (retention pond) at Outfall BC010	1,539,300	44,800
WQ_05	Water Quality	Strawberry Meadows Detention Pond Retrofit	85,100	1,600
WQ_06	Water Quality	Vegetated Infiltration Facility (rain garden) at Weedin Park	297,100	7,300
WQ_07	Water Quality	Stuart Ridge Detention Pond Retrofit	60,500	500
WQ_08	Water Quality	Vegetated Infiltration Facility (rain garden) at Sweetbriar Park	145,400	3,300

Table ES-1. CIP Summary				
CIP number	CIP type	CIP name	Estimated CIP project cost, dollars	Estimated CIP maintenance cost, dollars (annual)[3]
WQ_09	Water Quality	Stormwater Planters (Green Streets) at SE Evans Avenue	373,700	7,700
WQ_10	Water Quality	Stormwater Planters (Green Streets) at SW 21st Avenue	184,200	3,900

[1] *CIP WQFC_01 and CIP FC_04 address the same flood control opportunity area. If WQFC_01 is deemed in feasible, FC_04 may be considered. However, both CIPs would not need to be implemented.*

[2] *CIP WQ_01a and CIP WQ_01b address the same water quality issue. If WQ_01b is feasible from a downstream pipe capacity standpoint, then WQ_01a would not need to be implemented.*

[3] Maintenance costs assume sediment removal and other activities that may only be conducted as needed (i.e., every five to ten years). Therefore, these costs are conservative as they reflect the maximum maintenance cost that would be anticipated in one year.



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CIP SUMMARY

FIGURE ES-1

CITY OF TROUTDALE

SOUTH TROUTDALE
STORMWATER MASTER PLAN

Section 1
Introduction

The South Troutdale Storm Drainage Master Plan documents the methods and results of the stormwater quality and storm system capacity evaluation for the South Troutdale study area. This study area includes land within the incorporated city limits and urban planning area of Troutdale that drains to Beaver Creek and the Sandy River. The study area does not include areas that discharge to underground injection control (UIC) facilities, with the exception of a small area associated with UICs that are scheduled to be decommissioned. This section provides a summary of the need for the plan, the plan objectives, a description of the approach for preparing the plan and a summary of how this plan is organized.

1.1 Need for the Plan

In 1996, the City of Troutdale (City) completed the previous South Troutdale Storm Drainage Master Plan. This plan addressed capacity and water quality issues within South Troutdale for development conditions expected at that time. Most of the capital improvements recommended in that plan have been implemented to date.

Since 1996, development and regulatory requirements within South Troutdale have changed. The City has added land to its service boundary and is now planning for future annexations. As related to regulatory requirements, in 2001, the Oregon Department of Environmental Quality (DEQ) passed new rules regulating the discharge of stormwater runoff to UICs (e.g., dry wells). In March 2005, DEQ completed the Sandy River Basin total maximum daily load (TMDL), which identifies Beaver Creek (within the City) as water quality limited for bacteria. In May 2007 the City was issued a Phase II municipal separate storm sewer (MS4) National Pollutant Discharge Elimination System (NPDES) permit to regulate the discharge of stormwater runoff to waters of the state and to reduce pollutants in runoff to the maximum extent practicable.

These development and regulatory changes, combined with recent planning efforts conducted by the City including the 2009 Comprehensive Land Use Plan Update and the 2009 South Troutdale Road Storm Drainage Plan, warranted an update to the South Troutdale Storm Drainage Master Plan. The City's goal for the 2011 South Troutdale Storm Drainage Master Plan is to develop a comprehensive assessment and strategy to address stormwater quality and quantity management within the South Troutdale drainage basin.

1.2 Plan Objectives

This storm drainage master plan is intended to help the City in the development and prioritization of a 20-year stormwater capital improvement project list (CIP) for the South Troutdale area. The plan objectives include the following:

- Compile system information into a comprehensive XP-SWMM model for use in evaluating the capacity of the storm drainage system and identifying trouble spots.
- Ensure that future annexations, projected development patterns, and county road projects are considered when evaluating capacity and water quality.
- Comply with MS4 NPDES Permit Renewal Requirements to develop TMDL benchmarks due November 1, 2011.

- Address drainage from the decommissioning of non-rule authorizable dry wells to move the City away from the need to obtain a Water Pollution Control Facility permit.
- Select water quality CIPs that address the bacteria TMDL as well as position the City to comply with anticipated future stormwater regulations related to hydromodification, retrofits, design storms, maintenance, low impact development (LID), and potential future TMDLs for other parameters of concern.
- Develop CIPs to address the identified hydraulic constraints and capacity deficiencies in the system. Where feasible, develop flood control CIPs using facilities that also address water quality objectives.
- Use pipe age to help prioritize the implementation of capital projects.
- Develop planning-level cost estimates that will allow the City to evaluate its stormwater user fee, rate structure, and system development charges and determine appropriate funding mechanisms.

1.3 Approach

The approach for developing the South Troutdale Storm Drainage Master Plan is summarized in Figure 1-1. This approach was developed to meet the City's water quality and flood control objectives and uses a parallel process that combines to integrate data collection, data compilation, and data evaluation efforts.

As shown in Figure 1-1, water quality was considered at the beginning of the process in order to develop TMDL pollutant load reduction benchmarks (as required for the City's MS4 NPDES permit renewal). The data collection, data compilation, and data evaluation efforts were conducted as follows:

1. Previous master plans and geographic information system (GIS) data were reviewed with respect to land use, open space, topography, structural best management practice (BMP) drainage areas, and potential high pollutant source areas.
2. A review was conducted of areas where UICs are required to be decommissioned.
3. The Sandy River TMDL was reviewed to identify applicable bacteria waste load allocations.
4. Based on the data review, water quality CIP opportunity areas were identified and reviewed with the City. The opportunity areas would allow the City to reduce pollutant loads and position them to address future stormwater regulations.
5. A pollutant load spreadsheet model was developed to assist in estimating pollutant loads (specifically bacteria) and pollutant load reductions (associated with structural BMP implementation).
6. Using the pollutant loads model results, TMDL pollutant load reduction benchmarks were developed for submittal to DEQ.

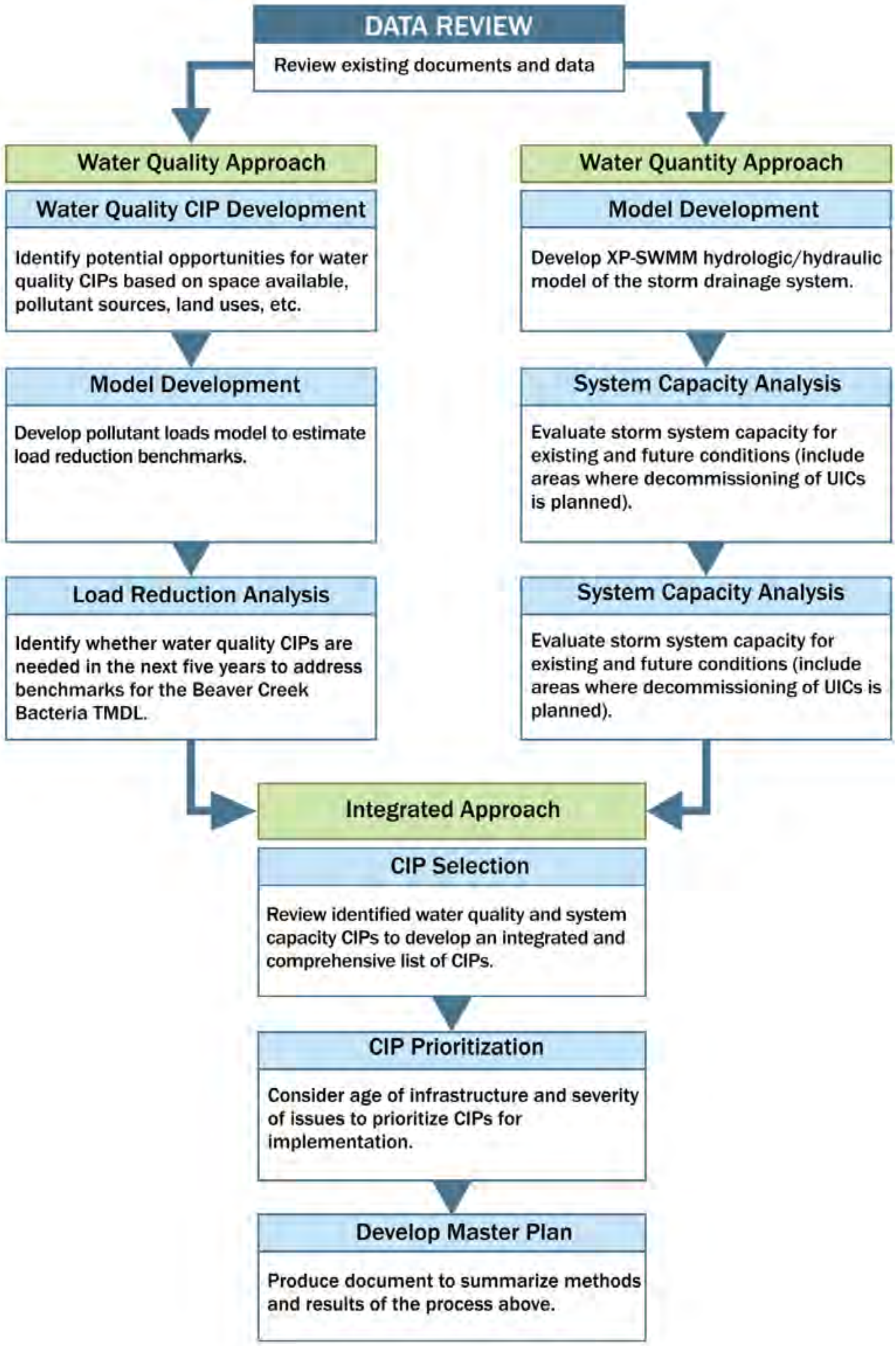


Figure 1-1. Storm Drainage Master Plan Approach

In conjunction with the efforts to evaluate water quality, the storm system capacity was evaluated to address flood control and conveyance issues as follows:

1. Existing storm system data from previous master plans, the City's GIS inventory, and as-builts were reviewed and compiled to develop a current storm drainage system in GIS. Data gaps were identified and missing information was obtained from the City.
2. An XP-SWMM model was developed from the updated GIS to simulate the hydrology and hydraulics of the storm system.
3. The capacity of the storm drainage system was evaluated for select design storms and existing and future development conditions.
4. System capacity problems were identified and reviewed. For those capacity issues that appear to be the result of a structural impairment, those areas were identified as a flood control CIP opportunity.

The integrated master planning approach addressed both water quality and flood control as follows:

1. Water quality and flood control CIP opportunity areas were reviewed to determine whether multiple objectives could be addressed with one project.
2. Flood control CIP opportunity areas that were isolated from water quality CIP opportunity areas were modeled in order to develop conceptual sizing and preliminary costs for the required structural improvement.
3. Flood control CIPs that were located within a water quality CIP opportunity area were assessed to determine whether the deficiency may be addressed with implementation of the proposed water quality facility.
4. Water quality CIPs were sized conceptually using XP SWMM or an alternative sizing methodology (i.e., City of Gresham simplified method for LID) and preliminary costs identified.

1.4 Plan Organization

The South Troutdale Storm Drainage Master Plan is organized as follows:

Section 2.0 includes a description of study area characteristics and associated mapping.

Section 3.0 describes the modeling methods used and results of the storm system capacity evaluation.

Section 4.0 describes the methods used and results of the storm system water quality evaluation.

Section 5.0 describes the recommended integrated management strategy to address the storm system capacity and water quality issues identified for the South Troutdale area over the next 20-years.

Section 6.0 describes the City's priorities for implementation of the integrated management strategy.

Appendices A through E provide supporting information for Sections 2 through 6.

Section 2

Study Area Characteristics

This section includes an overview of study area characteristics including location, topography, soils, land use, rainfall, drainage system, and current water quality conditions.

2.1 Location

Troutdale is located within the eastern portion of the Portland Area Metropolitan Service District's (Metro) urban growth boundary (UGB) in Multnomah County. Figure 2-1 is a map that shows Troutdale's location within the region.

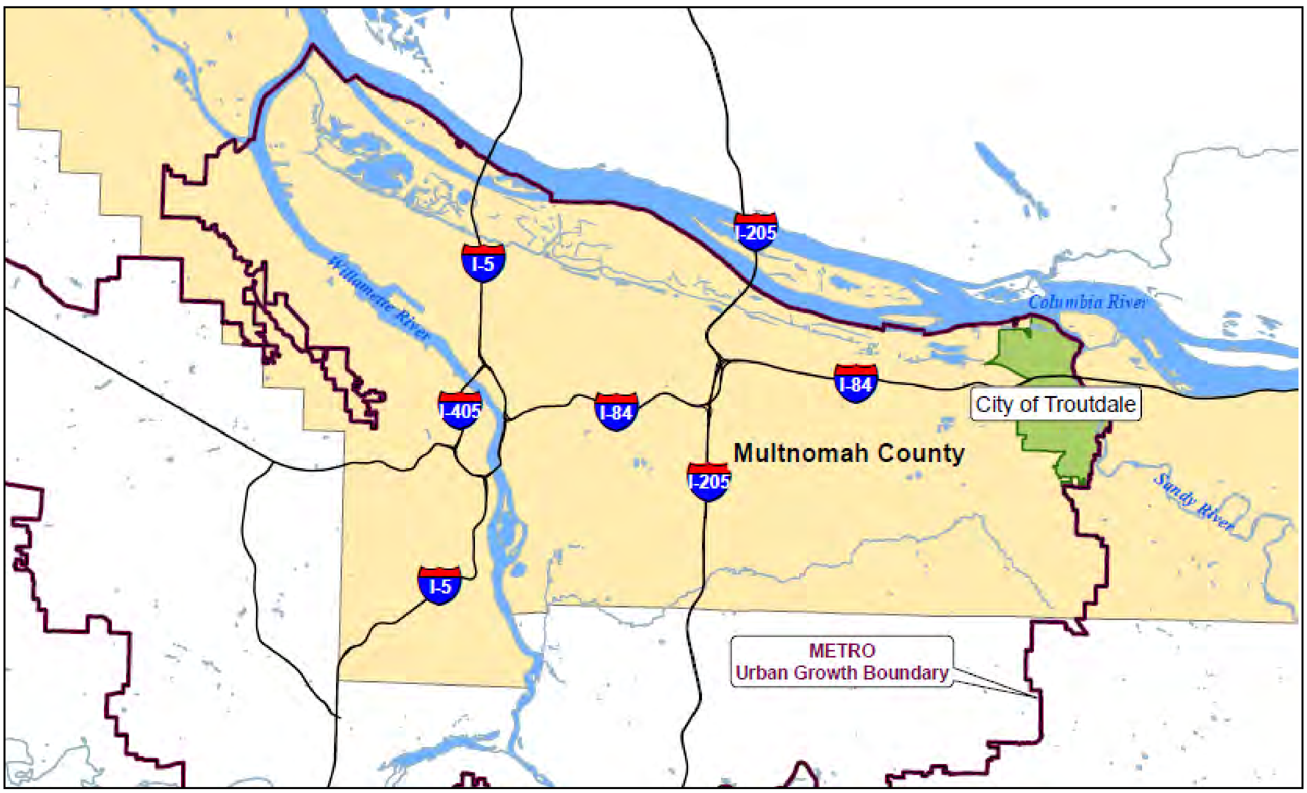


Figure 2-1. Vicinity Map

Troutdale is approximately 15 miles east of downtown Portland along Interstate 84 (I-84) and is bordered by the cities of Wood Village and Fairview to the west, the City of Gresham to the south, the Sandy River to the east, and the Columbia River to the north.

The city is approximately 6 square miles with two distinct drainage areas, the North Troutdale area and the South Troutdale area. This storm drainage master plan includes analysis for South Troutdale. South Troutdale encompasses the portion of the city draining to the Sandy River and Beaver Creek, south of I-84 and the Historic Columbia River Highway. The North Troutdale Storm Drainage Master Plan was completed in 2007 and encompasses areas of Troutdale that drain to the Columbia River and the Sandy River north of I-84 and the Historic Columbia River Highway.

2.2 Topography

Topographic information was compiled using 2008 6-inch resolution aerial imagery and LIDAR data, which were used to produce 2-foot contours. Anecdotal information from City of Troutdale (City) staff was used to supplement this data.

The topography in South Troutdale is influenced by the Beaver Creek and Sandy River drainage systems. Burlingame Creek joins Beaver Creek near Mt. Hood Community College, at the intersection of Southeast Stark Street and South Troutdale Road in the southwest corner of the city. From the college, Beaver Creek flows through Troutdale in a northeasterly direction. Beaver Creek flows through a steep canyon to its confluence with the Sandy River at Depot City Park near the Historic Columbia River Highway. The Sandy River runs near the eastern boundary of Troutdale.

The canyon associated with the Beaver Creek drainage system is approximately 100 to 150 feet deep and distinctly divides the Beaver Creek drainage system within South Troutdale. The upland area west of the Beaver Creek canyon extends from the western city limits east to the canyon. Slopes typically range from less than 1 percent to 20 percent in this area. The steeper slopes are located near Troutdale Road between Southeast Stark Street and Cherry Park Road and to the north of Cherry Park Road. The upland area east of the Beaver Creek canyon, between the Sandy River and Beaver Creek, is relatively flat, with most slopes typically ranging from less than 1 percent to 5 percent. This area extends from Southeast Strebin Road at the southern city boundary to Southeast Evans Loop.

The area located within the Sandy River floodplain near the Sandy River confluence with Beaver Creek is relatively flat. This area was delineated and included in the hydrologic model to provide subbasin runoff flow rates and volumes because there is a lack of existing data on infrastructure.

Additional undeveloped area along Beaver Creek and the Sandy River was also delineated to provide hydrologic information, because it is located within the UGB and the South Troutdale study area. However, much of this area is on steep slopes and it is currently undeveloped with limited data on existing infrastructure.

Figure 2-2 illustrates the topography of the South Troutdale study area and is included at the end of this section.

2.3 Soils

Soil classification is an important characteristic to consider when determining runoff flow rates and volumes. Soil types within the South Troutdale study area were identified using data from the National Resources Conservation Service Soil Survey. Soil information is based upon data obtained from a 1976 survey of soils within Multnomah County.

Soils within the delineated South Troutdale study area include silt and sandy loams. Information regarding soil textures was used to assign soil parameters for input into the hydrologic model (see Section 3.2.2).

Figure 2-3 identifies the soil coverage in the South Troutdale study area and is included at the end of this section.

2.4 Land Use

Development, specifically the conversion from undisturbed land to developed land, can affect the quantity and quality of stormwater runoff. Stormwater runoff flows and volumes increase with increased impervious surface.

Land use categories are used to assign impervious area percentages for areas within the South Troutdale study area. The City's 2009 Comprehensive Land Use Plan in conjunction with an inventory of currently vacant land was used to develop current and future condition land use coverage for the South Troutdale study area. Vacant lands were identified using Metro's 2005 vacant lands coverage and updated based on 2008 aerial imagery and the City's feedback. All currently vacant lands were assumed to be developed in the future condition model scenario.

Land use coverage within the South Troutdale study area is shown graphically in Figure 2-4 and is included at the end of this section. Residential development is the primary land use within the urbanized area of South Troutdale. Vacant areas are scattered throughout the city, but a large portion of vacant area exists on the steep slopes along Beaver Creek and the Sandy River.

2.5 Climate and Rainfall

Troutdale experiences a similar temperate climate to the surrounding Portland metropolitan area, with relatively warm dry summers and mild wet winters. Winter temperatures average approximately 40 degrees Fahrenheit (F) and summer temperatures average approximately 65 degrees F.

The majority of rainfall occurs during the months of November through April. The driest months are July and August, which typically average approximately 1 inch of monthly rainfall. The average annual precipitation in Troutdale is approximately 44 inches.

2.6 Drainage System

The drainage conveyance system associated with the South Troutdale study area was initially compiled from City-provided geographic information system (GIS) data of existing stormwater infrastructure, as-built information, 2-foot contours, parcel locations, aerial imagery, and anecdotal information from City staff. Runoff from a large area within the South Troutdale study area discharges into underground injection control (UIC) facilities. Areas draining to UICs were not included in this study's hydrologic or hydraulic model, with the exception of six UICs that were identified for decommissioning (see Section 2.8). Drainage areas associated with the six UICs were delineated and included in the future condition hydrologic model, in order to identify runoff flows and volumes for future planning purposes.

Topography within the South Troutdale drainage system results in several outfalls that drain relatively small areas. The City maintains 28 outfalls within the South Troutdale study area, 14 along Beaver Creek and 14 along the Sandy River. As a result of the multiple outfalls, the majority of the City's stormwater infrastructure is relatively small in size with respect to pipe diameter. Approximately 70 percent of the modeled pipe system is less than 24 inches in diameter and the maximum size of conveyance pipes is 60 inches. Pipes owned by Multnomah County along the main arterials within the South Troutdale study area were included in the model, but pipe systems owned by the Oregon Department of Transportation (i.e., within the right-of-way of I-84) and private entities were not included in the model because these systems are maintained separately from the City's system.

There are several subbasins that were delineated and included in the hydrologic model, that are currently undeveloped or lack existing infrastructure information. These subbasins are located along Beaver Creek and the Sandy River and are modeled to provide information on hydrology.

Stormwater facilities that provide detention storage include detention ponds and detention pipes. Some of these facilities were included in the model and are further discussed in Section 4. Other in-line water quality facilities with a conveyance component, such as vegetated swales, were also included in the hydraulic model. The modeled drainage system is shown in Figure 2-5 and is included at the end of this Section.

The majority of the City's drainage system shown in Figure 2-5 was constructed between 1970 and 1980. Figure 2-6 indicates the relative age and material of pipes within the South Troutdale system. Pipe material information was not available for all pipes in the City's GIS database; therefore these pipes are reflected in Figure 2-6 as other/unknown.

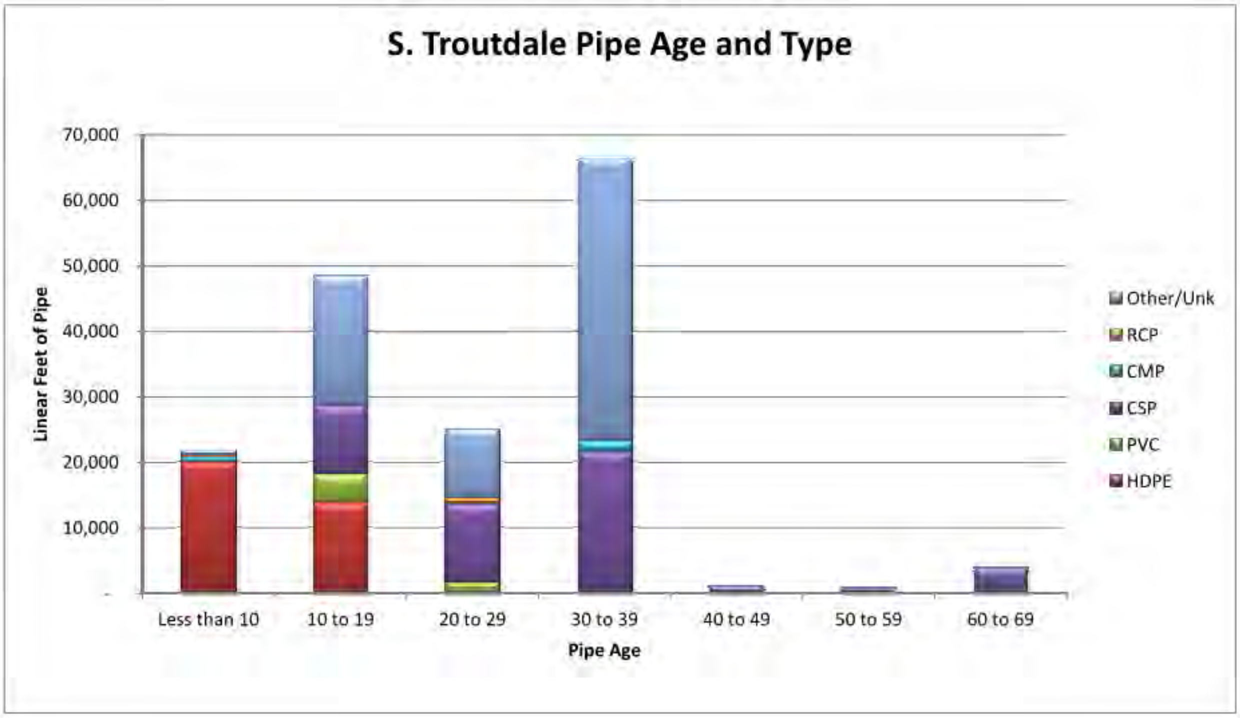


Figure 2-6. South Troutdale Drainage System Age and Material Type

RCP = Reinforced concrete pipe; CMP = Corrugated metal pipe; CSP = Concrete sewer pipe; PVC = Poly-vinyl chloride; HDPE = High Density Polyethylene (HDPE)

Figure 2-6 indicates that the majority of the City's storm infrastructure is less than 40 years of age. Of the 167,000 linear feet of pipe inventoried in the City's GIS system for S. Troutdale, approximately 5,600 linear feet is older then 40 years. Though service life is heavily dependent on the quality of installation and conditions following installation, there are generally accepted service life estimates for different types of storm piping. Concrete pipe typically lasts 50-100 years, corrugated metal pipe typically lasts 20-40 years and PVC and HDPE pipe is expected to last 80-100 years. Quality of bedding and backfill are major factors that affect service life which can be controlled during installation. Following installation, factors such as soil corrosivity, flows and abrasivity of material in stormwater also affect service life. Due to the variability of pipe service life, the most reliable way to determine the life sp n of existing infrastructure is to develop a baseline of pipe condition vs. lifetime based on inspection. As the City's infrastructure ages it would be useful to develop that baseline as a tool for planning needed rehabilitation and replacement costs.

2.7 Stormwater Quality

This section outlines the general water quality problems that occur in urbanized environments, documents the steps the City has taken to address water quality within the South Troutdale study area, and discusses the regulatory background associated with water quality.

2.7.1 Stormwater Quality in Urbanized Environments

As urbanization occurs, changes in the quality and quantity of stormwater runoff adversely affect the health of receiving waters. Historically, stormwater management has focused primarily on drainage and flood control. Drainage and flood control is still an important component to stormwater management; however, the degraded quality of stormwater runoff has become an increasing concern. Typical parameters of concern with respect to surface waters include bacteria, heavy metals, oils and grease, sediments, nutrients, and temperature. Recently, more attention is being paid to toxics (such as pesticides) and chemical contaminants of emerging concern such as pharmaceuticals.

In an urbanized environment, the general characteristics of urban runoff may be attributed to the land use associated with the source of discharge. The Oregon Association of Clean Water Agencies funded a study in 1996 and created a report entitled “Analysis of Oregon Urban Runoff Water Quality Monitoring Data Collected from 1990 to 1996” that was based on a series of statistical analyses of stormwater monitoring data collected by the Oregon Municipal Stormwater National Pollutant Discharge Elimination System (NPDES) applicants and permitted agencies in the Willamette Valley. The report indicates that stormwater pollutant concentrations from different land uses are statistically different from each other. In general, depending on the parameter, industrial land use typically showed the highest pollutant concentrations, followed by transportation, commercial and residential land uses. Open space (i.e., undeveloped) land use represented lowest pollutant concentrations. (Note: These are the general results. Results sometimes varied depending upon the specific pollutant.) Therefore, as development occurs, and changes to land use are observed (e.g., transition of open space or undeveloped land use to developed land use), pollutants in the stormwater runoff generally increase.

In addition to the ubiquitous problems associated with urbanization and stormwater runoff quality, spills and illicit discharges, which also commonly occur in urban environments, pose a threat to surface waters. Changes in land use associated with urbanization are a more predictable source of degraded water quality conditions. However, unpredictable, intermittent spills and illicit discharges can also impact water quality. Generally these discharge sources involve a small quantity of pollutants entering a single stormwater conveyance system component (e.g., catch basin, pipe). Typical pollutants associated with intermittent spills and illicit discharges vary greatly but may include oil and grease, automotive fluids, fertilizers and pesticides, trash and debris, and bacteria.

Typical stormwater pollutants and pollutant sources are summarized in Table 2-1.

Table 2-1. Typical Problem Pollutants in Stormwater

Typical stormwater pollutant[1]	Description	Major sources potentially associated with stormwater runoff	Potential in-stream water quality problem
Bacteria[2]	• *E. Coli* • Enterococcus • Fecal coliform • Fecal streptococcus	• Animal wastes (droppings from wild/domestic animals) • Human wastes (leaking sanitary sewer pipes, and seepage from septic tanks as well as illicit recreational vehicle waste dumping).	These are commonly used indicators of human microbial pathogens. Water contact may cause eye and skin irritations and gastro-intestinal diseases if water is swallowed.
Heavy metals	• Antimony • Beryllium • Chromium • Lead • Nickel • Silver • Arsenic • Cadmium • Copper • Mercury • Selenium • Thallium • Zinc	• Vehicles (combustion of fossil fuels, improper disposal of car batteries, wear and tear of tires and brake pads) • Metal corrosion (rain gutters, metal roofs, etc.) • Pigments for paints • Solder • Moss killers • Fungicides • Pesticides • Wood preservatives	Heavy metals are toxic to aquatic ecosystems. These metals are often considered to be the most significant toxic substances which are commonly found in urban stormwater runoff.
Oil and grease	A broad group of pollutants including the following: • Animal fats • Petroleum products	• Food wastes (animal and vegetable fats from garbage) • Petroleum products (gas, oils, lubricants, etc.)	These compounds can coat the surface of the water limiting oxygen exchange, clog fish gills, and cling to waterfowl feathers. When ingested these compounds can be toxic to birds, animals, and other aquatic life.
Total suspended solids	Sediments in the water are considered to be pollutants when they exceed natural concentrations and adversely affect water quality and/or beneficial uses of the water.	• Erosion from increased stream flows • Construction site runoff • Landscaping activities • Agricultural activities • Logging • All other activities where the ground surface is disturbed	Sediments cause increased turbidity, reduced prey capture for sight-feeding predators, clogging of gills/filters of fish and aquatic insects, and reduced oxygen levels and blocked light which limits food production available for fish. Sediments also accumulate in stream bottoms which reduces the capacity of the stream (and hence increases the potential for flooding) and covers stream bottom habitats. Sediment also acts as a carrier of toxic pollutants such as metals and organics.
Nutrients	• Nitrogen • Phosphorus	• Landscaping activities • Yard debris • Human wastes (leaks from septic tanks and sanitary sewers) • Animal wastes • Vehicle exhausts • Agricultural activities • Detergents (car washing) • Food processing	Excess levels of nutrients can lead to eutrophication in downstream receiving waters. Problems include surface algal scum, odors, reduced oxygen levels, and dense mats of algae. In addition to water quality problems, these effects have an adverse impact to the aesthetic quality of water bodies.

Table 2-1. Typical Problem Pollutants in Stormwater			
Typical stormwater pollutant[1]	**Description**	**Major sources potentially associated with stormwater runoff**	**Potential in-stream water quality problem**
Organics	There are many organic compounds both natural and synthetic; however, the synthetic organics are of most concern and include pollutants from the following sources: • Fuels • Solvents • Pesticides • Herbicides	• Illegal dumping • Illicit connections • Spills • Leaks from drums and storage tanks • Landscaping activities • Agricultural activities	Most synthetic organics are highly toxic to aquatic life at very low concentrations, and many are carcinogenic (cancer causing) or suspected carcinogens.
Litter and other floatable debris	• Plastics • Paper products • Yard debris • Tires • Metal • Glass • Appliances • Old electronics	• Littering • Dumping • Spills	These pollutants degrade the aesthetic quality of water bodies. In addition, they contribute pollutants as they decompose, and they can reduce the capacity of the water body. Excess yard debris contributes to high levels of nutrients and it reduces oxygen levels as it decomposes. Some discarded materials such as appliances, tires, and auto wreckage may contain toxic/ heavy metals such as mercury, cadmium, and copper.

[1] While elevated temperatures are a problem in many streams statewide, urban stormwater runoff has not been implicated as a source of this problem in this area and management measures have not been encouraged to address temperature issues in stormwater runoff from piped systems. However, for perennial open channel portions of the system, shading is a management measure that has been encouraged.

[2] Several regional DNA tracking studies have shown that the largest portion of bacteria in streams is associated with birds and rodents which are not sources typically controlled by municipalities. The controllable sources (pet waste, cross-connections, and failing septic systems) were shown to represent only a very small percentage of the problem.

2.7.2 Stormwater Quality Measures

The City operates under a Phase II Municipal Separate Storm Sewer System (MS4) NPDES permit, which requires the City to implement stormwater management strategies for reducing pollutants discharged from its stormwater systems. Such management strategies are called Best Management Practices (BMPs), and the BMPs are developed to address six minimum measures, as specified in the permit. The six minimum measures are as follows:

1. Public education and outreach on Stormwater Impacts
2. Public Involvement/Participation
3. Illicit Discharge Detection and Elimination
4. Construction Site Stormwater Runoff Control
5. Post-Construction Stormwater management in New Development and Redevelopment
6. Pollution Prevention in Municipal Operations

Each minimum measure requires that BMPs are implemented to reduce the discharge of pollutants to the maximum extent practicable and each BMP includes reference to measurable goals (in order to assess progress of implementing the BMP), the responsible party, and the rationale for how and why each BMP was selected. The BMPs are outlined in the 2007 City of Troutdale Stormwater Management Plan (MS4 Plan).

The City's MS4 Plan summarizes (in the form of BMPs) a variety of programmatic, non-structural, and source control activities that the City conducts in order to improve stormwater quality and reduce pollutant discharges in stormwater. Development of this Storm Drainage Master Plan is directly referenced under the MS4 Plan's Minimum Control Measure #5. Specifically, BMPs associated with Minimum Control Measure #5 (Post Construction Stormwater Management for New Development and Redevelopment) relate to the selection, design, installation, and maintenance of structural stormwater BMPs to promote improved water quality. As a result of developing this master plan, structural stormwater facilities as capital improvement projects have been identified.

A map of existing structural stormwater facility coverage within the South Troutdale study area is shown in Figure 2-7. This figure is included at the end of this section.

2.7.3 TMDL Program

In accordance with its Phase II MS4 NPDES permit, issued May 3, 2007, the City is required to establish pollutant load reduction benchmarks for receiving waters with an established Total Maximum Daily Load (TMDL). A TMDL with established waste load allocations (WLAs) for urban stormwater has been established for Beaver Creek within the Sandy River subbasin for bacteria, as identified in the City's MS4 NPDES permit. Thus, the City must address the contribution of bacteria) as a result of urban stormwater runoff within its permit area.

A summary of the development of benchmarks to address WLAs in the Sandy River subbasin TMDL is provided in Section 4.

Given the 2005 finalization of the Sandy River TMDL, the City is focused on using the proposed water quality CIPs herein to address water quality objectives in accordance with its MS4 Plan. The types of water quality CIPs proposed include green streets, rain gardens, pond retrofits, and other infiltration-based facilities. Water quality problem areas and CIP identification are provided in Section 4.

2.8 Groundwater

The Safe Drinking Water Act regulates the injection of stormwater into the ground to protect groundwater that is primarily used for drinking water from contamination. UICs or dry wells are of specific interest to the Oregon Department of Environmental Quality, which regulates this program in Oregon.

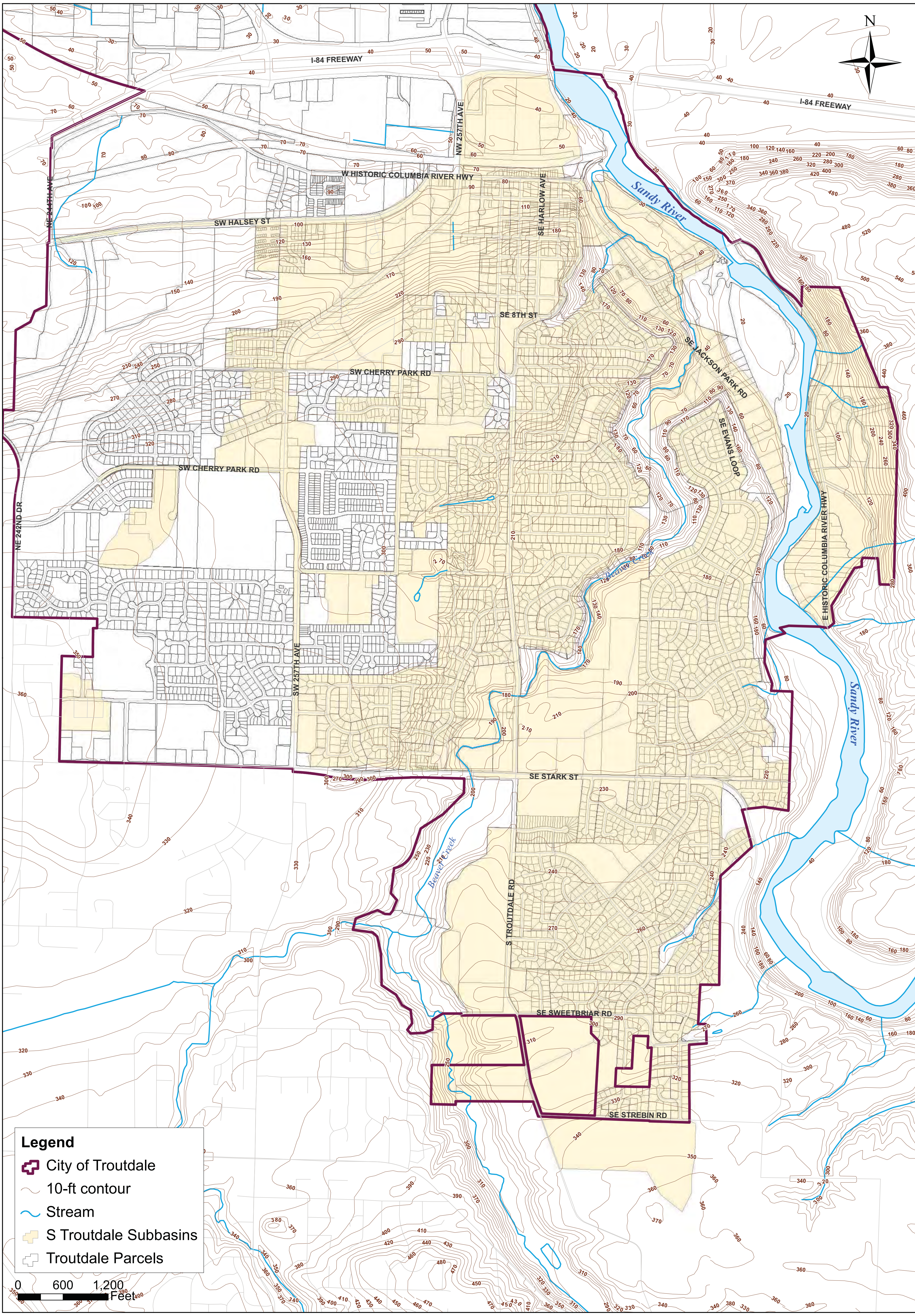
The UIC rules require an evaluation of UICs to ensure that the stormwater discharged is not a risk to groundwater quality and public health. The City completed this evaluation in 2001, entitled “City of Troutdale Underground Injection Control Program Report.” At the time of the City’s evaluation, the City owned and operated 129 drywells. Since that time, the City closed ten drywells in 2010 as part of the Sedona Park Drywell Project, and acquired seven Rule Authorized drywells through development. Today, the City of Troutdale owns and operates 126 Underground Injection Control (UIC) facilities that discharge stormwater from public streets. The City has applied for Rule Authorization of 113 drywells and permit coverage for six drywells. The six drywells not appearing to meet Rule Authorization criteria and therefore needing permit coverage are located within the two-year time of travel for the City’s municipal drinking water wells. The six drywells within the 2-year time of travel are described in Table 2-2.

Table 2-2. UICs in 2-year Time of Travel Zone

Dry well number	Latitude	Longitude	Subdivision	Year built	Street
C440	45.52157	-122.40949	Tower Estates	1997	SE Country Club Avenue
C438	45.52143	-122.40844	Tower Estates	1997	SE 29th Street
B32	45.53573	-122.39048	Lady Ann Addition	1972	SW 8th Circle and Spence Road
B28	45.536	-122.39273	Arndt’s Addition	1976	SW 8th Circle
B29	45.53596	-122.39279	Arndt’s Addition	1976	SW 8th Circle
B31	45.53519	-122.39175	Alpha Centauri	1978	SW 9th and Kings Byway

Since the time of the UIC study, the City has planned for the decommissioning of the six UIC facilities listed in Table 2-2. These facilities are currently in use, so runoff from their drainage areas is excluded from the existing condition system for both water quality and water quantity (hydrologic) evaluations. Runoff from drainage areas associated with the six UICs has been represented in future condition system water quality and water quantity evaluations. The UIC drainage areas are shown in Figure 2-5.

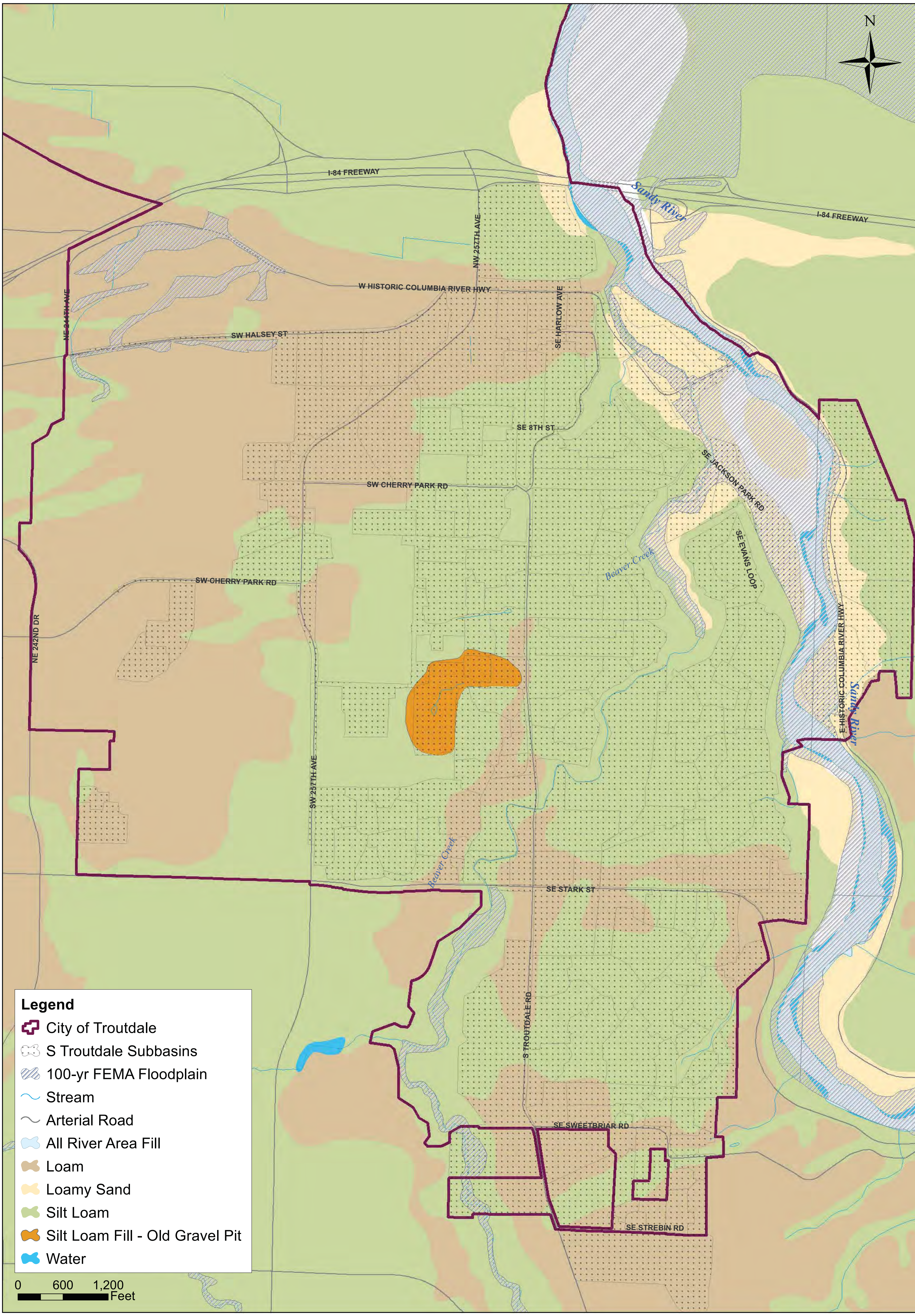
With the exception of the UIC drainage areas associated with UICs to be decommissioned, other areas discharging to UICs were not evaluated for this SDMP.



Brown AND Caldwell

TOPOGRAPHY
FIGURE 2-2

CITY OF TROUTDALE
SOUTH TROUTDALE
STORMWATER MASTER PLAN



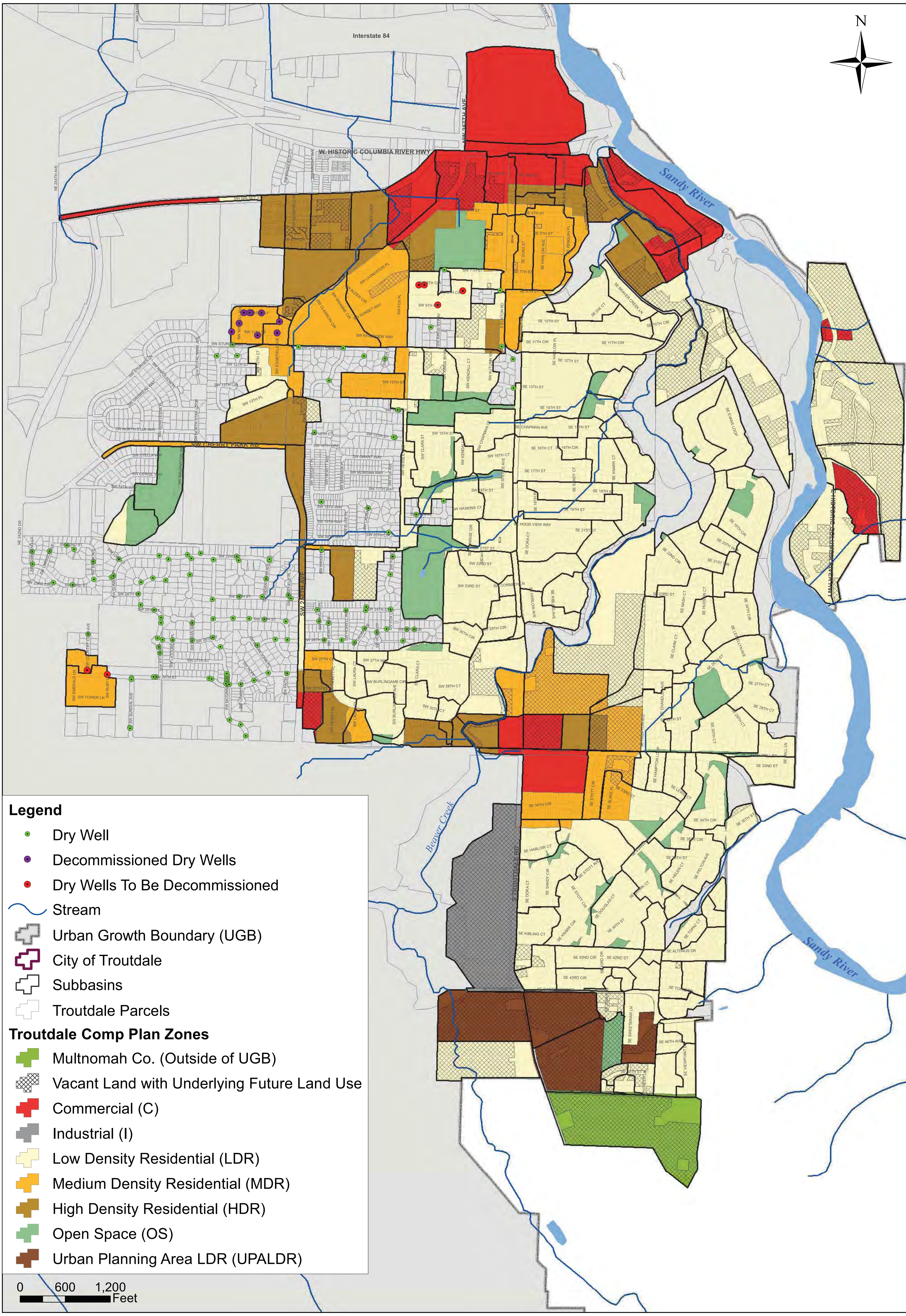
Brown AND Caldwell

SOILS

FIGURE 2-3

CITY OF TROUTDALE

SOUTH TROUTDALE
STORMWATER MASTER PLAN



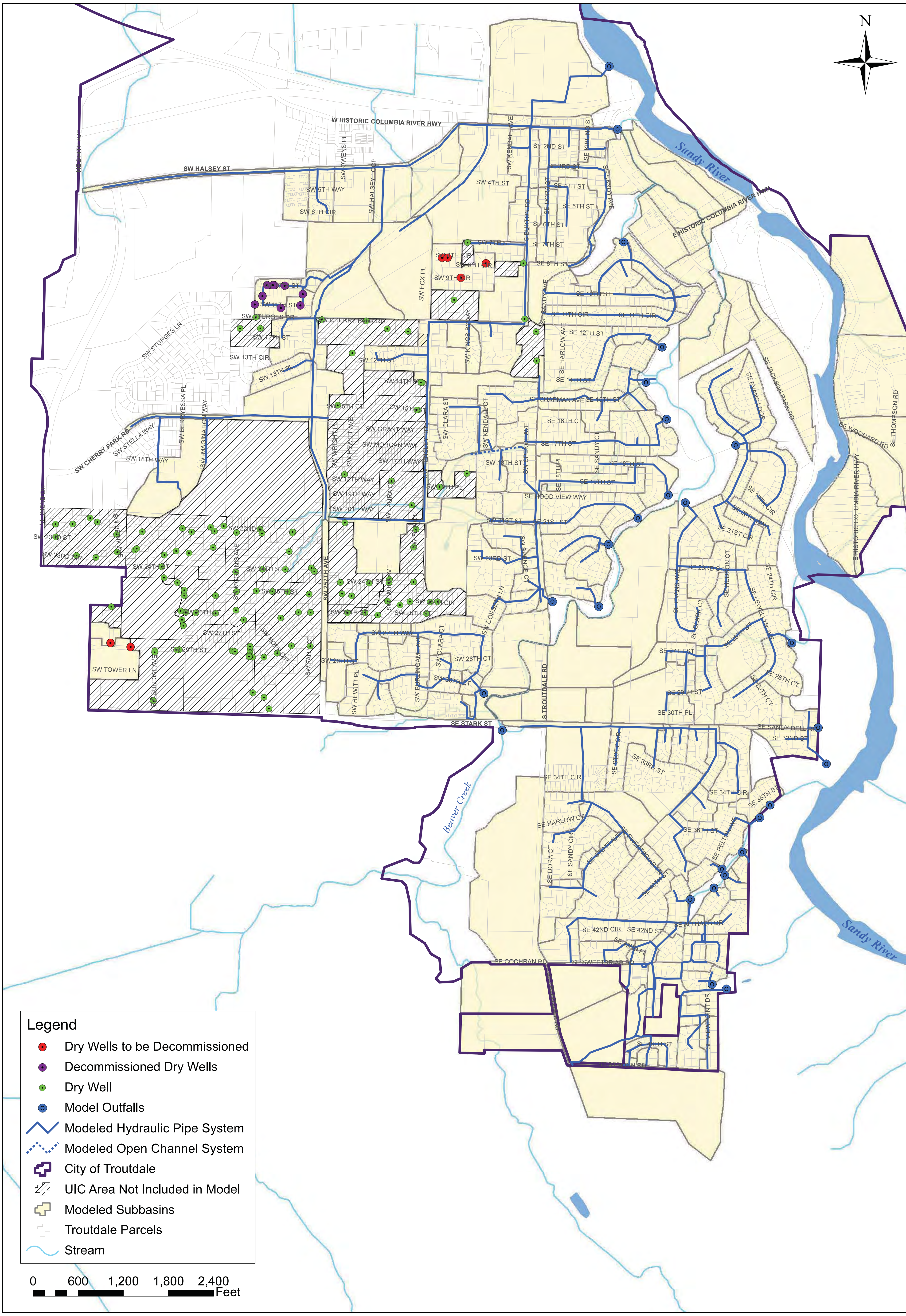
Brown AND Caldwell

LAND USE

FIGURE 2-4

CITY OF TROUTDALE

SOUTH TROUTDALE
STORMWATER MASTER PLAN



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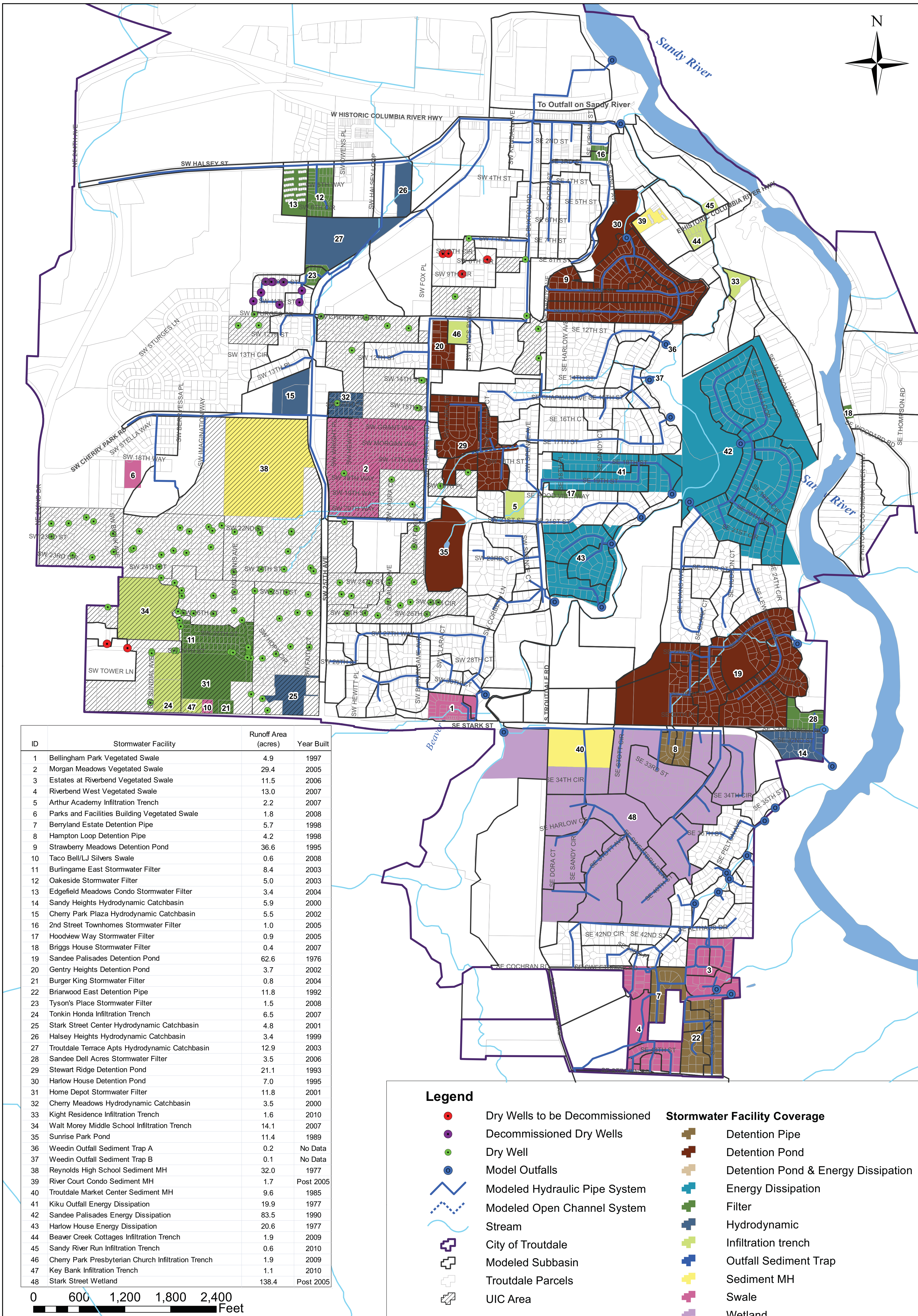
DRAINAGE SYSTEM

FIGURE 2-5

CITY OF TROUTDALE

SOUTH TROUTDALE STORMWATER MASTER PLAN



ID	Stormwater Facility	Runoff Area (acres)	Year Built
1	Bellingham Park Vegetated Swale	4.9	1997
2	Morgan Meadows Vegetated Swale	29.4	2005
3	Estates at Riverbend Vegetated Swale	11.5	2006
4	Riverbend West Vegetated Swale	13.0	2007
5	Arthur Academy Infiltration Trench	2.2	2007
6	Parks and Facilities Building Vegetated Swale	1.8	2008
7	Berryland Estate Detention Pipe	5.7	1998
8	Hampton Loop Detention Pipe	4.2	1998
9	Strawberry Meadows Detention Pond	36.6	1995
10	Taco Bell/LJ Silvers Swale	0.6	2008
11	Burlingame East Stormwater Filter	8.4	2003
12	Oakeside Stormwater Filter	5.0	2003
13	Edgefield Meadows Condo Stormwater Filter	3.4	2004
14	Sandy Heights Hydrodynamic Catchbasin	5.9	2000
15	Cherry Park Plaza Hydrodynamic Catchbasin	5.5	2002
16	2nd Street Townhomes Stormwater Filter	1.0	2005
17	Hoodview Way Stormwater Filter	0.9	2005
18	Briggs House Stormwater Filter	0.4	2007
19	Sandee Palisades Detention Pond	62.6	1976
20	Gentry Heights Detention Pond	3.7	2002
21	Burger King Stormwater Filter	0.8	2004
22	Briarwood East Detention Pipe	11.8	1992
23	Tyson's Place Stormwater Filter	1.5	2008
24	Tonkin Honda Infiltration Trench	6.5	2007
25	Stark Street Center Hydrodynamic Catchbasin	4.8	2001
26	Halsey Heights Hydrodynamic Catchbasin	3.4	1999
27	Troutdale Terrace Apts Hydrodynamic Catchbasin	12.9	2003
28	Sandee Dell Acres Stormwater Filter	3.5	2006
29	Stewart Ridge Detention Pond	21.1	1993
30	Harlow House Detention Pond	7.0	1995
31	Home Depot Stormwater Filter	11.8	2001
32	Cherry Meadows Hydrodynamic Catchbasin	3.5	2000
33	Kight Residence Infiltration Trench	1.6	2010
34	Walt Morey Middle School Infiltration Trench	14.1	2007
35	Sunrise Park Pond	11.4	1989
36	Weedin Outfall Sediment Trap A	0.2	No Data
37	Weedin Outfall Sediment Trap B	0.1	No Data
38	Reynolds High School Sediment MH	32.0	1977
39	River Court Condo Sediment MH	1.7	Post 2005
40	Troutdale Market Center Sediment MH	9.6	1985
41	Kiku Outfall Energy Dissipation	19.9	1977
42	Sandee Palisades Energy Dissipation	83.5	1990
43	Harlow House Energy Dissipation	20.6	1977
44	Beaver Creek Cottages Infiltration Trench	1.9	2009
45	Sandy River Run Infiltration Trench	0.6	2010
46	Cherry Park Presbyterian Church Infiltration Trench	1.9	2009
47	Key Bank Infiltration Trench	1.1	2010
48	Stark Street Wetland	138.4	Post 2005

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EXISTING STORMWATER
FACILITY COVERAGE
FIGURE 2-7

CITY OF TROUTDALE
SOUTH TROUTDALE
STORMWATER MASTER PLAN

Section 3

Storm System Capacity Evaluation

To identify conveyance limitations and opportunities for flood control capital improvements in the public stormwater drainage system, the South Troutdale study area hydrology and hydraulic system capacity was evaluated for both existing and future development scenarios. This section provides a description of evaluation methods and results.

3.1 South Troutdale Study Area

As described in Section 2.1, Troutdale has been divided into north and south study areas for purposes of stormwater master planning. This SDMP evaluates the South Troutdale study area, which drains to the Sandy River either directly or via Beaver Creek. The North Troutdale study area was evaluated in the 2007 North Troutdale Storm Drainage Master Plan and drains to the Columbia River.

The South Troutdale study area is approximately 1,500 acres in size. It includes a majority of land within Troutdale south of Interstate 84, with the exception of locations that discharge to underground injection control or have private stormwater drainage systems that do not discharge to the publically-owned and maintained stormwater conveyance system. Five parcels totaling approximately 100 acres within the South Troutdale study area were evaluated in the 2009 South Troutdale Road Storm Drainage Plan by Tetra Tech. This area is bounded by Beaver Creek to the west, SE Stark Street to the north, South Troutdale Road to the east and SE Strebin Road to the south. Since this area was previously evaluated it was not extensively studied in this SDMP. The South Troutdale Road Storm Drainage Plan is included as Appendix E for reference. Figures 3-1 through 3-4 outline in detail the modeled stormwater drainage system within the South Troutdale study area.

3.2 Hydrology/Hydraulic Model Development

To evaluate the capacity of the South Troutdale stormwater drainage system, a computer model was developed to simulate the hydrologic/hydraulic conditions of the public system. The storm system was evaluated under both existing and anticipated future development conditions. XP Software's XP SWMM v2010 model software was selected to conduct these analyses.

To develop the hydrologic and hydraulic computer model of the existing storm pipe system, a number of input parameters were needed. The information in this section describes the required input parameters and specifies methods for developing the data. The necessary model input parameters and methods are listed below in the following three categories:

- Meteorological (e.g., rainfall, evaporation)
- Subbasin Hydrologic Data (e.g., area, impervious percentage, infiltration parameters)
- Storm Drainage System Hydraulic Data (e.g., pipe size, material, length and invert elevations)

A description of the method or literature reference used to determine the value for each parameter is also provided.

3.2.1 Meteorological Data

This section includes a summary of design storms and evapotranspiration data used as input for the model.

3.2.1.1 Design Storms

SCS rainfall distributions were used to estimate runoff flow and volumes for purposes of this master plan. Design storms were specified and provided by the City of Troutdale (City) and included the water quality, the 2-year, 5-year, 10-year, and 25-year events. The rainfall distribution for those events was based on the 24-hour SCS Type IA distribution applicable to the Pacific Northwest. Precipitation depths associated with the select design storms are consistent with those used in the 2007 North Troutdale Storm Drainage Master Plan and published in the National Oceanic and Atmospheric Administration Atlas 24-hour precipitation depths.

The City of Gresham water quality design storm was also simulated. Based on an evaluation conducted by the City of Gresham, this water quality design storm is estimated to represent 80 percent of the average annual runoff. The Oregon Department of Environmental Quality has been encouraging and/or requiring municipalities to provide this level of treatment. Given the City's proximity to Gresham, this water quality design storm was determined to be applicable.

Table 3-1 lists the precipitation depths for each design storm event used in the model.

Table 3-1. Design Storm Depths

Design storm event	Rainfall depth, inches
Water quality, 24-hour	1.2
2-year, 24-hour	2.7
5-year, 24-hour	3.3
10-year, 24-hour	3.8
25-year, 24-hour	4.1

3.2.1.2 Evapotranspiration

Evapotranspiration data are estimated based on the monthly evapotranspiration data provided by the Oregon State Agricultural Extension for the Willamette Valley. Table 3-2 lists the monthly evapotranspiration rates for the wet season.

Table 3-2. Evapotranspiration Rates

Month	Depth, inches
November	0.47
December	0.71
January	0.71
February	1.13
March	1.54

Since most large storm events are likely to occur in the wet season, the synthetic design storms (identified in Section 3.2.1.1) were assumed to take place in the month of January.

3.2.2 Hydrologic Data

This section includes a summary of subbasin delineations and model input parameters used to define the hydrologic characteristics of the subbasins.

3.2.2.1 Subbasin Delineation

The South Troutdale study area was subdivided into smaller subbasins for modeling purposes. The subbasin boundaries were delineated based on topographic information and the locations of the existing drainage system in the geographic information system (GIS).

As a result of the relatively small diameter pipes included in the hydraulic assessment, the subbasins were delineated to represent relatively small areas contributing to the conveyance system and approximate the actual drainage and discharge patterns of the site. A total of 200 subbasins are reflected in the hydrologic model.

3.2.2.2 Input Parameters

In order for XP-SWMM to generate a stormwater runoff hydrograph from each subbasin, the following parameters were specified for each subbasin:

- Subbasin name or number
- Area of subbasin (acres)
- Width of subbasin (feet)
- Hydraulically connected impervious area (percent)
- Average ground slope (dimensionless, foot per foot)
- Manning's roughness coefficient for impervious areas
- Manning's roughness coefficient for pervious areas
- Depression storage for impervious areas (inches of water over subbasin)
- Depression storage for pervious areas (inches of water over subbasin)
- Green-Ampt soil infiltration parameters: average capillary suction (inches), saturated hydraulic conductivity (inches per hour), and initial moisture deficit (volume air/volume voids)

For each parameter, a discussion is presented below describing the methods that were used to generate the values used in XP-SWMM. For many parameters, GIS was utilized to generate area-weighted average values for each subbasin.

Subbasin Name

Subbasin names were initially developed based on whether the subbasin discharges to the Beaver Creek (BC) or Sandy River (SR) drainage system.

The subbasins were then numbered from downstream to upstream in accordance with the outfall where the subbasin discharges.

Subbasin Area

The subbasin areas were calculated using GIS based on the subbasin delineation.

Subbasin Width

Subbasin width is defined as the physical width of overland flow. The subbasin width was calculated using the area of the subbasin divided by the average maximum distance from the subbasin boundary to the main flow path of the drainage system.

Subbasin Effective Impervious Percentage

Effective impervious percentage is the portion of the impervious area that is directly connected to the drainage collection system. For example, curb-and-gutter streets are directly connected to the drainage collection system and represent “effective impervious area.” However, a sidewalk that is separated from the street by a vegetated strip is not considered to be directly connected since the runoff has the opportunity to infiltrate.

The amount of impervious area in a subbasin differs depending on its land use. The City does not have specific information for effective impervious surface versus average impervious surface by land use. Therefore, average impervious surface was used in the modeling effort. The average impervious surface percentage for each land use category was based on values used in the 1996 South Troutdale Storm Drainage Master Plan and verified with the City. Table 3-3 summarizes the impervious percentage for each land use category and identifies the percentage land use coverage within the South Troutdale study area. For each subbasin, an area weighted impervious percentage was calculated based on the land use coverage.

Table 3-3. Impervious Percentage and Land Use Coverage

Land use	Impervious percentage	Percentage of the current South Troutdale study area	Percentage of the future South Troutdale study area
Open space	5	5.3	5.6
Low density residential	40	49.7	58.7
Medium density residential	60	8.7	11.1
High density residential	70	7.3	9.0
Industrial	80	0	3.0
Commercial	80	4.2	6.6
Urban planning area[1]	40	0.5	3.5
Vacant land	2	23.8	0
Developed Multnomah County land outside of UGB	5	0.5	2.5

[1] Urban Planning Area is area outside of the Troutdale city limits but within the urban growth boundary (UGB). According to the City's 2009 Comprehensive Land Use Plan, the City signed an Urban Planning Area Agreement in 1979 with Multnomah County to coordinate planning and provide certain services for these areas.

Subbasin Slope (units = dimensionless, foot per foot)

The subbasin slope is the average slope along the pathway of overland flow to the inlet of the drainage system. The slope for each subbasin was calculated from the digital topographic information contained in the GIS.

Manning's Roughness Coefficient for Impervious Areas (dimensionless)

Manning's roughness coefficient provides a measure of friction resistance to flow across a surface or channel. The Manning's roughness for impervious surfaces is based on values presented in the SWMM User's Manual. Based on the assumption that most, if not all, of the impervious surfaces are asphalt or concrete, the Manning's roughness coefficient for impervious areas was set equal to 0.014.

Manning's Roughness Coefficient for Pervious Areas (dimensionless)

The Manning's roughness coefficient for pervious surfaces was also based on values presented in the SWMM User's Manual. The Manning's roughness coefficient for impervious areas was set equal to 0.24.

Depression Storage for Impervious Areas (units = inches)

The depression storage is the volume of depression in the land surface that must be filled prior to the occurrence of runoff. Depression storage was set equal to 0.05 inch for all impervious areas based on typical values recommended by the SWMM User's Manual.

Depression Storage for Pervious Areas (units = inches)

The depression storage for pervious areas was based on U.S. Department of Agriculture soil texture classification. Since the predominant soil type in the study area is silt loam, the depression storage was set equal to 0.15 inch (typical for loam). This depression storage was estimated based on values recommended by the SWMM User's Manual.

Green-Ampt Infiltration Parameters (units vary)

The Green-Ampt infiltration method was used to estimate the infiltration losses associated with pervious areas. The Green-Ampt infiltration calculation requires estimation of three infiltration parameters: average capillary suction (inches), saturated hydraulic conductivity (inches per hour), and initial moisture deficit (dimensionless ratio). The values for each of these three infiltration parameters were based on the soil types found in the South Troutdale study area.

Table 3-4 provides the breakdown of the soil types within the South Troutdale study area and provides a summary of assigned Green-Ampt parameters used in the hydrologic model. The values for the Green-Ampt infiltration parameters have been estimated from literature (Rawls, et al., 1983). Based on the values presented in Table 3-4, the area-weighted average values for each parameter in each subbasin were generated using GIS.

Table 3-4. Green-Ampt Infiltration Parameters

Soil texture	Soil name	Percentage of basin	Green-Ampt infiltration parameters		
			Available water capacity[1]	Wetting front soil suction head, inches[2]	Hydraulic conductivity, inches per hour[3]
Loam	Latourell Quaferno Quatama	5.5 2.1 23.2	0.116	3.50	0.13
Silt loam	Aloha Haplumbrepts Multnomah Wapato Wollent Cornelius	17.1 7.4 21.6 0.6 11.9 1.5	0.149	6.57	0.26
Fill, assumed to be silt loam	Was a quarry at the time of survey	1.6	0.149	6.57	0.26
Loamy sand	Dabney	7.4	0.058	2.41	1.18
Sand[4]	Riverwash	0.1	0.038	1.95	4.64

[1] *Available water capacity is the amount of water that a soil can store that is available for use by plants.*

[2] *Wetting front soil suction head is the suction in soil void space due to capillary attraction. This value is large for fine grained soils, such as clay and small for coarse soils such as sand.*

[3] *Hydraulic conductivity is a measure of the rate water moves through the soil.*

[4] *Not shown on map in Figure 2-3.*

3.2.3 Hydraulic Data

This section describes the naming convention used in the model for the conveyance system components. In addition, it describes the model input parameters used to characterize the hydraulic characteristics of the system and describes how the model was validated.

3.2.3.1 Conveyance System Naming Convention

Information on the South Troutdale drainage (conveyance) system was provided in GIS by the City, but no formal naming convention had been adopted. For purposes of this Storm Drainage Master Plan, elements of the stormwater conveyance system including nodes (manholes) and links (pipes or open channel conveyances) were named. Correlation between the node names, the link names, and the subbasin names is important for the model to be usable and for results from the modeling to be interpreted easily.

Nodes (manholes or junctions between open channel segments) were named in accordance with the subbasin where they were located and the relative location (upstream or downstream) within the subbasin. Therefore, as with the subbasins, the node naming convention is based on whether the conveyance system discharges to the Beaver Creek (BC) or Sandy River (SR) drainage system. The naming convention for nodes is as follows: "SubbasinName_XXX" where the XXX refers to a specific node identification number. Node identification numbers are three digits, established based on the relative location of the node along the main conveyance line within the subbasin. Node numbering (per subbasin) begins at the farthest downstream node and extends upstream.

Links (or conduits) between identified nodes were named according to the upstream and downstream node numbers. The naming convention for links is as follows: "UpstreamNode-DownstreamNode."

3.2.3.2 Input Parameters

The primary purpose of the modeling was to conduct a hydraulic analysis of the storm drainage system. The evaluation of the storm drainage system includes a hydraulic analysis of the major roadway crossings and open channels that convey stormwater discharges. The following parameters were required for the open channels and pipes:

- Segment name
- Upstream node number
- Downstream node number
- Length of segment, graphical and measured (feet)
- Invert elevation at upstream node (feet)
- Ground surface elevation at upstream node (feet)
- Invert elevation at downstream node (feet)
- Ground elevation at downstream node (feet)
- Shape, size, and material

The segment name (or conduit name) and the upstream and downstream node number were assigned as explained in Section 3.2.3.1.

Length of Segment

The length of each pipe or open channel segment was provided by the City in GIS. As necessary, lengths were extended or combined with other segments to ensure continuity in the system.

Invert Elevations at Upstream and Downstream Nodes

The upstream and downstream invert elevations for each pipe segment were provided by the City. For open channel segments, the invert elevations were obtained from the digital terrain model, developed from the LIDAR data.

Ground Surface Elevation at Upstream and Downstream Nodes

The ground surface elevation at each node location was necessary to simulate possible surcharging of the drainage system accurately. The elevation of the rim of each manhole was either derived from the LIDAR data or provided by the City.

Conduit Shape

Unless otherwise noted in GIS, each pipe segment was assumed to be circular.

Open channels were either deemed trapezoidal or natural, depending on information in GIS and available as-built information. Typically, as-built information for open channels was referenced when a constructed channel (bioswale) was included in the model for conveyance, and such channel was modeled as a trapezoidal channel. Information (i.e., cross sections) related to natural channels was obtained using LIDAR, as such channels were not constructed channels.

Conduit Size

The diameter for each pipe segment, in inches, was provided by the City. All pipes of diameter 12 inches or greater were included in the model.

As described above for open channels, the size of the open channel was obtained from either as-built information or LIDAR, depending on whether the channel was considered to be trapezoidal or natural.

Conduit Material

In order to assign a Manning's roughness coefficient "n" for each conduit, the pipe material or relative roughness of the open channel segment must be specified. The City provided information on conduit material, and the roughness coefficient was then assigned based on the values listed in Table 3-5.

Table 3-5. Manning Roughness Coefficients

Material	Manning's n
Reinforced concrete pipe	0.013
Corrugated metal pipe	0.024
High-density polyethylene	0.0125
Corrugated polyethylene	0.018
Corrugated steel pipe	0.012
Poly-vinyl chloride	0.010
Ductile iron	0.012
Unknown	0.013
Open channel	0.03

3.2.3.3 Hydraulic Model Validation

Once the XP-SWMM model was developed, based on the hydrologic and hydraulic input parameters described in Sections 3.2.2.2 and 3.2.3.2, a model validation was conducted based on a recent large storm event that resulted in localized flooding within the city. Specific calibration information (measured flow information) was not available for the storm drain system within the South Troutdale study area, so a detailed calibration of the XP-SWMM model was not possible. Existing land use conditions were modeled for the validation exercise.

The model validation storm event occurred on August 29, 2005. The City reported flooding of the manholes in 257th Avenue near the intersection of the Historic Columbia River Highway.

To conduct the model validation, the precipitation record for the model validation storm event was obtained from the Troutdale-Portland Airport gauge. The rainfall depth for the peak hour (from 2 p.m. to 3 p.m.) per the airport gauge was 2.65 inches. For the same time-frame, the Portland International Airport gauge reported significantly less precipitation. The discrepancy between the two airport gauges indicates the localized nature of this storm event.

