

Carolina-Terwilliger Subwatershed Improvement Strategies Report

2009



Willamette
Watershed
Team



ENVIRONMENTAL SERVICES
CITY OF PORTLAND

working for clean rivers

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— CITY OF PORTLAND —
ENVIRONMENTAL SERVICES



1120 SW Fifth Avenue, Room 1000, Portland, Oregon 97204 ■ Dan Saltzman, Commissioner ■ Dean Marriott, Director

June 15, 2009

Dear Friends of Portland's Watersheds:

I am pleased to present this *Carolina-Terwilliger Subwatershed Improvement Strategies Report* for the Willamette Watershed. This document helps guide the City of Portland's ongoing efforts to manage stormwater runoff and protect and restore our waterways and natural areas. The report describes the current conditions of the Carolina-Terwilliger subwatershed and identifies opportunities to protect and improve watershed health.

In March 2006, City Council adopted the Portland Watershed Management Plan (PWMP). The plan describes the city's comprehensive, strategic, and integrative approach to improving watershed conditions. It identifies watershed health goals in hydrology, physical habitat, water quality and biological communities and outlines strategies and actions to meet these goals.

The *Carolina-Terwilliger Subwatershed Improvement Strategies Report* builds upon the principles of the PWMP. Taking a watershed approach, we have identified opportunities to better manage stormwater runoff, protect and improve aquatic and terrestrial habitat and revegetate our natural areas. This approach uses collaboration and partnerships with landowners, neighborhood groups, non-profits and local agencies to achieve the greatest benefits from our actions.

We are currently developing Improvement Strategies reports for each of the Willamette watershed's 27 subwatersheds. The Stephens subwatershed in southwest Portland was the first area for which this process was applied. The report, published in 2004, includes a list of over 100 prioritized projects and recommendations. Today, with local citizen support, a number of these projects have been implemented including: the Burlingame Sewer Repair and Streambank Restoration, the SW Texas Green Street and Wetland Enhancement, and the Stephens Creek Confluence Habitat Enhancement project.

In addition to guiding the work of our bureau, it is our hope that this report will provide residents and friends of the Carolina-Terwilliger subwatershed an opportunity for community stewardship of their local stream basin. Together, we can work to improve water quality and watershed health, and to protect and restore our natural resources.

Sincerely,

Paul Ketcham
BES Willamette Watershed Manager



Southwest Subwatersheds Improvement Strategies

Carolina-Terwilliger Subwatershed Improvement Strategies Final Report

Environmental Services
City of Portland
Watershed Services Group
Willamette Watershed

Final - June 15, 2009

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ACRONYMS

BDS	Bureau of Development Services
BMP	best management practice
BPS	Bureau of Planning and Sustainability (formerly Bureau of Planning)
BES	Bureau of Environmental Services
CIP	City of Portland Capital Improvement Program
CSO	Combined Sewer Overflow
CSSP	Combined System Sewer Plan
DDT	dichlorodiphenyltrichloroethane
DEQ	Oregon Department of Environmental Quality
ECSI	Environmental Cleanup Site Information
EDT	Ecosystem Diagnosis and Treatment
EIA	effective impervious area
ESA	Endangered Species Act
GIS	Geographic Information Systems
IC	inflow control
IS	Improvement Strategies
LID	Local Improvement District
LWD	large woody debris
MOU	Memorandum of Understanding
MS4	Municipal Separate Storm Sewer System
NFWF	National Fish and Wildlife Foundation
NRI	Natural Resources Inventory
NPDES	National Pollutant Discharge Elimination System
NWI	National Wetlands Inventory
ODFW	Oregon Department of Fish and Wildlife
ODOT	Oregon Department of Transportation
OHSU	Oregon Health Sciences University
OLA	off-leash area
OWEB	Oregon Watershed Enhancement Board
PAH	polycyclic aromatic hydrocarbons
PBOT	Portland Bureau of Transportation
PCB	polychlorinated biphenyls
PP&R	Portland Parks and Recreation
PWMP	Portland Watershed Management Plan
ROW	right of way
SAC	Stormwater Advisory Committee
SHA	Special Habitat Area
SWMM	Stormwater Management Manual
SWMP	Stormwater Management Plan
TEES	Terrestrial Ecology Enhancement Strategy
TMDL	Total Maximum Daily Loads
UIC	Underground Injection Controls
VA	Veterans' Medical Center

WRDA Water Resources Development Act

EXECUTIVE SUMMARY

The Bureau of Environmental Services (BES) Willamette Watershed team has developed Improvement Strategies (IS) reports for the Willamette River watershed's Marquam-Woods, Carolina-Terwilliger, and California subwatersheds. The reports identify and prioritize opportunities to protect and improve watershed conditions in the subwatersheds.

Improvement Strategies are groups of actions that individually and collectively improve watershed health. The actions are guided by the goals and objectives outlined in the Portland Watershed Management Plan (PWMP), a plan developed by the City of Portland in 2005 to improve watershed health and to protect and restore natural resources. The IS reports identify and rank recommended projects based on PWMP goals of improving hydrology, water quality, physical habitat, and biological communities.

The purpose of the Marquam-Woods, Carolina-Terwilliger, and California subwatershed IS reports is to provide a guide for City staff as well as other interested stakeholders such as local agencies, non-profits, and volunteer citizen groups, to focus resources and efforts on actions that will best benefit watershed health. Projects are organized by the following strategies: Stormwater Management, Revegetation, Aquatic and Terrestrial Enhancement, Protection and Policy, Operations and Maintenance, and Education, Involvement, and Stewardship.

The IS process is conducted at the subwatershed scale for a number of reasons. The subwatershed scale has been identified as the most effective for evaluating watershed improvements (Schueler and Holland 2000). Conditions that impact resources, such as impervious area, are more consistent and readily assessable at this scale. It is more efficient to encourage and support community and individual stewardship at this scale (e.g., neighborhood groups are organized at a similar scale). Finally, this scale is fine enough to conduct thorough field assessments and allow accurate analysis of the extent to which the identified improvement opportunities can contribute to meeting each watershed objective.

The reports identify recommended actions, grouped as geographic and/or programmatic clusters. The actions were assembled for their ability to address areas that have been identified as important assets to protect or problems to solve in order to improve local subwatershed conditions. Recommendations have been made for the following areas/programs in the Carolina-Terwilliger subwatershed: Marquam Nature Park, George Himes Park Streams, Mitchell Creek, and Cottonwood Bay. Potential projects and programs for these areas include:

	Marquam Nature Park	George Himes Park	Mitchell Creek	Cottonwood Bay
<i>Stormwater Management Projects</i>	<ul style="list-style-type: none"> • Marquam Nature Park (MNP) Shelter – Stormwater (*) 	<ul style="list-style-type: none"> • George Himes Park Stream Daylighting, North Reach (6) 	<ul style="list-style-type: none"> • Stream Daylighting of Culvert ACH562 (29) • CSSP Green Streets: West of Terwilliger Project Area (32) • Next Generation Children's Center Parking Lot Stormwater Planters (50) • Next Generation Children's Center Ecoroof (44) • Chevron Food Mart Parking Lot Vegetative Stormwater Planter (60) • John's Landing Dry Cleaners Parking Lot Vegetative Stormwater Planters (55) • Sorenson Photography Vegetative Swale (67) • Sorenson Photography Parking Lot Vegetative Stormwater Planter (69) • Sorenson Photography Ecoroof (42) • Macadam Center Pervious Asphalt Parking Lot (33) • Macadam Center Vegetative Swale (53) • 5025 SW Corbett Ecoroof (34) • The Water Tower Stormwater Retrofit (16) • Over The Landing Salon 	<ul style="list-style-type: none"> • River Forum Ecoroof (24) • Avalon Ecoroof (40) • 455 SW Hamilton Court Ecoroof (41)

	Marquam Nature Park	George Himes Park	Mitchell Creek	Cottonwood Bay
			Ecoroof (21)	
<i>Aquatic and Terrestrial Enhancement Projects</i>	<ul style="list-style-type: none"> • Marquam Gulch Daylighting, North Branch (*) • Marquam Gulch Daylighting, South Branch (*) • MNP Shelter Wetland Construction (*) • Terwilliger Creek Trail Stream Enhancement (3) 	<ul style="list-style-type: none"> • George Himes South Stream Daylighting (*) 	<ul style="list-style-type: none"> • Greenbriar Village Stream Enhancement (31) 	<ul style="list-style-type: none"> • Carolina-Terwilliger Cottonwood Bay SHA (5) • Marquam-Woods Cottonwood Bay SHA (*)
<i>Revegetation Projects</i>	<ul style="list-style-type: none"> • MNP Shelter Wetland Revegetation (*) • MNP Shelter Revegetation, Plum Hill (*) • Fairmont Forest Revegetation (83) 	<ul style="list-style-type: none"> • Carolina-Terwilliger George Himes Park Revegetation (92) • California George Himes Park Revegetation (*) 	<ul style="list-style-type: none"> • Chart House Hill Revegetation (93) • ODOT Lairhill North Revegetation (91) 	<ul style="list-style-type: none"> • Cottonwood Bay Revegetation (*) • River Forum Revegetation (*) • Heron Pointe Revegetation (102)
<i>Protection and Policy Projects</i>	<ul style="list-style-type: none"> • Marquam Gulch South Potential Property Acquisition (*) • Marquam Oak Special Habitat Area (SHA) Property Acquisition (*) • BraeMar and Broadway Drive Property Acquisition (*) • Council Crest and MNP Properties Acquisition (*) • Council Crest Area 	<ul style="list-style-type: none"> • Upper George Himes Creek West Property Acquisition (10) • Lower George Himes East Property Acquisition (94) • George Himes East Property Acquisition (*) • George Himes 	<ul style="list-style-type: none"> • Property Acquisition along SW Trail #6 (100) • Chart House Hill Property Acquisition (98) • Chart House Hill--Central Menefee Drive Property Acquisition (12) • Chart House Hill-West Menefee Lane Property Acquisition (22) • Chart House Hill Land Acquisition (84) 	<ul style="list-style-type: none"> • Waterside Development Project ECSI Site (80) • Tequila Willies Property Acquisition (96) • Cottonwood Bay SHA WRDA Property Acquisition (*)

	Marquam Nature Park	George Himes Park	Mitchell Creek	Cottonwood Bay
	Property Acquisition (*) <ul style="list-style-type: none"> • MNP Property Acquisition (90) • MNP South Property Acquisition (*) • West Keller Woods Property Acquisition (95) • Oregon Health Sciences University Conservation Easement (97) 	South Property Acquisition (*) <ul style="list-style-type: none"> • George Himes West Property Acquisition (*) 	<ul style="list-style-type: none"> • Iowa Viaduct -ODOT reconstruction project (2) • John's Landing Cleaners Environmental Cleanup Site Information (ECSI Site (79)) 	
<i>Education, Involvement and Stewardship Projects</i>	<ul style="list-style-type: none"> • Invasive Species Outreach • Pet Waste Outreach 	<ul style="list-style-type: none"> • Invasive Species Outreach • Pet Waste Outreach 	<ul style="list-style-type: none"> • Menefee Drive Outreach and Education • Residential Non-Point Source Pollution Outreach 	<ul style="list-style-type: none"> • Riparian Zone Outreach • Riverbank Maintenance Practices Outreach • Invasive Species Outreach • Residential Non-Point Source Pollution Outreach

SECTION 1: PURPOSE

This report summarizes the Improvement Strategies (IS) process to improve and protect watershed health in the Carolina-Terwilliger subwatershed, which is located within the southwest portion of the lower Willamette Watershed. Improvement Strategies are categories of actions that can be taken to improve watershed conditions. The main element of this report is Section 6, which lists and ranks specific projects that have been identified through the IS process to improve Carolina-Terwilliger subwatershed health.

The IS process is guided by the 2005 Portland Watershed Management Plan (PWMP; City of Portland 2005). The PWMP, adopted by Portland City Council in 2006, provides a long-term adaptive management cycle of identifying, implementing, measuring, and evaluating improvements to the conditions of the watershed. The PWMP uses a watershed approach to outline objectives and strategies for improving watershed health while meeting the City of Portland's (City) and the Bureau of Environmental Services' (BES) missions, BES's service responsibilities, and environmental regulations. The watershed approach considers all activities that affect watershed conditions and maximizes the use of limited resources by looking for solutions that meet multiple objectives. This IS report provides the analysis necessary to identify implementation options and create recommendations that help to achieve these objectives in the Carolina-Terwilliger subwatershed.

The IS process is conducted at the subwatershed scale to identify opportunities that will contribute to cumulative improvements for Portland's Willamette Watershed and the Willamette River channel as a whole. The subwatershed scale has been identified as the most effective for evaluating watershed improvements (Schueler and Holland 2000). Conditions that impact resources, such as impervious area, are more consistent and readily assessable at this scale. It is more efficient to encourage and support community and individual stewardship at this scale; citizens generally have higher levels of knowledge and interest in the conditions of their local area or stream basin. In addition, neighborhood groups are organized at a similar scale, providing stewardship opportunities for individual and community actions to improve watershed health. Finally, the subwatershed scale is fine enough to conduct thorough field assessments and allow accurate analysis of the extent to which the identified improvement opportunities can contribute to meeting each watershed objective.

The Carolina-Terwilliger IS objectives are built off of the specific conditions of the subwatershed that were identified in the Carolina-Terwilliger Characterization (City of Portland 2008). Opportunities to improve watershed health have been identified through a comprehensive process that included data analysis, review of available information about current and historical subwatershed conditions, field assessments, stakeholder involvement, and City staff input. Potential opportunities are organized by the following strategies: stormwater management; revegetation; aquatic and terrestrial enhancement; protection and policy; operations and maintenance; and education, involvement, and

stewardship.

SECTION 2: BACKGROUND

Improvement Strategies Process

The purpose of the IS process is to identify specific project and program opportunities to protect and improve subwatershed health. These specific opportunities, called actions, are identified through a series of steps that collectively make up the IS process. These steps, and their supporting technical memoranda for the Carolina-Terwilliger subwatershed, are:

Table 1: Improvement Strategies Process and Work Products

Step	Technical Memoranda	Description
Project Management		Plans, schedules, and coordinates each step, and ensures they are completed well and in a timely manner.
Characterization	Carolina-Terwilliger Subwatershed Characterization Summary Technical Memorandum (TM)	Reviews and documents existing subwatershed analysis, conditions data, and information on action opportunities.
	Carolina-Terwilliger Subwatershed Pipe System Data Analysis and Review TM	
	Carolina-Terwilliger Subwatershed Data Analysis and Review TM	
Stakeholder Input	Carolina-Terwilliger Subwatershed Stakeholder Input Summary TM	Identifies all key stakeholders, keeps them informed, and obtains their input throughout the IS process.
IS Development	Improvement Strategies Development TM	Identifies opportunities to apply strategies and implement specific actions. Identifies and ranks subwatershed objectives. Completes field work to identify actions.
IS Evaluation	Improvement Strategies Evaluation TM	Prioritizes, maps, and evaluates actions identified in the IS Development step.
Reporting and Information Management	Carolina-Terwilliger Subwatershed Improvement Strategies Report	Ensures all information collected is documented and shared appropriately to maximize the utility of the work.

Characterization Overview

The Carolina-Terwilliger subwatershed covers 854 acres. It is bounded by the West Hills to the west, the Willamette River to the east, and the Oregon Health and Science University (OHSU) to the north (Figure 1, at the end of this section).

The western two-thirds of the subwatershed are composed primarily of slopes greater than 25 percent. The lower elevations are characterized by gently sloping topography to the Willamette River floodplain. Residential land uses comprise about one half of the subwatershed and are concentrated in the southwest and east. Lands zoned Public/Open Space comprise about one-quarter of the subwatershed and are concentrated centrally and to the north. Commercial areas are generally concentrated along SW Macadam Avenue. Major transportation corridors in the subwatershed include Interstate-5, Barbur Boulevard, Terwilliger Boulevard, and SW Macadam Avenue.

The sanitary and stormwater systems in the upper areas of the Carolina-Terwilliger subwatershed are combined. Sanitary waste from residential and commercial areas is combined with stormwater runoff and routed to the Columbia Boulevard Wastewater Treatment Plant for treatment. The sewer system in the lower riverfront area is separated; sanitary waste from residential and commercial areas is routed to the Columbia Boulevard Wastewater Treatment Plant, and stormwater runoff is routed into pipes that discharge into the Willamette River or flows over land directly into the river (Figure 2, at the end of this section).

Stormwater that is transported through the City's public storm infrastructure and discharged into a water body is regulated under a permit issued by the Oregon Department of Environmental Quality (DEQ) under the federal Clean Water Act (CWA). The permit, called the Phase I National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Permit, requires the City to develop and implement a Stormwater Management Plan (SWMP) in order to control pollutants from stormwater to the maximum extent practicable. Many of the projects identified in this IS report will help provide these pollution control benefits.

The subwatershed is bisected by Interstate 5, Barbur Boulevard, and Macadam Avenue, each of which represents a potential source of polluted stormwater runoff. There are a number of permitted MS4 outfalls and basins associated with these transportation corridors. Both the City and Oregon Department of Transportation (ODOT) hold the permits for the MS4 outfalls related to these roads. Interstate-5/Barbur stormwater runoff is piped to outfall number 04A, which is located in the Carolina-Terwilliger and Marquam-Woods subwatersheds.

Table 2 on the following page provides information about combined sewer overflow (CSO) outfalls that drain the subwatershed. When BES completes its CSO control program in 2011, there will be CSOs to the Willamette River on average four times each year during the winter and once every three years during summer months.