The model validation storm event (per the obtained precipitation record) was simulated, and widespread system flooding was observed. This may have been due to an intense and very localized event being simulated city-wide. To ensure that the model was not overly conservative (as widespread flooding was not reported for the validation storm event), the 25-year SCS design storm was also simulated. SCS design storms are typically conservative. Very limited system flooding was observed for the 25-year storm event. Results of the two simulations were discussed with the City. Because no additional information was available for conducting the model validation, and results seemed to be reasonable, no adjustments to the model were made.

3.3 Drainage Standards

The City's Public Works Standards, Part V Storm Sewer Collection System, were referenced for general requirements related to stormwater infrastructure. Information such as minimum drainage pipe depths, pipe sizes, pipe drop within a manhole, and system design requirements were referenced. From the Public Works Standards, drainage systems must be sized to accommodate a 25-year storm event in post-development conditions and a 10-year storm event in the pre-development conditions.

3.4 Hydrology/Hydraulic Model Results

Once the XP-SWMM model was developed and validated in accordance with Sections 3.1 and 3.2, the water quality, 2-year, 5-year, 10-year, and 25-year storm events were simulated for current and future development conditions. Results of the hydrologic and hydraulic simulations are tabulated in Appendix A (Tables A-1 and A-2).

3.4.1 Initial Identification of Flooding Problems

Based on the hydraulic model results summarized in Table A-2, conduits experiencing backwater conditions that resulted in the flooding of the upstream manhole were identified. Flooding of the upstream manhole is indicated by the loss of runoff volume in the closed conduit system. For open channel segments, flooding was identified by water overtopping the banks.

Based on model results, a total of ten pipe segments are estimated to experience some degree of flooding in either the existing or future development condition. The smallest design storm event that resulted in flooding was used to identify the capacity deficiency. Modeled flooding problems were generally limited to single conduits within a stormwater pipe network and were located throughout the City (i.e., not limited to certain subbasins within the City). In a majority of cases, the model predicted flooding problems were a result of conservative modeling assumptions described later in this section.

Conduits experiencing flooding are listed in Table 3-6 and shown in Figure 3-5 in accordance with the map identification number. The flooding conduits are also represented in Figures 3-2, 3-3, and 3-4. Each flooding location was reviewed in the XP-SWMM model to evaluate the source of the identified capacity deficiency. Results of the initial review are outlined in Table 3-6 as well.

	Table 3-6. Initial Modeled Flooding Problems						
Map ID[1]	Conduit ID[2]	Diameter, inches	Flooding frequency and scenario	Upstream drainage area, acres	Upstream subbasins	Source of capacity deficiency	Rationale for capacity deficiency
1	BC030_010 - BC020_120	12	5-year existing	31.4	BC030, BC040, BC050, BC060, BC070, BC080	Pipe size	Conduit is located near the confluence of two major pipe networks
2	BC030_020 - BC030_010	12	25-year existing	13.7	BC030, BC040, BC050, BC060	Pipe size	Upstream segment from conduit BC030_010-BC020_120
3	BC200_050 - BC200_040	12	5-year future	11.0	BC200	Conservative modeling assumption	The upstream conduit manhole is the modeled inlet point for flows from the upstream subbasin
4	BC320_030 - BC320_020	12	25-year existing	4.0	BC320	Pipe backslope	GIS indicates a backslope on the pipe. During the draft of this master plan, the City field verified that the backslope is incorrect in the GIS system. However, one segment of main line connects to a catchbasin instead of a manhole, which is resulting in some localized flooding.
5	BC410_050 - BC410_040	12	25-year existing	8.3	BC410	Conservative modeling assumption	The upstream conduit manhole is the modeled inlet point for flows from the upstream subbasin
6	BC570_010 - BC560_020	12	5-year existing	60.9	BC650, BC640, BC630, BC620, BC610, BC600, BC590, BC580, BC570	Pipe size	Conduit is located downstream of a large pipe network
7	BC1030_060 - BC1030_050	12	25-year existing	13.3	BC1030	Conservative modeling assumption	The upstream conduit manhole is the modeled inlet point for flows from the upstream subbasin
8	SR010_120 - SR010_110	18	25-year future	52.7	SR080, SR010	Conservative modeling assumption	Conduit collects a relatively large upstream drainage area. The upstream conduit manhole is the modeled inlet point for flows from the subbasin SR010 (drainage area = 31.5 acres).
9	SR080_010 - SR010_130	15	25-year existing	21.0	SR080	Conservative modeling assumption	The upstream conduit manhole is the modeled inlet point for flows from the upstream subbasin
10	SR270_050 - SR270_040	12	5-year future	17.0	SR270	Conservative modeling assumption	The upstream conduit manhole is the modeled inlet point for flows from the upstream subbasin

[1] *The Map ID refers to the flood control opportunity area portrayed in Figure 3-5.*

[2] *The conduit ID refers to the conveyance system segment experiencing flooding and is referenced in Table A-2.*

In Table 3-6, the source of the capacity deficiency is identified as pipe size, pipe slope, or conservative modeling assumption. For conduits for which pipe size appears to be the cause of the capacity deficiency, a flood control CIP is identified (see Section 5). For the conduit for which negative pipe slope appears to be the cause of the capacity deficiency, the City has since field verified that the pipe has a shallow positive slope. During the field visit the City also observed localized flooding because one segment of main line is connected to a catchbasin instead of a manhole. The City has developed a CIP recommendation to install a curb at the end of the street off of SE 15th to allow for additional capacity for minimal ponding within the street. Due to the timing of the field verification, this CIP has not been hydraulically evaluated by Brown and Caldwell. Finally, for the conduits for which a conservative modeling assumption may be the cause of the modeled flooding, additional review related to the delineation and routing of the upstream subbasins was conducted. The detailed review is summarized in the following text.

The term conservative modeling assumption refers to how the upstream subbasin flows are routed into the conduit in the model. For all conduits for which a conservative model assumption is the potential cause of the capacity deficiency, the upstream manhole of the flooded conduit is also the inlet manhole for the flows for the entire subbasin. As a conservative modeling method, the inlet manhole is typically the most upstream manhole that is modeled in the subbasin. However, specifically for relatively long and narrow subbasins, identifying the most upstream manhole as the inlet manhole may not be consistent with how flows from the subbasin are actually routed into the conveyance system.

As a result, for those conduits for which a conservative model assumption may be the cause of the modeled flooding problem, a further detailed review of the subbasin configuration and the conduit pipe capacity was conducted. The intent of the review was to determine whether flooding would still be expected if the upstream manhole of the identified conduit was not the inlet manhole for the entire subbasin area. Table 3-7 summarizes the results of the detailed review.

Table 3-7. Detailed Review for Select Flooded Conduits									
Map ID[1]	Conduit ID[2]	Conduit diameter	Maximum pipe capacity, cubic feet per second (cfs)	Upstream subbasins draining to conduit	Upstream subbasin inlet manhole ID	Upstream subbasin drainage area, modeled, acres	Estimated percent of upstream subbasin drainage area actually draining through conduit	Revised 25-year, future condition flow estimate based on estimated actual basin area, cfs	Results of revising flow estimates to address issues associated with conservative modeling assumptions
3	BC200_050 - BC200_040	12	2.2	BC200	BC200_050	11.0	10	0.6	Pipe capacity > revised flow estimate (no flooding anticipated)
5	BC410_050 - BC410_040	12	2.4	BC410	BC410_050	8.3	30	1.8	Pipe capacity > revised flow estimate (no flooding anticipated)
7	BC1030_060 - BC1030_050	12	4.9	BC1030	BC1030_060	13.3	30	1.5	Pipe capacity > revised flow estimate (no flooding anticipated)
8	SR010_120 - SR010_110	18	28.1	SR080 SR010	SR010_120 (for subbasin SR010 only)	31.5 (for subbasin SR010 only)	50 (SR010)	27.0	Pipe capacity still estimated as deficient based on revised flow estimate. (flooding anticipated)
9	SR080_010 - SR010_130	15	13.1	SR080	SR080_010	21.0	75	12.9	Pipe capacity still estimated as deficient based on revised flow estimate. (flooding anticipated)
10	SR270_050 - SR270_040	12	4.6	SR270	SR270_050	17.0	25	2.15	Pipe capacity > revised flow estimate (no flooding anticipated)

[1] The map ID refers to the flood control opportunity area portrayed on Figure 3-5.

[2] The conduit ID refers to the conveyance system segment experiencing flooding and is referenced in Table A-2.

3.4.2 Final Identification of Flooding Problems

Table 3-8 summarizes the flood control opportunity areas that were evaluated further in developing an integrated approach to stormwater management and development of capital improvement projects (CIPs) (Section 5). Table 3-8 also groups the individual capacity deficiencies by location, as some of the flooded conduits are located along one pipe segment. A single CIP may resolve the flooding in multiple conduits if the capacity deficiency is the result of a pipe constriction or backwater effects.

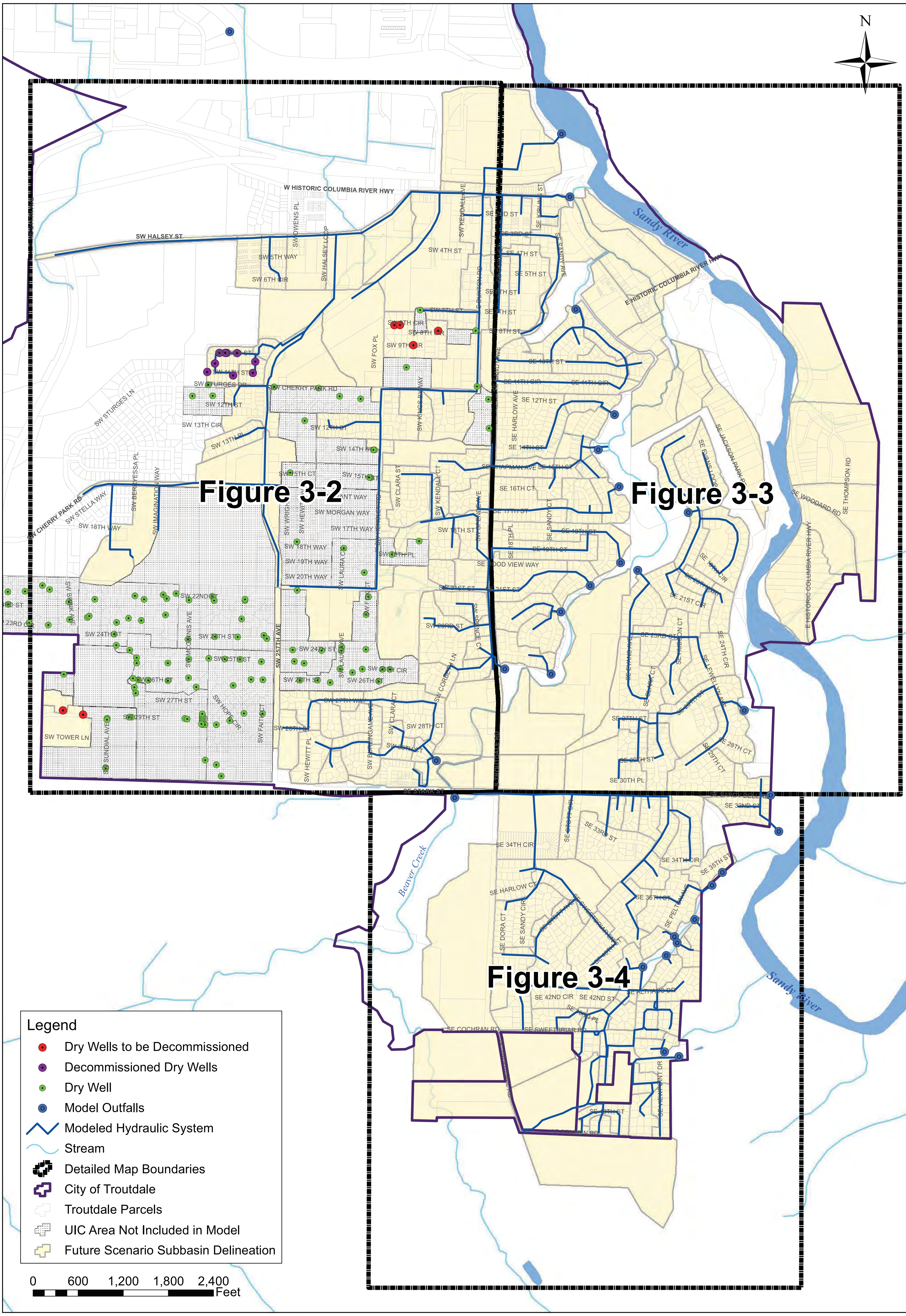
Table 3-8. Summary of Proposed Flood Control CIP Locations

<table>
<tr><th>Map ID[1]</th><th>Conduit ID[2]</th><th>Diameter</th><th>Flooded frequency and scenario</th><th>Flooding volume, cubic feet[3]</th><th>Upstream drainage area, acres</th><th>Upstream subbasins</th><th>CIP development strategy</th></tr>
<tr><td>1</td><td>BC030_010 - BC020_120</td><td>12</td><td>5-year existing</td><td>8,232</td><td>31.4</td><td>BC030, BC040, BC050, BC060, BC070, BC080</td><td rowspan="2">Conduit BC030_010-BC020_120 is directly downstream of conduit BC030_020-BC030_010.
A single integrated (flood control and water quality) facility or selective pipe upsizing would be expected to resolve the capacity deficiency in both conduits.</td></tr>
<tr><td>2</td><td>BC030_020 - BC030_010</td><td>12</td><td>25-year existing</td><td>223</td><td>13.7</td><td>BC030, BC040, BC050, BC060</td></tr>
<tr><td>4</td><td>BC320_030 - BC320_020</td><td>12</td><td>25-year existing</td><td>314</td><td>4.0</td><td>BC320</td><td>Hydraulic modeling attributed this problem to a pipe backslope. During the draft of this master plan, the City field verified that the backslope is incorrect in the GIS system. However, one segment of main line connects to a catchbasin instead of a manhole, which is resulting in some localized flooding. The City has developed a CIP to install approximately 50-ft of curb in the street off of SE15th to provide some storage capacity in the street.</td></tr>
<tr><td>6</td><td>BC570_010 - BC560_020</td><td>12</td><td>5-year existing</td><td>2,123</td><td>60.9</td><td>BC650, BC640, BC630, BC620, BC610, BC600, BC590, BC580, BC570</td><td>A single integrated (flood control and water quality) facility or upsizing of the specific flooded conduit would be expected to resolve the capacity deficiency.</td></tr>
<tr><td>8</td><td>SR010_120 - SR010_110</td><td>18</td><td>25-year future</td><td>1,429</td><td>52.7</td><td>SR080, SR010</td><td rowspan="2">Conduit SR010_120-SR010_110 is directly downstream of conduit SR080_010-SR010_130.
A single integrated (flood control and water quality) facility or selective pipe upsizing would be expected to resolve the capacity deficiency in both conduits.</td></tr>
<tr><td>9</td><td>SR080_010 - SR010_130</td><td>15</td><td>25-year existing</td><td>2,383</td><td>21.0</td><td>SR080</td></tr>
</table>

[1] *The map ID refers to the flood control opportunity area portrayed on Figure 3-5.*

[2] *The conduit ID refers to the conveyance system segment experiencing flooding and is referenced in Table A-2.*

[3] *The flooded volume refers to the modeled estimates volume of runoff that discharges from the conduit during the 25-year future condition model scenario.*

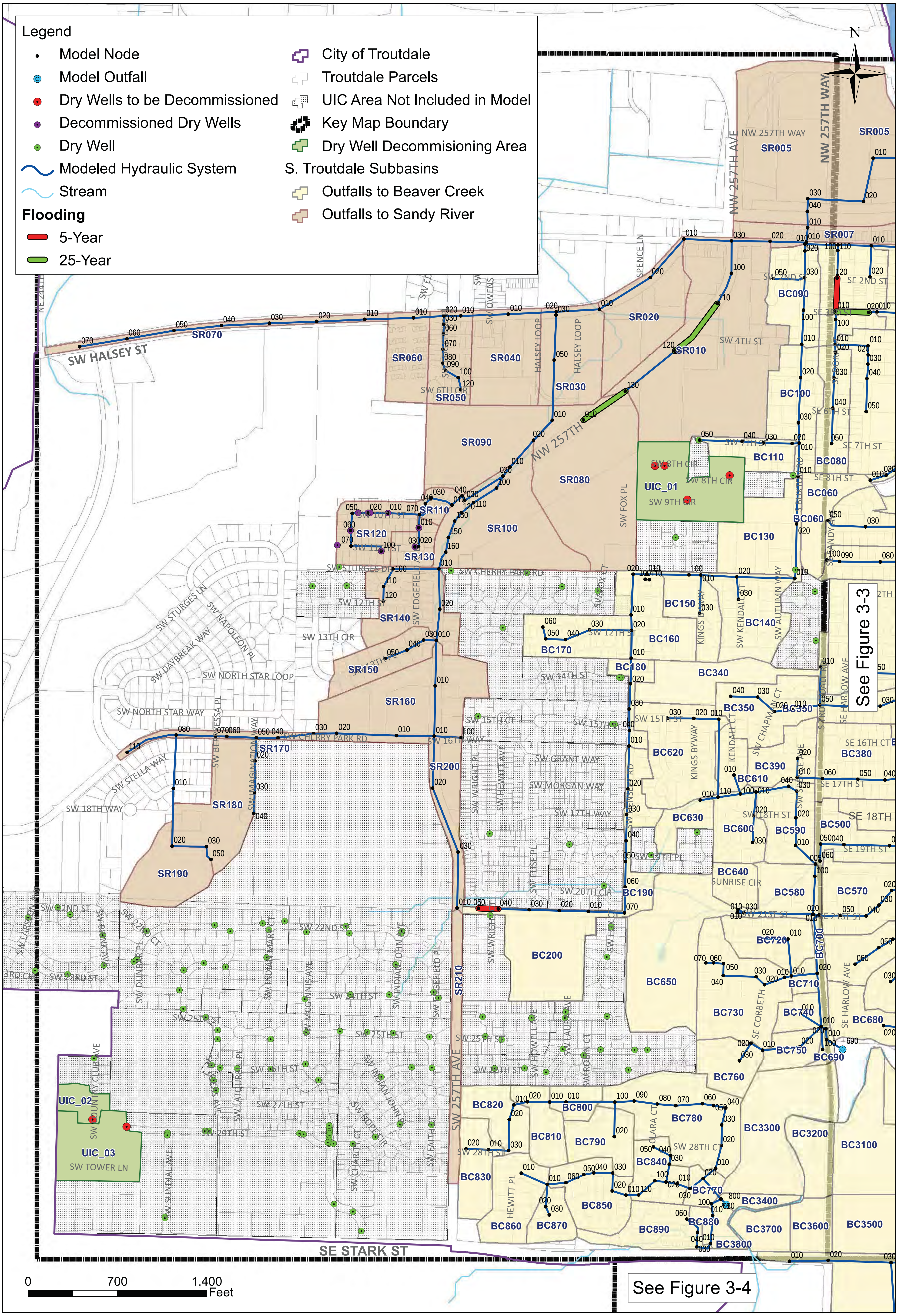


Brown AND Caldwell

DRAINAGE SYSTEM KEY MAP

FIGURE 3-1

CITY OF TROUTDALE
SOUTH TROUTDALE
STORMWATER MASTER PLAN



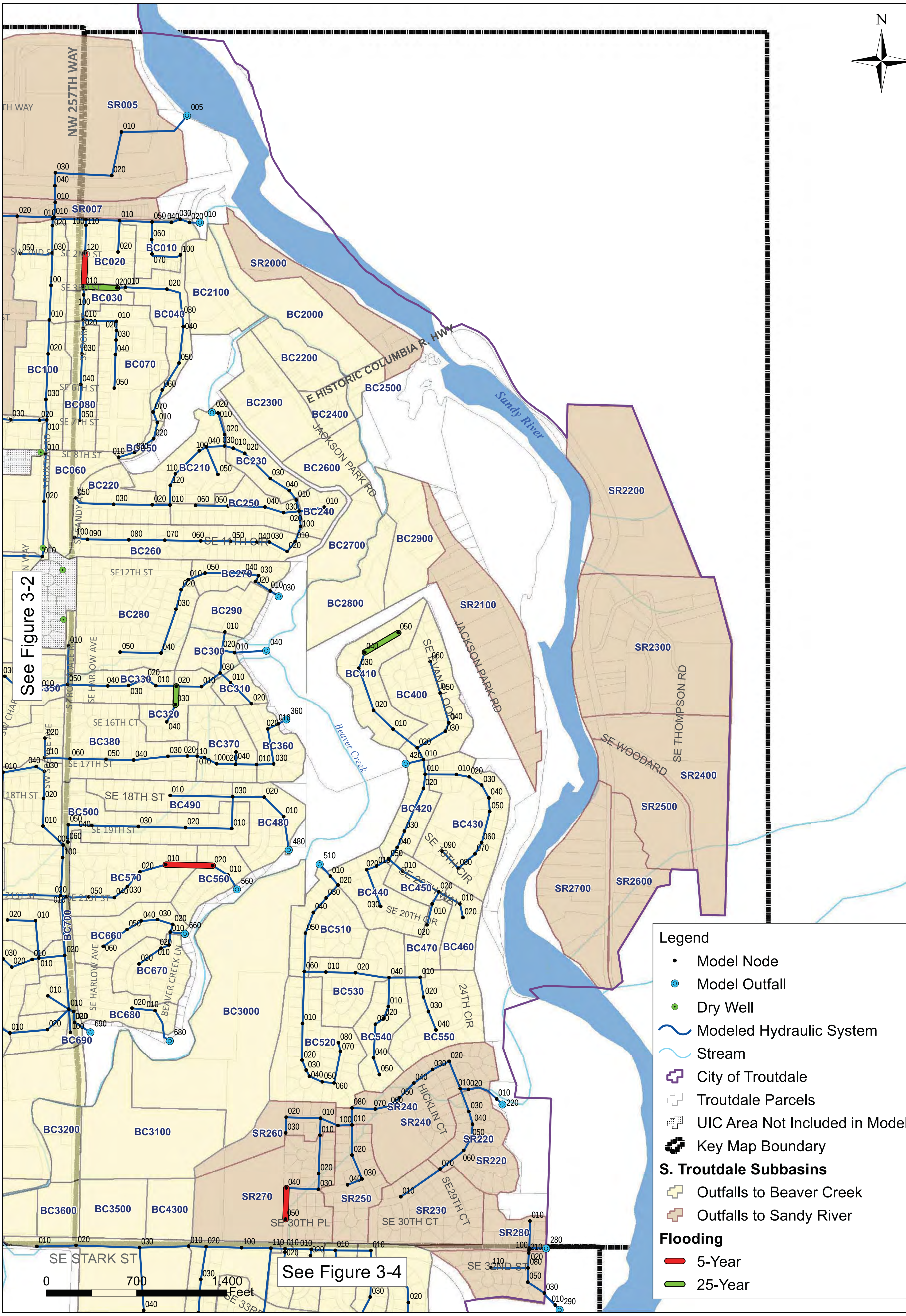
Brown AND Caldwell

NORTHWEST DRAINAGE SYSTEM

FIGURE 3-2

CITY OF TROUTDALE

SOUTH TROUTDALE STORMWATER MASTER PLAN

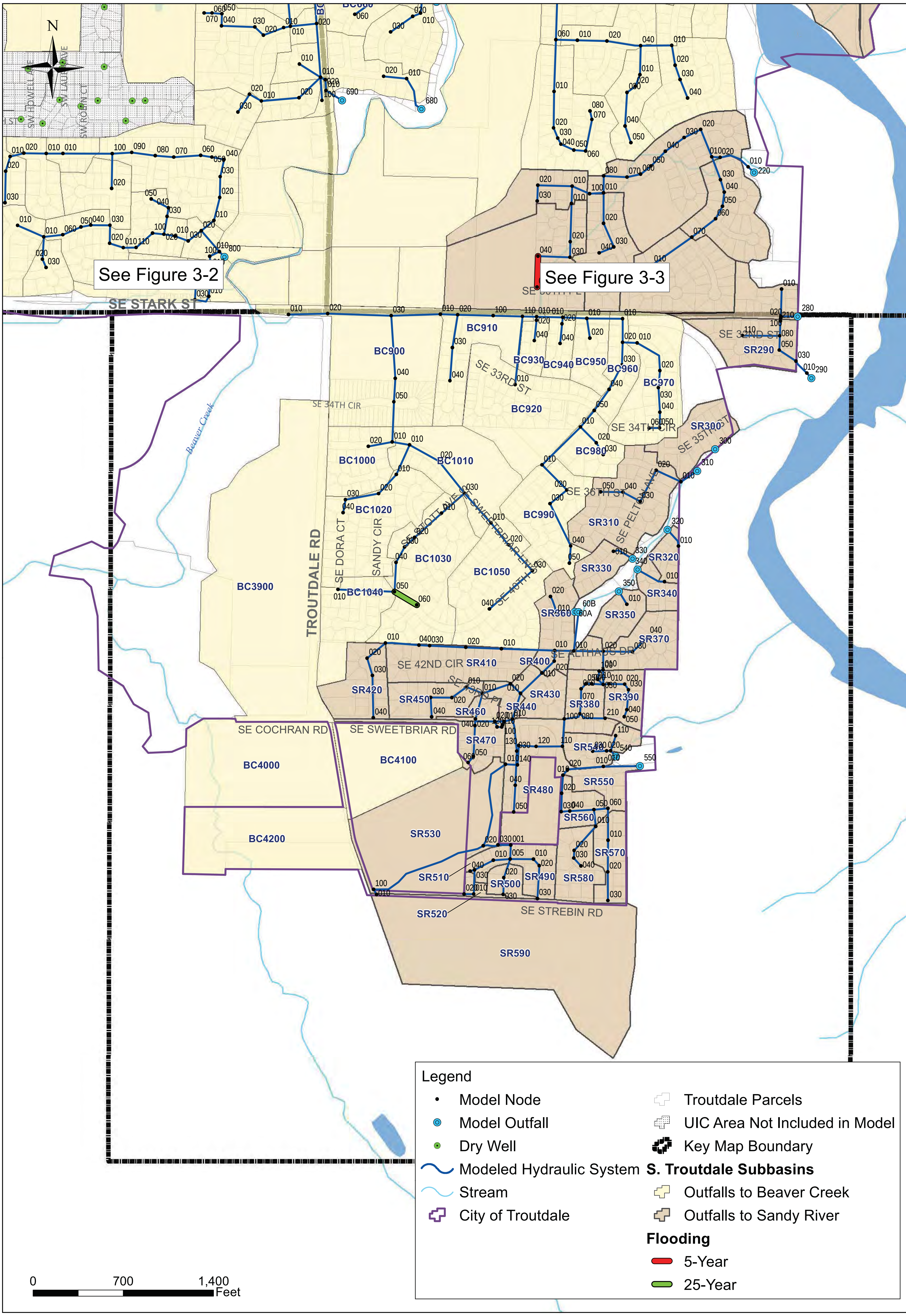


Brown AND Caldwell

NORTHEAST DRAINAGE SYSTEM

FIGURE 3-3

CITY OF TROUTDALE
SOUTH TROUTDALE
STORMWATER MASTER PLAN

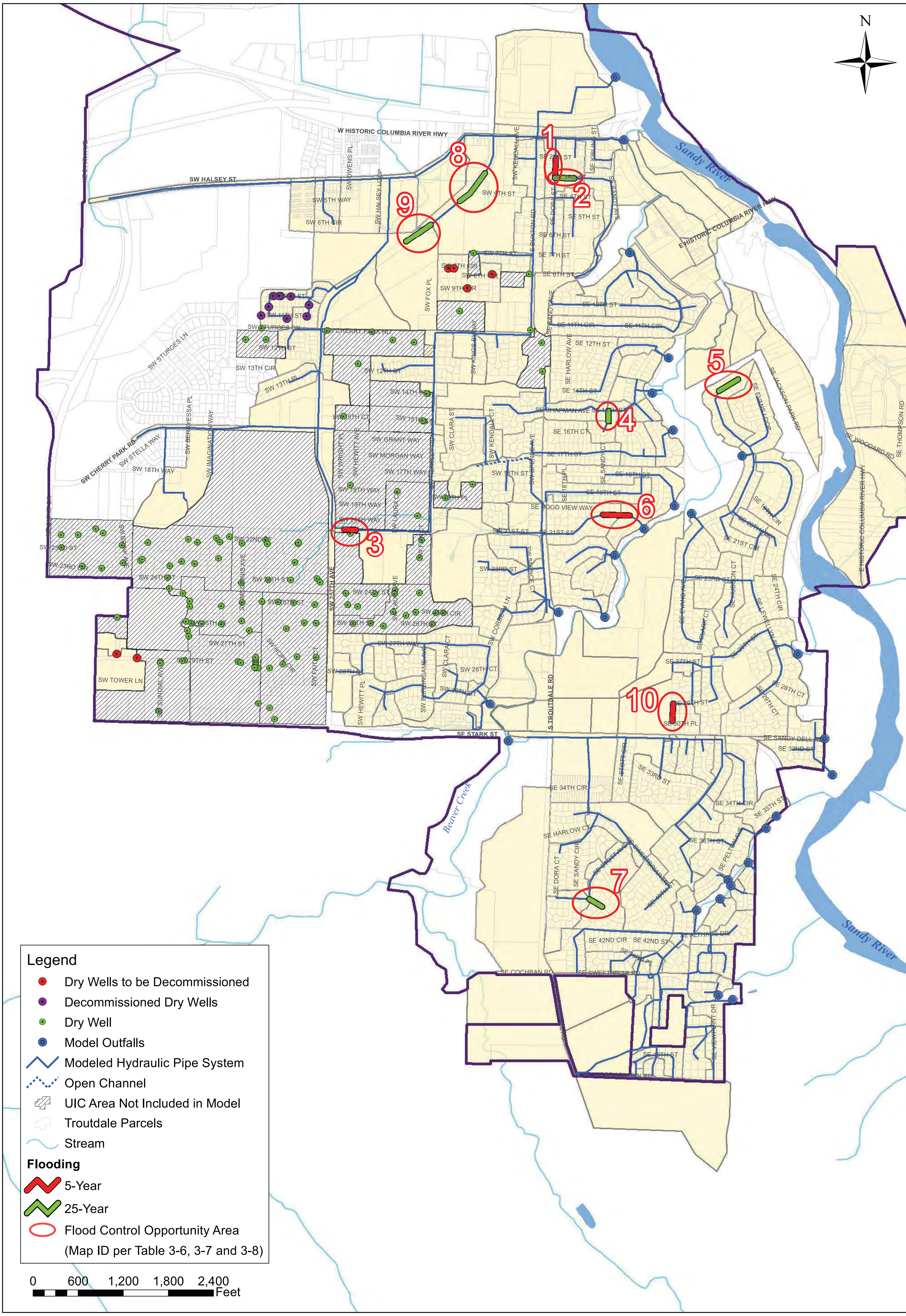


Brown AND Caldwell

SOUTH DRAINAGE SYSTEM

FIGURE 3-4

CITY OF TROUTDALE
SOUTH TROUTDALE
STORMWATER MASTER PLAN



Brown AND Caldwell

FLOOD CONTROL
CIP OPPORTUNITY AREAS

FIGURE 3-5

CITY OF TROUTDALE

SOUTH TROUTDALE
STORMWATER MASTER PLAN

Section 4

Storm System Water Quality Evaluation

The South Troutdale study area was evaluated to identify opportunistic areas for water quality capital improvement projects (CIPs) as part of this Storm Drainage Master Plan. The water quality evaluation was also conducted to help the City of Troutdale (City) develop total maximum daily load (TMDL) pollutant load benchmarks, as required per its Phase II Municipal Separate Storm Sewer System (MS4) National Pollutant Discharge Elimination System (NPDES) permit.

This section describes the methods used and water quality opportunity areas identified as a part of this water quality evaluation. Specific water quality CIPs identified herein have been carried forward and further coordinated with flood control CIPs identified in Section 3, to develop an integrated strategy for the comprehensive provision of stormwater quality and quantity management within the South Troutdale study area.

4.1 Identification of Water Quality Opportunity Areas

The following water quality CIP opportunity areas were identified by first reviewing information from the City's GIS system including aerial photos, the location of existing water quality facilities, existing vacant areas, publically-owned lands, existing and future condition land uses, storm system layout, topography, and drainage areas.

The following steps were conducted to identify the initial opportunity areas for water quality CIPs:

Step 1 Identify Areas with Applicable Regulatory Requirements. As described in Section 2.8, there are six underground injection controls (UICs) proposed to be decommissioned. If the UICs are decommissioned and runoff is routed to the City's stormwater conveyance system, then the drainage area associated with these UICs will require treatment in accordance with new development requirements. These drainage areas were automatically identified as a potential water quality opportunity area.

Step 2 Identify Vacant Lands. A review of existing vacant lands was conducted to identify parcels where space may be available for the siting of a new water quality facility.

Step 3 Review Condition of Vacant Lands. When a vacant land parcel was identified, vegetated conditions were reviewed via aerial photographs. If the site was highly forested, it was not considered to be a priority opportunity, as high quality forested areas should be protected. Topography of vacant sites was reviewed to ensure they were not located on steep slopes unsuitable for the siting of a water quality facility. The Federal Emergency Management Agency's 100-year floodplain delineation was also referenced in order to site facilities outside of an established floodplain.

Step 4 Check the Upstream Drainage Area. If the site appeared to be suitable after Step 3, it was reviewed in terms of its location within the respective storm drainage system. If the site was at the upstream end of the storm system, then only minimal drainage area could be treated by the facility. If the site was located toward the downstream end of the system, it was considered further as a potential treatment site.

Step 5 Review Land Uses of the Upstream Drainage Area. In conjunction with Step 4, the site was reviewed in terms of upstream land uses. Sites with urbanized land uses upstream were further considered as water quality CIP opportunity areas.

Step 6 Check for Existing Water Quality Facilities. If the site was deemed suitable for a water quality facility following Steps 2 through 5, a check was conducted to ensure that an existing water quality facility was not already present at the site. For purposes of the TMDL benchmark evaluation and pollutant load modeling, more benefit is obtained by increasing the coverage of water quality facilities as opposed to having multiple water quality facilities treat the same area.

Step 7 Consider Retrofit Opportunities. In addition to the review conducted in Steps 2 through 6 for the identification of new water quality facilities, existing structural stormwater facilities that were constructed mainly for peak flow control as opposed to water quality were reviewed as a potential retrofit opportunity. Flood control projects were also reviewed for the potential to incorporate water quality benefits.

Once initial opportunity areas were identified, they were reviewed with City staff who further commented on feasibility and practicability of water quality facility installations in the identified area.

The potential water quality CIP opportunity areas and water quality CIP descriptions are summarized in Table 4-1. Figure 4-1 identifies the location of the water quality opportunity areas.

Table 4-1. Summary of Proposed Water Quality CIP Locations

Map ID	Water quality opportunity area description	Upstream contributing land use[1]	Within TMDL benchmark area (Y/N)[2]	Proposed CIP facility type
1	Northern UIC decommissioning area	Low density residential (LDR)	Yes[3]	Linear surface infiltration such as a green street or swale
2	Eastern UIC decommissioning area	Medium density residential (MDR)	No	Swale, rain garden, or green street
3	Sandee Palisades Detention Pond	LDR, MDR and open space (OS)	No	Detention pond retrofit
4	Confluence of Beaver Creek and Sandy River	Commercial, high density residential (HDR), MDR, LDR, OS and vacant	Yes	Stormwater filter retrofit and/or regional stormwater facility
5	Strawberry Meadows/Harlow House Detention Ponds	LDR and OS	Yes	Detention pond retrofit
6	Weedin Park	LDR and OS	Yes	Regional stormwater facility
7	Stuart Ridge Nature Pond	LDR and OS	Yes	Vegetation improvements and flow through retrofit
8	Sweetbriar Park	LDR and OS	Yes	Regional stormwater facility
9	SE Evans Avenue	LDR and vacant	Yes	Green streets
10	SW 21st Avenue	HDR, LDR, vacant	Yes	Green streets

[1] Refer to Figure 2-4 for a description of each land use.

[2] Within the TMDL benchmark area refers to whether the facility location and upstream drainage area are within the Beaver Creek watershed area and were included in the pollutant load modeling effort to establish TMDL pollutant load reduction benchmarks (see Section 4.2).

[3] Decommissioning of UICs results in increased loads to the MS4 permit area. Water Quality CIP implementation would help to offset some of the load generated.

4.2 NPDES/TMDL Benchmarks

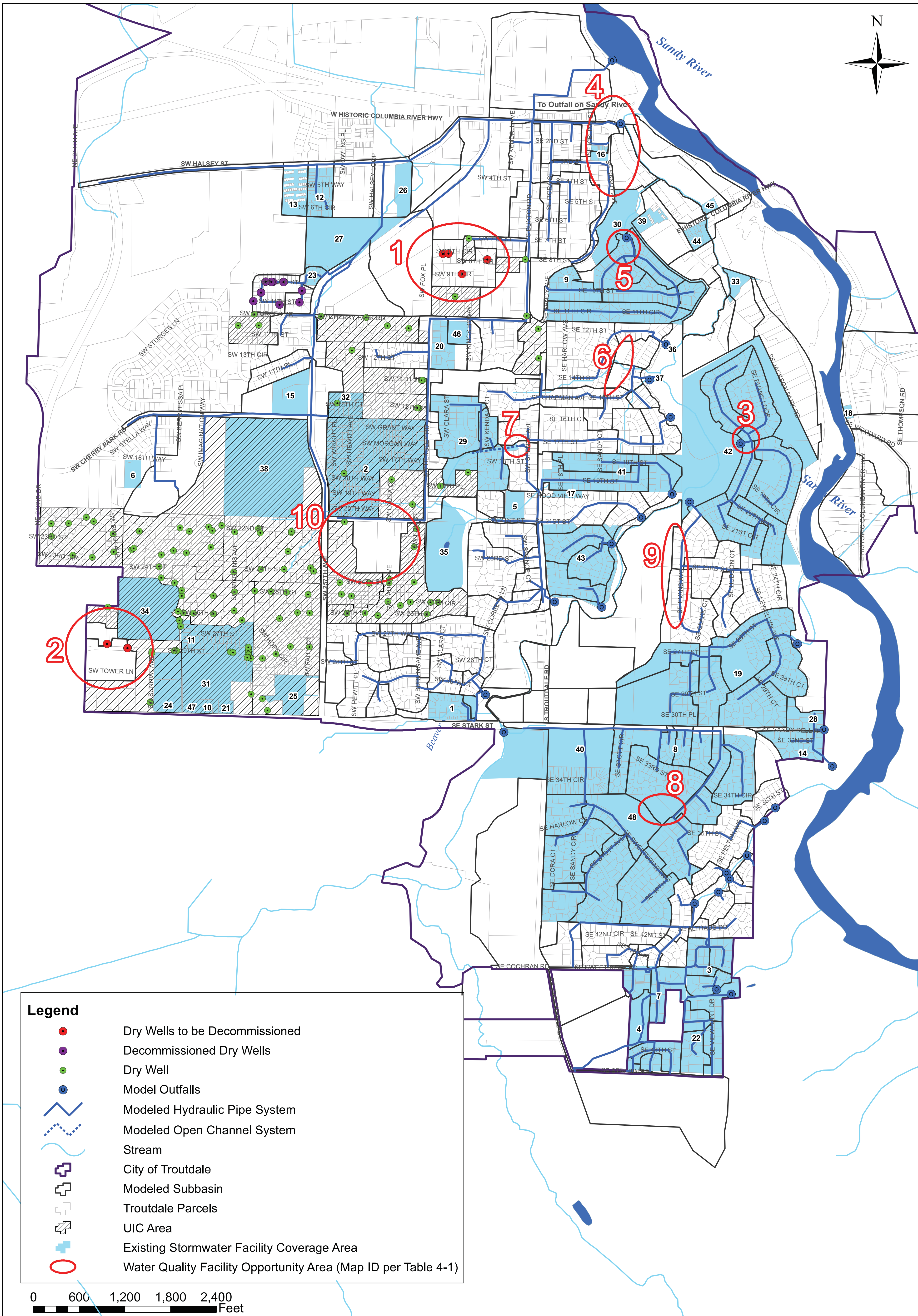
In accordance with its Phase II MS4 NPDES permit, issued May 3, 2007, the City is required to establish pollutant load reduction benchmarks for receiving waters with an established TMDL. A TMDL with waste load allocations (WLAs) for urban stormwater has been established for the Sandy River and tributaries. Thus, the City must address the contribution of applicable TMDL pollutant load(s) as a result of urban stormwater runoff within its permit area. For Troutdale, the development of TMDL pollutant load reduction benchmarks is required to address bacteria loads within Beaver Creek, a tributary to the Sandy River.

Under this contract, TMDL pollutant load reduction benchmarks for the City were developed for Beaver Creek. The report, entitled "Pollutant Load Reduction Benchmarks 2011: Sandy River TMDL," dated October 14, 2011 is included as Appendix B. This section provides a brief summary of that document.

Establishing TMDL pollutant load reduction benchmarks relies on the use of a pollutant loads spreadsheet model, which was prepared for the City. Information related to drainage areas, land uses, rainfall, and structural BMP facility types and drainage areas were input into the model. Two development scenarios were simulated: a 2005 scenario (representative of development conditions when the TMDL became effective) and a 2016 scenario (representative of development conditions at the end of the next permit term). The difference in bacteria loads between these two scenarios represents the City's pollutant load reduction estimates, or TMDL pollutant load reduction benchmarks.

A load reduction over the next permit period is required in order to show progress toward meeting the WLA. In 2005, the City had limited best management practice (BMP) coverage within the TMDL benchmark area. In 2005, BMPs within the TMDL benchmark area covered approximately 6.7 percent of the total drainage area. By 2016, the City expects to increase this to 24.8 percent. The increase in BMP coverage is due to the installation of several water quality facilities since 2005 and the City's commitment to treat vacant lands that are expected to develop between 2005 and 2016. This additional BMP coverage between 2005 and 2016 is anticipated to result in a bacteria load reduction, which will allow the City to meet the TMDL benchmark requirements.

During the next permit period, following 2016, it is anticipated that further load reductions will be required beyond the 24.8 percent reduction, to show continued progress toward meeting the bacteria WLA. Such load reduction will be achieved through implementation of the potential water quality CIP opportunities, described in Section 4.1.



Brown AND Caldwell

WATER QUALITY
CIP OPPORTUNITY AREAS

FIGURE 4-1

CITY OF TROUTDALE
SOUTH TROUTDALE
STORMWATER MASTER PLAN

Section 5

Integrated Management Strategy

This section presents a selected and integrated list of flood control and water quality capital improvement projects (CIPs). As the previous South Troutdale Drainage Master Plan included flood control CIPs that have since been implemented, the need for additional flood control CIPs was found to be minimal. With increasing regulatory requirements focused on water quality, the majority of the CIPs in this plan address water quality.

To summarize the development of the CIPs, Section 5.1 discusses the potential to integrate flood control and water quality objectives; Section 5.2 summarizes the development of unit costs for use in the conceptual CIP development; Section 5.3 summarizes the conceptual CIP sizing and design to address the flood control and water quality opportunity areas; And Section 5.4 summarizes each CIP in narrative and tabular format.

5.1 Integrated CIP Development

In order to integrate development of the flood control and water quality CIPs, the identified pipe capacity deficiencies and water quality opportunity areas were reviewed together to determine whether a water quality facility (to address a specific water quality opportunity area) could be sized, designed, and/or located in such a way to address an identified system capacity deficiency concurrently. For example, the system capacity deficiency located at conduit BC570_010 - BC560_020 (Figure 3-5, Map ID 6) potentially could be alleviated through a retrofit of the Stuart Ridge Nature Pond (Figure 4-1, Map ID 7), as both locations are within the same modeled pipe network.

Section 3 (Table 3-8) summarizes the flooding issues and associated CIP opportunities. A total of six conduit segments have been identified that have flooding as the result of either a pipe capacity issue or a negative pipe slope. Based on the location of the specific flooded conduits, the conduits have been grouped based on the ability of a single CIP strategy to alleviate the flooding.

Section 4 (Table 4-1) summarizes the water quality CIP opportunity areas. A total of ten water quality opportunity areas were identified.

Based on an overlay of the pipe capacity deficiencies with the water quality CIP opportunity areas, three integrated facilities were identified initially for further review. These were evaluated using the developed XP-SWMM hydrologic and hydraulic model. Table 5-1 summarizes the findings.

Table 5-1. Potential Integrated Flood Control and Water Quality CIPs			
Integrated CIP name	Flood control opportunity areas (by map ID, see Figure 3-5)	Water quality CIP opportunity Areas (by map ID, see Figure 4-1)	Proposed integrated CIP description
WQFC_01	Map IDs 8 and 9	N/A	Flooding is anticipated to occur during the 25-year event. No water quality facilities are proposed in Section 4 within contributing subbasins. Implement a low impact development (LID) pilot project in subbasin SR080 (farthest upstream subbasin discharging to flooded conduits) to reduce runoff volume and eliminate the need for costly pipe replacement. The contributing area for this project is comprised mostly of Multnomah County Right-of-Way and private property. Further coordination with these entities is needed before this project can be executed.
WQFC_02	Map IDs 1 and 2	Map ID 4	Relocate water quality opportunity area (Map ID 4) to subbasin BC040 or BC2100 to provide runoff storage and retention for treatment and to alleviate the flooding in downstream conduits.
WQFC_03	Map ID 6	Map ID 7	Retrofit existing Stuart Ridge Detention Pond to provide additional runoff storage and retention for treatment and to alleviate the flooding in the downstream conduit.

For CIPs WQFC_02 and WQFC_03, the XP-SWMM model was used to evaluate whether a sufficient storage volume could be accommodated in the modeled drainage system to alleviate the need to upsize the pipes for the indentified flooded conduits. The model results showed that adequate storage volume could not be accommodated in the system to eliminate the need to upsize the pipes completely. It was determined that the pipe will need to be increased by one incremental size (i.e., pipe diameter of 15 inches to a pipe diameter of 18 inches) to eliminate flooding. Therefore, it is not cost-effective to consider use of an integrated facility because the pipes require upsizing by one incremental size. The identified flooded conduits (per Table 5-1) are located at the downstream end of the stormwater conveyance system, such that upsizing of the conduits does not result in any unanticipated flooding or other impacts to the downstream conveyance systems.

As a result, integrated CIPs WQFC_02 and WQFC_03 are not included in the CIP list at the end of this section. WQFC_01 has been included as an integrated CIP facility. However, if such an integrated pilot project is not deemed to be feasible, an alternative flood control focused CIP has also been developed to address the capacity deficiencies in the conduits associated with WQFC_01.

5.2 Unit Cost Estimates for CIP Development

Unit cost information for construction elements of the CIP facilities was compiled from recent, local planning and design projects in the City of Portland (2010) and City of Eugene (2007). Specific material costs for pipes and structures were confirmed in RS Means Heavy Construction Cost Data (2010).

Preliminary CIP cost estimates are based on the unit cost information for construction elements plus a 30 percent contingency. Permitting, surveying and design, and construction administration costs are based on a general percentage of the total construction cost. Land acquisition costs are not included in the estimates.

The unit cost information is reflected in the individual cost estimates for CIPs and included in Appendix B.

5.3 CIP Sizing and Design

This section includes a summary of the design storms used to develop conceptual CIP sizes.

5.3.1 CIP Sizing Methodology

Flood control CIPs are sized to eliminate modeled system flooding for the peak design storm event (25-year) in the future development condition. Flood control CIPs are limited to pipe upsizing (i.e., no detention facilities have been proposed for flood control).

Water quality CIPs are sized based on a water quality design storm of 1.2 inches over 24 hours. As described in Section 3.2.1.1, the City used a water quality design storm of 1.2 inches in this plan to represent 80 percent of the average annual runoff. Although the City currently references the City of Portland's Stormwater Management Manual for the sizing and design of water quality facilities, this alternative design storm was used to reflect local, reissued Municipal Separate Storm Sewer System National Pollutant Discharge Elimination System permit language and feedback from DEQ that they are moving in the direction of requiring municipalities to provide treatment for 80 percent of the average annual runoff. The 1.2-inch water quality design storm is the established water quality design storm for the City of Gresham and was developed specifically to address the requirement for treatment of 80 percent of the average annual runoff.

CIP design for the integrated (water quality and flood control) CIP facilities, the flood control CIP facility, and the water quality CIP facilities is described in Section 5.3.2. A detailed master planning level cost breakdown for each CIP is included in Appendix B.

5.3.2 CIP Design Methodology

This section includes a summary of methods used to develop master planning level sizes/designs for the integrated, flood control and water quality CIPs

5.3.2.1 Integrated Water Quality and Flood Control CIP

As described in Section 5.1, an integrated water quality/ flood control CIP is proposed to eliminate the flooding identified for conduits SR010_120-SR010_110 and SR080_010-SR010_130 (Figure 3-5, Map IDs 8 and 9). Flooding is predicted to occur in the model for both conduits during a 25-year frequency storm event for future conditions. No water quality facilities are currently located within the contributing subbasins. Therefore, addressing these pipe capacity deficiencies was considered to be an ideal opportunity for implementation of an integrated flood control/water quality pilot project.

For the two flooded conduits, the maximum flooded volume during the simulated 25-year design storm under future development conditions was estimated to be 2,400 cubic feet. Therefore, it is estimated that removal (i.e., infiltration) of 2,400 cubic feet of runoff volume from the piped conveyance system will alleviate system flooding and remove the need to upsize the existing pipes. Such runoff volume reduction may be achieved through the installation of LID facilities in subbasin SR080, upstream of the flooding conduits.

Based on the City of Portland's standard detail for a stormwater planter (Appendix C), which assumes a maximum storage depth of 12 inches in the growing media and additional storage volume in the drain rock layer (assuming 42 percent void space), approximately 1,500 square feet of planter will be necessary to achieve the required volume reduction.

Assuming facility sizing based on the water quality design storm only, and assuming the average imperviousness and soil infiltration characteristics throughout subbasin SR080, 1,500 square feet of planter will address water quality for approximately 1.3 acres of drainage area. Therefore, the integrated CIP (CIP WQFC_01) includes implementation of an LID pilot project for an (approximate) 1.3 acre drainage area.

Given that the conceptual sizing for CIP WQFC_01 is based on the average imperviousness and infiltration characteristics for subbasin SR080, it is recommended that selection of a pilot drainage basin considers the upstream drainage area conditions to ensure that 2,400 cubic feet of runoff volume will be removed from the system. Additionally during design, the XP-SWMM hydraulic model could be used to simulate revised conditions to ensure flooding is fully resolved.

Section 5.4 summarizes the design features of CIP WQFC_01.

5.3.2.2 Flood Control CIPs

A total of four flood control CIPs (FC_01, FC_02, FC_03, and FC_04) are proposed to address the model-predicted pipe capacity deficiencies summarized in Table 3-8. Design of the flood control CIPs required evaluation of the XP-SWMM hydraulic model to upsize the flooded conduits and ensure that the installation of the CIP (i.e., relief of a constriction) did not result in downstream flooding. Revised hydraulic results tables reflecting inclusion of the flood control CIPs are included in Appendix D.

Although an integrated CIP has been proposed to address flood control opportunity areas Map IDs 8 and 9, a flood control CIP is also proposed to address these areas if the integrated strategy is determined to be infeasible.

5.3.2.3 Water Quality CIPs

Although water quality CIPs were sized in accordance with the City of Gresham design storm, design of the facilities is based on standard details from the City of Portland Stormwater Management Manual. Standard details that were referenced for the design of water quality CIPs are included in Appendix C.

A total of ten water quality CIPs (WQ_01 to WQ_10) are proposed to address the water quality CIPs opportunity areas identified in Table 4-1. Proposed water quality CIPs include the following:

1. planter boxes (constructed as part of a green street/LID pilot project application)
2. vegetated infiltration facilities (either rain gardens or water quality retention pond facilities, depending on the amount of storage volume required and surface area available)
3. detention pond retrofits, sized to include a specified storage volume consistent with the water quality runoff volume

The methods used to design the different types of facilities conceptually are described below.

Planter Boxes

Planter boxes (associated with green streets and LID pilot projects) were sized and designed using the City of Portland standard detail SW-312, which assumes a maximum storage depth of 12 inches. Using the average (or area weighted average) imperviousness and soil infiltration rate for the contributing subbasins, a planter footprint area was calculated on a unit acre basis. As LID facilities for water quality likely will be installed on an opportunistic basis, CIP cost estimates on a unit acre basis will provide the City with the flexibility to install the facilities where space is available.

With the exception of CIP WQ_01a and CIP WQ_02, planter boxes were sized exclusively to address the water quality design storm. Therefore, an overflow or other piped collection and conveyance system will need to be installed in conjunction with the planter facilities to allow for bypass of storm events that exceed the water quality design storm. These bypass flows will be discharged into the existing conveyance system. For CIP WQ_01 (a and b) and WQ_02, the contributing subbasins contain underground injection controls (UICs) that require decommissioning. Decommissioning of existing UICs results in rerouting of all flows from UICs to the downstream stormwater conveyance system, potentially constraining these systems. Therefore, the planter facilities associated with CIP WQ_01a and CIP WQ_02 were sized to infiltrate up to the 10-year storm event under future development conditions to address both conveyance and water quality. For comparison purposes, CIP WQ-01b was sized for the water quality storm and includes installation of 350 linear feet of pipe necessary to convey the facility overflow to the nearest conveyance system.

Vegetated Infiltration Facilities

Vegetated infiltration facilities are proposed as regional water quality facilities and can be designed either as rain gardens or water quality retention ponds. Rain garden applications are ideal for the retention of smaller runoff volumes if sufficient surface area is available, as the ponding depth is typically less than that for a pond application. Water quality retention ponds can accommodate a greater storage volume and depth. Both facilities require the addition of drain rock and engineered growing medium at the facility bottom to provide treatment via filtration and infiltration. Water quality retention ponds may be designed for detention of larger storm events as well, but for purposes of the water quality CIP design, flood control was not considered in the sizing of vegetated infiltration facilities.

The vegetated infiltration facility sizing was based on the storage of the cumulative water quality runoff volume for contributing upstream subbasins under future development conditions. Depending on the available surface area estimated at each water quality opportunity area, the conceptual water quality CIP was specified as either a rain garden or water quality retention pond. The facility footprint area and depth is estimated based on storage of the entire water quality runoff volume and a 3:1 (horizontal:vertical) facility sideslope.

City of Portland standard detail SW-140 for a water quality retention pond (basin) was used in facility sizing. Sizing is based on an additional 18 inches of engineered soil and 18 inches of drain rock at the bottom of the vegetated infiltration facility footprint. Vegetated infiltration facilities are intended to be offline facilities that bypass storm events exceeding the water quality design storm; therefore a bypass manhole and an outlet control structure are included in the cost estimate for each vegetated infiltration facility.

The conceptual sizing of the vegetated infiltration facilities included conservative assumptions. The sizing assumed storage of the entire water quality runoff volume, but did not take into account routing of the volume into and out of the facility.

Detention Pond Retrofit

Three detention pond retrofits are proposed as water quality CIPs, in order to provide infiltration and treatment from contributing upstream subbasins. Detention pond retrofits are opportunistic and therefore are not designed to accommodate (store) the entire calculated water quality runoff volume as are the vegetated infiltration facilities. For purposes of developing water quality CIPs and cost estimates, retrofit of existing detention ponds requires 36 inches of excavation and fill (drain rock and engineered soil) to be installed at the bottom of the pond to provide treatment and infiltration of runoff. The maximum storage capacity calculated for each pond retrofit is less than the contributing water quality runoff volume (Table 5-2); therefore collection and treatment of the entire water quality runoff volume may not be achieved.

The existing detention ponds considered for retrofit and their associated outlet structures do not appear to be sized to accommodate water quality or flow control (based on as-built information). Therefore, the City may consider additional water quality or flow control objectives when pursuing detailed design of the retrofits. Cost estimates for the detention pond retrofits assume modifications to the existing outlet control structure to maximize retention of runoff volume.

Two of the three detention ponds (Sandee Palisades and Stuart Ridge Detention Pond) are included in the existing XP-SWMM hydraulic model. The Strawberry Meadows Detention Pond was not included in the XP-SWMM model due to the limited information available for the combined Strawberry Meadows and Harlow House detention systems.

5.4 CIP Summary

The following CIP narratives describe the proposed integrated, flood control, and water quality CIPs. A summary of the design features and assumptions is also provided in Table 5-2 for each CIP. See Figure 5-1 for the location of each of these CIPs. Appendix B includes the detailed cost breakdown used to estimate CIP costs.

5.4.1 Integrated CIP Facility Summary

CIP Number	WQFC_01: Integrated CIP – SW 257th Avenue
Objective addressed	Flood Control - Pipe Capacity Deficiency and Water Quality Opportunity Area (Map IDs 8 and 9)
CIP description	Development of an LID pilot project within subbasin SR080 to remove 2,400 cubic feet of runoff volume from the stormwater collection system for 25-year event under future conditions. Preliminary estimates indicate that the pilot drainage basin will need to be approximately 1.3 acres. This area is adjacent to steep slopes. Infiltration facilities must be located at a minimum of 300 feet from steep slopes.
CIP size (per cost estimate)	A lump sum of $50,000 was included in the CIP to reflect identification of an ideal pilot project location and preliminary design of the proposed LID facilities.
Estimated planning cost	$50,000. Detailed cost spreadsheet is not included in Appendix B for this CIP.

5.4.2 Flood Control CIP Facility Summary

CIP Number	FC_01: Pipe Size Increase – SE 3rd Street and SE Dora Street
Objective addressed	Flood Control – Pipe Capacity Deficiency (Map IDs 1 and 2)
CIP description	Upsize conduit BC020_120-BC020_110 and BC030_010-BC020_120 from a 12-inch to a 15-inch-diameter pipe to alleviate flooding up through the 25-year design storm under future development conditions.
CIP size (per cost estimate)	453 feet of 15-inch high-density polyethylene (HDPE)
Estimated total project cost	$130,100. Does not include costs for utility relocation.

CIP Number	FC_02: Pipe Slope – SE Chapman Street and SE 15th Street
Objective addressed	Flood Control – Pipe Capacity Deficiency (Map ID 4)
CIP description	Based on geographic information system data received from the City, there is a negative slope on conduit BC320_030 - BC320_020. This negative slope results in model estimated flooding during the 25-year storm event. During the draft of this master plan, the City field verified that the backslope is incorrect in the GIS system. However, a separate capacity issue was identified during the visit. One segment of main line connects to a catchbasin instead of a manhole, which is resulting in some localized flooding. The City has developed a CIP to install approximately 50 ft of curb in the street off of SE15th to provide some storage capacity in the street
CIP size (per cost estimate)	A lump sum of $2,500 was provided by the City as an estimate for the installation of 50 feet of new curb.
Estimated total project cost	$2,500. Detailed cost spreadsheet is not included in Appendix B for this CIP.

CIP Number	FC_03: Pipe Size Increase – SE 21st Street
Objective addressed	Flood Control – Pipe Capacity Deficiency (Map ID #6)
CIP description	Upsize conduit BC570_010-BC560_020 from a 12-inch to a 15-inch diameter pipe in order to alleviate flooding up through the 25-year design storm under future development conditions.
CIP size (per cost estimate)	364 feet of 15-inch HDPE
Estimated total project cost	$106,100. Does not include costs for utility relocation.

CIP Number	FC_04: Pipe Size Increase SW 257th
Objective addressed	Flood Control – Pipe Capacity Deficiency (Map IDs 8 and 9)
CIP description	This facility is only required if WQFC_01 is deemed infeasible. Upsize existing piped stormwater system on NW 257th Avenue from manhole SR080_010 to manhole SR010_100. Upsize existing 15-inch-diameter conduits would to 18 inches and existing 18–inch-diameter conduits to 24 inches to alleviate flooding up to a 25-year design storm under future development conditions.
CIP size (per cost estimate)	900 feet of 18-inch HDPE and 753 feet of 24-inch HDPE
Estimated total project cost	$522,700. Does not include costs for utility relocation.

5.4.3 Water Quality CIP Facility Summary

CIP Number	WQ_01a: Rain Garden Pilot Project – SW 8th and 9th Circle
Objective addressed	Water Quality - Opportunity Area (Map ID 1)
CIP description	Stormwater planters implemented as a part of a green street or LID pilot project. Subbasin UIC_01 contains four UICs that are required for decommissioning. Therefore, planter sizing is based on surface infiltration of up to the 10-year design storm under future development conditions. Based on average infiltration and imperviousness in the subbasin, 2,320 square feet of planter per unit acre of drainage area is required or a total of 23,664 square feet throughout the 10.2 acre subbasin UIC_01. This area is adjacent to steep slopes. Infiltration facilities should be located at a minimum of 300 feet from steep slopes.
CIP size (per cost estimate)	23,664 square feet of stormwater planter including curbing and engineered fill.
Estimated total project cost	$717,500. Cost estimate does not include land acquisition or storm system pipe modifications to collect and convey runoff to the facilities.

CIP Number	WQ_01b: Rain Garden Pilot Project – SW 8th and 9th Circle
Objective addressed	Water Quality - Opportunity Area (Map ID 1)
CIP description	Stormwater planters implemented as a part of a green street or LID pilot project. Subbasin UIC_01 contains four UICs that are required for decommissioning. As opposed to CIP WQ_01a, this alternative is based on planter sizing for surface infiltration of the water quality storm under future development conditions. Flows in excess of the water quality storm would be piped to the closest storm system on SW 7th St. Based on average infiltration and imperviousness in the subbasin, 733 square feet of planter per unit acre of drainage area is required or a total of 7,477 square feet throughout the 10.2 acre subbasin UIC_01. This area is adjacent to steep slopes. Infiltration facilities should be located at a minimum of 300 feet from steep slopes.
CIP size (per cost estimate)	7,477 square feet of stormwater planter including curbing and engineered fill, and 300 linear feet of 12” HDPE.
Estimated total project cost	$293,400. Cost estimate does not include land acquisition or storm system pipe modifications to collect and convey runoff to the facilities. It does include a conveyance pipe to carry flows above the water quality storm to the conveyance system on SW 7th. Note: capacity of the downstream pipe system has not been validated through modeling and would need to be reviewed prior to design.

CIP Number	WQ_02: Rain Garden Pilot Project – SW 29th and SW Tower Lane
Objective addressed	Water Quality - Opportunity Area (Map ID 2)
CIP description	Stormwater planters implemented as a part of a green street or LID pilot project. Subbasins UIC_02 and UIC_03 each contain one UIC that is required for decommissioning. Planter sizing is based on surface infiltration of up to the 10-year design storm under future development conditions. Based on average infiltration and imperviousness in the subbasin, 3,921 square feet of planter per unit acre of drainage area is required for a total of 37,642 square feet throughout the 9.6 acre drainage area.
CIP size (per cost estimate)	37,642 square feet of stormwater planter including curbing and engineered fill.
Estimated total project cost	$1,099,500. Cost estimate does not include land acquisition or piping modifications to collect and convey runoff to the facilities.

CIP Number	WQ_03: Sandee Palisades Detention Pond Retrofit – SE Evans Avenue and SE Evans Loop
Objective addressed	Water Quality - Opportunity Area (Map ID 3)
CIP description	Retrofit of the existing Sandee Palisades Detention Pond. The existing pond contains a 12-inch outlet (that does not appear to provide any water quality or flow control benefit) and a 51.5 acre drainage area. Amend the bottom of the pond with drain rock and engineered soil and vegetation to enhance existing pond treatment capabilities. Due to the proximity of steep slopes to the existing Sandee Palisades detention pond, a geotechnical evaluation is recommended prior to this project.
CIP size (per cost estimate)	Retrofit of the existing detention pond includes the excavation of 3 feet from the pond bottom and the addition of 18-inch drain rock and 18-inch engineered fill. Total excavation and fill volume estimate is 11,505 cubic feet.
Estimated total project cost	$153,800. Cost estimate does not include piping modifications to collect and convey runoff to and from the facility.

CIP Number	WQ_04: Vegetated Infiltration Facility – Historic Columbia River Highway
Objective addressed	Water Quality - Opportunity Area (Map ID 4)
CIP description	Installation of an off-line vegetated infiltration facility at the downstream end of the stormwater conveyance system discharging to outfall BC010_100. Runoff may be diverted at manhole BC010_050. The contributing water quality runoff volume is 6.018 acre-feet (or 262,128 cubic feet) from the 112.8 acre drainage area. Amend the bottom of the pond with drain rock and engineered soil and vegetation to enhance pond treatment capabilities. This area is adjacent to steep slopes. Space infiltration facilities at least 300 feet from steep slopes.
CIP size (per cost estimate)	1.4-acre vegetated infiltration facility with a maximum depth of 5.1 feet, a 1- acre bottom area, and 3:1 sideslopes.
Estimated total project cost	$1,539,300. Cost estimate does not include land acquisition or piping modifications to collect and convey runoff to the facility.

CIP Number	WQ_05: Strawberry Meadows Detention Pond Retrofit – North of Beavercreek Lane
Objective addressed	Water Quality - Opportunity Area (Map ID 5)
CIP description	Retrofit of the existing Strawberry Meadows Detention Pond. The existing pond drains a 36.6 acre area and contains an outlet structure that does not appear to provide any water quality benefit. Amend the bottom of the pond with drain rock and engineered soil and vegetation to enhance existing pond treatment capabilities. Due to the proximity of steep slopes to the existing Strawberry Meadows detention pond, a geotechnical evaluation is recommended prior to this project.
CIP size (per cost estimate)	Retrofit of the existing detention pond includes the excavation of 3 feet from the pond bottom and the addition of 18-inch drain rock and 18-inch engineered fill. Total excavation and fill volume estimate is 1,764 cubic feet.
Estimated total project cost	$85,100. Cost estimate does not include piping modifications to collect and convey runoff to and from the facility or geotechnical investigation

CIP Number	WQ_06: Vegetated Infiltration – Weedin City Park/SE Chapman Street
Objective addressed	Water Quality - Opportunity Area (Map ID 6)
CIP description	Installation of an off-line vegetated infiltration facility (rain garden) at Weedin Park. Runoff may be diverted at manhole BC320_010. The contributing water quality runoff volume is 0.71 acre-feet (or 30817 cubic feet) from a 23.3 acre drainage area. Amend the bottom of the pond with drain rock and engineered soil and vegetation to enhance pond treatment capabilities.
CIP size (per cost estimate)	0.32-acre vegetated infiltration facility with a maximum depth of 3 feet, a 6,900-square foot bottom area, and 3:1 sideslopes.
Estimated total project cost	$297,100. Cost estimate does not include land acquisition or piping modifications to collect and convey runoff to the facilities.

CIP Number	WQ_07: Stuart Ridge Detention Pond Retrofit – SW Spence Avenue and SW 17th Street
Objective addressed	Water Quality - Opportunity Area (Map ID 7)
CIP description	Retrofit of the existing Stuart Ridge Detention Pond. The existing pond drains a 20.7 acre area and contains an outlet structure that does not appear to provide any water quality benefit. Amend the bottom of the pond with drain rock and engineered soil and vegetation to enhance existing pond treatment capabilities.
CIP size (per cost estimate)	Retrofit of the existing detention pond includes the excavation of 3 feet from the pond bottom and the addition of 18-inch drain rock and 18-inch engineered fill. Total excavation and fill volume estimate is 620 cubic feet.
Estimated total project cost	$60,500. Cost estimate does not include piping modifications to collect and convey runoff to and from the facility.

CIP Number	WQ_08: Vegetated Infiltration Facility - Sweetbriar Park/SE Evans Avenue and SE 36th Street
Objective addressed	Water Quality - Opportunity Area (Map ID 8)
CIP description	Installation of an off-line vegetated infiltration facility (rain garden) at Sweetbriar Park. Runoff may be diverted at manhole BC990_010. The contributing water quality runoff volume is 0.30 acre-feet (or 12,831 cubic feet) from a drainage area of 8.6 acres. Amend the bottom of the pond with drain rock and engineered soil and vegetation to enhance pond treatment capabilities.
CIP size (per cost estimate)	0.14-acre vegetated infiltration facility with a maximum depth of 3 feet, a 2,800-square foot bottom area, and 3:1 sideslopes.
Estimated total project cost	$145,400. Cost estimate does not include land acquisition or piping modifications to collect and convey runoff to the facility.

CIP Number	WQ_09: Rain Garden Pilot Project – SE Evans Street and SE 23rd Street
Objective addressed	Water Quality - Opportunity Area (Map ID 9)
CIP description	Stormwater planters implemented as a part of a green street or LID pilot project along SE Evans Street. Facility location can either be within the right-of-way or rerouted behind lots within vegetated corridor associated with subbasin BC3000. Planter sizing is based on surface infiltration of the water quality design storm under future development conditions. Based on average infiltration and imperviousness in the subbasin, 729 square feet of planter per unit acre of drainage area is required. The basin subbasin drains 40.9 acres.
CIP size (per cost estimate)	13,924 square feet of stormwater planter including curbing and engineered fill.
Estimated total project cost	$373,700. Cost estimate does not include land acquisition or piping modifications to collect and convey runoff to the facilities.

CIP Number	WQ_10 Rain Garden Pilot Project – SW Hensley Road/SW 21st Avenue
Objective addressed	Water Quality - Opportunity Area (Map ID 10)
CIP description	Stormwater planters implemented as a part of a green street or LID pilot project along SW 21st Avenue. Facility location can either be within the right-of-way or located within existing vacant area. Planter sizing is based on surface infiltration of the water quality design storm under future development conditions. Based on average infiltration and imperviousness in the subbasin, 586 square feet of planter per unit acre of drainage area is required. The subbasin drains 11 acres.
CIP size (per cost estimate)	6,446 square feet of stormwater planter including curbing and engineered fill.
Estimated total project cost	$184,200. Cost estimate does not include land acquisition or piping modifications to collect and convey runoff to the facilities.