Table 2: Outfall Summary Information for the Carolina-Terwilliger Subwatershed

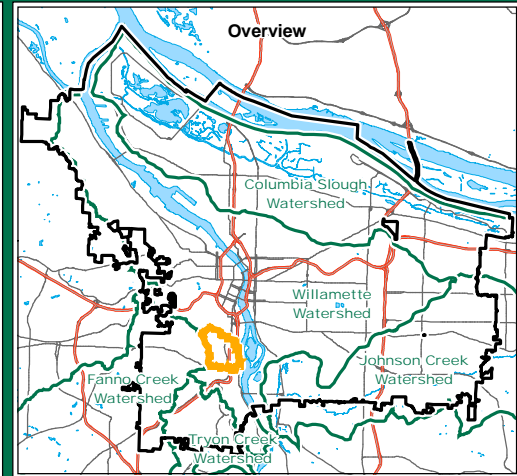
Subwatershed	Outfall	Type	Permitted MS4	Permitted CSO	Owner	River Mile
Carolina-Terwilliger	03	Control ¹	No	Yes	BES ²	15.4
Marquam-Woods and Carolina-Terwilliger	04A & WR-324	Storm/CSP	Yes	No	ODOT	14.5

¹A controlled outfall is a combined sewer outfall that has been designed to meet DEQ requirements and discharges stormwater during most storms from separated areas

² City of Portland, Bureau of Environmental Services

Natural features in the subwatershed include Marquam Nature Park, Keller Woodlands, Terwilliger Parkway, George Himes Park, Cottonwood Bay Natural Area Park, and 0.7 mile of the Willamette River (River mile 14.8 – 15.5). A number of unnamed streams flow through the steep ravines of Marquam Nature Park, George Himes Park, and Terwilliger Parkway (south of Marquam Hill) in the upper subwatershed. The streams are ultimately piped into the combined sewer system through the lower portions of the subwatershed and do not reach the Willamette River.

Nearly half of the subwatershed (419.5 acres) is within an environmental overlay zone. The Environmental Protection zones cover most of Marquam Nature Park, Terwilliger Boulevard, and George Himes Park. Environmental Protection zones make up 99.1 acres or 12% percent of the subwatershed. Environmental Conservation zones compose 320.4 acres or 38% of the subwatershed. Approximately 9.5 acres of the Carolina-Terwilliger subwatershed are within the Willamette Greenway overlay zone. The greenway overlay zones are intended to protect, conserve, enhance, and maintain the natural, scenic, historical, economic, and recreational qualities of lands along the Willamette River (Figure 3, below).



Legend

- City of Portland
- Subwatershed Boundary
- Neighborhood Boundaries
- Open Channel Streams
- Stormwater Pipe or Culvert
- Combined Stormwater/Sewer Pipe

1 inch equals 1,250 feet

0 1,250 2,500 Feet

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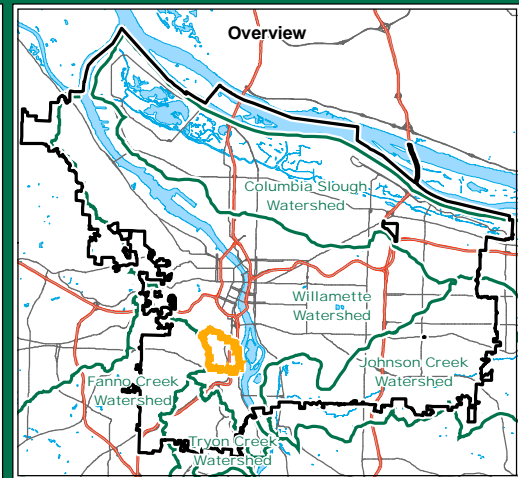
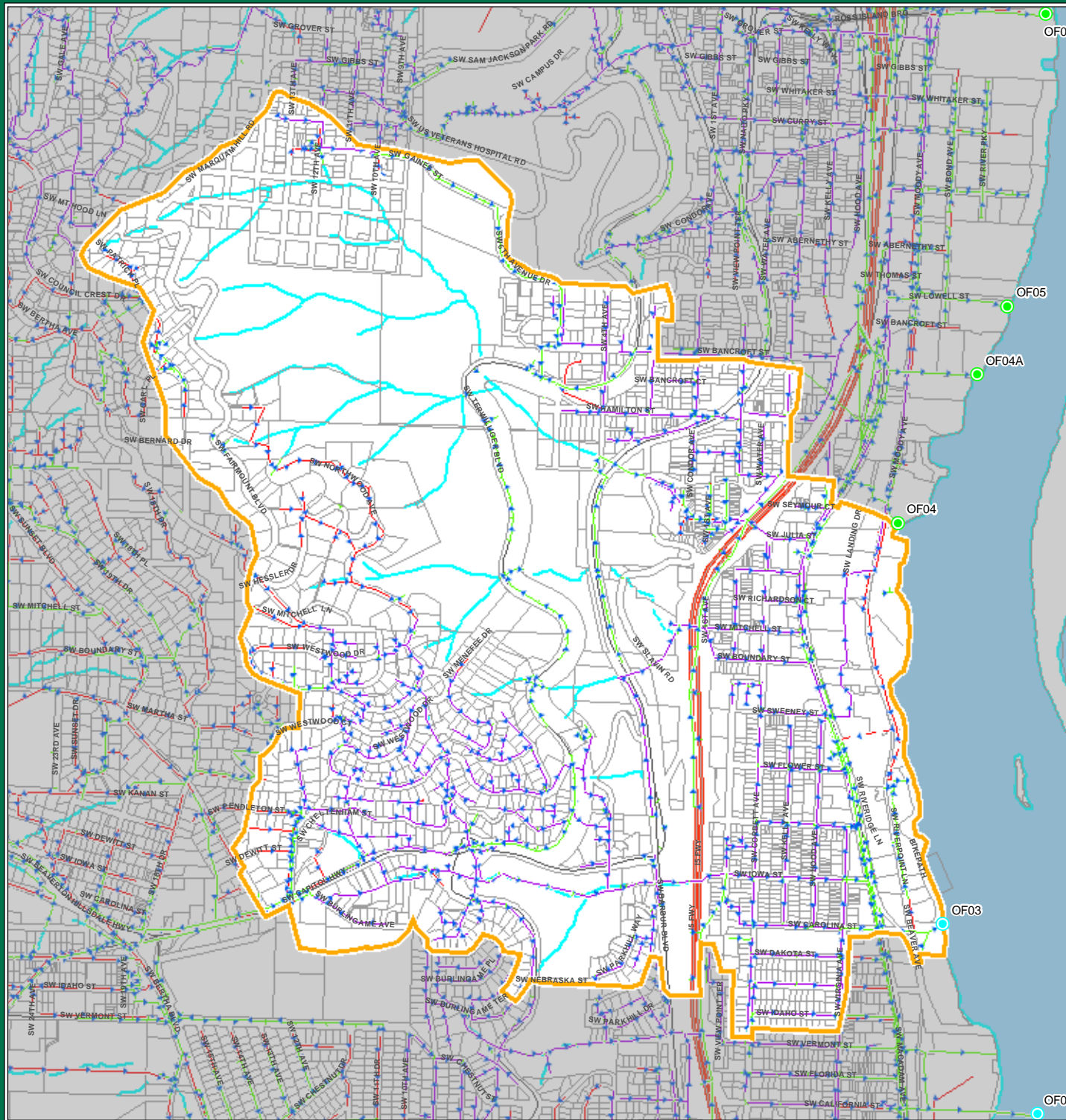
Systems Analysis
Spatial Analysis and Modeling



Southwest Subwatersheds Improvement Strategies

Figure-1
*Carolina-Terwilliger
Subwatershed Overview*

Project No	Date Printed:
8800	05/21/09



Legend

- City of Portland
- Subwatershed Boundary
- Existing Taxlots
- Freeways
- Open Channel Streams
- Existing Sewer System**
- Sanitary Sewer Pipes
- Sanitary Pressure Mains
- Combined Sewer Pipes
- Stormdrain Pipes
- Stormwater Only Outfalls
- CSO Outfalls With Stormwater
- Controlled CSO Outfalls With Stormwater
- Abandoned Outfalls

1 inch equals 1,250 feet

0 1,250 2,500 Feet

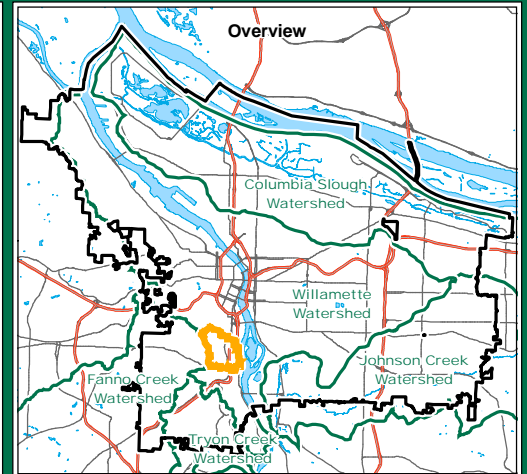
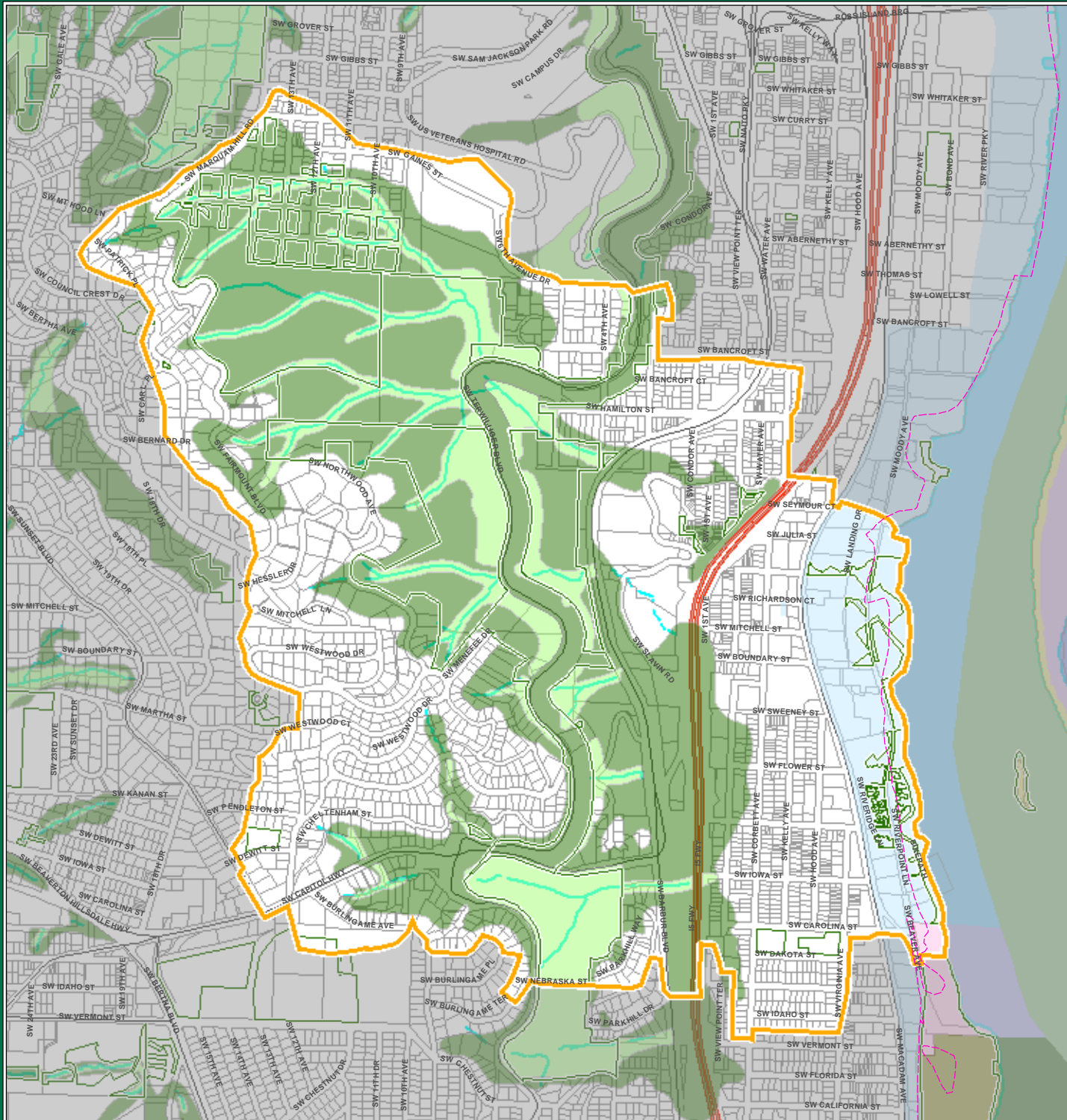
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Systems Analysis
Spatial Analysis and Modeling

Southwest Subwatersheds Improvement Strategies

Figure-2
Carolina-Terwilliger Infrastructure

Project No	Date Printed:
8800	05/21/09



Legend

	City of Portland		Existing Taxlots
	Subwatershed Boundary		Freeways
	100yr Floodplain		Open Channel Streams
	Parks and Open Spaces	Environmental Zones	
	Conservation		Protection

Greenway Zones

	g	River General Overlay Zone
	n	River Natural Overlay Zone
	r	River Recreational Overlay Zone
	q	River Water Quality Overlay Zone
	gq	River General Overlay Zone River Water Quality Overlay Zone
	nq	River Natural Overlay Zone River Water Quality Overlay Zone
	rq	River Recreational Overlay Zone River Water Quality Overlay Zone

1 inch equals 1,250 feet

0 1,250 2,500 Feet

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CITY OF PORTLAND ENVIRONMENTAL SERVICES

Systems Analysis
Spatial Analysis and Modeling

Southwest Subwatersheds Improvement Strategies

Figure-3
Carolina-Terwilliger Natural Resources

Project No	Date Printed:
8800	05/21/09

SECTION 3: SUBWATERSHED CONDITIONS

This section describes significant asset and problem areas in the Carolina-Terwilliger subwatershed. These areas were identified through a detailed review of existing information on subwatershed conditions, which is documented in the following technical memoranda (TM):

- *Carolina-Terwilliger Subwatershed Characterization Summary TM*
- *Carolina-Terwilliger Subwatershed Pipe System Data Analysis and Review TM*
- *Carolina-Terwilliger Subwatershed Data Analysis and Review TM*

Technical memoranda are available by contacting Anne Nelson of the Willamette Watershed Team at (503) 823-2584, or at anne.nelson@bes.ci.portland.or.us.

Carolina-Terwilliger Subwatershed Significant Asset Areas

For the purposes of this report, asset areas are areas that provide important or unique watershed services. Designation as an asset area generally follows recommendations made by two previous City efforts: 1) the City's Draft Natural Resource Inventory: Riparian Corridor and Wildlife Habitat Project Report (NRI), a citywide project to revise and update existing information on natural resources in Portland [Bureau of Planning and Sustainability (BPS)] and 2) the City's Terrestrial Ecology Enhancement Strategy (TEES), which identifies priority wildlife and plant species and terrestrial habitats for protection, conservation, and/or restoration. TEES prioritizes key management and control issues (City of Portland 2007a). Assets were also identified through internal and external stakeholder input.

Sanitary and storm sewer infrastructure is also an asset. All pipes within the basin are included as part of a combined sewer and stormwater system. The "type" is defined by the type of sewer lateral that may be connected to the pipe. Stormwater pipes do not have sewage lateral connections. However, stormwater pipes downstream of diversion structures may receive combined flows during large storm events. Combined pipes in the subwatershed are 14.8 miles in length, stormwater only pipes are 1.7 miles in length and sanitary-only pipes are 3.3 miles in length.

There are six asset areas in the Carolina-Terwilliger subwatershed. Each is discussed in terms of its geographic location in the following sections (Figure 4, at the end of this section).

Willamette River Channel and Shoreline

The Willamette River in Portland has been designated as critical habitat for Chinook salmon and steelhead, which are provided protection under the Endangered Species Act (ESA). The designation is reflected in the City's Draft NRI, which identifies the river's

beaches and shallow water habitat as Special Habitat Areas (SHA). The TEES identified the river corridor as a site with high restoration value.

The Ross Island to Sellwood reach of the river is an important rearing and refuge complex for juvenile salmonids as they migrate from spawning habitats in the upper reaches of the Willamette and Clackamas rivers. The reach has diverse and abundant shoreline vegetation, gently sloping beaches and a natural riverbed relative to the other city of Portland river reaches. The southern portion of this reach falls within the Carolina-Terwilliger subwatershed.

Cottonwood Bay

Cottonwood Bay is a habitat area containing a small wetland, coves, and inlets. Most of the area defined as Cottonwood Bay is privately owned; however, a small portion is managed as a natural area by Portland Parks and Recreation (PP&R). The southern portion of Cottonwood Bay is located in the Carolina-Terwilliger subwatershed. Natural resources in this area provide key ecological functions, and include a mudflat with emergent wetlands and a relatively undisturbed riparian area (City of Portland 2000).

The City's Draft NRI has identified four acres of Cottonwood Bay as special habitat areas. The designation criteria includes a bottomland hardwood forest, migratory bird stopover habitat, a wildlife corridor between patches or habitats, and resources or structures that provide critical or unique habitat function in natural or built environments (City of Portland 2007b). TEES has identified the area's mudflats as an important stopover habitat for migratory and resident shorebirds.



Terwilliger Parkway

Terwilliger Parkway is a three mile scenic, recreational, and wildlife corridor. The parkway consists of approximately 78 acres of primarily forested open space with

Environmental Conservation and Protection zone overlays. A portion of this site is composed of the Terwilliger Nature Park. A trail system provides a connection between Terwilliger Parkway and Marquam Nature Park. A 2003-2004 PP&R inventory found the ecological health of the parkway to be severely degraded due to invasive plants, the impacts of domestic animals, litter, and informal trails. In recent years, stewardship of the parkway has been taken up by a consortium of public and non-profit groups under the direction of PP&R. In addition, the West Willamette Restoration Partnership, spearheaded by the Three Rivers Land Conservancy, is making considerable headway in removing invasive non-native plants from this area.

Marquam Nature Park

Marquam Nature Park is approximately 71 acres fragmented across various locations. The southern half of the park is within the Carolina-Terwilliger subwatershed. Numerous acquisitions over time have begun to link the undeveloped remnants of the steep forested hills. The park is densely forested with steep ravines and has a high to medium habitat value as ranked by the City's Draft NRI (City of Portland 2007b). Four miles of unimproved right of way (ROW) are interspersed between park boundaries. The ROWs are considered undisturbed natural areas that contribute to the habitat quality, and provide pedestrian and wildlife passage.

Keller Woodlands

Keller Woodlands, south of Marquam Nature Park, covers 40 acres. The site is owned and managed by Three Rivers Land Conservancy. The site, located along the heavily trafficked Terwilliger Boulevard and a Marquam Nature Park hiking trail, serves as a demonstration site for the West Willamette Restoration Partnership.

George Himes Park

George Himes Park is a 35 acre natural area that includes paved and unpaved paths and hiking trails. The northern half of George Himes Park is located in the Carolina-Terwilliger subwatershed. A wooded ravine that connects the park to the Corbett neighborhood provides the only wildlife connectivity across Interstate-5 and Barbur Boulevard in southwest Portland. The ravine provides a critical habitat connection between the lower elevations of the subwatershed, to the uplands of Terwilliger Parkway and Marquam Nature Park, and beyond to the Tualatin Hills (City of Portland 1992).

Collectively, the natural areas in the Carolina-Terwilliger subwatershed have been identified as the Westside Wildlife Corridor. The Corridor has been identified by TEES as a critical passageway between anchor habitats. These areas provide a forested spine in the west hills of Portland that will help protect remnants of natural habitat and create a continuous wildlife corridor from Forest Park south to Tryon Creek State Park.

Carolina-Terwilliger Subwatershed Significant Problem Conditions

For the purpose of this report, “problems” are defined as issues that will need to be resolved to a measured extent in order to achieve watershed health objectives defined in the 2005 PWMP. The problems were identified through a review and analysis of Geographic Information Systems (GIS) data, planning documents, scientific research, stewardship activities, inventories, field assessments, and input from City staff and residents. The problems described below are specific to the Carolina-Terwilliger subwatershed, but are organized by their relationship to the citywide watershed health goals and objectives defined in the PWMP.

PWMP Goal #1: HYDROLOGY

PWMP Objective: Stream Flow and Hydrologic Complexity

Carolina-Terwilliger Subwatershed Problem Condition: Stream flow regimes have been greatly altered. High stormwater runoff volume impairs water quality, causes flooding and erosion, degrades habitat quality, and contributes to combined sewer overflows (CSOs). In some sections of George Himes Park, natural channels are intact, but stream flows are drained into a combined sewer pipe.

Source of Problem Condition: The underlying source of the altered stream hydrograph is stormwater contributions from the developed portions of the subwatershed. This is exacerbated by the dewatering of natural channels as well as natural conditions such as slopes and moderate to poorly-draining and erodible soils.

Transportation, residential, and commercial development have resulted in a loss of native understory and canopy vegetation and increased impervious surface. This reduces the volume of water that would naturally infiltrate into vegetated soils resulting in increased flow velocity and volume. The increase in flow and volume causes stream incision, channel erosion, and additional pollutant and nutrient loading to the ecosystem.

Impervious surfaces cover 39.9% of the Carolina-Terwilliger subwatershed and are concentrated along the major north/south transportation routes including Macadam Avenue, Interstate-5, and Barbur and Terwilliger boulevards. These transportation routes comprise the largest portion of impervious area (27.4% of total subwatershed area). Much of the impervious area from parking lots (3.9% of total subwatershed area) is concentrated in the eastern third of the subwatershed. Buildings (8.1% of the total subwatershed area) are concentrated in the far western and eastern portions of the subwatershed.

PWMP Objective: Channel and Floodplain Function

Problem conditions associated with this PWMP objective relate to both the Willamette River mainstem and to its tributary streams within the Carolina-Terwilliger subwatershed.

Willamette River Problem Condition: Floodplain area and connectivity have been greatly reduced or eliminated in the Willamette River bottomland area, which reduces floodplain function.

Source of Problem Condition: Development has eliminated most of the connection between the Willamette River and its current and historic floodplains within city limits. Historically, the Willamette River floodplain bottomland was interconnected with the river's main channel and side channels. Today, the Willamette River bottomlands are piped and filled and the tributaries now flow through pipes.

The reduced level of interaction between the river and the floodplain results in a reduction in attenuation and flood storage functions. Much of the riparian canopy and native vegetation have been removed. Structural complexity from large wood accumulations has been eliminated and the banks have been filled and hardened (City of Portland 2001).

Carolina-Terwilliger Subwatershed Streams Problem Condition: Little floodplain exists in the upper watershed. While some of the upper portions of the streams flowing from the southwest hills to the Willamette River remain intact, many have steeply sloped and eroded banks. The lower portions are piped through the developed residential and commercial areas.

Source of Problem Condition: Development has impacted the channel and floodplain function of the streams in the upper subwatershed. In some sections, the stream channels are intact, but dry, because flow has been drained into combined or stormwater pipes. The dewatering has resulted in the reduction or elimination of floodplain function in several sections of the Carolina-Terwilliger subwatershed's natural areas. Where there are functioning open channels with flowing water, the stream flow is ultimately piped into the combined sewer system. There are no tributary stream channels remaining that reach the Willamette River in the Carolina-Terwilliger subwatershed.

PWMP Objective: Stormwater Conveyance

Carolina-Terwilliger Subwatershed Problem Condition: Stormwater collection and conveyance infrastructure problems; CSOs.

Source of Problem Condition: Much of the Carolina-Terwilliger subwatershed is served by the combined sewer system. Combined sewer areas carry sanitary sewage and stormwater in the same pipe. An increase in impervious surfaces as a result of development has resulted in increased stormwater flow into the combined sewer system. When it rains, stormwater can fill the pipe to capacity causing (CSOs) to the Willamette River.

BES began the West Side Big Pipe project in 2002 in order to control CSOs. The project, completed in 2006, increased sewer system capacity and helps alleviate basement flooding problems. The new pipe system significantly reduces but does not completely eliminate CSOs however, because heavy rains may still fill the system to capacity.

An effective sewer infrastructure is critical to watershed health. Some sewer pipes in the subwatershed have either structural issues or are too small to handle large volumes of stormwater runoff, which may cause street flooding and/or sewers backing up into basements during heavy rain. System capacity analysis was used to identify and evaluate potential areas of street flooding, high-risk areas for basement sewer backup, and related hydraulic capacity problems in the Carolina-Terwilliger basin. Modeling results from the analysis indicated the following:

- *Capacity.* Under existing conditions, 60 pipes have potential capacity problems for the 25-year design storm, representing 9% of pipes in the subwatershed. Under future conditions, potential capacity problems are predicted in 75 pipes, representing 12% of pipes in the subwatershed. Modeling results also indicated 128 pipes (20% of total) may have pipe surcharge¹ problems.
- *Basement flooding.* Under existing conditions, 84 properties were predicted to be at risk of basement sewer backup during the 25-year design storm, and 111 were predicted to be at risk under future conditions.
- *High risk.* Twenty-four properties were predicted to be at risk during the 2-year design storm and 52 were predicted to be at risk during the 5-year design storm.

Detailed information on the Carolina-Terwilliger subwatershed pipe system can be found in the Carolina-Terwilliger Subwatershed Pipe System Data Analysis and Review Technical Memorandum.

Opportunities to solve the hydraulic and pipe condition problems include: conveyance improvements, stormwater separation, inflow controls, watershed projects, and backflow prevention devices.

PWMP Goal #2: PHYSICAL HABITAT

PWMP Objective: Aquatic Habitat

Problem conditions associated with this PWMP objective relate to both the Willamette River mainstem and to its tributary streams within the Carolina-Terwilliger subwatershed.

Willamette River Problem Condition: Simplified channel morphology, hardened banks, vegetation removal, and extensive filling and development in the floodplain have

¹ Pipe surcharges occur when excess water in pipes causes the flow to become pressurized, which is a problem for the majority of sewer pipes in the subwatershed that use gravity to move water. The degree of surcharging of a pipe system directly relates to the risk of basement sewer backups and street flooding.

degraded aquatic habitat in the Willamette River. Off-channel and shallow water habitat have been reduced or eliminated.

Source of Problem Condition:

Upstream hydrologic alterations and water quality impacts have reduced channel habitat value. Historic filling and bank hardening as well as vegetation removal have reduced and degraded channel habitat extent and value. Invasive species and overwater structures such as docks, marinas, and houseboats have further reduced habitat value.

Cottonwood Bay has been identified as a site where aquatic habitat restoration and protection are needed to increase shallow water and off-channel habitat (City of Portland, 2006).



Carolina-Terwilliger Subwatershed

Streams Problem Condition: Open stream reaches are degraded. Piped segments of the streams pose accessibility barriers to potential habitat in the upper subwatershed.

Source of Problem Condition: Development and the subsequent hydrologic alterations, water quality impacts, and vegetation removal have reduced stream channel habitat extent and value. Invasive plant species have further impacted potential habitat. Tributary streams have been piped and filled and are not accessible to Willamette River fish communities. The streams do not support any known fish communities. Data are not available for other aquatic organisms.

Data gaps: Additional study is needed to determine the conditions, extent, and type of aquatic habitat in the Carolina-Terwilliger subwatershed including historic extent of fish habitat, and the current use and extent of habitat for other aquatic organisms.

PWMP Objective: Terrestrial Habitat

Carolina-Terwilliger Subwatershed Problem Condition: The watershed function and habitat value throughout the subwatershed are currently degraded.

Source of Problem Condition: Loss and fragmentation of forest canopy, native vegetation, and open, naturally functioning stream channels have reduced the amount and degraded the quality and connectivity of wildlife habitat. The quantity, connectivity, and distribution of these areas are impacted, and continue to be threatened by residential, commercial, and transportation development.

There are large contiguous tracts of forest and open space in the Carolina-Terwilliger subwatershed, such as Marquam Nature Park, Terwilliger Parkway, and George Himes Park. While they provide large wildlife habitat areas, the predominance of invasive plants has simplified the forest understory and degraded habitat quality and connectivity. Invasive plants such as English ivy, Himalayan blackberry, clematis, and English holly are the main threat to watershed function and habitat quality in these areas. Invasive plants are usually introduced into an environment (i.e., are not native) and spread at such a rate that they cause harm to human health, the environment, and/or the economy. They grow and reproduce quickly, out-compete native species, and reduce habitat diversity for biological communities. Many invasive plant species have shallow root systems that do little to hold the soil and control erosion, especially on stream banks. PP&R's surveys have quantified the extent of non-native species in these parks and found most areas to be poor to severely degraded. Portions of Marquam Nature Park were rated fair. Illegal dumping, adjacent landowner practices, and recreational overuse also contribute to the degradation of these areas.

The ability of these natural areas to function as wildlife habitat is further compromised by the major transportation corridors that bisect them, creating barriers to wildlife movement. These wildlife barriers include Interstate 5, Terwilliger Boulevard, and Barbur Boulevard.

Stream channel segments that have been diverted into the combined sewer system have further degraded habitat value and extent by limiting terrestrial biological communities' access to a perennial water supply.

PWMP Goal #3: WATER AND SEDIMENT QUALITY

PWMP Objective: Stream Temperature

Problem conditions associated with this PWMP objective relate to both the Willamette River mainstem and to its tributary streams within the Carolina-Terwilliger subwatershed.

Willamette River Problem Condition: The lower Willamette River currently violates federal Clean Water Act temperature standards, which places it on Oregon's 303(d) list of water quality limited waters. The Willamette River has established Total Maximum Daily Loads (TMDLs) for temperature.

Source of Problem Condition: The Willamette River channel and banks have been extensively filled, cleared and armored, reducing channel and riparian conditions,

channel structure, complexity and sources of large woody debris. These activities and upstream hydrologic alterations have likely caused increased stream temperatures as well as other water quality impacts.

Data gaps: Information on water quality, including temperature, in the upper subwatershed streams has not been fully studied.

PWMP Objective: Urban Pollutants and Human Pathogens

Carolina-Terwilliger Subwatershed Problem Condition: The lower Willamette River currently violates federal bacteria and mercury standards, which places it on Oregon's 303(d) list. The Willamette River has established TMDLs for the following pollutants: bacteria, temperature, polychlorinated biphenyls (PCBs), dioxin, polycyclic aromatic hydrocarbons (PAHs), and trace metals².

Source of Problem Condition: Urban stormwater nonpoint-source pollution is the likely cause of a significant portion of the water quality problems in this subwatershed. Runoff from various land uses (industrial, commercial, and residential properties) carries soil, metals, oil, grease, bacteria, and chemicals to the river. Stormwater from the commercial and transportation corridors can contribute pollutants such as phosphates, copper, lead, zinc, and chromium to levels that impair water quality. Synthetic organic compounds, such as pesticides and fertilizers, are not produced naturally and are attributable to human activity. Metals are present naturally, but human activities have contributed to increased levels of these pollutants. The subwatershed is bisected by Interstate-5, which represents a significant source of polluted stormwater runoff (i.e., heavy metals, petroleum products) that currently does not receive any treatment before reaching the Willamette River. Other major transportation corridors with stormwater-only pipes that discharge directly to the river are Terwilliger Boulevard and Macadam Avenue.

Some upland sites and river sediments are contaminated with a variety of pollutants such as PCBs, dichlorodiphenyltrichloroethane (DDT), and metals at levels that pose ecological and human health threats. The DEQ Environmental Cleanup Site Information (ECSI) inventory lists sites that may have groundwater, surfacewater, soil, or sediments contamination. Sites in ECSI comprise a wide variety of sizes, locations, features, contaminant profiles, and degrees of Cleanup Program information. Some ECSI sites have minimal information available and need an initial evaluation, while others have completed investigative and remedial actions, and have earned a No Further Action (NFA) decision from DEQ. It is important to note that information contained in ECSI may be unconfirmed, outdated, or incomplete and information is subject to change at any time. There are seven ECSI locations listed in the Carolina-Terwilliger subwatershed.

Data Gaps: Monitoring data are not available for the MS4 outfalls in the Carolina-Terwilliger subwatershed. Monitoring and/or data analysis are needed to quantify the

² The mercury TMDL is a phased TMDL for which no load allocations for non-point sources or wasteload allocations for point sources were set; however, a reduction target was set in 2006 (City of Portland 2008b).

magnitude of contamination at these outfalls, as well as specific sources of pollutants, their locations within the watershed, and their relative contributions.

PWMP Goal #4: BIOLOGICAL COMMUNITIES

PWMP Objective: Fish and Other Aquatic Organisms

Problem conditions associated with this PWMP objective relate to both the Willamette River mainstem and to its tributary streams within the Carolina-Terwilliger subwatershed.

Willamette River Problem Condition: Native fish and other aquatic biological communities in the Willamette River have been greatly impacted by extensive urban development. Native fish species are in decline, and several invasive non-native species are established. Several salmonid species are listed under the state and federal ESA as threatened or endangered.

Source of Problem Condition: The hydrology, habitat, and water quality problems listed previously have contributed to adverse impacts on fish and other biological populations. Little off-channel habitat remains in the Carolina-Terwilliger subwatershed. Off-channel sites (alcoves, lagoons, backwaters, secondary channels) have been eliminated. These factors reduce the quantity and quality of habitat, and alter and reduce habitat complexity.

Carolina-Terwilliger Subwatershed Streams Problem Condition: Stream channels in the upper subwatershed do not support any known fish communities.

Source of Problem Condition: Tributary streams have been piped and filled below Barbur Boulevard. The piped stream reaches pose a barrier between the natural areas in the upper subwatershed and the Willamette River. The remaining open channels do not support any known fish communities.

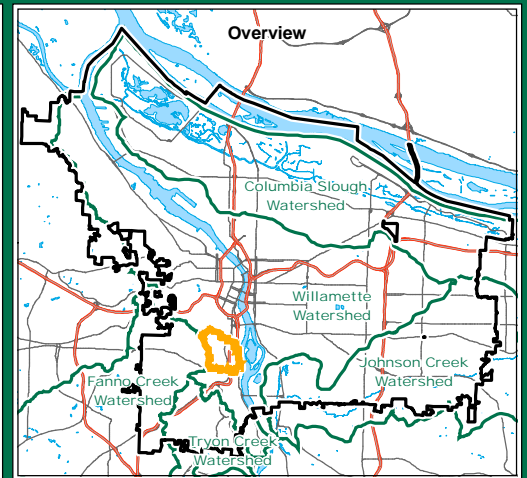
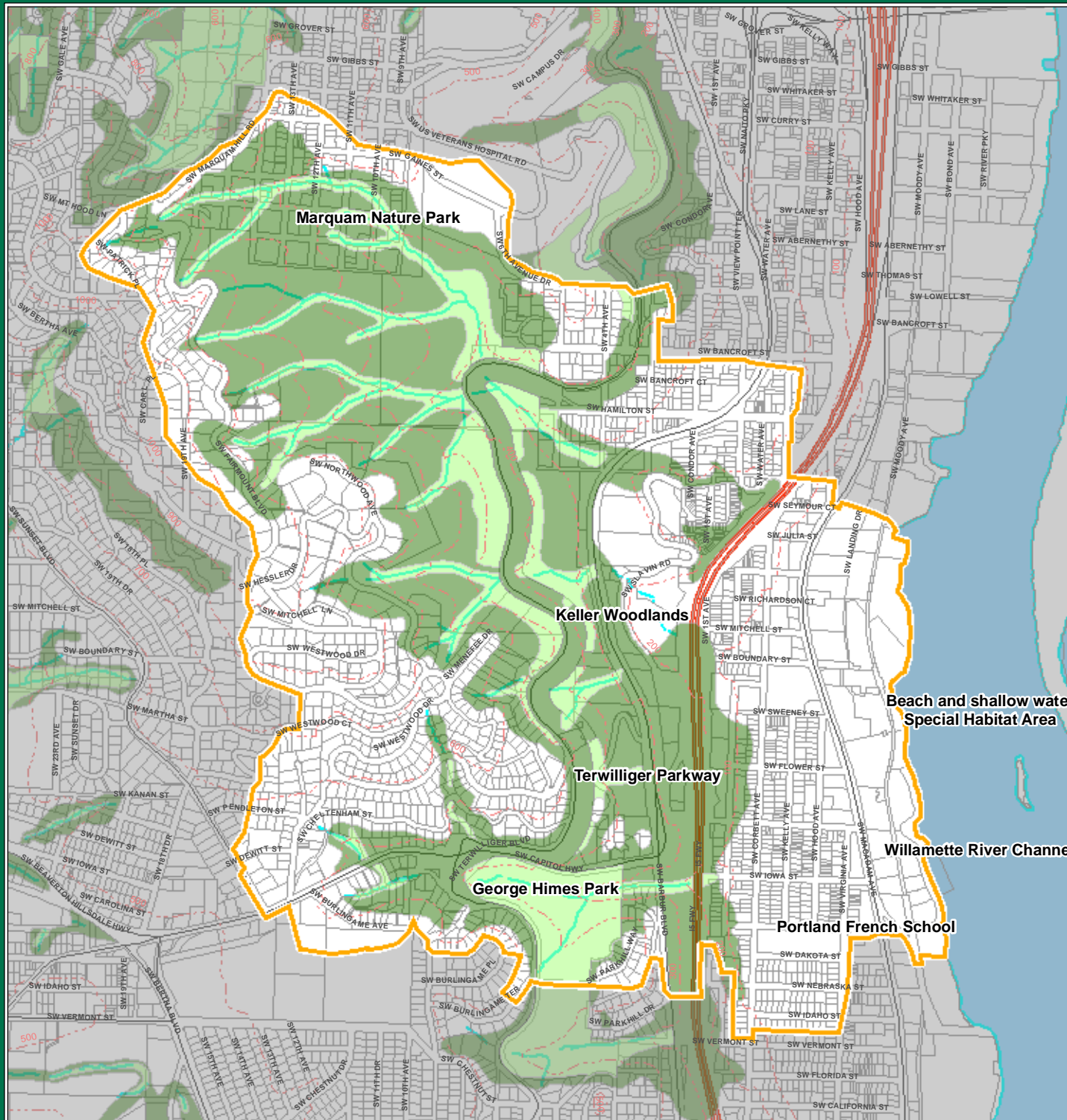
Data gaps: Additional study is needed to determine the conditions, extent and type of aquatic organisms in the Carolina-Terwilliger subwatershed, including historic extent of fish habitat and the current extent of other aquatic organisms. In-stream habitat in the tributary reaches should be evaluated to determine the current and potential habitat quality. Data regarding amphibian and resident fish populations are not available, however, local populations of amphibians and resident fish may be viable in some of the remaining reaches.