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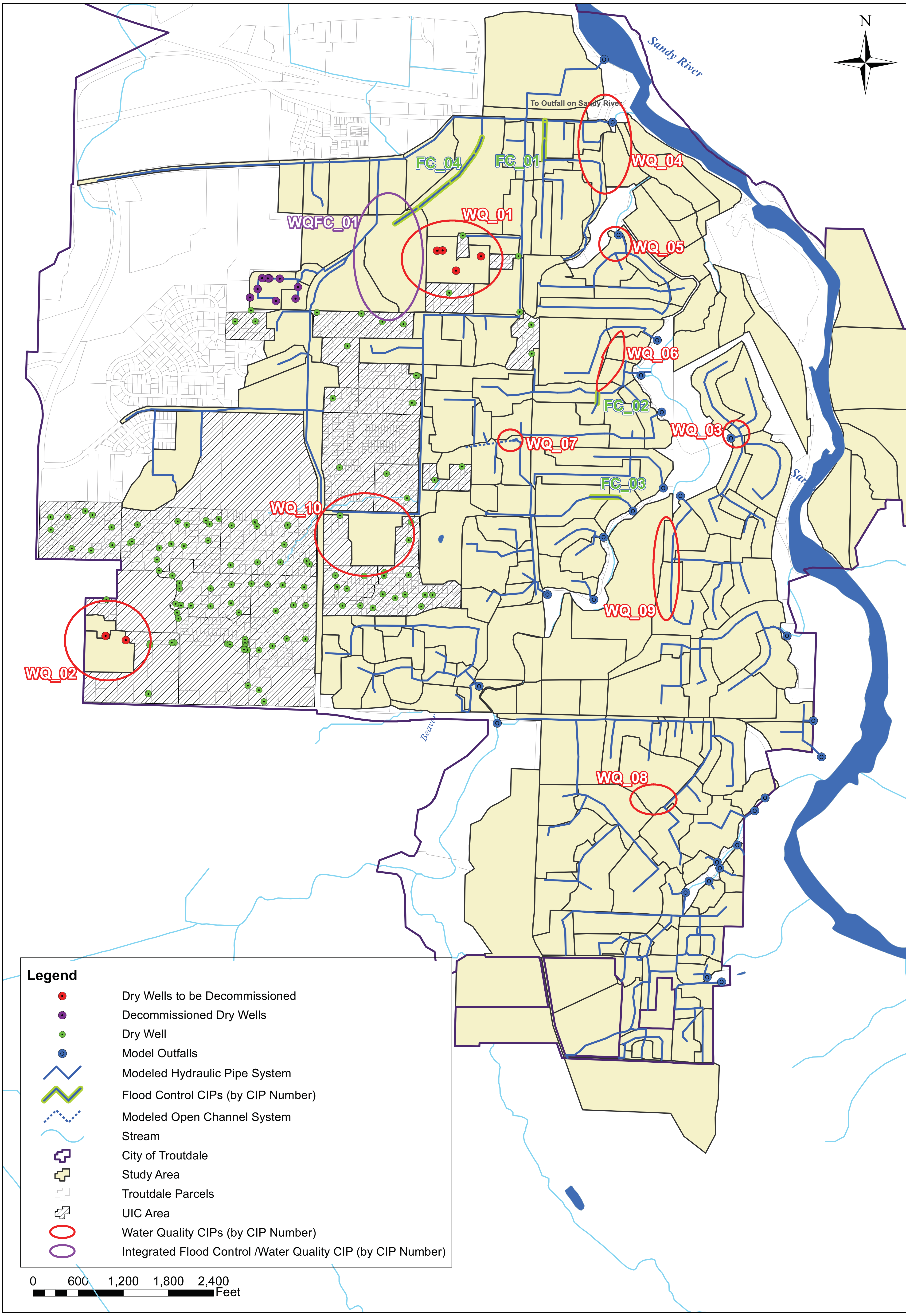
Table 5-2. South Troutdale CIP Summary

CIP Number	CIP Type	CIP Name	CIP location	CIP description	Opportunity areas addressed by the CIP		Contributing Area Characteristics					CIP Design Characteristics				CIP Description		
					Flood control (by Map ID per Figure 3-5)	Water quality (by Map ID per Figure 4-1)	Subbasin(s)	Total drainage area, acres	Existing land use	Average impervious percentage	Average hydraulic conductivity, inches per hour	Design storm	Max existing flooding volume to address, cf	Max existing facility storage volume (estimated), cf	Water quality runoff volume	Pipe size, inches	Total pipe length, feet	Water quality facility size
*WQFC_01	Integrated Flood Control and Water Quality	Rain Garden Pilot Project (Alternative CIP is FC_04)	Subbasin SR080	LID pilot project within subbasin SR080 to remove 2,400 cubic feet of runoff volume from the stormwater collection system	#8 and #9	N/A	SR080	21.2	MDR, HDR, vacant	60.8	0.22	water quality	2,400	N/A	N/A	N/A	N/A	1,500 sf of stormwater planter. Treatment facility size is associated with a 1.3 acre drainage area.
FC_01	Flood Control	Pipe Size Increase - SE 3rd St. and SE Dora St.	Conduits BC020_120-BC020_110 and BC030_010-BC020_120 along S Buxton Road	Upsize downstream conduits to alleviate existing system flooding on (12-inch) conduits BC030_010-BC020_120 and BC030_020-BC030_010	#1 and #2	N/A	BC030, BC040, BC050, BC060, BC070, BC080	31.3	COM, HDR, LDR, MDR	61.3	0.22	25-year	8,231	N/A	N/A	15	453	N/A
FC_02	Flood Control	Pipe Slope - SE Chapman St. and SE 15th St.	Stub street curb installation between SE 15th Street and SE 16th Ct.	The City has developed a CIP to install approximately 50-ft of curb in the stub street off of SE15th to provide some storage capacity in the street.	#4	N/A	BC320	4.4	LDR	40.0	0.18	25-year	314	N/A	N/A	N/A	N/A	N/A
FC_03	Flood Control	Pipe Upsizing on SE 21st Street	Conduit BC570_010-BC560_020 along SE 21st St	Upsize existing (12-inch)conduit to alleviate flooding	#6	N/A	BC650, BC640, BC630, BC620, BC610, BC600, BC590, BC580, BC570	60.9	LDR, OS	29.2	0.25	25-year	2,123	N/A	N/A	15	364	N/A
*FC_04	Flood Control	Pipe Upsizing on SW 257th Ave (Alternative CIP is WQFC_01)	Conduits SR010_110-SR010_100, SR010_120-SR010_110, SR010_130-SR010_120, and SR080_010-SR010_130 along NW 257th Ave	In lieu of CIP WQFC_01, upsize drain/age system on SW 257th to alleviate existing system flooding on (15-inch) conduit SR080_010-SR010_130 and (18") conduit SR010_120-SR010_110	#8 and #9	N/A	SR080, SR010	52.7	COM, HDR, MDR, vacant	56.5	0.15	25-year	2,383	N/A	N/A	18 and 24	900 18-inch 753 24-inch	N/A
*WQ_01a	Water Quality	Rain Garden Pilot Project - SW 8th and 9th Circle (Alternative CIP is WQ_01b)	Subbasin UIC_01	Stormwater planters implemented as a part of a green street or LID pilot project (sized for the 10_year storm)	N/A	#1	UIC_01	10.2	LDR	40.0	0.26	10-year	N/A	N/A	N/A	N/A	N/A	23,664-sf stormwater planter
*WQ_01b	Water Quality	Rain Garden Pilot Project - SW 8th and 9th Circle (Alternative CIP is WQ_01a)	Subbasin UIC_01	Stormwater planters implemented as a part of a green street or LID pilot project (sized for the water quality storm)	N/A	#1	UIC_01	10.2	LDR	40.0	0.26	water quality	N/A	N/A	N/A	12	350	7,477-sf stormwater planter
WQ_02	Water Quality	Rain Garden Pilot Project - SW 29th and SW Tower Lane	Subbasin UIC_03	Stormwater planters implemented as a part of a green street or LID pilot project	N/A	#2	UIC_02 and UIC_03	9.6	MDR	60.0	0.14	10-year	N/A	N/A	N/A	N/A	N/A	37,642-sf stormwater planter
WQ_03	Water Quality	Sandee Palisades Detention Pond Retrofit	Subbasin SR220	Retrofit of the existing Sandee Palisades Detention Pond to accommodate water quality	N/A	#3	SR220, SR230, SR240, SR250, SR260, SR270	62.8	LDR, OS, MDR	40.4	0.75	N/A	N/A	46,000	2.4 ac-ft (104,740 cf)	N/A	N/A	Excavate and add 11,505 cubic feet of drain rock and engineered fill

Table 5-2. South Troutdale CIP Summary

CIP Number	CIP Type	CIP Name	CIP location	CIP description	Opportunity areas addressed by the CIP		Contributing Area Characteristics					CIP Design Characteristics				CIP Description		
					Flood control (by Map ID per Figure 3-5)	Water quality (by Map ID per Figure 4-1)	Subbasin(s)	Total drainage area, acres	Existing land use	Average impervious percentage	Average hydraulic conductivity, inches per hour	Design storm	Max existing flooding volume to address, cf	Max existing facility storage volume (estimated), cf	Water quality runoff volume	Pipe size, inches	Total pipe length, feet	Water quality facility size
																		(vegetation)
WQ_04	Water Quality	Vegetated Infiltration Facility - Historic Columbia River Highway (Outfall BC010)	Subbasin SR007	Vegetated infiltration facility to address water quality for largely developed subbasins	N/A	#4	BC010, BC020, BC030, BC040, BC050, BC060, BC070, BC080, BC090, BC100, BC110, BC130, BC140, BC150, BC160, BC170, BC180, BC190, BC200	112.8	LDR, MDR, HDR, vacant, COM, OS	56.3	0.32	water quality	N/A	N/A	6.018 ac-ft (262,128 cf)	N/A	N/A	1.4-acre vegetated infiltration facility
WQ_05	Water Quality	Strawberry Meadows Detention Pond Retrofit	Subbasin BC210	Retrofit of the existing Strawberry Meadows Detention Pond to accommodate water quality	N/A	#5	BC210, BC220, BC230, BC240, BC250, BC260	36.6	LDR, OS	39.7	0.84	N/A	N/A	35,000	1.379 ac-ft (60,074 cf)	N/A	N/A	Excavate and add 2,880 cf of drain rock and engineered fill (vegetation)
WQ_06	Water Quality	Vegetated Infiltration Facility - Weedin Park	Subbasin BC300	Vegetated infiltration facility to address water quality for largely developed subbasins	N/A	#6	BC320, BC330, BC340, BC350	24.3	LDR, OS	30.7	0.20	water quality	N/A	N/A	0.71 ac-ft (30,817 cf)	N/A	N/A	0.32 acre vegetated infiltration facility
WQ_07	Water Quality	Stuart Ridge Detention Pond Retrofit	Subbasin BC590	Retrofit of the existing Stuart Ridge Detention Pond to accommodate water quality	N/A	#7	BC600, BC610, BC620, BC630	20.7	LDR, OS	35.1	0.26	N/A	N/A	5,300	0.69 ac-ft (29,983 cf)	N/A	N/A	Excavate and add 620 cf of drain rock and engineered fill (vegetation)
WQ_08	Water Quality	Vegetated Infiltration Facility - Sweetbriar Park	Subbasin BC920	Vegetated infiltration facility to address water quality for largely developed subbasins	N/A	#8	BC990	8.6	LDR, OS	36.1	0.26	water quality	N/A	N/A	0.30 ac-ft (12,831 cf)	N/A	N/A	0.14-acre vegetated infiltration facility
WQ_09	Water Quality	Rain Garden Pilot Project - SE Evans St. and SE 23rd St.	Subbasins BC510 and BC 520	Stormwater planters implemented as a part of a green street or LID pilot project	N/A	#9	BC510, BC520, BC530, BC540, BC550	40.9	LDR, vacant	39.9	0.26	water quality	N/A	N/A	N/A	N/A	N/A	729-sf stormwater planter per unit acre drainage area
WQ_10	Water Quality	Rain Garden Pilot Project - SW Hensley Rd.	Subbasin BC200	Stormwater planters implemented as a part of a green street or LID pilot project.	N/A	#10	BC200	11.0	HDR, LDR, vacant	58.8	1.17	water quality	N/A	N/A	N/A	N/A	N/A	586-sf stormwater planter per unit acre drainage area

** = These CIPs are presented as one of two alternatives to address the same issue. Only one of the two would ultimately be selected and implemented.*



Brown AND Caldwell

CIP SUMMARY

FIGURE 5-1

CITY OF TROUTDALE

SOUTH TROUTDALE
STORMWATER MASTER PLAN

Section 6

CIP Implementation Priorities

This section summarizes the integrated, flood control, and water quality capital improvement projects (CIPs) and priorities developed as part of the South Troutdale Storm Drainage Master Plan. Flood control and water quality CIPs typically address different objectives, and prioritization of CIPs to implement can depend on multiple factors including effectiveness, cost, safety, regulations, and maintenance requirements. Table 6-1 summarizes identified CIPs and is followed by a description of the City's priorities for CIP implementation.

Table 6-1. CIP Summary

CIP number	CIP type	CIP name	Estimated CIP project cost, dollars	Estimated CIP maintenance cost, dollars (annual)[3]
WQFC_01[1]	Integrated Flood Control/Water Quality	LID Pilot Project	50,000	N/A
FC_01	Flood Control	Pipe Upsizing on S Buxton Road	130,100	N/A
FC_02	Flood Control	Curb Installation	2,500	N/A
FC_03	Flood Control	Pipe Upsizing on SE 21st Street	106,100	N/A
FC_04[1]	Flood Control	Pipe Upsizing on NW 257th Avenue	522,700	N/A
WQ_01a[2]	Water Quality	Stormwater Planter for Northern UIC Decommissioning	717,500	13,000
WQ_1b[2]	Water Quality	Stormwater Planter for Northern UIC Decommissioning	293,400	5,100
WQ_02	Water Quality	Stormwater Planter for Western UIC Decommissioning	1,099,500	20,400
WQ_03	Water Quality	Sandee Palisades Detention Pond Retrofit	153,800	4,600
WQ_04	Water Quality	Vegetated Infiltration Facility (retention pond) at Outfall BC010	1,539,300	44,800
WQ_05	Water Quality	Strawberry Meadows Detention Pond Retrofit	85,100	1,600
WQ_06	Water Quality	Vegetated Infiltration Facility (rain garden) at Weedin Park	297,100	7,300
WQ_07	Water Quality	Stuart Ridge Detention Pond Retrofit	60,500	500
WQ_08	Water Quality	Vegetated Infiltration Facility (rain garden) at Sweetbriar Park	145,400	3,300

Table 6-1. CIP Summary

CIP number	CIP type	CIP name	Estimated CIP project cost, dollars	Estimated CIP maintenance cost, dollars (annual)[3]
WQ_09	Water Quality	Stormwater Planters (Green Streets) at SE Evans Avenue	373,700	7,700
WQ_10	Water Quality	Stormwater Planters (Green Streets) at SW 21st Avenue	184,200	3,900

[1] CIP WQFC_01 and CIP FC_04 address the same flood control opportunity area. If WQFC_01 is deemed in feasible, FC_04 may be considered. However, both CIPs would not need to be implemented.

[2] CIP WQ_01a and CIP WQ_01b address the same water quality issue. If WQ_01b is feasible from a downstream pipe capacity standpoint, then WQ_01a would not need to be implemented.

[3] Maintenance costs assume sediment removal and other activities that may only be conducted as needed (i.e., every five to ten years). Therefore, these costs are conservative as they reflect the maximum maintenance cost that would be anticipated in one year.

Because both flood control and water quality CIPs are proposed as part of this master plan, general CIP prioritization factors have been identified. The City will evaluate individual CIPs based on their ability the address the following factors. Within this prioritization structure the City will evaluate cost of all CIPs prior to implementation.

1. Alleviate Flooding Issues: CIPs that remove or eliminate a drainage problem that is anticipated to occur under existing development conditions are a high priority.
2. Compliance with State Law: CIPs that include the decommissioning of non-rule authorized UICs so that a water pollution control facility permit will not be needed are a high priority. Based on current draft UIC permit templates and UIC rules, UICs located within the 2-year time of travel of a drinking water source are illegal and must be decommissioned. These facilities will be prioritized over other water quality facilities.
3. Provides Water Quality Benefits: Water quality CIPs that provide bacteria removal in a TMDL Benchmark Area will be prioritized above water quality CIPs in non-TMDL areas.
4. Facility Retrofit: Retrofit of existing facilities will be prioritized over the installation of new facilities.
5. Facility Ownership: Facilities owned and operated by the City will be prioritized over projects that rely on other parties. Projects relying on other parties can be more complex to manage, especially if they involve securing funding or land from other parties.

Appendix A: Hydrologic and Hydraulic Results Tables

Table A-1: Major Hydrologic Input Data and Results

Sub-basin Name	Inlet Node	Sub-basin Area (acres)	Impervious Area (%)			Average Sub-basin Slope (ft/ft)	Green-Ampt Infiltration Parameters			Existing Sub-basin Peak Flows (cfs)					Future Sub-basin Peak Flows (cfs)				
			Existing Land Use	Future Land Use	Increase (%)		Initial Moisture Deficit	Average Capilary Suction (in)	Saturated Hydraulic Conductivity (in/hr)	WQ Storm Peak Flow (cfs)	2 yr 24 hr Peak Flow (cfs)	5 yr 24 hr Peak Flow (cfs)	10yr 24hr Peak Flow (cfs)	25yr 24hr Peak Flow (cfs)	WQ Storm Peak Flow (cfs)	2 yr 24 hr Peak Flow (cfs)	5 yr 24 hr Peak Flow (cfs)	10yr 24hr Peak Flow (cfs)	25yr 24hr Peak Flow (cfs)
BEAVER CREEK																			
Outfall BC010																			
BC010	BC010_100	4.0	79.4	79.6	0.2%	0.180	0.12	3.89	0.15	0.9	2.1	2.7	3.3	3.7	0.9	2.1	2.7	3.3	3.7
BC020	BC020_020	6.4	77.8	77.8	0.0%	0.165	0.12	3.50	0.13	1.4	3.2	4.4	5.4	6.0	1.4	3.2	4.4	5.4	6.0
BC030	BC030_010	2.2	64.2	67.2	3.0%	0.194	0.12	3.50	0.13	0.4	0.9	1.3	1.7	2.0	0.4	1.0	1.4	1.8	2.0
BC040	BC040_020	5.9	65.9	66.0	0.1%	0.139	0.13	4.92	0.19	1.1	2.5	3.1	3.9	4.4	1.1	2.6	3.1	3.9	4.4
BC050	BC050_010	0.7	53.3	53.3	0.0%	0.039	0.15	6.69	0.26	0.1	0.2	0.3	0.3	0.4	0.1	0.2	0.3	0.3	0.4
BC060	BC060_010	4.9	59.1	59.1	0.0%	0.005	0.15	6.69	0.26	0.8	1.9	2.3	2.7	2.9	0.8	1.9	2.3	2.7	2.9
BC070	BC070_050	12.1	59.5	60.0	0.5%	0.053	0.14	6.05	0.23	2.1	4.7	5.8	6.6	7.2	2.1	4.7	5.8	6.7	7.2
BC080	BC080_050	5.6	58.8	60.0	1.2%	0.046	0.14	5.69	0.22	0.9	2.1	2.6	3.0	3.3	1.0	2.2	2.7	3.1	3.4
BC090	BC090_050	6.5	59.0	76.6	17.6%	0.072	0.12	3.50	0.13	1.1	2.5	3.4	4.4	5.2	1.4	3.2	4.2	5.2	5.9
BC100	BC100_020	7.5	57.5	60.0	2.5%	0.101	0.14	6.21	0.24	1.2	2.8	3.4	4.0	4.3	1.3	2.9	3.6	4.1	4.5
BC110	BC110_050	3.5	39.8	40.8	1.0%	0.016	0.15	6.69	0.26	0.4	0.9	1.1	1.3	1.4	0.4	0.9	1.1	1.3	1.4
BC130	BC130_020	8.7	34.7	51.3	16.6%	0.058	0.15	6.69	0.26	0.9	2.0	2.4	2.8	3.0	1.3	2.9	3.6	4.1	4.4
BC140	BC140_030	8.2	36.6	36.6	0.0%	0.012	0.15	6.69	0.26	0.9	1.9	2.4	2.7	3.0	0.9	1.9	2.4	2.7	3.0
BC150	BC150_030	4.8	36.2	36.2	0.0%	0.011	0.15	6.69	0.26	0.5	1.1	1.4	1.6	1.7	0.5	1.1	1.4	1.6	1.7
BC160	BC160_020	7.1	38.0	38.7	0.7%	0.003	0.15	6.50	0.25	0.7	1.7	2.1	2.4	2.6	0.7	1.7	2.1	2.5	2.7
BC170	BC170_060	6.5	60.0	60.0	0.0%	0.019	0.15	6.67	0.26	1.1	2.5	3.1	3.6	3.8	1.1	2.5	3.1	3.6	3.8
BC180	BC180_020	2.2	38.0	39.9	1.9%	0.004	0.15	6.69	0.26	0.2	0.5	0.7	0.8	0.8	0.2	0.6	0.7	0.8	0.9
BC190	BC190_020	5.1	38.9	38.9	0.0%	0.008	0.15	6.69	0.26	0.6	1.3	1.6	1.8	2.0	0.6	1.3	1.6	1.8	2.0
BC200	BC200_050	11.0	41.2	58.8	17.6%	0.007	0.06	2.46	1.17	1.3	2.9	3.6	4.1	4.5	1.8	4.1	5.1	5.9	6.3
Outfall BC020																			
BC210	BC210_050	7.7	37.7	37.7	0.0%	0.078	0.12	5.21	0.58	0.8	1.9	2.3	2.7	2.9	0.8	1.9	2.3	2.7	2.9
BC220	BC220_050	5.6	40.9	40.9	0.0%	0.049	0.06	2.40	1.18	0.7	1.5	1.8	2.1	2.3	0.7	1.5	1.8	2.1	2.3
BC230	BC230_020	4.4	40.0	40.0	0.0%	0.012	0.10	4.16	0.80	0.5	1.2	1.4	1.6	1.8	0.5	1.2	1.4	1.6	1.8
BC240	BC240_010	2.3	40.0	40.0	0.0%	0.060	0.06	2.40	1.18	0.3	0.6	0.7	0.9	0.9	0.3	0.6	0.7	0.9	0.9
BC250	BC250_060	5.5	40.0	40.0	0.0%	0.051	0.06	2.40	1.18	0.6	1.4	1.8	2.0	2.2	0.6	1.4	1.8	2.0	2.2
BC260	BC260_100	11.0	40.2	40.2	0.0%	0.026	0.11	5.06	0.61	1.3	2.9	3.5	4.0	4.4	1.3	2.9	3.5	4.0	4.4
Outfall BC030																			
BC270	BC270_040	3.6	39.9	39.9	0.0%	0.021	0.13	5.76	0.46	0.4	0.9	1.1	1.3	1.4	0.4	0.9	1.1	1.3	1.4
BC280	BC280_050	17.6	40.0	40.0	0.0%	0.145	0.06	2.52	1.16	2.0	4.6	5.6	6.5	7.0	2.0	4.6	5.6	6.5	7.0
Outfall BC040																			
BC290	BC290_010	3.9	30.3	30.3	0.0%	0.034	0.07	2.77	1.10	0.3	0.8	1.0	1.1	1.2	0.3	0.8	1.0	1.1	1.2
BC300	BC300_020	3.1	24.6	24.6	0.0%	0.059	0.15	6.69	0.26	0.2	0.5	0.6	0.7	0.8	0.2	0.5	0.6	0.7	0.8
BC310	BC310_020	2.0	40.0	40.0	0.0%	0.002	0.14	6.17	0.24	0.2	0.5	0.6	0.7	0.8	0.2	0.5	0.6	0.7	0.8
BC320	BC320_040	4.4	40.0	40.0	0.0%	0.080	0.13	4.80	0.18	0.5	1.1	1.4	1.8	2.2	0.5	1.1	1.4	1.8	2.2
BC330	BC330_010	4.9	40.0	40.0	0.0%	0.065	0.14	5.40	0.21	0.6	1.3	1.6	1.8	2.2	0.6	1.3	1.6	1.8	2.2

Table A-1: Major Hydrologic Input Data and Results

			Impervious Area (%)				Green-Ampt Infiltration Parameters			Existing Sub-basin Peak Flows (cfs)					Future Sub-basin Peak Flows (cfs)				
Sub-basin Name	Inlet Node	Sub-basin Area (acres)	Existing Land Use	Future Land Use	Increase (%)	Average Sub-basin Slope (ft/ft)	Initial Moisture Deficit	Average Capilary Suction (in)	Saturated Hydraulic Conductivity (in/hr)	WQ Storm Peak Flow (cfs)	2 yr 24 hr Peak Flow (cfs)	5 yr 24 hr Peak Flow (cfs)	10yr 24hr Peak Flow (cfs)	25yr 24hr Peak Flow (cfs)	WQ Storm Peak Flow (cfs)	2 yr 24 hr Peak Flow (cfs)	5 yr 24 hr Peak Flow (cfs)	10yr 24hr Peak Flow (cfs)	25yr 24hr Peak Flow (cfs)
BC340	BC340_010	7.5	9.8	9.8	0.0%	0.032	0.15	6.69	0.26	0.2	0.5	0.6	0.7	0.7	0.2	0.5	0.6	0.7	0.7
BC350	BC350_040	7.6	39.7	39.9	0.2%	0.041	0.12	3.54	0.13	0.9	2.0	2.9	4.2	5.1	0.9	2.0	2.9	4.2	5.1
Outfall BC360																			
BC360	BC360_020	4.5	40.0	40.0	0.0%	0.010	0.12	3.59	0.13	0.5	1.2	1.5	2.0	2.4	0.5	1.2	1.5	2.0	2.4
BC370	BC370_040	6.1	40.0	40.0	0.0%	0.013	0.14	5.63	0.22	0.7	1.6	1.9	2.2	2.4	0.7	1.6	1.9	2.2	2.4
BC380	BC380_010	11.4	40.0	40.0	0.0%	0.044	0.15	6.68	0.26	1.3	3.0	3.6	4.2	4.5	1.3	3.0	3.6	4.2	4.5
BC390	BC390_020	4.7	39.9	39.9	0.0%	0.095	0.13	5.13	0.20	0.5	1.2	1.5	1.7	2.0	0.5	1.2	1.5	1.7	2.0
Outfall BC420																			
BC400	BC400_060	10.8	40.0	40.0	0.0%	0.017	0.13	5.13	0.20	1.2	2.8	3.4	3.9	4.4	1.2	2.8	3.4	3.9	4.4
BC410	BC410_050	8.3	39.3	39.3	0.0%	0.032	0.12	3.50	0.13	1.0	2.1	3.4	4.9	6.0	1.0	2.1	3.4	4.9	6.0
BC420	BC420_020	4.2	40.0	40.0	0.0%	0.005	0.13	5.29	0.20	0.5	1.1	1.3	1.5	1.7	0.5	1.1	1.3	1.5	1.7
BC430	BC430_090	12.8	33.4	33.4	0.0%	0.007	0.12	3.50	0.13	1.2	2.8	3.7	5.0	6.2	1.2	2.8	3.7	5.0	6.2
BC440	BC440_030	6.0	40.0	40.0	0.0%	0.006	0.15	6.69	0.26	0.7	1.6	1.9	2.2	2.4	0.7	1.6	1.9	2.2	2.4
BC450	BC450_010	2.8	40.0	40.0	0.0%	0.014	0.15	6.69	0.26	0.3	0.7	0.9	1.0	1.1	0.3	0.7	0.9	1.0	1.1
BC460	BC460_020	3.7	40.0	40.0	0.0%	0.005	0.15	6.69	0.26	0.4	0.9	1.2	1.3	1.4	0.4	0.9	1.2	1.3	1.4
BC470	BC470_020	2.9	40.0	40.0	0.0%	0.010	0.15	6.69	0.26	0.3	0.8	0.9	1.1	1.2	0.3	0.8	0.9	1.1	1.2
Outfall BC480																			
BC480	BC480_020	5.7	29.1	29.1	0.0%	0.009	0.15	6.69	0.26	0.5	1.1	1.3	1.5	1.6	0.5	1.1	1.3	1.5	1.6
BC490	BC490_010	5.8	40.0	40.0	0.0%	0.023	0.15	6.69	0.26	0.7	1.5	1.8	2.1	2.3	0.7	1.5	1.8	2.1	2.3
BC500	BC500_060	10.2	40.0	40.0	0.0%	0.023	0.15	6.47	0.25	1.2	2.7	3.3	3.8	4.1	1.2	2.7	3.3	3.8	4.1
Outfall BC510																			
BC510	BC510_050	7.3	39.4	39.4	0.0%	0.011	0.15	6.69	0.26	0.8	1.8	2.3	2.6	2.8	0.8	1.8	2.3	2.6	2.8
BC520	BC520_080	11.8	34.2	40.0	5.8%	0.025	0.15	6.69	0.26	1.2	2.6	3.2	3.7	4.0	1.4	3.1	3.8	4.3	4.7
BC530	BC530_020	7.3	40.0	40.0	0.0%	0.002	0.15	6.69	0.26	0.8	1.8	2.3	2.6	2.8	0.8	1.8	2.3	2.6	2.8
BC540	BC540_050	5.6	40.0	40.0	0.0%	0.003	0.15	6.69	0.26	0.6	1.4	1.8	2.0	2.2	0.6	1.4	1.8	2.0	2.2
BC550	BC550_040	8.9	40.0	40.0	0.0%	0.009	0.15	6.69	0.26	1.0	2.3	2.8	3.2	3.5	1.0	2.3	2.8	3.2	3.5
Outfall BC560																			
BC560	BC560_020	4.3	40.0	40.0	0.0%	0.015	0.15	6.69	0.26	0.5	1.1	1.3	1.6	1.7	0.5	1.1	1.3	1.6	1.7
BC570	BC570_010	10.8	40.0	40.0	0.0%	0.012	0.15	6.64	0.26	1.2	2.8	3.4	4.0	4.3	1.2	2.8	3.4	4.0	4.3
BC580	BC580_020	5.1	39.8	40.0	0.2%	0.064	0.14	5.76	0.22	0.6	1.3	1.6	1.9	2.0	0.6	1.3	1.6	1.9	2.0
BC590	BC590_010	6.1	36.4	36.4	0.0%	0.089	0.14	5.60	0.22	0.6	1.4	1.8	2.0	2.2	0.6	1.4	1.8	2.0	2.2
BC600	BC600_030	5.0	36.7	36.7	0.0%	0.107	0.15	6.69	0.26	0.5	1.2	1.5	1.7	1.8	0.5	1.2	1.5	1.7	1.8
BC610	BC610_010	2.6	39.1	39.1	0.0%	0.010	0.15	6.69	0.26	0.3	0.7	0.8	0.9	1.0	0.3	0.7	0.8	0.9	1.0
BC620	BC620_030	10.4	35.8	35.8	0.0%	0.018	0.15	6.69	0.26	1.1	2.4	3.0	3.4	3.7	1.1	2.4	3.0	3.4	3.7
BC630	BC630_010	2.7	25.9	25.9	0.0%	0.024	0.15	6.69	0.26	0.2	0.5	0.6	0.6	0.7	0.2	0.5	0.6	0.6	0.7
BC640	BC640_010	2.7	40.0	40.0	0.0%	0.060	0.15	6.69	0.26	0.3	0.7	0.8	1.0	1.1	0.3	0.7	0.8	1.0	1.1
BC650	BC650_010	15.6	5.8	5.8	0.0%	0.067	0.15	6.69	0.26	0.3	0.6	0.7	0.8	0.9	0.3	0.6	0.7	0.8	0.9

Table A-1: Major Hydrologic Input Data and Results																				
			Impervious Area (%)				Green-Ampt Infiltration Parameters			Existing Sub-basin Peak Flows (cfs)					Future Sub-basin Peak Flows (cfs)					
Sub-basin Name	Inlet Node	Sub-basin Area (acres)	Existing Land Use	Future Land Use	Increase (%)	Average Sub-basin Slope (ft/ft)	Initial Moisture Deficit	Average Capilary Suction (in)	Saturated Hydraulic Conductivity (in/hr)	WQ Storm Peak Flow (cfs)	2 yr 24 hr Peak Flow (cfs)	5 yr 24 hr Peak Flow (cfs)	10yr 24hr Peak Flow (cfs)	25yr 24hr Peak Flow (cfs)	WQ Storm Peak Flow (cfs)	2 yr 24 hr Peak Flow (cfs)	5 yr 24 hr Peak Flow (cfs)	10yr 24hr Peak Flow (cfs)	25yr 24hr Peak Flow (cfs)
Outfall BC660																			
BC660	BC660_060	6.3	40.0	40.0	0.0%	0.023	0.15	6.69	0.26	0.7	1.6	2.0	2.3	2.5	0.7	1.6	2.0	2.3	2.5
BC670	BC670_030	5.6	40.0	40.0	0.0%	0.032	0.15	6.69	0.26	0.7	1.5	1.8	2.1	2.2	0.7	1.5	1.8	2.1	2.2
Outfall BC680																			
BC680	BC680_020	5.5	40.0	40.0	0.0%	0.032	0.15	6.62	0.26	0.6	1.4	1.7	2.0	2.2	0.6	1.4	1.7	2.0	2.2
Outfall BC690																			
BC690	BC690_100	0.8	40.0	40.0	0.0%	0.037	0.12	3.70	0.14	0.1	0.2	0.4	0.5	0.6	0.1	0.2	0.4	0.5	0.6
BC700	BC700_010	1.5	40.0	40.0	0.0%	0.003	0.15	6.43	0.25	0.2	0.4	0.5	0.5	0.6	0.2	0.4	0.5	0.5	0.6
BC710	BC710_010	1.1	40.0	40.0	0.0%	0.026	0.12	4.31	0.16	0.1	0.3	0.4	0.5	0.6	0.1	0.3	0.4	0.5	0.6
BC720	BC720_020	5.4	39.5	40.0	0.5%	0.113	0.14	5.83	0.23	0.6	1.4	1.7	2.0	2.1	0.6	1.4	1.7	2.0	2.2
BC730	BC730_070	11.5	39.9	39.9	0.0%	0.075	0.14	6.22	0.24	1.3	3.0	3.7	4.2	4.6	1.3	3.0	3.7	4.2	4.6
BC740	BC740_010	2.1	40.0	40.0	0.0%	0.079	0.12	4.25	0.16	0.2	0.5	0.7	1.0	1.2	0.2	0.5	0.7	1.0	1.2
BC750	BC750_020	2.8	40.0	40.0	0.0%	0.055	0.12	3.94	0.15	0.3	0.7	1.0	1.3	1.6	0.3	0.7	1.0	1.3	1.6
BC760	BC760_030	4.2	40.0	40.0	0.0%	0.110	0.14	5.56	0.21	0.5	1.1	1.4	1.6	1.8	0.5	1.1	1.4	1.6	1.8
Outfall BC3800																			
BC3800	O_BC3800	1.5	70.0	70.0	0.0%	0.225	0.15	6.65	0.26	0.3	0.7	0.8	1.0	1.0	0.3	0.7	0.8	1.0	1.0
BC770	BC770_020	1.8	41.0	41.0	0.0%	0.064	0.12	3.86	0.15	0.2	0.5	0.7	1.0	1.2	0.2	0.5	0.7	1.0	1.2
BC780	BC780_030	13.1	37.6	37.6	0.0%	0.100	0.13	5.23	0.20	1.4	3.2	3.9	4.5	5.7	1.4	3.2	3.9	4.5	5.7
BC790	BC790_020	4.9	40.0	40.0	0.0%	0.014	0.15	6.69	0.26	0.6	1.3	1.6	1.8	1.9	0.6	1.3	1.6	1.8	1.9
BC800	BC800_010	2.1	40.0	40.0	0.0%	0.025	0.15	6.69	0.26	0.2	0.6	0.7	0.8	0.8	0.2	0.6	0.7	0.8	0.8
BC810	BC810_020	3.9	40.0	40.0	0.0%	0.013	0.15	6.69	0.26	0.4	1.0	1.2	1.4	1.5	0.4	1.0	1.2	1.4	1.5
BC820	BC820_030	4.5	55.3	55.3	0.0%	0.007	0.15	6.69	0.26	0.7	1.6	1.9	2.2	2.4	0.7	1.6	1.9	2.2	2.4
BC830	BC830_020	4.8	30.0	75.8	45.8%	0.005	0.15	6.69	0.26	0.4	0.9	1.1	1.3	1.4	1.0	2.3	2.8	3.2	3.5
BC840	BC840_050	4.3	40.0	40.0	0.0%	0.193	0.15	6.34	0.25	0.5	1.1	1.4	1.6	1.7	0.5	1.1	1.4	1.6	1.7
BC850	BC850_060	6.4	39.3	39.3	0.0%	0.033	0.15	6.69	0.26	0.7	1.7	2.0	2.3	2.5	0.7	1.7	2.0	2.3	2.5
BC860	BC860_010	6.2	64.8	64.8	0.0%	0.016	0.15	6.69	0.26	1.1	2.6	3.2	3.6	3.9	1.1	2.6	3.2	3.6	3.9
BC870	BC870_030	2.8	61.3	61.3	0.0%	0.002	0.15	6.69	0.26	0.5	1.1	1.3	1.5	1.7	0.5	1.1	1.3	1.5	1.7
BC880	BC880_010	0.8	70.0	70.0	0.0%	0.100	0.12	4.07	0.15	0.2	0.4	0.5	0.6	0.7	0.2	0.4	0.5	0.6	0.7
BC890	BC890_060	5.3	61.3	61.3	0.0%	0.084	0.13	5.00	0.19	0.9	2.1	2.6	3.0	3.5	0.9	2.1	2.6	3.0	3.5
Outfall BC900																			
BC900	BC900_040	18.8	72.6	72.6	0.0%	0.014	0.13	5.24	0.20	3.8	8.7	10.7	12.4	13.6	3.8	8.7	10.7	12.4	13.6
BC910	BC910_040	8.0	48.5	59.8	11.3%	0.023	0.13	4.68	0.18	1.1	2.5	3.1	3.8	4.4	1.4	3.1	3.8	4.5	5.2
BC920	BC920_010	14.1	41.5	43.8	2.3%	0.023	0.14	6.08	0.24	1.7	3.8	4.7	5.4	5.8	1.8	4.0	4.9	5.7	6.1
BC930	BC930_040	2.1	40.0	40.1	0.1%	0.007	0.14	5.78	0.22	0.2	0.5	0.6	0.7	0.8	0.2	0.5	0.7	0.7	0.8
BC940	BC940_040	2.6	39.9	39.9	0.0%	0.006	0.15	6.69	0.26	0.3	0.7	0.8	0.9	1.0	0.3	0.7	0.8	0.9	1.0
BC950	BC950_020	3.7	39.6	39.6	0.0%	0.014	0.15	6.69	0.26	0.4	0.9	1.2	1.3	1.4	0.4	0.9	1.2	1.3	1.4
BC960	BC960_020	3.7	39.8	39.8	0.0%	0.019	0.15	6.69	0.26	0.4	1.0	1.2	1.4	1.5	0.4	1.0	1.2	1.4	1.5

Table A-1: Major Hydrologic Input Data and Results

			Impervious Area (%)				Green-Ampt Infiltration Parameters			Existing Sub-basin Peak Flows (cfs)					Future Sub-basin Peak Flows (cfs)				
Sub-basin Name	Inlet Node	Sub-basin Area (acres)	Existing Land Use	Future Land Use	Increase (%)	Average Sub-basin Slope (ft/ft)	Initial Moisture Deficit	Average Capilary Suction (in)	Saturated Hydraulic Conductivity (in/hr)	WQ Storm Peak Flow (cfs)	2 yr 24 hr Peak Flow (cfs)	5 yr 24 hr Peak Flow (cfs)	10yr 24hr Peak Flow (cfs)	25yr 24hr Peak Flow (cfs)	WQ Storm Peak Flow (cfs)	2 yr 24 hr Peak Flow (cfs)	5 yr 24 hr Peak Flow (cfs)	10yr 24hr Peak Flow (cfs)	25yr 24hr Peak Flow (cfs)
BC970	BC970_060	9.7	33.3	33.3	0.0%	0.003	0.13	5.21	0.20	0.9	2.1	2.5	2.9	3.2	0.9	2.1	2.5	2.9	3.2
BC980	BC980_030	4.1	33.6	33.6	0.0%	0.024	0.15	6.69	0.26	0.4	0.9	1.1	1.3	1.4	0.4	0.9	1.1	1.3	1.4
BC990	BC990_050	8.6	36.1	36.1	0.0%	0.023	0.15	6.69	0.26	0.9	2.0	2.5	2.9	3.1	0.9	2.0	2.5	2.9	3.1
BC1000	BC1000_020	6.0	44.1	44.2	0.1%	0.022	0.13	5.20	0.20	0.8	1.7	2.1	2.4	2.7	0.8	1.7	2.1	2.4	2.7
BC1010	BC1010_010	10.7	40.1	40.1	0.0%	0.007	0.15	6.69	0.26	1.2	2.8	3.4	3.9	4.2	1.2	2.8	3.4	3.9	4.2
BC1020	BC1020_040	11.2	37.8	38.1	0.3%	0.049	0.15	6.52	0.25	1.2	2.8	3.4	3.9	4.2	1.2	2.8	3.4	3.9	4.2
BC1030	BC1030_060	13.3	37.3	37.3	0.0%	0.040	0.15	6.56	0.26	1.4	3.2	4.0	4.6	4.9	1.4	3.2	4.0	4.6	4.9
BC1040	BC1040_010	7.1	33.7	40.0	6.3%	0.043	0.14	5.62	0.22	0.7	1.6	1.9	2.2	2.4	0.8	1.8	2.3	2.6	2.8
BC1050	BC1050_040	13.2	38.3	38.3	0.0%	0.025	0.15	6.69	0.26	1.4	3.3	4.0	4.6	5.0	1.4	3.3	4.0	4.6	5.0
Disconnected Subbasins																			
BC2000	BC2000_000	9.4	51.4	78.8	27.4%	0.058	0.15	6.69	0.26	1.4	3.2	3.9	4.5	4.8	2.1	4.8	5.9	6.8	7.4
BC2100	BC2100_000	6.6	30.9	70.5	39.6%	0.417	0.15	6.69	0.26	0.6	1.3	1.6	1.9	2.0	1.4	3.0	3.7	4.3	4.6
BC2200	BC2200_000	4.6	47.3	73.7	26.4%	0.038	0.15	6.69	0.26	0.6	1.4	1.7	2.0	2.1	1.0	2.2	2.7	3.1	3.3
BC2300	BC2300_000	8.9	40.5	65.4	24.9%	0.115	0.15	6.69	0.26	1.0	2.4	2.9	3.3	3.6	1.7	3.8	4.7	5.4	5.8
BC2400	BC2400_000	2.5	79.9	79.9	0.0%	0.006	0.15	6.69	0.26	0.6	1.3	1.6	1.8	2.0	0.6	1.3	1.6	1.8	2.0
BC2500	BC2500_000	1.6	70.6	80.0	9.4%	0.008	0.15	6.69	0.26	0.3	0.7	0.9	1.0	1.1	0.4	0.8	1.0	1.2	1.3
BC2600	BC2600_000	4.9	21.3	40.0	18.7%	0.002	0.15	6.69	0.26	0.3	0.7	0.8	1.0	1.0	0.6	1.3	1.6	1.8	1.9
BC2700	BC2700_000	5.3	3.7	40.0	36.3%	0.604	0.15	6.69	0.26	0.1	0.1	0.2	0.2	0.2	0.6	1.4	1.7	2.0	2.1
BC2800	BC2800_000	7.4	5.9	40.0	34.1%	0.084	0.15	6.69	0.26	0.1	0.3	0.3	0.4	0.4	0.9	1.9	2.4	2.7	2.9
BC2900	BC2900_000	7.2	18.7	40.0	21.3%	0.015	0.15	6.69	0.26	0.4	0.9	1.1	1.2	1.3	0.8	1.9	2.3	2.7	2.9
BC3000	BC3000_000	31.7	20.7	39.9	19.2%	0.092	0.15	6.69	0.26	1.9	4.3	5.3	6.1	6.5	3.7	8.3	10.1	11.7	12.6
BC3100	BC3100_000	15.7	5.4	60.0	54.6%	0.036	0.15	6.69	0.26	0.2	0.6	0.7	0.8	0.8	2.7	6.1	7.5	8.6	9.3
BC3200	BC3200_000	4.2	48.7	60.0	11.3%	0.081	0.15	6.69	0.26	0.6	1.3	1.6	1.9	2.0	0.7	1.6	2.0	2.3	2.5
BC3300	BC3300_000	13.0	28.6	40.0	11.4%	0.109	0.15	6.69	0.26	1.1	2.4	3.0	3.4	3.7	1.5	3.4	4.2	4.8	5.2
BC3400	BC3400_000	1.3	70.0	70.0	0.0%	0.035	0.15	6.69	0.26	0.3	0.6	0.7	0.9	0.9	0.3	0.6	0.7	0.9	0.9
BC3500	BC3500_000	5.5	2.8	80.0	77.2%	0.021	0.15	6.69	0.26	0.0	0.1	0.1	0.1	0.2	1.2	2.8	3.4	4.0	4.3
BC3600	BC3600_000	3.1	79.9	79.9	0.0%	0.089	0.15	6.69	0.26	0.7	1.6	2.0	2.3	2.5	0.7	1.6	2.0	2.3	2.5
BC3700	BC3700_000	3.1	48.3	70.0	21.7%	0.053	0.15	6.69	0.26	0.4	1.0	1.2	1.4	1.5	0.6	1.4	1.8	2.0	2.2
BC3900	BC3900_000	43.5	4.5	80.0	75.5%	0.037	0.15	6.69	0.26	0.6	1.3	1.6	1.8	1.9	9.7	22.3	27.4	31.6	34.1
BC4000	BC4000_000	18.1	7.2	40.0	32.8%	0.002	0.15	6.69	0.26	0.4	0.8	1.0	1.2	1.3	1.9	4.5	5.5	6.4	6.9
BC4100	BC4100_000	12.1	7.0	40.0	33.0%	0.030	0.15	6.69	0.26	0.2	0.6	0.7	0.8	0.8	1.4	3.1	3.8	4.4	4.8
BC4200	BC4200_000	14.8	10.1	40.0	29.9%	0.028	0.15	6.69	0.26	0.4	1.0	1.2	1.4	1.5	1.7	3.8	4.7	5.4	5.8
BC4300	BC4300_000	3.9	2.5	70.0	67.5%	0.017	0.15	4.73	0.18	0.0	0.1	0.1	0.3	0.5	0.8	1.8	2.2	2.6	2.9
UIC_01	UIC_01	10.2	0.0	40.0	40.0%	0.016	0.15	6.60	0.26						1.1	2.6	3.2	3.7	4.0
UIC_02	UIC_02	2.1	0.0	60.0	60.0%	0.017	0.13	4.57	0.17						0.4	0.8	1.0	1.2	1.3
UIC_03	UIC_03	7.5	0.0	60.0	60.0%	0.008	0.12	3.52	0.13	Not applicable for existing condition					1.3	2.9	3.7	4.6	5.3

Table A-1: Major Hydrologic Input Data and Results

			Impervious Area (%)				Green-Ampt Infiltration Parameters			Existing Sub-basin Peak Flows (cfs)					Future Sub-basin Peak Flows (cfs)				
Sub-basin Name	Inlet Node	Sub-basin Area (acres)	Existing Land Use	Future Land Use	Increase (%)	Average Sub-basin Slope (ft/ft)	Initial Moisture Deficit	Average Capilary Suction (in)	Saturated Hydraulic Conductivity (in/hr)	WQ Storm Peak Flow (cfs)	2 yr 24 hr Peak Flow (cfs)	5 yr 24 hr Peak Flow (cfs)	10yr 24hr Peak Flow (cfs)	25yr 24hr Peak Flow (cfs)	WQ Storm Peak Flow (cfs)	2 yr 24 hr Peak Flow (cfs)	5 yr 24 hr Peak Flow (cfs)	10yr 24hr Peak Flow (cfs)	25yr 24hr Peak Flow (cfs)
SANDY RIVER																			
Outfall SR005																			
SR005	SR005_020	40.0	80.0	80.0	0.0%	0.011	0.15	6.00	0.36	8.9	20.5	25.2	29.1	31.4	8.9	20.5	25.2	29.1	31.4
SR007	SR007_010	4.7	80.0	80.0	0.0%	0.133	0.15	3.64	0.14	1.1	2.5	3.2	4.0	4.4	1.1	2.5	3.2	4.0	4.4
SR010	SR010_120	31.5	35.4	53.6	18.2%	0.039	0.12	4.01	0.15	3.2	7.3	9.1	12.2	14.5	4.8	10.9	13.5	17.1	19.5
SR020	SR020_020	10.4	48.4	79.9	31.5%	0.085	0.12	3.50	0.13	1.5	3.3	4.7	6.4	7.8	2.4	5.4	7.0	8.6	9.6
SR030	SR030_050	8.7	70.0	70.0	0.0%	0.078	0.12	3.50	0.13	1.7	3.9	5.2	6.5	7.5	1.7	3.9	5.2	6.5	7.5
SR040	SR040_010	9.3	35.7	70.0	34.3%	0.109	0.12	3.50	0.13	1.0	2.2	3.3	4.8	6.0	1.9	4.2	5.5	7.0	8.0
SR050	SR050_120	5.7	70.0	70.0	0.0%	0.064	0.12	3.50	0.13	1.1	2.6	3.4	4.4	5.0	1.1	2.6	3.4	4.4	5.0
SR060	SR060_010	5.3	69.3	69.3	0.0%	0.025	0.12	3.50	0.13	1.0	2.4	3.1	3.8	4.4	1.0	2.4	3.1	3.8	4.4
SR070	SR070_070	3.4	71.4	71.4	0.0%	0.010	0.12	3.81	0.14	0.7	1.5	1.9	2.3	2.6	0.7	1.5	1.9	2.3	2.6
SR080	SR080_010	21.2	55.6	60.8	5.2%	0.124	0.12	3.71	0.14	3.4	7.7	10.9	14.7	16.6	3.7	8.4	11.6	15.3	17.2
SR090	SR090_010	11.8	70.0	70.0	0.0%	0.047	0.12	3.50	0.13	2.3	5.3	6.8	8.4	9.7	2.3	5.3	6.8	8.4	9.7
SR100	SR100_020	14.8	60.1	60.1	0.0%	0.066	0.12	3.50	0.13	2.6	5.8	8.1	10.5	12.3	2.6	5.8	8.1	10.5	12.3
SR110	SR110_030	1.5	68.1	68.2	0.1%	0.051	0.12	3.50	0.13	0.3	0.7	1.0	1.2	1.4	0.3	0.7	1.0	1.2	1.4
SR120	SR120_100	5.9	60.0	60.0	0.0%	0.055	0.12	3.50	0.13	1.0	2.3	3.5	4.5	5.2	1.0	2.3	3.5	4.5	5.2
SR130	SR130_030	2.5	60.0	60.0	0.0%	0.044	0.12	3.50	0.13	0.4	1.0	1.3	1.7	2.0	0.4	1.0	1.3	1.7	2.0
SR140	SR140_120	8.3	49.5	50.8	1.3%	0.024	0.12	4.28	0.16	1.2	2.6	3.2	3.9	4.5	1.2	2.7	3.3	4.0	4.6
SR150	SR150_050	5.0	40.2	40.2	0.0%	0.018	0.15	6.41	0.25	0.6	1.3	1.6	1.8	2.0	0.6	1.3	1.6	1.8	2.0
SR160	SR160_010	13.9	60.5	67.1	6.6%	0.015	0.15	6.62	0.26	2.3	5.4	6.6	7.6	8.2	2.6	6.0	7.3	8.4	9.1
SR170	SR170_110	3.4	60.0	60.0	0.0%	0.032	0.13	4.72	0.18	0.6	1.3	1.6	1.9	2.2	0.6	1.3	1.6	1.9	2.2
SR180	SR180_040	9.4	5.0	5.0	0.0%	0.025	0.12	3.58	0.13	0.1	0.3	0.8	1.5	2.2	0.1	0.3	0.8	1.5	2.2
SR190	SR190_050	6.6	17.5	17.5	0.0%	0.006	0.12	3.50	0.13	0.3	0.7	1.0	1.3	1.7	0.3	0.7	1.0	1.3	1.7
SR200	SR200_020	5.0	69.4	69.4	0.0%	0.004	0.06	2.39	1.27	1.0	2.2	2.8	3.2	3.4	1.0	2.2	2.8	3.2	3.4
SR210	SR210_010	4.0	57.7	57.7	0.0%	0.007	0.06	2.57	1.32	0.6	1.5	1.8	2.1	2.3	0.6	1.5	1.8	2.1	2.3
Outfall SR220																			
SR220	SR220_040	7.8	39.1	39.1	0.0%	0.008	0.13	5.80	0.45	0.9	2.0	2.4	2.8	3.0	0.9	2.0	2.4	2.8	3.0
SR230	SR230_010	10.5	39.1	39.1	0.0%	0.033	0.12	5.47	0.52	1.2	2.7	3.3	3.8	4.1	1.2	2.7	3.3	3.8	4.1
SR240	SR240_040	14.7	28.8	28.8	0.0%	0.006	0.14	6.07	0.38	1.2	2.7	3.4	3.9	4.2	1.2	2.7	3.4	3.9	4.2
SR250	SR250_040	7.0	38.7	38.7	0.0%	0.042	0.08	3.27	0.99	0.8	1.8	2.2	2.5	2.7	0.8	1.8	2.2	2.5	2.7
SR260	SR260_030	5.9	17.2	42.4	25.2%	0.028	0.07	2.62	0.97	0.3	0.7	0.8	0.9	1.0	0.7	1.6	2.0	2.3	2.5
SR270	SR270_050	16.9	17.7	51.8	34.1%	0.016	0.06	2.40	1.18	0.9	2.0	2.4	2.8	3.0	2.4	5.6	6.9	8.0	8.6
Outfall SR280																			
SR280	SR280_020	3.9	36.5	36.5	0.0%	0.125	0.12	3.60	0.13	0.4	0.9	1.4	2.0	2.4	0.4	0.9	1.4	2.0	2.4
Outfall SR290																			
SR290	SR290_110	5.9	39.4	39.4	0.0%	0.096	0.12	3.50	0.13	0.7	1.5	2.4	3.5	4.3	0.7	1.5	2.4	3.5	4.3
Outfall SR300																			

Table A-1: Major Hydrologic Input Data and Results

			Impervious Area (%)				Green-Ampt Infiltration Parameters			Existing Sub-basin Peak Flows (cfs)					Future Sub-basin Peak Flows (cfs)				
Sub-basin Name	Inlet Node	Sub-basin Area (acres)	Existing Land Use	Future Land Use	Increase (%)	Average Sub-basin Slope (ft/ft)	Initial Moisture Deficit	Average Capilary Suction (in)	Saturated Hydraulic Conductivity (in/hr)	WQ Storm Peak Flow (cfs)	2 yr 24 hr Peak Flow (cfs)	5 yr 24 hr Peak Flow (cfs)	10yr 24hr Peak Flow (cfs)	25yr 24hr Peak Flow (cfs)	WQ Storm Peak Flow (cfs)	2 yr 24 hr Peak Flow (cfs)	5 yr 24 hr Peak Flow (cfs)	10yr 24hr Peak Flow (cfs)	25yr 24hr Peak Flow (cfs)
SR300	O_SR300	4.7	35.7	39.0	3.3%	0.004	0.12	3.50	0.13	0.5	1.1	1.4	1.9	2.4	0.5	1.2	1.6	2.1	2.5
Outfall SR310																			
SR310	SR310_050	10.1	39.7	39.7	0.0%	0.016	0.15	6.37	0.25	1.1	2.6	3.2	3.6	3.9	1.1	2.6	3.2	3.6	3.9
Outfall SR320																			
SR320	SR320_010	1.6	40.0	40.0	0.0%	0.009	0.13	5.29	0.20	0.2	0.4	0.5	0.6	0.6	0.2	0.4	0.5	0.6	0.6
Outfall SR330																			
SR330	SR330_010	2.5	39.0	39.0	0.0%	0.028	0.15	6.69	0.26	0.3	0.6	0.8	0.9	1.0	0.3	0.6	0.8	0.9	1.0
Outfall SR340																			
SR340	SR340_010	2.0	40.0	40.0	0.0%	0.019	0.14	6.01	0.23	0.2	0.5	0.6	0.7	0.8	0.2	0.5	0.6	0.7	0.8
Outfall SR350																			
SR350	SR350_010	2.8	38.5	38.5	0.0%	0.015	0.15	6.69	0.26	0.3	0.7	0.9	1.0	1.1	0.3	0.7	0.9	1.0	1.1
Outfall SR360A																			
SR360A	SR360_020	3.7	40.0	40.0	0.0%	0.018	0.15	6.69	0.26	0.4	1.0	1.2	1.4	1.5	0.4	1.0	1.2	1.4	1.5
Outfall SR360B																			
SR370	SR370_040	6.0	39.9	39.9	0.0%	0.020	0.14	5.87	0.23	0.7	1.5	1.9	2.2	2.4	0.7	1.5	1.9	2.2	2.4
SR380	SR380_210	3.6	38.7	40.0	1.3%	0.034	0.14	6.03	0.23	0.4	0.9	1.1	1.3	1.4	0.4	0.9	1.2	1.3	1.4
SR390	SR390_050	2.9	40.0	40.0	0.0%	0.012	0.14	5.44	0.21	0.3	0.8	0.9	1.1	1.2	0.3	0.8	0.9	1.1	1.2
SR400	SR400_020	1.0	40.0	40.0	0.0%	0.023	0.15	6.69	0.26	0.1	0.3	0.3	0.4	0.4	0.1	0.3	0.3	0.4	0.4
SR410	SR410_040	7.0	39.9	39.9	0.0%	0.016	0.13	4.94	0.19	0.8	1.8	2.2	2.6	3.0	0.8	1.8	2.2	2.6	3.0
SR420	SR420_040	5.5	34.1	40.0	5.9%	0.033	0.12	3.50	0.13	0.5	1.2	2.0	2.9	3.7	0.6	1.4	2.2	3.1	3.9
SR430	SR430_010	3.1	40.0	40.0	0.0%	0.070	0.14	5.72	0.22	0.4	0.8	1.0	1.2	1.2	0.4	0.8	1.0	1.2	1.2
SR440	SR440_010	1.4	40.0	40.0	0.0%	0.035	0.14	6.00	0.23	0.2	0.4	0.5	0.5	0.6	0.2	0.4	0.5	0.5	0.6
SR450	SR450_040	4.4	40.0	40.0	0.0%	0.011	0.12	3.94	0.15	0.5	1.1	1.4	1.8	2.1	0.5	1.1	1.4	1.8	2.1
SR460	SR460_020	1.2	40.0	40.0	0.0%	0.097	0.14	5.61	0.22	0.1	0.3	0.4	0.4	0.5	0.1	0.3	0.4	0.4	0.5
SR470	SR470_060	3.4	38.7	40.0	1.3%	0.046	0.12	3.51	0.13	0.4	0.9	1.3	1.9	2.4	0.4	0.9	1.4	1.9	2.4
SR480	SR480_050	10.3	31.0	40.0	9.0%	0.021	0.14	5.35	0.21	0.9	2.1	2.5	2.9	3.4	1.2	2.7	3.3	3.8	4.2
SR490	SR490_030	2.8	38.9	38.9	0.0%	0.007	0.12	3.50	0.13	0.3	0.7	1.0	1.3	1.6	0.3	0.7	1.0	1.3	1.6
SR500	SR500_030	1.5	36.7	36.7	0.0%	0.085	0.12	3.50	0.13	0.2	0.4	0.7	1.0	1.2	0.2	0.4	0.7	1.0	1.2
SR510	SR510_040	1.4	39.6	39.7	0.1%	0.012	0.12	3.66	0.14	0.2	0.4	0.5	0.7	0.8	0.2	0.4	0.5	0.7	0.8
SR520	SR520_020	0.7	18.0	30.0	12.0%	0.079	0.12	3.50	0.13	0.0	0.1	0.2	0.3	0.4	0.1	0.1	0.2	0.4	0.5
SR530	SR530_010	19.8	3.0	32.3	29.3%	0.200	0.14	5.51	0.21	0.2	0.4	0.5	0.6	1.5	1.8	4.2	5.1	5.9	6.8
SR590	SR590_010	35.2	2.5	5.0	2.5%	0.036	0.15	6.69	0.26	0.3	0.6	0.7	0.8	0.9	0.5	1.2	1.4	1.6	1.8
Outfall SR540																			
SR540	SR540_030	3.1	40.0	40.0	0.0%	0.002	0.12	4.14	0.16	0.3	0.8	1.0	1.2	1.3	0.3	0.8	1.0	1.2	1.3
Outfall SR550																			
SR550	SR550_010	2.5	40.0	40.0	0.0%	0.082	0.14	5.40	0.21	0.3	0.7	0.8	0.9	1.1	0.3	0.7	0.8	0.9	1.1
SR560	SR560_030	2.4	39.9	39.9	0.0%	0.091	0.12	3.97	0.15	0.3	0.6	1.0	1.4	1.7	0.3	0.6	1.0	1.4	1.7

Table A-1: Major Hydrologic Input Data and Results																			
			Impervious Area (%)				Green-Ampt Infiltration Parameters			Existing Sub-basin Peak Flows (cfs)					Future Sub-basin Peak Flows (cfs)				
Sub-basin Name	Inlet Node	Sub-basin Area (acres)	Existing Land Use	Future Land Use	Increase (%)	Average Sub-basin Slope (ft/ft)	Initial Moisture Deficit	Average Capilary Suction (in)	Saturated Hydraulic Conductivity (in/hr)	WQ Storm Peak Flow (cfs)	2 yr 24 hr Peak Flow (cfs)	5 yr 24 hr Peak Flow (cfs)	10yr 24hr Peak Flow (cfs)	25yr 24hr Peak Flow (cfs)	WQ Storm Peak Flow (cfs)	2 yr 24 hr Peak Flow (cfs)	5 yr 24 hr Peak Flow (cfs)	10yr 24hr Peak Flow (cfs)	25yr 24hr Peak Flow (cfs)
SR570	SR570_030	3.8	37.8	37.8	0.0%	0.042	0.12	3.50	0.13	0.4	0.9	1.4	2.0	2.5	0.4	0.9	1.4	2.0	2.5
SR580	SR580_040	4.1	38.0	38.0	0.0%	0.016	0.12	3.50	0.13	0.5	1.0	1.5	2.2	2.7	0.5	1.0	1.5	2.2	2.7
Disconnected Subbasins																			
SR2000	SR2000_000	8.5	53.2	80.0	26.8%	0.088	0.13	4.44	0.17	1.3	3.0	3.6	5.3	6.1	2.0	4.4	5.4	6.8	7.6
SR2100	SR2100_000	15.7	25.8	40.0	14.2%	0.015	0.15	6.69	0.26	1.2	2.6	3.2	3.7	4.0	1.8	4.1	5.0	5.8	6.2
SR2200	SR2200_000	20.0	7.0	42.8	35.8%	0.310	0.14	6.14	0.24	0.4	0.9	1.1	1.3	1.8	2.5	5.6	6.9	7.9	8.5
SR2300	SR2300_000	29.3	13.2	40.0	26.8%	0.106	0.12	3.79	0.14	1.1	2.5	5.7	10.6	14.1	3.4	7.7	11.4	16.4	19.6
SR2400	SR2400_000	16.4	9.3	40.0	30.7%	0.093	0.15	6.69	0.26	0.4	1.0	1.2	1.4	1.5	1.9	4.3	5.3	6.1	6.5
SR2500	SR2500_000	9.2	17.1	72.1	55.0%	0.155	0.13	5.28	0.20	0.5	1.0	1.3	1.6	2.5	1.9	4.3	5.3	6.1	6.9
SR2600	SR2600_000	7.5	35.9	40.0	4.1%	0.012	0.15	6.69	0.26	0.8	1.8	2.1	2.5	2.7	0.9	2.0	2.4	2.8	3.0
SR2700	SR2700_000	13.3	25.6	40.0	14.4%	0.016	0.14	5.41	0.21	1.0	2.2	2.7	3.1	3.6	1.5	3.5	4.2	4.9	5.3

Table A-2: Model Conduit Parameters and Results

Conduit Name (US Node - DS Node)	Node ID		Conduit Attributes				Existing S. Troutdale Model - Peak Flows (cfs)					Future S. Troutdale Model - Peak Flows (cfs)					Node Rim and Invert Elevation (IE)				Maximum Hydraulic Grade Line - Existing Conditions				Maximum Hydraulic Grade Line - Future Conditions				When hydraulically deficient
																					10yr 24hr HGL (feet)		25yr 24hr HGL (feet)		10yr 24hr HGL (feet)		25yr 24hr HGL (feet)		
	US	DS	Type	Conduit Dia or Channel Height (inches)	Manning's Roughness	Conduit Length	WQ Peak Flows (cfs)	2yr 24hr Peak Flows (cfs)	5yr 24hr Peak Flows (cfs)	10yr 24hr Peak Flow (cfs)	25yr 24hr Peak Flow (cfs)	WQ Peak Flows (cfs)	2yr 24hr Peak Flows (cfs)	5yr 24hr Peak Flows (cfs)	10yr 24hr Peak Flow (cfs)	25yr 24hr Peak Flow (cfs)	US Rim (ft)	US IE (ft)	DS Rim (ft)	DS IE (ft)	US	DS	US	DS	US	DS	US	DS	
BEAVER CREEK																													
Outfall BC010																													
BC010_020-O_BC010	BC010_020	O_BC010	Pipe	30	0.0240	80	15.9	36.8	44.7	50.3	53.8	17.1	39.4	47.8	53.5	57.0	57.6	46.1	27.1	16.7	47.1	17.8	47.2	17.8	47.2	17.8	47.2	17.9	
BC010_030-BC010_020	BC010_030	BC010_020	Pipe	30	0.0120	98	15.9	36.8	44.7	50.3	53.8	17.1	39.4	47.8	53.5	57.0	59.7	49.3	57.6	46.1	50.9	47.1	50.9	47.2	50.9	47.2	51.0	47.2	
BC010_040-BC010_030	BC010_040	BC010_030	Pipe	30	0.0120	70	15.9	36.8	44.7	50.3	53.8	17.1	39.4	47.8	53.5	57.0	61.8	51.7	59.7	49.3	53.1	50.9	53.2	50.9	53.2	50.9	53.2	51.0	
BC010_050-BC010_040	BC010_050	BC010_040	Pipe	30	0.0120	150	15.9	36.8	44.7	50.3	53.8	17.1	39.4	47.8	53.5	57.0	68.6	56.7	61.8	51.7	58.1	53.1	58.1	53.2	58.1	53.2	58.2	53.2	
BC010_060-BC010_050	BC010_060	BC010_050	Pipe	12	0.0120	145	0.9	2.1	2.7	3.3	3.7	0.9	2.1	2.7	3.3	3.7	84.0	74.9	68.6	57.2	75.2	58.1	75.2	58.1	75.2	58.1	75.2	58.2	
BC010_070-BC010_060	BC010_070	BC010_060	Pipe	12	0.0120	101	0.9	2.1	2.7	3.3	3.7	0.9	2.1	2.7	3.3	3.7	100.8	91.1	84.0	75.1	91.4	75.2	91.4	75.2	91.4	75.2	91.4	75.2	
BC010_100-BC010_070	BC010_100	BC010_070	Pipe	12	0.0180	237	0.9	2.1	2.7	3.3	3.7	0.9	2.1	2.7	3.3	3.7	102.9	96.5	100.8	90.6	97.1	91.4	97.2	91.4	97.1	91.4	97.2	91.4	
BC020_010-BC010_050	BC020_010	BC010_050	Pipe	30	0.0120	255	15.0	34.8	42.0	47.1	50.2	16.2	37.5	45.1	50.2	53.3	75.5	62.0	68.6	56.7	63.6	58.1	63.7	58.1	63.7	58.1	63.8	58.2	
BC020_020-BC020_010	BC020_020	BC020_010	Pipe	12	0.0120	240	1.4	3.2	4.4	5.4	6.0	1.4	3.2	4.4	5.4	6.0	96.3	85.3	75.5	64.0	85.8	63.6	85.8	63.7	85.8	63.7	85.8	63.8	
BC020_100-BC020_010	BC020_100	BC020_010	Pipe	30	0.0120	260	13.6	31.7	37.8	41.8	44.4	14.9	34.4	40.8	45.0	47.5	78.7	66.0	75.5	62.0	67.6	63.6	67.7	63.7	67.7	63.7	67.8	63.8	
BC020_110-BC020_100	BC020_110	BC020_100	Pipe	15	0.0120	75	5.5	12.4	13.7	13.7	13.7	5.5	12.4	13.7	13.7	13.7	80.0	73.4	78.7	70.2	74.4	67.6	74.4	67.7	74.4	67.7	74.4	67.8	
BC020_120-BC020_110	BC020_120	BC020_110	Pipe	12	0.0120	191	5.5	12.4	13.7	13.7	13.7	5.5	12.4	13.7	13.7	13.7	100.0	90.8	80.0	73.7	97.6	74.4	97.6	74.4	97.6	74.4	97.6	74.4	
BC030_010-BC020_120	BC030_010	BC020_120	Pipe	12	0.0120	262	5.5	12.4	13.7	13.8	13.8	5.5	12.5	13.7	13.8	13.8	127.6	117.3	100.0	91.2	127.6	97.6	127.6	97.6	127.6	97.6	127.6	97.6	5-yr Existing
BC030_020-BC030_010	BC030_020	BC030_010	Pipe	12	0.0120	260	2.0	4.6	5.7	6.7	7.1	2.0	4.7	5.7	6.7	7.1	135.5	126.6	127.6	117.5	134.8	127.6	135.5	127.6	134.8	127.6	135.5	127.6	25-yr Existng
BC040_010-BC030_020	BC040_010	BC030_020	Pipe	12	0.0130	46	2.0	4.6	5.7	6.7	7.5	2.0	4.7	5.7	6.7	7.5	138.1	130.3	135.5	128.1	136.3	134.8	137.4	135.5	136.3	134.8	137.4	135.5	
BC040_020-BC040_010	BC040_020	BC040_010	Pipe	12	0.0130	334	2.0	4.6	5.7	6.7	7.5	2.0	4.7	5.7	6.7	7.5	153.8	146.3	138.1	130.5	147.3	136.3	151.6	137.4	147.3	136.3	151.6	137.4	
BC040_030-BC040_020	BC040_030	BC040_020	Pipe	12	0.0130	276	0.9	2.1	2.6	3.0	3.4	0.9	2.1	2.6	3.0	3.4	168.8	160.2	153.8	146.5	160.6	147.3	160.6	151.6	160.6	147.3	160.6	151.6	
BC040_040-BC040_030	BC040_040	BC040_030	Pipe	12	0.0130	64	0.9	2.1	2.6	3.0	3.2	0.9	2.1	2.6	3.0	3.2	172.9	163.1	168.8	160.4	163.6	160.6	163.6	160.6	163.6	160.6	163.6	160.6	
BC040_050-BC040_040	BC040_050	BC040_040	Pipe	12	0.0130	252	0.9	2.1	2.6	3.0	3.2	0.9	2.1	2.6	3.0	3.2	185.7	176.0	172.9	163.2	176.5	163.6	176.5	163.6	176.5	163.6	176.5	163.6	
BC040_060-BC040_050	BC040_060	BC040_050	Pipe	12	0.0130	270	0.9	2.1	2.6	3.0	3.2	0.9	2.1	2.6	3.0	3.2	197.2	188.9	185.7	176.2	189.3	176.5	189.3	176.5	189.3	176.5	189.3	176.5	
BC040_070-BC040_060	BC040_070	BC040_060	Pipe	12	0.0130	210	0.9	2.1	2.6	3.0	3.2	0.9	2.1	2.6	3.0	3.2	215.5	197.8	197.2	189.1	198.2	189.3	198.2	189.3	198.2	189.3	198.2	189.3	
BC050_010-BC040_070	BC050_010	BC040_070	Pipe	12	0.0130	68	0.9	2.1	2.6	3.0	3.2	0.9	2.1	2.6	3.0	3.2	209.0	199.9	215.5	198.0	200.4	198.2	200.5	198.2	200.4	198.2	200.5	198.2	
BC050_020-BC050_010	BC050_020	BC050_010	Pipe	15	0.0120	115	0.8	1.9	2.3	2.7	2.9	0.8	1.9	2.3	2.7	2.9	212.8	205.5	209.0	200.1	205.9	200.4	205.9	200.5	205.9	200.4	205.9	200.5	
BC050_030-BC050_020	BC050_030	BC050_020	Pipe	15	0.0120	175	0.8	1.9	2.3	2.7	2.9	0.8	1.9	2.3	2.7	2.9	221.9	213.5	212.8	206.0	213.9	205.9	213.9	205.9	213.9	205.9	213.9	205.9	
BC060_010-BC050_030	BC060_010	BC050_030	Pipe	15	0.0120	166	0.8	1.9	2.3	2.7	2.9	0.8	1.9	2.3	2.7	2.9	228.9	222.3	221.9	213.6	222.6	213.9	222.7	213.9	222.6	213.9	222.7	213.9	
BC030_100-BC030_010	BC030_100	BC030_010	Pipe	12	0.0120	60	3.0	6.8	8.4	9.6	10.4	3.0	6.9	8.4	9.8	10.5	138.2	129.5	127.6	117.9	131.2	127.6	131.8	127.6	131.3	127.6	131.9	127.6	
BC080_010-BC030_100	BC080_010	BC030_100	Pipe	12	0.0120	205	3.0	6.8	8.4	9.7	10.4	3.0	6.9	8.4	9.8	10.5	176.5	166.6	138.2	129.5	167.2	131.2	167.2	131.8	167.2	131.3	167.2	131.9	
BC080_020-BC080_010	BC080_020	BC080_010	Pipe	12	0.0120	63	0.9	2.1	2.6	3.0	3.3	1.0	2.2	2.7	3.1	3.4	185.4	170.0	176.5	167.3	170.4	167.2	170.4	167.2	170.4	167.2	170.5	167.2	
BC080_030-BC080_020	BC080_030	BC080_020	Pipe	12	0.0120	200	0.9	2.1	2.6	3.0	3.3	1.0	2.2	2.7	3.1	3.4	212.6	204.7	185.4	170.0	205.0	170.4	205.0	170.4	205.0	170.4	205.0	170.5	
BC080_040-BC080_030	BC080_040	BC080_030	Pipe	12	0.0120	232	0.9	2.1	2.6	3.0	3.3	1.0	2.2	2.7	3.1	3.4	220.8	209.4	212.6	204.4	209.9	205.0	209.9	205.0	209.9	205.0	209.9	205.0	
BC080_050-BC080_040	BC080_050	BC080_040	Pipe	12	0.0120	297	0.9	2.1	2.6	3.0	3.3	1.0	2.2	2.7	3.1	3.4	233.5	225.4	220.8	209.6	225.8	209.9	225.8	209.9	225.8	209.9	225.8	209.9	
BC070_010-BC080_010	BC070_010	BC080_010	Pipe	12	0.0120	260	2.1	4.7	5.7	6.6	7.1	2.1	4.7	5.8	6.7	7.2	190.0	181.8	176.5	167.1	182.4	167.2	182.4	167.2	182.4	167.2	182.4	167.2	
BC070_020-BC070_010	BC070_020	BC070_010	Pipe	12	0.0120	68	2.1	4.7	5.7	6.6	7.1	2.1	4.7	5.8	6.7	7.2	203.7	193.0	190.0	182.2	193.5	182.4	193.5	182.4	193.5	182.4	193.5	182.4	
BC070_030-BC070_020	BC070_030	BC070_020	Pipe	12	0.0120	88	2.1	4.7	5.7	6.6	7.1	2.1	4.7	5.8	6.7	7.2	218.5	209.1	203.7	193.0	209.5	193.5	209.6	193.5	209.5	193.5	209.6	193.5	
BC080_040-BC070_030	BC080_040	BC080_030	Pipe	12	0.0120	232	0.9	2.1	2.6	3.0	3.3	1.0	2.2	2.7	3.1	3.4	220.8	209.4	212.6	204.4	209.9	205.0	209.9	205.0	209.9	205.0	209.9	205.0	
BC070_050-BC080_040	BC070_050	BC070_040	Pipe	12	0.0120	261	2.1	4.7	5.7	6.6	7.1	2.1	4.7	5.8	6.7	7.2	225.1	217.0	227.0	210.5	220.9	213.5	222.5	214.0	221.1	213.6	222.7	214.0	
BC090_010-BC020_100	BC090_010	BC020_100	Pipe	30	0.0120	264	8.4	19.4	24.0	28.1	30.7	9.6	22.1	27.1	31.2	33.8	81.4	69.5	78.7	66.0	70.8	67.6	70.9	67.7	70.9	67.7	71.0	67.8	
BC090_020-BC090_010	BC090_020	BC090_010	Pipe	24	0.0120	54	8.4	19.4	24.0	28.1	30.7	9.6	22.1	27.1	31.2	33.8	83.1	70.1	81.4	69.5	71.7	70.8	71.8	70.9	71.8	70.9	72.0	71.0	
BC090_030-BC090_020	BC090_030	BC090_020	Pipe	24	0.0120	244	8.4	19.4	24.1	28.1	30.7	9.6	22.1	27.1	31.2	33.8	101.5	90.7	83.1	70.1	91.6	71.7	91.6	71.8	91.6	71.8	91.7	72.0	
BC090_050-BC090_030	BC090_050	BC090_030	Pipe	12	0.0100	240	1.1	2.5	3.4	4.4	5.2	1.4	3.2	4.2	5.2	5.9	100.3	91.2	101.5	90.8	93.7	91.6	94.5	91.6	94.6	91.6	95.4	91.7	
BC090_100-BC090_030	BC090_100	BC090_030	Pipe	24	0.0120	261	7.3	16.9	20.7	23.8	25.6	8.2	19.0	23.0	26.1	27.9	126.0	115.4	101.5	90.8	116.2	91.6	116.2	91.6	116.2	91.6	116.3	91.7	
BC100_010-BC090_100	BC100_010	BC090_100	Pipe	24	0.0120	260	7.3	16.9	20.7	23.8	25.6	8.2	19.0	23.0	26.1	27.9	161.6	149.3	126.0	115.5	150.0	116.2	150.0	116.2	150.0	116.2	150.1	116.3	
BC100_020-BC100_010	BC100_020	BC100_010	Pipe	24	0.0120	260	7.3	16.9	20.7	23.8	25.6	8.2	19.0	23.0	26.1	27.9	195.4	183.2	161.6	149.4	183.9	150.0	183.9	150.0	183.9	150.0	184.0	150.1	
BC100_030-BC100_020	BC100_030	BC100_020	Pipe	24	0.0120	355	6.2	14.3	17.5	20.0	21.5	7.0	16.3	19.6	22.1	23.5	230.7	219.5	195.4	183.3	220.2	183.9	220.2	183.9	220.2	183.9	220.3	184.0	
BC110_010-BC100_030	BC110_010	BC100_030	Pipe	24	0.0120	151	6.2	14.3	17.5	20.0	21.5	7.0	16.3	19.6	22.1	23.5	237.7	224.7	230.7	219.6	225.6	220.2	225.7	220.2	225.7	220.2	225.7	220.3	
BC110_020-BC110_010	BC110_020	BC110_010	Pipe	12	0.0130	54	0.4	0.9	1.1	1.3	1.4	0.4	0.9	1.1	1.3	1.4	240.0	229.0	237.7	226.8	229.3	225.6	229.3	225.7	229.3	225.7	229.3	225.7	
BC110_030-BC110_020	BC110_030	BC110_020	Pipe	12	0.0130	225	0.4	0.9	1.1	1.3	1.4	0.4	0.9	1.1	1.3	1.4	250.0	239.5	240.0	229.5	239.8	229.3	239.8	229.3	239.8	229.3	239.8	229.3	
BC110_040-BC110_030	BC110_040	BC110_030	Pipe	12	0.0130	165	0.4	0.9	1.1	1.3	1.4	0.4	0.9	1.1	1.3	1.4	263.9	253.5	250.0	240.0	253.7	239.8	253.7	239.8	253.7	239.8	253.8	239.8	
BC110_050-BC110_040	BC110_050	BC110_040	Pipe	12	0.0130	327	0.4	0.9	1.1	1.3	1.4	0.4	0.9	1.1	1.3	1.4	269.0	257.5	263.9	254.2	257.9	253.7	257.9	253.7	257.9	253.7	257.9	253.8	
BC130_010-BC110_010	BC130_010	BC110_010	Pipe	24	0.0120	275	5.8	13.4	16.4	18.8	20.2	6.6	15.4	18.5	20.8	22.2	248.2	236.2	237.7	224.7	237.1	225.6	237.1	225.7	237.1	225.7	237.2	225.7	
BC130_020-BC130_010	BC130_020	BC130_010	Pipe	24	0.0120	373	5.8	13.4	16.4	18.8	20.2	6.6	15.4	18.5	20.8	22.2	258.0	245.4	248.2	236.5	246.4	237.1	246.5	237.1	246.5	237.1	246.5	237.2	
BC140_010-BC130_020	BC140_010	BC130_020	Pipe	24	0.0120	194	5.0	11.6	14.2	16.2	17.4	5.5	12.7	15.1	16.9	17.9	265.9	257.8	258.0	245.4	258.5	246.4	258.6	246.5	258.6	246.5	258.6	246.5	
BC140_020-BC140_010	BC140_020	BC140_010	Pipe	24	0.0130	454	5.0	11.6	14.2	16.2	17.4	5.5	12.7	15.1	16.9	17.9	281.7	270.9	265.9	258.0	271.8	258.5	271.9	258.6	271.9	258.6	271.9	258.6	
BC140_030-BC140_020	BC140_030	BC140_020	Pipe	12	0.0120	172	0.9	1.9	2.4	2.7	3.0	0.9	1.9	2.4	2.7	3.0	281.4	274.6	281.7	271.1	275.1	271.8	275.1	271.9	275.1	271.9	275.1	271.9	
BC150_010-BC140_020	BC150_010	BC140_020	Pipe	24	0.0130	284	4.2	9.8	12.0	13.7	14.6	4.7	10.9	12.8	14.4	15.1	286.6	273.5	281.7	271.1	274.7	271.8	274.7	271.9	274.7	271.9	274.7	271.9	
BC150_030-BC150_010	BC150_030	BC150_010	Pipe	12	0.0130	303	0.5	1.1	1.4	1.6	1.7	0.5	1.1	1.4	1.6	1.7	286.1	277.4	286.6	273.7	277.8	274.7	277.9	274.7	277.8	274.7	277.9	274.7	
BC150_100-BC150_010	BC150_100	BC150_010	Pipe	24	0.0130	91	3.8	8.7	10.7	12.1	13.0	4.2	9.9	11.6	12.9	13.5	287.7	274.5	286.6	273.7	275.6	274.7	275.6	274.7	275.6	274.7	275.6	274.7	
BC160_010-BC150_100	BC160_010	BC150_100	Pipe	24	0.0130	326	3.8	8.7	10.7	12.1	13.0	4.2	9.9	11.6	12.9	13.5	292.6	277.7	287.7	274.7	278.8	275.6	278.8	275.6	278.8	275.6	278.8	275.6	
BC160_020-BC160_010	BC160_020	BC160_010	Pipe	24	0.0130	96	3.8	8.7	10.7	12.2	13.0	4.2	9.9	11.6	12.9	13.5	294.1	279.0	292.6	277.7	280.0	278.8	280.0	278.8	280.0	278.8	280.0	278.8	
BC170_010-BC160_020	BC170_010	BC160_020	Pipe	18	0.0130	324	3.1	7.0	8.6	9.8	10.5	3.6	8.2	9.6	10.5	10.9	292.4	281.9	294.1	279.2	283.2	280.0	283.3	280.0	283.3	280.0	283.7	280.0	

Table A-2: Model Conduit Parameters and Results

Conduit Name (US Node - DS Node)	Node ID		Conduit Attributes				Existing S. Troutdale Model - Peak Flows (cfs)					Future S. Troutdale Model - Peak Flows (cfs)					Node Rim and Invert Elevation (IE)				Maximum Hydraulic Grade Line - Existing Conditions: 10yr 24hr HGL (feet)		Maximum Hydraulic Grade Line - Existing Conditions: 25yr 24hr HGL (feet)		Maximum Hydraulic Grade Line - Future Conditions: 10yr 24hr HGL (feet)		Maximum Hydraulic Grade Line - Future Conditions: 25yr 24hr HGL (feet)		When hydraulically deficient
	US	DS	Type	Conduit Dia or Channel Height (inches)	Manning's Roughness	Conduit Length	WQ Peak Flows (cfs)	2yr 24hr Peak Flows (cfs)	5yr 24hr Peak Flows (cfs)	10yr 24hr Peak Flow (cfs)	25yr 24hr Peak Flow (cfs)	WQ Peak Flows (cfs)	2yr 24hr Peak Flows (cfs)	5yr 24hr Peak Flows (cfs)	10yr 24hr Peak Flow (cfs)	25yr 24hr Peak Flow (cfs)	US Rim (ft)	US IE (ft)	DS Rim (ft)	DS IE (ft)	US	DS	US	DS	US	DS	US	DS	
BC170_020-BC170_010	BC170_020	BC170_010	Pipe	18	0.0130	122	3.1	7.0	8.6	9.8	10.5	3.6	8.2	9.6	10.5	10.9	293.3	282.8	292.4	282.1	284.4	283.2	284.5	283.3	284.5	283.3	284.9	283.7	
BC170_030-BC170_020	BC170_030	BC170_020	Pipe	12	0.0120	314	1.1	2.5	3.0	3.5	3.8	1.1	2.5	3.0	3.5	3.8	294.0	284.3	293.3	283.0	286.9	284.4	287.5	284.5	287.1	284.5	287.7	284.9	
BC170_040-BC170_030	BC170_040	BC170_030	Pipe	12	0.0120	204	1.1	2.5	3.1	3.5	3.8	1.1	2.5	3.0	3.5	3.8	295.4	285.3	294.0	284.5	288.6	286.9	289.4	287.5	288.7	287.1	289.6	287.7	
BC170_050-BC170_040	BC170_050	BC170_040	Pipe	12	0.0120	153	1.1	2.5	3.1	3.5	3.8	1.1	2.5	3.1	3.5	3.8	296.5	286.1	295.4	285.5	289.8	288.6	290.8	289.4	290.0	288.7	291.0	289.6	
BC170_060-BC170_050	BC170_060	BC170_050	Pipe	12	0.0120	100	1.1	2.5	3.1	3.5	3.8	1.1	2.5	3.1	3.5	3.8	294.3	287.3	296.5	286.3	290.6	289.8	291.7	290.8	290.8	290.0	291.9	291.0	
BC180_010-BC170_020	BC180_010	BC170_020	Pipe	18	0.0130	208	2.0	4.6	5.7	6.5	7.0	2.5	5.8	6.7	7.1	7.3	294.0	283.3	293.3	283.0	285.1	284.4	285.4	284.5	285.4	284.5	285.9	284.9	
BC180_020-BC180_010	BC180_020	BC180_010	Pipe	18	0.0130	194	2.0	4.6	5.7	6.4	6.9	2.5	5.8	6.7	7.1	7.3	293.8	284.3	294.0	283.5	285.8	285.1	286.2	285.4	286.3	285.4	286.9	285.9	
BC180_030-BC180_020	BC180_030	BC180_020	Pipe	18	0.0130	197	1.8	4.1	5.1	5.7	6.3	2.3	5.2	6.1	6.4	6.5	296.1	285.3	293.8	284.5	286.5	285.8	286.9	286.2	287.0	286.3	287.6	286.9	
BC180_040-BC180_030	BC180_040	BC180_030	Pipe	18	0.0130	169	1.8	4.1	5.1	5.8	6.2	2.3	5.2	6.1	6.4	6.5	297.1	287.0	296.1	285.5	287.8	286.5	287.9	286.9	287.9	287.0	288.2	287.6	
BC190_010-BC180_040	BC190_010	BC180_040	Pipe	18	0.0130	121	1.8	4.1	5.1	5.8	6.2	2.3	5.2	6.1	6.4	6.5	298.5	287.7	297.1	287.2	288.7	287.8	288.8	287.9	288.8	287.9	288.8	288.2	
BC190_020-BC190_010	BC190_020	BC190_010	Pipe	18	0.0130	335	1.8	4.1	5.1	5.8	6.2	2.3	5.2	6.1	6.4	6.5	302.2	289.6	298.5	287.9	290.6	288.7	290.6	288.8	290.7	288.8	290.7	288.8	
BC190_030-BC190_020	BC190_030	BC190_020	Pipe	18	0.0130	203	1.3	2.9	3.6	4.0	4.4	1.8	4.0	4.6	4.6	4.6	302.5	290.5	302.2	289.5	291.3	290.6	291.4	290.6	291.4	290.7	291.4	290.7	
BC190_040-BC190_030	BC190_040	BC190_030	Pipe	15	0.0130	203	1.3	2.9	3.6	4.0	4.4	1.8	4.0	4.6	4.6	4.6	301.9	291.6	302.5	290.7	292.5	291.3	292.6	291.4	292.7	291.4	292.7	291.4	
BC190_050-BC190_040	BC190_050	BC190_040	Pipe	15	0.0130	166	1.3	2.9	3.6	4.0	4.4	1.8	4.0	4.6	4.6	4.6	301.1	292.6	301.9	291.8	293.5	292.5	293.6	292.6	293.6	292.7	293.6	292.7	
BC190_060-BC190_050	BC190_060	BC190_050	Pipe	15	0.0130	201	1.3	2.9	3.6	4.0	4.4	1.8	4.0	4.6	4.6	4.6	302.4	293.7	301.1	292.8	294.6	293.5	294.7	293.6	294.8	293.6	294.8	293.6	
BC190_070-BC190_060	BC190_070	BC190_060	Pipe	15	0.0130	201	1.3	2.9	3.6	4.0	4.4	1.8	4.0	4.6	4.6	4.6	304.0	294.6	302.4	293.9	295.7	294.6	295.7	294.7	295.8	294.8	295.8	294.8	
BC200_010-BC190_070	BC200_010	BC190_070	Pipe	12	0.0130	283	1.3	2.9	3.6	4.0	4.4	1.8	4.0	4.6	4.6	4.6	307.4	297.9	304.0	294.3	299.2	295.7	300.0	295.7	300.4	295.8	300.4	295.8	
BC200_020-BC200_010	BC200_020	BC200_010	Pipe	12	0.0130	231	1.3	2.9	3.6	4.1	4.4	1.8	4.1	4.6	4.6	4.6	310.3	300.6	307.4	298.1	302.0	299.2	303.4	300.0	304.1	300.4	304.1	300.4	
BC200_030-BC200_020	BC200_030	BC200_020	Pipe	12	0.0130	236	1.3	2.9	3.6	4.1	4.4	1.8	4.1	4.6	4.6	4.7	313.0	302.1	310.3	300.8	304.9	302.0	306.8	303.4	307.8	304.1	307.8	304.1	
BC200_040-BC200_030	BC200_040	BC200_030	Pipe	12	0.0130	236	1.3	2.9	3.6	4.1	4.4	1.8	4.1	4.7	4.8	4.9	313.6	303.4	313.0	302.3	307.9	304.9	310.2	306.8	311.4	307.8	311.4	307.8	
BC200_050-BC200_040	BC200_050	BC200_040	Pipe	12	0.0130	163	1.3	2.9	3.6	4.1	4.4	1.8	4.1	4.8	5.0	5.1	313.8	304.2	313.6	303.6	310.0	307.9	312.5	310.2	313.8	311.4	313.8	311.4	5-yr Future
Outfall BC020																													
BC210_010-O_BC020	BC210_010	O_BC020	Pipe	30	0.0120	51	4.2	9.4	11.5	13.3	14.4	4.2	9.4	11.5	13.3	14.4	165.5	148.8	156.5	148.6	149.9	149.7	150.0	149.7	149.9	149.7	150.0	149.7	
BC210_020-BC210_010	BC210_020	BC210_010	Pipe	30	0.0120	178	4.2	9.4	11.5	13.3	14.4	4.2	9.4	11.5	13.3	14.4	167.7	149.9	165.5	149.0	151.0	149.9	151.1	150.0	151.0	149.9	151.1	150.0	
BC210_030-BC210_020	BC210_030	BC210_020	Pipe	30	0.0120	92	4.2	9.4	11.5	13.3	14.4	4.2	9.4	11.5	13.3	14.4	169.6	150.6	167.7	150.1	151.7	151.0	151.8	151.1	151.7	151.0	151.8	151.1	
BC210_040-BC210_030	BC210_040	BC210_030	Pipe	18	0.0120	139	1.5	3.4	4.2	4.8	5.2	1.5	3.4	4.2	4.8	5.2	171.3	152.2	169.6	150.8	152.9	151.7	152.9	151.8	152.9	151.7	152.9	151.8	
BC210_050-BC210_040	BC210_050	BC210_040	Pipe	12	0.0120	231	0.8	1.9	2.3	2.7	2.9	0.8	1.9	2.3	2.7	2.9	172.4	157.0	171.3	132.5	157.4	152.9	157.5	152.9	157.4	152.9	157.5	152.9	
BC210_100-BC210_040	BC210_100	BC210_040	Pipe	12	0.0120	63	0.7	1.5	1.8	2.1	2.3	0.7	1.5	1.8	2.1	2.3	173.1	158.5	171.3	152.4	158.8	152.9	158.8	152.9	158.8	152.9	158.8	152.9	
BC210_110-BC210_100	BC210_110	BC210_100	Pipe	12	0.0120	258	0.7	1.5	1.8	2.1	2.3	0.7	1.5	1.8	2.1	2.3	194.6	184.5	173.1	158.7	184.8	158.8	184.8	158.8	184.8	158.8	184.8	158.8	
BC210_120-BC210_110	BC210_120	BC210_110	Pipe	12	0.0120	96	0.7	1.5	1.8	2.1	2.3	0.7	1.5	1.8	2.1	2.3	205.2	195.3	194.6	184.7	195.6	184.8	195.6	184.8	195.6	184.8	195.6	184.8	
BC220_010-BC210_120	BC220_010	BC210_120	Pipe	12	0.0120	155	0.7	1.5	1.8	2.1	2.3	0.7	1.5	1.8	2.1	2.3	212.2	202.5	205.2	195.5	202.8	195.6	202.8	195.6	202.8	195.6	202.8	195.6	
BC220_020-BC220_010	BC220_020	BC220_010	Pipe	12	0.0120	147	0.7	1.5	1.8	2.1	2.3	0.7	1.5	1.8	2.1	2.3	226.0	215.7	212.2	202.7	216.0	202.8	216.0	202.8	216.0	202.8	216.0	202.8	
BC220_030-BC220_020	BC220_030	BC220_020	Pipe	12	0.0120	300	0.7	1.5	1.8	2.1	2.3	0.7	1.5	1.8	2.1	2.3	240.5	227.9	226.0	215.5	228.3	216.0	228.3	216.0	228.3	216.0	228.3	216.0	
BC220_050-BC220_030	BC220_050	BC220_030	Pipe	12	0.0130	313	0.7	1.5	1.8	2.1	2.3	0.7	1.5	1.8	2.1	2.3	249.0	242.4	240.5	228.1	242.8	228.3	242.8	228.3	242.8	228.3	242.8	228.3	
BC230_010-BC210_030	BC230_010	BC210_030	Pipe	24	0.0120	70	2.7	6.1	7.4	8.5	9.2	2.7	6.1	7.4	8.5	9.2	168.8	151.1	169.6	150.8	152.1	151.7	152.2	151.8	152.1	151.7	152.2	151.8	
BC230_020-BC230_010	BC230_020	BC230_010	Pipe	24	0.0120	99	2.7	6.1	7.4	8.5	9.2	2.7	6.1	7.4	8.5	9.2	167.6	151.8	168.8	151.3	152.8	152.1	152.9	152.2	152.8	152.1	152.9	152.2	
BC230_030-BC230_020	BC230_030	BC230_020	Pipe	24	0.0120	280	2.2	4.9	6.0	6.9	7.5	2.2	4.9	6.0	6.9	7.5	165.0	153.4	167.6	152.0	154.3	152.8	154.3	152.9	154.3	152.8	154.3	152.9	
BC230_040-BC230_030	BC230_040	BC230_030	Pipe	24	0.0120	173	2.2	4.9	6.0	6.9	7.5	2.2	4.9	6.0	6.9	7.5	163.3	154.5	165.0	153.6	155.4	154.3	155.4	154.3	155.4	154.3	155.4	154.3	
BC250_010-BC230_040	BC250_010	BC230_040	Pipe	24	0.0120	93	2.2	4.9	6.0	6.9	7.5	2.2	4.9	6.0	6.9	7.5	164.5	155.2	163.3	154.7	156.0	155.4	156.1	155.4	156.0	155.4	156.1	155.4	
BC240_010-BC250_020	BC240_010	BC250_020	Pipe	12	0.0120	196	0.3	0.6	0.7	0.9	0.9	0.3	0.6	0.7	0.9	0.9	168.2	157.0	167.7	156.0	157.4	156.7	157.4	156.7	157.4	156.7	157.4	156.7	
BC250_020-BC250_010	BC250_020	BC250_010	Pipe	24	0.0120	88	2.2	4.9	6.0	6.9	7.5	2.2	4.9	6.0	6.9	7.5	167.7	155.8	164.5	155.4	156.7	156.0	156.7	156.1	156.7	156.0	156.7	156.1	
BC250_030-BC250_020	BC250_030	BC250_020	Pipe	18	0.0120	120	0.6	1.4	1.8	2.0	2.2	0.6	1.4	1.8	2.0	2.2	166.5	157.2	167.7	156.0	157.6	156.7	157.7	156.7	157.6	156.7	157.7	156.7	
BC250_040-BC250_030	BC250_040	BC250_030	Pipe	18	0.0120	156	0.6	1.4	1.8	2.0	2.2	0.6	1.4	1.8	2.0	2.2	168.4	159.0	166.5	157.4	159.4	157.6	159.4	157.7	159.4	157.6	159.4	157.7	
BC250_050-BC250_040	BC250_050	BC250_040	Pipe	12	0.0120	283	0.6	1.4	1.8	2.0	2.2	0.6	1.4	1.8	2.0	2.2	176.6	167.0	168.4	159.5	167.4	159.4	167.4	159.4	167.4	159.4	167.4	159.4	
BC250_060-BC250_050	BC250_060	BC250_050	Pipe	12	0.0120	254	0.6	1.4	1.8	2.0	2.2	0.6	1.4	1.8	2.0	2.2	190.1	180.7	176.6	167.2	181.0	167.4	181.0	167.4	181.0	167.4	181.0	167.4	
BC250_100-BC250_020	BC250_100	BC250_020	Pipe	18	0.0120	120	1.3	2.9	3.5	4.0	4.4	1.3	2.9	3.5	4.0	4.4	170.6	157.2	167.7	156.0	157.8	156.7	157.9	156.7	157.8	156.7	157.9	156.7	
BC260_010-BC250_100	BC260_010	BC250_100	Pipe	18	0.0120	121	1.3	2.9	3.5	4.0	4.4	1.3	2.9	3.5	4.0	4.4	173.1	158.6	170.6	157.4	159.2	157.8	159.3	157.9	159.2	157.8	159.3	157.9	
BC260_020-BC260_010	BC260_020	BC260_010	Pipe	18	0.0120	102	1.3	2.9	3.5	4.0	4.4	1.3	2.9	3.5	4.0	4.4	174.8	159.3	173.1	158.8	160.1	159.2	160.1	159.3	160.1	159.2	160.1	159.3	
BC260_030-BC260_020	BC260_030	BC260_020	Pipe	18	0.0120	156	1.3	2.9	3.5	4.0	4.4	1.3	2.9	3.5	4.0	4.4	169.6	160.3	174.8	159.5	161.1	160.1	161.1	160.1	161.1	160.1	161.1	160.1	
BC260_040-BC260_030	BC260_040	BC260_030	Pipe	18	0.0120	117	1.3	2.9	3.5	4.0	4.4	1.3	2.9	3.5	4.0	4.4	168.0	160.9	169.6	160.5	161.7	161.1	161.8	161.1	161.7	161.1	161.8	161.1	
BC260_050-BC260_040	BC260_050	BC260_040	Pipe	18	0.0120	179	1.3	2.9	3.5	4.0	4.4	1.3	2.9	3.5	4.0	4.4	172.2	162.3	168.0	161.1	163.0	161.7	163.0	161.8	163.0	161.7	163.0	161.8	
BC260_060-BC260_050	BC260_060	BC260_050	Pipe	12	0.0120	231	1.3	2.9	3.5	4.0	4.4	1.3	2.9	3.5	4.0	4.4	186.4	174.8	172.2	163.0	175.3	163.0	175.3	163.0	175.3	163.0	175.3	163.0	
BC260_070-BC260_060	BC260_070	BC260_060	Pipe	12	0.0120	275	1.3	2.9	3.5	4.0	4.4	1.3	2.9	3.5	4.0	4.4	226.9	219.3	186.4	177.0	219.7	175.3	219.7	175.3	219.7	175.3	219.7	175.3	
BC260_080-BC260_070	BC260_080	BC260_070	Pipe	12	0.0120	300	1.3	2.9	3.5	4.0	4.4	1.3	2.9	3.5	4.0	4.4	240.1	230.2	226.9	218.7	230.7	219.7	230.7	219.7	230.7	219.7	230.7	219.7	
BC260_090-BC260_080	BC260_090	BC260_080	Pipe	12	0.0120	299	1.3	2.9	3.5	4.0	4.4	1.3	2.9	3.5	4.0	4.4	253.4	243.1	240.1	231.1	243.6	230.7	243.6	230.7	243.6	230.7	243.6	230.7	
BC260_100-BC260_090	BC260_100	BC260_090	Pipe	12	0.0130	103	1.3	2.9	3.5	4.0	4.4	1.3	2.9	3.5	4.0	4.4	256.2	249.6	253.4	244.7	250.1	243.6	250.1	243.6	250.1	243.6	250.1	243.6	
Outfall BC030																													
BC270_010-O_BC030	BC270_010	O_BC030	Pipe	12	0.0120	173	2.4	5.5	6.7	7.8	8.4	2.4	5.5	6.7	7.8	8.4	168.5	161.7	145.1	133.0	162.2	133.5	162.2	133.5	162.2	133.5	162.2	133.5	
BC270_020-BC270_010	BC270_020	BC270_010	Pipe	18	0.0120	138	2.4	5.5	6.7	7.8	8.4	2.4	5.5	6.7	7.8	8.4	173.2	165.0	168.5	161.7	165.8	162.2	165.8	162.2	165.8	162.2	165.8	162.2	
BC270_030-BC270_020	BC270_030	BC270_020	Pipe	18	0.0120	50.85	2.4	5.5	6.7	7.8	8.4	2.4	5.5	6.7	7.8	8.4	173.0	165.7	173.2	165.2	166.6	165.8	166.7	165.8	166.6	165.8	166.7	165.8	
BC270_040-BC270_030	BC270_040	BC270_030	Pipe	18	0.0120	117	2.4	5.5	6.7	7.8	8.4	2.4	5.5	6.7	7.8	8.4	174.0	167.4	173.0	165.9	168.2	166.6	168.3	166.7	168.2	166.6	168.3	166.7	

Table A-2: Model Conduit Parameters and Results

Conduit Name (US Node - DS Node)	Node ID		Conduit Attributes				Existing S. Troutdale Model - Peak Flows (cfs)					Future S. Troutdale Model - Peak Flows (cfs)					Node Rim and Invert Elevation (IE)				Maximum Hydraulic Grade Line - Existing Conditions: 10yr 24hr HGL (feet)		Maximum Hydraulic Grade Line - Existing Conditions: 25yr 24hr HGL (feet)		Maximum Hydraulic Grade Line - Future Conditions: 10yr 24hr HGL (feet)		Maximum Hydraulic Grade Line - Future Conditions: 25yr 24hr HGL (feet)		When hydraulically deficient
	US	DS	Type	Conduit Dia or Channel Height (inches)	Manning's Roughness	Conduit Length	WQ Peak Flows (cfs)	2yr 24hr Peak Flows (cfs)	5yr 24hr Peak Flows (cfs)	10yr 24hr Peak Flow (cfs)	25yr 24hr Peak Flow (cfs)	WQ Peak Flows (cfs)	2yr 24hr Peak Flows (cfs)	5yr 24hr Peak Flows (cfs)	10yr 24hr Peak Flow (cfs)	25yr 24hr Peak Flow (cfs)	US Rim (ft)	US IE (ft)	DS Rim (ft)	DS IE (ft)	US	DS	US	DS	US	DS	US	DS	
BC270_050-BC270_040	BC270_050	BC270_040	Pipe	15	0.0120	299	2.0	4.6	5.6	6.5	7.0	2.0	4.6	5.6	6.5	7.0	185.0	177.5	174.0	167.6	178.1	168.2	178.2	168.3	178.1	168.2	178.2	168.3	
BC280_010-BC270_050	BC280_010	BC270_050	Pipe	15	0.0120	139	2.0	4.6	5.6	6.5	7.0	2.0	4.6	5.6	6.5	7.0	193.6	184.3	185.0	178.3	184.9	178.1	184.9	178.2	184.9	178.1	184.9	178.2	
BC280_020-BC280_010	BC280_020	BC280_010	Pipe	15	0.0120	108	2.0	4.6	5.6	6.5	7.0	2.0	4.6	5.6	6.5	7.0	196.2	185.4	193.6	184.3	186.3	184.9	186.4	184.9	186.3	184.9	186.4	184.9	
BC280_030-BC280_020	BC280_030	BC280_020	Pipe	15	0.0120	158	2.0	4.6	5.6	6.5	7.0	2.0	4.6	5.6	6.5	7.0	194.3	186.9	196.2	185.4	187.9	186.3	188.0	186.4	187.9	186.3	188.0	186.4	
BC280_040-BC280_030	BC280_040	BC280_030	Pipe	12	0.0120	353	2.0	4.6	5.6	6.5	7.0	2.0	4.6	5.6	6.5	7.0	200.3	192.9	194.3	187.2	197.8	187.9	199.2	188.0	197.8	187.9	199.2	188.0	
BC280_050-BC280_040	BC280_050	BC280_040	Pipe	12	0.0120	320	2.0	4.6	5.7	6.5	7.0	2.0	4.6	5.7	6.5	7.0	218.2	211.3	200.3	192.9	212.0	197.8	212.0	199.2	212.0	197.8	212.0	199.2	
Outfall BC040																													
BC300_010-O_BC040	BC300_010	O_BC040	Pipe	12	0.0120	234	2.9	6.6	8.2	10.2	11.6	2.9	6.6	8.2	10.2	11.6	171.3	161.3	107.3	106.2	161.8	106.7	161.8	106.8	161.8	106.7	161.8	106.8	
BC300_020-BC300_010	BC300_020	BC300_010	Pipe	18	0.0120	100	2.9	6.6	8.2	10.2	11.6	2.9	6.6	8.2	10.2	11.6	176.2	163.0	171.3	161.3	164.0	161.8	164.1	161.8	164.0	161.8	164.1	161.8	
BC290_010-BC300_020	BC290_010	BC300_020	Pipe	12	0.0120	143	0.3	0.8	1.0	1.1	1.2	0.3	0.8	1.0	1.1	1.2	173.0	165.5	176.2	164.0	165.9	164.0	165.9	164.1	165.9	164.0	165.9	164.1	
BC300_030-BC300_020	BC300_030	BC300_020	Pipe	15	0.0120	178	2.4	5.4	6.7	8.7	9.7	2.4	5.4	6.7	8.7	9.6	179.2	166.5	176.2	163.2	167.4	164.0	167.5	164.1	167.4	164.0	167.5	164.1	
BC310_010-BC300_030	BC310_010	BC300_030	Pipe	12	0.0120	110	0.2	0.5	0.6	0.7	0.8	0.2	0.5	0.6	0.7	0.8	177.3	169.9	179.2	169.0	170.2	167.4	170.2	167.5	170.2	167.4	170.2	167.5	
BC310_020-BC310_010	BC310_020	BC310_010	Pipe	12	0.0120	230	0.2	0.5	0.6	0.7	0.8	0.2	0.5	0.6	0.7	0.8	177.8	170.8	177.3	169.9	171.2	170.2	171.2	170.2	171.2	170.2	171.2	170.2	
BC320_010-BC300_030	BC320_010	BC300_030	Pipe	12	0.0120	179	2.1	4.9	6.1	8.0	8.9	2.2	4.9	6.1	8.0	8.9	183.8	177.2	179.2	169.0	178.0	167.4	179.1	167.5	178.0	167.4	179.1	167.5	
BC320_020-BC320_010	BC320_020	BC320_010	Pipe	12	0.0120	195	2.1	4.9	6.1	8.0	9.2	2.2	4.9	6.1	8.0	9.2	193.4	184.2	183.8	177.2	186.2	178.0	189.1	179.1	186.3	178.0	189.1	179.1	
BC320_030-BC320_020	BC320_030	BC320_020	Pipe	12	0.0120	135	0.5	1.5	1.6	1.7	2.0	0.5	1.5	1.6	1.7	2.0	189.2	184.5	193.4	184.8	186.5	186.2	189.2	189.1	186.6	186.3	189.2	189.1	25-yr Existing
BC320_040-BC320_030	BC320_040	BC320_030	Pipe	12	0.0120	150	0.5	1.1	1.4	1.7	2.2	0.5	1.1	1.4	1.7	2.2	192.8	184.5	189.2	183.9	186.8	186.5	189.6	189.2	186.8	186.6	189.6	189.2	
BC330_010-BC320_020	BC330_010	BC320_020	Pipe	12	0.0120	160	1.6	3.7	4.8	6.4	7.9	1.6	3.7	4.8	6.4	7.9	202.9	196.3	193.4	186.0	196.9	186.2	197.0	189.1	196.9	186.3	197.0	189.1	
BC330_020-BC330_010	BC330_020	BC330_010	Pipe	12	0.0120	93	1.1	2.4	3.4	4.8	5.7	1.1	2.5	3.4	4.8	5.7	208.6	202.0	202.9	196.3	202.5	196.9	202.6	197.0	202.5	196.9	202.6	197.0	
BC330_030-BC330_020	BC330_030	BC330_020	Pipe	12	0.0120	147	1.1	2.4	3.4	4.8	5.7	1.1	2.5	3.4	4.8	5.7	214.2	207.5	208.6	202.0	208.1	202.5	208.2	202.6	208.1	202.5	208.2	202.6	
BC330_040-BC330_030	BC330_040	BC330_030	Pipe	12	0.0120	161	1.1	2.4	3.4	4.8	5.7	1.1	2.5	3.4	4.8	5.7	224.5	217.6	214.2	207.5	218.1	208.1	218.2	208.2	218.1	208.1	218.2	208.2	
BC330_050-BC330_040	BC330_050	BC330_040	Pipe	12	0.0130	309	1.1	2.4	3.4	4.8	5.7	1.1	2.5	3.4	4.8	5.7	246.5	235.6	224.5	217.6	236.1	218.1	236.2	218.2	236.1	218.1	236.2	218.2	
BC340_010-BC330_050	BC340_010	BC330_050	Pipe	12	0.0130	306	0.2	0.5	0.6	0.7	0.7	0.2	0.5	0.6	0.7	0.7	260.5	253.0	246.5	237.6	253.2	236.1	253.2	236.2	253.2	236.1	253.2	236.2	
BC350_010-BC330_050	BC350_010	BC330_050	Pipe	12	0.0100	209	0.9	2.0	2.9	4.2	5.1	0.9	2.0	2.9	4.2	5.1	257.5	249.2	246.5	235.8	249.6	236.1	249.7	236.2	249.6	236.1	249.7	236.2	
BC350_020-BC350_010	BC350_020	BC350_010	Pipe	12	0.0100	145	0.9	2.0	2.9	4.2	5.1	0.9	2.0	2.9	4.2	5.1	267.9	259.3	257.5	249.4	259.7	249.6	259.8	249.7	259.7	249.6	259.8	249.7	
BC350_030-BC350_020	BC350_030	BC350_020	Pipe	12	0.0120	173	0.9	2.0	2.9	4.2	5.1	0.9	2.0	2.9	4.2	5.1	275.2	266.6	267.9	259.5	267.1	259.7	267.2	259.8	267.1	259.7	267.2	259.8	
BC350_040-BC350_030	BC350_040	BC350_030	Pipe	12	0.0100	212	0.9	2.0	2.9	4.2	5.1	0.9	2.0	2.9	4.2	5.1	283.9	275.6	275.2	266.8	276.1	267.1	276.1	267.2	276.1	267.1	276.1	267.2	
Outfall BC360																													
BC360_010-O_BC360	BC360_010	O_BC360	Pipe	24	0.0130	71.2	3.0	6.9	8.5	10.0	11.0	3.0	6.9	8.5	10.0	11.0	173.7	142.0	115.2	113.1	142.4	113.5	142.4	113.5	142.4	113.5	142.4	113.5	
BC360_020-BC360_010	BC360_020	BC360_010	Pipe	21	0.0120	86.4	3.0	6.9	8.5	10.0	11.0	3.0	6.9	8.5	10.0	11.0	174.5	162.5	173.7	156.8	163.0	142.4	163.1	142.4	163.0	142.4	163.1	142.4	
BC360_030-BC360_020	BC360_030	BC360_020	Pipe	21	0.0120	275	2.5	5.7	7.0	8.1	8.8	2.5	5.7	7.0	8.1	8.8	175.9	164.5	174.5	162.5	165.5	163.0	165.6	163.1	165.5	163.0	165.6	163.1	
BC370_010-BC360_030	BC370_010	BC360_030	Pipe	18	0.0120	135	2.5	5.7	7.0	8.1	8.8	2.5	5.7	7.0	8.1	8.8	175.0	166.3	175.9	164.7	167.2	165.5	167.2	165.6	167.2	165.5	167.2	165.6	
BC370_020-BC370_010	BC370_020	BC370_010	Pipe	18	0.0120	165	2.5	5.7	7.0	8.1	8.8	2.5	5.7	7.0	8.1	8.8	177.1	167.9	175.0	166.3	168.9	167.2	168.9	167.2	168.9	167.2	168.9	167.2	
BC370_040-BC370_020	BC370_040	BC370_020	Pipe	12	0.0120	125	0.7	1.6	1.9	2.2	2.4	0.7	1.6	1.9	2.2	2.4	175.3	169.7	177.1	168.0	170.2	168.9	170.3	168.9	170.2	168.9	170.3	168.9	
BC370_100-BC370_020	BC370_100	BC370_020	Pipe	15	0.0120	145	1.8	4.2	5.1	5.9	6.4	1.8	4.2	5.1	5.9	6.4	178.9	171.3	177.1	169.2	172.1	168.9	172.2	168.9	172.1	168.9	172.2	168.9	
BC370_110-BC370_100	BC370_110	BC370_100	Pipe	15	0.0120	165	1.8	4.2	5.1	5.9	6.4	1.8	4.2	5.1	5.9	6.4	180.2	174.0	178.9	171.3	174.7	172.1	174.8	172.2	174.7	172.1	174.8	172.2	
BC380_010-BC370_110	BC380_010	BC370_110	Pipe	12	0.0120	80	1.8	4.2	5.1	5.9	6.4	1.8	4.2	5.1	5.9	6.4	181.5	177.0	180.2	174.1	177.7	174.7	177.7	174.8	177.7	174.7	177.7	174.8	
BC380_020-BC380_010	BC380_020	BC380_010	Pipe	12	0.0120	76	0.5	1.2	1.5	1.8	2.1	0.5	1.2	1.5	1.8	2.1	184.3	176.1	181.5	174.1	177.8	177.7	177.9	177.7	177.8	177.7	177.9	177.7	
BC380_030-BC380_020	BC380_030	BC380_020	Pipe	12	0.0120	152	0.5	1.2	1.5	1.7	2.0	0.5	1.2	1.5	1.7	2.0	189.0	179.0	184.3	177.1	179.4	177.8	179.5	177.9	179.4	177.8	179.5	177.9	
BC380_040-BC380_030	BC380_040	BC380_030	Pipe	12	0.0120	267	0.5	1.2	1.5	1.7	2.0	0.5	1.2	1.5	1.7	2.0	200.5	191.0	189.0	179.0	191.3	179.4	191.3	179.5	191.3	179.4	191.3	179.5	
BC380_050-BC380_040	BC380_050	BC380_040	Pipe	12	0.0120	214	0.5	1.2	1.5	1.7	2.0	0.5	1.2	1.5	1.7	2.0	208.7	198.9	200.5	191.2	199.2	191.3	199.3	191.3	199.2	191.3	199.3	191.3	
BC380_060-BC380_050	BC380_060	BC380_050	Pipe	12	0.0120	282	0.5	1.2	1.5	1.7	2.0	0.5	1.2	1.5	1.7	2.0	231.2	219.4	208.7	199.1	219.7	199.2	219.7	199.3	219.7	199.2	219.7	199.3	
BC390_010-BC380_060	BC390_010	BC380_060	Pipe	12	0.0120	188	0.5	1.2	1.5	1.7	2.0	0.5	1.2	1.5	1.7	2.0	242.0	232.6	231.2	219.5	232.9	219.7	232.9	219.7	232.9	219.7	232.9	219.7	
BC390_020-BC390_010	BC390_020	BC390_010	Pipe	12	0.0120	148	0.5	1.2	1.5	1.7	2.0	0.5	1.2	1.5	1.7	2.0	247.0	237.5	242.0	232.8	237.9	232.9	237.9	232.9	237.9	232.9	237.9	232.9	
Outfall BC420																													
BC400_010-O_BC420	BC400_010	O_BC420	Pipe	36	0.0120	175	5.6	12.7	16.0	20.2	23.5	5.6	12.7	16.0	20.2	23.5	173.4	154.0	173.3	153.0	155.2	154.2	155.4	154.3	155.2	154.2	155.4	154.3	
BC400_020-BC400_010	BC400_020	BC400_010	Pipe	18	0.0120	100	2.2	4.9	6.5	8.5	9.9	2.2	4.9	6.5	8.5	9.9	172.7	155.9	173.4	154.3	156.7	155.2	156.8	155.4	156.7	155.2	156.8	155.4	
BC400_030-BC400_020	BC400_030	BC400_020	Pipe	18	0.0120	256	1.2	2.8	3.4	3.9	4.4	1.2	2.8	3.4	3.9	4.4	171.3	157.4	172.7	156.2	158.1	156.7	158.2	156.8	158.1	156.7	158.2	156.8	
BC400_040-BC400_030	BC400_040	BC400_030	Pipe	18	0.0120	69	1.2	2.8	3.4	3.9	4.4	1.2	2.8	3.4	3.9	4.4	170.9	157.8	171.3	157.5	158.6	158.1	158.6	158.2	158.6	158.1	158.6	158.2	
BC400_050-BC400_040	BC400_050	BC400_040	Pipe	18	0.0120	237	1.2	2.8	3.4	3.9	4.4	1.2	2.8	3.4	3.9	4.4	169.9	158.8	170.9	157.9	159.6	158.6	159.7	158.6	159.6	158.6	159.7	158.6	
BC400_060-BC400_050	BC400_060	BC400_050	Pipe	12	0.0120	254	1.2	2.8	3.4	3.9	4.4	1.2	2.8	3.4	3.9	4.4	168.1	160.9	169.9	159.3	162.8	159.6	163.4	159.7	162.8	159.6	163.4	159.7	
BC410_010-BC400_020	BC410_010	BC400_020	Pipe	15	0.0120	244	0.9	2.1	3.3	4.7	5.5	0.9	2.1	3.3	4.7	5.5	171.5	158.3	172.7	156.5	159.1	156.7	159.3	156.8	159.1	156.7	159.3	156.8	
BC410_020-BC410_010	BC410_020	BC410_010	Pipe	15	0.0120	215	0.9	2.1	3.3	4.8	5.6	0.9	2.1	3.3	4.8	5.6	172.3	159.3	171.5	158.3	160.3	159.1	160.6	159.3	160.3	159.1	160.6	159.3	
BC410_030-BC410_020	BC410_030	BC410_020	Pipe	15	0.0120	345	0.9	2.1	3.3	4.8	5.6	0.9	2.1	3.3	4.8	5.6	170.6	161.0	172.3	159.3	162.0	160.3	162.8	160.6	162.0	160.3	162.8	160.6	
BC410_040-BC410_030	BC410_040	BC410_030	Pipe	12	0.0120	143	0.9	2.1	3.3	4.8	5.7	0.9	2.1	3.3	4.8	5.6	171.3	161.8	170.6	161.2	164.3	162.0	165.6	162.8	164.3	162.0	165.6	162.8	
BC410_050-BC410_040	BC410_050	BC410_040	Pipe	12	0.0120	297	0.9	2.1	3.4	4.8	5.7	0.9	2.1	3.4	4.8	5.7	171.4	163.0	171.3	161.8	168.8	164.3	171.4	165.6	168.8	164.3	171.4	165.6	25-yr Existing

Table A-2: Model Conduit Parameters and Results

Conduit Name (US Node - DS Node)	Node ID		Conduit Attributes				Existing S. Troutdale Model - Peak Flows (cfs)					Future S. Troutdale Model - Peak Flows (cfs)					Node Rim and Invert Elevation (IE)				Maximum Hydraulic Grade Line - Existing Conditions: 10yr 24hr HGL (feet)		Maximum Hydraulic Grade Line - Existing Conditions: 25yr 24hr HGL (feet)		Maximum Hydraulic Grade Line - Future Conditions: 10yr 24hr HGL (feet)		Maximum Hydraulic Grade Line - Future Conditions: 25yr 24hr HGL (feet)		When hydraulically deficient
	US	DS	Type	Conduit Dia or Channel Height (inches)	Manning's Roughness	Conduit Length	WQ Peak Flows (cfs)	2yr 24hr Peak Flows (cfs)	5yr 24hr Peak Flows (cfs)	10yr 24hr Peak Flow (cfs)	25yr 24hr Peak Flow (cfs)	WQ Peak Flows (cfs)	2yr 24hr Peak Flows (cfs)	5yr 24hr Peak Flows (cfs)	10yr 24hr Peak Flow (cfs)	25yr 24hr Peak Flow (cfs)	US Rim (ft)	US IE (ft)	DS Rim (ft)	DS IE (ft)	US	DS	US	DS	US	DS	US	DS	
BC420_010-BC400_010	BC420_010	BC400_010	Pipe	30	0.0120	117	3.4	7.8	9.7	11.8	13.6	3.4	7.8	9.7	11.8	13.6	173.9	156.6	173.4	155.0	157.4	155.2	157.5	155.4	157.4	155.2	157.5	155.4	
BC420_020-BC420_010	BC420_020	BC420_010	Pipe	30	0.0120	111	2.2	5.0	6.2	7.1	7.7	2.2	5.0	6.2	7.1	7.7	174.7	164.5	173.9	163.9	165.3	157.4	165.3	157.5	165.3	157.4	165.3	157.5	
BC420_030-BC420_020	BC420_030	BC420_020	Pipe	27	0.0120	358	1.7	4.0	4.9	5.6	6.1	1.7	4.0	4.9	5.6	6.1	176.5	166.3	174.7	164.5	167.0	165.3	167.1	165.3	167.0	165.3	167.1	165.3	
BC420_040-BC420_030	BC420_040	BC420_030	Pipe	27	0.0120	130	1.7	4.0	4.9	5.6	6.1	1.7	4.0	4.9	5.6	6.1	177.2	159.7	176.5	158.8	167.1	167.0	167.1	167.1	167.1	167.0	167.1	167.1	
BC420_050-BC420_040	BC420_050	BC420_040	Pipe	27	0.0120	118	1.7	4.0	4.9	5.6	6.1	1.7	4.0	4.9	5.6	6.1	178.0	168.5	177.2	166.9	169.1	167.1	169.1	167.1	169.1	167.1	169.1	167.1	
BC430_010-BC420_010	BC430_010	BC420_010	Pipe	24	0.0120	244	1.2	2.8	3.6	4.9	6.2	1.2	2.8	3.6	4.9	6.2	172.6	158.8	173.9	156.6	159.4	157.4	159.5	157.5	159.4	157.4	159.5	157.5	
BC430_020-BC430_010	BC430_020	BC430_010	Pipe	24	0.0120	102	1.2	2.8	3.6	4.9	6.2	1.2	2.8	3.6	4.9	6.2	173.5	159.7	172.6	158.8	160.4	159.4	160.4	159.5	160.4	159.4	160.4	159.5	
BC430_030-BC430_020	BC430_030	BC430_020	Pipe	18	0.0120	110	1.2	2.8	3.6	4.9	6.2	1.2	2.8	3.6	4.9	6.2	174.3	161.0	173.5	160.0	161.7	160.4	161.8	160.4	161.7	160.4	161.8	160.4	
BC430_040-BC430_030	BC430_040	BC430_030	Pipe	18	0.0120	115	1.2	2.8	3.6	4.9	6.2	1.2	2.8	3.6	4.9	6.2	175.1	162.0	174.3	161.0	162.7	161.7	162.8	161.8	162.7	161.7	162.8	161.8	
BC430_050-BC430_040	BC430_050	BC430_040	Pipe	15	0.0120	106	1.2	2.8	3.6	4.9	6.2	1.2	2.8	3.6	4.9	6.2	176.0	163.2	175.1	162.2	164.0	162.7	164.1	162.8	164.0	162.7	164.1	162.8	
BC430_060-BC430_050	BC430_060	BC430_050	Pipe	15	0.0120	252	1.2	2.8	3.6	4.9	6.2	1.2	2.8	3.6	4.9	6.2	177.8	165.5	176.0	163.2	166.3	164.0	166.4	164.1	166.3	164.0	166.4	164.1	
BC430_070-BC430_060	BC430_070	BC430_060	Pipe	15	0.0120	100	1.2	2.8	3.6	4.9	6.2	1.2	2.8	3.6	4.9	6.2	178.5	165.9	177.8	165.5	166.9	166.3	167.2	166.4	166.9	166.3	167.2	166.4	
BC430_080-BC430_070	BC430_080	BC430_070	Pipe	15	0.0120	174	1.2	2.8	3.6	4.9	6.2	1.2	2.8	3.6	4.9	6.2	179.9	166.6	178.5	165.9	167.7	166.9	168.6	167.2	167.7	166.9	168.6	167.2	
BC430_090-BC430_080	BC430_090	BC430_080	Pipe	12	0.0120	180	1.2	2.8	3.6	5.0	6.2	1.2	2.8	3.6	5.0	6.2	178.7	167.9	179.9	166.8	170.6	167.7	173.0	168.6	170.6	167.7	173.0	168.6	
BC440_010-BC420_050	BC440_010	BC420_050	Pipe	15	0.0120	111	0.7	1.5	1.9	2.2	2.4	0.7	1.5	1.9	2.2	2.4	178.5	169.1	178.0	168.5	169.7	169.1	169.7	169.1	169.7	169.1	169.7	169.1	
BC440_020-BC440_010	BC440_020	BC440_010	Pipe	15	0.0120	81	0.7	1.5	1.9	2.2	2.4	0.7	1.5	1.9	2.2	2.4	178.8	169.5	178.5	169.1	170.1	169.7	170.1	169.7	170.1	169.7	170.1	169.7	
BC440_030-BC440_020	BC440_030	BC440_020	Pipe	15	0.0120	260	0.7	1.6	1.9	2.2	2.4	0.7	1.6	1.9	2.2	2.4	180.8	171.8	178.8	169.5	172.3	170.1	172.3	170.1	172.3	170.1	172.3	170.1	
BC450_010-BC420_050	BC450_010	BC420_050	Pipe	21	0.0120	145	1.1	2.4	3.0	3.4	3.7	1.1	2.4	3.0	3.4	3.7	178.1	169.4	178.0	168.5	170.0	169.1	170.0	169.1	170.0	169.1	170.0	169.1	
BC450_020-BC450_010	BC450_020	BC450_010	Pipe	21	0.0120	316	0.7	1.7	2.1	2.4	2.6	0.7	1.7	2.1	2.4	2.6	181.4	171.2	178.1	169.4	171.7	170.0	171.7	170.0	171.7	170.0	171.7	170.0	
BC460_010-BC450_020	BC460_010	BC450_020	Pipe	12	0.0120	193	0.4	0.9	1.2	1.3	1.4	0.4	0.9	1.2	1.3	1.4	183.2	173.6	181.4	171.7	174.0	171.7	174.0	171.7	174.0	171.7	174.0	171.7	
BC460_020-BC460_010	BC460_020	BC460_010	Pipe	12	0.0120	109	0.4	0.9	1.2	1.3	1.4	0.4	0.9	1.2	1.3	1.4	185.6	176.2	183.2	173.8	176.6	174.0	176.6	174.0	176.6	174.0	176.6	174.0	
BC470_010-BC450_020	BC470_010	BC450_020	Pipe	12	0.0120	109	0.3	0.8	0.9	1.1	1.2	0.3	0.8	0.9	1.1	1.2	182.1	172.5	181.4	171.7	172.8	171.7	172.9	171.7	172.8	171.7	172.9	171.7	
BC470_020-BC470_010	BC470_020	BC470_010	Pipe	12	0.0120	159	0.3	0.8	0.9	1.1	1.2	0.3	0.8	0.9	1.1	1.2	183.5	173.6	182.1	172.5	174.0	172.8	174.0	172.9	174.0	172.8	174.0	172.9	
Outfall BC480																													
BC480_010-O_BC480	BC480_010	O_BC480	Pipe	21	0.0120	218	2.3	5.2	6.4	7.4	7.9	2.3	5.2	6.4	7.4	7.9	180.8	165.3	170.9	164.0	166.2	164.9	166.2	164.9	166.2	164.9	166.2	164.9	
BC480_020-BC480_010	BC480_020	BC480_010	Pipe	21	0.0120	210	2.3	5.2	6.4	7.4	7.9	2.3	5.2	6.4	7.4	7.9	176.2	166.8	180.8	165.3	167.6	166.2	167.7	166.2	167.6	166.2	167.7	166.2	
BC480_030-BC480_020	BC480_030	BC480_020	Pipe	18	0.0120	245	1.8	4.1	5.1	5.8	6.3	1.8	4.1	5.1	5.8	6.3	178.6	166.5	176.2	166.8	168.4	167.6	168.6	167.7	168.4	167.6	168.6	167.7	
BC490_010-BC480_030	BC490_010	BC480_030	Pipe	18	0.0120	486	0.7	1.5	1.8	2.1	2.3	0.7	1.5	1.8	2.1	2.3	187.7	179.6	178.6	166.5	179.9	168.4	179.9	168.6	179.9	168.4	179.9	168.6	
BC500_010-BC480_030	BC500_010	BC480_030	Pipe	12	0.0120	247	1.2	2.7	3.2	3.7	4.0	1.2	2.7	3.2	3.7	4.0	180.9	173.0	178.6	168.4	173.6	168.4	173.6	168.6	173.6	168.4	173.6	168.6	
BC500_020-BC500_010	BC500_020	BC500_010	Pipe	12	0.0120	360	1.2	2.7	3.2	3.7	4.0	1.2	2.7	3.2	3.7	4.0	186.8	178.9	180.9	173.0	179.5	173.6	179.6	173.6	179.5	173.6	179.6	173.6	
BC500_030-BC500_020	BC500_030	BC500_020	Pipe	12	0.0120	365	1.2	2.7	3.2	3.7	4.0	1.2	2.7	3.2	3.7	4.0	195.3	187.6	186.8	178.9	188.2	179.5	188.2	179.6	188.2	179.5	188.2	179.6	
BC500_040-BC500_030	BC500_040	BC500_030	Pipe	12	0.0120	365	1.2	2.7	3.3	3.7	4.0	1.2	2.7	3.2	3.7	4.0	204.4	196.7	195.3	187.6	197.3	188.2	197.3	188.2	197.3	188.2	197.3	188.2	
BC500_050-BC500_040	BC500_050	BC500_040	Pipe	12	0.0120	188	1.2	2.7	3.3	3.7	4.0	1.2	2.7	3.3	3.7	4.0	219.5	208.3	204.4	196.7	208.7	197.3	208.7	197.3	208.7	197.3	208.7	197.3	
BC500_060-BC500_050	BC500_060	BC500_050	Pipe	12	0.0120	131	1.2	2.7	3.3	3.7	4.0	1.2	2.7	3.3	3.7	4.0	218.2	209.6	219.5	208.3	210.5	208.7	210.7	208.7	210.5	208.7	210.7	208.7	
Outfall BC510																													
BC510_010-O_BC510	BC510_010	O_BC510	Pipe	42	0.0240	135	4.3	10.0	12.2	14.1	15.2	4.5	10.4	12.7	14.7	15.9	178.8	168.5	163.9	144.5	169.1	145.1	169.1	145.1	169.1	145.1	169.1	145.1	
BC510_020-BC510_010	BC510_020	BC510_010	Pipe	36	0.0120	140	4.3	10.0	12.2	14.1	15.2	4.5	10.4	12.7	14.7	15.9	180.2	169.7	178.8	169.2	170.8	169.1	170.9	169.1	170.9	169.1	170.9	169.1	
BC510_030-BC510_020	BC510_030	BC510_020	Pipe	36	0.0120	135	4.3	10.0	12.2	14.1	15.2	4.5	10.4	12.7	14.7	15.9	181.0	170.4	180.2	169.9	171.5	170.8	171.6	170.9	171.6	170.9	171.6	170.9	
BC510_040-BC510_030	BC510_040	BC510_030	Pipe	36	0.0120	153	4.3	10.0	12.2	14.1	15.2	4.5	10.4	12.7	14.7	15.9	181.7	170.9	181.0	170.4	172.1	171.5	172.1	171.6	172.1	171.6	172.2	171.6	
BC510_050-BC510_040	BC510_050	BC510_040	Pipe	36	0.0120	172	4.3	10.0	12.2	14.1	15.2	4.5	10.4	12.7	14.7	15.9	182.9	171.5	181.7	170.9	172.7	172.1	172.7	172.1	172.7	172.1	172.8	172.2	
BC510_060-BC510_050	BC510_060	BC510_050	Pipe	36	0.0120	302	3.5	8.2	10.0	11.5	12.4	3.7	8.6	10.5	12.2	13.1	184.9	172.6	182.9	171.5	173.7	172.7	173.7	172.7	173.7	172.7	173.7	172.8	
BC520_010-BC510_060	BC520_010	BC510_060	Pipe	15	0.0120	402	1.2	2.6	3.2	3.7	4.0	1.4	3.1	3.8	4.3	4.7	187.4	178.2	184.9	174.4	178.9	173.7	178.9	173.7	178.9	173.7	179.0	173.7	
BC520_020-BC520_010	BC520_020	BC520_010	Pipe	15	0.0120	283	1.2	2.6	3.2	3.7	4.0	1.4	3.1	3.8	4.3	4.7	189.3	179.9	187.4	178.3	180.7	178.9	180.7	178.9	180.8	178.9	180.8	179.0	
BC520_030-BC520_020	BC520_030	BC520_020	Pipe	15	0.0120	85	1.2	2.6	3.2	3.7	4.0	1.4	3.1	3.8	4.3	4.7	189.7	180.4	189.3	179.9	181.1	180.7	181.2	180.7	181.2	180.8	181.3	180.8	
BC520_040-BC520_030	BC520_040	BC520_030	Pipe	15	0.0120	54	1.2	2.6	3.2	3.7	4.0	1.4	3.1	3.8	4.3	4.7	190.4	180.7	189.7	180.4	181.4	181.1	181.5	181.2	181.5	181.2	181.6	181.3	
BC520_050-BC520_040	BC520_050	BC520_040	Pipe	15	0.0120	112	1.2	2.6	3.2	3.7	4.0	1.4	3.1	3.8	4.3	4.7	190.6	181.3	190.4	180.7	182.1	181.4	182.1	181.5	182.2	181.5	182.2	181.6	
BC520_060-BC520_050	BC520_060	BC520_050	Pipe	15	0.0120	91	1.2	2.6	3.2	3.7	4.0	1.4	3.1	3.8	4.3	4.7	191.2	181.8	190.6	181.3	182.6	182.1	182.6	182.1	182.7	182.2	182.7	182.2	
BC520_070-BC520_060	BC520_070	BC520_060	Pipe	12	0.0120	253	1.2	2.6	3.2	3.7	4.0	1.4	3.1	3.8	4.3	4.7	189.6	183.3	191.2	182.0	185.1	182.6	185.5	182.6	186.0	182.7	186.5	182.7	
BC520_080-BC520_070	BC520_080	BC520_070	Pipe	12	0.0120	82	1.2	2.6	3.2	3.7	4.0	1.4	3.1	3.8	4.3	4.7	189.0	183.7	189.6	183.3	185.9	185.1	186.4	185.5	187.0	186.0	187.7	186.5	
BC530_010-BC510_060	BC530_010	BC510_060	Pipe	30	0.0120	167	2.4	5.5	6.8	7.8	8.5	2.4	5.5	6.8	7.8	8.5	183.6	173.8	184.9	173.1	174.7	173.7	174.7	173.7	174.7	173.7	174.7	173.7	
BC530_020-BC530_010	BC530_020	BC530_010	Pipe	30	0.0120	230	2.4	5.5	6.8	7.8	8.5	2.4	5.5	6.8	7.8	8.5	184.8	175.3	183.6	174.7	176.3	174.7	176.4	174.7	176.3	174.7	176.4	174.7	
BC530_040-BC530_020	BC530_040	BC530_020	Pipe	24	0.0120	422.77	1.6	3.7	4.6	5.2	5.7	1.6	3.7	4.6	5.2	5.7	184.1	176.2	184.8	175.2	177.2	176.3	177.2	176.4	177.2	176.3	177.2	176.4	
BC540_010-BC530_040	BC540_010	BC530_040	Pipe	12	0.0120	225	0.6	1.4	1.8	2.0	2.2	0.6	1.4	1.8	2.0	2.2	185.1	178.5	184.1	177.3	179.1	177.2	179.2	177.2	179.1	177.2	179.2	177.2	
BC540_020-BC540_010	BC540_020	BC540_010	Pipe	12	0.0120	225	0.6	1.4	1.8	2.0	2.2	0.6	1.4	1.8	2.0	2.2	186.0	178.5	185.1	177.3	179.7	179.1	179.9	179.2	179.7	179.1	179.9	179.2	
BC540_030-BC540_020	BC540_030	BC540_020	Pipe	12	0.0120	98	0.6	1.4	1.8	2.0	2.2	0.6	1.4	1.8	2.0	2.2	186.9	179.0	186.0	178.5	180.0	179.7	180.2	179.9	180.0	179.7	180.2	179.9	
BC540_040-BC540_030	BC540_040	BC540_030	Pipe	12	0.0120	83	0.6	1.4	1.8	2.0	2.2	0.6	1.4	1.8	2.0	2.2	188.0	179.4	186.9	179.0	180.2	180.0	180.4	180.2	180.2	180.0	180.4	180.2	

Table A-2: Model Conduit Parameters and Results

	Node ID		Conduit Attributes				Existing S. Troutdale Model - Peak Flows (cfs)					Future S. Troutdale Model - Peak Flows (cfs)					Node Rim and Invert Elevation (IE)				Maximum Hydraulic Grade Line - Existing Conditions				Maximum Hydraulic Grade Line - Future Conditions				
																					10yr 24hr HGL (feet)		25yr 24hr HGL (feet)		10yr 24hr HGL (feet)		25yr 24hr HGL (feet)		
Conduit Name (US Node - DS Node)	US	DS	Type	Conduit Dia or Channel Height (inches)	Manning's Roughness	Conduit Length	WQ Peak Flows (cfs)	2yr 24hr Peak Flows (cfs)	5yr 24hr Peak Flows (cfs)	10yr 24hr Peak Flow (cfs)	25yr 24hr Peak Flow (cfs)	WQ Peak Flows (cfs)	2yr 24hr Peak Flows (cfs)	5yr 24hr Peak Flows (cfs)	10yr 24hr Peak Flow (cfs)	25yr 24hr Peak Flow (cfs)	US Rim (ft)	US IE (ft)	DS Rim (ft)	DS IE (ft)	US	DS	US	DS	US	DS	US	DS	When hydraulically deficient
BC540_050-BC540_040	BC540_050	BC540_040	Pipe	12	0.0120	204	0.6	1.4	1.8	2.0	2.2	0.6	1.4	1.8	2.0	2.2	189.7	180.5	188.0	179.4	181.1	180.2	181.2	180.4	181.1	180.2	181.2	180.4	
BC550_010-BC530_040	BC550_010	BC530_040	Pipe	21	0.0120	247	1.0	2.3	2.8	3.2	3.5	1.0	2.3	2.8	3.2	3.5	186.0	177.5	184.1	176.1	178.1	177.2	178.1	177.2	178.1	177.2	178.1	177.2	
BC550_020-BC550_010	BC550_020	BC550_010	Pipe	18	0.0120	161	1.0	2.3	2.8	3.2	3.5	1.0	2.3	2.8	3.2	3.5	186.5	178.7	186.0	177.8	179.3	178.1	179.3	178.1	179.3	178.1	179.3	178.1	
BC550_030-BC550_020	BC550_030	BC550_020	Pipe	18	0.0120	121	1.0	2.3	2.8	3.2	3.5	1.0	2.3	2.8	3.2	3.5	187.5	179.4	186.5	178.7	180.0	179.3	180.1	179.3	180.0	179.3	180.1	179.3	
BC550_040-BC550_030	BC550_040	BC550_030	Pipe	18	0.0120	152	1.0	2.3	2.8	3.2	3.5	1.0	2.3	2.8	3.2	3.5	188.1	180.3	187.5	179.4	180.9	180.0	181.0	180.1	180.9	180.0	181.0	180.1	
Outfall BC560																													
BC560_010-O_BC560	BC560_010	O_BC560	Pipe	18	0.0120	130	3.6	7.8	9.1	9.3	9.4	3.6	7.8	9.1	9.3	9.4	181.8	173.0	158.0	156.4	173.5	156.8	173.5	156.8	173.5	156.8	173.5	156.8	
BC560_020-BC560_010	BC560_020	BC560_010	Pipe	18	0.0120	140	3.6	7.8	9.1	9.3	9.4	3.6	7.8	9.1	9.3	9.4	182.9	173.9	181.8	173.2	175.3	173.5	175.3	173.5	175.3	173.5	175.3	173.5	
BC570_010-BC560_020	BC570_010	BC560_020	Pipe	12	0.0120	364	3.1	6.7	7.8	7.8	7.8	3.1	6.7	7.8	7.8	7.8	188.7	180.0	182.9	174.1	188.7	175.3	188.7	175.3	188.7	175.3	188.7	175.3	5-yr Existing
BC570_020-BC570_010	BC570_020	BC570_010	Pipe	12	0.0120	206	1.9	4.0	4.8	5.1	5.3	1.9	4.0	4.8	5.1	5.3	194.7	183.6	188.7	179.8	192.0	188.7	192.2	188.7	192.0	188.7	192.2	188.7	
BC570_030-BC570_020	BC570_030	BC570_020	Pipe	12	0.0120	150	1.9	3.9	4.7	5.1	5.3	1.9	3.9	4.7	5.1	5.3	196.9	186.5	194.7	183.9	194.4	192.0	194.8	192.2	194.4	192.0	194.8	192.2	
BC570_040-BC570_030	BC570_040	BC570_030	Pipe	12	0.0120	125	1.9	3.9	4.7	5.1	5.3	1.9	3.9	4.7	5.1	5.3	199.2	190.0	196.9	186.7	196.4	194.4	197.0	194.8	196.4	194.4	197.0	194.8	
BC570_050-BC570_040	BC570_050	BC570_040	Pipe	12	0.0120	200	1.9	3.9	4.7	5.1	5.3	1.9	4.0	4.7	5.1	5.3	204.3	195.0	199.2	190.0	199.7	196.4	200.5	197.0	199.7	196.4	200.6	197.0	
BC580_010-BC570_050	BC580_010	BC570_050	Pipe	12	0.0120	160	1.9	3.9	5.0	5.3	5.5	1.9	4.0	5.0	5.3	5.5	215.2	207.5	204.3	195.2	208.0	199.7	208.1	200.5	208.0	199.7	208.1	200.6	
BC640_010-BC580_030	BC640_010	BC580_030	Pipe	12	0.0120	50	0.3	0.7	0.8	1.0	1.1	0.3	0.7	0.8	1.0	1.1	253.4	243.4	250.9	242.3	243.7	242.4	243.7	242.4	243.7	242.4	243.7	242.4	
BC650_010-BC580_030	BC650_010	BC580_030	Pipe	12	0.0120	55	0.3	0.6	0.7	0.8	0.9	0.3	0.6	0.7	0.8	0.9	253.5	245.8	250.9	242.3	246.0	242.4	246.0	242.4	246.0	242.4	246.0	242.4	
BC580_020-BC580_010	BC580_020	BC580_010	Pipe	12	0.0120	53	1.9	4.2	5.1	5.9	6.4	1.9	4.2	5.2	5.9	6.4	216.2	211.4	215.2	208.2	212.0	208.0	212.0	208.1	212.0	208.0	212.0	208.1	
BC580_030-BC580_020	BC580_030	BC580_020	Pipe	12	0.0120	498	0.6	1.3	1.6	1.8	2.0	0.6	1.3	1.6	1.8	2.0	250.9	242.1	216.2	211.6	242.4	212.0	242.4	212.0	242.4	212.0	242.4	212.0	
BC580_100-BC580_020	BC580_100	BC580_020	Pipe	21	0.0120	387	0.7	1.6	2.0	2.3	2.5	0.7	1.6	2.0	2.3	2.5	218.1	211.0	216.2	208.5	212.0	212.0	212.1	212.0	212.0	212.0	212.1	212.0	
BC590_005-BC580_100	BC590_005	BC580_100	Pipe	18	0.0120	92	0.7	1.6	2.0	2.3	2.5	0.7	1.6	2.0	2.3	2.5	218.3	211.4	218.1	211.1	212.1	212.0	212.2	212.1	212.1	212.0	212.2	212.1	
BC590_010-BC590_005	BC590_010	BC590_005	Pipe	18	0.0120	182	0.7	1.6	2.0	2.3	2.5	0.7	1.6	2.0	2.3	2.5	227.7	217.5	218.3	212.2	217.8	212.1	217.9	212.2	217.8	212.1	217.9	212.2	
BC590_020-BC590_010	BC590_020	BC590_010	Pipe	18	0.0120	211	0.2	0.4	0.5	0.5	0.6	0.2	0.4	0.5	0.5	0.6	235.7	225.9	227.7	218.6	226.0	217.8	226.0	217.9	226.0	217.8	226.0	217.9	
BC590_030-BC590_020	BC590_030	BC590_020	Pipe	18	0.0120	205	0.2	0.4	0.5	0.5	0.6	0.2	0.4	0.5	0.5	0.6	239.8	230.1	235.7	226.1	230.5	226.0	230.5	226.0	230.5	226.0	230.5	226.0	
BC590_040-BC590_030	BC590_040	BC590_030	Pipe	18	0.0120	45	0.2	0.4	0.5	0.5	0.6	0.2	0.4	0.5	0.5	0.6	250.0	233.0	239.8	230.3	237.9	230.5	237.9	230.5	237.9	230.5	237.9	230.5	
BC600_010-BC590_040	BC600_010	BC590_040	Channel	74	0.0500	257	2.0	4.7	5.7	6.6	7.1	2.0	4.7	5.7	6.6	7.1	267.7	261.5	244.0	237.8	253.3	237.9	253.3	237.9	253.3	237.9	253.3	237.9	
BC600_020-BC600_010	BC600_020	BC600_010	Pipe	12	0.0120	153	0.5	1.2	1.5	1.7	1.8	0.5	1.2	1.5	1.7	1.8	263.8	254.5	270.0	253.8	255.0	253.3	255.1	253.3	255.0	253.3	255.1	253.3	
BC600_030-BC600_020	BC600_030	BC600_020	Pipe	12	0.0120	205	0.5	1.2	1.5	1.7	1.8	0.5	1.2	1.5	1.7	1.8	263.7	255.8	263.8	254.7	256.3	255.0	256.4	255.1	256.3	255.0	256.4	255.1	
BC600_100-BC600_010	BC600_100	BC600_010	Channel	148	0.0500	125	1.5	3.5	4.3	4.9	5.3	1.5	3.5	4.3	4.9	5.3	271.9	259.6	267.7	255.4	260.1	253.3	260.1	253.3	260.1	253.3	260.1	253.3	
BC610_010-BC600_100	BC610_010	BC600_100	Pipe	12	0.0120	132	0.3	0.7	0.8	0.9	1.0	0.3	0.7	0.8	0.9	1.0	286.7	277.2	279.2	265.0	277.4	260.1	277.4	260.1	277.4	260.1	277.4	260.1	
BC600_110-BC600_100	BC600_110	BC600_100	Channel	148	0.0500	176	1.3	2.9	3.5	4.0	4.3	1.3	2.9	3.5	4.0	4.3	281.8	269.5	271.9	259.6	268.6	260.1	268.6	260.1	268.6	260.1	268.6	260.1	
BC630_010-BC600_110	BC630_010	BC600_110	Channel	136	0.0500	142	0.2	0.5	0.6	0.6	0.7	0.2	0.5	0.6	0.6	0.7	286.6	275.3	281.8	270.5	276.3	268.6	276.3	268.6	276.3	268.6	276.3	268.6	
BC620_010-BC600_110	BC620_010	BC600_110	Pipe	18	0.0120	635	1.1	2.4	2.9	3.4	3.7	1.1	2.4	2.9	3.4	3.7	289.1	281.3	286.0	278.1	281.9	268.6	282.0	268.6	281.9	268.6	282.0	268.6	
BC620_020-BC620_010	BC620_020	BC620_010	Pipe	15	0.0120	195	1.1	2.4	3.0	3.4	3.7	1.1	2.4	3.0	3.4	3.7	289.9	282.1	289.1	281.6	283.0	281.9	283.1	282.0	283.0	281.9	283.1	282.0	
BC620_030-BC620_020	BC620_030	BC620_020	Pipe	12	0.0120	205	1.1	2.4	3.0	3.4	3.7	1.1	2.4	3.0	3.4	3.7	292.2	287.9	289.9	282.3	288.4	283.0	288.4	283.1	288.4	283.0	288.4	283.1	
Outfall BC660																													
BC660_010-O_BC660	BC660_010	O_BC660	Pipe	12	0.0240	62	1.4	3.1	3.8	4.4	4.7	1.4	3.1	3.8	4.4	4.7	181.7	168.5	147.4	146.3	168.9	146.7	168.9	146.7	168.9	146.7	168.9	146.7	
BC660_020-BC660_010	BC660_020	BC660_010	Pipe	12	0.0120	64	0.7	1.6	2.0	2.3	2.5	0.7	1.6	2.0	2.3	2.5	181.9	172.8	181.7	168.7	173.1	168.9	173.1	168.9	173.1	168.9	173.1	168.9	
BC660_030-BC660_020	BC660_030	BC660_020	Pipe	12	0.0120	129	0.7	1.6	2.0	2.3	2.5	0.7	1.6	2.0	2.3	2.5	187.2	178.7	181.9	173.0	179.1	173.1	179.1	173.1	179.1	173.1	179.1	173.1	
BC660_040-BC660_030	BC660_040	BC660_030	Pipe	12	0.0120	122	0.7	1.6	2.0	2.3	2.5	0.7	1.6	2.0	2.3	2.5	189.9	180.7	187.2	178.9	181.2	179.1	181.2	179.1	181.2	179.1	181.2	179.1	
BC660_050-BC660_040	BC660_050	BC660_040	Pipe	12	0.0120	131	0.7	1.6	2.0	2.3	2.5	0.7	1.6	2.0	2.3	2.5	191.4	182.9	189.9	180.9	183.3	181.2	183.4	181.2	183.3	181.2	183.4	181.2	
BC660_060-BC660_050	BC660_060	BC660_050	Pipe	12	0.0120	225	0.7	1.6	2.0	2.3	2.5	0.7	1.6	2.0	2.3	2.5	196.4	188.4	191.4	183.1	188.8	183.3	188.8	183.4	188.8	183.3	188.8	183.4	
BC670_010-BC660_010	BC670_010	BC660_010	Pipe	12	0.0120	92	0.7	1.5	1.8	2.1	2.2	0.7	1.5	1.8	2.1	2.2	182.2	173.8	181.7	168.7	174.1	168.9	174.1	168.9	174.1	168.9	174.1	168.9	
BC670_020-BC670_010	BC670_020	BC670_010	Pipe	12	0.0120	72	0.7	1.5	1.8	2.1	2.2	0.7	1.5	1.8	2.1	2.2	183.2	175.8	182.2	174.0	176.2	174.1	176.2	174.1	176.2	174.1	176.2	174.1	
BC670_030-BC670_020	BC670_030	BC670_020	Pipe	12	0.0120	209	0.7	1.5	1.8	2.1	2.2	0.7	1.5	1.8	2.1	2.2	189.8	181.2	183.2	176.0	181.6	176.2	181.7	176.2	181.6	176.2	181.7	176.2	
Outfall BC680																													
BC680_010-O_BC680	BC680_010	O_BC680	Pipe	12	0.0120	274	0.6	1.4	1.7	2.0	2.2	0.6	1.4	1.7	2.0	2.2	187.5	179.5	187.5	153.1	179.8	153.4	179.8	153.4	179.8	153.4	179.8	153.4	
BC680_020-BC680_010	BC680_020	BC680_010	Pipe	12	0.0120	177	0.6	1.4	1.7	2.0	2.2	0.6	1.4	1.7	2.0	2.2	194.0	185.7	187.5	179.7	186.0	179.8	186.0	179.8	186.0	179.8	186.0	179.8	
Outfall BC690																													
BC690_010-O_BC690	BC690_010	O_BC690	Pipe	27	0.0120	137	3.4	7.9	9.8	12.1	13.7	3.4	7.9	9.8	12.1	13.7	208.7	195.6	198.4	181.3	196.1	181.8	196.1	181.8	196.1	181.8	196.1	181.8	
BC690_020-BC690_010	BC690_020	BC690_010	Pipe	27	0.0120	87	3.4	7.9	9.8	12.1	13.7	3.4	7.9	9.8	12.1	13.7	208.5	198.1	208.7	195.8	198.8	196.1	198.8	196.1	198.8	196.1	198.8	196.1	
BC700_010-BC690_020	BC700_010	BC690_020	Pipe	30	0.0120	33	3.4	7.9	9.8	12.1	13.7	3.4	7.9	9.8	12.1	13.7	209.2	198.2	208.5	197.8	199.1	198.8	199.1	198.8	199.1	198.8	199.1	198.8	
BC690_100-BC700_010	BC690_100	BC700_010	Pipe	12	0.0120	303	0.1	0.2	0.4	0.5	0.6	0.1	0.2	0.4	0.5	0.6	210.2	202.0	209.2	199.0	202.2	199.1	202.3	199.1	202.2	199.1	202.3	199.1	
BC740_010-BC700_010	BC740_010	BC700_010	Pipe	12	0.0120	202	0.2	0.5	0.7	1.0	1.2	0.2	0.5	0.7	1.0	1.2	210.8	204.0	209.2	199.4	204.3	199.1	204.4	199.1	204.3	199.1	204.4	199.1	
BC700_020-BC700_010	BC700_020	BC700_010	Pipe	30	0.0120	411	2.1	4.9	6.2	7.4	8.3	2.1	5.0	6.2	7.5	8.3	210.2	199.1	209.2	195.6	199.9	199.1	200.0	199.1	199.9	199.1	200.0	199.1	
BC580_010-BC700_020	BC580_010	BC570_050	Pipe	30	0.0120	495	0.0	0.2	0.5	0.8	1.1	0.0	0.3	0.5	0.8	1.1	215.2	207.8	210.2	202.1	208.0	199.9	208.1	200.0	208.0	199.9	208.1	200.0	
BC710_010-BC700_020	BC710_010	BC700_020	Pipe	18	0.0120	202	2.1	4.7	5.7	6.6	7.2	2.1	4.7	5.8	6.6	7.2	215.8	205.7	210.2	202.7	206.4	199.9	206.5	200.0	206.4	199.9	206.5	200.0	