PWMP Objective: Terrestrial Wildlife and Vegetation

Carolina-Terwilliger Subwatershed Problem Condition: The native plant and wildlife communities in the subwatershed have been greatly impacted by residential, commercial, and transportation development. The proliferation of invasive species and the inadequate resources devoted to their management in natural and undeveloped areas have further impacted these native communities.

Source of Problem Condition: Development throughout the subwatershed has resulted in a loss and fragmentation of forest canopy and native understory vegetation. The problem of non-native invasive plants is prevalent and persistent in the Carolina-Terwilliger subwatershed. The predominance of English ivy, a highly invasive plant species, has simplified the forest understory and degraded the habitat quality for native species. Terrestrial wildlife habitat barriers also exist at major transportation corridors in the subwatershed, including Interstate-5, Barbur Boulevard, and Macadam Avenue.

Diverting tributary streams has further impacted structural diversity of the forest plant communities and wildlife habitats by eliminating or reducing wetlands and year-round stream flows.



Legend

- City of Portland
- Subwatershed Boundary
- Existing Taxlots
- Freeways
- Open Channel Streams
- 100 ft Contours

Environmental Zones

- Conservation
- Protection

1 inch equals 1,250 feet

0 1,250 2,500 Feet

CITY OF PORTLAND ENVIRONMENTAL SERVICES
Systems Analysis
 Spatial Analysis and Modeling

Southwest Subwatersheds Improvement Strategies

Figure-4
Carolina-Terwilliger Asset Areas

Project No	Date Printed:
8800	05/21/09

SECTION 4: OPPORTUNITY SELECTION AND RANKING

The Willamette Watershed objectives were developed in coordination with the other BES watershed teams, and are documented in the PWMP. The objectives serve as a guide for identifying potential subwatershed actions for improvement strategies. A measure was developed for each objective, to quantify the degree to which potential actions would provide benefit towards achieving the watershed objective.

For the southwest subwatersheds, the PWMP objectives were reviewed and then ranked in order of importance relative to improving the current conditions in the subwatersheds. Results are shown in Table 3. The weights in Table 3 were calculated by applying a formula based upon the objectives' assigned ranks, to refine the analysis for determining their benefits towards improving subwatershed conditions [i.e., improving stream flow (which is ranked number 1) is not necessarily twice as beneficial as improving aquatic habitat (which is ranked number 2)] in the subwatershed.

The ranked objectives, their weights, and their associated measures were then used to prioritize specific subwatershed improvement opportunities, using a multi-attribute utility analysis (MUA) tool. Detailed information on how the PWMP objectives were ranked to produce the southwest subwatersheds objectives and on how the MUA was applied to the improvement opportunities can be found in the Technical Memorandum included in Appendix A.

The results of the MUA assigned scores to each subwatershed improvement opportunity. The opportunities with the highest scores for the highest-ranking objectives were identified as priorities. More information about how the opportunities were identified for evaluation is described in detail in Section 5.

Helpful Definitions

Strategy: Broad categories of approaches to meet subwatershed objectives. There are six strategies in the PWMP. See Section 5 for more detail.

Action: Finer scale than strategy. Actions are projects or programs that are not site-specific.

Opportunity: Project or program that is site-specific. Opportunities are based on needs identified during field assessment.

Table 3: Results of Ranking Process for SW Subwatershed Objectives and Measures

Objective	Measure	Rank	Weight
Stream Flow and Hydrologic Complexity: Protect and increase rainfall interception areas, create infiltration and detention areas to normalize stream hydrographs, reduce stormwater flow to sewer systems, and reduce basement flooding.	Effective Impervious Area (EIA) reduced (acres)	1	0.146

Objective	Measure	Rank	Weight
Aquatic Habitat: Protect and improve aquatic, riparian, and floodplain habitat extent, quality, and connectivity that supports the persistence of native fish and wildlife communities.	Aquatic habitat restored/enhanced (linear feet)	2	0.139
Urban Pollutants: Manage the sources and transport of urban stormwater and industrial pollutants and nutrients to limit surface water, groundwater, soil, and sediment contamination to levels that protect ecological and human health and achieve applicable water quality standards.	Urban pollutants reduced in soil or water (Y/N)	3	0.131
Channel and Floodplain Function: Protect and restore the extent, connectivity, and function of streams, other open drainageways, wetlands, riparian areas, and floodplains to improve bank stability and natural hydrologic functions and reduce risk to development and human safety.	Channel/Floodplain restored or enhanced (acres)	4	0.117
Fish and Other Aquatic Organisms: Implement watershed actions to maximize the persistence of native Willamette and Columbia River fish and other aquatic organisms and assist with species recovery and potential population productivity by protecting and improving hydrology, habitat, and water quality.	Biotic measures improved (Y/N)	5	0.102
Terrestrial Wildlife and Vegetation: Implement watershed actions to restore populations of terrestrial organisms to healthy, self-sustaining levels, protect and restore the composition and structure of native vegetation communities, and reduce populations of non-native plants and organisms to levels that do not compete with native species.	Terrestrial wildlife and vegetation restoration and enhancement (acres)	6	0.095
Terrestrial Habitat: Protect and improve upland habitat extent, quality, and connectivity that support the persistence of native terrestrial communities and connectivity to aquatic and riparian habitat.	Terrestrial habitat protected through acquisition (acres)	7	0.088
Human Pathogens: Maintain and manage sewer infrastructure and stormwater inputs and runoff to limit sewage overflow and the delivery of pathogens to waterways and achieve applicable water quality and sewer design manual standards.	Fecal inputs reduced (Y/N)	8	0.080
Stream Temperature: Protect and improve stream temperatures, dissolved oxygen, and pH levels that protect ecological health and achieve applicable water quality standards.	Stream temperature maintained/reduced (Y/N)	9	0.058
Stormwater Conveyance: Maintain stormwater collection and conveyance infrastructure capacity.	Substandard Stormwater pipes maintained (Y/N)	10	0.044

SECTION 5: STRATEGIES AND ACTIONS

The watershed health objectives outlined in Section 4 describe the desired changes in watershed conditions and functions. The PWMP outlines six strategies to bring about those changes. Strategies are broad approaches that are used to work toward the watershed goals and objectives. The six strategies are: Stormwater Management, Revegetation, Aquatic and Terrestrial Enhancement, Protection and Policy, Operations and Maintenance, and Education, Involvement, and Stewardship.

Actions are general projects or programs implemented to achieve the strategies. Table 4 summarizes the watershed strategies and actions as outlined in the PWMP. Additional actions, specific to the Carolina-Terwilliger subwatershed, were identified by a city-staffed technical advisory team (Appendix A) and external stakeholder input. This information is summarized in this section.

Table 4: PWMP Strategies and Actions

STRATEGIES	ACTIONS
Stormwater Management	Modify the storm drainage system to increase infiltration and maximize evapotranspiration
	Modify the storm drainage system to increase reuse or detain stormwater
	Modify the storm drainage system to treat stormwater pollutants
	Modify the storm drainage system to separate the flow from combined storm/sanitary sewer
Revegetation	Increase the extent of canopy and other vegetative cover
	Improve the quality and composition of vegetative cover
Aquatic and Terrestrial Enhancement	Restore channel and floodplain function and stability
	Restore or create river, stream, wetland, and terrestrial habitat structure and function
	Restore habitat connectivity and access
	Manage for appropriate native species
Protection and Policy	Implement management of erosion, sediment, and pollutant discharge from construction sites
	Implement management of stormwater for all new and redevelopment projects
	Implement management of pollutant discharges for industrial and commercial sites
	Protect sites and features with high watershed values and functions
Operations and Maintenance	Operate and maintain the storm sewer system, public rights-of-way, greenspaces and other city facilities and infrastructure to remove and prevent pollutant discharges
	Reduce illicit and non-stormwater discharges
	Maintain and repair sewer systems to ensure conveyance for current demand and future growth

Education, Involvement and Stewardship	Promote watershed awareness with city staff, schools, the business community, organizations, and general public
	Provide pollutant prevention education to city staff, the business community, organizations, and general public
	Provide technical assistance and incentives to city staff, schools, the business community, organizations, and general public

Once the actions were identified, they were evaluated for the Carolina-Terwilliger subwatershed using field assessments to develop opportunities, or site-specific projects and programs. The field assessments verified current subwatershed conditions (i.e., asset areas and problem conditions) and identified opportunities to address the problems or to protect these assets. The field assessments involved an overview of all streams, resource areas, and developed and undeveloped upland areas within the subwatershed, and resulted in detailed documentation of all potential action sites (See Appendix A for more information).

The summary is not intended to be exhaustive of opportunities to improve watershed health in the Carolina-Terwilliger subwatershed, but rather serve as an illustration of how the project team arrived at the specific action opportunities outlined in Section 6.

Some potential actions address many needs and could be included under more than one strategy but, to avoid duplication, are listed under only one strategy.

Stormwater Management

Stormwater management is an essential component of watershed health improvements. Development, and the consequent increase in impervious surfaces, increases the volume and velocity of stormwater runoff which can lead to flooding and erosion, habitat degradation, and impaired water quality. Managing stormwater runoff through site design or retrofits of existing development can reduce these effects. Directing runoff to natural systems like landscaped planters, swales, and rain gardens, or implementing an ecoroof reduces and filters stormwater runoff. Consideration should be given to site constraints arising from geotechnical (e.g., soils/infiltration) and environmental issues (e.g., contamination).

The following is a summary of potential stormwater management actions for the Carolina-Terwilliger subwatershed:

- Identify opportunities to increase infiltration for onsite stormwater management at schools and institutions, take advantage of low grade areas and large public right of ways.
- Explore daylighting options for the streams that are currently draining into the combined sewer system.

- Identify opportunities to treat polluted stormwater runoff from major transportation corridors such as Interstate 5.
- Explore opportunities in the right of way (ROW) at Miles Place.

Revegetation

Removing non-native, invasive species and planting native vegetation is a key strategy to meet watershed goals. Increasing the amount of canopy cover and native vegetation improves the physical-biological elements of the urban environment such as water quality, stream integrity, and fish and wildlife habitat. Vegetation intercepts, stores, and absorbs rainfall as well as filters pollutants and nutrients from stormwater runoff. Revegetation efforts can also produce aesthetic, economic, and other community benefits.

The following is a summary of potential revegetation actions for the Carolina-Terwilliger subwatershed:

- Explore revegetation opportunities in Marquam Nature Park, Cottonwood Bay, and other asset areas.
- Increase the extent of canopy and other vegetative cover.
- Manage vegetation for fire safety: remove invasive plants from high fire risk areas.
- Reduce and revegetate informal trails on public land.
- Improve native vegetation as food sources for wildlife.

Aquatic and Terrestrial Enhancement

Aquatic and Terrestrial enhancements improve hydrology, physical habitat, water quality, and biological communities. Restoring channel complexity and increasing riparian vegetation helps normalize stream flows, provide flood storage, and recharge ground water. Natural areas enhancements improve habitat and protect biodiversity.



The following is a summary of potential aquatic and terrestrial enhancement actions for the Carolina-Terwilliger subwatershed:

- Increase connection between the Willamette River and the floodplain.
- Improve bank conditions by softening banks.
- Vegetate floodplain with bottomland hardwood forest species.
- Increase shallow water habitat and protect off-channel areas (alcoves, lagoons, backwaters, secondary channels) and riparian habitats.
- Revegetate stream banks in the upland natural areas of the subwatershed.
- Reduce the number of piped stream segments that pose barriers to habitat connectivity for fish and amphibians, and that prevent wildlife accessibility.
- Retain snags and downed wood in ravines in the southwest hills.
- Reduce yard and other debris on public land.
- Reduce the impacts of domestic animals on public lands.
- Restore habitat connectivity and access.
- Manage or reduce the number of structures such as pilings, docks, marinas, and houseboats that are common in the reach to reduce cover for introduced aquatic species that prey on salmonids.

Protection and Policy

Protecting important watershed functions and applying policies that integrate sustainable practices into citywide plans and projects are important to watershed health. Conservation and protection of existing vegetation, stream channels, and wetlands are critical strategies to achieve watershed health.

The following is a summary of potential actions for the Carolina-Terwilliger subwatershed:

- Pursue acquisitions of privately owned land.
- Coordinate and collaborate with ODOT on their Interstate-5 bridge replacement project.
- Partner with Bureau of Planning and Sustainability (BPS) on the River Plan and other projects to protect, conserve, and restore natural resources.

Operations and Maintenance

The City operates and maintains a wide variety of infrastructure, such as storm, sanitary and combined sewer systems and wastewater treatment plants, that benefits and helps protect public health and safety, water quality, and property. Effective operation and maintenance practices are essential to watershed health.

The following is a summary of potential operations and maintenance actions for the Carolina-Terwilliger subwatershed:

- Work collaboratively with Maintenance Operations in the Portland Bureau of Transportation (PBOT) to remove/control roadside invasive plant species and install green streets in public ROWs.
- Support staffing for PP&R maintenance staff to include trail maintenance, invasive removal, and trash removal (including pet waste).

Education, Involvement and Stewardship

The Education, Involvement, and Stewardship strategy is integrated into all other strategies. Public involvement and stewardship encourages citizens to get involved in the work of protecting our natural resources. Raising awareness of watershed issues and fostering stewardship of city-owned natural areas promotes healthy watersheds.

The following is a summary of potential education, involvement, and stewardship actions for the Carolina-Terwilliger subwatershed:

- Provide education to the general public and organizations on the impacts of informal trails and domestic animals on watershed functions.
- Provide education to organizations and the general public on the problem of non-native invasive plants and their impacts on watershed functions.
- Develop signage to increase public awareness.
- Provide education to the landowners at the headwaters of streams on riparian enhancement and native vegetation.

SECTION 6: PROJECT OPPORTUNITIES

This section describes specific actions that can be taken throughout the Carolina-Terwilliger subwatershed to improve subwatershed health. They are geographically specific applications of the potential actions outlined in Section 5. Opportunities to improve watershed health were identified according to the process that included data analysis, review of available information of current and historical subwatershed conditions, field assessments, stakeholder involvement, and City staff input, and then scored and ranked according to the process described in Section 4. They are organized by the six PWMP strategies presented in Section 5 (Figure 5).

A single list of ranked projects was developed across all strategies; however, for descriptive purposes, the projects are organized below in tables by PWMP strategy. Therefore, the ranking is not sequential within each set of strategies. Citywide programmatic opportunities were not included in the subwatershed objective ranking

process and did not receive a ranking; however, they are included in the tables in this section.

Stormwater Management Opportunities

The specific stormwater projects and programs presented in Table 5 are designed to improve natural stormwater function, and are the foundation for all other watershed protection and improvement efforts. These projects help minimize the effects of development on watershed processes and natural conditions, providing water quality treatment, flow attenuation, interception and infiltration, reduced channel erosion, improved aquatic habitat conditions, and protection of downstream restoration projects. Projects include structural retrofits and other stormwater management measures that reduce effective impervious area (EIA) by promoting interception, infiltration, retention, and detention as well as by collecting and limiting contaminant transport. Some potential project sites may

be constrained by geotechnical (soils/infiltration) concerns and other environmental issues (contamination).

Environmental site assessments will be conducted at a later planning stage.

Education and outreach is a critical element of improving watershed health and will be incorporated into all stormwater management projects.



Selection, design, and implementation of these projects will be coordinated with or rely directly on a variety of City partners and programs. Critical partners, programs, and regulatory requirements include: Portland Bureau of Transportation (PBOT), PBOT Maintenance Operations, Urban Forestry, NPDES MS4 permit program, Underground Injection Controls, TMDLs, CSOs, Clean River Rewards (stormwater discount) Program, Clean Rivers Education Program, Downspout Disconnection Program, Sustainable Stormwater Program, Community Watershed Stewardship Program, and the 2008 SWMM.

The process of identifying stormwater management opportunities through watershed field assessments included many internal and external stakeholders. The BES Asset

Management System Analysis and Sustainable Stormwater groups were key players in this process. Staff from both groups took part in a mapping workshop and provided feedback that was used to guide the IS field assessments and the subsequent development of potential projects.

The subwatershed IS process also integrated information gathered from the Combined System Sewer Plan (CSSP) inflow control (IC) field assessments conducted in spring 2007. These assessments were used to identify potential projects and have been organized by stormwater facility type and project area.

Opportunities that have been identified on private properties will not be pursued without the consent and cooperation of affected property owners. Opportunities identified on properties owned or managed by PP&R will follow the process established through a Memorandum of Understanding (MOU) between PP&R and BES. The MOU process will be used to guide the implementation of any opportunities selected for concept planning or design development.

Table 5: Carolina-Terwilliger Subwatershed Stormwater Opportunities

Rank	Project/Program	Location	Project/Program Description
1	Carolina Urban Stream Daylighting	French American School, SW Corbett	Create urban stream channel at French American School, daylight stormwater that is currently in combined system. Protect substandard pipes. Create new stormwater-only pipe to the Willamette River. Pretreat stormwater runoff before it discharges to the river.
4	SW Bancroft to SW Homestead Stormwater Control	Bancroft to Homestead above Terwilliger	Stormwater eroding bank where volunteer revegetation project is underway. Create curb to protect revegetation project, capture stormwater running off large impervious street surface. Stormwater goes to Woods Outfall.
6	George Himes Park Stream Daylighting (North Reach)	George Himes Park	Daylight stream. Include area west of Terwilliger Boulevard through George Himes Park to end of ODOT ROW at Corbett Neighborhood.
11	Dynalectric Ecoroofs	5805 & 5711 SW Hood	This tax lot was identified by the Systems Analysis Group for potential disconnection from the combined system. It is in an area where there is a need for pipe upsizing and/or stormwater separation to reduce the risk of basement sewer backups. This project would install ecoroofs on both Dynalectric buildings.
13	SW Iowa Street Green Street	SW Iowa/Virginia	This area was identified by the Systems Analysis Group for potential disconnection from the combined system. It is in an area where there is a need for pipe upsizing and/or stormwater separation to reduce the risk of basement sewer backups. This project would install green streets at the intersection of SW Iowa and SW Virginia streets. Two vegetative swales could be located in the parking strip ROW on Iowa (NW corner) and Virginia (North of Iowa).
14	SW Macadam Grill Stormwater Retrofit	5833 SW Macadam Avenue	This tax lot was identified by the Systems Analysis Group for potential disconnection from the combined system. It is in an area where there is a need for pipe upsizing and/or stormwater separation to reduce the risk of basement sewer backups. This project would retrofit the parking lot by extending the existing planter near the building entrance to capture parking lot runoff. The downspout near the entrance could also be rerouted into

Rank	Project/Program	Location	Project/Program Description
			this facility.
15	Southwest Charter School Ecoroof	5839 SW Hood Avenue	This tax lot was identified by the Systems Analysis Group for potential disconnection from the combined system. It is in an area where there is a need for pipe upsizing and/or stormwater separation to reduce the risk of basement sewer backups. This project would install an ecoroof on the school. The ecoroof would be visible from sidewalk, providing a great outreach opportunity.
16	The Water Tower Stormwater Retrofit	5331 SW Macadam Avenue	This tax lot was identified by the Systems Analysis Group for potential disconnection from the combined system. It is in an area where there is a need for pipe upsizing and/or stormwater separation to reduce the risk of basement sewer backups. This project would retrofit the Water Tower's parking lot by narrowing the driving lane in the southeast corner of the lot and constructing a bioswale to capture 25% of the lot runoff.
17	435 SW Iowa Street Parking Lot Retrofit	435 SW Iowa Street	This tax lot was identified by the Systems Analysis Group for potential disconnection from the combined system. It is in an area where there is a need for pipe upsizing and/or stormwater separation to reduce the risk of basement sewer backups. This project would regrade the parking lot to route lot runoff to a bioswale on the west side of the sidewalk.
18	435 SW Iowa Street Ecoroof	435 SW Iowa Street	This tax lot was identified by the Systems Analysis Group for potential disconnection from the combined system. It is in an area where there is a need for pipe upsizing and/or stormwater separation to reduce the risk of basement sewer backups. This project would install an ecoroof on a light industrial building.
19	Southwest Charter School Stormwater Retrofit	5839 SW Hood Avenue	This tax lot was identified by the Systems Analysis Group for potential disconnection from the combined system. It is in an area where there is a need for pipe upsizing and/or stormwater separation to reduce the risk of basement sewer backups. This project would install vegetative planters along a school building on SW Pendleton and Hood avenues.
20	Dynalectric Stormwater Retrofit	5805 & 5711 SW Hood	This tax lot was identified by the Systems Analysis Group for potential disconnection from the combined system. It is in an area where there is a need for pipe upsizing and/or stormwater separation to reduce the risk of basement sewer backups. This project would retrofit both parking lots. The parking spaces in the lot on SW Hood could be reconfigured to allow for a swale without losing parking spaces. A swale or planter could manage stormwater in the parking lot on SW Flowers.
21	Over The Landing Salon Ecoroof	5511 SW Hood	This tax lot was identified by the Systems Analysis Group for potential disconnection from the combined system. It is in an area where there is a need for pipe upsizing and/or stormwater separation to reduce the risk of basement sewer backups. This project would install an ecoroof on the Over The Landing Salon building.
23	CSSP Parking Lot Retrofits: Carolina-Terwilliger Project Area	Multiple	This area has been identified by the Combined Sewer System Plan (CSSP) as having sewer capacity issues. In this project area, the CSSP Field Team identified 14 potential parking lots that could be retrofitted.
24	OHSU Parking Lot 93 Retrofit	OHSU Marquam Hill	This project was one of 30 Capital Improvement Program (CIP) Projects identified by OHSU through their Stormwater Management Plan (October 2007). Replace parking stall areas and entrance on SW 6th

Rank	Project/Program	Location	Project/Program Description
			Avenue with pervious pavement. Install flow-through planters in existing island areas, and use curb cut inlet structures to introduce flows. Construct one flow-through planter along the southwest edge of the lot to capture runoff from the southern portion that currently drains into the west inlet. Construct a swale at the south end along SW 6th Avenue to treat runoff that flows into the east inlet.
25	5100 SW Macadam Parking Lot Retrofit	5100 SW Macadam	Retrofit office building parking lot with vegetated swales (Tax lots 5100 SW Macadam and 505 S/SW Landing Square Drive). Use existing landscaped planters to create swales.
26	CSSP Carolina Terwilliger Green Streets: Corbett/Macadam Project Area	Multiple	This area has been identified by the CSSP as having sewer capacity issues. In this project area, bounded by SW Corbett, Boundary, Macadam and Iowa Streets, the CSSP Field Team identified eight potential locations for stormwater facilities.
28	CSSP Roof Retrofits: Carolina Terwilliger Project Area	Multiple	This area has been identified by the CSSP as having sewer capacity issues. In this project area, the CSSP Field Team identified three potential sites for downspout disconnections.
29	Stream Daylighting of Culvert ACH562	SW Trail #6, Culvert ACH562, just off Northwood Avenue	Daylight a short stream segment located along SW Trail #6, at BES culvert number ACH 562-5721. This section of stream is currently piped under a trail. Removing this section of pipe would reconnect the stream to its headwaters. This project is also a potential acquisition opportunity.
30	CSSP Green Streets: SW Barbur/Corbett Project Area	SW Barbur/Corbett Area	This area has been identified by the CSSP as having sewer capacity issues. In this project area (west of Interstate-5, east of Terwilliger and north of Slavin), the CSSP Field Team identified three potential locations for stormwater facilities.
32	CSSP Green Streets: Carolina-Terwilliger, West of Terwilliger Project Area	West of SW Terwilliger Parkway	This area has been identified by the CSSP as having sewer capacity issues. In this project area (west of Terwilliger Parkway), the CSSP Field Team identified nine potential locations for stormwater facilities.
33	Macadam Center Pervious Asphalt Parking Lot	5125 SW Macadam (back parking lot)	Install pervious asphalt in the back parking lot of Macadam Center.
34	5025 SW Corbett Ecoroof	5025 SW Corbett	Install ecoroofs on two narrow apartment buildings.
35	Barbur Triangle Retrofit	SW Barbur/Hamilton	Create a stormwater facility in a large paved triangle area at the intersection of SW Barbur and Hamilton to capture runoff from Barbur and reduce impervious surface at the intersection. The area is highly visible, providing outreach opportunities.
36	CIDA Building Downspout Disconnect	4445 SW Barbur	Disconnect downspouts on the CIDA building into existing planters.
37	CIDA Building Ecoroof	4445 SW Barbur	Install an ecoroof on the CIDA building.
38	Riverside Center Ecoroof	5100 SW Macadam	Install an ecoroof on the Riverside Center building.
39	The Landing Parking Lot Retrofit	5200 SW Macadam Ave.	Install a swale through the center of the lot to capture runoff. Re-stripe The Landing parking lot to allow for swale.
40	5550 SW Macadam Ecoroof	5550 SW Macadam	Install an ecoroof on the 5550 SW Macadam building.
41	Sorenson Photography Parking Lot Vegetative Stormwater Planter	5221 SW Corbett (back lot at SW Corbett/Mitchell)	Install two vegetative stormwater planters in the large parking lot behind the photography studio. This large impervious area is not used as a parking lot and presents a good opportunity for a stormwater retrofit.

Rank	Project/Program	Location	Project/Program Description
42	Sorenson Photography Ecoroof	5221 SW Corbett	Install an ecoroof on the Sorenson Photography building.
43	Corbett Center Parking Lot Vegetative Stormwater Planter	4515 SW Corbett	Install a vegetative stormwater planter to capture and treat runoff from the Corbett Center Parking lot.
44	Next Generation Children's Center Ecoroof	5210 SW Corbett	Install an ecoroof on the building shared by NGCC and Modurne Home Furnishings.
45	CIDA Building Parking Lot Vegetative Stormwater Planter	4445 SW Barbur	Install a vegetative stormwater planter to capture and treat runoff by removing two parking stalls adjacent to the inlet.
46	The Landing Ecoroof	5200 SW Macadam	Install an ecoroof on the 5200 SW Macadam office building.
47	5550 SW Macadam North Parking Lot Retrofit	5550 SW Macadam	Remove far east end parking spot(s) to create swale that captures and treats runoff before it enters the river. Parking lots appear to have very low usage.
48	5410 SW Macadam Ecoroof	5410 SW Macadam	Install an ecoroof on the building at 5410 SW Macadam.
49	Seventh Day Adventist Church Main Parking Lot Retrofit	26 SW Condor Way	Retrofit the main church parking lot, which is extra large with a very wide driving lane. Reconfigure the lot and construct a swale in the southeast corner. Install interpretive signage.
50	Next Generation Children's Center Parking Lot Stormwater Planters	5210 SW Corbett	Install vegetative stormwater planters in two loading bay areas to capture and treat stormwater runoff.
51	Portland French School Roof Rain Garden	6318 SW Corbett	Install a rain garden or flow-through basin within an asphalt playground to treat roof runoff, reduce impervious area, and improve microclimate adjacent to building windows, similar to Mt Tabor School.
52	Swan Mart Parking Lot Island Retrofit	SW Barbur/Hamilton	Create a stormwater facility in parking lot island on the corner of SW Barbur and Hamilton.
53	Macadam Center Vegetative Swale	5117-5131 SW Macadam (north section of front lot)	Install a bioswale on the east side of the north section of parking lot. Facility will need to be lined due to adjacent slope/retaining wall.
54	Portland French School Playground Swale	6318 SW Corbett	Install a rain garden or swale in the existing grass area east of the paved playground area. Existing inlet receives runoff sheet flow from the majority of hardscape playground. Could also take runoff from disconnected downspouts through runnels across the playground.
55	John's Landing Dry Cleaners Parking Lot Vegetative Stormwater Planters	5221 SW Macadam	Install a vegetative stormwater planter in parking lot to capture and treat stormwater runoff.
56	5550 SW Macadam West Parking Lot Retrofit	5550 SW Macadam	Construct two swales in the parking lot around existing inlets by removing approximately three parking spaces. Extend existing planter and narrow exit lane to construct additional swale.
57	Seventh Day Adventist Church SE Parking Lot Retrofit	26 SW Condor Way	Retrofit small lot off of SW Viewpoint Terrace (one of three church parking lots). Remove one parking space and install infiltration planter at the existing inlet. The lot is sloped and the inlet appears to be clogged, stormwater is eroding landscaped area.
58	Seventh Day Adventist Church NE Parking Lot Retrofit	26 SW Condor Way	Retrofit small northeast parking lot off SW Viewpoint Terrace. Reconfigure parking to install an infiltration planter at the existing inlet on the eastern side of the lot. Proximity to property line and house next door (likely with a basement) may be concern.

Rank	Project/Program	Location	Project/Program Description
59	Seventh Day Adventist Church Downspout Disconnect	26 SW Condor Way	Disconnect downspouts on east side of church building. Remove some sidewalk and create rain garden in existing landscaped area. Could also install soakage trench if church did not want to lose sidewalk/yard.
60	Chevron Food Mart Parking Lot Vegetative Stormwater Planter	5235 SW Macadam	Install a vegetative stormwater planter in parking lot to capture and treat stormwater runoff.
61	Best Friend's Veterinary Medical Center Downspout Disconnect	0123 SW Hamilton	Disconnect downspouts of building and direct flow into existing planters. Line planters.
62	Portland French School Flow-Through Planters North and South	6318 SW Corbett	Install flow-through planters on the landscape strips between the building and sidewalk on the north and south sides of property. Each side has three downspouts and a six-foot wide unused landscaped area.
63	Portland French School Rain Garden West	6318 SW Corbett	Install a rain garden or swale on either side of the main entrance to the school.
64	Portland French School Parking Lot Retrofit	6318 SW Corbett	Remove parking stall around inlet and replace with rain garden or swale.
65	Portland French School Rain Garden East	6318 SW Corbett	Install rain garden in lawn area east of secondary school building on Carolina Street. Disconnect building downspouts and manage sheet flow from surface and roofs.
66	Portland French School Front Walkway Swale	6318 SW Corbett	Install vegetative swale to collect walkway runoff near main entrance of school. Existing inlet could serve as overflow. High visibility.
67	Sorenson Photography Vegetative Swale	5221 SW Corbett/Boundary	Install a vegetative swale in the planter strip along SW Boundary.
69	Sorenson Photography Bottom Parking Lot Vegetative Stormwater Planter	5221 SW Corbett (corner of SW Corbett/Boundary)	Install a vegetative stormwater planter in the bottom corner of parking lot to capture and treat stormwater runoff.
70	SW Westwood Water Bureau Tank Runoff	938 SW Westwood Ave.	This area has been identified by the CSSP as having sewer capacity issues. Install a planter or swale to treat sheet flow runoff from a Water Bureau tank.
71	OHSU Parking Lot 94 Retrofit	OHSU Marquam Hill	This project was one of 30 CIP projects identified by OHSU through their Stormwater Management Plan. Decrease the width of the existing parking lot access aisle from 33 feet to 24 feet. Remove asphalt pavement, existing trench drain, and curb, and replace with a vegetated swale.
72	OHSU CDRD Front Entrance Planter	OHSU Marquam Hill	This project was one of 30 CIP projects identified by OHSU through their Stormwater Management Plan. Install contained planters near front entrance to reduce impervious surface.
73	SW Virginia Green Street	SW Virginia between SW Dakota and Nevada streets	Install a series of street swales (curb extensions) along SW Virginia Avenue between SW Dakota and Nevada streets. This project is being funded by a Community Benefit Opportunity (CBO) grant that was originally aimed at street calming.
85	Terwilliger Creek Trail Erosion Control	Terwilliger Creek Trail	Develop a natural 'Terwilliger Creek'. Install a stormwater facility to slow rain events at developed uplands, reduce Effective Impervious Area (EIA), revegetate stream bank, and restore stream channel meander.
87	Portland French School Curb Extensions	Multiple Areas around SW Corbett and SW Carolina	Retrofit curb extensions at nearly every inlet on streets surrounding Portland French School by removing some parking. Identify where pedestrian crossings are most frequent. Project could have good synergy with potential

Rank	Project/Program	Location	Project/Program Description
			Carolina Creek daylighting. Many of these intersections also identified in the CSSP as areas with capacity issues.

Revegetation Opportunities

Efforts to preserve native vegetation will increase the City’s ability to achieve and maintain healthy watersheds. Increasing canopy cover and native vegetation improves the physical-biological elements of the urban environment, such as water quality, stream integrity, and fish and wildlife habitat. Revegetation projects can also result in cost savings on infrastructure expenditures, as well as produce aesthetic, economic, and other community benefits.

Removing invasive plant species is a critical element of the revegetation strategy. Invasive plants impact watershed health by degrading water quality by increasing erosion, reducing biodiversity, altering habitat quality, reducing tree cover, and changing soil characteristics. The City of Portland has a number of plans and programs that support invasive removal including the PWMP, the City’s Invasive Plant Strategy, the BES Early Detection and Rapid Response Program, and PP&R’s Protect the Best program. Selection, design, and implementation of revegetation opportunities will be coordinated with these plans and programs.

The Willamette team worked closely with the BES Watershed Revegetation Team, PP&R’s City Nature, the West Willamette Restoration Partnership, and others to identify potential projects. Education and outreach is a critical element of improving watershed health and will be incorporated into all revegetation projects.

Opportunities that have been identified on private properties will not be pursued without the consent and cooperation of affected property owners. Opportunities identified on properties owned or managed by PP&R will follow the process established through a MOU between PP&R and BES. The MOU process will be used to guide the implementation of any opportunities selected for concept planning or design development.

Table 5: Carolina-Terwilliger Subwatershed Revegetation Opportunities

Rank	Project/Program	Location	Project/Program Description
68	The Landing Revegetation	5200 SW Macadam	Revegetate back lawn of The Landing condominium units west of the Greenway Trail. Currently the area is maintained grass with the likely use of chemical fertilizer and/or herbicides. Revegetate with native shrubs and grasses ('ecolawn'). Educate condominium owners about stormwater runoff. Project area includes south end of Heron Pointe tax lot.
82	Terwilliger Parkway East @ Hamilton Revegetation	Natural area below Terwilliger Parkway @ Hamilton	Remove invasive plants in natural area with open stream channel in Terwilliger corridor between SW Terwilliger and SW Barbur. This project provides an outreach opportunity to work with and support Friends of Terwilliger. Work with PP&R to develop interpretive opportunities.