Table A-2: Model Conduit Parameters and Results

	Node ID		Conduit Attributes				Existing S. Troutdale Model - Peak Flows (cfs)					Future S. Troutdale Model - Peak Flows (cfs)					Node Rim and Invert Elevation (IE)				Maximum Hydraulic Grade Line - Existing Conditions				Maximum Hydraulic Grade Line - Future Conditions				
																					10yr 24hr HGL (feet)		25yr 24hr HGL (feet)		10yr 24hr HGL (feet)		25yr 24hr HGL (feet)		
Conduit Name (US Node - DS Node)	US	DS	Type	Conduit Dia or Channel Height (inches)	Manning's Roughness	Conduit Length	WQ Peak Flows (cfs)	2yr 24hr Peak Flows (cfs)	5yr 24hr Peak Flows (cfs)	10yr 24hr Peak Flow (cfs)	25yr 24hr Peak Flow (cfs)	WQ Peak Flows (cfs)	2yr 24hr Peak Flows (cfs)	5yr 24hr Peak Flows (cfs)	10yr 24hr Peak Flow (cfs)	25yr 24hr Peak Flow (cfs)	US Rim (ft)	US IE (ft)	DS Rim (ft)	DS IE (ft)	US	DS	US	DS	US	DS	US	DS	When hydraulically deficient
BC720_010-BC710_010	BC720_010	BC710_010	Pipe	12	0.0120	290	0.6	1.4	1.7	2.0	2.1	0.6	1.4	1.7	2.0	2.2	217.3	208.8	215.8	205.9	209.3	206.4	209.3	206.5	209.3	206.4	209.3	206.5	
BC720_020-BC720_010	BC720_020	BC720_010	Pipe	12	0.0120	218	0.6	1.4	1.7	2.0	2.1	0.6	1.4	1.7	2.0	2.2	225.6	215.8	217.3	209.0	216.1	209.3	216.2	209.3	216.2	209.3	216.2	209.3	
BC730_010-BC710_010	BC730_010	BC710_010	Pipe	15	0.0120	88	1.3	3.0	3.7	4.2	4.6	1.3	3.0	3.7	4.2	4.6	216.9	209.3	215.8	205.9	209.7	206.4	209.7	206.5	209.7	206.4	209.7	206.5	
BC730_020-BC730_010	BC730_020	BC730_010	Pipe	15	0.0120	140	1.3	3.0	3.7	4.2	4.6	1.3	3.0	3.7	4.2	4.6	222.9	212.5	216.9	209.5	213.1	209.7	213.1	209.7	213.1	209.7	213.1	209.7	
BC730_030-BC730_020	BC730_030	BC730_020	Pipe	12	0.0120	95	1.3	3.0	3.7	4.2	4.6	1.3	3.0	3.7	4.2	4.6	222.2	215.0	222.9	212.7	215.6	213.1	215.7	213.1	215.6	213.1	215.7	213.1	
BC730_040-BC730_030	BC730_040	BC730_030	Pipe	12	0.0120	256	1.3	3.0	3.7	4.2	4.6	1.3	3.0	3.7	4.2	4.6	226.9	219.0	222.2	215.2	219.8	215.6	219.8	215.7	219.8	215.6	219.8	215.7	
BC730_050-BC730_040	BC730_050	BC730_040	Pipe	12	0.0120	95	1.3	3.0	3.7	4.2	4.6	1.3	3.0	3.7	4.2	4.6	227.9	220.4	226.9	219.2	221.2	219.8	221.3	219.8	221.2	219.8	221.3	219.8	
BC730_060-BC730_050	BC730_060	BC730_050	Pipe	12	0.0120	109	1.3	3.0	3.7	4.2	4.6	1.3	3.0	3.7	4.2	4.6	235.3	227.0	227.9	220.6	227.4	221.2	227.4	221.3	227.4	221.2	227.4	221.3	
BC730_070-BC730_060	BC730_070	BC730_060	Pipe	12	0.0120	53	1.3	3.0	3.7	4.2	4.6	1.3	3.0	3.7	4.2	4.6	254.2	249.0	235.3	227.0	249.3	227.4	249.3	227.4	249.3	227.4	249.3	227.4	
BC750_020-BC700_010	BC750_020	BC700_010	Pipe	18	0.0120	246	0.8	1.8	2.2	2.8	3.3	0.8	1.8	2.2	2.8	3.3	211.1	201.6	209.2	197.8	202.0	199.1	202.1	199.1	202.0	199.1	202.1	199.1	
BC760_010-BC750_020	BC760_010	BC750_020	Pipe	12	0.0120	288	0.5	1.1	1.4	1.6	1.8	0.5	1.1	1.4	1.6	1.8	227.2	218.5	211.1	202.1	218.8	202.0	218.8	202.1	218.8	202.0	218.8	202.1	
BC760_020-BC760_010	BC760_020	BC760_010	Pipe	12	0.0120	108	0.5	1.1	1.4	1.6	1.8	0.5	1.1	1.4	1.6	1.8	230.1	222.5	227.2	218.7	222.8	218.8	222.8	218.8	222.8	218.8	222.8	218.8	
BC760_030-BC760_020	BC760_030	BC760_020	Pipe	12	0.0120	162	0.5	1.1	1.4	1.6	1.8	0.5	1.1	1.4	1.6	1.8	238.5	229.1	230.1	222.7	229.4	222.8	229.5	222.8	229.4	222.8	229.5	222.8	
Outfall BC3800																													
BC770_010-O_BC3800	BC770_010	O_BC3800	Pipe	36	0.0120	53	7.7	17.7	21.8	25.5	28.3	8.2	19.0	23.4	26.9	30.4	223.2	192.4	216.8	192.3	194.1	193.9	194.2	194.0	194.2	194.0	194.3	194.1	
BC880_010-BC770_100	BC880_010	BC770_100	Pipe	12	0.0100	96	1.1	2.5	3.0	3.6	4.1	1.1	2.5	3.0	3.6	4.1	235.6	224.2	236.9	215.0	224.6	215.3	224.6	215.3	224.6	215.3	224.6	215.3	
BC890_010-BC880_010	BC890_010	BC880_010	Channel	18	0.0500	220	0.9	2.1	2.6	3.0	3.5	0.9	2.1	2.6	3.0	3.5	232.8	229.0	235.6	224.2	229.3	224.6	229.3	224.6	229.3	224.6	229.3	224.6	
BC890_030-BC890_010	BC890_030	BC890_010	Pipe	12	0.0100	114	0.9	2.1	2.6	3.0	3.5	0.9	2.1	2.6	3.0	3.5	246.9	236.1	232.8	229.0	236.5	229.3	236.5	229.3	236.5	229.3	236.5	229.3	
BC890_040-BC890_030	BC890_040	BC890_030	Pipe	12	0.0100	115	0.9	2.1	2.6	3.0	3.5	0.9	2.1	2.6	3.0	3.5	245.2	237.4	246.9	236.3	238.0	236.5	238.1	236.5	238.0	236.5	238.1	236.5	
BC890_060-BC890_040	BC890_060	BC890_040	Pipe	12	0.0100	137	0.9	2.1	2.6	3.0	3.5	0.9	2.1	2.6	3.0	3.5	251.5	242.8	245.2	237.6	243.2	238.0	243.3	238.1	243.2	238.0	243.3	238.1	
BC770_020-BC770_010	BC770_020	BC770_010	Pipe	24	0.0120	275	6.6	15.3	18.8	21.9	24.2	7.1	16.5	20.3	23.7	26.3	245.2	227.0	223.2	192.4	227.7	194.1	227.7	194.2	227.7	194.2	227.8	194.3	
BC770_030-BC770_020	BC770_030	BC770_020	Pipe	15	0.0120	129	2.8	6.4	7.8	9.0	9.6	2.8	6.4	7.8	9.0	9.6	251.0	241.1	245.2	231.6	241.7	227.7	241.7	227.7	241.7	227.7	241.7	227.8	
BC770_100-BC770_010	BC770_100	BC770_010	Pipe	12	0.0100	71	1.1	2.5	3.0	3.6	4.4	1.1	2.5	3.0	4.4	4.4	236.9	215.0	223.2	192.4	215.3	194.1	215.3	194.2	215.3	194.2	215.3	194.3	
BC780_010-BC770_020	BC780_010	BC770_020	Pipe	24	0.0120	124	3.7	8.4	10.4	11.9	13.5	4.2	9.7	11.9	13.8	15.6	242.9	228.3	245.2	227.4	229.4	227.7	229.5	227.7	229.5	227.7	229.6	227.8	
BC780_020-BC780_010	BC780_020	BC780_010	Pipe	24	0.0120	185	3.7	8.4	10.4	11.9	13.5	4.2	9.7	11.9	13.8	15.6	240.2	229.7	242.9	228.5	230.8	229.4	230.9	229.5	231.0	229.5	231.1	229.6	
BC780_030-BC780_020	BC780_030	BC780_020	Pipe	21	0.0120	161	3.7	8.4	10.4	12.0	13.6	4.2	9.7	11.9	13.8	15.6	241.0	231.9	240.2	230.0	232.9	230.8	233.0	230.9	233.0	231.0	233.1	231.1	
BC780_040-BC780_030	BC780_040	BC780_030	Pipe	18	0.0120	140	2.3	5.3	6.5	7.5	8.1	2.8	6.6	8.1	9.4	10.1	243.3	235.0	241.0	232.2	235.7	232.9	235.7	233.0	235.8	233.0	235.9	233.1	
BC780_050-BC780_040	BC780_050	BC780_040	Pipe	18	0.0120	97	2.3	5.3	6.5	7.5	8.1	2.8	6.6	8.1	9.4	10.1	249.1	240.6	243.3	235.5	241.2	235.7	241.2	235.7	241.3	235.8	241.3	235.9	
BC780_060-BC780_050	BC780_060	BC780_050	Pipe	18	0.0120	88	2.3	5.3	6.5	7.5	8.1	2.8	6.6	8.1	9.4	10.1	263.3	252.7	249.1	241.3	253.1	241.2	253.1	241.2	253.1	241.3	253.2	241.3	
BC780_070-BC780_060	BC780_070	BC780_060	Pipe	18	0.0120	212	2.3	5.3	6.5	7.5	8.1	2.8	6.6	8.1	9.4	10.1	296.5	286.5	263.3	252.7	286.9	253.1	286.9	253.1	287.0	253.1	287.0	253.2	
BC780_080-BC780_070	BC780_080	BC780_070	Pipe	18	0.0120	142	2.3	5.3	6.5	7.5	8.1	2.8	6.6	8.1	9.4	10.1	309.9	289.1	296.5	286.6	289.9	286.9	289.9	286.9	290.0	287.0	290.0	287.0	
BC780_090-BC780_080	BC780_090	BC780_080	Pipe	18	0.0120	182	2.3	5.3	6.5	7.5	8.1	2.8	6.6	8.1	9.4	10.1	311.4	292.2	309.9	289.3	293.0	289.9	293.0	289.9	293.1	290.0	293.1	290.0	
BC780_100-BC780_090	BC780_100	BC780_090	Pipe	18	0.0120	151	2.3	5.3	6.5	7.5	8.1	2.8	6.6	8.1	9.4	10.1	312.7	298.4	311.4	292.2	298.9	293.0	299.0	293.0	299.0	293.1	299.0	293.1	
BC790_020-BC780_100	BC790_020	BC780_100	Pipe	12	0.0120	270	0.6	1.3	1.6	1.8	1.9	0.6	1.3	1.6	1.8	1.9	314.3	305.1	312.7	298.9	305.5	298.9	305.5	299.0	305.5	299.0	305.5	299.0	
BC800_010-BC780_100	BC800_010	BC780_100	Pipe	18	0.0120	383	1.7	4.0	4.9	5.7	6.2	2.3	5.3	6.6	7.6	8.2	316.3	305.3	312.7	298.4	305.9	298.9	306.0	299.0	306.1	299.0	306.1	299.0	
BC810_010-BC800_010	BC810_010	BC800_010	Pipe	18	0.0120	151	1.5	3.5	4.3	4.9	5.3	2.0	4.8	5.9	6.8	7.3	317.4	298.4	316.3	291.1	306.2	305.9	306.3	306.0	306.6	306.1	306.7	306.1	
BC810_020-BC810_010	BC810_020	BC810_010	Pipe	21	0.0120	173	1.5	3.5	4.3	4.9	5.3	2.0	4.8	5.9	6.8	7.3	318.7	307.8	317.4	307.0	308.6	306.2	308.6	306.3	308.7	306.6	308.8	306.7	
BC820_010-BC810_020	BC820_010	BC810_020	Pipe	18	0.0120	112	1.1	2.5	3.0	3.5	3.8	1.6	3.8	4.7	5.4	5.8	318.9	309.8	318.7	308.0	310.3	308.6	310.3	308.6	310.4	308.7	310.4	308.8	
BC820_020-BC820_010	BC820_020	BC820_010	Pipe	18	0.0120	128	1.1	2.5	3.0	3.5	3.8	1.6	3.8	4.7	5.4	5.8	319.8	310.8	318.9	310.0	311.5	310.3	311.5	310.3	311.7	310.4	311.7	310.4	
BC820_030-BC820_020	BC820_030	BC820_020	Pipe	18	0.0120	234	1.1	2.5	3.0	3.5	3.8	1.6	3.8	4.7	5.4	5.8	321.1	312.3	319.8	311.0	312.9	311.5	313.0	311.5	313.1	311.7	313.2	311.7	
BC830_010-BC820_030	BC830_010	BC820_030	Pipe	15	0.0120	159	0.4	0.9	1.1	1.3	1.4	1.0	2.3	2.8	3.2	3.5	321.3	313.5	321.1	312.5	313.9	312.9	313.9	313.0	314.2	313.1	314.2	313.2	
BC830_020-BC830_010	BC830_020	BC830_010	Pipe	12	0.0120	174	0.4	0.9	1.1	1.3	1.4	1.0	2.3	2.8	3.2	3.5	322.2	315.1	321.3	314.0	315.6	313.9	315.6	313.9	316.0	314.2	316.2	314.2	
BC840_010-BC770_030	BC840_010	BC770_030	Pipe	15	0.0120	110	2.8	6.4	7.8	9.0	9.6	2.8	6.4	7.8	9.0	9.6	257.1	248.2	251.0	241.5	248.8	241.7	248.9	241.7	248.8	241.7	248.9	241.7	
BC840_020-BC840_010	BC840_020	BC840_010	Pipe	15	0.0120	86	2.8	6.4	7.8	9.0	9.6	2.8	6.4	7.8	9.0	9.6	268.3	260.0	257.1	248.2	260.5	248.8	260.6	248.9	260.5	248.8	260.6	248.9	
BC840_030-BC840_020	BC840_030	BC840_020	Pipe	12	0.0120	149	0.5	1.1	1.4	1.6	1.7	0.5	1.1	1.4	1.6	1.7	273.5	263.8	268.3	260.5	264.1	260.5	264.2	260.6	264.1	260.5	264.2	260.6	
BC840_040-BC840_030	BC840_040	BC840_030	Pipe	12	0.0120	70	0.5	1.1	1.4	1.6	1.7	0.5	1.1	1.4	1.6	1.7	278.1	272.0	273.5	264.0	272.2	264.1	272.2	264.2	272.2	264.1	272.2	264.2	
BC840_050-BC840_040	BC840_050	BC840_040	Pipe	12	0.0120	121	0.5	1.1	1.4	1.6	1.7	0.5	1.1	1.4	1.6	1.7	305.5	299.7	278.1	272.4	299.9	272.2	299.9	272.2	299.9	272.2	299.9	272.2	
BC840_100-BC840_020	BC840_100	BC840_020	Pipe	15	0.0120	90	2.3	5.3	6.4	7.5	8.0	2.3	5.3	6.4	7.5	8.0	283.2	274.5	268.3	260.0	274.9	260.5	275.0	260.6	274.9	260.5	275.0	260.6	
BC840_110-BC840_100	BC840_110	BC840_100	Pipe	15	0.0120	162	2.3	5.3	6.4	7.5	8.0	2.3	5.3	6.4	7.5	8.0	295.0	283.7	283.2	274.5	284.4	274.9	284.4	275.0	284.4	274.9	284.4	275.0	
BC850_010-BC840_110	BC850_010	BC840_110	Pipe	15	0.0120	62	2.3	5.3	6.4	7.5	8.0	2.3	5.3	6.4	7.5	8.0	316.3	286.5	295.0	284.0	287.1	284.4	287.1	284.4	287.1	284.4	287.1	284.4	
BC850_020-BC850_010	BC850_020	BC850_010	Pipe	15	0.0120	112	2.3	5.3	6.4	7.5	8.0	2.3	5.3	6.4	7.5	8.0	315.3	304.7	316.3	286.7	305.2	287.1	305.2	287.1	305.2	287.1	305.2	287.1	
BC850_030-BC850_020	BC850_030	BC850_020	Pipe	15	0.0120	142	2.3	5.3	6.4	7.5	8.0	2.3	5.3	6.4	7.5	8.0	316.5	306.7	315.3	304.9	307.7	305.2	307.8	305.2	307.7	305.2	307.8	305.2	
BC850_040-BC850_030	BC850_040	BC850_030	Pipe	15	0.0120	151	2.3	5.3	6.4	7.5	8.0	2.3	5.3	6.4	7.5	8.0	318.1	308.4	316.5	306.9	309.5	307.7	309.8	307.8	309.5	307.7	309.8	307.8	
BC850_050-BC850_040	BC850_050	BC850_040	Pipe	15	0.0120	75	2.3	5.3	6.4	7.5	8.0	2.3	5.3	6.4	7.5	8.0	319.1	309.2	318.1	308.5	310.4	309.5	310.8	309.8	310.4	309.5	310.8	309.8	
BC850_060-BC850_050	BC850_060	BC850_050	Pipe	15	0.0120	159	2.3	5.3	6.4	7.5	8.0	2.3	5.3	6.4	7.5	8.0	320.2	310.0	319.1	309.3	312.2	310.4	312.8	310.8	312.2	310.4	312.8	310.8	
BC860_010-BC870_010	BC860_010	BC870_010	Pipe	12	0.0120	229	1.1	2.6	3.1	3.6	3.9	1.1	2.6	3.1	3.6	3.9	320.9	312.8	321.1	311.3	315.0	313.0	316.0	313.7	315.0	313.0	316.0	313.7	

Table A-2: Model Conduit Parameters and Results

	Node ID		Conduit Attributes				Existing S. Troutdale Model - Peak Flows (cfs)					Future S. Troutdale Model - Peak Flows (cfs)					Node Rim and Invert Elevation (IE)				Maximum Hydraulic Grade Line - Existing Conditions				Maximum Hydraulic Grade Line - Future Conditions				
																					10yr 24hr HGL (feet)		25yr 24hr HGL (feet)		10yr 24hr HGL (feet)		25yr 24hr HGL (feet)		
Conduit Name (US Node - DS Node)	US	DS	Type	Conduit Dia or Channel Height (inches)	Manning's Roughness	Conduit Length	WQ Peak Flows (cfs)	2yr 24hr Peak Flows (cfs)	5yr 24hr Peak Flows (cfs)	10yr 24hr Peak Flow (cfs)	25yr 24hr Peak Flow (cfs)	WQ Peak Flows (cfs)	2yr 24hr Peak Flows (cfs)	5yr 24hr Peak Flows (cfs)	10yr 24hr Peak Flow (cfs)	25yr 24hr Peak Flow (cfs)	US Rim (ft)	US IE (ft)	DS Rim (ft)	DS IE (ft)	US	DS	US	DS	US	DS	US	DS	When hydraulically deficient
BC870_010-BC850_060	BC870_010	BC850_060	Pipe	15	0.0120	150	1.6	3.6	4.5	5.2	5.6	1.6	3.6	4.5	5.2	5.6	321.1	311.1	320.2	310.2	313.0	312.2	313.7	312.8	313.0	312.2	313.7	312.8	
BC870_020-BC870_010	BC870_020	BC870_010	Pipe	12	0.0120	173	0.5	1.1	1.3	1.5	1.8	0.5	1.1	1.3	1.5	1.8	322.7	313.0	321.1	311.3	313.5	313.0	314.0	313.7	313.5	313.0	314.1	313.7	
BC870_030-BC870_020	BC870_030	BC870_020	Pipe	12	0.0120	71	0.5	1.1	1.3	1.5	1.7	0.5	1.1	1.3	1.5	1.7	323.3	313.4	322.7	313.2	314.0	313.5	314.2	314.0	314.0	313.5	314.2	314.1	
Outfall BC900																													
BC900_020-BC900_010	BC900_020	BC900_010	Pipe	42	0.0120	200	16.6	38.2	46.7	53.8	58.6	17.1	39.3	47.8	55.3	60.2	221.2	208.5	224.8	206.0	210.2	207.7	210.2	207.7	210.2	207.7	210.3	207.8	
BC900_030-BC900_020	BC900_030	BC900_020	Pipe	42	0.0120	545	16.6	38.2	46.7	53.8	58.6	17.1	39.3	47.8	55.2	60.2	222.4	211.9	221.2	208.6	213.9	210.2	214.0	210.2	214.0	210.2	214.1	210.3	
BC900_040-BC900_030	BC900_040	BC900_030	Pipe	30	0.0120	484	10.5	24.0	29.3	33.7	36.5	10.6	24.3	29.4	33.9	36.9	229.4	219.1	222.4	212.8	220.6	213.9	220.7	214.0	220.6	214.0	220.7	214.1	
BC900_050-BC900_040	BC900_050	BC900_040	Pipe	30	0.0120	175	6.7	15.3	18.6	21.3	23.0	6.9	15.6	18.8	21.6	23.4	229.8	220.3	229.4	219.1	221.7	220.6	221.8	220.7	221.7	220.6	221.8	220.7	
BC910_010-BC900_030	BC910_010	BC900_030	Pipe	36	0.0120	330	6.2	14.3	17.5	20.3	22.2	6.5	15.1	18.4	21.4	23.4	223.7	213.7	222.4	212.3	215.1	213.9	215.2	214.0	215.1	214.0	215.2	214.1	
BC910_020-BC910_010	BC910_020	BC910_010	Pipe	36	0.0120	134	6.2	14.3	17.5	20.3	22.2	6.5	15.1	18.4	21.4	23.3	224.3	214.9	223.7	213.9	216.1	215.1	216.2	215.2	216.1	215.1	216.2	215.2	
BC910_030-BC910_020	BC910_030	BC910_020	Pipe	15	0.0120	258	1.1	2.5	3.1	3.7	4.3	1.4	3.1	3.8	4.5	5.1	230.6	218.8	224.3	215.9	219.4	216.1	219.4	216.2	219.5	216.1	219.5	216.2	
BC910_040-BC910_030	BC910_040	BC910_030	Pipe	12	0.0120	258	1.1	2.5	3.1	3.8	4.4	1.4	3.1	3.8	4.5	5.2	228.4	220.6	230.6	219.0	222.2	219.4	223.1	219.4	223.3	219.5	224.3	219.5	
BC910_100-BC910_020	BC910_100	BC910_020	Pipe	36	0.0120	445	5.1	11.8	14.4	16.6	18.0	5.2	12.0	14.7	16.9	18.3	225.1	215.1	224.3	213.7	216.6	216.1	216.7	216.2	216.7	216.1	216.7	216.2	
BC910_110-BC910_100	BC910_110	BC910_100	Pipe	36	0.0120	370	5.1	11.8	14.4	16.7	18.0	5.2	12.0	14.7	17.0	18.3	226.3	216.2	225.1	215.1	217.6	216.6	217.6	216.7	217.6	216.7	217.7	216.7	
BC920_010-BC910_110	BC920_010	BC910_110	Pipe	24	0.0120	536	1.7	3.8	4.6	5.3	5.8	1.8	4.0	4.9	5.6	6.1	229.2	218.7	226.3	217.0	219.6	217.6	219.6	217.6	219.6	217.6	219.7	217.7	
BC930_010-BC910_110	BC930_010	BC910_110	Pipe	30	0.0120	110	3.5	8.0	9.9	11.4	12.3	3.5	8.0	9.9	11.4	12.3	226.8	217.0	226.3	216.4	218.0	217.6	218.1	217.6	218.0	217.6	218.1	217.7	
BC930_040-BC930_020	BC930_040	BC930_020	Pipe	48	0.0130	145	0.2	0.5	0.6	0.7	0.8	0.2	0.5	0.6	0.7	0.8	228.1	217.7	223.3	217.4	218.1	218.1	218.1	218.1	218.1	218.1	218.1	218.1	
BC940_010-BC930_010	BC940_010	BC930_010	Pipe	30	0.0120	200	3.3	7.5	9.2	10.6	11.5	3.3	7.5	9.2	10.6	11.5	227.6	218.1	226.8	217.2	219.1	218.0	219.1	218.1	219.1	218.0	219.1	218.1	
BC940_040-BC940_020	BC940_040	BC940_020	Pipe	48	0.0130	140	0.3	0.7	0.8	0.9	1.0	0.3	0.7	0.8	0.9	1.0	228.5	218.8	223.9	218.5	219.2	219.1	219.2	219.2	219.2	219.1	219.2	219.2	
BC950_010-BC940_010	BC950_010	BC940_010	Pipe	30	0.0120	174	3.0	6.9	8.4	9.7	10.5	3.0	6.9	8.4	9.7	10.5	228.3	219.3	227.6	218.1	220.2	219.1	220.2	219.1	220.2	219.1	220.2	219.1	
BC950_020-BC950_010	BC950_020	BC950_010	Pipe	12	0.0120	162	0.4	0.9	1.2	1.3	1.4	0.4	0.9	1.2	1.3	1.4	226.4	220.1	228.3	219.3	220.6	220.2	220.6	220.2	220.6	220.2	220.6	220.2	
BC960_010-BC950_010	BC960_010	BC950_010	Pipe	30	0.0120	302	2.6	5.9	7.2	8.4	9.0	2.6	5.9	7.2	8.4	9.0	228.3	219.3	228.3	219.0	220.6	220.2	220.7	220.2	220.6	220.2	220.7	220.2	
BC960_020-BC960_010	BC960_020	BC960_010	Pipe	24	0.0120	180	2.6	5.9	7.3	8.4	9.0	2.6	5.9	7.3	8.4	9.0	228.1	220.5	228.3	219.4	221.5	220.6	221.5	220.7	221.5	220.6	221.5	220.7	
BC960_030-BC960_020	BC960_030	BC960_020	Pipe	24	0.0120	174	1.3	2.9	3.6	4.1	4.4	1.3	2.9	3.6	4.1	4.4	229.9	221.0	228.1	221.0	222.0	221.5	222.1	221.5	222.0	221.5	222.1	221.5	
BC960_040-BC960_030	BC960_040	BC960_030	Pipe	18	0.0120	220	1.3	2.9	3.6	4.1	4.4	1.3	2.9	3.6	4.1	4.4	238.6	223.1	229.9	221.4	223.8	222.0	223.8	222.1	223.8	222.0	223.8	222.1	
BC960_050-BC960_040	BC960_050	BC960_040	Pipe	18	0.0120	200	1.3	2.9	3.6	4.1	4.4	1.3	2.9	3.6	4.1	4.4	233.5	224.6	238.6	223.1	225.3	223.8	225.3	223.8	225.3	223.8	225.3	223.8	
BC970_010-BC960_020	BC970_010	BC960_020	Pipe	15	0.0120	112	0.9	2.1	2.5	2.9	3.2	0.9	2.1	2.5	2.9	3.2	228.3	221.5	228.1	221.0	222.2	221.5	222.2	221.5	222.2	221.5	222.2	221.5	
BC970_020-BC970_010	BC970_020	BC970_010	Pipe	12	0.0120	318	0.9	2.1	2.5	2.9	3.2	0.9	2.1	2.5	2.9	3.2	232.8	224.2	228.3	221.7	224.9	222.2	225.0	222.2	224.9	222.2	225.0	222.2	
BC970_030-BC970_020	BC970_030	BC970_020	Pipe	12	0.0120	147	0.9	2.1	2.5	2.9	3.2	0.9	2.1	2.5	2.9	3.2	234.7	225.8	232.8	224.2	226.4	224.9	226.5	225.0	226.4	224.9	226.5	225.0	
BC970_040-BC970_030	BC970_040	BC970_030	Pipe	12	0.0120	174	0.9	2.1	2.5	2.9	3.2	0.9	2.1	2.5	2.9	3.2	238.4	229.0	234.7	225.8	229.5	226.4	229.6	226.5	229.5	226.4	229.6	226.5	
BC970_050-BC970_040	BC970_050	BC970_040	Pipe	12	0.0120	123	0.9	2.1	2.5	2.9	3.2	0.9	2.1	2.5	2.9	3.2	242.1	232.8	238.4	229.0	233.2	229.5	233.2	229.6	233.2	229.5	233.2	229.6	
BC970_060-BC970_050	BC970_060	BC970_050	Pipe	12	0.0120	104	0.9	2.1	2.5	2.9	3.2	0.9	2.1	2.5	2.9	3.2	240.3	233.5	242.1	232.8	234.3	233.2	234.3	233.2	234.3	233.2	234.3	233.2	
BC980_010-BC960_050	BC980_010	BC960_050	Pipe	18	0.0120	166	1.3	2.9	3.6	4.1	4.4	1.3	2.9	3.6	4.1	4.4	234.3	225.3	233.5	224.6	226.1	225.3	226.2	225.3	226.1	225.3	226.2	225.3	
BC980_020-BC980_010	BC980_020	BC980_010	Pipe	12	0.0120	160	0.4	0.9	1.1	1.3	1.4	0.4	0.9	1.1	1.3	1.4	238.4	229.3	234.3	225.7	229.6	226.1	229.6	226.2	229.6	226.1	229.6	226.2	
BC980_030-BC980_020	BC980_030	BC980_020	Pipe	12	0.0120	108	0.4	0.9	1.1	1.3	1.4	0.4	0.9	1.1	1.3	1.4	241.4	234.0	238.4	229.3	234.3	229.6	234.3	229.6	234.3	229.6	234.3	229.6	
BC990_010-BC980_010	BC990_010	BC980_010	Pipe	15	0.0120	420	0.9	2.0	2.5	2.8	3.1	0.9	2.0	2.5	2.8	3.1	238.2	229.7	234.3	225.5	230.3	226.1	230.3	226.2	230.3	226.1	230.3	226.2	
BC990_020-BC990_010	BC990_020	BC990_010	Pipe	12	0.0120	273	0.9	2.0	2.5	2.8	3.1	0.9	2.0	2.5	2.8	3.1	243.0	233.2	238.2	229.9	233.8	230.3	233.8	230.3	233.8	230.3	233.8	230.3	
BC990_030-BC990_020	BC990_030	BC990_020	Pipe	12	0.0120	171	0.9	2.0	2.5	2.8	3.1	0.9	2.0	2.5	2.8	3.1	244.1	234.4	243.0	233.4	235.2	233.8	235.2	233.8	235.2	233.8	235.2	233.8	
BC990_040-BC990_030	BC990_040	BC990_030	Pipe	12	0.0120	362	0.9	2.0	2.5	2.9	3.1	0.9	2.0	2.5	2.9	3.1	252.5	244.9	244.1	234.6	245.4	235.2	245.4	235.2	245.4	235.2	245.4	235.2	
BC990_050-BC990_040	BC990_050	BC990_040	Pipe	12	0.0120	120	0.9	2.0	2.5	2.9	3.1	0.9	2.0	2.5	2.9	3.1	257.3	249.0	252.5	244.9	249.5	245.4	249.5	245.4	249.5	245.4	249.5	245.4	
BC1000_010-BC900_050	BC1000_010	BC900_050	Pipe	30	0.0120	313	6.7	15.3	18.6	21.3	23.0	6.9	15.6	18.8	21.6	23.4	232.4	222.5	229.8	220.3	223.9	221.7	223.9	221.8	223.9	221.7	223.9	221.8	
BC1000_020-BC1000_010	BC1000_020	BC1000_010	Pipe	12	0.0120	157	0.8	1.7	2.1	2.4	2.7	0.8	1.7	2.1	2.4	2.7	233.3	224.8	232.4	224.0	225.5	223.9	225.6	223.9	225.5	223.9	225.6	223.9	
BC1010_010-BC1000_010	BC1010_010	BC1000_010	Pipe	24	0.0120	149	6.0	13.6	16.5	18.9	20.3	6.1	13.9	16.7	19.2	20.7	233.1	224.0	232.4	223.7	226.2	223.9	226.3	223.9	226.2	223.9	226.4	223.9	
BC1010_020-BC1010_010	BC1010_020	BC1010_010	Pipe	18	0.0120	256	3.6	8.1	9.8	11.2	12.0	3.7	8.3	10.1	11.5	12.4	234.9	226.4	233.1	224.3	228.6	226.2	229.2	226.3	228.8	226.2	229.4	226.4	
BC1010_030-BC1010_020	BC1010_030	BC1010_020	Pipe	18	0.0120	322	3.6	8.1	9.8	11.2	12.0	3.7	8.3	10.1	11.5	12.4	238.3	228.9	234.9	226.4	231.7	228.6	232.7	229.2	232.1	228.8	233.1	229.4	
BC1020_010-BC1010_010	BC1020_010	BC1010_010	Pipe	12	0.0120	284	1.2	2.8	3.4	3.9	4.2	1.2	2.8	3.4	3.9	4.2	239.5	231.1	233.1	224.8	231.7	226.2	231.7	226.3	231.7	226.2	231.7	226.4	
BC1020_020-BC1020_010	BC1020_020	BC1020_010	Pipe	12	0.0120	190	1.2	2.8	3.4	3.9	4.2	1.2	2.8	3.4	3.9	4.2	246.0	236.4	239.5	231.1	236.9	231.7	237.0	231.7	236.9	231.7	237.0	231.7	
BC1020_030-BC1020_020	BC1020_030	BC1020_020	Pipe	12	0.0120	256	1.2	2.8	3.4	3.9	4.2	1.2	2.8	3.4	3.9	4.2	250.0	241.0	246.0	236.4	241.7	236.9	241.7	237.0	241.7	236.9	241.7	237.0	
BC1020_040-BC1020_030	BC1020_040	BC1020_030	Pipe	12	0.0120	105	1.2	2.8	3.4	3.9	4.2	1.2	2.8	3.4	3.9	4.2	253.4	246.0	250.0	241.2	246.5	241.7	246.5	241.7	246.5	241.7	246.5	241.7	
BC1030_010-BC1010_030	BC1030_010	BC1010_030	Pipe	12	0.0120	245	2.1	4.8	5.8	6.7	7.1	2.2	5.1	6.2	7.1	7.5	244.5	234.3	238.3	229.4	238.9	231.7	240.7	232.7	240.0	232.1	241.6	233.1	
BC1030_020-BC1030_010	BC1030_020	BC1030_010	Pipe	12	0.0120	280	2.1	4.8	5.8	6.7	7.1	2.2	5.1	6.2	7.1	7.5	255.3	246.6	244.5	234.3	247.5	238.9	249.9	240.7	249.2	240.0	251.5	241.6	
BC1030_030-BC1030_020	BC1030_030	BC1030_020	Pipe	12	0.0120	108	2.1	4.8	5.8	6.8	7.2	2.2	5.1	6.2	7.1	7.5	259.0	249.9	255.3	246.6	250.7	247.5	253.5	249.9	252.8	249.2	255.3	251.5	
BC1030_040-BC1030_030	BC1030_040	BC1030_030	Pipe	12	0.0120	136	2.1	4.8	5.8	6.7	7.2	2.2	5.1	6.2	7.2	7.5	267.5	259.0	259.0	249.9	259.6	250.7	259.7	253.5	259.7	252.8	260.1	255.3	
BC1030_050-BC1030_040	BC1030_050	BC1030_040	Pipe	12	0.0120	230	2.1	4.8	5.8	6.7	7.2	2.2	5.1	6.2	7.2	7.6	272.7	261.7	267.5	259.0	267.7	259.6	268.2	259.7	268.4	259.7	268.5	260.1	
BC1030_060-BC1030_050	BC1030_060	BC1030_050	Pipe	12	0.0120	222	1.4	3.2	3.9	4.6	4.9	1.4	3.2	3.9	4.6	4.8	271.2	265.4	272.7	261.9	270.6	267.7	271.2	268.2	271.2	268.4	271.2	268.5	25-yr Existing
BC1040_010-BC1030_050	BC1040_010	BC1030_050	Pipe	12	0.0120	219	0.7	1.6	1.9	2.2	2.4	0.8	1.8	2.3	2.6	2.9	277.3	268.7	272.7	265.4	269.3	267.7	269.4	268.2	269.4	268.4	269.6	268.5	

Table A-2: Model Conduit Parameters and Results

	Node ID		Conduit Attributes				Existing S. Troutdale Model - Peak Flows (cfs)					Future S. Troutdale Model - Peak Flows (cfs)					Node Rim and Invert Elevation (IE)				Maximum Hydraulic Grade Line - Existing Conditions				Maximum Hydraulic Grade Line - Future Conditions				
																					10yr 24hr HGL (feet)		25yr 24hr HGL (feet)		10yr 24hr HGL (feet)		25yr 24hr HGL (feet)		
Conduit Name (US Node - DS Node)	US	DS	Type	Conduit Dia or Channel Height (inches)	Manning's Roughness	Conduit Length	WQ Peak Flows (cfs)	2yr 24hr Peak Flows (cfs)	5yr 24hr Peak Flows (cfs)	10yr 24hr Peak Flow (cfs)	25yr 24hr Peak Flow (cfs)	WQ Peak Flows (cfs)	2yr 24hr Peak Flows (cfs)	5yr 24hr Peak Flows (cfs)	10yr 24hr Peak Flow (cfs)	25yr 24hr Peak Flow (cfs)	US Rim (ft)	US IE (ft)	DS Rim (ft)	DS IE (ft)	US	DS	US	DS	US	DS	US	DS	When hydraulically deficient
BC1050_010-BC1010_030	BC1050_010	BC1010_030	Pipe	18	0.0120	290	1.4	3.3	4.0	4.8	5.0	1.4	3.3	4.0	4.8	5.0	248.7	237.1	238.3	228.9	237.5	231.7	237.6	232.7	237.5	232.1	237.6	233.1	
BC1050_020-BC1050_010	BC1050_020	BC1050_010	Pipe	18	0.0120	190	1.4	3.3	4.0	4.5	5.0	1.4	3.3	4.0	4.5	5.0	256.1	246.9	248.7	237.1	247.4	237.5	247.4	237.6	247.4	237.5	247.4	237.6	
BC1050_030-BC1050_020	BC1050_030	BC1050_020	Pipe	18	0.0120	317	1.4	3.3	4.0	4.5	5.0	1.4	3.3	4.0	4.5	5.0	258.3	248.8	256.1	246.9	249.7	247.4	249.7	247.4	249.7	247.4	249.7	247.4	
BC1050_040-BC1050_030	BC1050_040	BC1050_030	Pipe	12	0.0120	450	1.4	3.3	4.0	4.5	5.0	1.4	3.3	4.0	4.5	5.0	270.3	254.6	258.3	249.3	256.2	249.7	257.5	249.7	256.2	249.7	257.5	249.7	
SANDY RIVER																													
Outfall SR005																													
SR005_010-O_SR005	SR005_010	O_SR005	Pipe	60	0.0120	537	36.0	83.0	105.8	132.3	150.0	40.0	92.3	116.7	143.4	157.2	44.2	27.2	44.2	24.0	30.0	26.8	30.2	27.0	30.1	26.9	30.3	27.1	
SR005_020-SR005_010	SR005_020	SR005_010	Pipe	60	0.0120	336	36.0	83.0	105.8	132.3	149.9	40.0	92.2	116.7	143.1	157.2	44.7	29.3	44.2	27.4	32.2	30.0	32.4	30.2	32.3	30.1	32.5	30.3	
SR005_030-SR005_020	SR005_030	SR005_020	Pipe	54	0.0120	435	27.2	62.7	82.1	105.3	119.6	31.2	71.9	92.6	115.1	126.9	45.6	35.4	44.7	29.8	37.5	32.2	37.6	32.4	37.6	32.3	37.7	32.5	
SR005_040-SR005_030	SR005_040	SR005_030	Pipe	42	0.0120	96	27.2	62.7	82.1	105.3	119.6	31.2	71.9	92.6	115.0	126.9	55.0	41.9	45.6	36.4	43.4	37.5	43.6	37.6	43.5	37.6	43.6	37.7	
SR007_010-SR005_040	SR007_010	SR005_040	Pipe	48	0.0120	108	27.2	62.7	82.1	105.2	119.6	31.2	71.9	92.6	115.0	126.9	64.8	45.0	55.0	42.0	46.8	43.4	46.9	43.6	46.9	43.5	47.0	43.6	
SR010_010-SR007_010	SR010_010	SR007_010	Pipe	36	0.0120	135	26.1	60.4	79.6	102.3	116.2	30.2	69.6	89.9	111.5	122.8	81.4	65.8	64.8	45.4	67.1	46.8	67.1	46.9	67.1	46.9	67.2	47.0	
SR010_020-SR010_010	SR010_020	SR010_010	Pipe	54	0.0120	280	26.1	60.4	79.6	102.3	116.2	30.2	69.6	89.9	111.5	122.8	81.7	68.2	81.4	66.0	70.6	67.1	70.8	67.1	70.7	67.1	70.9	67.2	
SR010_090-SR010_020	SR010_090	SR010_020	Pipe	54	0.0120	320	26.1	60.4	79.6	102.4	116.3	30.2	69.6	90.0	111.5	122.7	85.1	70.8	81.7	68.2	73.1	70.6	73.3	70.8	73.2	70.7	73.4	70.9	
SR010_100-SR010_090	SR010_100	SR010_090	Pipe	24	0.0120	253	6.6	15.0	19.8	26.6	28.8	8.5	19.3	24.8	30.6	30.6	86.0	77.5	85.1	72.5	78.9	73.1	78.9	73.3	79.0	73.2	79.0	73.4	
SR010_110-SR010_100	SR010_110	SR010_100	Pipe	18	0.0120	259.69	6.6	15.0	19.8	26.6	28.8	8.5	19.3	24.8	30.6	30.6	100.8	94.5	86.0	78.0	95.6	78.9	95.7	78.9	95.9	79.0	95.9	79.0	
SR010_120-SR010_110	SR010_120	SR010_110	Pipe	18	0.0120	493.45	6.6	15.0	19.8	26.6	28.9	8.5	19.3	24.9	30.6	30.6	130.0	124.5	100.8	94.5	125.7	95.6	125.8	95.7	130.0	95.9	130.0	95.9	25-yr Future
SR010_130-SR010_120	SR010_130	SR010_120	Pipe	15	0.0120	500	3.4	7.7	10.8	14.5	14.9	3.7	8.4	11.5	14.4	14.1	149.8	144.5	130.0	124.8	145.6	125.7	146.8	125.8	148.6	130.0	148.6	130.0	
SR020_010-SR010_090	SR020_010	SR010_090	Pipe	48	0.0120	375	19.7	45.6	59.8	75.8	87.5	21.8	50.4	65.1	80.9	92.1	89.2	79.3	85.1	71.3	80.9	73.1	81.0	73.3	80.9	73.2	81.1	73.4	
SR020_020-SR020_010	SR020_020	SR020_010	Pipe	54	0.0120	385	19.7	45.6	59.8	75.8	87.5	21.8	50.4	65.1	80.9	92.1	97.8	82.9	89.2	79.6	84.8	80.9	85.0	81.0	84.9	80.9	85.0	81.1	
SR030_010-SR020_020	SR030_010	SR020_020	Pipe	54	0.0120	385	18.3	42.5	55.4	69.6	79.9	19.5	45.2	58.4	72.7	82.7	101.2	85.4	97.8	82.9	87.4	84.8	87.5	85.0	87.4	84.9	87.6	85.0	
SR030_020-SR030_010	SR030_020	SR030_010	Pipe	54	0.0120	385	18.3	42.5	55.5	69.7	79.9	19.5	45.2	58.5	72.8	82.8	100.4	87.9	101.2	85.4	89.8	87.4	90.0	87.5	89.9	87.4	90.1	87.6	
SR030_030-SR030_020	SR030_030	SR030_020	Pipe	48	0.0120	55	14.8	34.1	44.0	54.7	62.3	15.0	34.7	44.8	55.6	63.2	99.6	89.1	100.4	88.4	90.6	89.8	90.7	90.0	90.6	89.9	90.7	90.1	
SR030_050-SR030_030	SR030_050	SR030_030	Pipe	30	0.0120	354	14.8	34.1	44.0	54.7	62.3	15.0	34.7	44.8	55.6	63.2	135.2	124.0	99.6	90.5	125.1	90.6	125.2	90.7	125.1	90.6	125.2	90.7	
SR040_010-SR030_020	SR040_010	SR030_020	Pipe	42	0.0130	375	3.6	8.4	11.5	15.0	17.7	4.5	10.5	13.7	17.2	19.6	101.2	91.7	100.4	89.0	92.6	89.8	92.7	90.0	92.7	89.9	92.8	90.1	
SR050_010-SR040_010	SR050_010	SR040_010	Pipe	42	0.0130	375	2.7	6.3	8.3	10.3	11.7	2.7	6.3	8.3	10.3	11.7	103.6	94.3	101.2	91.9	95.1	92.6	95.2	92.7	95.1	92.7	95.2	92.8	
SR050_020-SR050_010	SR050_020	SR050_010	Pipe	42	0.0130	138	2.7	6.3	8.3	10.4	11.7	2.7	6.3	8.3	10.4	11.7	104.7	95.2	103.6	94.5	96.1	95.1	96.2	95.2	96.1	95.1	96.2	95.2	
SR050_030-SR050_020	SR050_030	SR050_020	Pipe	18	0.0130	65	1.1	2.6	3.4	4.4	5.0	1.1	2.6	3.4	4.4	5.0	103.2	96.4	104.7	94.4	96.9	96.1	97.0	96.2	96.9	96.1	97.0	96.2	
SR050_060-SR050_030	SR050_060	SR050_030	Pipe	18	0.0130	76	1.1	2.6	3.4	4.4	5.0	1.1	2.6	3.4	4.4	5.0	109.9	100.6	103.2	96.4	101.0	96.9	101.1	97.0	101.0	96.9	101.1	97.0	
SR050_070-SR050_060	SR050_070	SR050_060	Pipe	12	0.0130	120	1.1	2.6	3.4	4.4	5.0	1.1	2.6	3.4	4.4	5.0	124.2	113.8	109.9	100.8	114.3	101.0	114.3	101.1	114.3	101.0	114.3	101.1	
SR050_080-SR050_070	SR050_080	SR050_070	Pipe	12	0.0130	107	1.1	2.6	3.4	4.4	5.0	1.1	2.6	3.4	4.4	5.0	136.8	126.4	124.2	114.0	126.8	114.3	126.8	114.3	126.8	114.3	126.8	114.3	
SR050_090-SR050_080	SR050_090	SR050_080	Pipe	12	0.0130	61	1.1	2.6	3.4	4.4	5.0	1.1	2.6	3.4	4.4	5.0	143.4	134.6	136.8	126.6	135.0	126.8	135.1	126.8	135.0	126.8	135.1	126.8	
SR050_100-SR050_090	SR050_100	SR050_090	Pipe	12	0.0130	114	1.1	2.6	3.4	4.3	5.0	1.1	2.6	3.4	4.3	5.0	157.5	147.7	143.4	134.8	148.1	135.0	148.2	135.1	148.1	135.0	148.2	135.1	
SR050_120-SR050_100	SR050_120	SR050_100	Pipe	12	0.0130	93	1.1	2.6	3.4	4.3	5.0	1.1	2.6	3.4	4.3	5.0	166.2	157.3	157.5	156.2	158.4	148.1	158.9	148.2	158.4	148.1	158.9	148.2	
SR060_010-SR050_020	SR060_010	SR050_020	Pipe	42	0.0130	237	1.6	3.8	4.9	6.1	6.9	1.6	3.8	4.9	6.1	6.9	105.0	96.1	104.7	92.1	96.6	96.1	96.6	96.2	96.6	96.1	96.6	96.2	
SR070_010-SR060_010	SR070_010	SR060_010	Pipe	36	0.0130	375	0.6	1.5	1.9	2.3	2.5	0.6	1.5	1.9	2.3	2.5	106.3	96.8	105.0	95.0	97.2	96.6	97.3	96.6	97.2	96.6	97.3	96.6	
SR070_020-SR070_010	SR070_020	SR070_010	Pipe	36	0.0130	375	0.7	1.5	1.9	2.3	2.5	0.7	1.5	1.9	2.3	2.5	108.3	98.8	106.3	97.0	99.2	97.2	99.2	97.3	99.2	97.2	99.2	97.3	
SR070_030-SR070_020	SR070_030	SR070_020	Pipe	36	0.0130	375	0.7	1.5	1.9	2.3	2.5	0.7	1.5	1.9	2.3	2.5	110.9	101.0	108.3	99.0	101.4	99.2	101.5	99.2	101.4	99.2	101.5	99.2	
SR070_040-SR070_030	SR070_040	SR070_030	Pipe	36	0.0130	375	0.7	1.5	1.9	2.3	2.5	0.7	1.5	1.9	2.3	2.5	114.0	104.0	110.9	101.2	104.4	101.4	104.4	101.5	104.4	101.4	104.4	101.5	
SR070_050-SR070_040	SR070_050	SR070_040	Pipe	36	0.0130	375	0.7	1.5	1.9	2.3	2.6	0.7	1.5	1.9	2.3	2.6	117.6	107.0	114.0	104.0	107.4	104.4	107.4	104.4	107.4	104.4	107.4	104.4	
SR070_060-SR070_050	SR070_060	SR070_050	Pipe	36	0.0130	375	0.7	1.5	1.9	2.3	2.6	0.7	1.5	1.9	2.3	2.6	121.7	111.0	117.6	107.2	111.4	107.4	111.4	107.4	111.4	107.4	111.4	107.4	
SR070_070-SR070_060	SR070_070	SR070_060	Pipe	36	0.0130	375	0.7	1.5	1.9	2.3	2.6	0.7	1.5	1.9	2.3	2.6	125.6	114.9	121.7	111.2	115.3	111.4	115.3	111.4	115.3	111.4	115.3	111.4	
SR080_010-SR010_130	SR080_010	SR010_130	Pipe	15	0.0120	400.06	3.4	7.7	10.9	14.6	15.2	3.7	8.4	11.6	14.9	15.0	163.5	158.5	149.8	144.5	162.4	145.6	163.5	146.8	163.5	148.6	163.5	148.6	25-yr Existing
SR090_010-SR030_050	SR090_010	SR030_050	Pipe	30	0.0120	362	13.0	30.2	38.9	48.3	55.0	13.3	30.8	39.6	49.2	55.9	170.8	148.8	135.2	124.0	149.9	125.1	150.0	125.2	149.9	125.1	150.0	125.2	
SR090_020-SR090_010	SR090_020	SR090_010	Pipe	30	0.0120	112	10.8	24.9	32.1	39.9	45.4	11.0	25.5	32.9	40.8	46.3	192.6	156.5	170.8	148.8	157.5	149.9	157.6	150.0	157.5	149.9	157.6	150.0	
SR100_010-SR090_020	SR100_010	SR090_020	Pipe	30	0.0120	215	10.8	24.9	32.1	39.9	45.4	11.0	25.5	32.9	40.8	46.3	208.6	166.2	192.6	156.5	167.3	157.5	167.4	157.6	167.4	157.5	167.5	157.6	
SR100_020-SR100_010	SR100_020	SR100_010	Pipe	27	0.0120	287	10.8	24.9	32.1	39.9	45.4	11.0	25.5	32.9	40.8	46.3	214.9	192.7	208.6	170.3	193.7	167.3	193.8	167.4	193.8	167.4	193.8	167.5	
SR100_030-SR100_020	SR100_030	SR100_020	Pipe	24	0.0130	375	1.7	3.9	5.6	7.2	8.4	1.7	3.9	5.6	7.2	8.4	239.2	230.7	214.9	205.7	231.1	193.7	231.2	193.8	231.1	193.8	231.2	193.8	
SR100_040-SR100_030	SR100_040	SR100_030	Pipe	18	0.0130	52	1.7	3.9	5.6	7.2	8.4	1.7	3.9	5.6	7.2	8.4	239.4	232.0	239.2	230.9	232.8	231.1	232.8	231.2	232.8	231.1	232.8	231.2	
SR100_100-SR100_020	SR100_100	SR100_020	Pipe	27	0.0100	105	6.6	15.3	18.8	22.2	25.0	6.8	15.9	19.6	23.1	25.9	222.1	210.6	214.9	192.9	211.1	193.7	211.2	193.8	211.2	193.8	211.2	193.8	
SR100_110-SR100_100	SR100_110	SR100_100	Pipe	27	0.0100	214	6.6	15.3	18.8	22.2	25.0	6.8	15.9	19.6	23.1	26.0	240.0	236.0	222.1	210.8	236.6	211.1	236.6	211.2	236.6	211.2	236.7	211.2	
SR100_120-SR100_110	SR100_120	SR100_110	Pipe	27	0.0100	124	6.6	15.3	18.8	22.2	25.0	6.8	15.9	19.6	23.1	26.0	245.4	242.0	240.0	236.0	242.8	236.6	242.9	236.6	242.9	236.6	242.9	236.7	
SR100_130-SR100_120	SR100_130	SR100_120	Pipe	27	0.0100	86	6.6	15.3	18.8	22.2	25.0	6.8	15.9	19.5	23.1	25.9	251.3	244.0	245.4	242.0	245.0	242.8	245.0	242.9	245.0	242.9	245.1	242.9	
SR100_150-SR100_130	SR100_150	SR100_130	Pipe	27	0.0100	140	6.6	15.3	18.8	22.2	25.0	6.8	15.9	19.5	23.1	25.9	261.4	257.0	251.3	244.0	257.6	245.0	257.7	245.0	257.7	245.0	257.7	245.1	
SR100_160-SR100_150	SR100_160	SR100_150	Pipe	27	0.0100	116	6.6	15.3	18.8	22.2	25.0	6.8	15.9	19.5	23.1	25.9	268.6	258.4	261.4	257.0	259.6	257.6	259.7	257.7	259.6	257.7	259.7	257.7	
SR110_010-SR100_040	SR110_010	SR100_040	Pipe	18	0.0130	81.12	1.7	3.9	5.6	7.2	8.4	1.7	3.9	5.6	7.2	8.4	247.1	233.0	239.4	232.2	234.0	232.8	234.1	232.8	234.0	232.8	234.1	232.8	
SR110_030-SR110_010	SR110_030	SR110_010	Pipe	18	0.0130	175	1.7	3.9	5.6	7.2	8.4	1.7	3.9	5.6	7.2	8.4	247.8	234.2	247.1	233.2	235.4	234.0	235.5	234.1	235.4	234.0	235.5	234.1	

Table A-2: Model Conduit Parameters and Results

	Node ID		Conduit Attributes				Existing S. Troutdale Model - Peak Flows (cfs)					Future S. Troutdale Model - Peak Flows (cfs)					Node Rim and Invert Elevation (IE)				Maximum Hydraulic Grade Line - Existing Conditions				Maximum Hydraulic Grade Line - Future Conditions				
																					10yr 24hr HGL (feet)		25yr 24hr HGL (feet)		10yr 24hr HGL (feet)		25yr 24hr HGL (feet)		
Conduit Name (US Node - DS Node)	US	DS	Type	Conduit Dia or Channel Height (inches)	Manning's Roughness	Conduit Length	WQ Peak Flows (cfs)	2yr 24hr Peak Flows (cfs)	5yr 24hr Peak Flows (cfs)	10yr 24hr Peak Flow (cfs)	25yr 24hr Peak Flow (cfs)	WQ Peak Flows (cfs)	2yr 24hr Peak Flows (cfs)	5yr 24hr Peak Flows (cfs)	10yr 24hr Peak Flow (cfs)	25yr 24hr Peak Flow (cfs)	US Rim (ft)	US IE (ft)	DS Rim (ft)	DS IE (ft)	US	DS	US	DS	US	DS	US	DS	When hydraulically deficient
SR110_040-SR110_030	SR110_040	SR110_030	Pipe	18	0.0130	53.99	1.4	3.3	4.7	6.1	7.1	1.4	3.3	4.7	6.1	7.1	253.7	234.8	247.8	234.4	235.7	235.4	235.8	235.5	235.7	235.4	235.8	235.5	
SR110_070-SR110_040	SR110_070	SR110_040	Pipe	18	0.0130	133.1	1.4	3.3	4.7	6.1	7.1	1.4	3.3	4.7	6.1	7.1	253.0	239.7	253.7	234.4	240.3	235.7	240.3	235.8	240.3	235.7	240.3	235.8	
SR120_010-SR110_070	SR120_010	SR110_070	Pipe	18	0.0130	245	1.0	2.3	3.4	4.4	5.1	1.0	2.3	3.4	4.4	5.1	247.1	240.4	253.0	240.0	241.5	240.3	241.7	240.3	241.5	240.3	241.7	240.3	
SR120_020-SR120_010	SR120_020	SR120_010	Pipe	18	0.0130	160	1.0	2.3	3.5	4.4	5.2	1.0	2.3	3.5	4.4	5.2	245.7	240.6	247.1	240.5	241.9	241.5	242.0	241.7	241.9	241.5	242.0	241.7	
SR120_050-SR120_020	SR120_050	SR120_020	Pipe	18	0.0130	132	1.0	2.3	3.5	4.5	5.2	1.0	2.3	3.5	4.5	5.2	247.9	241.1	245.7	240.7	242.1	241.9	242.3	242.0	242.1	241.9	242.3	242.0	
SR120_060-SR120_050	SR120_060	SR120_050	Pipe	12	0.0130	142	1.0	2.3	3.5	4.5	5.2	1.0	2.3	3.5	4.5	5.2	255.4	243.6	247.9	241.2	244.4	242.1	245.3	242.3	244.4	242.1	245.3	242.3	
SR120_070-SR120_060	SR120_070	SR120_060	Pipe	12	0.0130	125	1.0	2.3	3.5	4.5	5.3	1.0	2.3	3.5	4.5	5.3	263.9	254.9	255.4	243.7	255.4	244.4	255.4	245.3	255.4	244.4	255.4	245.3	
SR120_100-SR120_070	SR120_100	SR120_070	Pipe	12	0.0130	272	1.0	2.3	3.5	4.5	5.2	1.0	2.3	3.5	4.5	5.2	269.2	263.2	263.9	254.9	263.9	255.4	264.0	255.4	263.9	255.4	264.0	255.4	
SR130_010-SR110_070	SR130_010	SR110_070	Pipe	18	0.0130	108	0.4	1.0	1.3	1.7	2.0	0.4	1.0	1.3	1.7	2.0	257.8	250.9	253.0	240.0	251.1	240.3	251.1	240.3	251.1	240.3	251.1	240.3	
SR130_020-SR130_010	SR130_020	SR130_010	Pipe	18	0.0130	151	0.4	1.0	1.3	1.7	2.0	0.4	1.0	1.3	1.7	2.0	264.6	257.7	257.8	253.2	258.0	251.1	258.0	251.1	258.0	251.1	258.0	251.1	
SR130_030-SR130_020	SR130_030	SR130_020	Pipe	18	0.0130	30	0.4	1.0	1.3	1.7	2.0	0.4	1.0	1.3	1.7	2.0	265.4	258.1	264.6	257.9	258.6	258.0	258.6	258.0	258.6	258.0	258.6	258.0	
SR140_010-SR100_160	SR140_010	SR100_160	Pipe	27	0.0120	96	6.6	15.3	18.8	22.2	25.0	6.8	15.9	19.5	23.1	25.9	278.6	265.8	268.6	261.0	266.6	259.6	266.6	259.7	266.6	259.6	266.7	259.7	
SR140_020-SR140_010	SR140_020	SR140_010	Pipe	27	0.0120	291	5.4	12.6	15.5	18.2	20.5	5.7	13.2	16.2	19.0	21.4	294.8	281.1	278.6	269.6	281.9	266.6	281.9	266.6	281.9	266.6	282.0	266.7	
SR140_100-SR140_010	SR140_100	SR140_010	Pipe	12	0.0100	359	1.2	2.6	3.2	3.9	4.4	1.2	2.7	3.3	4.0	4.5	277.1	270.1	278.6	266.0	270.8	266.6	270.8	266.6	270.8	266.6	270.8	266.7	
SR140_110-SR140_100	SR140_110	SR140_100	Pipe	12	0.0100	155	1.2	2.6	3.2	3.9	4.5	1.2	2.7	3.3	4.0	4.6	279.4	271.8	277.1	270.3	272.5	270.8	272.6	270.8	272.6	270.8	272.6	270.8	
SR140_120-SR140_110	SR140_120	SR140_110	Pipe	12	0.0100	117	1.2	2.6	3.2	3.9	4.5	1.2	2.7	3.3	4.0	4.6	286.4	275.3	279.4	272.0	275.8	272.5	275.9	272.6	275.8	272.6	275.9	272.6	
SR150_010-SR140_020	SR150_010	SR140_020	Pipe	27	0.0120	273	5.4	12.6	15.5	18.2	20.5	5.7	13.2	16.2	19.1	21.4	301.1	290.5	294.8	280.4	291.3	281.9	291.3	281.9	291.3	281.9	291.3	282.0	
SR150_030-SR150_010	SR150_030	SR150_010	Pipe	12	0.0120	101	0.6	1.3	1.6	1.8	2.0	0.6	1.3	1.6	1.8	2.0	301.8	293.7	301.1	292.8	294.2	291.3	294.3	291.3	294.2	291.3	294.3	291.3	
SR150_040-SR150_030	SR150_040	SR150_030	Pipe	12	0.0120	152	0.6	1.3	1.6	1.8	2.0	0.6	1.3	1.6	1.8	2.0	304.5	295.3	301.8	293.7	295.7	294.2	295.8	294.3	295.7	294.2	295.8	294.3	
SR150_050-SR150_040	SR150_050	SR150_040	Pipe	12	0.0120	180	0.6	1.3	1.6	1.8	2.0	0.6	1.3	1.6	1.8	2.0	309.9	300.7	304.5	295.3	301.0	295.7	301.0	295.8	301.0	295.7	301.0	295.8	
SR160_010-SR150_010	SR160_010	SR150_010	Pipe	30	0.0120	358	4.9	11.3	13.9	16.5	18.7	5.1	11.9	14.7	17.3	19.5	306.5	295.0	301.1	290.8	296.0	291.3	296.1	291.3	296.0	291.3	296.1	291.3	
SR170_010-SR200_010	SR170_010	SR200_010	Pipe	30	0.0120	295	1.0	2.3	3.1	4.5	5.8	1.0	2.3	3.1	4.5	5.8	315.9	302.0	312.5	300.0	302.6	300.4	302.7	300.4	302.6	300.4	302.7	300.4	
SR170_020-SR170_010	SR170_020	SR170_010	Pipe	24	0.0120	470	1.0	2.3	3.1	4.5	5.8	1.0	2.3	3.1	4.5	5.8	318.7	308.0	315.9	302.5	308.6	302.6	308.6	302.7	308.6	302.6	308.6	302.7	
SR170_030-SR170_020	SR170_030	SR170_020	Pipe	24	0.0120	180	1.0	2.3	3.1	4.5	5.8	1.0	2.3	3.1	4.5	5.8	321.0	309.3	318.7	308.0	309.9	308.6	310.0	308.6	309.9	308.6	310.0	308.6	
SR170_040-SR170_030	SR170_040	SR170_030	Pipe	24	0.0120	280	1.0	2.3	3.1	4.5	5.8	1.0	2.3	3.1	4.5	5.8	322.9	311.2	321.0	309.3	311.8	309.9	311.9	310.0	311.8	309.9	311.9	310.0	
SR170_050-SR170_040	SR170_050	SR170_040	Pipe	18	0.0120	170	1.0	2.3	3.1	4.5	5.8	1.0	2.3	3.1	4.5	5.8	325.6	314.9	322.9	311.7	315.4	311.8	315.5	311.9	315.4	311.8	315.5	311.9	
SR170_060-SR170_050	SR170_060	SR170_050	Pipe	18	0.0120	230	0.9	2.0	2.5	3.2	3.8	0.9	2.0	2.5	3.2	3.8	333.1	319.2	325.6	314.9	319.7	315.4	319.7	315.5	319.7	315.4	319.7	315.5	
SR170_070-SR170_060	SR170_070	SR170_060	Pipe	24	0.0120	180	0.9	2.0	2.5	3.2	3.8	0.9	2.0	2.5	3.2	3.8	335.6	309.3	333.1	308.0	319.7	319.7	319.7	319.7	319.7	319.7	319.7	319.7	
SR170_080-SR170_070	SR170_080	SR170_070	Pipe	18	0.0120	183	0.9	2.0	2.5	3.2	3.8	0.9	2.0	2.5	3.2	3.8	336.6	325.0	335.6	323.8	325.6	319.7	325.7	319.7	325.6	319.7	325.7	319.7	
SR170_110-SR170_080	SR170_110	SR170_080	Pipe	18	0.0120	419	0.6	1.3	1.6	1.9	2.2	0.6	1.3	1.6	1.9	2.2	333.7	326.0	336.6	322.8	326.5	325.6	326.5	325.7	326.5	325.6	326.5	325.7	
SR180_020-SR170_050	SR180_020	SR170_050	Pipe	12	0.0130	181	0.1	0.3	0.8	1.5	2.2	0.1	0.3	0.8	1.5	2.2	327.0	320.2	325.6	314.9	320.6	315.4	320.6	315.5	320.6	315.4	320.6	315.5	
SR180_030-SR180_020	SR180_030	SR180_020	Pipe	12	0.0130	250	0.1	0.3	0.8	1.5	2.2	0.1	0.3	0.8	1.5	2.2	328.5	321.1	327.0	320.3	321.8	320.6	322.1	320.6	321.8	320.6	322.1	320.6	
SR180_040-SR180_030	SR180_040	SR180_030	Pipe	12	0.0130	144	0.1	0.3	0.8	1.5	2.2	0.1	0.3	0.8	1.5	2.2	328.0	321.6	328.5	321.2	322.3	321.8	322.5	322.1	322.3	321.8	322.5	322.1	
SR190_010-SR170_080	SR190_010	SR170_080	Pipe	12	0.0120	300	0.3	0.7	1.0	1.3	1.6	0.3	0.7	1.0	1.3	1.6	340.2	329.2	336.6	327.4	329.7	325.6	329.7	325.7	329.7	325.6	329.7	325.7	
SR190_020-SR190_010	SR190_020	SR190_010	Pipe	12	0.0120	300	0.3	0.7	1.0	1.3	1.6	0.3	0.7	1.0	1.3	1.6	344.4	331.0	340.2	329.2	331.5	329.7	331.5	329.7	331.5	329.7	331.5	329.7	
SR190_030-SR190_020	SR190_030	SR190_020	Pipe	12	0.0120	82	0.3	0.7	1.0	1.3	1.7	0.3	0.7	1.0	1.3	1.7	340.2	331.5	344.4	331.0	332.0	331.5	332.0	331.5	332.0	331.5	332.0	331.5	
SR190_050-SR190_030	SR190_050	SR190_030	Pipe	12	0.0120	116	0.3	0.7	1.0	1.3	1.7	0.3	0.7	1.0	1.3	1.7	340.4	333.5	340.2	331.5	333.8	332.0	333.9	332.0	333.8	332.0	333.9	332.0	
Outfall SR220																													
SR220_020-SR220_010	SR220_020	SR220_010	Pipe	30	0.0120	249.9	5.1	11.7	14.3	16.5	17.8	7.1	16.2	19.7	21.7	22.9	182.8	175.0	182.8	174.5	176.6	172.2	176.7	172.2	177.0	172.4	177.0	172.5	
SR220_030-SR240_010	SR220_030	SR240_010	Pipe	18	0.0120	188	2.0	4.6	5.7	6.6	7.1	2.0	4.6	5.7	6.6	7.1	188.7	176.9	186.9	176.7	178.5	177.8	178.6	177.8	178.6	178.1	178.8	178.1	
SR220_040-SR220_030	SR220_040	SR220_030	Pipe	18	0.0120	103	2.0	4.6	5.7	6.6	7.1	2.0	4.6	5.7	6.6	7.1	190.4	185.2	188.7	180.1	185.7	178.5	185.8	178.6	185.7	178.6	185.8	178.8	
SR220_050-SR220_040	SR220_050	SR220_040	Pipe	15	0.0120	111	1.2	2.7	3.3	3.8	4.1	1.2	2.7	3.3	3.8	4.1	193.8	185.2	190.4	181.6	186.0	185.7	186.1	185.8	186.0	185.7	186.1	185.8	
SR220_060-SR220_050	SR220_060	SR220_050	Pipe	15	0.0120	113	1.2	2.7	3.3	3.8	4.1	1.2	2.7	3.3	3.8	4.1	199.4	189.9	193.8	181.6	190.3	186.0	190.3	186.1	190.3	186.0	190.3	186.1	
SR220_070-SR220_060	SR220_070	SR220_060	Pipe	15	0.0120	230	1.2	2.7	3.3	3.8	4.1	1.2	2.7	3.3	3.8	4.1	206.0	196.8	199.4	190.1	197.3	190.3	197.3	190.3	197.3	190.3	197.3	190.3	
SR230_010-SR220_070	SR230_010	SR220_070	Pipe	12	0.0120	374	1.2	2.7	3.3	3.8	4.1	1.2	2.7	3.3	3.8	4.1	218.2	207.8	206.0	197.0	208.4	197.3	208.4	197.3	208.4	197.3	208.4	197.3	
SR240_010-SR220_020	SR240_010	SR220_020	Pipe	30	0.0120	360	5.2	11.7	14.3	16.5	17.8	7.1	16.3	19.7	21.7	22.9	186.9	176.3	182.8	175.0	177.8	176.6	177.8	176.7	178.1	177.0	178.1	177.0	
SR240_020-SR240_010	SR240_020	SR240_010	Pipe	30	0.0120	230	3.1	7.1	8.7	10.0	10.8	5.1	11.7	14.1	15.2	15.9	189.6	178.3	186.9	176.5	179.2	177.8	179.2	177.8	179.4	178.1	179.4	178.1	
SR240_030-SR240_020	SR240_030	SR240_020	Pipe	30	0.0120	146	3.1	7.1	8.7	10.0	10.8	5.1	11.7	14.1	15.2	15.9	188.3	179.2	189.6	178.3	180.1	179.2	180.1	179.2	180.3	179.4	180.3	179.4	
SR240_040-SR240_030	SR240_040	SR240_030	Pipe	30	0.0120	179	3.1	7.1	8.7	10.0	10.8	5.1	11.7	14.1	15.2	15.9	189.1	182.4	188.3	179.4	183.1	180.1	183.2	180.1	183.3	180.3	183.3	180.3	
SR240_050-SR240_040	SR240_050	SR240_040	Pipe	24	0.0120	156	1.9	4.4	5.3	6.1	6.6	3.9	8.9	10.7	11.3	11.7	192.1	182.5	189.1	180.6	183.3	183.1	183.3	183.2	183.7	183.3	183.7	183.3	
SR240_060-SR240_050	SR240_060	SR240_050	Pipe	24	0.0120	104	1.9	4.4	5.3	6.1	6.6	3.9	8.9	10.7	11.3	11.7	194.3	184.7	192.1	182.7	185.3	183.3	185.3	183.3	185.5	183.7	185.5	183.7	
SR240_070-SR240_060	SR240_070	SR240_060	Pipe	24	0.0120	108	1.9	4.4	5.3	6.1	6.6	3.9	8.9	10.7	11.3	11.7	195.7	185.0	194.3	183.9	185.8	185.3	185.8	185.3	186.1	185.5	186.1	185.5	
SR240_080-SR240_070	SR240_080	SR240_070	Pipe	24	0.0120	181	1.9	4.4	5.3	6.1	6.6	3.9	8.9	10.7	11.3	11.7	197.2	187.0	195.7	185.2	187.7	185.8	187.7	185.8	188.0	186.1	188.0	186.1	
SR250_010-SR240_080	SR250_010	SR240_080	Pipe	24	0.0120	132	1.9	4.4	5.3	6.1	6.6	3.9	8.9	10.7	11.3	11.7	198.0	188.6	197.2	187.2	189.2	187.7	189.3	187.7	189.5	188.0	189.5	188.0	
SR250_020-SR250_010	SR250_020	SR250_010	Pipe	15	0.0120	232	0.8	1.8	2.2	2.5	2.7	0.8	1.8	2.2	2.5	2.7	199.4	191.1	198.0	188.8	191.6	189.2	191.6	189.3	191.6	189.5	191.6	189.5	
SR250_030-SR250_020	SR250_030	SR250_020	Pipe	15	0.0120	203	0.8	1.8	2.2	2.5	2.7	0.8	1.8	2.2	2.5	2.7	204.3	196.0	199.4	191.3	196.4	191.6	196.4	191.6	196.4	191.6	196.4	191.6	