Rank	Project/Program	Location	Project/Program Description
83	Fairmont Forest Revegetation	Marquam Nature Park South	This area is largely in PP&R ownership with some private and some State Board of Education in holdings. Upland streams have been degraded by invasive species and overuse (recreation). Some areas may be eligible for PP&R's "protect the best". Opportunity for public education about recreation impacts.
88	Keller Woods Revegetation	Keller Woods	Work with Three Rivers Land Conservancy (land owners) to control invasive plants and plant natives.
89	Terwilliger Parkway South Revegetation	SW Terwilliger Parkway	Remove invasive plants in the area east of Terwilliger Parkway owned by Metro and the City.
91	ODOT Lairhill North Revegetation	Interstate-5 ROW between Interstate-5 and Barbur Boulevard	This ODOT property north of Capitol Highway has greater than 50% invasive plant cover in trees and understory. This area should be proposed as primary mitigation area for Iowa Bridge (ODOT Lairhill South in California subwatershed as secondary mitigation area).
92	Carolina-Terwilliger George Himes Park Revegetation	George Himes Park	Remove invasive ivy, blackberry, clematis, and weedy trees (Norway Maple) in the northern section of the park (that falls in Carolina-Terwilliger subwatershed).
93	Chart House Hill Revegetation	5700 SW Terwilliger	Remove invasive plants threatening streams and slopes. This project provides an education/stewardship opportunity with Backyard Habitat Certification program but will need landowner consent.
101	ODOT/PDOT John's Landing Revegetation	ODOT/PDOT ROW John's Landing	Remove invasive plants in densely forested, very steep undeveloped area of mixed ODOT/PDOT ROW and private tax lots east of Interstate-5. A temporary pipe system drains from Pendleton Street with year-round flow. Potential seep or spring. Potential link to Iowa stormwater project. Work with ODOT to improve stormwater policy.
102	Heron Pointe Revegetation	Heron Point Condominiums	Remove grass lawn behind Heron Pointe Condominiums east of the Greenway Trail. Install 'ecolawn' of native shrubs, grasses that would require fewer chemicals. Currently it appears as though the lawn is maintained with chemicals.
103	SW Pendleton Greenway Revegetation	Greenway Trail at the end of SW Pendleton	Revegetate area east and west of the greenway trail.

Aquatic and Terrestrial Enhancement Opportunities

These specific stream enhancement projects are designed to improve the amount and quality of important habitat in the Willamette River channel and its Carolina-Terwilliger subwatershed tributaries. The lower Willamette functions as a critical salmonid migration corridor and rearing ground, and the ecological effects of local conditions impact Chinook, coho, and steelhead populations throughout the entire Willamette subbasin. These projects will increase habitat extent and diversity by daylighting stream channels, improving streambank conditions, creating shallow water and off-channel habitat, increasing tributary stream accessibility, adding channel complexity, and increasing channel stability. Examples of specific terrestrial enhancements to protect, restore, and enhance aquatic and terrestrial habitat conditions (as appropriate to the site) include:

- Snag creations
- Seasonal ponds for amphibian breeding
- Bat or bird habitat artificial structures

- Oak replacement

Once a dominant habitat type in the Portland area, Oregon white oak woodland is particularly important both locally and regionally. Many different wildlife species, such as neo-tropical migrant birds and Western gray squirrels, utilize this valuable plant community for nesting and foraging .

Selection, design, and implementation of these projects will be coordinated with or rely directly on a variety of existing City and other agency programs. Critical programs, partners, and regulatory requirements include: the BES Science Fish and Wildlife Program, TEES, the ESA, Water Resource Development Act (WRDA), River Renaissance Program, BPS and Metro’s riparian corridor and wildlife habitat inventories, PP&R, Oregon Department of Fish and Wildlife (ODFW) Restoration and Enhancement Program, and Oregon Watershed Enhancement Board (OWEB).

Education and outreach is a critical element of improving watershed health and will be incorporated into all aquatic and terrestrial enhancement projects. Opportunities that have been identified on private properties will not be pursued without the consent and cooperation of affected property owners. Opportunities identified on properties owned or managed by PP&R will follow the process established through a MOU between PP&R and the Bureau. The MOU process will be used to guide the implementation of any opportunities selected for concept planning or design development.

Table 6: Carolina-Terwilliger Subwatershed Aquatic and Terrestrial Enhancement Opportunities

Rank	Project/Program	Location	Project/Program Description
3	Terwilliger Creek Trail Stream Enhancement	Terwilliger Creek Trail and Marquam Nature Park South	Enhance stream channel for aquatic and terrestrial wildlife. Protect stream from upland stormwater inputs of pollutants and flashy flows. Remove invasive ivy. Look for opportunities to treat and manage stormwater flow.
5	Carolina-Terwilliger Cottonwood Bay Special Habitat Area	Cottonwood Bay, Carolina-Terwilliger	Area has numerous alcoves. Improve banks; increase large woody debris. Increase quality and quantity of shallow water habitat. Improve native vegetation communities. Address CSO discharges. Greenway provides good opportunity for interpretive outreach to property owners about riparian vegetation, pet waste, and stormwater.
9	Terwilliger Creek Culvert Repair/Revegetation	East Side of Terwilliger Parkway	Culvert is eroding steep bank and channel below roadway, which will eventually undercut the road. Rebuild culvert to improve stream channel and reduce erosion. Revegetation would complement volunteer efforts in the vicinity.
31	Greenbriar Village Stream Enhancement	5010 - 5024 SW Slavin Road	Improve open channel that runs through Greenbriar Village Apartments by revegetating and stabilizing banks.

Protection and Policy Opportunities

Projects and programs in this category identify opportunities to protect and improve watershed function, habitat value, and connectivity through acquisition, zoning overlay, resource tracts, development standards review, building code review, and other protection

measures and programs. This approach strives to ensure that the highest quality areas are protected, and that development that does occur in and near resource areas is completed with the most environmentally sensitive design and with the least impact. Education and outreach is a critical element of improving watershed health and will be incorporated into all protection and policy projects.

Protection of areas with the highest remaining function and value has been identified as a cornerstone for effective watershed management (City of Portland 2004). Areas for which protection and policy actions could be pursued include:

- Remaining forested areas, stream remnants, and associated ravines that serve as key habitat area anchors and connections between larger habitat areas
- Any area where vegetated floodplain is accessible to the river, or where natural, gently sloped streambanks are present
- Wetlands and forested areas, natural streambanks, and tributary confluences, which provide some of the highest quality habitats and most sensitive portions of the watershed
- Citywide development issues related to the amount of hardened streambanks, shallow water habitat, and riparian or floodplain vegetation

A number of policy and regulatory strategies have been effectively used by the City to protect watershed resources. Selection, design, and implementation of these projects will be coordinated with or rely directly on a variety of existing City programs. Critical partners and programs include: BPS Portland Plan and River Plan projects, Regulatory Improvement Program, PBOT Planning, Urban Forestry Program, SWMM, development standards review, building code review, environmental review, Metro natural resources planning, and Portland Development Commission.

Willamette Watershed Property Acquisition Program

Acquisition is a tool under the Protection and Policy strategy of the PWMP. Properties for potential acquisition (listed below) were chosen on the basis of their ability to protect watershed assets or to allow BES to implement an IS project that would be more appropriately located on public property. Properties identified for potential acquisitions in the Willamette Watershed in Portland will be managed through a “willing seller” approach. Through the program, willing sellers are offered fair market value for their property and are under no obligation to sell. If they choose to sell, the land acquired through the willing seller program will be managed to improve fish and wildlife habitat, restore wetlands, improve water quality, and may provide passive recreation activities. Some properties identified as potential acquisition sites may be constrained by contamination and/or other feasibility issues. These issues will be identified and addressed at a later planning stage.

Land conservation easements may also work to achieve some of the PWMP protection and policy goals, and thus the IS goals. A conservation easement is a legally binding agreement made by the property owner not to develop part of a property, but to leave it permanently “natural”. The landowner retains title to the property. The easement becomes

part of the land deed, meaning that all future property owners will be bound by the terms of the easement.

In November 2007, the City's Grey to Green Initiative was launched to accelerate some principal elements of PWMP implementation. The Grey to Green Land Acquisition Program will build on previous and current efforts to permanently protect important natural resources areas by placing land in public ownership.

Opportunities that have been identified on private properties will not be pursued without the consent and cooperation of affected property owners. Opportunities identified on properties owned or managed by PP&R will follow the process established through a MOU between PP&R and BES. The MOU process will be used to guide the implementation of any opportunities selected for concept planning or design development.

Some protection and policy projects/programs that have been identified are citywide opportunities and were not included in the subwatershed objective ranking process; however, they are included in the following table.

Table 7: Carolina-Terwilliger Subwatershed Protection and Policy Opportunities

Rank	Project/Program	Location	Project/Program Description
2	Iowa Viaduct, ODOT Reconstruction Project	I-5 Viaduct at Iowa Street, Corbett Neighborhood	Work with ODOT, PBOT, Bureau of Development Services (BDS), and other groups to develop a project that will provide stormwater and vegetation community improvements through design and construction of the new bridge over the natural area.
8	Keller Heights East Property Acquisitions	Keller Heights Properties	Investigate potential lot line adjustment in natural area adjacent to Keller Woods that contains stream headwaters.
10	Upper George Himes Creek West Property Acquisition	Vicinity of George Himes Creek	Acquire undeveloped properties adjacent to stream headwaters to buffer open channel/stream from development. Ownership and property prices may limit acquisition feasibility, so also explore conservation easements. Educate landowners about Backyard Habitat Certification program.
12	Chart House Hill, Central Menefee Drive Property Acquisition	SW Menefee Drive	Acquire property to protect Terwilliger streams headwaters and buffer open channel. Work with property owners via Backyard Habitat Certification program.
22	Chart House Hill, West Menefee Drive Property Acquisition	West SW Menefee Drive	Acquire property to protect open channel/stream headwaters from development. Conduct outreach to property owners "living on the headwaters" and about invasive plants/Backyard Habitat Certification program. Promote conservation easements.
27	Iowa Street Stormwater Complex Property Acquisition	SW Iowa St. viaduct to viewpoint S. to Carolina	Acquisition would allow two proposed projects in this area: 1. George Himes to French American school stormwater daylighting project. 2. Iowa Street viaduct, ODOT stormwater treatment off Interstate-5 corridor. There are currently contaminated soils present on this site from Interstate-5 uncontrolled stormwater runoff.
74	Macadam Sunset Fuel ECSI Site	6230 SW Macadam	This property is listed in DEQ's ECSI database. The site is on the Voluntary Cleanup Program waiting list, so a cleanup measure has not yet been implemented. Potential project activities at the site could include: 1) outreach to property owners through the BES Brownfield program and 2) identify opportunities for monitoring of cleanup activities and long

Rank	Project/Program	Location	Project/Program Description
			term impacts of the contaminant sources.
75	J.C. Cleaners ECSI Site	6141 SW Macadam	This property is listed in DEQ's ECSI database. The DEQ recommends a "State Expanded Preliminary Assessment" on this site, so a cleanup measure has not yet been implemented. Potential project activities at the site could include: 1) outreach to property owners through the BES Brownfield program and 2) identify opportunities for monitoring of cleanup activities and long term impacts of the contaminant sources.
76	Pacific Pride Site 1 ECSI Site	6140-6230 SW Macadam	This property is listed in DEQ's ECSI database. The site is on the Voluntary Cleanup Program waiting list, so a cleanup measure has not yet been implemented. Potential project activities at the site could include: 1) outreach to property owners through the BES Brownfield program and 2) identify opportunities for monitoring of cleanup activities and long term impacts of the contaminant sources.
77	ODOT- Iowa Street Viaduct ECSI Site	SW Iowa Street	This property is listed in DEQ's ECSI database. The site is in the "Remedial Investigation" phase, so a cleanup measure has not yet been implemented. Potential project activities at the site could include: 1) outreach to property owners through the BES Brownfield program and 2) identify opportunities for monitoring of cleanup activities and long term impacts of the contaminant sources.
78	Former Multnomah Metal Co. Works ECSI Site	0236 SW Flower St.	This property is listed in DEQ's ECSI database. The DEQ has recommended a "Site Investigation", so a cleanup measure has not yet been implemented. Potential project activities at the site could include: 1) outreach to property owners through the BES Brownfield program and 2) identify opportunities for monitoring of cleanup activities and long term impacts of the contaminant sources.
79	John's Landing Cleaners ECSI Site	5221 SW Macadam	This property is listed in DEQ's ECSI database. The DEQ has recommended a "Site Screening" at this site, so a cleanup measure has not yet been implemented. Potential project activities at the site could include: 1) outreach to property owners through the BES Brownfield program and 2) identify opportunities for monitoring of cleanup activities and long term impacts of the contaminant sources.
80	Waterside Development Project ECSI Site	4850 SW Macadam	This property is listed in DEQ's ECSI database. The site is in the "Site Evaluation" phase, so a cleanup measure has not yet been implemented. Potential project activities at the site could include: 1) outreach to property owners through the BES Brownfield program and 2) identify opportunities for monitoring of cleanup activities and long term impacts of the contaminant sources.
81	Slavin Road Landfill ECSI Site	SW Slavin Rd and SW Seymour Rd	This property is listed in DEQ's ECSI database. The site is in the "Remedial Action" phase, so a cleanup measure is in the process of being implemented. Potential project activities at the site could include: 1) outreach to property owners through the BES Brownfield program and 2) identify opportunities for monitoring of cleanup activities and long term impacts of the contaminant sources.
84	Chart House Hill East Land Acquisition	5700 SW Terwilliger	Potential land acquisition site. Four tax lots adjacent to Chart House. High value resource (streams and steep slopes) at southern end of Terwilliger corridor.
86	Pendleton Wetlands Property Acquisition	Above SW Corbett	Acquire property to protect wetlands, springs and unstable slopes from development. This property has a history of seeps and springs that impact neighbors. Heavy invasives: ivy, clematis, knotweed. Restoration of wetlands could improve neighbor water problems, increase wetland habitat. High property values could limit feasibility. Work with BPS to

Rank	Project/Program	Location	Project/Program Description
			designate springs as SHA.
90	Marquam Nature Park Property Acquisition	Uplands around Marquam Nature Park	Protect undeveloped forested areas surrounding natural areas of Marquam Nature Park (MNP). Increase area of MNP for westside wildlife corridor. Increase capacity of West Willamette Partnership for Backyard Habitat Stewardship program.
94	Lower George Himes East Property Acquisition	East portion of George Himes Park	Acquire five properties that are upslope of Barbur Boulevard and downslope of George Himes Park in order to protect from the threat of development and to buffer the stream. Also increase protection of wildlife habitat corridor. ODOT will be potentially impacting the area with bridge redevelopment.
95	West Keller Woods Property Acquisition	Uplands west of Keller Woods	Protect undeveloped forested areas west of Keller Woods Natural Area. Increase size of Westside Wildlife corridor buffer. Increase capacity of West Willamette Partnership Backyard Habitat Certification Program. Remove invasive plants.
96	Tequila Willies Property Acquisition	SW Macadam Avenue, south of Cottonwood Bay	Acquire former Tequila Willies property south of Cottonwood Bay.
97	OHSU Conservation Easement	Between OHSU and Marquam Nature Park	Acquire several undeveloped lots that are located south of OHSU, adjacent to MNP, or apply conservation easements to protect stream habitat and natural area from development, and facilitate removal of invasive ivy and clematis.
98	Chart House Hill North Property Acquisition	Chart House Hill	Acquire property or apply easement to fill gaps in Terwilliger Parkway and Keller Woodlands to increase wildlife connectivity and terrestrial habitat buffers. Provide outreach to property owners on issues such as protection from development and Backyard Habitat Certification. Property values may impair feasibility, look for opportunities.
100	Property Acquisition along SW Trail #6	SW Trail #6, adjacent to SW Mitchell Lane	Acquire property to protect forested area prone to erosion. Site is steeply sloped with erosion on private property adjacent to Terwilliger Parkway. Erosion has been caused by vegetation removal. Acquisition would focus on streams and require lot line adjustment or possible conservation easement. Conduct education and outreach to landowners along this slope adjacent to natural area.
	Environmental Land Use and Zoning Program	Citywide	Participate in the City's natural resource inventory update to protect high quality habitats and sensitive portions of the watershed. The update of this program is needed to reflect recent science and better data and to enhance protections for streams and drainages, wetlands, riparian areas and upland wildlife habitat. As part of this update, the City will address compliance with Metro Title 13 Nature in Neighborhoods, and State Land Use Goals 5 (Significant Resources) and 6 (Air and Water Quality). The update will also inform potential changes to the Environmental Overlay zones.
	The Portland Plan	Citywide	Participate in BPS's Portland Plan process. This project will update Portland's Comprehensive Plan, including policies and goals related to natural resources and watershed health.
	The River Plan	Citywide	Participate in BPS's River Plan process. The River Plan project will address protection, conservation, and restoration of natural resources in the Willamette River corridor east of Interstate-5. Beginning in 2009, the River Plan will focus on the central and south reaches of the project area, which include portions of the southwest subwatersheds. As part of the project, previously adopted natural resource inventories and environmental overlay zoning will be updated as needed to address current natural resource information, City watershed goals and policies, and Metro Title 13 Nature in Neighborhoods requirements.

Rank	Project/Program	Location	Project/Program Description
	NPDES Coordination	Citywide	Participate in NPDES permit-related efforts within the City to maximize opportunities for Watershed Services to provide input on future modifications to the City's NPDES permit, allow earlier identification of potential impacts of permit modifications on watershed restoration planning, and provide opportunity to recommend modifications of the NPDES monitoring program to optimize data collection efforts.
	River Bank Treatment Policy	Citywide	Participate in City policies pertaining to river banks to eliminate construction of new vertical walls, minimize use of pilings, encourage alternative and bio-engineered bank treatments, and protect existing beach, off-channel, vegetated, and shallow water habitats.
	Subwatershed-Specific Stormwater Management Manual	Citywide	Develop subwatershed-specific stormwater manual guidelines for new and redevelopment sites with BDS. Develop EIA targets for new and existing development with each subwatershed. Pursue City policy and codes that would limit EIA to a maximum level.
	Tree Canopy Management	Citywide	Participate in the Citywide Tree Policy Review and Regulatory Improvement Project. This project is a two-year effort to clarify, simplify, and improve the consistency and effectiveness of the City's regulations pertaining to trees. Options under consideration include restructuring code; establishing a single point of contact to address tree-related inquiries and requests; consolidating permitting functions; and amending code to improve tree preservation, replacement, and protection during construction.
	ODOT Coordination	Interstate-5 and Barbur Boulevard	Coordinate with ODOT on water quality issues to facilitate the treatment and detention of stormwater runoff from ODOT transportation corridors.
	Wood Retention Policy	Citywide	Develop an interbureau wood retention policy.

Operations and Maintenance Opportunities

Maintaining a functional sewer infrastructure is a core BES charge. Opportunities in this category are broad undertakings that include citywide sewer maintenance actions related to the protection and improvement of watershed conditions.

Selection, design, and implementation of these projects will be coordinated with or rely directly on a variety of existing City programs. Critical partners and programs include: PBOT Maintenance Operations, and the BES Wastewater Maintenance group, Spill Protection and Citizen Response Section, Illicit Discharge Controls, Industrial Pretreatment Program, and the Industrial Stormwater Program.

Opportunities that have been identified on private properties will not be pursued without the consent and cooperation of affected property owners. Opportunities identified on properties owned or managed by PP&R will follow the process established through a MOU between PP&R and BES. The MOU process will be used to guide the implementation of any opportunities selected for concept planning or design development.

Operations and maintenance projects that have been identified are citywide opportunities

and were not included in the subwatershed objective ranking process; however, they are included in the following table.

Table 8: Carolina-Terwilliger Subwatershed Operations & Maintenance Opportunities

Rank	Project/Program	Location	Project/Program Description
	Maintenance Staff BMP Program	Citywide	Coordinate adoption of BMPs with PBOT Maintenance Operations staff in the interest of watershed health.
	Maintenance Inspection Program	Citywide	Conduct maintenance inspections of existing facilities, illicit discharges, etc.

Education, Involvement, and Stewardship Opportunities

Education and outreach is a critical element of improving watershed health and will be incorporated into all Carolina-Terwilliger IS projects. The following projects are solely focused on this strategy. Public and commercial education programs are necessary to reach out to watershed residents and businesses to help improve watershed conditions. Projects in this category relate to a range of issues, such as maintenance practices, commercial pollution control practices, public stormwater education, pet waste clean up, yard design and invasive species education, and dumping prevention.

Selection, design, and implementation of these projects will be coordinated with or rely directly on a variety of existing City programs. Leveraging existing resources and encouraging and supporting watershed improvement actions at the community level is a key factor in the Education, Involvement and Stewardship strategy. Critical existing programs include: Neighborhood groups and associations, local business groups, Friends groups, the Community Watershed Stewardship Program, Three Rivers Land Conservancy’s Backyard Habitat program, the West Willamette Restoration Partnership, Metro, and the West Multnomah Soil & Water Conservation District.

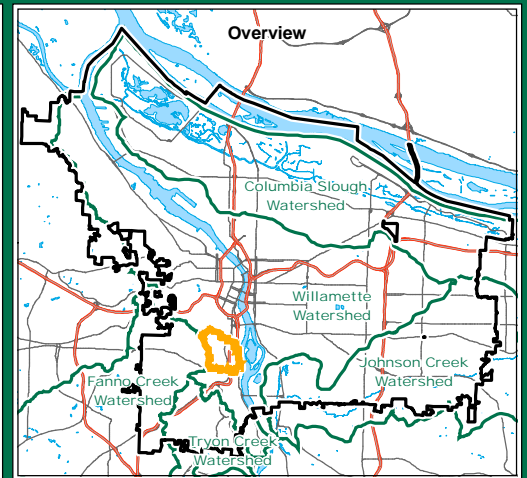
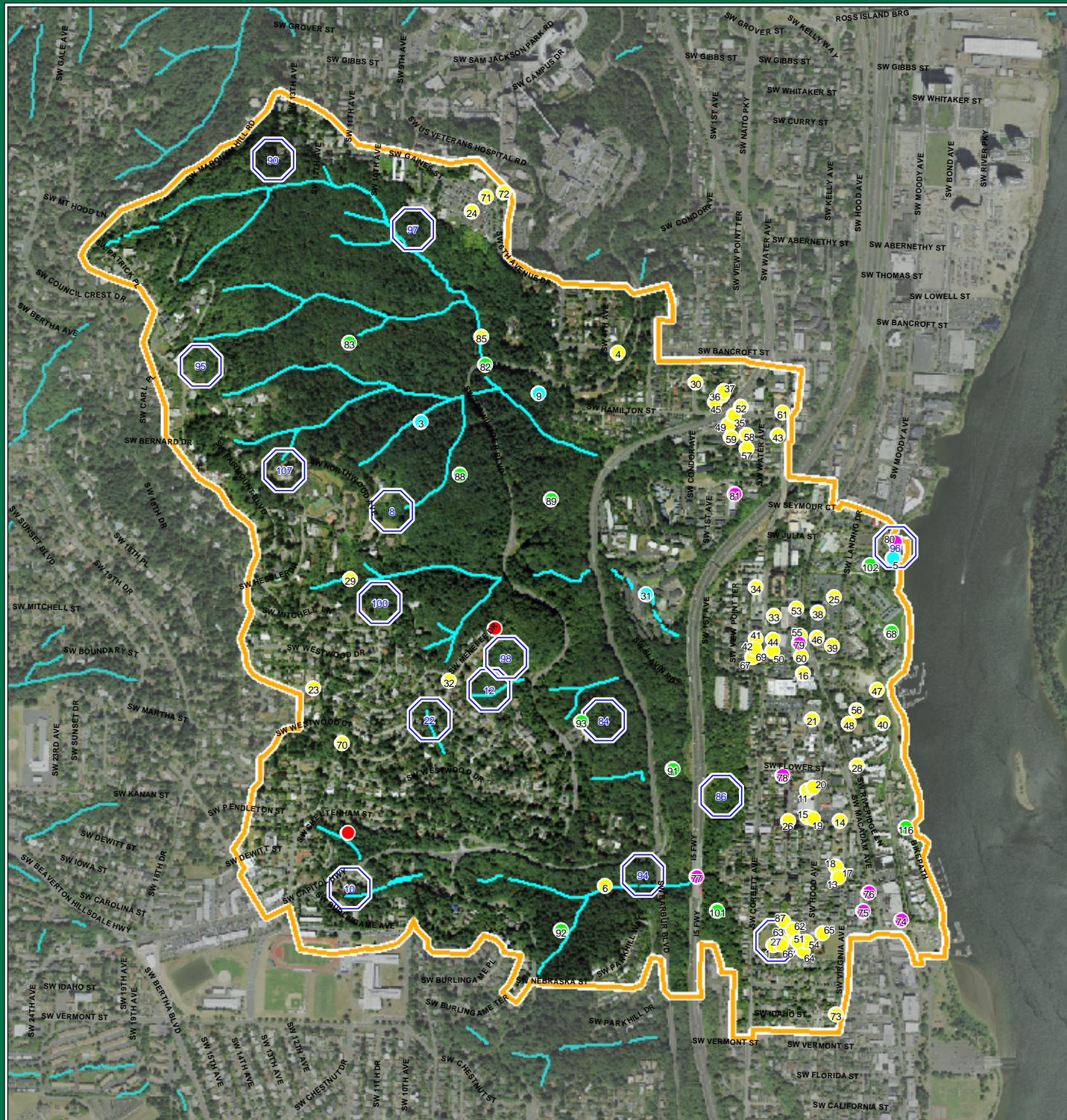
Opportunities that have been identified on private properties will not be pursued without the consent and cooperation of affected property owners. Opportunities identified on properties owned or managed by PP&R will follow the process established through a MOU between PP&R and BES. The MOU process will be used to guide the implementation of any opportunities selected for concept planning or design development.

Most of the Education, Involvement, and Stewardship programs/projects that have been identified are citywide opportunities and were not included in the subwatershed objective ranking process; however, they are included in the following table.

Table 9: Carolina-Terwilliger Subwatershed Education, Involvement, and Stewardship Opportunities

Rank	Project/Program	Location	Project/Program Description
	Cheltenham Neighborhood Outreach	Cheltenham Neighborhood	Conduct outreach and education about watershed health to private property owners at headwaters above

Rank	Project/Program	Location	Project/Program Description
	and Education		Terwilliger Park. Provide native plants, possible Community Watershed Stewardship Program grant opportunity. Remove invasive plants.
	Menefee Drive Outreach and Education	End of Menefee Drive; adjacent to Keller Natural Area	Educate residents adjacent to Terwilliger Parkway and Keller Natural Area about inappropriate dumping, invasive plants, and general stormwater outreach. Yard debris dumping was observed at the end of the street. Invasive plants were noted in the area.
	Riparian Zone Outreach	Environmental Zones and Drainage Reserve Areas	Conduct outreach and education to homeowners living in a riparian zone. Potential partnership with Three Rivers Land Conservancy's Backyard Habitat program.
	Riverbank Maintenance Practices Outreach	Willamette River Property Owners	Conduct outreach and education to improve riverbank maintenance practices related to stormwater routing, stream protection, and landscaping practices.
	Illegal dumping Outreach	Citywide	Develop trash and yard debris disposal education for homeowners adjacent to natural areas. Install signs, fences.
	Invasive Species Outreach	Citywide	Support landowner education throughout the Willamette Watershed to control the spread of existing problem species, to prevent introduction of new invasive species, and to provide educational opportunities particularly in parks and other public and open spaces.
	Naturescaping and Yard Tree Outreach	Citywide	Support landowner education throughout the Willamette Watershed to encourage yard trees, naturescaping, and backyard habitat. Provide educational opportunities particularly in parks and other public and open spaces.
	Pet Waste Outreach	Citywide	Support pet waste education throughout the plan area. Install signs, bag stations, and trash bins in natural areas.
	Residential Maintenance Practices Outreach	Citywide	Conduct outreach, training, and education for apartment and condominium owners, managers, and maintenance workers to protect and improve stream and riparian areas.
	Residential Non-Point Source Pollution Outreach	Citywide	Conduct outreach and education to reduce impacts of non- point source pollutants such as oil and fertilizers.
	Promote Fire Safe Landscaping	Residences in high fire hazard areas	Support education efforts to property owners in high fire hazard areas of the City. Help residents learn about fire safe methods of landscaping their property.



Legend

- City of Portland
- Carolina-Terwilliger Subwatershed Boundary
- Open Channel Streams

Carolina-Terwilliger Potential Project Strategies

- Aquatic Terrestrial Enhancement
- Education Involvement Stewardship
- Protection and Policy
- Revegetation
- Storm Water Management
- Easements or Acquisitions

1 inch equals 1,250 feet

0 1,250 2,500 Feet

CITY OF PORTLAND ENVIRONMENTAL SERVICES

Systems Analysis
Spatial Analysis and Modeling

Southwest Subwatersheds Improvement Strategies

Figure-5
Carolina-Terwilliger Potential Projects

Project No	Date Printed:
8800	05/21/09

SECTION 7: RECOMMENDATIONS

This report summarizes the IS process for the Carolina-Terwilliger subwatershed and identifies opportunities, in the form of ranked site-specific projects, to protect and improve watershed health. This process is only one step in the larger watershed management process, a long-term adaptive management system that will include implementation, monitoring, evaluation and improvement of projects and programs.

The projects in this IS report were developed through a rapid assessment method that is based on a well established science based method for the identification of subwatershed improvements. The method was developed by the Center for Watershed Protection. Selecting the improvement strategies involved the collaboration of various stakeholders including City bureaus with an interest or expertise in the area, non-profit organizations and citizens local to the subwatershed.

The following recommended actions are grouped relative to geographic and/or programmatic clusters. Actions in this section have been grouped and prioritized based on an integrated approach that addresses multiple goals and needs including watershed health, sewer capacity, pipe rehabilitation, and combined sewer overflow (CSO) control. The groups of actions are intended to protect areas that 1) have been identified in the IS process as assets, or 2) work toward improving local subwatershed conditions in areas that have been identified as problematic. The projects individually and collectively work toward achieving the goals and objectives identified in the Portland Watershed Management Plan (PWMP). Additionally, the actions were grouped based on the Technical team's understanding of opportunities that exist for funding, partnerships, and/or local support.

Marquam Nature Park Enhancements

Background

Marquam Nature Park was identified in the IS characterization as both an asset, due to the importance of the natural area as a core terrestrial habitat, and its designation as a wildlife connectivity corridor, and as a problem, due to its degraded ecological health that is the result of heavy encroachment by invasive plant species.

Two major planning efforts in the Marquam Hill area provided direction for the improvement strategy projects in the Marquam Nature Park area:

- The Westside Streams Combined Sewer Separation Pre-design (2000) identified a number of projects. The projects that were not developed as part of the pre-design are included in this report for implementation as potential projects and programs.
- The Marquam Hill Plan was developed over a number of years with the involvement of a broad range of stakeholders. Among other things, the Plan focused on the use of innovative stormwater management solutions and the restoration of terrestrial and aquatic habitat. Several projects here are supported

by that planning effort. The grouping of recommendations for the Marquam Nature Park Enhancements will provide an additive effect toward improving watershed health.

Site Description

Marquam Nature Park spans both the Marquam-Woods and the Carolina-Terwilliger subwatersheds. The park contains dense forests and headwater streams that are an integral part of a chain of natural areas that traverse the West Hills of Southwest Portland. Marquam Gulch is located at the north end of the nature park (in the Marquam-Woods subwatershed) and includes two dozen tributary creeks which provide stormwater drainage, aquatic and terrestrial habitat, and groundwater recharge.

PP&R completed an ecological health survey of the natural area vegetation in Marquam Nature Park in October 2004. The area surveyed ranged from severely degraded to fair. More information on the ecological health survey is available at <http://www.portlandonline.com/parks>.

Constraints

Historic fill activities in the area that was once the Marquam Gulch (now Duniway Park) may limit the ability for stream daylighting in this area. More information is needed to understand those constraints.

Partnerships

Forging partnerships will be a critical component to project implementation in the Marquam Nature Park area. The Willamette Watershed team will partner with staff from City bureaus, local, state and federal agencies, citizens' groups, and private property owners to protect the area's natural resources, restore critical ecosystems, and implement stormwater management solutions that integrate the urban area with the natural environment. Potential partners include: BES Revegetation Team, Sustainable Stormwater Group and Systems Analysis Group; PP&R, the West Willamette Restoration Partnership's Backyard Habitat Program, citizen groups (including individual private property owners) and the Portland Development Commission (PDC).

Potential Funding Sources

Potential funding sources include: Oregon Department of Agriculture (ODA), Oregon Watershed Enhancement Board (OWEB), Oregon Department of Fish & Wildlife (ODFW), and the National Fish & Wildlife Foundation (NFWF).

Benefits

The projects grouped below address flood storage and bank stabilization issues, water quality improvements, and aquatic and terrestrial wildlife habitat enhancements. Opportunities are organized by the following improvement strategies: stormwater management, aquatic and terrestrial enhancements, revegetation, policy and protection, and education, involvement, and stewardship.

Potential Projects and Programs

The following potential projects and programs were identified for the Marquam Nature Park area. Descriptive information for each is available from the contact provided on the inside cover of this report. The potential projects and programs are conceptual; no design or project development was conducted during the assessment and development of this Improvement Strategies (IS) report. Potential project and programs for the Marquam Nature Park that were prioritized through the IS process include:

Stormwater Management Projects

All stormwater management projects will require agreements with property owners. Potential projects and their rankings are as follows:

- Marquam Nature Park Shelter – Stormwater (*)

Aquatic and Terrestrial Enhancement Projects

All aquatic and terrestrial enhancement projects will require agreements with property owners. Potential projects and their rankings are as follows:

- Marquam Gulch Daylighting, North Branch (*)
- Marquam Gulch Daylighting, South Branch (*)
- Marquam Nature Park Shelter Wetland Construction (*)
- Terwilliger Creek Trail Stream Enhancement (3)

Revegetation Projects

All revegetation projects will require agreements with property owners. Potential projects and their rankings are as follows:

- Marquam Nature Park Shelter Wetland Revegetation (*)
- Marquam Nature Park Shelter Revegetation, Plum Hill (*)
- Fairmont Forest Revegetation (83)

Protection and Policy Projects

All protection and policy projects will require agreements with property owners. Potential projects and their rankings are as follows:

- Marquam Gulch South Potential Property Acquisition (*)
- Marquam Oak Special Habitat Area (SHA) Property Acquisition (*)
- BraeMar and Broadway Drive Property Acquisition (*)
- Council Crest and MNP Properties Acquisition (*)
- Council Crest Area Property Acquisition (*)
- Marquam Nature Park Property Acquisition (90)
- Marquam Nature Park South Property Acquisition (*)
- West Keller Woods Property Acquisition (95)
- Oregon Health Sciences University (OHSU) Conservation Easement (97)

Education, Involvement and Stewardship Projects:

Education, Involvement, and Stewardship projects are as follows (these projects have not been ranked):

- Invasive Species Outreach

- Pet Waste Outreach

** These projects are ranked in the Marquam-Woods Subwatershed IS Report.*

George Himes Park Stream Daylighting

Background

Streams that flow through George Himes Park are ultimately piped into the combined sewer system. This exacerbates pipe system capacity issues and delivers nutrient-rich cold water tributary flows to the treatment plant, rather than to the Willamette River where it could improve fish habitat. The following group of recommended actions would improve watershed health while relieving system capacity problems. The projects build on the work of the Systems Analysis Group who, as part of the Combined System Plan, considered daylighting portions of Carolina Creek (the main channel that flows out of George Himes Park) to help solve the pipe system capacity problems. The actions may also be considered as mitigation opportunities for ODOT as they begin construction on the Iowa Street Viaduct project through the existing environmental overlay zoning process.

Site Description

George Himes Park spans both the Carolina-Terwilliger and the California subwatersheds. The park contains dense forests and headwater streams that are an integral part of a chain of natural areas that traverse the West Hills of Southwest Portland. The open stream channels provide stormwater drainage, aquatic and terrestrial habitat, and groundwater recharge.

PP&R completed an ecological health survey of the natural vegetation in George Himes Park in October 2004. The area surveyed ranged from poor to fair. More information on the ecological health survey is available at <http://www.portlandonline.com/parks>.

Constraints

Construction of an open channel through the developed portion of the subwatershed will be constrained by development. Where it is found to be feasible (in ROWs and with private landowner agreements) construction may be constrained by costs. Acquisition will be constrained by landowner willingness and costs.