Table A-2: Model Conduit Parameters and Results

	Node ID		Conduit Attributes				Existing S. Troutdale Model - Peak Flows (cfs)					Future S. Troutdale Model - Peak Flows (cfs)					Node Rim and Invert Elevation (IE)				Maximum Hydraulic Grade Line - Existing Conditions				Maximum Hydraulic Grade Line - Future Conditions				
																					10yr 24hr HGL (feet)		25yr 24hr HGL (feet)		10yr 24hr HGL (feet)		25yr 24hr HGL (feet)		
Conduit Name (US Node - DS Node)	US	DS	Type	Conduit Dia or Channel Height (inches)	Manning's Roughness	Conduit Length	WQ Peak Flows (cfs)	2yr 24hr Peak Flows (cfs)	5yr 24hr Peak Flows (cfs)	10yr 24hr Peak Flow (cfs)	25yr 24hr Peak Flow (cfs)	WQ Peak Flows (cfs)	2yr 24hr Peak Flows (cfs)	5yr 24hr Peak Flows (cfs)	10yr 24hr Peak Flow (cfs)	25yr 24hr Peak Flow (cfs)	US Rim (ft)	US IE (ft)	DS Rim (ft)	DS IE (ft)	US	DS	US	DS	US	DS	US	DS	When hydraulically deficient
SR250_040-SR250_030	SR250_040	SR250_030	Pipe	12	0.0120	130	0.8	1.8	2.2	2.5	2.7	0.8	1.8	2.2	2.5	2.7	211.9	203.0	204.3	196.2	203.3	196.4	203.3	196.4	203.3	196.4	203.3	196.4	
SR250_100-SR250_010	SR250_100	SR250_010	Pipe	24	0.0120	110	1.1	2.6	3.2	3.7	4.0	3.1	7.2	8.6	8.9	9.0	199.7	191.0	198.0	188.8	191.4	189.2	191.5	189.3	191.7	189.5	191.7	189.5	
SR260_010-SR250_100	SR260_010	SR250_100	Pipe	24	0.0120	133	1.1	2.6	3.2	3.7	4.0	3.1	7.2	8.6	8.9	9.0	202.3	192.2	199.7	191.1	192.8	191.4	192.8	191.5	193.1	191.7	193.1	191.7	
SR260_020-SR260_010	SR260_020	SR260_010	Pipe	18	0.0120	265	0.3	0.7	0.8	0.9	1.0	0.7	1.6	2.0	2.3	2.5	208.0	198.4	202.3	192.3	198.6	192.8	198.6	192.8	198.8	193.1	198.8	193.1	
SR260_030-SR260_020	SR260_030	SR260_020	Pipe	18	0.0120	155	0.3	0.7	0.8	0.9	1.0	0.7	1.6	2.0	2.3	2.5	208.8	200.2	208.0	198.4	200.5	198.6	200.5	198.6	200.7	198.8	200.7	198.8	
SR270_010-SR260_010	SR270_010	SR260_010	Pipe	24	0.0120	135	0.9	1.9	2.4	2.7	3.0	2.4	5.6	6.6	6.6	6.6	200.7	192.8	202.3	192.5	193.5	192.8	193.5	192.8	193.9	193.1	193.9	193.1	
SR270_020-SR270_010	SR270_020	SR270_010	Pipe	15	0.0120	292	0.9	2.0	2.4	2.8	3.0	2.4	5.6	6.6	6.6	6.6	206.4	197.0	200.7	192.8	197.5	193.5	197.6	193.5	197.9	193.9	197.9	193.9	
SR270_030-SR270_020	SR270_030	SR270_020	Pipe	12	0.0120	125	0.9	2.0	2.4	2.8	3.0	2.4	5.6	6.6	6.6	6.6	213.7	203.9	206.4	197.1	204.3	197.5	204.3	197.6	204.5	197.9	204.5	197.9	
SR270_040-SR270_030	SR270_040	SR270_030	Pipe	12	0.0120	249	0.9	2.0	2.4	2.8	3.0	2.4	5.6	6.6	6.6	6.6	215.5	206.1	213.7	204.1	206.7	204.3	206.8	204.3	212.0	204.5	212.0	204.5	
SR270_050-SR270_040	SR270_050	SR270_040	Pipe	12	0.0120	240	0.9	2.0	2.4	2.8	3.0	2.4	5.6	6.6	6.6	6.6	218.4	209.6	215.5	206.2	210.2	206.7	210.2	206.8	218.4	212.0	218.4	212.0	5-yr Future
Outfall SR280																													
SR280_020-SR280_100	SR280_020	SR280_100	Pipe	12	0.0130	15.78	0.4	0.9	1.4	1.9	2.4	0.4	0.9	1.4	1.9	2.4	200.3	192.5	200.1	191.6	192.9	192.0	192.9	192.1	192.9	192.0	192.9	192.1	
Outfall SR290																													
SR290_010-O_SR290	SR290_010	O_SR290	Pipe	12	0.0130	47	0.7	1.5	2.4	3.4	4.3	0.7	1.5	2.4	3.4	4.3	147.9	137.7	126.4	118.7	137.9	119.0	137.9	119.0	137.9	119.0	137.9	119.0	
SR290_030-SR290_010	SR290_030	SR290_010	Pipe	12	0.0130	128	0.7	1.5	2.4	3.4	4.3	0.7	1.5	2.4	3.4	4.3	194.3	168.2	147.9	140.3	168.5	137.9	168.6	137.9	168.5	137.9	168.6	137.9	
SR290_080-SR290_210	SR290_080	SR290_210	Pipe	72	0.0130	110	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	196.3	186.4	196.4	185.9	186.2	185.9	186.3	185.9	186.2	185.9	186.3	185.9	
SR290_080-SR290_050	SR290_080	SR290_210	Pipe	72	0.0130	90	0.7	1.5	2.4	3.4	4.3	0.7	1.5	2.4	3.4	4.3	196.3	185.7	198.1	185.5	186.2	185.3	186.3	185.4	186.2	185.3	186.3	185.4	
SR290_110-SR290_080	SR290_110	SR290_080	Pipe	12	0.0130	288	0.7	1.5	2.4	3.4	4.3	0.7	1.5	2.4	3.4	4.3	223.2	214.9	196.3	188.2	215.3	186.2	215.3	186.3	215.3	186.2	215.3	186.3	
Outfall SR310																													
SR310_010-O_SR310	SR310_010	O_SR310	Pipe	18	0.0120	151	1.1	2.6	3.2	3.6	3.9	1.1	2.6	3.2	3.6	3.9	243.7	232.9	243.9	232.2	233.6	232.9	233.6	232.9	233.6	232.9	233.6	232.9	
SR310_020-SR310_010	SR310_020	SR310_010	Pipe	18	0.0120	204	1.1	2.6	3.2	3.6	3.9	1.1	2.6	3.2	3.6	3.9	241.5	233.8	243.7	232.9	234.5	233.6	234.5	233.6	234.5	233.6	234.5	233.6	
SR310_030-SR310_020	SR310_030	SR310_020	Pipe	15	0.0120	271	1.1	2.6	3.2	3.6	3.9	1.1	2.6	3.2	3.6	3.9	248.5	235.3	241.5	234.0	236.1	234.5	236.2	234.5	236.1	234.5	236.2	234.5	
SR310_040-SR310_030	SR310_040	SR310_030	Pipe	12	0.0120	147	1.1	2.6	3.2	3.6	3.9	1.1	2.6	3.2	3.6	3.9	245.9	236.2	248.5	235.5	237.6	236.1	237.8	236.2	237.6	236.1	237.8	236.2	
SR310_050-SR310_040	SR310_050	SR310_040	Pipe	12	0.0120	177	1.1	2.6	3.2	3.6	3.9	1.1	2.6	3.2	3.6	3.9	244.9	236.9	245.9	236.2	239.1	237.6	239.6	237.8	239.1	237.6	239.6	237.8	
Outfall SR320																													
SR320_010-O_SR320	SR320_010	O_SR320	Pipe	12	0.0120	142	0.2	0.4	0.5	0.6	0.6	0.2	0.4	0.5	0.6	0.6	261.1	250.1	256.4	247.5	250.4	247.7	250.4	247.7	250.4	247.7	250.4	247.7	
Outfall SR330																													
SR330_010-O_SR330	SR330_010	O_SR330	Pipe	12	0.0120	167.85	0.3	0.6	0.8	0.9	1.0	0.3	0.6	0.8	0.9	1.0	256.2	254.5	257.4	254.0	255.0	254.4	255.0	254.4	255.0	254.4	255.0	254.4	
Outfall SR340																													
SR340_010-O_SR340	SR340_010	O_SR340	Pipe	12	0.0120	228	0.2	0.5	0.6	0.7	0.8	0.2	0.5	0.6	0.7	0.8	268.3	259.0	255.8	252.6	259.3	252.8	259.3	252.8	259.3	252.8	259.3	252.8	
Outfall SR350																													
SR350_010-O_SR350	SR350_010	O_SR350	Pipe	12	0.0120	83	0.3	0.7	0.9	1.0	1.1	0.3	0.7	0.9	1.0	1.1	268.0	259.1	260.4	254.7	259.4	255.0	259.4	255.0	259.4	255.0	259.4	255.0	
Outfall SR360A																													
SR360_010-O_SR360A	SR360_010	O_SR360A	Pipe	12	0.0120	145	0.4	1.0	1.2	1.4	1.5	0.4	1.0	1.2	1.4	1.5	263.8	255.3	262.7	254.7	255.8	255.2	255.8	255.2	255.8	255.2	255.8	255.2	
SR360_020-SR360_010	SR360_020	SR360_010	Pipe	12	0.0120	143	0.4	1.0	1.2	1.4	1.5	0.4	1.0	1.2	1.4	1.5	266.4	258.0	263.8	255.5	258.3	255.8	258.3	255.8	258.3	255.8	258.3	255.8	
Outfall SR360B																													
SR370_010-O_SR360B	SR370_010	O_SR360B	Pipe	30	0.0120	308	5.9	13.6	17.0	21.1	25.0	8.0	17.9	21.9	26.1	29.9	265.1	256.1	262.9	254.5	257.6	256.0	257.7	256.2	257.8	256.3	258.0	256.4	
SR370_020-SR370_010	SR370_020	SR370_010	Pipe	24	0.0120	230	2.1	4.9	6.0	7.2	8.4	3.8	8.4	9.9	11.1	12.1	266.8	259.4	265.1	256.3	260.1	257.6	260.1	257.7	260.3	257.8	260.3	258.0	
SR370_030-SR370_020	SR370_030	SR370_020	Pipe	15	0.0120	226	0.7	1.5	1.9	2.2	2.3	0.7	1.5	1.9	2.2	2.3	268.9	261.2	266.8	261.0	262.1	260.1	262.1	260.1	262.1	260.3	262.1	260.3	
SR370_040-SR370_030	SR370_040	SR370_030	Pipe	12	0.0120	177	0.7	1.5	1.9	2.2	2.4	0.7	1.5	1.9	2.2	2.4	270.8	262.9	268.9	261.2	263.5	262.1	263.5	262.1	263.5	262.1	263.5	262.1	
SR380_010-SR370_020	SR380_010	SR370_020	Pipe	18	0.0120	133	1.4	3.5	4.3	5.2	6.6	3.2	7.0	8.2	9.2	10.0	269.2	260.4	266.8	259.6	261.2	260.1	261.4	260.1	261.7	260.3	261.8	260.3	
SR380_100-SR380_010	SR380_100	SR380_010	Pipe	12	0.0130	32	1.1	2.0	2.4	2.7	3.2	1.9	3.3	3.3	3.4	3.5	267.6	260.7	269.2	260.3	261.4	261.2	261.6	261.4	261.9	261.7	262.0	261.8	
SR380_110-SR380_010	SR380_110	SR380_100	Channel	72	0.0500	65	1.1	2.0	2.4	2.7	3.2	1.9	3.2	3.4	3.4	3.5	270.2	261.2	267.6	260.7	261.5	261.4	261.6	261.6	262.0	261.9	262.1	262.0	
SR390_010-SR380_030	SR390_010	SR380_030	Pipe	24	0.0130	45	0.3	0.7	0.9	1.1	1.1	0.3	0.7	0.9	1.0	1.1	273.0	261.5	272.2	261.5	262.1	262.0	262.1	262.1	262.4	262.4	262.5	262.5	
SR390_020-SR390_010	SR390_020	SR390_010	Pipe	66	0.0240	122.05	0.3	0.8	0.9	1.1	1.2	0.3	0.7	0.9	1.1	1.1	276.6	261.7	273.0	261.5	262.2	262.1	262.2	262.1	262.4	262.4	262.5	262.5	
SR390_030-SR390_020	SR390_030	SR390_020	Pipe	12	0.0130	51.72	0.3	0.8	0.9	1.1	1.2	0.3	0.8	0.9	1.1	1.2	278.2	268.1	276.6	261.8	268.3	262.2	268.3	262.2	268.3	262.4	268.3	262.5	
SR390_040-SR390_030	SR390_040	SR390_030	Pipe	12	0.0130	157.19	0.3	0.8	0.9	1.1	1.2	0.3	0.8	0.9	1.1	1.2	282.9	273.5	278.2	268.2	273.8	268.3	273.8	268.3	273.8	268.3	273.8	268.3	
SR390_050-SR390_040	SR390_050	SR390_040	Pipe	12	0.0130	57.43	0.3	0.8	0.9	1.1	1.2	0.3	0.8	0.9	1.1	1.2	284.7	275.6	282.9	273.6	275.9	273.8	275.9	273.8	275.9	273.8	275.9	273.8	
SR380_030-SR380_110	SR380_030	SR380_010	Pipe	12	0.0130	45	1.1	2.0	2.4	2.8	3.2	1.9	3.3	3.4	3.5	3.6	272.2	261.2	270.2	261.2	262.0	261.5	262.1	261.6	262.4	262.0	262.5	262.1	
SR380_040-SR380_030	SR380_040	SR380_030	Pipe	24	0.0130	85.8	1.1	2.8	3.5	4.4	5.9	2.9	6.4	7.5	8.4	9.2	273.2	261.6	272.2	261.5	262.5	262.0	262.7	262.1	262.9	262.4	262.9	262.5	
SR380_050-SR380_040	SR380_050	SR380_040	Pipe	66	0.0240	50	1.1	2.8	3.5	4.4	5.9	2.9	6.4	7.5	8.4	9.2	274.1	261.6	273.2	261.6	262.6	262.5	262.7	262.7	263.0	262.9	263.0	262.9	
SR380_060-SR380_050	SR380_060	SR380_050	Pipe	24	0.0130	52	1.1	2.8	3.5	4.4	5.9	2.9	6.4	7.5	8.4	9.2	275.1	262.0	274.1	261.6	262.7	262.6	262.8	262.7	263.1	263.0	263.1	263.0	
SR380_070-SR380_060	SR380_070	SR380_060	Pipe	66	0.0240	105.12	1.1	2.8	3.5	4.4	5.9	2.9	6.4	7.5	8.4	9.2	277.5	262.0	275.1	262.1	263.0	262.7	263.1	262.8	263.3	263.1	263.4	263.1	
SR380_080-SR380_070	SR380_080	SR380_070	Pipe	18	0.0130	88.55	1.1	2.8	3.5	4.4	5.9	2.9	6.4	7.5	8.4	9.2	279.2	268.9	277.5	263.1	269.3	263.0	269.4	263.1	269.5	263.3	269.5	263.4	
SR380_210-SR380_080	SR380_210	SR380_080	Pipe	12	0.0130	209.38	0.4	0.9	1.1	1.3	1.4	0.4	0.9	1.2	1.3	1.4	283.5	274.0	279.2	269.1	274.3	269.3	274.3	269.4	274.3	269.5	274.3	269.5	
SR480_100-SR380_080	SR480_100	SR380_080	Pipe	18	0.0130	112.33	0.8	2.0	2.7	3.7	5.1	2.5	5.6	6.6	7.5	8.2	286.7	275.7	279.2	269.8	276.1	269.3	276.2	269.4	276.3	269.5	276.3	269.5	

Table A-2: Model Conduit Parameters and Results

	Node ID		Conduit Attributes				Existing S. Troutdale Model - Peak Flows (cfs)					Future S. Troutdale Model - Peak Flows (cfs)					Node Rim and Invert Elevation (IE)				Maximum Hydraulic Grade Line - Existing Conditions				Maximum Hydraulic Grade Line - Future Conditions				
																					10yr 24hr HGL (feet)		25yr 24hr HGL (feet)		10yr 24hr HGL (feet)		25yr 24hr HGL (feet)		
Conduit Name (US Node - DS Node)	US	DS	Type	Conduit Dia or Channel Height (inches)	Manning's Roughness	Conduit Length	WQ Peak Flows (cfs)	2yr 24hr Peak Flows (cfs)	5yr 24hr Peak Flows (cfs)	10yr 24hr Peak Flow (cfs)	25yr 24hr Peak Flow (cfs)	WQ Peak Flows (cfs)	2yr 24hr Peak Flows (cfs)	5yr 24hr Peak Flows (cfs)	10yr 24hr Peak Flow (cfs)	25yr 24hr Peak Flow (cfs)	US Rim (ft)	US IE (ft)	DS Rim (ft)	DS IE (ft)	US	DS	US	DS	US	DS	US	DS	When hydraulically deficient
SR480_110-SR380_080	SR480_110	SR480_100	Pipe	18	0.0130	240.74	0.8	2.0	2.7	3.7	5.1	2.5	5.6	6.6	7.5	8.2	289.8	279.9	286.7	276.1	280.4	276.1	280.5	276.2	280.7	276.3	280.7	276.3	
SR480_120-SR480_110	SR480_120	SR480_110	Pipe	15	0.0130	167	0.8	2.0	2.7	3.7	5.1	2.5	5.6	6.6	7.5	8.2	292.8	284.3	289.8	281.6	284.9	280.4	285.0	280.5	285.3	280.7	285.3	280.7	
SR480_130-SR480_120	SR480_130	SR480_120	Pipe	15	0.0130	137	0.8	2.0	2.7	3.7	5.1	2.5	5.6	6.6	7.5	8.2	295.3	286.2	292.8	284.4	286.8	284.9	287.0	285.0	287.3	285.3	287.6	285.3	
SR480_140-SR480_130	SR480_140	SR480_130	Pipe	15	0.0130	149	0.8	2.0	2.7	3.7	5.1	2.5	5.6	6.6	7.5	8.2	298.8	288.3	295.3	286.3	289.0	286.8	289.1	287.0	289.4	287.3	289.8	287.6	
SR530_010-SR480_140	SR530_010	SR480_140	Pipe	15	0.0130	93	0.8	2.0	2.7	3.7	5.1	2.5	5.6	6.6	7.5	8.2	296.3	288.9	298.8	288.5	289.8	289.0	290.1	289.1	290.9	289.4	291.3	289.8	
SR530_020-SR530_010	SR530_020	SR530_010	Channel	42	0.0500	700	0.7	1.8	2.6	3.6	4.4	0.9	2.2	3.2	4.3	5.1	318.6	310.1	296.3	288.9	310.4	289.8	310.5	290.1	310.5	290.9	310.5	291.3	
SR530_030-SR530_020	SR530_030	SR530_020	Channel	42	0.0500	100	0.7	1.5	2.2	3.2	4.0	0.7	1.5	2.3	3.3	4.0	317.1	310.9	318.6	310.1	311.4	310.4	311.5	310.5	311.4	310.5	311.5	310.5	
SR490_001-SR530_030	SR490_001	SR530_030	Pipe	18	0.0130	99.31	0.7	1.5	2.3	3.2	4.0	0.7	1.5	2.3	3.3	4.0	321.2	311.2	317.1	310.9	312.0	311.4	312.1	311.5	312.0	311.4	312.1	311.5	
SR490_005-SR490_001	SR490_005	SR490_001	Pipe	18	0.0130	108.29	0.7	1.5	2.3	3.2	4.0	0.7	1.5	2.3	3.3	4.0	326.2	311.5	321.2	311.2	312.3	312.0	312.4	312.1	312.3	312.0	312.4	312.1	
SR490_010-SR490_005	SR490_010	SR490_005	Pipe	12	0.0130	180.56	0.3	0.7	1.0	1.3	1.6	0.3	0.7	1.0	1.3	1.6	332.7	322.7	326.2	313.6	323.0	312.3	323.0	312.4	323.0	312.3	323.0	312.4	
SR490_020-SR490_010	SR490_020	SR490_010	Pipe	12	0.0130	67.99	0.3	0.7	1.0	1.3	1.6	0.3	0.7	1.0	1.3	1.6	336.5	326.1	332.7	322.4	326.4	323.0	326.4	323.0	326.4	323.0	326.4	323.0	
SR490_030-SR490_020	SR490_030	SR490_020	Pipe	12	0.0130	255.56	0.3	0.7	1.0	1.3	1.6	0.3	0.7	1.0	1.3	1.6	348.5	334.7	336.5	326.2	335.0	326.4	335.1	326.4	335.0	326.4	335.1	326.4	
SR500_020-SR490_005	SR500_020	SR490_005	Pipe	12	0.0130	154	0.2	0.4	0.7	1.0	1.2	0.2	0.4	0.7	1.0	1.2	333.5	321.1	326.2	311.8	321.3	312.3	321.3	312.4	321.3	312.3	321.3	312.4	
SR500_030-SR500_020	SR500_030	SR500_020	Pipe	12	0.0130	130.28	0.2	0.4	0.7	1.0	1.2	0.2	0.4	0.7	1.0	1.2	344.2	331.4	333.5	321.1	331.6	321.3	331.6	321.3	331.6	321.3	331.6	321.3	
SR510_010-SR490_005	SR510_010	SR490_005	Pipe	96	0.0240	123	0.2	0.4	0.6	1.0	1.2	0.2	0.5	0.7	1.0	1.3	326.8	312.1	326.2	311.8	312.5	312.3	312.5	312.4	312.5	312.3	312.5	312.4	
SR510_030-SR510_010	SR510_030	SR510_010	Pipe	96	0.0240	154	0.2	0.4	0.7	1.0	1.2	0.2	0.5	0.7	1.0	1.3	328.5	312.3	326.8	311.9	312.7	312.5	312.7	312.5	312.7	312.5	312.7	312.5	
SR510_040-SR510_030	SR510_040	SR510_030	Pipe	12	0.0130	35.59	0.2	0.4	0.5	0.7	0.8	0.2	0.4	0.5	0.7	0.8	335.4	331.3	328.5	314.3	331.4	312.7	331.4	312.7	331.4	312.7	331.4	312.7	
SR520_010-SR510_030	SR520_010	SR510_030	Pipe	12	0.0130	187.26	0.0	0.1	0.2	0.3	0.4	0.1	0.1	0.2	0.4	0.5	341.1	330.3	328.5	324.0	330.5	312.7	330.5	312.7	330.5	312.7	330.5	312.7	
SR520_020-SR520_010	SR520_020	SR520_010	Pipe	12	0.0130	74.88	0.0	0.1	0.2	0.3	0.4	0.1	0.1	0.2	0.4	0.5	339.0	331.3	341.1	330.5	331.5	330.5	331.5	330.5	331.5	330.5	331.5	330.5	
SR530_100-SR530_020	SR530_100	SR530_020	Channel	36	0.0500	941	0.1	0.3	0.4	0.5	0.5	0.3	0.7	0.9	1.1	1.2	318.0	314.0	318.6	313.6	314.3	310.4	314.4	310.5	314.5	310.5	314.5	310.5	
SR590_010-SR530_100	SR590_010	SR530_100	Pipe	18	0.0120	65	0.3	0.6	0.7	0.8	0.9	0.5	1.2	1.4	1.6	1.8	318.0	314.5	318.0	314.0	314.8	314.3	314.8	314.4	314.9	314.5	314.9	314.5	
SR400_010-SR370_010	SR400_010	SR370_010	Pipe	27	0.0120	146	3.9	8.8	11.0	13.9	16.7	4.3	9.7	12.0	15.0	17.8	266.0	258.0	265.1	256.2	259.0	257.6	259.1	257.7	259.0	257.8	259.2	258.0	
SR410_010-SR400_010	SR410_010	SR400_010	Pipe	27	0.0120	134	1.3	3.0	4.0	5.3	6.5	1.4	3.2	4.2	5.6	6.7	280.8	260.4	266.0	259.4	261.0	259.0	261.1	259.1	261.0	259.0	261.1	259.2	
SR410_020-SR410_010	SR410_020	SR410_010	Pipe	18	0.0120	275	1.3	3.0	4.0	5.3	6.5	1.4	3.2	4.2	5.6	6.7	286.4	270.2	280.8	260.6	270.7	261.0	270.8	261.1	270.7	261.0	270.8	261.1	
SR410_030-SR410_020	SR410_030	SR410_020	Pipe	18	0.0120	290	1.3	3.0	4.0	5.3	6.5	1.4	3.2	4.2	5.6	6.7	286.4	274.8	286.4	270.4	275.4	270.7	275.5	270.8	275.4	270.7	275.5	270.8	
SR410_040-SR410_030	SR410_040	SR410_030	Pipe	18	0.0120	355	1.3	3.0	4.0	5.4	6.6	1.4	3.2	4.2	5.6	6.7	285.6	276.7	286.4	274.8	277.6	275.4	277.8	275.5	277.7	275.4	277.8	275.5	
SR420_010-SR410_040	SR420_010	SR410_040	Pipe	15	0.0120	261	0.5	1.2	1.9	2.8	3.6	0.6	1.4	2.2	3.1	3.8	290.6	279.8	285.6	276.9	280.3	277.6	280.4	277.8	280.4	277.7	280.4	277.8	
SR420_020-SR420_010	SR420_020	SR420_010	Pipe	12	0.0120	185	0.5	1.2	1.9	2.9	3.6	0.6	1.4	2.2	3.1	3.8	296.4	287.4	290.6	279.8	287.8	280.3	287.9	280.4	287.8	280.4	287.9	280.4	
SR420_030-SR420_020	SR420_030	SR420_020	Pipe	12	0.0120	140	0.5	1.2	1.9	2.9	3.6	0.6	1.4	2.2	3.1	3.8	298.3	288.7	296.4	287.4	289.4	287.8	289.5	287.9	289.4	287.8	289.7	287.9	
SR420_040-SR420_030	SR420_040	SR420_030	Pipe	12	0.0120	329	0.5	1.2	2.0	2.9	3.7	0.6	1.4	2.2	3.1	3.9	305.8	294.6	298.3	288.7	295.2	289.4	295.3	289.5	295.2	289.4	295.3	289.7	
SR400_020-SR400_010	SR400_020	SR400_010	Pipe	24	0.0120	88	2.6	5.8	7.1	8.6	10.2	2.8	6.4	7.9	9.5	11.1	266.0	259.3	266.0	258.8	260.3	259.0	260.4	259.1	260.3	259.0	260.4	259.2	
SR430_010-SR400_020	SR430_010	SR400_020	Pipe	24	0.0120	131	2.4	5.5	6.8	8.3	9.9	2.7	6.2	7.6	9.1	10.8	267.2	259.8	266.0	259.5	261.0	260.3	261.1	260.4	261.1	260.3	261.2	260.4	
SR440_010-SR430_010	SR440_010	SR430_010	Pipe	18	0.0120	228	2.1	4.7	5.8	7.2	8.7	2.4	5.4	6.6	8.1	9.6	272.0	261.9	267.2	259.5	262.8	261.0	262.9	261.1	262.9	261.1	263.0	261.2	
SR440_020-SR440_010	SR440_020	SR440_010	Pipe	18	0.0120	114	0.6	1.4	1.8	2.2	2.6	0.6	1.4	1.8	2.2	2.6	272.3	264.1	272.0	263.5	264.7	262.8	264.7	262.9	264.7	262.9	264.7	263.0	
SR460_010-SR440_020	SR460_010	SR440_020	Pipe	18	0.0120	226	0.6	1.4	1.8	2.2	2.6	0.6	1.4	1.8	2.2	2.6	276.4	267.6	272.3	264.4	268.0	264.7	268.0	264.7	268.0	264.7	268.0	264.7	
SR460_020-SR460_010	SR460_020	SR460_010	Pipe	12	0.0120	200	0.1	0.3	0.4	0.4	0.5	0.1	0.3	0.4	0.4	0.5	293.8	285.2	276.4	274.0	285.4	268.0	285.4	268.0	285.4	268.0	285.4	268.0	
SR450_010-SR460_010	SR450_010	SR460_010	Pipe	12	0.0120	134	0.5	1.1	1.4	1.8	2.1	0.5	1.1	1.4	1.8	2.1	283.7	274.7	276.4	267.8	275.0	268.0	275.0	268.0	275.0	268.0	275.0	268.0	
SR450_020-SR450_010	SR450_020	SR450_010	Pipe	12	0.0120	144	0.5	1.1	1.4	1.8	2.1	0.5	1.1	1.4	1.8	2.1	288.5	278.8	283.7	274.9	279.1	275.0	279.1	275.0	279.1	275.0	279.1	275.0	
SR450_030-SR450_020	SR450_030	SR450_020	Pipe	12	0.0120	165	0.5	1.1	1.4	1.8	2.1	0.5	1.1	1.4	1.8	2.1	297.1	288.5	288.5	279.0	288.8	279.1	288.8	279.1	288.8	279.1	288.8	279.1	
SR450_040-SR450_030	SR450_040	SR450_030	Pipe	12	0.0120	136	0.5	1.1	1.4	1.8	2.1	0.5	1.1	1.4	1.8	2.1	300.0	290.0	297.1	288.7	290.5	288.8	290.5	288.8	290.5	288.8	290.5	288.8	
SR480_010-SR440_010	SR480_010	SR440_010	Pipe	12	0.0120	185	1.3	2.9	3.6	4.6	5.6	1.6	3.6	4.4	5.4	6.5	291.5	278.9	272.0	263.5	279.3	262.8	279.4	262.9	279.4	262.9	279.4	263.0	
SR480_030-SR480_010	SR480_030	SR480_010	Pipe	12	0.0130	230	0.9	2.1	2.5	2.9	3.3	1.2	2.7	3.3	3.8	4.2	296.5	292.1	291.5	282.1	292.5	279.3	292.5	279.4	292.6	279.4	292.6	279.4	
SR480_040-SR480_030	SR480_040	SR480_030	Pipe	12	0.0130	264	0.9	2.1	2.5	2.9	3.3	1.2	2.7	3.3	3.8	4.2	301.9	292.3	296.5	283.6	294.2	292.5	294.8	292.5	295.4	292.6	296.1	292.6	
SR480_050-SR480_040	SR480_050	SR480_040	Pipe	12	0.0130	206	0.9	2.1	2.5	2.9	3.4	1.2	2.7	3.3	3.8	4.2	304.3	294.7	301.9	292.5	295.6	294.2	296.6	294.8	297.7	295.4	298.9	296.1	
SR470_010-SR480_010	SR470_010	SR480_010	Pipe	15	0.0130	65.23	0.4	0.9	1.3	1.8	2.3	0.4	0.9	1.3	1.8	2.3	292.5	282.1	291.5	281.8	282.7	279.3	282.7	279.4	282.7	279.4	282.7	279.4	
SR470_020-SR470_010	SR470_020	SR470_010	Pipe	12	0.0120	73.25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	292.9	283.6	292.5	284.5	284.4	282.7	284.5	282.7	284.4	282.7	284.5	282.7	
SR470_020-SR470_120	SR470_020	SR470_010	Pipe	12	0.0130	46.41	0.4	0.9	1.3	1.9	2.3	0.4	0.9	1.3	1.9	2.4	292.9	283.6	293.0	283.8	284.4	284.2	284.5	284.2	284.4	284.2	284.5	284.2	
SR470_040-SR470_020	SR470_040	SR470_020	Pipe	12	0.0130	185.2	0.4	0.9	1.3	1.9	2.3	0.4	0.9	1.3	1.9	2.4	293.3	285.1	292.9	283.7	285.7	284.4	285.8	284.5	285.7	284.4	285.8	284.5	
SR470_050-SR470_040	SR470_050	SR470_040	Pipe	12	0.0130	239.3	0.4	0.9	1.3	1.9	2.3	0.4	0.9	1.3	1.9	2.4	304.5	293.4	293.3	285.4	293.7	285.7	293.8	285.8	293.7	285.7	293.8	285.8	
SR470_060-SR470_050	SR470_060	SR470_050	Pipe	12	0.0130	62.57	0.4	0.9	1.3	1.9	2.3	0.4	0.9	1.4	1.9	2.4	305.6	295.3	304.5	293.5	295.6	293.7	295.7	293.8	295.6	293.7	295.7	293.8	
SR470_110-SR470_100	SR470_110	SR470_100	Pipe	12	0.0130	20	0.4	0.9	1.3	1.8	2.3	0.4	0.9	1.3	1.8	2.3	293.0	283.1	292.1	283.2	283.9	283.3	283.9	283.4	283.9	283.4	284.0	283.4	
SR470_120-SR470_110	SR470_120	SR470_110	Channel	60	0.0500	100	0.4	0.9	1.3	1.8	2.3	0.4	0.9	1.3	1.9	2.3	293.0	283.8	293.0	283.0	284.2	283.9	284.2	283.9	284.2	283.9	284.2	284.0	
Outfall SR540																													
SR540_010-SR540_110	SR540_010	SR540_110	Pipe	66	0.0240	122.36	0.0	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1	287.4	276.2	288.6	275.9	276.4	276.4	276.4	276.4	276.4	276.4	276.4	276.4	
SR540_010-O_SR540	SR540_010	SR540_110	Pipe	12	0.0130	60	0.3	0.7	1.0	1.1	1.3	0.3	0.7	1.0	1.1	1.3	287.4	275.9	279.8	275.6	276.4	276.1	276.4	276.1	276.4	276.1	276.4	276.1	
SR540_020-SR540_010	SR540_020	SR540_010	Pipe	12	0.0130	31.27	0.3	0.8	1.0	1.2	1.3	0.3	0.8	1.0	1.2	1.3	287.0	278.3	287.4	278.1	278.7	276.4	278.8	276.4	278.7	276.4	278.8	276.4	

Table A-2: Model Conduit Parameters and Results

	Node ID		Conduit Attributes				Existing S. Troutdale Model - Peak Flows (cfs)					Future S. Troutdale Model - Peak Flows (cfs)					Node Rim and Invert Elevation (IE)				Maximum Hydraulic Grade Line - Existing Conditions				Maximum Hydraulic Grade Line - Future Conditions				
																					10yr 24hr HGL (feet)		25yr 24hr HGL (feet)		10yr 24hr HGL (feet)		25yr 24hr HGL (feet)		
Conduit Name (US Node - DS Node)	US	DS	Type	Conduit Dia or Channel Height (inches)	Manning's Roughness	Conduit Length	WQ Peak Flows (cfs)	2yr 24hr Peak Flows (cfs)	5yr 24hr Peak Flows (cfs)	10yr 24hr Peak Flow (cfs)	25yr 24hr Peak Flow (cfs)	WQ Peak Flows (cfs)	2yr 24hr Peak Flows (cfs)	5yr 24hr Peak Flows (cfs)	10yr 24hr Peak Flow (cfs)	25yr 24hr Peak Flow (cfs)	US Rim (ft)	US IE (ft)	DS Rim (ft)	DS IE (ft)	US	DS	US	DS	US	DS	US	DS	When hydraulically deficient
SR540_030-SR540_020	SR540_030	SR540_020	Pipe	12	0.0130	108.53	0.3	0.8	1.0	1.2	1.3	0.3	0.8	1.0	1.2	1.3	289.4	279.0	287.0	278.6	279.5	278.7	279.6	278.8	279.5	278.7	279.6	278.8	
Outfall SR550																													
SR550_020-SR550_010	SR550_020	SR550_010	Pipe	42	0.0130	325	1.1	2.6	3.8	5.4	6.6	1.1	2.6	3.8	5.4	6.6	289.5	276.9	286.2	276.6	277.9	277.7	278.1	277.8	277.9	277.7	278.1	277.8	
SR560_020-SR560_010	SR560_020	SR560_010	Pipe	42	0.0120	138	1.1	2.6	3.8	5.4	6.6	1.1	2.6	3.8	5.4	6.6	297.7	284.7	294.4	284.6	285.6	285.5	285.7	285.6	285.6	285.5	285.7	285.6	
SR560_030-SR560_020	SR560_030	SR560_020	Pipe	12	0.0120	151	1.1	2.6	3.8	5.4	6.6	1.1	2.6	3.8	5.4	6.6	307.1	291.2	297.7	288.2	292.0	285.6	293.5	285.7	292.0	285.6	293.5	285.7	
SR560_040-SR560_030	SR560_040	SR560_030	Pipe	12	0.0120	75	0.9	1.9	2.9	4.1	5.0	0.9	1.9	2.9	4.1	5.1	308.6	296.3	307.1	291.4	296.8	292.0	296.8	293.5	296.8	292.0	296.8	293.5	
SR560_050-SR560_040	SR560_050	SR560_040	Pipe	12	0.0120	186	0.9	1.9	2.9	4.1	5.0	0.9	1.9	2.9	4.1	5.0	308.6	298.5	308.6	296.5	299.4	296.8	300.5	296.8	299.4	296.8	300.5	296.8	
SR560_060-SR560_050	SR560_060	SR560_050	Pipe	12	0.0120	109	0.4	0.9	1.4	2.0	2.5	0.4	0.9	1.4	2.0	2.5	309.7	299.7	308.6	298.7	300.2	299.4	300.9	300.5	300.2	299.4	300.9	300.5	
SR570_010-SR560_060	SR570_010	SR560_060	Pipe	12	0.0120	246	0.4	0.9	1.4	2.0	2.5	0.4	0.9	1.4	2.0	2.5	328.1	318.1	309.7	299.9	318.4	300.2	318.4	300.9	318.4	300.2	318.4	300.9	
SR570_020-SR570_010	SR570_020	SR570_010	Pipe	12	0.0120	248	0.4	0.9	1.4	2.0	2.5	0.4	0.9	1.4	2.0	2.5	338.4	328.3	328.1	318.3	328.6	318.4	328.7	318.4	328.6	318.4	328.7	318.4	
SR570_030-SR570_020	SR570_030	SR570_020	Pipe	12	0.0120	219	0.4	0.9	1.4	2.0	2.5	0.4	0.9	1.4	2.0	2.5	348.2	337.8	338.4	328.5	338.1	328.6	338.2	328.7	338.1	328.6	338.2	328.7	
SR580_010-SR560_050	SR580_010	SR560_050	Pipe	12	0.0120	112	0.5	1.0	1.5	2.1	3.0	0.5	1.0	1.5	2.1	2.8	323.6	311.6	308.6	298.7	311.9	299.4	311.9	300.5	311.9	299.4	311.9	300.5	
SR580_020-SR580_010	SR580_020	SR580_010	Pipe	12	0.0120	255	0.5	1.0	1.5	2.1	2.7	0.5	1.0	1.5	2.1	2.7	331.7	321.6	323.6	311.8	321.9	311.9	322.0	311.9	321.9	311.9	322.0	311.9	
SR580_030-SR580_020	SR580_030	SR580_020	Pipe	12	0.0120	59	0.5	1.0	1.5	2.2	2.7	0.5	1.0	1.5	2.2	2.7	334.8	324.4	331.7	321.8	324.8	321.9	324.8	322.0	324.8	321.9	324.8	322.0	
SR580_040-SR580_030	SR580_040	SR580_030	Pipe	12	0.0120	82	0.5	1.0	1.5	2.2	2.7	0.5	1.0	1.5	2.2	2.7	337.1	326.9	334.8	324.6	327.3	324.8	327.3	324.8	327.3	324.8	327.3	324.8	

Appendix B: CIP Cost Estimates

City of Troutdale
South Troutdale Master Plan
CIP Facility Preliminary Cost Estimates

CIP Number: FC_01
CIP Type: Flood Control

ITEM	QUANTITY	UNIT	UNIT COST ($)	TOTAL COST ($)	Assumptions
CONSTRUCTION ELEMENTS					
Mobilization/Demobilization	1	LS		$ 6,998.50	10% Construction Costs
Traffic Control	1	LS	$10,000	$ 10,000.00	
Erosion Control					
Silt Fence	1000	LF	$1	$ 1,000.00	
Inlet Protection	20	EA	$29	$ 580.00	
Misc. Erosion and Sediment Control Protection	1	AC	$2,300	$ 2,300.00	
Site Set-up/ Removal/ Disposal					
Sawcut Pavement	1000	LF	$1.50	$ 1,500.00	
Pavement Removal	560	SY	$7.00	$ 3,920.00	Assume 10' trench
Clearing and Grubbing		SF	$0.30	$ -	
Remove Curbs		LF	$7.00	$ -	
Remove Culvert		LF	$55.00	$ -	
Pipe					
15-inch	453	LF	$95	$ 43,035.00	Assume 10+ feet cover
Structure Installation					
Precast Concrete Manhole (48", 0-8' deep)		EA	$2,025		
Precast Concrete Manhole (60", 0-8' deep)	3	EA	$2,550	$ 7,650.00	Manhole depths will be deeper than estimate
Precast Concrete Manhole (72", 0-8' deep)		EA	$4,650		
Concrete Inlet, Type G-1		EA	$2,204		
Concrete Inlet, Type G-2		EA	$1,839		
Concrete Curb		LF	$18		
Concrete Curbs, Curb and Gutter Modified		LF	$27		
PROJECT SUB-TOTALS					
Project Sub-Total				$ 76,983.50	
Construction Contingency (30%)				$ 23,095.05	
CONSTRUCTION COST ESTIMATE				**$ 100,078.55**	
Permitting (5%)			$0		
Surveying & Design (25%)			$0	$ 25,019.64	
Construction Admin. (5%)			$0	$ 5,003.93	
TOTAL PROJECT COST ESTIMATE				**$ 130,100.00**	

City of Troutdale
South Troutdale Master Plan
CIP Facility Preliminary Cost Estimates

CIP Number: FC_03
CIP Type: Flood Control

ITEM	QUANTITY	UNIT	UNIT COST ($)	TOTAL COST ($)	Assumptions
CONSTRUCTION ELEMENTS					
Mobilization/Demobilization	1	LS		$ 5,707.00	10% Construction Costs
Traffic Control	1	LS	$10,000	$ 10,000.00	
Erosion Control					
Silt Fence	800	LF	$1	$ 800.00	
Inlet Protection	10	EA	$29	$ 290.00	
Misc. Erosion and Sediment Control Protection	1	AC	$2,300	$ 2,300.00	
Site Set-up/ Removal/ Disposal					
Sawcut Pavement	800	LF	$1.50	$ 1,200.00	
Pavement Removal	400	SY	$7.00	$ 2,800.00	Assume 10' trench
Clearing and Grubbing		SF	$0.30	$ -	
Remove Curbs		LF	$7.00	$ -	
Remove Culvert		LF	$55.00	$ -	
Pipe					
15-inch	364	LF	$95	$ 34,580.00	Assume 10+ feet cover
Structure Installation					
Precast Concrete Manhole (48", 0-8' deep)		EA	$2,025		
Precast Concrete Manhole (60", 0-8' deep)	2	EA	$2,550	$ 5,100.00	Manhole depths will be deeper than estimate
Precast Concrete Manhole (72", 0-8' deep)		EA	$4,650		
Concrete Inlet, Type G-1		EA	$2,204		
Concrete Inlet, Type G-2		EA	$1,839		
Concrete Curb		LF	$18		
Concrete Curbs, Curb and Gutter Modified		LF	$27		
PROJECT SUB-TOTALS					
Project Sub-Total				$ 62,777.00	
Construction Contingency (30%)				$ 18,833.10	
CONSTRUCTION COST ESTIMATE				**$ 81,610.10**	
Permitting (5%)			$0		
Surveying & Design (25%)			$0	$ 20,402.53	
Construction Admin. (5%)			$0	$ 4,080.51	
TOTAL PROJECT COST ESTIMATE				**$ 106,100.00**	

City of Troutdale
South Troutdale Master Plan
CIP Facility Preliminary Cost Estimates

CIP Number: FC_04
CIP Type: Flood Control

ITEM	QUANTITY	UNIT	UNIT COST ($)	TOTAL COST ($)		Assumptions
CONSTRUCTION ELEMENTS						
Mobilization/Demobilization	1	LS		$	28,118.40	10% Construction Costs
Traffic Control	1	LS	$10,000	$	10,000.00	
Erosion Control						
Silt Fence	2000	LF	$1	$	2,000.00	
Inlet Protection	40	EA	$29	$	1,160.00	
Misc. Erosion and Sediment Control Protection	1	AC	$2,300	$	2,300.00	
Site Set-up/ Removal/ Disposal						
Sawcut Pavement	3500	LF	$1.50	$	5,250.00	
Pavement Removal	1850	SY	$7.00	$	12,950.00	Assume 10' trench
Clearing and Grubbing		SF	$0.30	$	-	
Remove Curbs		LF	$7.00	$	-	
Remove Culvert		LF	$55.00	$	-	
Pipe						
18-inch	900	LF	$117	$	105,300.00	Assume 15+ feet cover
24-inch	753	LF	$158	$	118,974.00	Assume 15+ feet cover
Structure Installation						
Precast Concrete Manhole (48", 0-8' deep)		EA	$2,025	$	-	
Precast Concrete Manhole (60", 0-8' deep)		EA	$2,550	$	-	
Precast Concrete Manhole (72", 0-8' deep)	5	EA	$4,650	$	23,250.00	Manhole depths will be deeper than estimate
Concrete Inlet, Type G-1		EA	$2,204	$	-	
Concrete Inlet, Type G-2		EA	$1,839	$	-	
Concrete Curb		LF	$18	$	-	
Concrete Curbs, Curb and Gutter Modified		LF	$27	$	-	
PROJECT SUB-TOTALS						
Project Sub-Total				$	309,302.40	
Construction Contingency (30%)				$	92,790.72	
CONSTRUCTION COST ESTIMATE				**$**	**402,093.12**	
Permitting (5%)			$0			
Surveying & Design (25%)			$0	$	100,523.28	
Construction Admin. (5%)			$0	$	20,104.66	
TOTAL PROJECT COST ESTIMATE				**$**	**522,700.00**	

City of Troutdale
South Troutdale Master Plan
CIP Facility Preliminary Cost Estimates

CIP Number: WQ_01A
CIP Type: Water Quality

ITEM	QUANTITY	UNIT	UNIT COST ($)	TOTAL COST ($)	Assumptions
CONSTRUCTION ELEMENTS					
Mobilization/Demobilization	1	LS		$ 37,167.80	10% Construction Costs
Traffic Control	1	LS	$10,000	$ 10,000.00	
Erosion Control					
Silt Fence		LF	$1	$ -	
Inlet Protection		EA	$29	$ -	
Misc. Erosion and Sediment Control Protection	0.6	AC	$2,300	$ 1,380.00	Based on area of planters
Site Set-up/ Removal/ Disposal					
Sawcut Pavement	3200	LF	$1.50	$ 4,800.00	
Pavement Removal	2630	SY	$7.00	$ 18,410.00	Assume planter installation in ROW
Clearing and Grubbing		SF	$0.30	$ -	
Remove Curbs	0	LF	$7.00	$ -	
Remove Culvert		LF	$55.00	$ -	
Water Quality Facility Installation					
General Earthwork/ Excavation	3506	CY	$22.00	$ 77,132.00	Assume total facility excavation depth of 4 feet and footprint of 23664 sf
Grading		CY	$6.00		
Geotextile Fabric		SY	$14.00		
Perforated Drain Pipe (installed)		LF	$15		
Rip-Rap, Class 50		CY	$61		
Drain Rock	1315	CY	$30	$ 39,450.00	Assume 18" depth
Pond Outlet Structure		EA	$5,000		
Pond Inlet Structure		EA	$4,000		
Check Dam		EA	$800		
Emergency Overflow Weir		LF	$20		
Engineered Soils	1315	CY	$30.00	$ 39,450.00	Assume 18" depth
Plantings (Engineered Soils)	23664	SF	$4.00	$ 94,656.00	
Plantings (Native Soil)		SF	$8.00		
Structure Installation					
Precast Concrete Manhole (48", 0-8' deep)		EA	$2,025		
Precast Concrete Manhole (60", 0-8' deep)		EA	$2,550		
Precast Concrete Manhole (72", 0-8' deep)		EA	$4,650	$ -	
Concrete Inlet, Type G-1		EA	$2,204		
Concrete Inlet, Type G-2		EA	$1,839		
Concrete Curb		LF	$18	$ -	
Concrete Curbs, Curb and Gutter Modified	3200	LF	$27	$ 86,400.00	
PROJECT SUB-TOTALS					
Project Sub-Total				$ 408,845.80	
Construction Contingency (30%)				$ 122,653.74	
CONSTRUCTION COST ESTIMATE				**$ 531,499.54**	
Permitting (5%)			$0	$ 26,574.98	
Surveying & Design (25%)			$0	$ 132,874.89	
Construction Admin. (5%)			$0	$ 26,574.98	
TOTAL PROJECT COST ESTIMATE				**$ 717,500.00**	
Inspection	10	HR	$ 32.50	$ 325.00	
Sediment Removal	439	CY	$ 25.00	$ 10,975.00	Assume 6" over the planter area
Maintain Vegetation	0.55	AC	$ 3,000.00	$ 1,650.00	
Clean Catch Basin		EA	$ 200.00	$ -	
Clean Manhole		EA	$ 400.00	$ -	
ANNUAL MAINTENANCE COST ESTIMATE				**$ 13,000.00**	

City of Troutdale
South Troutdale Master Plan
CIP Facility Preliminary Cost Estimates

CIP Number: WQ_01B
CIP Type: Water Quality

ITEM	QUANTITY	UNIT	UNIT COST ($)	TOTAL COST ($)	Assumptions
CONSTRUCTION ELEMENTS					
Mobilization/Demobilization	1	LS		$ 15,196.60	10% Construction Costs
Traffic Control	1	LS	$10,000	$ 10,000.00	
Erosion Control					
Silt Fence		LF	$1	$ -	
Inlet Protection		EA	$29	$ -	
Misc. Erosion and Sediment Control Protection	0.2	AC	$2,300	$ 460.00	Based on area of planters
Site Set-up/ Removal/ Disposal					
Sawcut Pavement	1170	LF	$1.50	$ 1,755.00	
Pavement Removal	831	SY	$7.00	$ 5,817.00	Assume planter installation in ROW
Clearing and Grubbing		SF	$0.30	$ -	
Remove Curbs	0	LF	$7.00	$ -	
Remove Culvert		LF	$55.00	$ -	
Pipe					
12-inch	350	LF	$66	$ 23,100.00	Assume 10-15 feet cover
Water Quality Facility Installation					
General Earthwork/ Excavation	1108	CY	$22.00	$ 24,376.00	Assume total facility excavation depth of 4 feet and footprint of 7477 sf
Grading		CY	$6.00		
Geotextile Fabric		SY	$14.00		
Perforated Drain Pipe (installed)		LF	$15		
Rip-Rap, Class 50		CY	$61		
Drain Rock	416	CY	$30	$ 12,480.00	Assume 18" depth
Pond Outlet Structure		EA	$5,000		
Pond Inlet Structure		EA	$4,000		
Check Dam		EA	$800		
Emergency Overflow Weir		LF	$20		
Engineered Soils	416	CY	$30.00	$ 12,480.00	Assume 18" depth
Plantings (Engineered Soils)	7477	SF	$4.00	$ 29,908.00	
Plantings (Native Soil)		SF	$8.00		
Structure Installation					
Precast Concrete Manhole (48", 0-8' deep)		EA	$2,025		
Precast Concrete Manhole (60", 0-8' deep)	2	EA	$2,550		To accommodate overflow piping
Precast Concrete Manhole (72", 0-8' deep)		EA	$4,650	$ -	
Concrete Inlet, Type G-1		EA	$2,204		
Concrete Inlet, Type G-2		EA	$1,839		
Concrete Curb		LF	$18	$ -	
Concrete Curbs, Curb and Gutter Modified	1170	LF	$27	$ 31,590.00	
PROJECT SUB-TOTALS					
Project Sub-Total				$ 167,162.60	
Construction Contingency (30%)				$ 50,148.78	
CONSTRUCTION COST ESTIMATE				**$ 217,311.38**	
Permitting (5%)			$0	$ 10,865.57	
Surveying & Design (25%)			$0	$ 54,327.85	
Construction Admin. (5%)			$0	$ 10,865.57	
TOTAL PROJECT COST ESTIMATE				**$ 293,400.00**	
Inspection	10	HR	$ 32.50	$ 325.00	
Sediment Removal	139	CY	$ 25.00	$ 3,475.00	Assume 6" over the planter area
Maintain Vegetation	0.17	AC	$ 3,000.00	$ 510.00	
Clean Catch Basin		EA	$ 200.00	$ -	
Clean Manhole	2	EA	$ 400.00	$ 800.00	
ANNUAL MAINTENANCE COST ESTIMATE				**$ 5,100.00**	

City of Troutdale
South Troutdale Master Plan
CIP Facility Preliminary Cost Estimates

CIP Number: WQ_02
CIP Type: Water Quality

ITEM	QUANTITY	UNIT	UNIT COST ($)		TOTAL COST ($)	Assumptions
CONSTRUCTION ELEMENTS						
Mobilization/Demobilization	1	LS		$	56,952.30	10% Construction Costs
Traffic Control	1	LS	$10,000	$	10,000.00	
Erosion Control						
Silt Fence		LF	$1	$	-	
Inlet Protection		EA	$29	$	-	
Misc. Erosion and Sediment Control Protection	0.9	AC	$2,300	$	2,070.00	Based on area of planters
Site Set-up/ Removal/ Disposal						
Sawcut Pavement	4540	LF	$1.50	$	6,810.00	
Pavement Removal	4183	SY	$7.00	$	29,281.00	Assume planter installation completely in ROW
Clearing and Grubbing		SF	$0.30	$	-	
Remove Curbs	0	LF	$7.00	$	-	
Remove Culvert		LF	$55.00	$	-	
Water Quality Facility Installation						
General Earthwork/ Excavation	5577	CY	$22.00	$	122,694.00	Assume total facility excavation depth of 4 feet and footprint of 37642 sf
Grading		CY	$6.00			
Geotextile Fabric		SY	$14.00			
Perforated Drain Pipe (installed)		LF	$15			
Rip-Rap, Class 50		CY	$61			
Drain Rock	2092	CY	$30	$	62,760.00	Assume 18" depth
Pond Outlet Structure		EA	$5,000			
Pond Inlet Structure		EA	$4,000			
Check Dam		EA	$800			
Emergency Overflow Weir		LF	$20			
Engineered Soils	2092	CY	$30.00	$	62,760.00	Assume 18" depth
Plantings (Engineered Soils)	37642	SF	$4.00	$	150,568.00	
Plantings (Native Soil)		SF	$8.00			
Structure Installation						
Precast Concrete Manhole (48", 0-8' deep)		EA	$2,025			
Precast Concrete Manhole (60", 0-8' deep)		EA	$2,550			
Precast Concrete Manhole (72", 0-8' deep)		EA	$4,650	$	-	
Concrete Inlet, Type G-1		EA	$2,204			
Concrete Inlet, Type G-2		EA	$1,839			
Concrete Curb		LF	$18	$	-	
Concrete Curbs, Curb and Gutter Modified	4540	LF	$27	$	122,580.00	
PROJECT SUB-TOTALS						
Project Sub-Total				$	626,475.30	
Construction Contingency (30%)				$	187,942.59	
CONSTRUCTION COST ESTIMATE				**$**	**814,417.89**	
Permitting (5%)			$0	$	40,720.89	
Surveying & Design (25%)			$0	$	203,604.47	
Construction Admin. (5%)			$0	$	40,720.89	
TOTAL PROJECT COST ESTIMATE				**$**	**1,099,500.00**	
Inspection	10	HR	$ 32.50	$	325.00	
Sediment Removal	698	CY	$ 25.00	$	17,450.00	Assume 6" over the planter area
Maintain Vegetation	0.87	AC	$ 3,000.00	$	2,610.00	
Clean Catch Basin		EA	$ 200.00	$	-	
Clean Manhole		EA	$ 400.00	$	-	
ANNUAL MAINTENANCE COST ESTIMATE				**$**	**20,400.00**	

CIP Number: WQ_03
CIP Type: Water Quality

ITEM	QUANTITY	UNIT	UNIT COST ($)	TOTAL COST ($)	Assumptions
CONSTRUCTION ELEMENTS					
Mobilization/Demobilization	1	LS		$ 7,965.90	10% Construction Costs
Traffic Control	1	LS	$10,000	$ 10,000.00	
Erosion Control					
Silt Fence	500	LF	$1	$ 500.00	Applied around pond
Inlet Protection		EA	$29	$ -	
Misc. Erosion and Sediment Control Protection	0.3	AC	$2,300	$ 690.00	Applied throughout pond footprint
Site Set-up/ Removal/ Disposal					
Sawcut Pavement	0	LF	$1.50	$ -	
Pavement Removal	0	SY	$7.00	$ -	
Clearing and Grubbing	11330	SF	$0.30	$ 3,399.00	Assume pond footprint
Remove Curbs	0	LF	$7.00	$ -	
Remove Culvert		LF	$55.00	$ -	
Water Quality Facility Installation					
General Earthwork/ Excavation	430	CY	$22.00	$ 9,460.00	Assume total excavation depth of 3 feet over pond bottom area (~3,835sf)
Grading	430	CY	$6.00	$ 2,580.00	
Geotextile Fabric		SY	$14.00	$ -	
Perforated Drain Pipe (installed)		LF	$15	$ -	
Rip-Rap, Class 50		CY	$61	$ -	
Drain Rock	215	CY	$30	$ 6,450.00	Assume 18" depth
Pond Outlet Structure	1	EA	$5,000	$ 5,000.00	
Pond Inlet Structure	1	EA	$4,000	$ 4,000.00	
Check Dam		EA	$800	$ -	
Emergency Overflow Weir		LF	$20	$ -	
Engineered Soils	215	CY	$30.00	$ 6,450.00	Assume 18" depth
Plantings (Engineered Soils)	3835	SF	$4.00	$ 15,340.00	
Plantings (Native Soil)		SF	$8.00		
Restoration/ Resurfacing					
Non-Water Quality Facility Landscaping	0.2	AC	$20,000	$ 4,000.00	Assume along the sideslopes of the pond
6-foot Chain Link Fence	500	LF	$20	$ 10,000.00	
Gravel Access Road	300	SF	$5	$ 1,350.00	Assume 25 foot long and 12 foot wide
Hydroseed	0.2	AC	$2,200	$ 440.00	Assume along the sideslopes of the pond
PROJECT SUB-TOTALS					
Project Sub-Total				$ 87,624.90	
Construction Contingency (30%)				$ 26,287.47	
CONSTRUCTION COST ESTIMATE				**$ 113,912.37**	
Permitting (5%)			$0	$ 5,695.62	
Surveying & Design (25%)			$0	$ 28,478.09	
Construction Admin. (5%)			$0	$ 5,695.62	
TOTAL PROJECT COST ESTIMATE				**$ 153,800.00**	
Inspection	4	HR	$ 32.50	$ 130.00	
Sediment Removal	142	CY	$ 25.00	$ 3,550.00	Assume 1' over the pond bottom
Maintain Vegetation	0.3	AC	$ 3,000.00	$ 900.00	Assume pond footprint
Clean Catch Basin		EA	$ 200.00	$ -	
Clean Manhole		EA	$ 400.00	$ -	
ANNUAL MAINTENANCE COST ESTIMATE				**$ 4,600.00**	

City of Troutdale
South Troutdale Master Plan
CIP Facility Preliminary Cost Estimates

CIP Number: WQ_04
CIP Type: Water Quality

ITEM	QUANTITY	UNIT	UNIT COST ($)	TOTAL COST ($)	Assumptions
CONSTRUCTION ELEMENTS					
Mobilization/Demobilization	1	LS		$ 79,735.20	10% Construction Costs
Traffic Control	1	LS	$10,000	$ 10,000.00	
Erosion Control					
Silt Fence	1000	LF	$1	$ 1,000.00	Applied around pond
Inlet Protection		EA	$29	$ -	
Misc. Erosion and Sediment Control Protection	1.4	AC	$2,300	$ 3,220.00	Applied throughout pond footprint
Site Set-up/ Removal/ Disposal					
Sawcut Pavement	0	LF	$1.50	$ -	
Pavement Removal	0	SY	$7.00	$ -	
Clearing and Grubbing	59780	SF	$0.30	$ 17,934.00	Assume pond footprint
Remove Curbs	0	LF	$7.00	$ -	
Remove Culvert		LF	$55.00	$ -	
Water Quality Facility Installation					
General Earthwork/ Excavation	14540	CY	$22.00	$ 319,880.00	Assume total excavation depth of 3 feet over pond bottom area (~1 acre) plus storage volume required (6.018 ac-ft)
Grading	14540	CY	$6.00	$ 87,240.00	Assume total excavation depth of 3 feet over pond bottom area (~1 acre) plus storage volume required (6.018 ac-ft)
Geotextile Fabric		SY	$14.00	$ -	
Perforated Drain Pipe (installed)		LF	$15	$ -	
Rip-Rap, Class 50		CY	$61	$ -	
Drain Rock	2416	CY	$30	$ 72,480.00	Assume 18" depth
Pond Outlet Structure	1	EA	$5,000	$ 5,000.00	
Pond Inlet Structure	1	EA	$4,000	$ 4,000.00	
Check Dam		EA	$800	$ -	
Emergency Overflow Weir		LF	$20	$ -	
Engineered Soils	2416	CY	$30.00	$ 72,480.00	Assume 18" depth for pond bottom footprint
Plantings (Engineered Soils)	43472	SF	$4.00	$ 173,888.00	Assume pond bottom footprint
Plantings (Native Soil)		SF	$8.00		
Restoration/ Resurfacing					
Non-Water Quality Facility Landscaping	0.4	AC	$20,000	$ 8,000.00	
6-foot Chain Link Fence	1000	LF	$20	$ 20,000.00	Applied around perimeter
Gravel Access Road	300	SF	$5	$ 1,350.00	Assume 25 foot long and 12 foot wide
Hydroseed	0.4	AC	$2,200	$ 880.00	Assume along the sideslopes of the pond
PROJECT SUB-TOTALS					
Project Sub-Total				$ 877,087.20	
Construction Contingency (30%)				$ 263,126.16	
CONSTRUCTION COST ESTIMATE				**$ 1,140,213.36**	
Permitting (5%)			$0	$ 57,010.67	
Surveying & Design (25%)			$0	$ 285,053.34	
Construction Admin. (5%)			$0	$ 57,010.67	
TOTAL PROJECT COST ESTIMATE				**$ 1,539,300.00**	
Inspection	10	HR	$ 32.50	$ 325.00	
Sediment Removal	1610	CY	$ 25.00	$ 40,250.00	Assume 1' over the pond bottom
Maintain Vegetation	1.4	AC	$ 3,000.00	$ 4,200.00	Assume pond footprint
Clean Catch Basin		EA	$ 200.00	$ -	
Clean Manhole		EA	$ 400.00	$ -	
ANNUAL MAINTENANCE COST ESTIMATE				**$ 44,800.00**	

City of Troutdale
South Troutdale Master Plan
CIP Facility Preliminary Cost Estimates

CIP Number: WQ_05
CIP Type: Water Quality

ITEM	QUANTITY	UNIT	UNIT COST ($)	TOTAL COST ($)	Assumptions
CONSTRUCTION ELEMENTS					
Mobilization/Demobilization	1	LS		$ 4,406.30	10% Construction Costs
Traffic Control	1	LS	$10,000	$ 10,000.00	
Erosion Control					
Silt Fence	360	LF	$1	$ 360.00	Applied around pond
Inlet Protection		EA	$29	$ -	
Misc. Erosion and Sediment Control Protection	0.2	AC	$2,300	$ 460.00	Applied throughout pond footprint
Site Set-up/ Removal/ Disposal					
Sawcut Pavement	0	LF	$1.50	$ -	
Pavement Removal	0	SY	$7.00	$ -	
Clearing and Grubbing	7550	SF	$0.30	$ 2,265.00	Assume pond footprint
Remove Curbs	0	LF	$7.00	$ -	
Remove Culvert		LF	$55.00	$ -	
Water Quality Facility Installation					
General Earthwork/ Excavation	107	CY	$22.00	$ 2,354.00	Assume total excavation depth of 3 feet over pond bottom area (~588 sf)
Grading	107	CY	$6.00	$ 642.00	
Geotextile Fabric		SY	$14.00	$ -	
Perforated Drain Pipe (installed)		LF	$15	$ -	
Rip-Rap, Class 50		CY	$61	$ -	
Drain Rock	54	CY	$30	$ 1,620.00	Assume 18" depth
Pond Outlet Structure	1	EA	$5,000	$ 5,000.00	
Pond Inlet Structure	1	EA	$4,000	$ 4,000.00	
Check Dam		EA	$800	$ -	
Emergency Overflow Weir		LF	$20	$ -	
Engineered Soils	54	CY	$30.00	$ 1,620.00	Assume 18" depth
Plantings (Engineered Soils)	960	SF	$4.00	$ 3,840.00	
Plantings (Native Soil)		SF	$8.00	$ -	
Restoration/ Resurfacing					
Non-Water Quality Facility Landscaping	0.15	AC	$20,000	$ 3,000.00	Assume along the sideslopes of the pond
6-foot Chain Link Fence	360	LF	$20	$ 7,200.00	
Gravel Access Road	300	SF	$5	$ 1,350.00	Assume 25 foot long and 12 foot wide
Hydroseed	0.16	AC	$2,200	$ 352.00	Assume along the sideslopes of the pond
PROJECT SUB-TOTALS					
Project Sub-Total				$ 48,469.30	
Construction Contingency (30%)				$ 14,540.79	
CONSTRUCTION COST ESTIMATE				**$ 63,010.09**	
Permitting (5%)			$0	$ 3,150.50	
Surveying & Design (25%)			$0	$ 15,752.52	
Construction Admin. (5%)			$0	$ 3,150.50	
TOTAL PROJECT COST ESTIMATE				**$ 85,100.00**	
Inspection	4	HR	$ 32.50	$ 130.00	
Sediment Removal	36	CY	$ 25.00	$ 900.00	Assume 1' over the pond bottom
Maintain Vegetation	0.2	AC	$ 3,000.00	$ 600.00	Assume pond footprint
Clean Catch Basin		EA	$ 200.00	$ -	
Clean Manhole		EA	$ 400.00	$ -	
ANNUAL MAINTENANCE COST ESTIMATE				**$ 1,600.00**	

City of Troutdale
South Troutdale Master Plan
CIP Facility Preliminary Cost Estimates

CIP Number: WQ_06
CIP Type: Water Quality

ITEM	QUANTITY	UNIT	UNIT COST ($)	TOTAL COST ($)	Assumptions
CONSTRUCTION ELEMENTS					
Mobilization/Demobilization	1	LS		$ 15,389.80	10% Construction Costs
Traffic Control	1	LS	$10,000	$ 10,000.00	
Erosion Control					
Silt Fence	1000	LF	$1	$ 1,000.00	Applied around pond
Inlet Protection		EA	$29	$ -	
Misc. Erosion and Sediment Control Protection	0.32	AC	$2,300	$ 736.00	Applied throughout pond footprint
Site Set-up/ Removal/ Disposal					
Sawcut Pavement	0	LF	$1.50	$ -	
Pavement Removal	0	SY	$7.00	$ -	
Clearing and Grubbing	13800	SF	$0.30	$ 4,140.00	Assume pond footprint
Remove Curbs	0	LF	$7.00	$ -	
Remove Culvert		LF	$55.00	$ -	
Water Quality Facility Installation					
General Earthwork/ Excavation	1910	CY	$22.00	$ 42,020.00	Assume total excavation depth of 3 feet over pond bottom area (~6900 sf) plus storage volume required (0.71 ac-ft)
Grading	1910	CY	$6.00	$ 11,460.00	
Geotextile Fabric		SY	$14.00	$ -	
Perforated Drain Pipe (installed)		LF	$15	$ -	
Rip-Rap, Class 50		CY	$61	$ -	
Drain Rock	384	CY	$30	$ 11,520.00	Assume 18" depth
Pond Outlet Structure	1	EA	$5,000	$ 5,000.00	
Pond Inlet Structure	1	EA	$4,000	$ 4,000.00	
Check Dam		EA	$800	$ -	
Emergency Overflow Weir		LF	$20	$ -	
Engineered Soils	384	CY	$30.00	$ 11,520.00	Assume 18" depth for pond bottom footprint
Plantings (Engineered Soils)	6900	SF	$4.00	$ 27,600.00	Assume pond bottom footprint
Plantings (Native Soil)		SF	$8.00		
Restoration/ Resurfacing					
Non-Water Quality Facility Landscaping	0.16	AC	$20,000	$ 3,200.00	Assume along the sideslopes of the pond
6-foot Chain Link Fence	1000	LF	$20	$ 20,000.00	
Gravel Access Road	300	SF	$5	$ 1,350.00	Assume 25 foot long and 12 foot wide
Hydroseed	0.16	AC	$2,200	$ 352.00	Assume along the sideslopes of the pond
PROJECT SUB-TOTALS					
Project Sub-Total				$ 169,287.80	
Construction Contingency (30%)				$ 50,786.34	
CONSTRUCTION COST ESTIMATE				**$ 220,074.14**	
Permitting (5%)			$0	$ 11,003.71	
Surveying & Design (25%)			$0	$ 55,018.54	
Construction Admin. (5%)			$0	$ 11,003.71	
TOTAL PROJECT COST ESTIMATE				**$ 297,100.00**	
Inspection	10	HR	$ 32.50	$ 325.00	
Sediment Removal	260	CY	$ 25.00	$ 6,500.00	Assume 1' over the pond bottom
Maintain Vegetation	0.16	AC	$ 3,000.00	$ 480.00	Assume pond footprint
Clean Catch Basin		EA	$ 200.00	$ -	
Clean Manhole		EA	$ 400.00	$ -	
ANNUAL MAINTENANCE COST ESTIMATE				**$ 7,300.00**	

City of Troutdale
South Troutdale Master Plan
CIP Facility Preliminary Cost Estimates

CIP Number: WQ_07
CIP Type: Water Quality

ITEM	QUANTITY	UNIT	UNIT COST ($)	TOTAL COST ($)	Assumptions
CONSTRUCTION ELEMENTS					
Mobilization/Demobilization	1	LS		$ 3,134.80	10% Construction Costs
Traffic Control	1	LS	$10,000	$ 10,000.00	
Erosion Control					
Silt Fence	260	LF	$1	$ 260.00	Applied around pond
Inlet Protection		EA	$29	$ -	
Misc. Erosion and Sediment Control Protection	0.1	AC	$2,300	$ 230.00	Applied throughout pond footprint
Utility Relocation		EA	X		Unknown
Site Set-up/ Removal/ Disposal					
Sawcut Pavement	0	LF	$1.50	$ -	
Pavement Removal	0	SY	$7.00	$ -	
Clearing and Grubbing	3000	SF	$0.30	$ 900.00	Assume pond footprint
Remove Curbs	0	LF	$7.00	$ -	
Remove Culvert		LF	$55.00	$ -	
Water Quality Facility Installation					
General Earthwork/ Excavation	23	CY	$22.00	$ 506.00	Assume total excavation depth of 3 feet over pond bottom area (~206 sf)
Grading	23	CY	$6.00	$ 138.00	
Geotextile Fabric		SY	$14.00	$ -	
Perforated Drain Pipe (installed)		LF	$15	$ -	
Rip-Rap, Class 50		CY	$61	$ -	
Drain Rock	12	CY	$30	$ 360.00	Assume 18" depth
Pond Outlet Structure	1	EA	$5,000	$ 5,000.00	
Pond Inlet Structure	1	EA	$4,000	$ 4,000.00	
Check Dam		EA	$800	$ -	
Emergency Overflow Weir		LF	$20	$ -	
Plantings (Engineered Soils)	12	CY	$30.00	$ 360.00	Assume 18" depth
Plantings (Engineered Soils)	206	SF	$4.00	$ 824.00	
Plantings (Native Soil)		SF	$8.00	$ -	
Restoration/ Resurfacing					
Non-Water Quality Facility Landscaping	0.1	AC	$20,000	$ 2,000.00	
6-foot Chain Link Fence	260	LF	$20	$ 5,200.00	
Gravel Access Road	300	SF	$5	$ 1,350.00	Assume 25 foot long and 12 foot wide
Hydroseed	0.1	AC	$2,200	$ 220.00	Assume along the sideslopes of the pond
PROJECT SUB-TOTALS					
Project Sub-Total				$ 34,482.80	
Construction Contingency (30%)				$ 10,344.84	
CONSTRUCTION COST ESTIMATE				**$ 44,827.64**	
Permitting (5%)			$0	$ 2,241.38	
Surveying & Design (25%)			$0	$ 11,206.91	
Construction Admin. (5%)			$0	$ 2,241.38	
TOTAL PROJECT COST ESTIMATE				**$ 60,500.00**	
Inspection	4	HR	$ 32.50	$ 130.00	
Sediment Removal	4	CY	$ 25.00	$ 100.00	Assume 1' over the pond bottom
Maintain Vegetation	0.1	AC	$ 3,000.00	$ 300.00	
Clean Catch Basin		EA	$ 200.00	$ -	
Clean Manhole		EA	$ 400.00	$ -	
ANNUAL MAINTENANCE COST ESTIMATE				**$ 500.00**	

City of Troutdale
South Troutdale Master Plan
CIP Facility Preliminary Cost Estimates

CIP Number: WQ_08
CIP Type: Water Quality

ITEM	QUANTITY	UNIT	UNIT COST ($)		TOTAL COST ($)	Assumptions
CONSTRUCTION ELEMENTS						
Mobilization/Demobilization	1	LS		$	7,532.92	10% Construction Costs
Traffic Control	1	LS	$10,000	$	10,000.00	
Erosion Control						
Silt Fence	400	LF	$1	$	400.00	Applied around pond
Inlet Protection		EA	$29	$	-	
Misc. Erosion and Sediment Control Protection	0.14	AC	$2,300	$	322.00	Applied throughout pond footprint
Site Set-up/ Removal/ Disposal						
Sawcut Pavement	0	LF	$1.50	$	-	
Pavement Removal	0	SY	$7.00	$	-	
Clearing and Grubbing	6004	SF	$0.30	$	1,801.20	Assume pond footprint
Remove Curbs	0	LF	$7.00	$	-	
Remove Culvert		LF	$55.00	$	-	
Water Quality Facility Installation						
General Earthwork/ Excavation	790	CY	$22.00	$	17,380.00	Assume total excavation depth of 3 feet over pond bottom area (~2800 sf) plus storage volume required (0.30 ac-ft)
Grading	790	CY	$6.00	$	4,740.00	
Geotextile Fabric		SY	$14.00	$	-	
Perforated Drain Pipe (installed)		LF	$15	$	-	
Rip-Rap, Class 50		CY	$61	$	-	
Drain Rock	156	CY	$30	$	4,680.00	Assume 18" depth
Pond Outlet Structure	1	EA	$5,000	$	5,000.00	
Pond Inlet Structure	1	EA	$4,000	$	4,000.00	
Check Dam		EA	$800	$	-	
Emergency Overflow Weir		LF	$20	$	-	
Engineered Soils	156	CY	$30.00	$	4,680.00	Assume 18" depth for pond bottom footprint
Plantings (Engineered Soils)	2800	SF	$4.00	$	11,200.00	Assume pond bottom footprint
Plantings (Native Soil)		SF	$8.00			
Restoration/ Resurfacing						
Non-Water Quality Facility Landscaping	0.08	AC	$20,000	$	1,600.00	
6-foot Chain Link Fence	400	LF	$20	$	8,000.00	
Gravel Access Road	300	SF	$5	$	1,350.00	Assume 25 foot long and 12 foot wide
Hydroseed	0.08	AC	$2,200	$	176.00	Assume along the sideslopes of the pond
PROJECT SUB-TOTALS						
Project Sub-Total				$	82,862.12	
Construction Contingency (30%)				$	24,858.64	
CONSTRUCTION COST ESTIMATE				**$**	**107,720.76**	
Permitting (5%)			$0	$	5,386.04	
Surveying & Design (25%)			$0	$	26,930.19	
Construction Admin. (5%)			$0	$	5,386.04	
TOTAL PROJECT COST ESTIMATE				**$**	**145,400.00**	
Inspection	10	HR	$ 32.50	$	325.00	
Sediment Removal	104	CY	$ 25.00	$	2,600.00	Assume 1' over the pond bottom
Maintain Vegetation	0.14	AC	$ 3,000.00	$	420.00	Assume pond footprint
Clean Catch Basin		EA	$ 200.00	$	-	
Clean Manhole		EA	$ 400.00	$	-	
ANNUAL MAINTENANCE COST ESTIMATE				**$**	**3,300.00**	

City of Troutdale
South Troutdale Master Plan
CIP Facility Preliminary Cost Estimates

CIP Number: WQ_09
CIP Type: Water Quality

ITEM	QUANTITY	UNIT	UNIT COST ($)	TOTAL COST ($)	Assumptions
CONSTRUCTION ELEMENTS					
Mobilization/Demobilization	1	LS		$ 19,356.10	10% Construction Costs
Traffic Control	1	LS	$10,000	$ 10,000.00	
Erosion Control					
Silt Fence		LF	$1	$ -	
Inlet Protection		EA	$29	$ -	
Misc. Erosion and Sediment Control Protection	0.32	AC	$2,300	$ 736.00	Based on area of planters
Site Set-up/ Removal/ Disposal					
Sawcut Pavement	858	LF	$1.50	$ 1,287.00	
Pavement Removal	1550	SY	$7.00	$ 10,850.00	Assume planter installation completely in ROW
Clearing and Grubbing		SF	$0.30	$ -	
Remove Curbs	0	LF	$7.00	$ -	
Remove Culvert		LF	$55.00	$ -	
Water Quality Facility Installation					
General Earthwork/ Excavation	2063	CY	$22.00	$ 45,386.00	Assume total facility depth of 4 feet and footprint of 13924 sf
Grading		CY	$6.00		
Geotextile Fabric		SY	$14.00		
Perforated Drain Pipe (installed)		LF	$15		
Rip-Rap, Class 50		CY	$61		
Drain Rock	774	CY	$30	$ 23,220.00	Assume 18" depth
Pond Outlet Structure		EA	$5,000		
Pond Inlet Structure		EA	$4,000		
Check Dam		EA	$800		
Emergency Overflow Weir		LF	$20		
Engineered Soils	774	CY	$30.00	$ 23,220.00	Assume 18" depth
Plantings (Engineered Soils)	13924	SF	$4.00	$ 55,696.00	
Plantings (Native Soil)		SF	$8.00		
Structure Installation					
Precast Concrete Manhole (48", 0-8' deep)		EA	$2,025		
Precast Concrete Manhole (60", 0-8' deep)		EA	$2,550		
Precast Concrete Manhole (72", 0-8' deep)		EA	$4,650	$ -	
Concrete Inlet, Type G-1		EA	$2,204		
Concrete Inlet, Type G-2		EA	$1,839		
Concrete Curb		LF	$18	$ -	
Concrete Curbs, Curb and Gutter Modified	858	LF	$27	$ 23,166.00	
PROJECT SUB-TOTALS					
Project Sub-Total				$ 212,917.10	
Construction Contingency (30%)				$ 63,875.13	
CONSTRUCTION COST ESTIMATE				**$ 276,792.23**	
Permitting (5%)			$0	$ 13,839.61	
Surveying & Design (25%)			$0	$ 69,198.06	
Construction Admin. (5%)			$0	$ 13,839.61	
TOTAL PROJECT COST ESTIMATE				**$ 373,700.00**	
Inspection	10	HR	$ 32.50	$ 325.00	
Sediment Removal	258	CY	$ 25.00	$ 6,450.00	Assume 6" over the planter area
Maintain Vegetation	0.32	AC	$ 3,000.00	$ 960.00	
Clean Catch Basin		EA	$ 200.00	$ -	
Clean Manhole		EA	$ 400.00	$ -	
ANNUAL MAINTENANCE COST ESTIMATE				**$ 7,700.00**	

City of Troutdale
South Troutdale Master Plan
CIP Facility Preliminary Cost Estimates

CIP Number: WQ_010
CIP Type: Water Quality

ITEM	QUANTITY	UNIT	UNIT COST ($)	TOTAL COST ($)	Assumptions
CONSTRUCTION ELEMENTS					
Mobilization/Demobilization	1	LS		$ 9,544.10	10% Construction Costs
Traffic Control	1	LS	$10,000	$ 10,000.00	
Erosion Control					
Silt Fence		LF	$1	$ -	
Inlet Protection		EA	$29	$ -	
Misc. Erosion and Sediment Control Protection	0.2	AC	$2,300	$ 460.00	Based on area of planters
Site Set-up/ Removal/ Disposal					
Sawcut Pavement	408	LF	$1.50	$ 612.00	
Pavement Removal	717	SY	$7.00	$ 5,019.00	Assume planter installation completely in ROW
Clearing and Grubbing		SF	$0.30	$ -	
Remove Curbs	0	LF	$7.00	$ -	
Remove Culvert		LF	$55.00	$ -	
Water Quality Facility Installation					
General Earthwork/ Excavation	955	CY	$22.00	$ 21,010.00	Assume total facility depth of 4 feet and footprint of 6446 sf
Grading		CY	$6.00		
Geotextile Fabric		SY	$14.00		
Perforated Drain Pipe (installed)		LF	$15		
Rip-Rap, Class 50		CY	$61		
Drain Rock	359	CY	$30	$ 10,770.00	Assume 18" depth
Pond Outlet Structure		EA	$5,000		
Pond Inlet Structure		EA	$4,000		
Check Dam		EA	$800		
Emergency Overflow Weir		LF	$20		
Plantings (Engineered Soils)	359	CY	$30.00	$ 10,770.00	Assume 18" depth
Plantings (Engineered Soils)	6446	SF	$4.00	$ 25,784.00	
Plantings (Native Soil)		SF	$8.00		
Structure Installation					
Precast Concrete Manhole (48", 0-8' deep)		EA	$2,025		
Precast Concrete Manhole (60", 0-8' deep)		EA	$2,550		
Precast Concrete Manhole (72", 0-8' deep)		EA	$4,650	$ -	
Concrete Inlet, Type G-1		EA	$2,204		
Concrete Inlet, Type G-2		EA	$1,839		
Concrete Curb		LF	$18	$ -	
Concrete Curbs, Curb and Gutter Modified	408	LF	$27	$ 11,016.00	
PROJECT SUB-TOTALS					
Project Sub-Total				$ 104,985.10	
Construction Contingency (30%)				$ 31,495.53	
CONSTRUCTION COST ESTIMATE				**$ 136,480.63**	
Permitting (5%)			$0	$ 6,824.03	
Surveying & Design (25%)			$0	$ 34,120.16	
Construction Admin. (5%)			$0	$ 6,824.03	
TOTAL PROJECT COST ESTIMATE				**$ 184,200.00**	
Inspection	10	HR	$ 32.50	$ 325.00	
Sediment Removal	120	CY	$ 25.00	$ 3,000.00	Assume 6" over the planter area
Maintain Vegetation	0.2	AC	$ 3,000.00	$ 600.00	
Clean Catch Basin		EA	$ 200.00	$ -	
Clean Manhole		EA	$ 400.00	$ -	
ANNUAL MAINTENANCE COST ESTIMATE				**$ 3,900.00**	

City of Troutdale Stormwater Master Plan

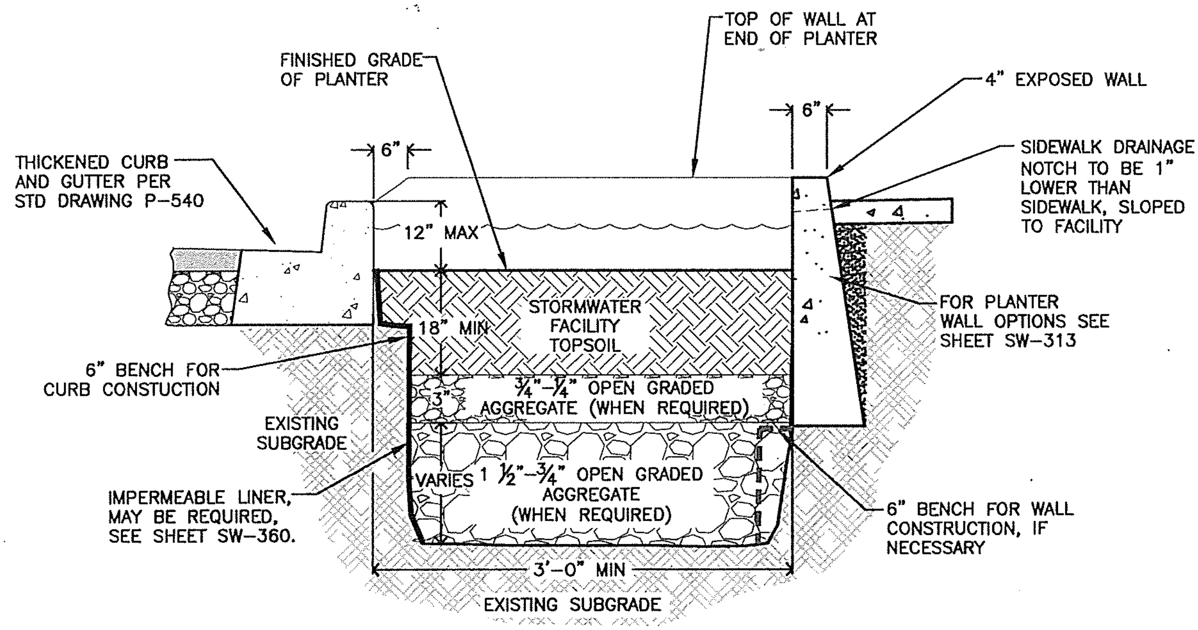
PIPE INSTALLATION with Asphalt

Storm Drain Pipe Construction Cost per Linear Foot										
	Diameter (inches)									
Cover Depth (feet)	**12**	**15**	**18**	24	30	36	42	48	54	60
2-5	$45	$64	$71	$96	$129	$160	$193	$233	$297	$338
5-10	$56	$79	$86	$117	$155	$191	$229	$275	$344	$390
10-15	$66	$95	$102	$138	$181	$222	$265	$316	$391	$441
15-20	$76	$110	$117	$158	$207	$254	$302	$358	$437	$493

Supporting Calculations

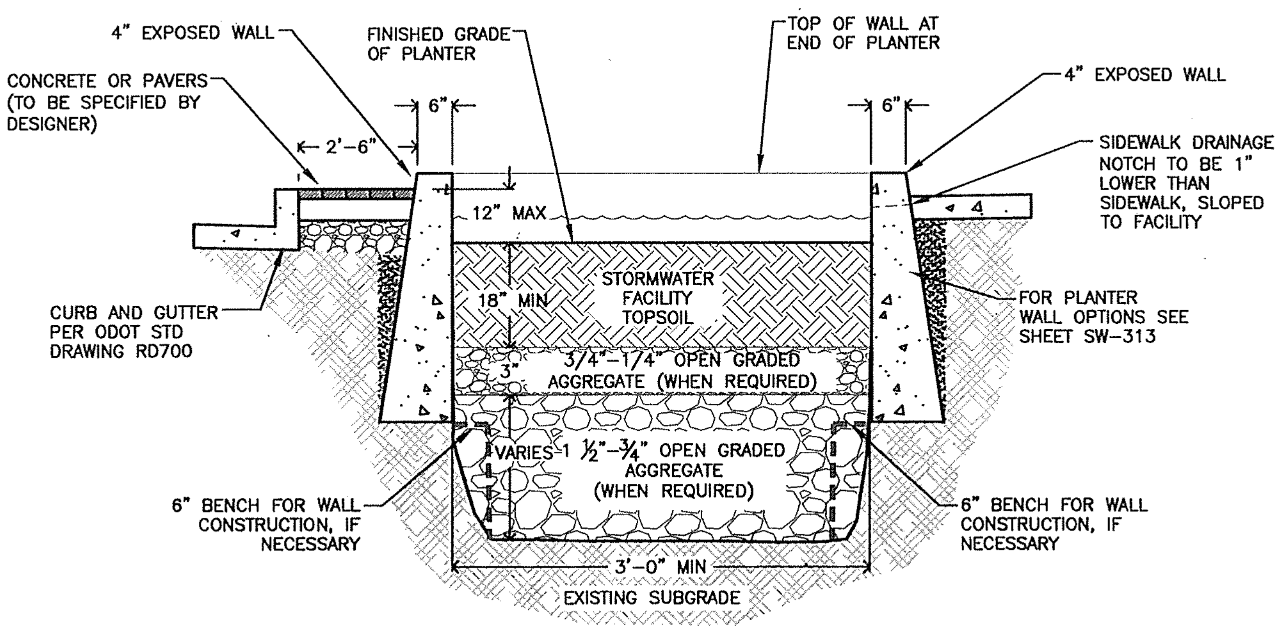
Depth of Cover (ft)	**12**	**15**	**18**	24	30	36	42	48	54	60	66	72	84	96
Sub Task														
Pipe + Bed (ft)	2	2	2	3	3	4	4	5	5	6	6	7	8	9
Width (ft)	2	3	3	4	5	6	7	8	9	10	11	12	14	16
Bedding (ft)	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.4	0.5	0.6
Shoring (lf)	$ 8.62	$ 9.48	$ 10.34	$12.42	$14.90	$17.88	$21.46	$25.75	$30.90	$30.90	$37.09	$44.51	$53.41	$64.09
Trench Excavation (CY)	$ 21.00	$ 21.00	$ 21.00	$ 21.00	$ 21.00	$ 21.00	$ 21.00	$ 21.00	$ 21.00	$ 21.00	$ 21.00	$ 21.00	$ 21.00	$ 21.00
Trench Backfill (CY)	$ 7.00	$ 7.00	$ 7.00	$ 7.00	$ 7.00	$ 7.00	$ 7.00	$ 7.00	$ 7.00	$ 7.00	$ 7.00	$ 7.00	$ 7.00	$ 7.00
HDPE Piping (lf)	$ 11.20	$ 14.30	$ 20.50	$28.50	$43.00	$53.50	$64.00	$80.50	$119.00	$138.00	$204.70	$203.55	$304.75	$379.50
Asphalt Restoration (SF)	$ 12.00	$ 18.00	$ 18.00	$ 24.00	$ 30.00	$ 36.00	$ 42.00	$ 48.00	$ 54.00	$ 60.00	$ 66.00	$ 72.00	$ 84.00	$ 96.00
Cover (CY)														
2-5	0.5	0.8	0.8	1.1	1.5	1.9	2.3	2.8	3.3	3.9	4.5	5.1	6.5	8.0
5-10	0.9	1.3	1.3	1.9	2.4	3.0	3.6	4.3	5.0	5.7	6.5	7.3	9.1	11.0
10-15	1.2	1.9	1.9	2.6	3.3	4.1	4.9	5.8	6.7	7.6	8.6	9.6	11.7	13.9
15-20	1.6	2.4	2.4	3.3	4.3	5.2	6.2	7.3	8.3	9.4	10.6	11.8	14.3	16.9
2-5	$45	$64	$71	$96	$129	$160	$193	$233	$297	$338	$433	$463	$624	$764
5-10	$56	$79	$86	$117	$155	$191	$229	$275	$344	$390	$490	$525	$696	$847
10-15	$66	$95	$102	$138	$181	$222	$265	$316	$391	$441	$547	$588	$769	$930
15-20	$76	$110	$117	$158	$207	$254	$302	$358	$437	$493	$604	$650	$841	$1,012

Appendix C: Referenced Standard Details



SECTION A-A
PLANTER WITHOUT PARKING

FOR PLAN VIEW REFER TO SW-310



SECTION B-B
PLANTER WITH PARKING

FOR PLAN VIEW REFER TO SW-311

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- 2010 Green Streets -

Section Views

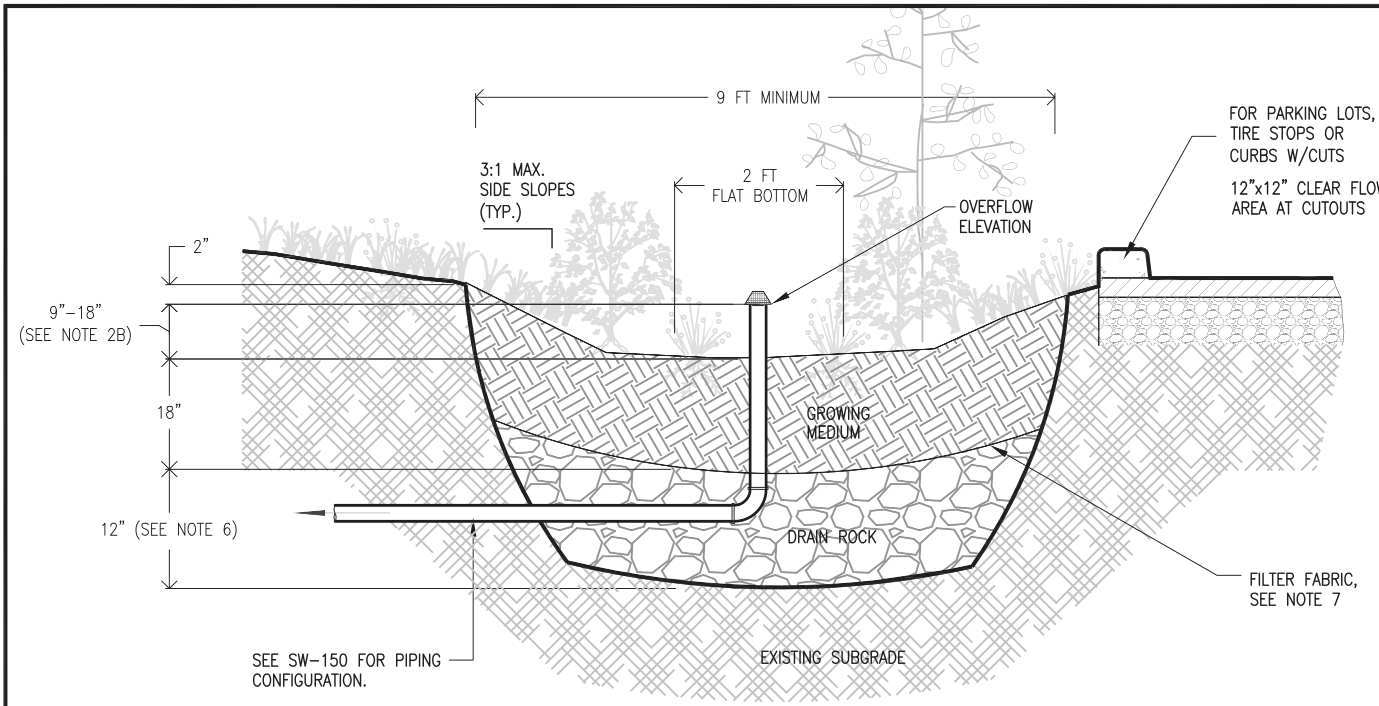
Planters

Bureau of Environmental Services

NUMBER

SW-312

REVISED: 03/05/10 11:18



1. Provide protection from all vehicle traffic, equipment staging, and foot traffic in proposed infiltration areas prior to, during, and after construction.

2. Dimensions:
   a. Width of basin: 9' minimum.
   b. Depth of basin (from top of growing medium to overflow elevation); Simplified: 12", Presumptive: 9"-18".
   c. Flat bottom width: 2' min.
   d. Side slopes of basin: 3:1 maximum.

3. Setbacks (from midpoint of facility):
   a. Infiltration basins must be 10' from foundations and 5' from property lines.
   b. Flow-through swales must be lined with connection to approved discharge point according to SWMM Section 1.3.

4. Overflow:
   a. Overflow required for Simplified Approach.
   b. Inlet elevation must allow for 2" of freeboard, minimum.
   c. Protect from debris and sediment with strainer or grate.

5. Piping: shall be ABS Sch.40, cast iron, or PVC Sch.40. 3" pipe required for up to 1,500 sq ft of impervious area, otherwise 4" min. Piping must have 1% grade and follow the Uniform Plumbing Code.

6. Drain rock:
   a. Size for infiltration basin: 1½" - ¾" washed
   b. Size for flow-through basin: ¾" washed
   c. Depth for Simplified: 12"
   d. Depth for Presumptive: 0-48", see calcs.

7. Separation between drain rock and growing medium: Use filter fabric (see SWMM Exhibit 2-5) or a gravel lens (¾ - ¼ inch washed, crushed rock 2 to 3 inches deep).

8. Growing medium:
   a. 18" minimum
   b. See Appendix F.3 for specification or use sand/loam/compost 3-way mix.

9. Vegetation: Follow landscape plans otherwise refer to plant list in SWMM Appendix F. Minimum container size is 1 gallon. # of plantings per 100sf of facility area):
   a. Zone A (wet): 115 herbaceous plants OR 100 herbaceous plants and 4 shrubs
   b. Zone B (moderate to dry): 1 tree AND 3 large shrubs AND 4 medium to small shrubs.

   The delineation between Zone A and B shall be either at the outlet elevation or the check dam elevation, whichever is lowest.

10. Install washed pea gravel or river rock to transition from inlets and splash pad to growing medium.

11. Inspections: Call BDS IVR Inspection Line, (503) 823-7000, for appropriate inspections.

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

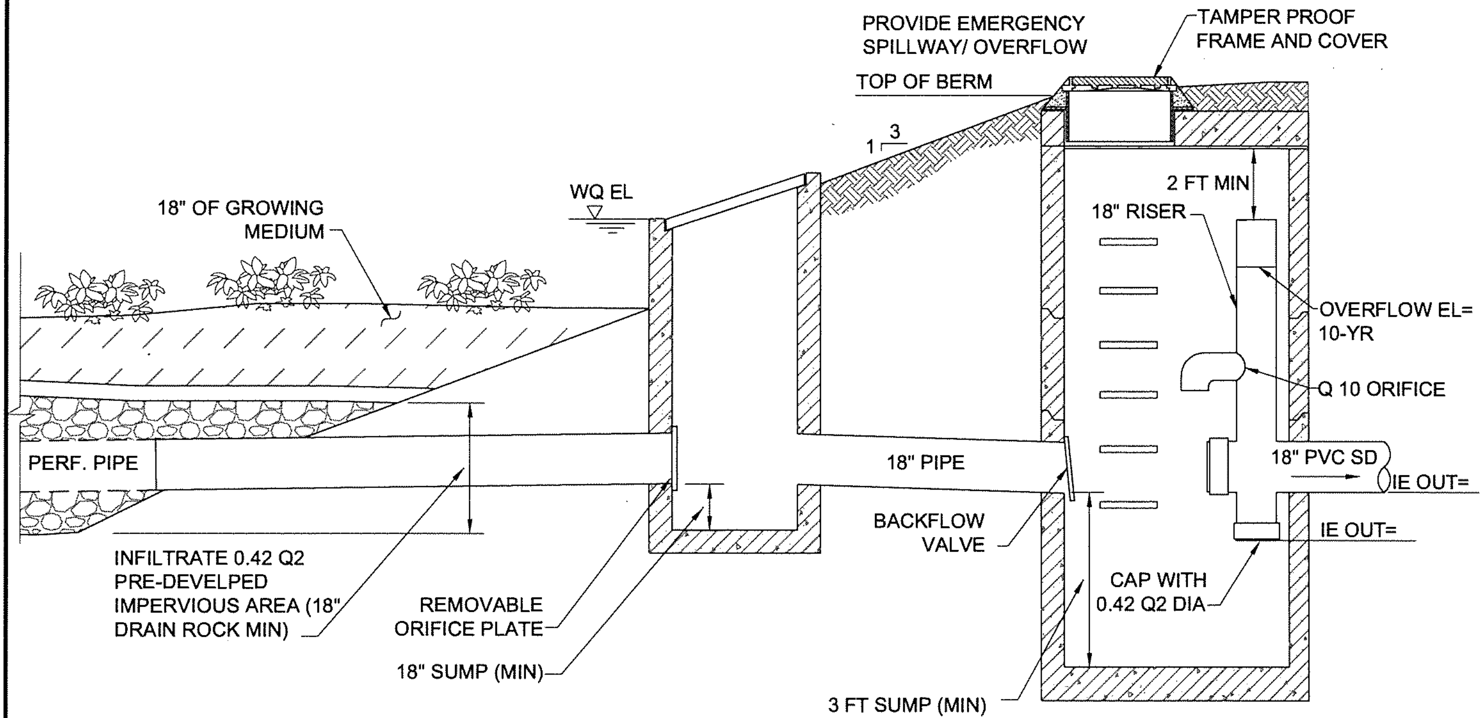
- Simplified / Presumptive Design Approach -

Basin

NUMBER

SW-140

Bureau of Environmental Services



WATER ENVIRONMENT SERVICES

Stormwater Facilities
Flow Control Structure

NUMBER

X

Appendix D: Revised Hydraulic Results Table (reflecting flood control CIP implementation)

Appendix D: Model Conduit Parameters and Results With CIPs

Conduit Name (US Node - DS Node)	Node ID		Conduit Attributes				Future 25yr 24hr Peak Flow (cfs)	Future 25yr 24hr Peak Flow (cfs)	Node Rim and Invert Elevation (IE)				Existing 25yr 24hr Maximum HGL (feet) Pre-CIP		Future 25yr 24hr Maximum HGL (feet) Post-CIP		Flood Control CIP Number
	US	DS	Type	Conduit Dia or Channel Height (inches)	Manning's Roughness	Conduit Length			US Rim (ft)	US IE (ft)	DS Rim (ft)	DS IE (ft)	US	DS	US	DS	
BEAVER CREEK																	
Outfall BC010																	
BC010_020-O_BC010	BC010_020	O_BC010	Pipe	30	0.0240	80	53.8	63.2	57.6	46.1	27.1	16.7	47.2	17.8	47.3	17.9	
BC010_030-BC010_020	BC010_030	BC010_020	Pipe	30	0.0120	98	53.8	63.2	59.7	49.3	57.6	46.1	50.9	47.2	51.1	47.3	
BC010_040-BC010_030	BC010_040	BC010_030	Pipe	30	0.0120	70	53.8	63.2	61.8	51.7	59.7	49.3	53.2	50.9	53.3	51.1	
BC010_050-BC010_040	BC010_050	BC010_040	Pipe	30	0.0120	150	53.8	63.2	68.6	56.7	61.8	51.7	58.1	53.2	58.3	53.3	
BC010_060-BC010_050	BC010_060	BC010_050	Pipe	12	0.0120	145	3.7	3.7	84.0	74.9	68.6	57.2	75.2	58.1	75.2	58.3	
BC010_070-BC010_060	BC010_070	BC010_060	Pipe	12	0.0120	101	3.7	3.7	100.8	91.1	84.0	75.1	91.4	75.2	91.4	75.2	
BC010_100-BC010_070	BC010_100	BC010_070	Pipe	12	0.0180	237	3.7	3.7	102.9	96.5	100.8	90.6	97.2	91.4	97.2	91.4	
BC020_010-BC010_050	BC020_010	BC010_050	Pipe	30	0.0120	255	50.2	59.5	75.5	62.0	68.6	56.7	63.7	58.1	64.0	58.3	
BC020_020-BC020_010	BC020_020	BC020_010	Pipe	12	0.0120	240	6.0	6.0	96.3	85.3	75.5	64.0	85.8	63.7	85.8	64.0	
BC020_100-BC020_010	BC020_100	BC020_010	Pipe	30	0.0120	260	44.4	53.8	78.7	66.0	75.5	62.0	67.7	63.7	68.0	64.0	
BC020_110-BC020_100	BC020_110	BC020_100	Pipe	15	0.0120	75	13.7	20.0	80.0	73.4	78.7	70.2	74.4	67.7	77.4	68.0	
BC020_120-BC020_110	BC020_120	BC020_110	Pipe	15	0.0120	191	13.7	20.0	100.0	90.6	80.0	73.4	97.6	74.4	92.0	77.4	FC_01
BC030_010-BC020_120	BC030_010	BC020_120	Pipe	15	0.0120	262	13.8	20.0	127.6	117.1	100.0	91.0	127.6	97.6	118.2	92.0	FC_01
BC030_020-BC030_010	BC030_020	BC030_010	Pipe	12	0.0120	260	7.1	7.6	135.5	126.6	127.6	117.5	135.5	127.6	127.5	118.2	
BC040_010-BC030_020	BC040_010	BC030_020	Pipe	12	0.0130	46	7.5	7.6	138.1	130.3	135.5	128.1	137.4	135.5	131.1	127.5	
BC040_020-BC040_010	BC040_020	BC040_010	Pipe	12	0.0130	334	7.5	7.6	153.8	146.3	138.1	130.5	151.6	137.4	147.1	131.1	
BC040_030-BC040_020	BC040_030	BC040_020	Pipe	12	0.0130	276	3.4	3.2	168.8	160.2	153.8	146.5	160.6	151.6	160.6	147.1	
BC040_040-BC040_030	BC040_040	BC040_030	Pipe	12	0.0130	64	3.2	3.2	172.9	163.1	168.8	160.4	163.6	160.6	163.6	160.6	
BC040_050-BC040_040	BC040_050	BC040_040	Pipe	12	0.0130	252	3.2	3.2	185.7	176.0	172.9	163.2	176.5	163.6	176.5	163.6	
BC040_060-BC040_050	BC040_060	BC040_050	Pipe	12	0.0130	270	3.2	3.2	197.2	188.9	185.7	176.2	189.3	176.5	189.3	176.5	
BC040_070-BC040_060	BC040_070	BC040_060	Pipe	12	0.0130	210	3.2	3.2	215.5	197.8	197.2	189.1	198.2	189.3	198.2	189.3	
BC050_010-BC040_070	BC050_010	BC040_070	Pipe	12	0.0130	68	3.2	3.2	209.0	199.9	215.5	198.0	200.5	198.2	200.5	198.2	
BC050_020-BC050_010	BC050_020	BC050_010	Pipe	15	0.0120	115	2.9	2.9	212.8	205.5	209.0	200.1	205.9	200.5	205.9	200.5	
BC050_030-BC050_020	BC050_030	BC050_020	Pipe	15	0.0120	175	2.9	2.9	221.9	213.5	212.8	206.0	213.9	205.9	213.9	205.9	
BC060_010-BC050_030	BC060_010	BC050_030	Pipe	15	0.0120	166	2.9	2.9	228.9	222.3	221.9	213.6	222.7	213.9	222.7	213.9	
BC030_100-BC030_010	BC030_100	BC030_010	Pipe	12	0.0120	60	10.4	10.5	138.2	129.5	127.6	117.9	131.8	127.6	130.1	118.2	
BC080_010-BC030_100	BC080_010	BC030_100	Pipe	12	0.0120	205	10.4	10.5	176.5	166.6	138.2	129.5	167.2	131.8	167.2	130.1	
BC080_020-BC080_010	BC080_020	BC080_010	Pipe	12	0.0120	63	3.3	3.4	185.4	170.0	176.5	167.3	170.4	167.2	170.5	167.2	
BC080_030-BC080_020	BC080_030	BC080_020	Pipe	12	0.0120	200	3.3	3.4	212.6	204.7	185.4	170.0	205.0	170.4	205.0	170.5	
BC080_040-BC080_030	BC080_040	BC080_030	Pipe	12	0.0120	232	3.3	3.4	220.8	209.4	212.6	204.4	209.9	205.0	209.9	205.0	
BC080_050-BC080_040	BC080_050	BC080_040	Pipe	12	0.0120	297	3.3	3.4	233.5	225.4	220.8	209.6	225.8	209.9	225.8	209.9	
BC070_010-BC080_010	BC070_010	BC080_010	Pipe	12	0.0120	260	7.1	7.2	190.0	181.8	176.5	167.1	182.4	167.2	182.4	167.2	
BC070_020-BC070_010	BC070_020	BC070_010	Pipe	12	0.0120	68	7.1	7.2	203.7	193.0	190.0	182.2	193.5	182.4	193.5	182.4	
BC070_030-BC070_020	BC070_030	BC070_020	Pipe	12	0.0120	88	7.1	7.2	218.5	209.1	203.7	193.0	209.6	193.5	209.6	193.5	
BC080_040-BC070_030	BC080_040	BC080_030	Pipe	12	0.0120	232	3.3	3.4	220.8	209.4	212.6	204.4	209.9	205.0	209.9	205.0	
BC070_050-BC080_040	BC070_050	BC070_040	Pipe	12	0.0120	261	7.1	7.2	225.1	217.0	227.0	210.5	222.5	214.0	222.7	214.0	
BC090_010-BC020_100	BC090_010	BC020_100	Pipe	30	0.0120	264	30.7	33.8	81.4	69.5	78.7	66.0	70.9	67.7	71.0	68.0	
BC090_020-BC090_010	BC090_020	BC090_010	Pipe	24	0.0120	54	30.7	33.8	83.1	70.1	81.4	69.5	71.8	70.9	72.0	71.0	
BC090_030-BC090_020	BC090_030	BC090_020	Pipe	24	0.0120	244	30.7	33.8	101.5	90.7	83.1	70.1	91.6	71.8	91.7	72.0	
BC090_050-BC090_030	BC090_050	BC090_030	Pipe	12	0.0100	240	5.2	5.9	100.3	91.2	101.5	90.8	94.5	91.6	95.4	91.7	

BC090_100-BC090_030	BC090_100	BC090_030	Pipe	24	0.0120	261	25.6	27.9	126.0	115.4	101.5	90.8	116.2	91.6	116.3	91.7	
BC100_010-BC090_100	BC100_010	BC090_100	Pipe	24	0.0120	260	25.6	27.9	161.6	149.3	126.0	115.5	150.0	116.2	150.1	116.3	
BC100_020-BC100_010	BC100_020	BC100_010	Pipe	24	0.0120	260	25.6	27.9	195.4	183.2	161.6	149.4	183.9	150.0	184.0	150.1	
BC100_030-BC100_020	BC100_030	BC100_020	Pipe	24	0.0120	355	21.5	23.5	230.7	219.5	195.4	183.3	220.2	183.9	220.3	184.0	
BC110_010-BC100_030	BC110_010	BC100_030	Pipe	24	0.0120	151	21.5	23.5	237.7	224.7	230.7	219.6	225.7	220.2	225.7	220.3	
BC110_020-BC110_010	BC110_020	BC110_010	Pipe	12	0.0130	54	1.4	1.4	240.0	229.0	237.7	226.8	229.3	225.7	229.3	225.7	
BC110_030-BC110_020	BC110_030	BC110_020	Pipe	12	0.0130	225	1.4	1.4	250.0	239.5	240.0	229.5	239.8	229.3	239.8	229.3	
BC110_040-BC110_030	BC110_040	BC110_030	Pipe	12	0.0130	165	1.4	1.4	263.9	253.5	250.0	240.0	253.7	239.8	253.8	239.8	
BC110_050-BC110_040	BC110_050	BC110_040	Pipe	12	0.0130	327	1.4	1.4	269.0	257.5	263.9	254.2	257.9	253.7	257.9	253.8	
BC130_010-BC110_010	BC130_010	BC110_010	Pipe	24	0.0120	275	20.2	22.2	248.2	236.2	237.7	224.7	237.1	225.7	237.2	225.7	
BC130_020-BC130_010	BC130_020	BC130_010	Pipe	24	0.0120	373	20.2	22.2	258.0	245.4	248.2	236.5	246.5	237.1	246.5	237.2	
BC140_010-BC130_020	BC140_010	BC130_020	Pipe	24	0.0120	194	17.4	17.9	265.9	257.8	258.0	245.4	258.6	246.5	258.6	246.5	
BC140_020-BC140_010	BC140_020	BC140_010	Pipe	24	0.0130	454	17.4	17.9	281.7	270.9	265.9	258.0	271.9	258.6	271.9	258.6	
BC140_030-BC140_020	BC140_030	BC140_020	Pipe	12	0.0120	172	3.0	3.0	281.4	274.6	281.7	271.1	275.1	271.9	275.1	271.9	
BC150_010-BC140_020	BC150_010	BC140_020	Pipe	24	0.0130	284	14.6	15.1	286.6	273.5	281.7	271.1	274.7	271.9	274.7	271.9	
BC150_030-BC150_010	BC150_030	BC150_010	Pipe	12	0.0130	303	1.7	1.7	286.1	277.4	286.6	273.7	277.9	274.7	277.9	274.7	
BC150_100-BC150_010	BC150_100	BC150_010	Pipe	24	0.0130	91	13.0	13.5	287.7	274.5	286.6	273.7	275.6	274.7	275.6	274.7	
BC160_010-BC150_100	BC160_010	BC150_100	Pipe	24	0.0130	326	13.0	13.5	292.6	277.7	287.7	274.7	278.8	275.6	278.8	275.6	
BC160_020-BC160_010	BC160_020	BC160_010	Pipe	24	0.0130	96	13.0	13.5	294.1	279.0	292.6	277.7	280.0	278.8	280.0	278.8	
BC170_010-BC160_020	BC170_010	BC160_020	Pipe	18	0.0130	324	10.5	10.9	292.4	281.9	294.1	279.2	283.3	280.0	283.7	280.0	
BC170_020-BC170_010	BC170_020	BC170_010	Pipe	18	0.0130	122	10.5	10.9	293.3	282.8	292.4	282.1	284.5	283.3	284.9	283.7	
BC170_030-BC170_020	BC170_030	BC170_020	Pipe	12	0.0120	314	3.8	3.8	294.0	284.3	293.3	283.0	287.5	284.5	287.7	284.9	
BC170_040-BC170_030	BC170_040	BC170_030	Pipe	12	0.0120	204	3.8	3.8	295.4	285.3	294.0	284.5	289.4	287.5	289.6	287.7	
BC170_050-BC170_040	BC170_050	BC170_040	Pipe	12	0.0120	153	3.8	3.8	296.5	286.1	295.4	285.5	290.8	289.4	291.0	289.6	
BC170_060-BC170_050	BC170_060	BC170_050	Pipe	12	0.0120	100	3.8	3.8	294.3	287.3	296.5	286.3	291.7	290.8	291.9	291.0	
BC180_010-BC170_020	BC180_010	BC170_020	Pipe	18	0.0130	208	7.0	7.3	294.0	283.3	293.3	283.0	285.4	284.5	285.9	284.9	
BC180_020-BC180_010	BC180_020	BC180_010	Pipe	18	0.0130	194	6.9	7.3	293.8	284.3	294.0	283.5	286.2	285.4	286.9	285.9	
BC180_030-BC180_020	BC180_030	BC180_020	Pipe	18	0.0130	197	6.3	6.5	296.1	285.3	293.8	284.5	286.9	286.2	287.6	286.9	
BC180_040-BC180_030	BC180_040	BC180_030	Pipe	18	0.0130	169	6.2	6.5	297.1	287.0	296.1	285.5	287.9	286.9	288.2	287.6	
BC190_010-BC180_040	BC190_010	BC180_040	Pipe	18	0.0130	121	6.2	6.5	298.5	287.7	297.1	287.2	288.8	287.9	288.8	288.2	
BC190_020-BC190_010	BC190_020	BC190_010	Pipe	18	0.0130	335	6.2	6.5	302.2	289.6	298.5	287.9	290.6	288.8	290.7	288.8	
BC190_030-BC190_020	BC190_030	BC190_020	Pipe	18	0.0130	203	4.4	4.6	302.5	290.5	302.2	289.5	291.4	290.6	291.4	290.7	
BC190_040-BC190_030	BC190_040	BC190_030	Pipe	15	0.0130	203	4.4	4.6	301.9	291.6	302.5	290.7	292.6	291.4	292.7	291.4	
BC190_050-BC190_040	BC190_050	BC190_040	Pipe	15	0.0130	166	4.4	4.6	301.1	292.6	301.9	291.8	293.6	292.6	293.6	292.7	
BC190_060-BC190_050	BC190_060	BC190_050	Pipe	15	0.0130	201	4.4	4.6	302.4	293.7	301.1	292.8	294.7	293.6	294.8	293.6	
BC190_070-BC190_060	BC190_070	BC190_060	Pipe	15	0.0130	201	4.4	4.6	304.0	294.6	302.4	293.9	295.7	294.7	295.8	294.8	
BC200_010-BC190_070	BC200_010	BC190_070	Pipe	12	0.0130	283	4.4	4.6	307.4	297.9	304.0	294.3	300.0	295.7	300.4	295.8	
BC200_020-BC200_010	BC200_020	BC200_010	Pipe	12	0.0130	231	4.4	4.6	310.3	300.6	307.4	298.1	303.4	300.0	304.1	300.4	
BC200_030-BC200_020	BC200_030	BC200_020	Pipe	12	0.0130	236	4.4	4.7	313.0	302.1	310.3	300.8	306.8	303.4	307.8	304.1	
BC200_040-BC200_030	BC200_040	BC200_030	Pipe	12	0.0130	236	4.4	4.9	313.6	303.4	313.0	302.3	310.2	306.8	311.4	307.8	
BC200_050-BC200_040	BC200_050	BC200_040	Pipe	12	0.0130	163	4.4	5.1	313.8	304.2	313.6	303.6	312.5	310.2	313.8	311.4	
Outfall BC560																	
BC560_010-O_BC560	BC560_010	O_BC560	Pipe	18	0.0120	130	9.4	11.4	181.8	173.0	158.0	156.4	173.5	156.8	173.5	156.9	
BC560_020-BC560_010	BC560_020	BC560_010	Pipe	18	0.0120	140	9.4	11.4	182.9	173.9	181.8	173.2	175.3	173.5	175.9	173.5	
BC570_010-BC560_020	BC570_010	BC560_020	Pipe	15	0.0120	364	7.8	9.7	188.7	179.8	182.9	173.9	188.7	175.3	182.8	175.9	FC_03
BC570_020-BC570_010	BC570_020	BC570_010	Pipe	12	0.0120	206	5.3	5.8	194.7	183.6	188.7	179.8	192.2	188.7	186.9	182.8	
BC570_030-BC570_020	BC570_030	BC570_020	Pipe	12	0.0120	150	5.3	5.7	196.9	186.5	194.7	183.9	194.8	192.2	189.8	186.9	
BC570_040-BC570_030	BC570_040	BC570_030	Pipe	12	0.0120	125	5.3	5.6	199.2	190.0	196.9	186.7	197.0	194.8	192.3	189.8	
BC570_050-BC570_040	BC570_050	BC570_040	Pipe	12	0.0120	200	5.3	5.6	204.3	195.0	199.2	190.0	200.5	197.0	196.2	192.3	
BC580_010-BC570_050	BC580_010	BC570_050	Pipe	12	0.0120	160	5.5	5.6	215.2	207.5	204.3	195.2	208.1	200.5	208.0	196.2	
BC640_010-BC580_030	BC640_010	BC580_030	Pipe	12	0.0120	50	1.1	1.1	253.4	243.4	250.9	242.3	243.7	242.4	243.7	242.4	

BC650_010-BC580_030	BC650_010	BC580_030	Pipe	12	0.0120	55	0.9	0.9	253.5	245.8	250.9	242.3	246.0	242.4	246.0	242.4	
BC580_020-BC580_010	BC580_020	BC580_010	Pipe	12	0.0120	53	6.4	6.4	216.2	211.4	215.2	208.2	212.0	208.1	212.0	208.0	
BC580_030-BC580_020	BC580_030	BC580_020	Pipe	12	0.0120	498	2.0	2.0	250.9	242.1	216.2	211.6	242.4	212.0	242.4	212.0	
BC580_100-BC580_020	BC580_100	BC580_020	Pipe	21	0.0120	387	2.5	2.5	218.1	211.0	216.2	208.5	212.1	212.0	212.1	212.0	
BC590_005-BC580_100	BC590_005	BC580_100	Pipe	18	0.0120	92	2.5	2.5	218.3	211.4	218.1	211.1	212.2	212.1	212.2	212.1	
BC590_010-BC590_005	BC590_010	BC590_005	Pipe	18	0.0120	182	2.5	2.5	227.7	217.5	218.3	212.2	217.9	212.2	217.9	212.2	
BC590_020-BC590_010	BC590_020	BC590_010	Pipe	18	0.0120	211	0.6	0.6	235.7	225.9	227.7	218.6	226.0	217.9	226.0	217.9	
BC590_030-BC590_020	BC590_030	BC590_020	Pipe	18	0.0120	205	0.6	0.6	239.8	230.1	235.7	226.1	230.5	226.0	230.5	226.0	
BC590_040-BC590_030	BC590_040	BC590_030	Pipe	18	0.0120	45	0.6	0.6	250.0	233.0	239.8	230.3	237.9	230.5	237.9	230.5	
BC600_010-BC590_040	BC600_010	BC590_040	Channel	74	0.0500	257	7.1	7.1	267.7	261.5	244.0	237.8	253.3	237.9	253.3	237.9	
BC600_020-BC600_010	BC600_020	BC600_010	Pipe	12	0.0120	153	1.8	1.8	263.8	254.5	270.0	253.8	255.1	253.3	255.1	253.3	
BC600_030-BC600_020	BC600_030	BC600_020	Pipe	12	0.0120	205	1.8	1.8	263.7	255.8	263.8	254.7	256.4	255.1	256.4	255.1	
BC600_100-BC600_010	BC600_100	BC600_010	Channel	148	0.0500	125	5.3	5.3	271.9	259.6	267.7	255.4	260.1	253.3	260.1	253.3	
BC610_010-BC600_100	BC610_010	BC600_100	Pipe	12	0.0120	132	1.0	1.0	286.7	277.2	279.2	265.0	277.4	260.1	277.4	260.1	
BC600_110-BC600_100	BC600_110	BC600_100	Channel	148	0.0500	176	4.3	4.3	281.8	269.5	271.9	259.6	268.6	260.1	268.6	260.1	
BC630_010-BC600_110	BC630_010	BC600_110	Channel	136	0.0500	142	0.7	0.7	286.6	275.3	281.8	270.5	276.3	268.6	276.3	268.6	
BC620_010-BC600_110	BC620_010	BC600_110	Pipe	18	0.0120	635	3.7	3.7	289.1	281.3	286.0	278.1	282.0	268.6	282.0	268.6	
BC620_020-BC620_010	BC620_020	BC620_010	Pipe	15	0.0120	195	3.7	3.7	289.9	282.1	289.1	281.6	283.1	282.0	283.1	282.0	
BC620_030-BC620_020	BC620_030	BC620_020	Pipe	12	0.0120	205	3.7	3.7	292.2	287.9	289.9	282.3	288.4	283.1	288.4	283.1	
SANDY RIVER																	
Outfall SR005																	
SR005_010-O_SR005	SR005_010	O_SR005	Pipe	60	0.0120	537	150.0	162.6	44.2	27.2	44.2	24.0	30.2	27.0	30.4	27.2	
SR005_020-SR005_010	SR005_020	SR005_010	Pipe	60	0.0120	336	149.9	162.6	44.7	29.3	44.2	27.4	32.4	30.2	32.6	30.4	
SR005_030-SR005_020	SR005_030	SR005_020	Pipe	54	0.0120	435	119.6	132.3	45.6	35.4	44.7	29.8	37.6	32.4	37.8	32.6	
SR005_040-SR005_030	SR005_040	SR005_030	Pipe	42	0.0120	96	119.6	132.3	55.0	41.9	45.6	36.4	43.6	37.6	43.7	37.8	
SR007_010-SR005_040	SR007_010	SR005_040	Pipe	48	0.0120	108	119.6	132.3	64.8	45.0	55.0	42.0	46.9	43.6	47.0	43.7	
SR010_010-SR007_010	SR010_010	SR007_010	Pipe	36	0.0120	135	116.2	128.2	81.4	65.8	64.8	45.4	67.1	46.9	67.2	47.0	
SR010_020-SR010_010	SR010_020	SR010_010	Pipe	54	0.0120	280	116.2	128.2	81.7	68.2	81.4	66.0	70.8	67.1	70.9	67.2	
SR010_090-SR010_020	SR010_090	SR010_020	Pipe	54	0.0120	320	116.3	128.3	85.1	70.8	81.7	68.2	73.3	70.8	73.5	70.9	
SR010_100-SR010_090	SR010_100	SR010_090	Pipe	24	0.0120	253	28.8	36.4	86.0	77.5	85.1	72.5	78.9	73.3	79.3	73.5	
SR010_110-SR010_100	SR010_110	SR010_100	Pipe	24	0.0120	260	28.8	36.5	100.8	94.0	86.0	77.5	95.7	78.9	95.6	79.3	FC_04
SR010_120-SR010_110	SR010_120	SR010_110	Pipe	24	0.0120	493	28.9	36.6	130.0	124.0	100.8	94.0	125.8	95.7	125.6	95.6	FC_04
SR010_130-SR010_120	SR010_130	SR010_120	Pipe	18	0.0120	500	14.9	17.1	149.8	144.3	130.0	124.5	146.8	125.8	145.5	125.6	FC_04
SR020_010-SR010_090	SR020_010	SR010_090	Pipe	48	0.0120	375	87.5	92.1	89.2	79.3	85.1	71.3	81.0	73.3	81.1	73.5	
SR020_020-SR020_010	SR020_020	SR020_010	Pipe	54	0.0120	385	87.5	92.1	97.8	82.9	89.2	79.6	85.0	81.0	85.0	81.1	
SR030_010-SR020_020	SR030_010	SR020_020	Pipe	54	0.0120	385	79.9	82.7	101.2	85.4	97.8	82.9	87.5	85.0	87.6	85.0	
SR030_020-SR030_010	SR030_020	SR030_010	Pipe	54	0.0120	385	79.9	82.8	100.4	87.9	101.2	85.4	90.0	87.5	90.1	87.6	
SR030_030-SR030_020	SR030_030	SR030_020	Pipe	48	0.0120	55	62.3	63.2	99.6	89.1	100.4	88.4	90.7	90.0	90.7	90.1	
SR030_050-SR030_030	SR030_050	SR030_030	Pipe	30	0.0120	354	62.3	63.2	135.2	124.0	99.6	90.5	125.2	90.7	125.2	90.7	
SR040_010-SR030_020	SR040_010	SR030_020	Pipe	42	0.0130	375	17.7	19.6	101.2	91.7	100.4	89.0	92.7	90.0	92.8	90.1	
SR050_010-SR040_010	SR050_010	SR040_010	Pipe	42	0.0130	375	11.7	11.7	103.6	94.3	101.2	91.9	95.2	92.7	95.2	92.8	
SR050_020-SR050_010	SR050_020	SR050_010	Pipe	42	0.0130	138	11.7	11.7	104.7	95.2	103.6	94.5	96.2	95.2	96.2	95.2	
SR050_030-SR050_020	SR050_030	SR050_020	Pipe	18	0.0130	65	5.0	5.0	103.2	96.4	104.7	94.4	97.0	96.2	97.0	96.2	
SR050_060-SR050_030	SR050_060	SR050_030	Pipe	18	0.0130	76	5.0	5.0	109.9	100.6	103.2	96.4	101.1	97.0	101.1	97.0	
SR050_070-SR050_060	SR050_070	SR050_060	Pipe	12	0.0130	120	5.0	5.0	124.2	113.8	109.9	100.8	114.3	101.1	114.3	101.1	
SR050_080-SR050_070	SR050_080	SR050_070	Pipe	12	0.0130	107	5.0	5.0	136.8	126.4	124.2	114.0	126.8	114.3	126.8	114.3	
SR050_090-SR050_080	SR050_090	SR050_080	Pipe	12	0.0130	61	5.0	5.0	143.4	134.6	136.8	126.6	135.1	126.8	135.1	126.8	
SR050_100-SR050_090	SR050_100	SR050_090	Pipe	12	0.0130	114	5.0	5.0	157.5	147.7	143.4	134.8	148.2	135.1	148.2	135.1	
SR050_120-SR050_100	SR050_120	SR050_100	Pipe	12	0.0130	93	5.0	5.0	166.2	157.3	157.5	156.2	158.9	148.2	158.9	148.2	
SR060_010-SR050_020	SR060_010	SR050_020	Pipe	42	0.0130	237	6.9	6.9	105.0	96.1	104.7	92.1	96.6	96.2	96.6	96.2	
SR070_010-SR060_010	SR070_010	SR060_010	Pipe	36	0.0130	375	2.5	2.5	106.3	96.8	105.0	95.0	97.3	96.6	97.3	96.6	

SR070_020-SR070_010	SR070_020	SR070_010	Pipe	36	0.0130	375	2.5	2.5	108.3	98.8	106.3	97.0	99.2	97.3	99.2	97.3	
SR070_030-SR070_020	SR070_030	SR070_020	Pipe	36	0.0130	375	2.5	2.5	110.9	101.0	108.3	99.0	101.5	99.2	101.5	99.2	
SR070_040-SR070_030	SR070_040	SR070_030	Pipe	36	0.0130	375	2.5	2.5	114.0	104.0	110.9	101.2	104.4	101.5	104.4	101.5	
SR070_050-SR070_040	SR070_050	SR070_040	Pipe	36	0.0130	375	2.6	2.6	117.6	107.0	114.0	104.0	107.4	104.4	107.4	104.4	
SR070_060-SR070_050	SR070_060	SR070_050	Pipe	36	0.0130	375	2.6	2.6	121.7	111.0	117.6	107.2	111.4	107.4	111.4	107.4	
SR070_070-SR070_060	SR070_070	SR070_060	Pipe	36	0.0130	375	2.6	2.6	125.6	114.9	121.7	111.2	115.3	111.4	115.3	111.4	
SR080_010-SR010_130	SR080_010	SR010_130	Pipe	18	0.0120	400	15.2	17.2	163.5	158.3	149.8	144.3	163.5	146.8	159.5	145.5	FC_04
SR090_010-SR030_050	SR090_010	SR030_050	Pipe	30	0.0120	362	55.0	55.9	170.8	148.8	135.2	124.0	150.0	125.2	150.0	125.2	
SR090_020-SR090_010	SR090_020	SR090_010	Pipe	30	0.0120	112	45.4	46.3	192.6	156.5	170.8	148.8	157.6	150.0	157.6	150.0	
SR100_010-SR090_020	SR100_010	SR090_020	Pipe	30	0.0120	215	45.4	46.3	208.6	166.2	192.6	156.5	167.4	157.6	167.5	157.6	
SR100_020-SR100_010	SR100_020	SR100_010	Pipe	27	0.0120	287	45.4	46.3	214.9	192.7	208.6	170.3	193.8	167.4	193.8	167.5	
SR100_030-SR100_020	SR100_030	SR100_020	Pipe	24	0.0130	375	8.4	8.4	239.2	230.7	214.9	205.7	231.2	193.8	231.2	193.8	
SR100_040-SR100_030	SR100_040	SR100_030	Pipe	18	0.0130	52	8.4	8.4	239.4	232.0	239.2	230.9	232.8	231.2	232.8	231.2	
SR100_100-SR100_020	SR100_100	SR100_020	Pipe	27	0.0100	105	25.0	26.0	222.1	210.6	214.9	192.9	211.2	193.8	211.2	193.8	
SR100_110-SR100_100	SR100_110	SR100_100	Pipe	27	0.0100	214	25.0	26.0	240.0	236.0	222.1	210.8	236.6	211.2	236.7	211.2	
SR100_120-SR100_110	SR100_120	SR100_110	Pipe	27	0.0100	124	25.0	26.0	245.4	242.0	240.0	236.0	242.9	236.6	242.9	236.7	
SR100_130-SR100_120	SR100_130	SR100_120	Pipe	27	0.0100	86	25.0	25.9	251.3	244.0	245.4	242.0	245.0	242.9	245.1	242.9	
SR100_150-SR100_130	SR100_150	SR100_130	Pipe	27	0.0100	140	25.0	25.9	261.4	257.0	251.3	244.0	257.7	245.0	257.7	245.1	
SR100_160-SR100_150	SR100_160	SR100_150	Pipe	27	0.0100	116	25.0	25.9	268.6	258.4	261.4	257.0	259.7	257.7	259.7	257.7	
SR110_010-SR100_040	SR110_010	SR100_040	Pipe	18	0.0130	81.12	8.4	8.4	247.1	233.0	239.4	232.2	234.1	232.8	234.1	232.8	
SR110_030-SR110_010	SR110_030	SR110_010	Pipe	18	0.0130	175	8.4	8.4	247.8	234.2	247.1	233.2	235.5	234.1	235.5	234.1	
SR110_040-SR110_030	SR110_040	SR110_030	Pipe	18	0.0130	53.99	7.1	7.1	253.7	234.8	247.8	234.4	235.8	235.5	235.8	235.5	
SR110_070-SR110_040	SR110_070	SR110_040	Pipe	18	0.0130	133.1	7.1	7.1	253.0	239.7	253.7	234.4	240.3	235.8	240.3	235.8	
SR120_010-SR110_070	SR120_010	SR110_070	Pipe	18	0.0130	245	5.1	5.1	247.1	240.4	253.0	240.0	241.7	240.3	241.7	240.3	
SR120_020-SR120_010	SR120_020	SR120_010	Pipe	18	0.0130	160	5.2	5.2	245.7	240.6	247.1	240.5	242.0	241.7	242.0	241.7	
SR120_050-SR120_020	SR120_050	SR120_020	Pipe	18	0.0130	132	5.2	5.2	247.9	241.1	245.7	240.7	242.3	242.0	242.3	242.0	
SR120_060-SR120_050	SR120_060	SR120_050	Pipe	12	0.0130	142	5.2	5.2	255.4	243.6	247.9	241.2	245.3	242.3	245.3	242.3	
SR120_070-SR120_060	SR120_070	SR120_060	Pipe	12	0.0130	125	5.3	5.3	263.9	254.9	255.4	243.7	255.4	245.3	255.4	245.3	
SR120_100-SR120_070	SR120_100	SR120_070	Pipe	12	0.0130	272	5.2	5.2	269.2	263.2	263.9	254.9	264.0	255.4	264.0	255.4	
SR130_010-SR110_070	SR130_010	SR110_070	Pipe	18	0.0130	108	2.0	2.0	257.8	250.9	253.0	240.0	251.1	240.3	251.1	240.3	
SR130_020-SR130_010	SR130_020	SR130_010	Pipe	18	0.0130	151	2.0	2.0	264.6	257.7	257.8	253.2	258.0	251.1	258.0	251.1	
SR130_030-SR130_020	SR130_030	SR130_020	Pipe	18	0.0130	30	2.0	2.0	265.4	258.1	264.6	257.9	258.6	258.0	258.6	258.0	
SR140_010-SR100_160	SR140_010	SR100_160	Pipe	27	0.0120	96	25.0	25.9	278.6	265.8	268.6	261.0	266.6	259.7	266.7	259.7	
SR140_020-SR140_010	SR140_020	SR140_010	Pipe	27	0.0120	291	20.5	21.4	294.8	281.1	278.6	269.6	281.9	266.6	282.0	266.7	
SR140_100-SR140_010	SR140_100	SR140_010	Pipe	12	0.0100	359	4.4	4.5	277.1	270.1	278.6	266.0	270.8	266.6	270.8	266.7	
SR140_110-SR140_100	SR140_110	SR140_100	Pipe	12	0.0100	155	4.5	4.6	279.4	271.8	277.1	270.3	272.6	270.8	272.6	270.8	
SR140_120-SR140_110	SR140_120	SR140_110	Pipe	12	0.0100	117	4.5	4.6	286.4	275.3	279.4	272.0	275.9	272.6	275.9	272.6	
SR150_010-SR140_020	SR150_010	SR140_020	Pipe	27	0.0120	273	20.5	21.4	301.1	290.5	294.8	280.4	291.3	281.9	291.3	282.0	
SR150_030-SR150_010	SR150_030	SR150_010	Pipe	12	0.0120	101	2.0	2.0	301.8	293.7	301.1	292.8	294.3	291.3	294.3	291.3	
SR150_040-SR150_030	SR150_040	SR150_030	Pipe	12	0.0120	152	2.0	2.0	304.5	295.3	301.8	293.7	295.8	294.3	295.8	294.3	
SR150_050-SR150_040	SR150_050	SR150_040	Pipe	12	0.0120	180	2.0	2.0	309.9	300.7	304.5	295.3	301.0	295.8	301.0	295.8	
SR160_010-SR150_010	SR160_010	SR150_010	Pipe	30	0.0120	358	18.7	19.5	306.5	295.0	301.1	290.8	296.1	291.3	296.1	291.3	
SR170_010-SR200_010	SR170_010	SR200_010	Pipe	30	0.0120	295	5.8	5.8	315.9	302.0	312.5	300.0	302.7	300.4	302.7	300.4	
SR170_020-SR170_010	SR170_020	SR170_010	Pipe	24	0.0120	470	5.8	5.8	318.7	308.0	315.9	302.5	308.6	302.7	308.6	302.7	
SR170_030-SR170_020	SR170_030	SR170_020	Pipe	24	0.0120	180	5.8	5.8	321.0	309.3	318.7	308.0	310.0	308.6	310.0	308.6	
SR170_040-SR170_030	SR170_040	SR170_030	Pipe	24	0.0120	280	5.8	5.8	322.9	311.2	321.0	309.3	311.9	310.0	311.9	310.0	
SR170_050-SR170_040	SR170_050	SR170_040	Pipe	18	0.0120	170	5.8	5.8	325.6	314.9	322.9	311.7	315.5	311.9	315.5	311.9	
SR170_060-SR170_050	SR170_060	SR170_050	Pipe	18	0.0120	230	3.8	3.8	333.1	319.2	325.6	314.9	319.7	315.5	319.7	315.5	
SR170_070-SR170_060	SR170_070	SR170_060	Pipe	24	0.0120	180	3.8	3.8	335.6	309.3	333.1	308.0	319.7	319.7	319.7	319.7	
SR170_080-SR170_070	SR170_080	SR170_070	Pipe	18	0.0120	183	3.8	3.8	336.6	325.0	335.6	323.8	325.7	319.7	325.7	319.7	
SR170_110-SR170_080	SR170_110	SR170_080	Pipe	18	0.0120	419	2.2	2.2	333.7	326.0	336.6	322.8	326.5	325.7	326.5	325.7	

SR180_020-SR170_050	SR180_020	SR170_050	Pipe	12	0.0130	181	2.2	2.2	327.0	320.2	325.6	314.9	320.6	315.5	320.6	315.5	
SR180_030-SR180_020	SR180_030	SR180_020	Pipe	12	0.0130	250	2.2	2.2	328.5	321.1	327.0	320.3	322.1	320.6	322.1	320.6	
SR180_040-SR180_030	SR180_040	SR180_030	Pipe	12	0.0130	144	2.2	2.2	328.0	321.6	328.5	321.2	322.5	322.1	322.5	322.1	
SR190_010-SR170_080	SR190_010	SR170_080	Pipe	12	0.0120	300	1.6	1.6	340.2	329.2	336.6	327.4	329.7	325.7	329.7	325.7	
SR190_020-SR190_010	SR190_020	SR190_010	Pipe	12	0.0120	300	1.6	1.6	344.4	331.0	340.2	329.2	331.5	329.7	331.5	329.7	
SR190_030-SR190_020	SR190_030	SR190_020	Pipe	12	0.0120	82	1.7	1.7	340.2	331.5	344.4	331.0	332.0	331.5	332.0	331.5	
SR190_050-SR190_030	SR190_050	SR190_030	Pipe	12	0.0120	116	1.7	1.7	340.4	333.5	340.2	331.5	333.9	332.0	333.9	332.0	

Appendix E: South Troutdale Road Storm Drainage Plan

City of Troutdale

South Troutdale Road
Storm Drainage Plan

January 2009

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City of Troutdale
SOUTH TROUTDALE ROAD STORM DRAINAGE PLAN

January 2009

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Project #135-29887-08-146

City of Troutdale
South Troutdale Road Storm Drainage Plan

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CHAPTER 1.
INTRODUCTION

The City of Troutdale's *South Troutdale Drainage Master Plan* (KCM, 1996) evaluated storm drainage issues and solutions for the portion of the South Troutdale Road area that was within the city limits at that time. A significant area in the South Troutdale Road vicinity has since been annexed into the City and is anticipated to be developed in the near future. This storm drainage plan has been prepared to provide updated analysis of drainage issues in the area. The City desires a conceptual plan for the orderly provision of storm drainage and flood prevention within the study area, which is in the southeast portion of the City, generally between South Troutdale Road and Beaver Creek (see Figure 1-1).

AUTHORIZATION AND PROJECT SCOPE

The City of Troutdale contracted with Tetra Tech, Inc. in July 2008 to develop this *South Troutdale Road Storm Drainage Plan* to provide a conceptual plan for the orderly provision of storm drainage and flood prevention within the study area.

Development of the plan included delineation of drainage basins and identification of the most feasible locations for discharge to Beaver Creek. Water quality treatment alternatives were identified, along with associated costs. Design criteria were developed and defined. Based on the design criteria, along with parcel ownership and existing drainage patterns, development to current zoning was assumed and a feasible drainage network for development was developed. A hydrologic model was developed to estimate pre-development, existing and future conditions for the design event. The XP-SWMM modeling software was used for the analysis of drainage improvement alternatives. The model provided a basis for estimating stormwater volumes to be retained, conveyed and discharged to Beaver Creek for the design storm event.

The project scope included the following:

- Review existing information, including regulatory requirements, city standards and available mapping.
- Develop a study area base map.
- Perform field reconnaissance to refine base mapping and overall character of the study area.
- Identify most feasible locations for discharge to Beaver Creek.
- Identify water quality treatment alternatives and possible locations.
- Develop design criteria and prepare conceptual design of the drainage network.
- Develop a system model for the concept drainage network and model it for the 25-year, 24-hour storm event.
- Develop a final system map for the developed scenario to provide a summary of the criteria and development of the network alternative, along with estimated costs for the drainage system.

CHAPTER 2.
STUDY AREA DESCRIPTION

LOCATION AND BOUNDARIES

The City of Troutdale is in Multnomah County approximately 10 miles east of Portland along Interstate-84. The study area encompasses five parcels totaling approximately 100 acres. It generally includes the area bounded by Beaver Creek on the west, SE Stark Street on the north, South Troutdale Road on the east, and SE Strebin Road on the south.

TOPOGRAPHY

Topography in the study area is relatively flat in the upland areas and steep along Beaver Creek. North of Cochrane Road, elevations vary from 200 to 300 feet; the undeveloped area along Beaver Creek consists of 20- to 25-percent slopes and the area along South Troutdale Road is relatively flat. South of Cochrane Road, slopes are 30 percent or more along Beaver Creek, becoming reduced to relatively flat terrain near Troutdale Road; elevations in this area range from about 250 to 310 feet.

SOILS

The *Soil Survey of Multnomah County* identifies four soil types within the study area. Along Beaver Creek, soils consist of Wapato Silt Loam. Soils on the steep slopes forming a canyon along Beaver Creek consist of Haplumbrepts. In the upland area, soils consist of Quatama loam and Aloha Silt Loam. The Soil Survey classifies Quatama Loam as somewhat poorly draining soil and Aloha Silt Loam as moderately well drained soil. Soils in the study area are generally Group C for the upland area and Group D along Beaver Creek, defined as follows:

- Group C—Soils with a slow infiltration rate when thoroughly wet. These consist chiefly of soils with a layer that impedes the downward movement of water, or soils of moderately fine or fine texture. These soils have a slow rate of water transmission.
- Group D—Soils with a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan 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.

LAND USE

Zoning in the study area is shown in Figure 2-1. The study area is primarily zoned Industrial Park (IP) and Residential (UPAR-10), with the western portion, nearest Beaver Creek, zoned Open Space (OS):

- The Industrial Park zoning is intended for a mix of clean, employee-intensive industries, offices, services, and retail commercial uses, which have no off-site impacts in terms of noise, odor, glare, light, vibration, smoke or dust. It provides for combining parking, landscaping, and other design features that physically and visually link structures and uses within one development.
- The UPAR-10 district represents single-family residential zoning in the City’s Urban Planning Area, which represents property not yet annexed to the City of Troutdale. The zoning is intended primarily for single-family detached dwellings in a low-density residential

neighborhood environment, with a minimum lot size of 10,000 square feet. The parcel zoned UPAR-10 immediately south of Cochrane Road was not included in the area recently annexed by the City of Troutdale, but it is expected to be annexed in the near future and has been included in the study area. The southernmost properties in the study area were recently annexed into the City, but the zoning map has not yet been updated.

- The Open Space zoning is intended to provide and preserve open space areas.

RAINFALL

Troutdale receives approximately 40 inches of rainfall annually, most of it between October and March. Summer months generally have warm days with little rainfall. Table 2-1 shows rainfall amounts from current NOAA Atlas II maps.

TABLE 2-1. RAINFALL DEPTH

Return Frequency	Rainfall Depth (inches) 24-Hour
2-Year	2.8
5-Year	3.4
10-Year	3.7
25-Year	4.2
50-Year	4.7
100-Year	5.0

NATURAL RESOURCES

Very little development currently exists along Beaver Creek in the study area. A large portion of the study area along Beaver Creek is included in Metro's Mount Hood Community College Greenway. The study area also includes the stretch of Beaver Creek identified as Reach 5 in the *Beaver Creek Natural Resource Inventory* (Martin Schott, July 1994). The inventory identifies vegetation species, assesses wildlife habitat, and identifies enhancement opportunities along Beaver Creek. Tree species identified along the reach include cottonwood, willow, Douglas fir, red alder, Oregon ash, big leaf maple, and red cedar. A wide variety of shrub and herbaceous species are present along the reach, including skunk cabbage, lady fern, false hellebore, pig-a-back, stinging nettles, Indian plum, Oregon grape, holly and salmonberry. The reach was given a high wildlife habitat assessment score due to its habitat diversity.

The study area includes two designated wetlands, one just south of Stark Street along Beaver Creek and a second approximately 430 feet south of Cochrane Road.

CHAPTER 3.
DESIGN CRITERIA

Under Section 5.8 of the City of Troutdale Development Code, the City has adopted the City of Portland's *Stormwater Management Manual* requirements and design standards for water quality facilities. Flow control is governed by the City's *Construction Standards for Public Works Facilities*. The following provides a summary of the applicable flow control and water quality facility criteria.

FLOW CONTROL

For discharges to surface water, flow control is required to avoid discharging flows that will cause channel erosion. Channel eroding flow is defined as one-half of the 2-year, 24-hour pre-development peak flow, unless more specific data is available. Facilities are also required to control peak flows to the pre-development 5-, 10-, and 25-year, 24-hour levels.

DESIGN FLOWS

Design flows were estimated using the XP-SWMM software, which uses rainfall information and percent-impervious information, along with subcatchment-specific parameters, to determine the hydrology and hydraulics of a modeled drainage area. Each catchment is subdivided into subcatchments that are hydrologically similar. The model requires the following parameters for each subcatchment to define the flow:

- Subcatchment area
- Percent impervious
- Pervious curve number (a rating of soil permeability)
- Time of concentration.

The study area is sufficiently small that the design rainfall is the same for the whole study area. The study area was divided into areas with similar infiltration characteristics. Infiltration for each subcatchment was calculated based on the following characteristics:

- Depression storage for impervious and pervious areas
- Roughness coefficients for impervious and pervious areas
- Infiltration rate information (maximum, minimum and decay rate).

A completed model simulates a series of manholes with connecting pipes. Hydrographs (estimates of expected flow for the duration of a storm) are developed for each manhole and the program checks the flow in each pipe, as well as the combined flow through the entire system.

The model was run for three conditions: pre-development (the study area in its natural state with no human development); existing (the study area with its current level of development); and future (the study area fully developed as allowed by the zoned land use and current City development standards). Results are summarized in Table 3-1; details are provided in Appendix A.

TABLE 3-1.
STORM DRAINAGE DESIGN FLOWS

					Drainage Area 4			
	Drainage Area 2	Drainage Area 1a	Drainage Area 1b	Drainage Area 3	North Parcel	Center Parcel	South Parcel	Drainage Area 5
Area (acres)	15.6	22.8	1.7	5.4	2.7	4.4	2.8	0.9
Pre-Development Conditions								
Curve number	74	74	74	74	74	74	74	74
2-year flow (cfs)	0.7	0.77	0.06	0.25	0.12	0.2	0.13	0.11
25-year flow (cfs)	1.66	1.62	0.12	0.6	0.26	0.48	0.13	0.32
Existing Conditions								
Curve number	74	74	88	89	88	89	90	88
2-year flow (cfs)	0.7	0.77	0.11	0.69	0.27	0.55	0.42	0.34
25-year flow (cfs)	1.66	1.62	0.19	1.29	0.51	1.02	0.77	0.63
Future Conditions								
Curve number	91	91	98	90	90	90	90	98
2-year flow (cfs)	2.14	1.68	0.17	0.74	0.31	0.58	0.42	0.55
25-year flow (cfs)	3.82	2.85	0.27	1.34	0.56	1.06	0.77	0.84

WATER QUALITY FACILITY CRITERIA

Onsite Infiltration

The *Stormwater Management Manual* requires that stormwater from a site be infiltrated onsite to the maximum extent feasible prior to discharging any flow offsite. This criterion should be applied to development within the study area to minimize offsite runoff. Water quality facilities that provide infiltration include planters, infiltration basins, filter strips, grassy swales, soakage trenches and drywells. Facility design criteria for specific water quality facilities are presented in the *Stormwater Management Manual*. As part of the development of a site drainage design, soil infiltration testing is required to determined the infiltration capacity.

Impervious Area Reduction

Additionally, incorporating impervious area reduction techniques such as eco-roofs, pervious pavement and street trees into the site design to reduce the overall area that requires stormwater management is encouraged. Design criteria for such techniques are presented in the *Stormwater Management Manual*.

Integrating stormwater facilities should be considered for future development.

Underground Injection Control

Any infiltration system is subject to the Oregon Department of Environmental Quality's (DEQ) Underground Injection Control (UIC) Structure requirements. According the DEQ's *Underground Injection Control Storm Water Information* fact sheet, a UIC is defined as "an assemblage of perforated pipes, drain tiles, or other similar mechanisms intended to distribute fluids below the ground surface." The fact sheet clarifies that "A gravel 'storage area' underlying a bioswale or contained within a water quality pretreatment system (i.e., surface infiltration soil media) is not a subsurface infiltration distribution system when its intended purpose is to temporarily store storm water for infiltration into the subsurface natural soils when storm event precipitation exceeds the infiltration rate of the natural soils. If used alone to discharge storm water, a gravel storage area is a UIC."

More specific information regarding UIC can be found in the City of Portland's *Stormwater Management Manual* and through the DEQ website at http://www.deq.state.or.us/wq/uic/uic.htm.

SOUTH TROUTDALE ROAD IMPROVEMENT REQUIREMENTS

With future development, South Troutdale Road would be widened to meet Multnomah County standards. The current road right of way within the study area is 60 feet. Upgrades to South Troutdale Road north of Sweetbriar Lane would require construction of a 44-foot-wide road (curb to curb) with a 5-foot sidewalk on the west side of the road. South of Sweetbriar Lane, the County will require that the road conform to the current standard of a 50-foot roadway and 6-foot sidewalks on both sides, which would require an additional 2 feet of right of way. For this study, it is assumed that development will only occur on the west side of South Troutdale Road.

PROPOSED PARK AT TROUTDALE ROAD AND STARK STREET

The City of Troutdale's Parks Department is in the process of planning for improvements to the open space area at the southwest corner of South Troutdale Road and Stark Street. With these improvements, Multnomah County has indicated that additional right of way will be required for a parking facility and a bioswale for stormwater treatment from the parking lot and road. According to Greg Kirby of Multnomah County, the swale would likely have a 2-foot bottom width, 2:1 side slopes, and a depth of 12 inches; a gravel storage area would be installed below the swale for additional storage prior to stormwater infiltrating into the native soil. The parking lot would add 30 feet and the swale would add 6 feet to the existing 60-foot right of way.

REGULATORY STANDARDS

Stormwater Management

Stormwater management in the City of Troutdale is regulated under Troutdale Development Code 5.800 and the City's *Construction Standards for Public Works Facilities*. The code references several documents relating to stormwater facilities, including the City of Portland *Stormwater Management Manual*, the South Troutdale Drainage Master Plan, the City of Troutdale *Construction Standards for Public Works Facilities*, the Metro Title 3 Water Quality and Flood Management Area Map, the Federal Emergency Management Agency's Flood Insurance Rate Map, and the National Wetlands Inventory Map.

Current code would require any development in the study area to include water quality treatment or stormwater detention, since the sites all drain to Beaver Creek, a protected water feature. Recommendations presented in this drainage plan are intended to take precedence over current code requirements once the plan is adopted.

For the northern portion of the current study area, the 1996 South Troutdale Drainage Master Plan recommended direct drainage to Beaver Creek, strict water quality best management practices (BMPs) and vegetation buffers along the creek. The plan also recommended that stormwater facilities be designed for infiltration and pollutant removal. It recommended construction of the Stark Street Floodplain Creation Project upstream of the Beaver Creek culvert under Stark Street. The project was to create floodplain to temporarily detain peak storm flows. A review of this proposed project in March 2007 concluded that the project as presented in the Master Plan would not likely be permittable and that it would not cost-effectively reduce stormwater flow to pre-development levels. As a result of the review, the project was removed from the City's capital improvement plan.

TMDL Implementation

The federal Clean Water Act requires that a total maximum daily load (TMDL) for pollutants be established when a water body does not meet water quality standards. The Oregon Department of Environmental Quality issued a TMDL in March 2005 setting limits on temperature and bacteria in the Sandy River Basin. The City of Troutdale is within the Sandy River Basin and is identified as a "designated management agency" (DMA) in the Sandy River TMDL program.

As a DMA, the City was required to develop a TMDL Implementation Plan describing management strategies the City has for protecting water quality in the basin, specifically relating to the TMDL. Strategies that affect development in the study area include requiring water quality and quantity controls on new development projects that create new impervious area, and establishing a vegetation buffer along Beaver Creek.

Natural Resource Protection

The Troutdale City Code addresses natural resource protection in sections titled "Vegetation Corridor and Slope District" and "Flood Management Area." Since the study area includes Beaver Creek, natural resource protection limits allowable development within the study area. The following codes apply to the study area:

- Steep Slopes—City Code 4.3 (Vegetation Corridor and Slope District) restricts development on slopes of 25 percent or more throughout the City that have a minimum horizontal distance of 50 feet.
- 100-Year Floodplain and Wetlands—City Code 4.6 (Flood Management Area) prohibits development within the floodway and wetlands. The City code provides limitations on development within the 100-year floodplain; additionally, the water quality resource and flood management area functions must be protected.
- Vegetation Corridor—City Code 4.3 (Vegetation Corridor and Slope District) restricts development within a defined vegetation corridor. Within this study area, the corridor is 50 feet from the top of the ravine (where the slopes are less than 25 percent).

CHAPTER 4.
STUDY AREA DRAINAGE

BASE MAP

Figure 4-1 is the base map for the study area. It shows the location of wetlands, steep slopes, the 100-year floodplain and the vegetation corridor within the study area.

EXISTING DRAINAGE

The existing drainage in the study area can be divided into six local drainage areas, as shown in Figure 4-1, with all drainage flowing toward Beaver Creek. Street drainage is directed as follows:

- Road drainage from South Troutdale Road is directed to the street shoulder for infiltration. No curbs exist along this portion of South Troutdale Road, except on the east side between SE Stark Street and SE Sweetbriar Lane.
- North of Cochrane Road, Troutdale Road drainage that does not infiltrate flows to the drainage system in SE Stark Street.
- South of Cochrane Road, Troutdale Road drainage flows to the existing wetland about 300 feet south of Cochrane Road.
- Street drainage from Cochrane Road flows directly to Beaver Creek.

FUTURE DRAINAGE

Although current zoning for the area gives an indication of likely future development, no specific development has been proposed for this area, with the exception of a preliminary proposal for residential development in a joint development plan for two abutting properties zoned UPAR-10 south of Cochrane Road. No specific application for subdivision has been submitted, but the annexation application included a conceptual layout for the subdivision. Because only a conceptual plan is available, the alternatives developed for this area are general in nature.

Developable land in the study area is all of the area zoned IP or UPAR-10, excluding existing road rights-of-way, defined vegetation corridors, and stream and wetland buffers. It is assumed that the area north of Cochrane Road zoned Industrial Park will be developed as one project through Mount Hood Community College. For the parcels south of Cochrane Road, it is assumed that the two parcels recently annexed will be developed jointly, with the third parcel developed independently. It is further assumed that street improvements along South Troutdale Road will occur at the time of development. The future development will change the drainage in the area, as shown in Figure 4-2 and described in the following sections.

Drainage North of Cochrane Road

Outfalls and Drainage Areas

Future drainage from South Troutdale Road between SE Stark Street and SE 34th Circle will discharge to the swale included in plans for the proposed park at the southwest corner of Troutdale Road and Stark Street; the swale will discharge treated flow to the wetland in the north portion of the study area. The remainder of the future drainage north of Cochrane Road will flow to two outfalls (see Figure 4-2):

- Outfall 1—The east portion of the IP-zoned property (Drainage Area 1a) and the north portion of South Troutdale Road (Drainage Area 1b) will discharge stormwater drainage to the wetland in the north portion of the study area (Outfall 1). Stormwater from Drainage Area 1a could be treated onsite by the property owner or in a regional facility sized to accommodate drainage from both the development and South Troutdale Road.
- Outfall 2— In order to maintain drainage similar to that under the current conditions, the west portion of the IP-zoned property (Drainage Area 2) should continue to drain directly to Beaver Creek (Outfall 2). As the area is zoned Industrial Park, it is assumed that all roads will be privately maintained; therefore, the property owner would be responsible for maintaining the outfall. Stormwater from Drainage Area 2 would be treated onsite by the property owner.

Treatment of Street Drainage

North of SE 34th Circle, water quality treatment of Troutdale Road runoff will be provided by the treatment facility that will be included in the proposed park at the southwest corner of Troutdale Road and Stark Street. Treatment of Troutdale Road stormwater runoff from south of SE 34th Circle could be done with either swales or a regional treatment facility:

- Swales—A continuous swale could be installed with a single discharge point at the downstream end and culverts under the access driveways for the Industrial Park; or a series of swales could be installed that discharge at multiple locations to a piped system in South Troutdale Road. Swales should be designed to be consistent with those installed as part of the park improvements. To achieve the County’s currently required standard road cross section, an additional 6-foot easement would be required for the swale.
- Regional Treatment Facility—If a regional facility were used, a traditional curb-and-gutter piped drainage system would be constructed along South Troutdale Road with catch basins and storm pipes to convey stormwater to the facility. The treatment facility could be sized either for the road runoff only or for drainage from the road and the development (Drainage Area 1a). A water quality pond would be appropriate for providing water quality treatment for both areas, and an infiltration basin could be used for treatment of drainage from the road alone.

Drainage South of Cochrane Road

Outfalls and Drainage Areas

The natural drainage outfall for the portion of the study area south of Cochrane Road is the wetland located approximately 300 feet south of Cochrane Road. As development occurs in this area, it is recommended that individual water quality facilities treat runoff from each development. Future drainage south of Cochrane Road will flow to this wetland at three outfall locations (see Figure 4-2):

- Outfall 3—The parcel between Cochrane Road and the wetland (Drainage Area 3) will discharge treated stormwater flow to the north side of the wetland, at its downstream end (Outfall 3).
- Outfall 4—The three study area parcels south of the wetland (Drainage Area 4) will discharge treated stormwater flow to the south side of the wetland, at its downstream end (Outfall 4).
- Outfall 5—The south portion of Troutdale Road (Drainage Area 5) will discharge treated stormwater flow to the wetland at a point immediately downstream of the road (Outfall 5).

Treatment of Street Drainage

South of Cochrane Road, treatment of stormwater runoff from Troutdale Road could be done with either swales or a regional treatment facility located near the existing wetland:

- Swales—If swales are used, a continuous swale would be installed with culverts under access driveways to the residential properties and an overflow at the downstream end of the swale. The swale should be designed to be consistent with those installed as part of the improvements at the southwest corner of Stark and Troutdale Road. To achieve the County's currently required standard road cross section, an additional 6 feet easement would be required for the swale.
- Regional Treatment Facility—If a regional facility were used, a traditional curb-and-gutter piped drainage system would be constructed along South Troutdale Road with catch basins and storm pipes to convey stormwater to the facility, which would be sized for the road runoff only. A regional facility would likely require an easement or the purchase of land. An infiltration basin would be appropriate for providing water quality treatment for the road runoff from South Troutdale Road.

CHAPTER 5.
DRAINAGE IMPROVEMENT ALTERNATIVES

DRAINAGE NORTH OF COCHRANE ROAD

The following sections describe alternatives that have been identified for stormwater treatment and conveyance for the drainage areas north of Cochrane Road.

Alternative 1

Under Alternative 1, on-site treatment would be provided for all runoff from Drainage Area 1a. A continuous swale would be used to treat runoff from South Troutdale Road. Drainage Area 2 runoff would be treated on site and discharged to Outfall 2. Key elements of Alternative 1 are shown in Figure 5-1 and described below.

Drainage Area 1a

Runoff from development in Drainage Area 1a would be treated by on-site stormwater water quality facilities discharging to Outfall 1.

Drainage Area 1b (South Troutdale Road)

Runoff from South Troutdale Road north of SE 34th Circle would be treated in the stormwater swale in the proposed new park at the southwest corner of Troutdale Road and Stark Street.

Runoff from South Troutdale Road south of SE 34th Circle would be treated in a continuous stormwater swale along the western side of the road discharging to Outfall 1. Culverts would be installed under the access driveways for the Industrial Park.

Drainage Area 2

Runoff from Drainage Area 2 would be treated on site with a private discharge to Beaver Creek at Outfall 2

Alternative 2

Under Alternative 2, on-site treatment would be provided for all runoff from Drainage Area 1a. A series of swales would be used to treat runoff from South Troutdale Road. Drainage Area 2 runoff would be treated on site and discharged to Outfall 2. Key elements of Alternative 2 are shown in Figure 5-2 and described below.

Drainage Area 1a

Runoff from development in Drainage Area 1a would be discharged using one of the following options:

- Option 1—Flow from the entire drainage area would be treated on-site at the north end of the drainage area and discharged to Outfall 1.
- Option 2—Flow from the northern portion of the drainage area would be treated on-site at the north end of the drainage area and discharged to Outfall 1; and flow from the remaining portion of the drainage area would be treated on-site and discharged to the new pipe system in Troutdale Road.

Drainage Area 1b (South Troutdale Road)

Runoff from South Troutdale Road north of SE 34th Circle would be treated in the stormwater swale in the proposed new park at the southwest corner of Troutdale Road and Stark Street.

Runoff from South Troutdale Road south of SE 34th Circle would be treated in a series of stormwater swales along the western side of South Troutdale Road. Each swale would discharge to a pipe system in South Troutdale Road, which in turn would discharge to Outfall 1. Sizing of the pipe would depend on whether it is designed to convey flow from Drainage Area 1a as well as roadway runoff:

- A 12-inch pipe would be adequate for expected flows in this system if only the roadway drainage is conveyed.
- If flow from Drainage Area 1a is discharged to the piped system, then the 12-inch pipe would be adequate south of SE Sweetbriar Lane, but a larger pipe would be needed north of SE Sweetbriar Lane:
  - a 15-inch pipe if the contributing private property is required to provide detention (recommended)
  - a 24-inch pipe if the contributing private property is not required to provide detention.

Drainage Area 2

Runoff from Drainage Area 2 would be treated on site with a private discharge to Beaver Creek at Outfall 2

Alternative 3

Under Alternative 3, on-site treatment would be provided for some or all of the runoff from Drainage Area 1a. A regional water quality facility would be used to treat runoff from South Troutdale Road, and optionally part of the runoff from Drainage Area 1a. Drainage Area 2 runoff would be treated on site and discharged to Outfall 2. Key elements of Alternative 3 are shown in Figure 5-3 and described below.

Drainage Area 1a

Runoff from development in Drainage Area 1a would be discharged using one of the following options:

- Option 1—Flow from the entire drainage area would be treated on-site at the north end of the drainage area and discharged to Outfall 1.
- Option 2—Flow from the northern portion of the drainage area would be treated on-site at the north end of the drainage area and discharged to Outfall 1; and flow from the remaining portion of the drainage area would be discharged without treatment to the new pipe system in Troutdale Road (treatment would be provided by a regional water quality facility downstream).

Drainage Area 1b (South Troutdale Road)

Runoff from South Troutdale Road north of SE 34th Circle would be treated in the stormwater swale in the proposed new park at the southwest corner of Troutdale Road and Stark Street.

Runoff from South Troutdale Road south of SE 34th Circle would be collected in a traditional curb-and-gutter piped drainage system along South Troutdale Road, with catch basins and storm pipes to convey stormwater to a regional treatment facility, which would discharge to Outfall 1. Sizing of the regional water quality facility would depend on whether it is designed to treat only roadway runoff or would also treat a portion of runoff from Drainage Area 1a. A water quality pond would be adequate for providing water quality treatment for both areas, and an infiltration basin could be used for treatment of drainage from the road alone. These options would also affect the sizing of the conveyance pipe, as follows:

- A 12-inch pipe would be adequate for expected flows in this system if only the roadway drainage is conveyed.
- If flow from Drainage Area 1a is discharged to the piped system, then the 12-inch pipe would be adequate south of SE Sweetbriar Lane, but a larger pipe would be needed north of SE Sweetbriar Lane:
  - a 15-inch pipe if the contributing private property is required to provide detention (recommended)
  - a 24-inch pipe if the contributing private property is not required to provide detention.

Drainage Area 2

Stormwater from Drainage Area 2 would be treated on site with a private discharge to Beaver Creek at Outfall 2

Alternative 4

Under Alternative 4, a regional water quality facility would be used to treat all runoff from Drainage Area 1a and South Troutdale Road. Drainage Area 2 runoff would be treated on site and discharged to Outfall 2. Key elements of Alternative 4 are shown in Figure 5-4 and described below.

Drainage Area 1a

Runoff from development in Drainage Area 1a would be discharged without on-site treatment using one of the following options:

- Option 1—Flow from the entire drainage area would be discharged at the north end of the drainage area to the new regional water quality facility.
- Option 2—Flow from the northern portion of the drainage area would be discharged at the north end of the drainage area to the new regional water quality facility; and flow from the remaining portion of the drainage area would be discharged to the new pipe system in Troutdale Road.

Drainage Area 1b (South Troutdale Road)

Runoff from South Troutdale Road north of SE 34th Circle would be treated in the stormwater swale in the proposed new park at the southwest corner of Troutdale Road and Stark Street.

Road runoff from South Troutdale Road south of SE 34th Circle would be collected in a traditional curb-and-gutter piped drainage system along South Troutdale Road, with catch basins and storm pipes to convey stormwater to the regional treatment facility shared with Drainage Area 1a. The piped system would discharge to the regional treatment facility, which in turn would discharge to Outfall 1. Sizing of the pipe would depend on whether it is designed to convey flow from Drainage Area 1a as well as roadway runoff:

- A 12-inch pipe would be adequate for expected flows in this system if only the roadway drainage is conveyed.

- If flow from Drainage Area 1a is discharged to the piped system, then the 12-inch pipe would be adequate south of SE Sweetbriar Lane, but a larger pipe would be needed north of SE Sweetbriar Lane:
  - a 15-inch pipe if the contributing private property is required to provide detention (recommended)
  - a 24-inch pipe if the contributing private property is not required to provide detention.

Drainage Area 2

Stormwater from Drainage Area 2 would be treated on site with a private discharge to Beaver Creek at Outfall 2

DRAINAGE SOUTH OF COCHRANE ROAD

The following options have been identified for stormwater treatment and conveyance for the area south of Cochrane Road.

Alternative 5

Alternative 5 is shown on Figure 5-5 and includes the following elements:

- Runoff from development in Drainage Areas 3, and 4 would be treated with onsite stormwater water quality facilities. Drainage Area 3 would have a final outfall on the north side of the wetland (Outfall 3). Drainage from Drainage Area 4 would be directed to a pipe system on the west side of the development with a final outfall location on the south side of the wetland (Outfall 4)
- Road Runoff from South Troutdale Road (Drainage Area 5) would be treated in a series of stormwater swales along the western side of South Troutdale Road, with final discharge to the wetland at Outfall 5.

Alternative 6

Alternative 6 is shown on Figure 5-6 and includes the following elements:

- Runoff from development in Drainage Areas 3, and 4 would be treated with onsite stormwater water quality facilities. Drainage Area 3 would have a final outfall on the north side of the wetland (Outfall 3). Drainage from Drainage Area 4 would be directed to a pipe system on the west side of the development with a final outfall location on the south side of the wetland (Outfall 4)
- Road Runoff from South Troutdale Road would be collected in a traditional curb-and-gutter system along South Troutdale Road with catch basins and storm pipes to convey stormwater to regional treatment facility discharging to the wetland at Outfall 5.

CHAPTER 6.
RECOMMENDATIONS

FLOW CONTROL

For discharges to surface water from developed properties, flow control should be provided to avoid discharging flows that will cause channel erosion. Flow control should limit off-site discharges to no more than one-half of the 2-year, 24-hour pre-development peak flow, unless more specific data is available. Facilities are also required to control peak flows to the pre-development 5-, 10-, and 25-year, levels.

WATER QUALITY FACILITY CRITERIA

Stormwater from new development should be infiltrated onsite to the maximum extent feasible prior to discharging any flow off site, using infiltration facilities such as swales, planters, basins, filter strips, grassy swales, soakage trenches and drywells.

SOUTH TROUTDALE ROAD IMPROVEMENTS REQUIREMENT

It is recommended that South Troutdale Road be upgraded to be consistent with the road cross section north of Sweetbriar Lane (44-foot-wide roadway and 5-foot-wide sidewalks on both sides).

DRAINAGE FACILITIES

Alternative 1 is recommended for the area north of Cochrane Road and Alternative 5 is recommended for the area south of Cochrane Road. Both alternatives use an infiltration swale along Troutdale Road. A typical swale cross section is presented in Figure 6-1.

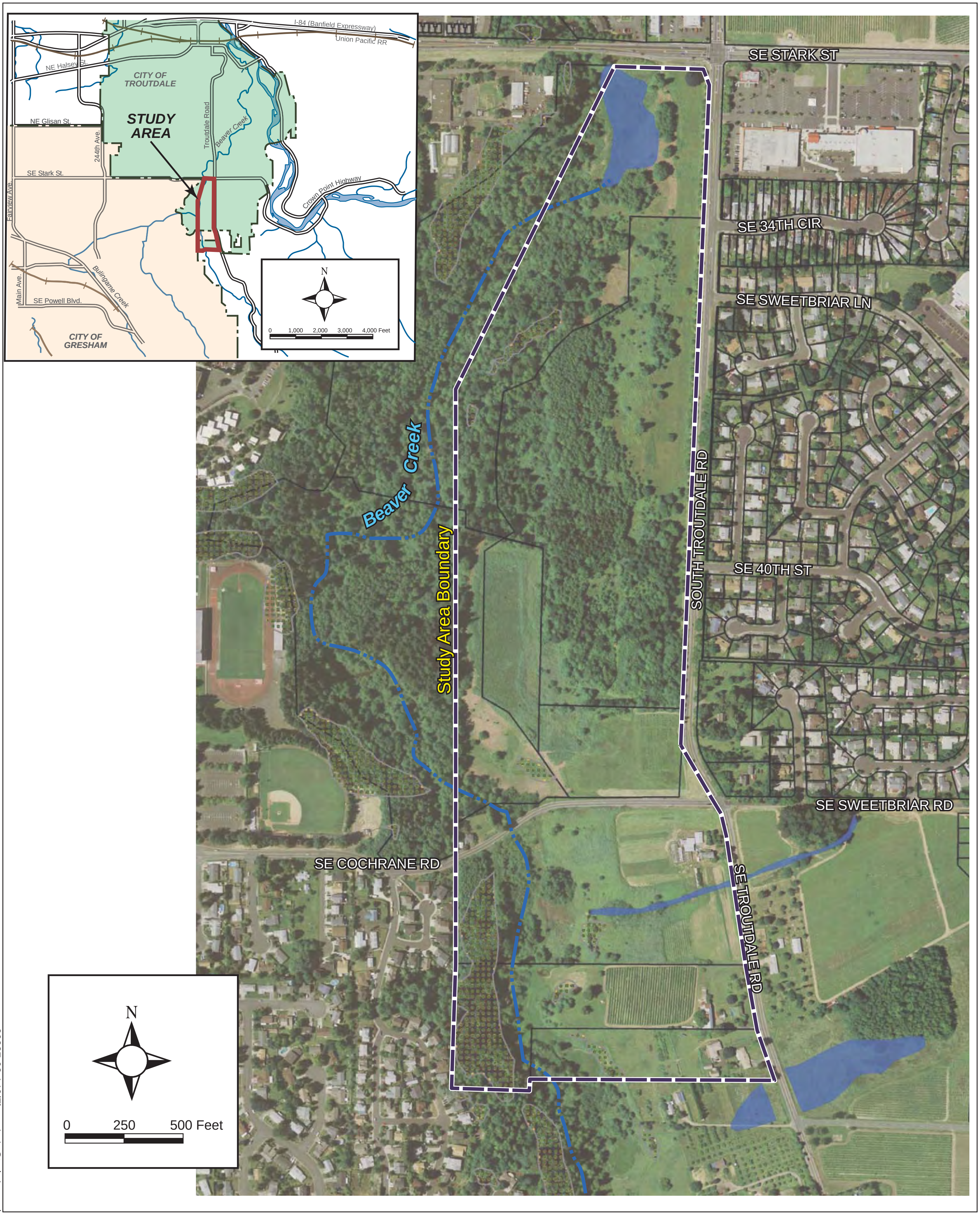
The estimated cost for Alternative 1 is $309,000; the cost for Alternative 5 is $225,000. Detailed cost estimates are presented in Appendix B

City of Troutdale

South Troutdale Road Storm Drainage Plan

FIGURES

January 2009



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SOUTH TROUTDALE ROAD STORM DRAINAGE PLAN

Figure 1-1.
STUDY AREA AND VICINITY

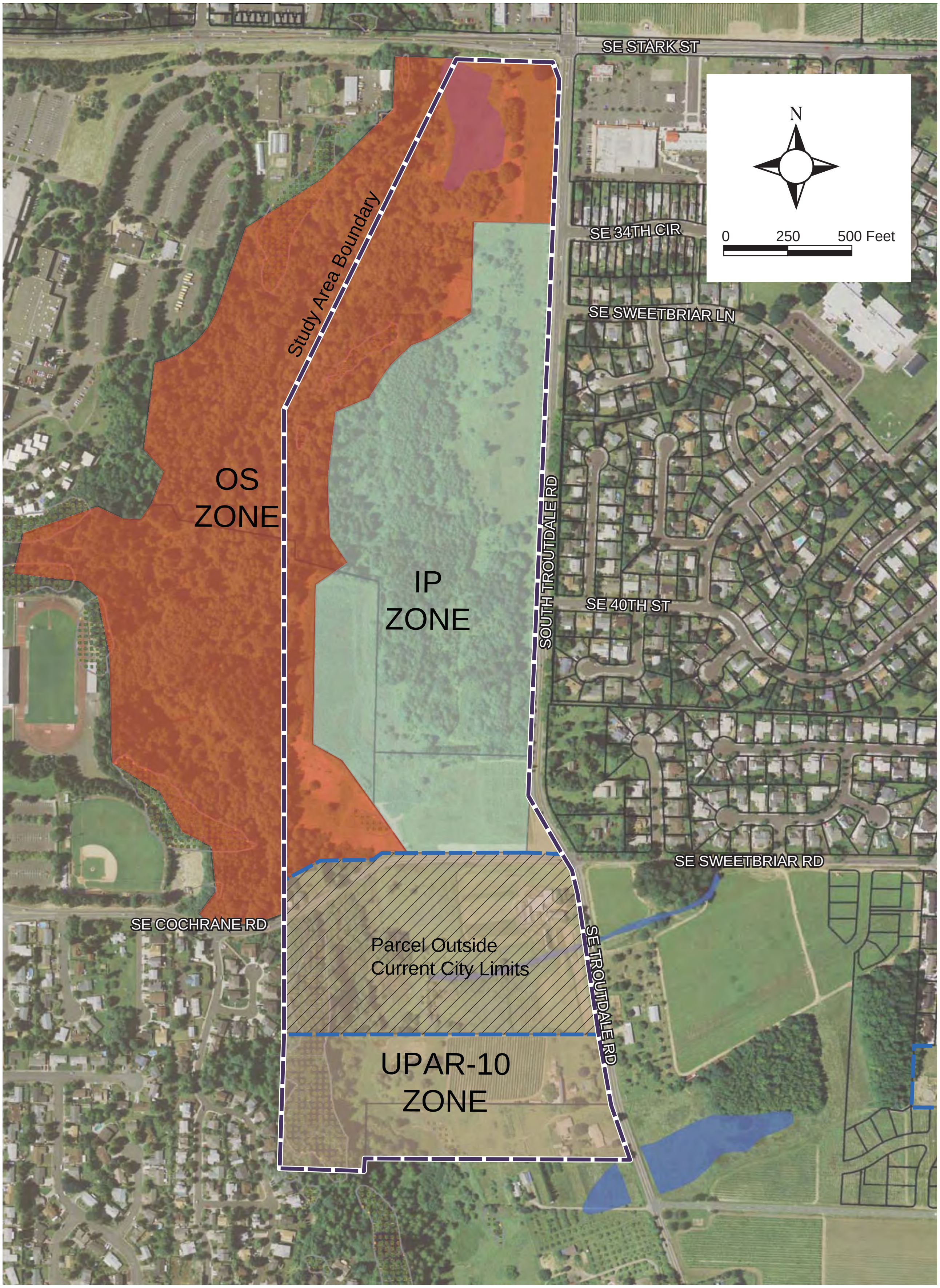

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Figure 2-1.
STUDY AREA ZONING

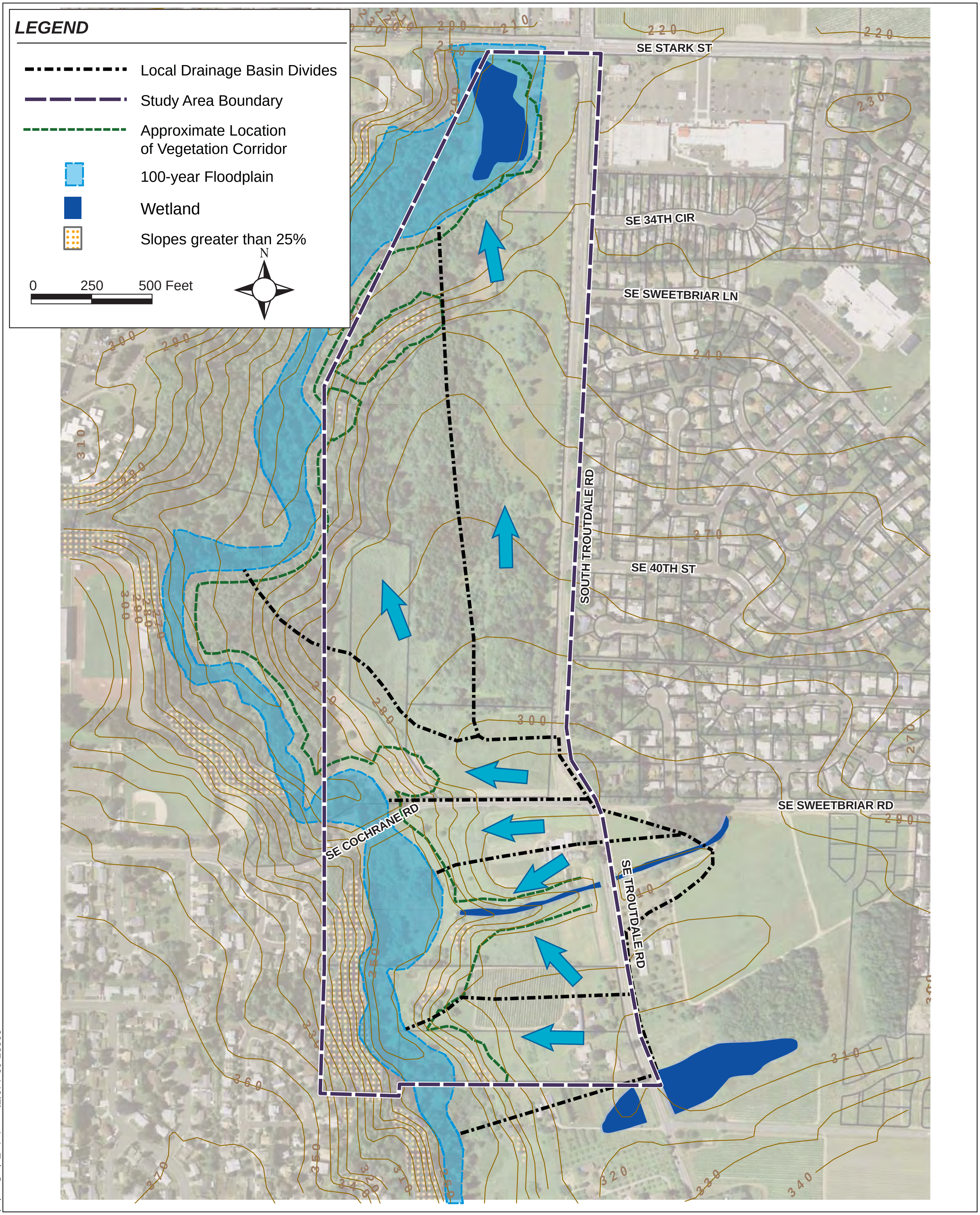

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Figure 4-1.
STUDY AREA EXISTING CONDITIONS

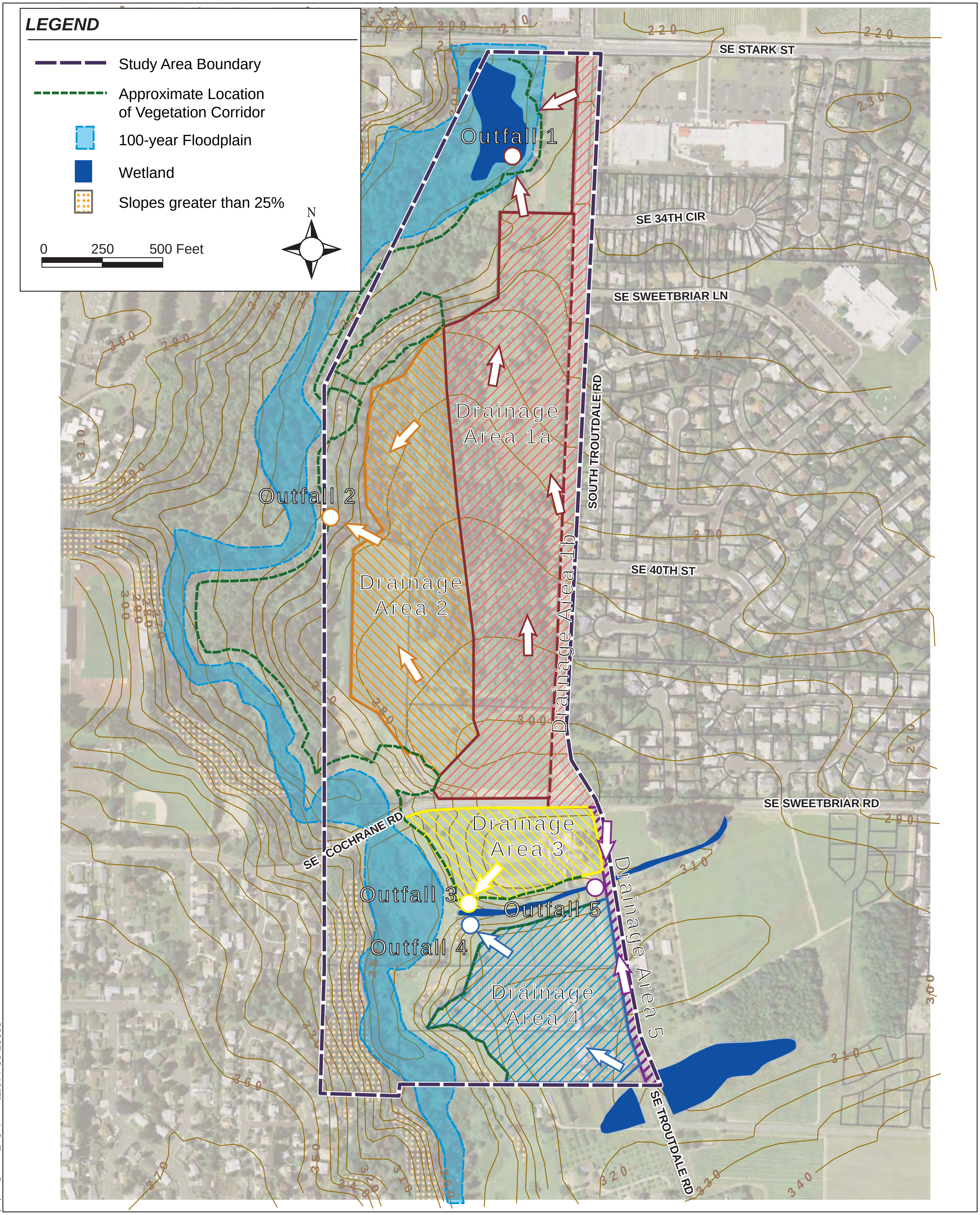

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Figure 4-2.
STUDY AREA FUTURE CONDITIONS

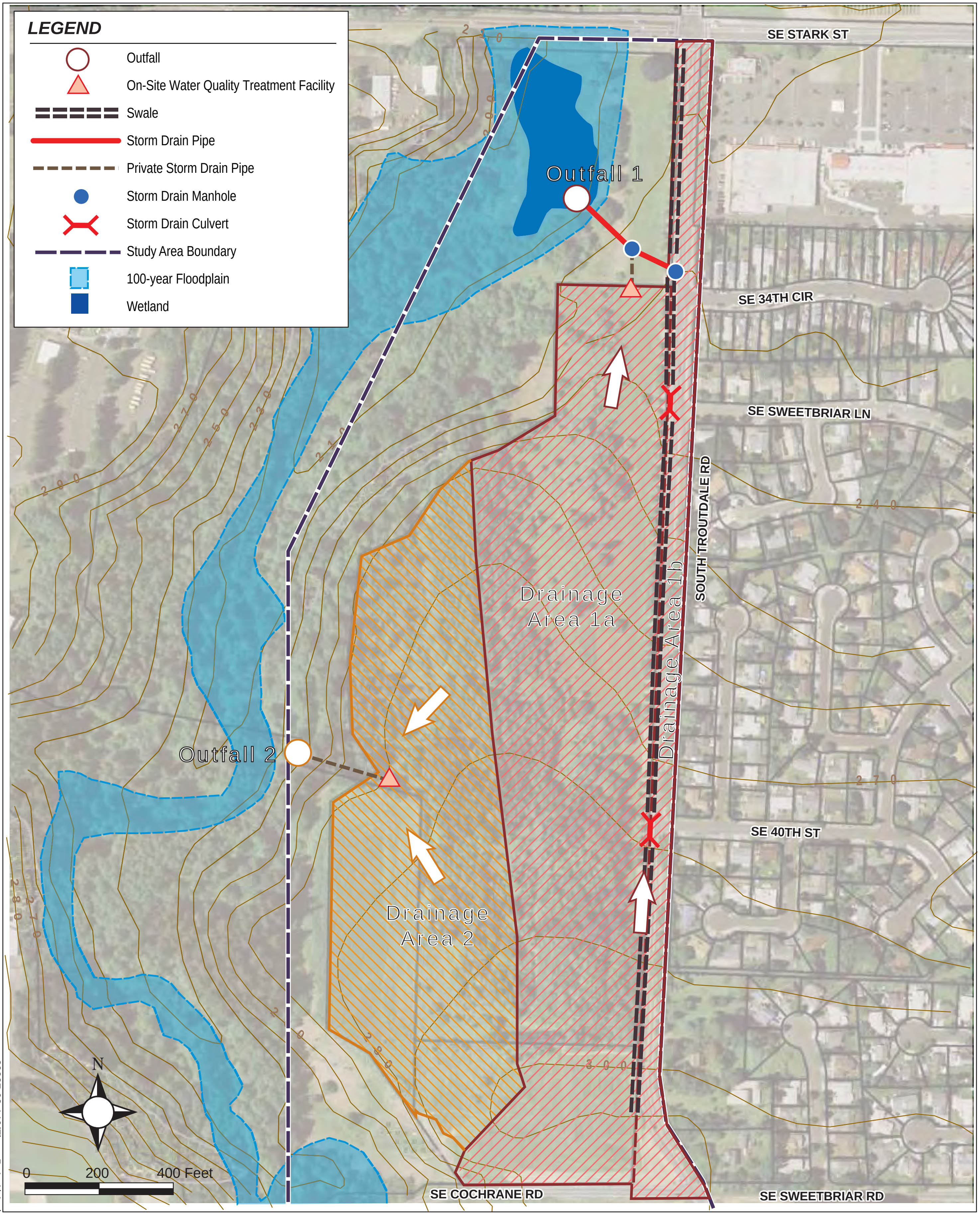

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Figure 5-1.
DRAINAGE NORTH OF COCHRANE ROAD; ALTERNATIVE 1

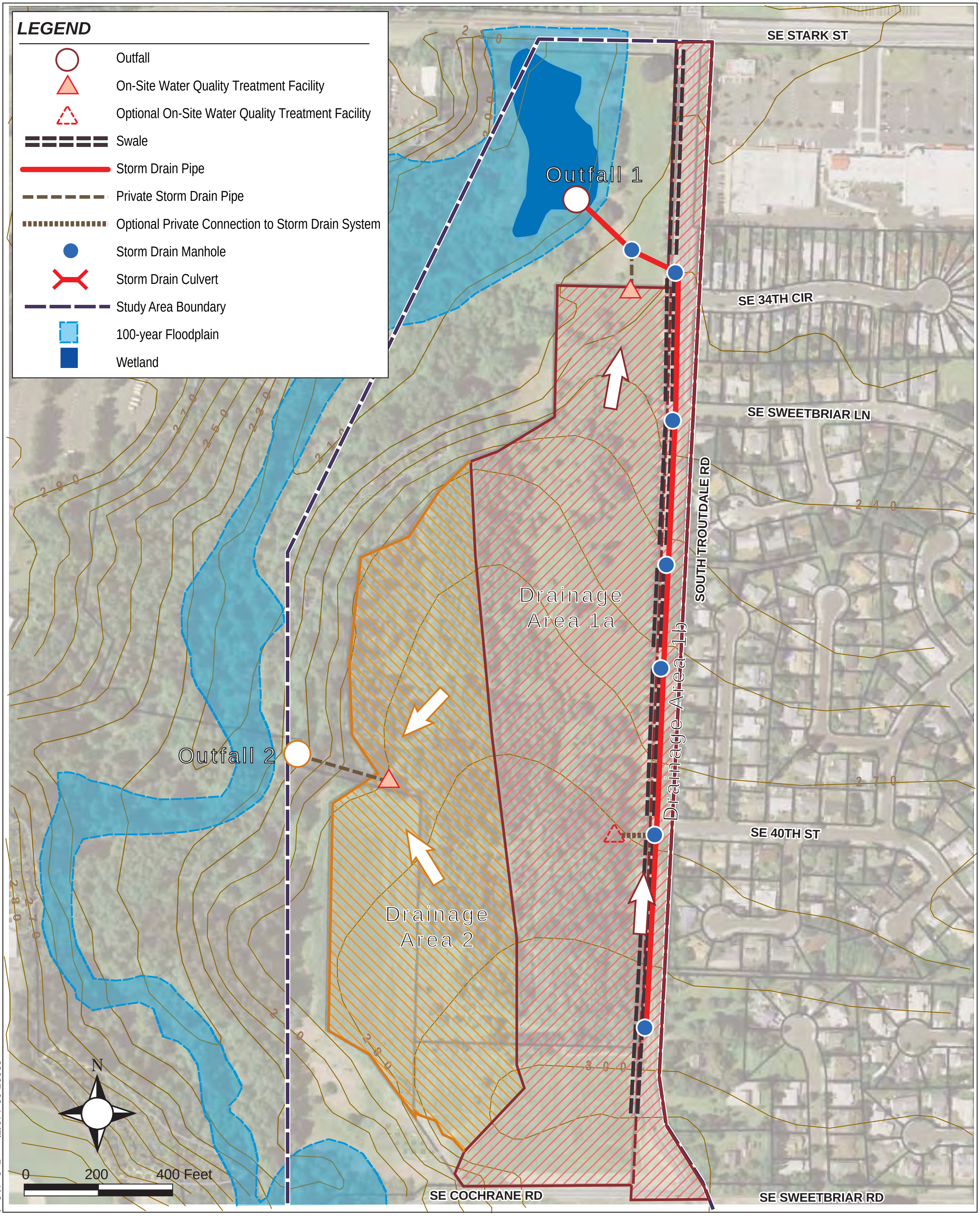

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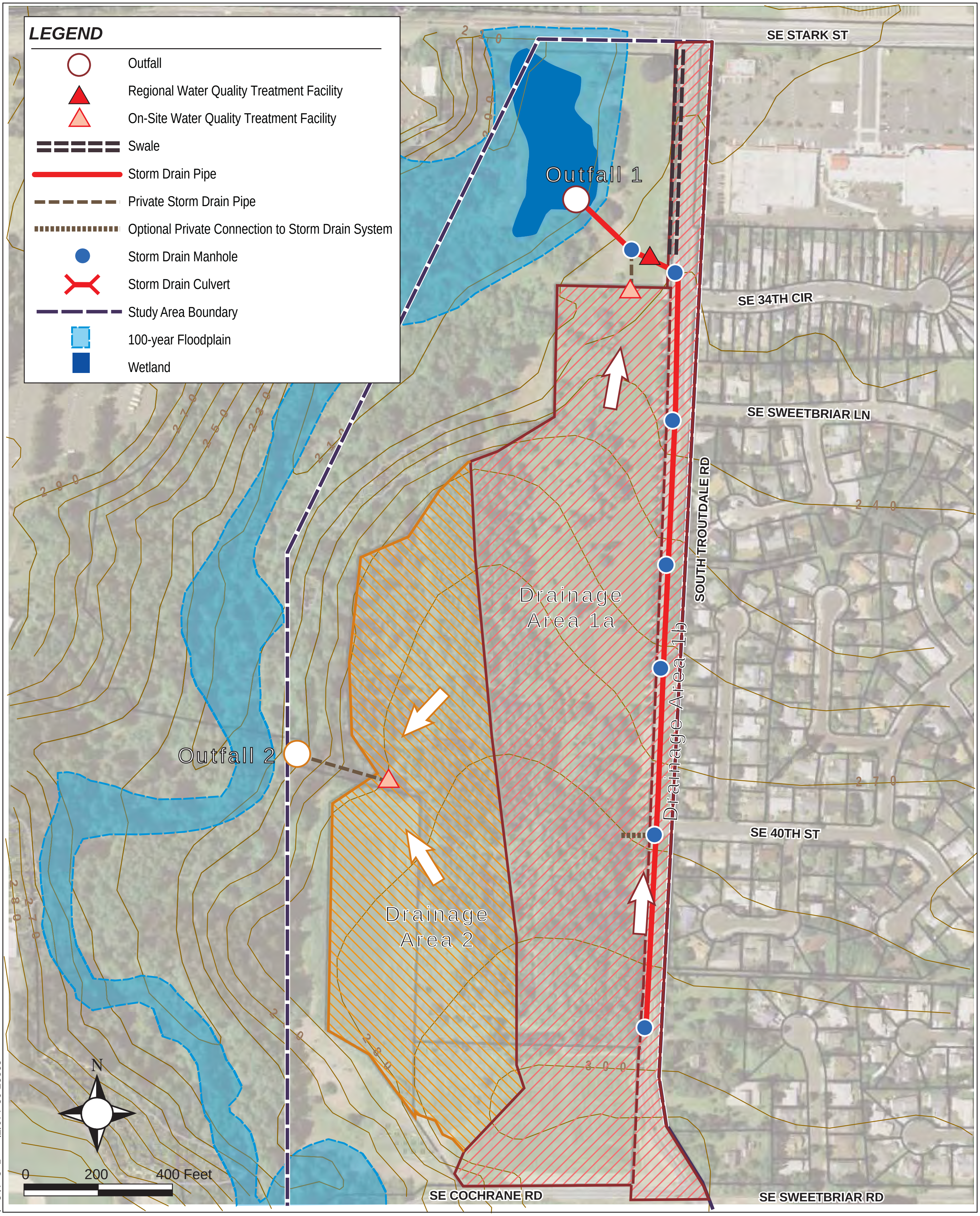
Figure 5-2.
DRAINAGE NORTH OF COCHRANE ROAD; ALTERNATIVE 2



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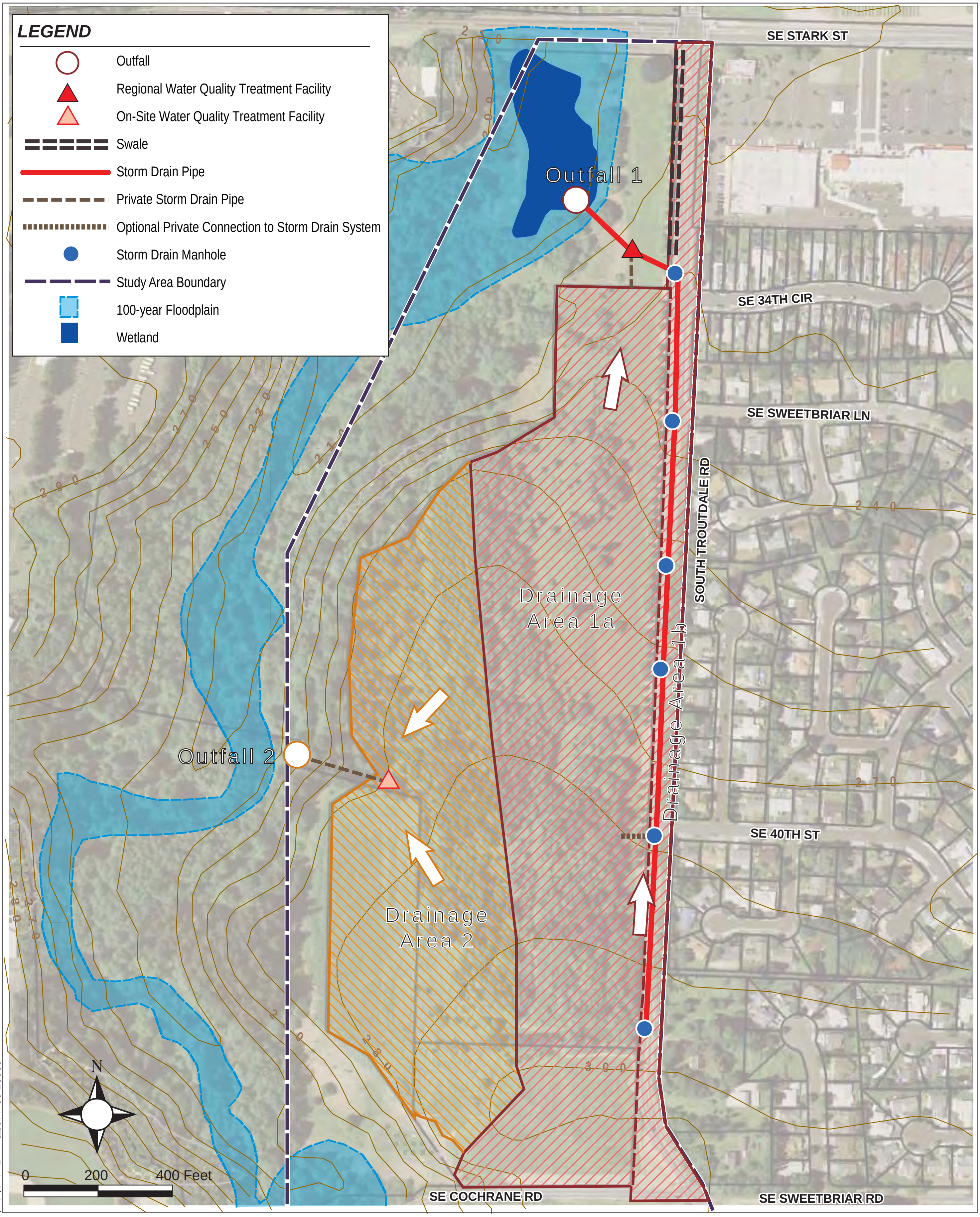
SOUTH TROUTDALE ROAD STORM DRAINAGE PLAN

Figure 5-3.
DRAINAGE NORTH OF COCHRANE ROAD; ALTERNATIVE 3



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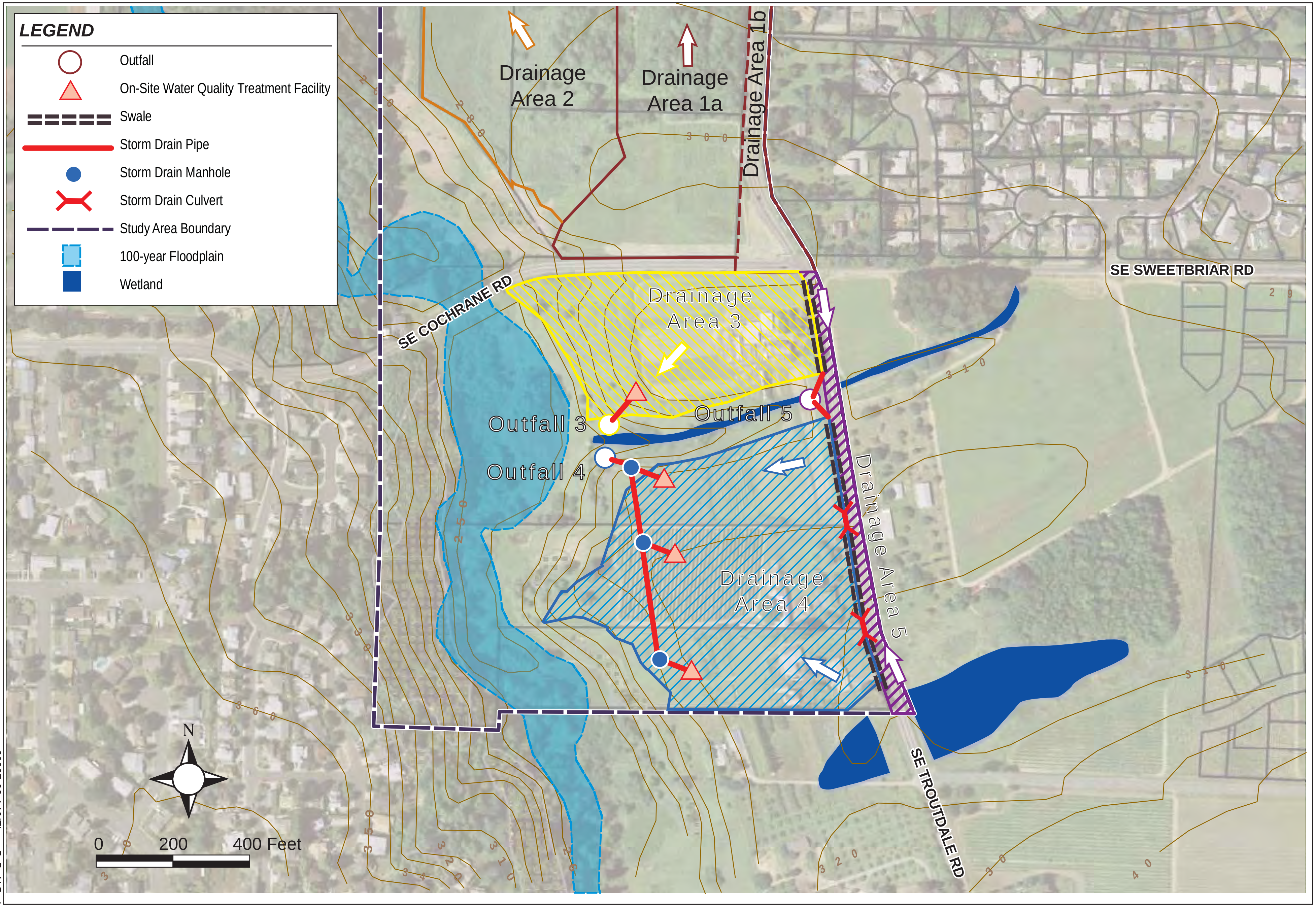
SOUTH TROUTDALE ROAD STORM DRAINAGE PLAN

Figure 5-4.
DRAINAGE NORTH OF COCHRANE ROAD; ALTERNATIVE 4



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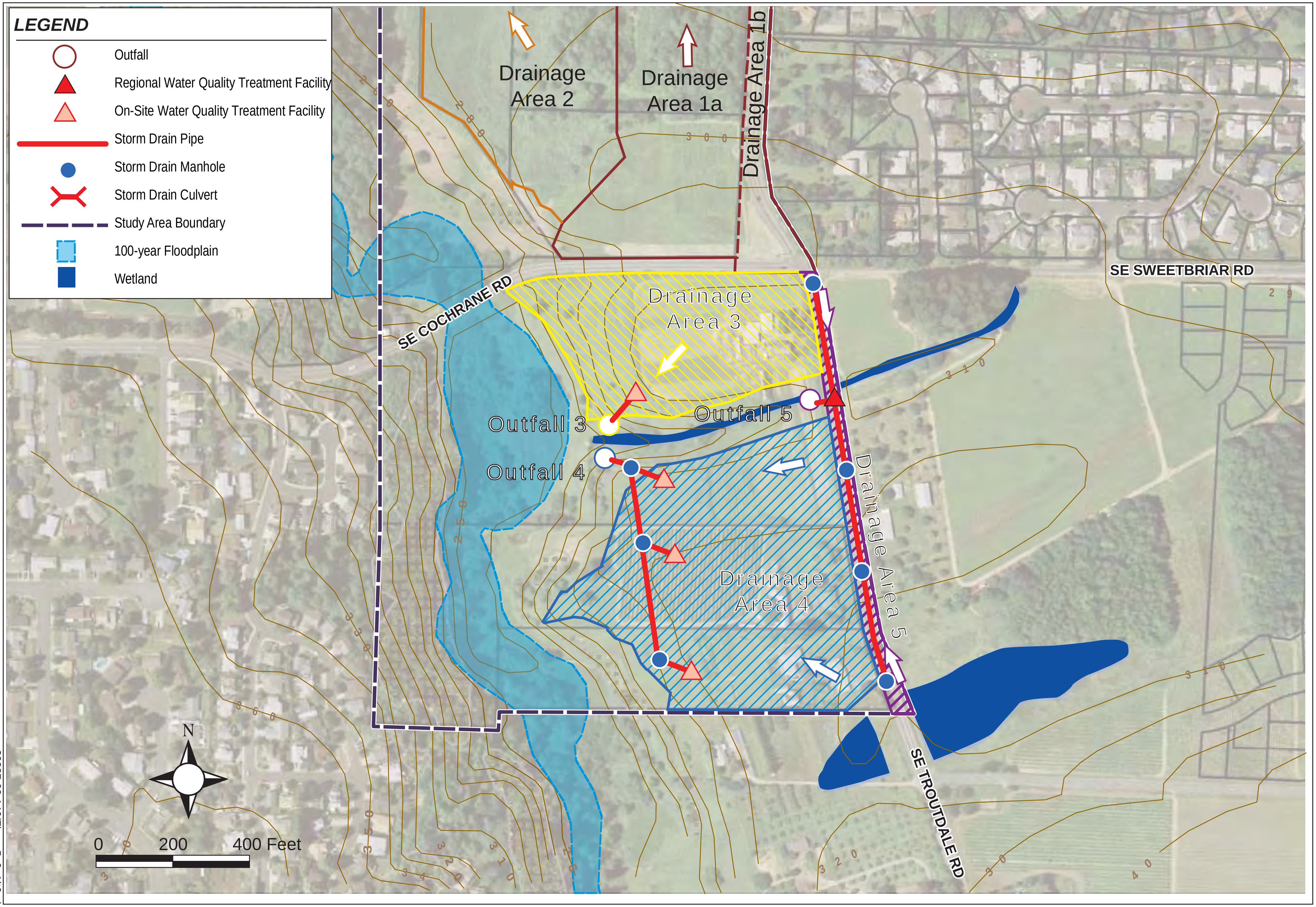
SOUTH TROUTDALE ROAD STORM DRAINAGE PLAN

Figure 5-5.
DRAINAGE SOUTH OF COCHRANE ROAD; ALTERNATIVE 5



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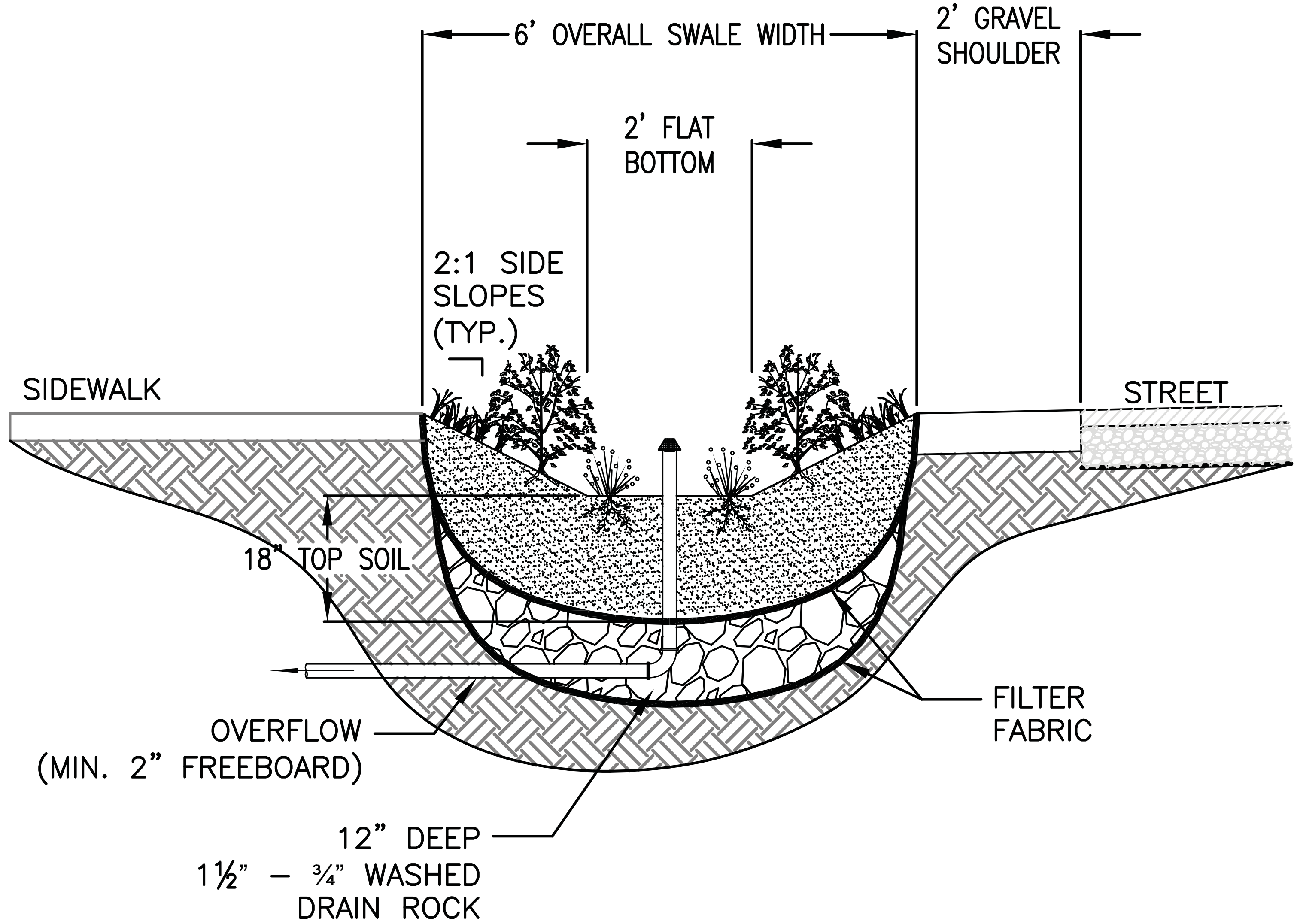
SOUTH TROUTDALE ROAD STORM DRAINAGE PLAN

Figure 5-6.
DRAINAGE SOUTH OF COCHRANE ROAD;
ALTERNATIVE 6



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SOUTH TROUTDALE ROAD STORM DRAINAGE PLAN

Figure 6-1.
TYPICAL WATER QUALITY TREATMENT SWALE CROSS SECTION

APPENDIX A.
XP-SWMM MODELING RESULTS

to be provided with final report

January 2009

APPENDIX A.
STORM SYSTEM EVALUATION METHODOLOGY

MODELING PARAMETERS

The software used for modeling the South Troutdale Road Study Area was XP-SWMM 2000, developed by *XP Software Pty. Ltd*. It is based on the U.S. Environmental Protection Agency's Storm Water Management Model (SWMM) and uses rainfall information and percent-impervious information, along with subcatchment-specific parameters, to determine the hydrology and hydraulics of a modeled drainage area. Each catchment is subdivided into subcatchments that are hydrologically similar. The model requires the following parameters for each subcatchment to define the flow:

- Subcatchment area
- Percent impervious
- Pervious curve number
- Time of concentration.

The study area is sufficiently small that the design rainfall is the same for the whole study area. The study area was divided into different drainage areas based on the existing storm/sanitary system configuration.

The approach used for defining each modeling parameter is described below.

Subcatchment Area

Subcatchment area is the actual area of the subcatchment in acres.

Impervious Areas

The percent-impervious value indicates the percentage of the drainage area that is covered with impervious surfaces that prevent infiltration of rainfall into the ground. Existing and future percent-impervious values were determined for each subcatchment based on existing zoning and land.

The impervious area used in the modeling was the *mapped impervious area* (MIA), which is the actual total impervious area. The modeling did not use *effective impervious area* (EIA), which is usually a percentage of the MIA and difficult to measure. Future development using biofiltration swales and other water quality facilities could result in an EIA that is significantly smaller than MIA; however, to be conservative in the modeling, MIA was used for future as well as existing conditions.

Existing land use was determined from the 2007 aerial photograph.

Pervious Curve Numbers

Pervious curve numbers for each subcatchment were developed for pervious areas. For pervious areas, the curve numbers are related to soil type, land use, cover and hydrologic condition. Table A-1 shows the curve numbers by land use for soil type C. Curve numbers were calculated for each subcatchment as a weighted average by area of land use.

TABLE A-1.
PERVIOUS CURVE NUMBERS

Land Use	Curve Number Group C Soils
Open Space (good condition)	74
Farm	88
Residential	90
Industrial Park	91
Roadway	98

Source: Urban Hydrology for Small Watersheds. Soil Conservation Service Technical Release 55. June 1986

Time of Concentration

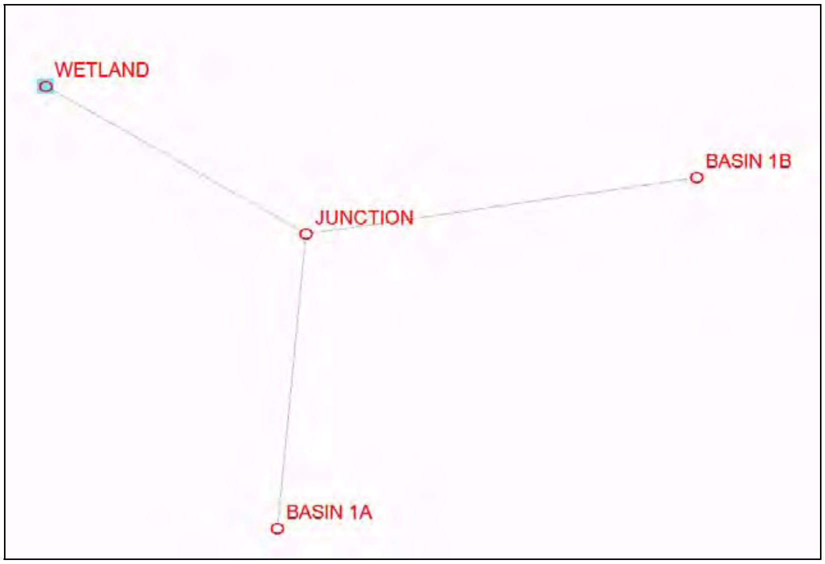
The time of concentration for a drainage area is defined as the time it takes for storm runoff to travel to the storm inlet from the most hydraulically distant point in the drainage area. This was calculated for each subcatchment as the length of travel divided by the estimated travel speed.

HYDROLOGIC ANALYSIS APPROACH

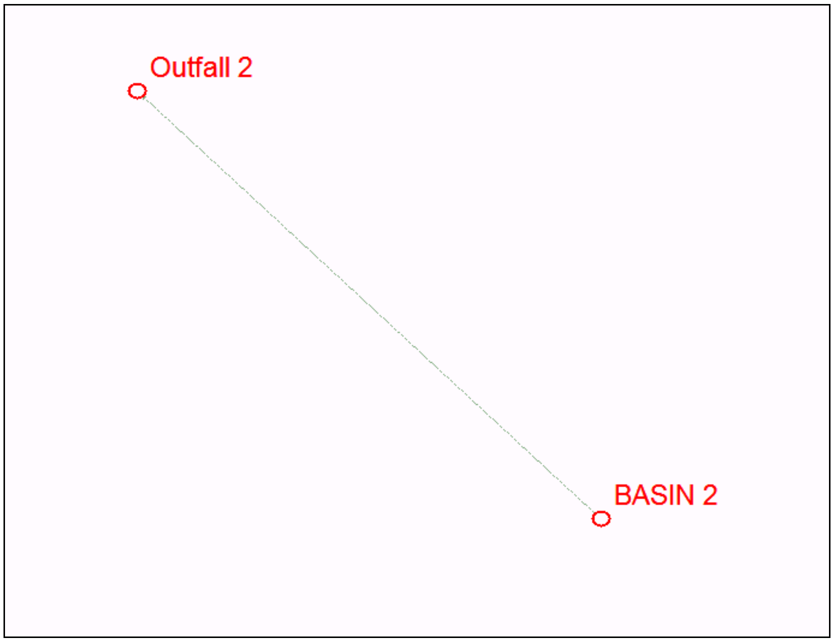
XPSWMM and the Santa Barbara Urban Hydrograph were used to determine the flow into the system. An SCS Type 1A 24 hour storm distribution was used to model the 2-year and 25-year rainfall events as presented in Chapter 2.

HYDRAULIC ANALYSIS APPROACH

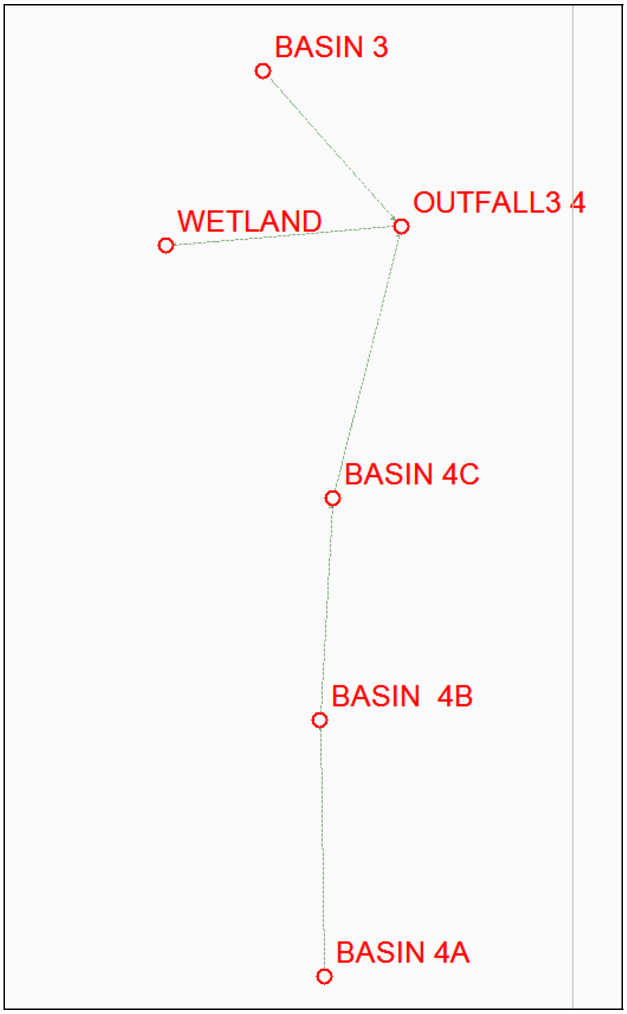
XPSWMM was used to evaluate design flows for the pre-development, existing and future conditions.



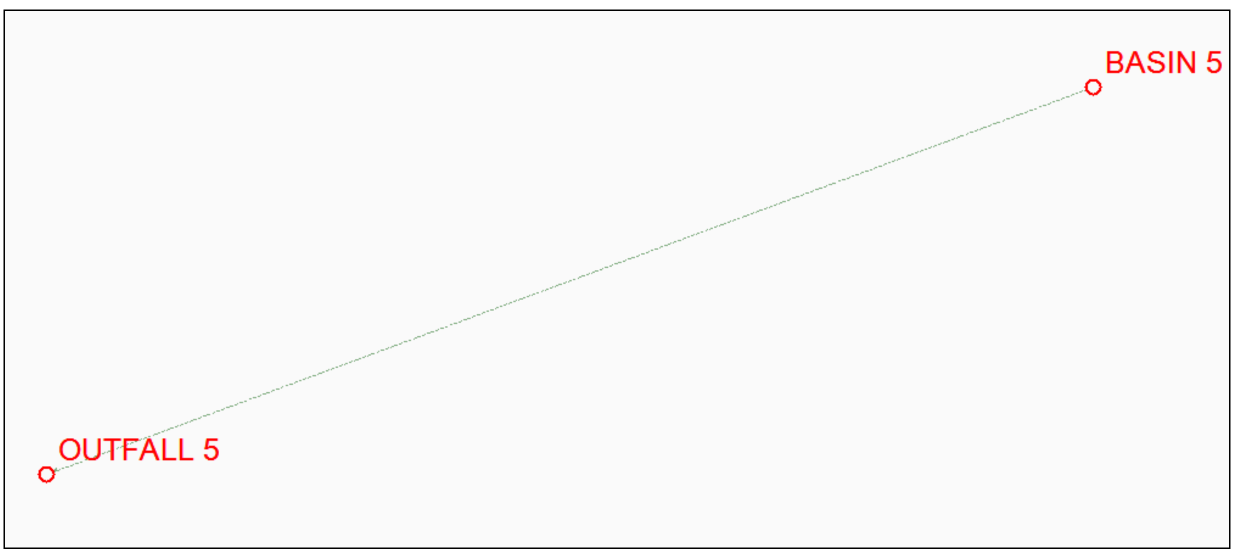
Alternative 1, Outfall 1 Model Schematic



Alternative 1, Outfall 2 Model Schematic



Alternative 5, Outfall 3 and 4 Model Schematic



Alternative 5, Outfall 5 Model Schematic

**TABLE A-1.
STORM DRAINAGE PIPE SUMMARY**

U/S Junction	D/S Junction	Pipe Dia (inches)	Length (feet)	Rim El (feet)	U/S Invert El (feet)	Rim El (feet)	D/S Invert El (feet)	Slope	System Capacity (cfs)
Alternative 1 Outfall 1									
Drainage Area 1a	Junction	12	120	230	226	225	221	4.2%	7.3
Drainage Area 1b	Junction	12	120	230	226	225	221	4.2%	7.3
Junction	Wetland Outfall	12	300	225	221	210	206	5.0%	8.0
Alternative 1 Outfall 2									
Drainage Area 2	Outfall 2	12	300	270	266	230	229	12.3%	12.5
Alternative 5 Outfall 3									
Drainage Area 3	Outfall 3	12	140	295	291	265	261	21.4%	16.5
Alternative 5 Outfall 4									
Drainage Area 4a	Drainage Area 4B	12	130	290	286	265	261	19.2%	15.7
Drainage Area 4b	Drainage Area 4C	12	190	302	286.4	290	280.7	3.0%	6.2
Drainage Area 4c	Outfall 4	12	320	300	296	302	286.4	3.0%	6.2
Alternative 5 Outfall 5									
Drainage Area 5	Outfall 5	12	75	305	301	300	296	6.7%	9.2

**TABLE A-2.
STORM DRAINAGE DESIGN FLOWS**

	Drainage Area 2	Drainage Area 1a	Drainage Area 1b	Drainage Area 3	Drainage Area 4 North Parcel	Drainage Area 4 Center Parcel	Drainage Area 4 South Parcel	Drainage Area 5
Area (acres)	15.6	22.8	1.7	5.4	2.7	4.4	2.8	0.9
Pre-Development Conditions								
Curve number	74	74	74	74	74	74	74	74
2-year flow (cfs)	0.7	0.77	0.06	0.25	0.12	0.2	0.13	0.11
25-year flow (cfs)	1.66	1.62	0.12	0.6	0.26	0.48	0.13	0.32
Existing Conditions								
Curve number	74	74	88	89	88	89	90	88
2-year flow (cfs)	0.7	0.77	0.11	0.69	0.27	0.55	0.42	0.34
25-year flow (cfs)	1.66	1.62	0.19	1.29	0.51	1.02	0.77	0.63
Future Conditions								
Curve number	91	91	98	90	90	90	90	98
2-year flow (cfs)	2.14	1.68	0.17	0.74	0.31	0.58	0.42	0.55
25-year flow (cfs)	3.82	2.85	0.27	1.34	0.56	1.06	0.77	0.84

City of Troutdale

South Troutdale Road Storm Drainage Plan

APPENDIX B.
DETAILED COST ESTIMATES

January 2009

CITY OF TROUTDALE					
South Troutdale Road Storm Drainage Plan					
Preliminary Cost Estimate					
North of Cochrane Road					
ITEM NO	**DESCRIPTION**	**UNIT**	**UNIT PRICE**	**EST QTY**	**TOTAL**
	Alternative 1				
1	Mobilization	LS	$19,400.00	1	$19,400.00
2	Manhole, 48”	EA	$2,500.00	2	$5,000.00
3	Pipe, Storm Drain, 12” PVC 3034 (Class B Backfill)	LF	$50.00	120	$6,000.00
4	Pipe, Storm Drain, 15” PVC 3034 (Class B Backfill)	LF	$60.00	310	$18,600.00
5	12" Culvert	LS	$55.00	60	$3,300.00
6	2790 Long Bio-swale along west side of South Troutdale Road				
	Permeable Filter Fabric (at swale)	SY	$3.00	5580	$16,740.00
	Erosion Control Blanket	SF	$0.50	19530	$9,765.00
	Soil Mixture	CY	$20.00	930	$18,600.00
	Plantings	SF	$4.00	16740	$66,960.00
	Rip Rap for Check Dams	CY	$85.00	28	$2,380.00
	Gravel	CY	$40.00	620	$24,800.00
7	Swale Outlet	EA	$500.00	2	$1,000.00
8	Outlet structure	EA	$5,000.00	1	$5,000.00
9	Traffic Control	LS	$10,000.00	1	$10,000.00
10	Erosion Control	LS	$5,000.00	1	$5,000.00
	Construction Subtotal				**$212,545.00**
	Construction Contingencies (percent of total)		20%		$43,000
	'Engr, Arch, Admin, Legal Fees (% of Total Constr. & Contingency)		25%		$53,000
	TOTAL COST				**$309,000**

CITY OF TROUTDALE					
South Troutdale Road Storm Drainage Plan					
Preliminary Cost Estimate					
South of Cochrane Road					
ITEM NO	**DESCRIPTION**	**UNIT**	**UNIT PRICE**	**EST QTY**	**TOTAL**
	Alternative 5				
1	Mobilization	LS	$14,200.00	1	$14,200.00
2	Manhole, 48”	EA	$2,500.00	5	$12,500.00
3	Pipe, Storm Drain, 12” PVC 3034 (Class B Backfill)	LF	$50.00	940	$47,000.00
4	12" Culvert	LS	$55.00	120	$6,600.00
5	925 Long Bio-swale along west side of South Troutdale Roa				
	Permeable Filter Fabric (at swale)	SY	$3.00	1850	$5,550.00
	Erosion Control Blanket	SF	$0.50	6475	$3,237.50
	Soil Mixture	CY	$20.00	308	$6,166.67
	Plantings	SF	$4.00	5550	$22,200.00
	Rip Rap for Check Dams	CY	$85.00	10	$807.50
	Gravel	CY	$40.00	206	$8,222.22
6	Swale Outlet	EA	$500.00	2	$1,000.00
7	Outlet structure	EA	$5,000.00	3	$15,000.00
8	Traffic Control	LS	$10,000.00	1	$10,000.00
9	Erosion Control	LS	$3,000.00	1	$3,000.00
	Construction Subtotal				**$155,483.89**
	Construction Contingencies (percent of total)		20%		$31,000
	'Engr, Arch, Admin, Legal Fees (% of Total Constr. & Contingency)		25%		$39,000
	TOTAL COST				**$225,000**