Partnerships

The Willamette Watershed team will partner with staff from City bureaus, local, state and federal agencies, citizens' groups, and private property owners to protect the area's natural resources and implement stormwater management solutions that integrate the urban area with the natural environment. Potential partners include: PP&R, the BES Revegetation Team and Sustainable Stormwater Group.

Potential Funding Sources

Potential funding sources include: ODA, OWEB, ODFW, and the NFWF.

Benefits

The projects grouped below address flood storage and bank stabilization issues, water quality improvements, and aquatic and terrestrial wildlife habitat enhancements.

Potential Projects and Programs

The following potential projects and programs were identified for the George Himes Park area. Descriptive information for each is available from the contact provided on the inside cover of this report. The potential projects and programs are conceptual; no design or project development was conducted during the assessment and development of this Improvement Strategies (IS) report. Potential project and programs for the daylighting project proposed for this area that were prioritized through the IS process include:

Stormwater Management Projects

All stormwater management projects will require agreements with property owners. Potential projects and their rankings are as follows:

- George Himes Park Stream Daylighting, North Reach (6)

Aquatic and Terrestrial Enhancement Projects:

All aquatic and terrestrial enhancement projects will require agreements with property owners. Potential projects and their rankings are as follows:

- George Himes South Stream Daylighting (*)

Revegetation Projects:

All revegetation projects will require agreements with property owners. Potential projects and their rankings are as follows:

- Carolina-Terwilliger George Himes Park Revegetation (92)
- California George Himes Park Revegetation (*)

Protection and Policy Projects:

All protection and policy projects will require agreements with property owners. Potential projects and their rankings are as follows:

- Upper George Himes Creek West Property Acquisition (10)
- Lower George Himes East Property Acquisition (94)
- George Himes East Property Acquisition (*)
- George Himes South Property Acquisition (*)
- George Himes West Property Acquisition (*)

Education, Involvement and Stewardship Projects:

Education, Involvement, and Stewardship projects are as follows (these projects have not been ranked):

- Invasive Species Outreach
- Pet Waste Outreach

** These projects are ranked in the California Subwatershed IS Report.*

Mitchell Creek³ Stormwater Reductions

Background

Modeling of the combined sewer system in this area has shown that this pipe is at capacity; discharging additional flow into the system at this point is predicted to cause surface flooding. The BES Systems Analysis group is currently evaluating alternatives to address this issue. These alternatives include pipe upsizing and/or stormwater separation. Projects identified by the Willamette Watershed team through the Carolina-Terwilliger IS process may help to remove or detain stormwater flow going into the combined system, and potentially eliminate the need to upsize downstream pipes.

Site Description

Mitchell Creek originates in Keller Woods, located in the upper portion of the subwatershed. An open channel runs through the Greenbriar Apartment complex before it is piped into the combined system at what is referred to as the Mitchell Street line.

Constraints

Potential projects will be constrained by private landowner willingness and costs.

Partnerships

The Willamette Watershed team will partner with staff from City bureaus and private property owners to implement stormwater management solutions that integrate the urban area with the natural environment, while protecting the area's natural resources. Potential partners include: PP&R; and the BES Systems Analysis Group, Sustainable Stormwater Group, and Revegetation Team.

Potential Funding Sources

Potential funding sources include: the BES 1% For Green program, Watershed Investment Fund (WIF), Capital Improvement Program (CIP), and Grey to Green initiative.

Benefits

The projects grouped below reduce, detain and/or treat stormwater flows, improve water quality, and enhance/restore aquatic and terrestrial wildlife habitat.

Potential Projects and Programs

The following potential projects and programs were identified for the Mitchell Creek area. Descriptive information for each is available from the contact provided on the inside

³ Mitchell Creek is an unofficial name given to the unnamed creek that ultimately drains into a pipe system on SW Mitchell Street.

cover of this report. The potential projects and programs are conceptual; no design or project development was conducted during the assessment and development of this Improvement Strategies (IS) report. Potential project and programs for the stormwater reductions proposed for this area that were prioritized through the IS process include:

Stormwater Management Project:

All stormwater management projects will require agreements with property owners. Potential projects and their rankings are as follows:

- Stream Daylighting of ACH562 (29)
- CSSP Green Streets: West of Terwilliger Project Area (32)
- Next Generation Children's Center Parking Lot Stormwater Planters (50)
- Next Generation Children's Center Ecoroof (44)
- Chevron Food Mart Parking Lot Vegetative Stormwater Planter (60)
- John's Landing Dry Cleaners Parking Lot Vegetative Stormwater Planters (55)
- Sorenson Photography Vegetative Swale (67)
- Sorenson Photography Parking Lot Vegetative Stormwater Planter (69)
- Sorenson Photography Ecoroof (42)
- Macadam Center Pervious Asphalt Parking Lot (33)
- Macadam Center Vegetative Swale (53)
- 5025 SW Corbett Ecoroof (34)
- The Water Tower Stormwater Retrofit (16)
- Over The Landing Salon Ecoroof (21)

Aquatic and Terrestrial Enhancement Projects:

All aquatic and terrestrial enhancement projects will require agreements with property owners. Potential projects and their rankings are as follows:

- Greenbriar Village Stream Enhancement (31)

Revegetation Projects:

All revegetation projects will require agreements with property owners. Potential projects and their rankings are as follows:

- Chart House Hill Revegetation (93)
- ODOT Lairhill North Revegetation (91)

Protection and Policy Projects:

All protection and policy projects will require agreements with property owners. Potential projects and their rankings are as follows:

- Property Acquisition along SW Trail #6 (100)
- Chart House Hill Property Acquisition (98)
- Chart House Hill--Central Menefee Drive Property Acquisition (12)
- Chart House Hill--West Menefee Lane Property Acquisition (22)
- Chart House Hill Land Acquisition (84)
- Iowa Viaduct -ODOT reconstruction project (2)

- John's Landing Cleaners Environmental Cleanup Site Information (ECSI Site (79))

Education, Involvement and Stewardship Projects:

Education, Involvement, and Stewardship projects are as follows (these projects have not been ranked):

- Menefee Drive Outreach and Education
- Residential Non-Point Source Pollution Outreach

Cottonwood Bay Aquatic and Terrestrial Enhancements

Background

Cottonwood Bay was identified in the IS characterization as both an asset and a problem. Assets include the presence of important riverine habitat such as alcoves and off-channel areas for listed salmonids in the adjacent Willamette River. A large area has been designated as a SHA (City of Portland 2008) for the presence of the following resources:

- Bottomland hardwood forest
- Migratory bird stopover
- Corridor between wildlife patches or habitats
- Resource or structure that provides critical habitat function in natural or built environments

Cottonwood Bay is also the location of a potential Water Resources Development Act (WRDA) project.

Cottonwood Bay was identified as a problem due to degraded habitat conditions, the presence of DEQ ECSI sites, and nearby development pressures. Degraded conditions found at this location are the result of invasive plant species establishment, lack of native riparian vegetation, hardened river banks, and impervious surfaces in the riparian zone of the river.

PP&R completed an ecological health survey of the natural vegetation in Cottonwood Bay in October 2004. The area surveyed was rated as fair. More information on the ecological health survey is available at <http://www.portlandonline.com/parks>.

The grouping of recommendations for the Cottonwood Bay enhancements will provide an additive effect toward improving watershed health.

Site Description

Cottonwood Bay spans both the Marquam-Woods and the Carolina-Terwilliger subwatersheds. It is a significant habitat area containing a small wetland, coves, and inlets. Most of the area defined as Cottonwood Bay is privately owned, with a small portion managed by PP&R.

Constraints

Some potential project sites may be constrained by geotechnical (soils/infiltration) concerns and other environmental issues as a result of former industrial uses in the area. The DEQ ESCI inventory identifies sites with known contamination issues, and one site is listed within the Cottonwood Bay habitat area. An outfall that was previously a CSO pipe is located in the middle cove of the bay and sediment in the vicinity of this outfall may be contaminated. These issues will be identified and addressed at a later planning stage.

Partnerships

The Willamette Watershed team will partner with staff from City bureaus, local, state and federal agencies, citizens' groups, and private property owners to protect the area's natural resources, and implement stormwater management solutions that integrate the urban area with the natural environment. Potential partners include: PP&R; and the BES Revegetation Team and Sustainable Stormwater Group.

Potential Funding Sources

Potential funding sources include: the BES 1% For Green program, WIF, CIP, Grey to Green, ODA, OWEB, ODFW, and NFWF.

Benefits

The projects grouped below reduce, detain and/or treat stormwater flows, address flood storage and bank stabilization issues, improve water quality, and enhance/restore aquatic and terrestrial wildlife habitat. Opportunities are organized by the following improvement strategies: stormwater management, aquatic and terrestrial enhancements, revegetation, policy and protection, and education, involvement and stewardship.

Potential Projects and Programs

The following potential projects and programs were identified for the Cottonwood Bay area. Descriptive information for each is available from the contact provided on the inside cover of this report. The potential projects and programs are conceptual; no design or project development was conducted during the assessment and development of this Improvement Strategies (IS) report. Potential project and programs for the enhancement work proposed for this area that were prioritized through the IS process include:

Stormwater Management Projects:

All stormwater retrofit projects will require agreements with property owners. Potential projects and their rankings are as follows:

- River Forum Ecoroof (24)
- Avalon Ecoroof (40)
- 455 SW Hamilton Court Ecoroof (41)

Aquatic and Terrestrial Enhancement Projects:

All aquatic and terrestrial enhancement projects will require agreements with property owners. Potential projects and their rankings are as follows:

- Carolina-Terwilliger Cottonwood Bay SHA (5)
- Marquam-Woods Cottonwood Bay SHA (*)

Revegetation Projects:

All revegetation projects will require agreements with property owners. Potential projects and their rankings are as follows:

- Cottonwood Bay Revegetation (*)
- River Forum Revegetation (*)
- Heron Pointe Revegetation (102)

Protection and Policy Projects:

All protection and policy projects will require agreements with property owners. Potential projects and their rankings are as follows:

- Waterside Development Project ECSI Site (80)
- Tequila Willies Property Acquisition (96)
- Cottonwood Bay SHA WRDA Property Acquisition (*)

Education, Involvement and Stewardship Projects:

Education, Involvement, and Stewardship projects are as follows (these projects have not been ranked):

- Riparian Zone Outreach
- Riverbank Maintenance Practices Outreach
- Invasive Species Outreach
- Residential Non-Point Source Pollution Outreach

****These projects are ranked in the Marquam-Woods Subwatershed IS Report.***

Implementation

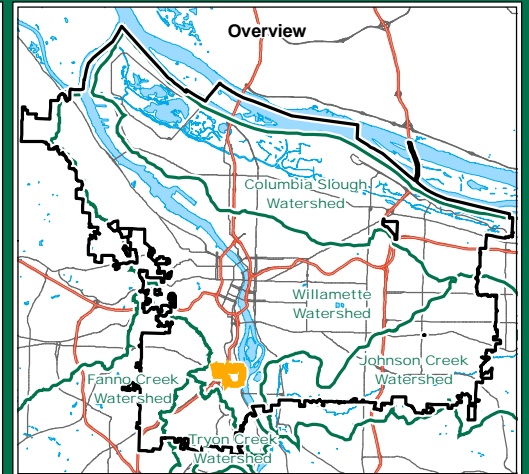
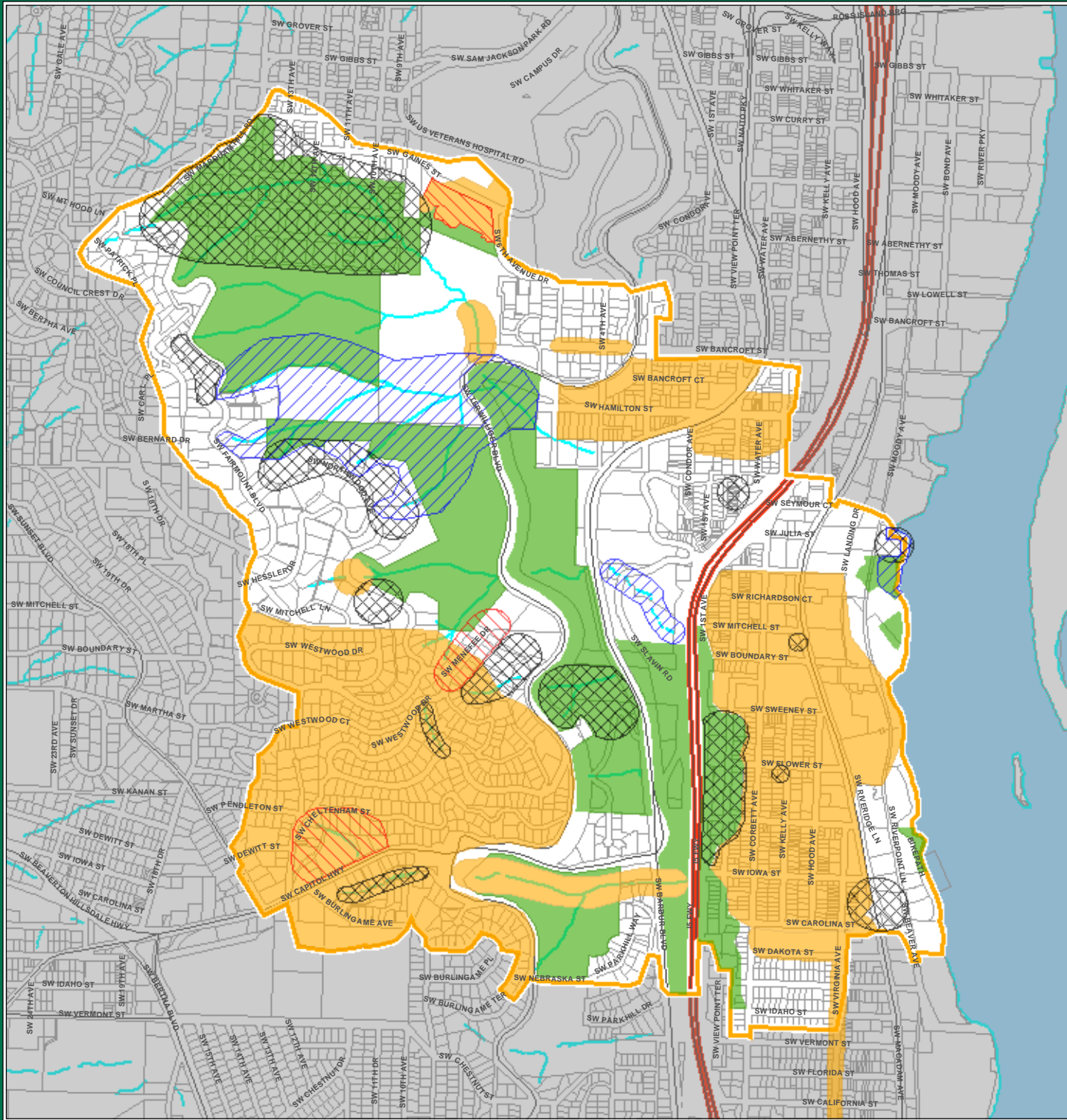
Opportunities to implement the recommendations will occur through a number of avenues. Project implementation will coincide with opportunities to:

- Reduce combined sewer overflows (CSOs).
- Mitigate for developments in the subwatershed
- Reduce non-point pollution entering local streams or the Willamette River
- Protect City investments and assets
- Coordinate with infrastructure improvements identified through the BES Systems Plan update process
- Coordinate with the Bureau of Planning and Sustainability's (BPS) River Plan
- Support and coordinate with PP&R on park improvement and habitat restoration projects
- Involve local citizens in education and stewardship
- Involve local citizens in on-the-ground restoration activities

- Involve property owners in building stormwater inflow control facilities
- Coordinate with other government agencies on development projects in the subwatershed

The Willamette Team will also work to move some projects forward by developing select projects (i.e. highest ranking) that will be implemented as Willamette Watershed Improvement Projects. Moving those projects forward would include:

- Developing projects that qualify as Capital Improvement Plan (CIP) projects through a rigorous selection and alternatives analysis process
- Analyzing projects developed as CIP projects through concept planning and pre-design
- Seeking opportunities for funding through local, state, and federal funding sources - projects that may be implemented through this process could include revegetation; property acquisition; and education, involvement, and stewardship



Legend

- City of Portland
- Carolina-Terwilliger Subwatershed Boundary
- Existing Taxlots
- Freeways
- Open Channel Streams

Carolina-Terwilliger Subwatershed Concept Strategies

- Education, Involvement & Stewardship
- Aquatic & Terrestrial Enhancement
- Protection & Policy
- Revegetation
- Stormwater

1 inch equals 1,250 feet



**Southwest Subwatersheds
 Improvement Strategies**

**Figure-6
 Carolina-Terwilliger
 Concept Plan**

<i>Project No.</i>	<i>Date Printed:</i>
8800	05/21/09

SECTION 8: REFERENCES

- CH2MHill. 2000. Westside Streams Combined Sewer Separation Pre-design.
- City of Portland, Office of Transportation. 2000. Southwest Urban Trails Plan.
- City of Portland, Bureau of Planning. 2001. Portland's Willamette River Atlas.
- City of Portland, Bureau of Planning River Renaissance. 2004. Willamette River Conditions Report.
- City of Portland, Bureau of Environmental Services. 2005. Portland Watershed Management Plan.
- City of Portland, Bureau of Environmental Services Science Fish and Wildlife Team. 2007a. Terrestrial Ecology Enhancement Strategy. August 2007.
- City of Portland, Bureau of Planning and Sustainability. 2007b. Draft Natural Resources Inventory.
- City of Portland, Bureau of Environmental Services Willamette Watershed Team. 2008. Characterization Summary Report, Carolina-Terwilliger Subwatershed.
- City of Portland, Bureau of Planning and Sustainability. 2009. Draft Natural Resources Inventory – map updates.
- Otak, Inc. 2007. OHSU Comprehensive Stormwater Management Plan.
- Schueler, Thomas R. and Heather K. Holland, Eds. 2000. *Assessing the Potential for Urban Watershed Restoration*, from *The Practice of Watershed Protection*. pp. 705 – 711.

The following technical memoranda were prepared for the purposes of developing this final report:

- Carolina-Terwilliger Subwatershed Data Analysis and Review Technical Memorandum 2.1
- Carolina-Terwilliger Subwatershed Pipe System Data Analysis and Review Technical Memorandum 2.2
- Carolina-Terwilliger Subwatershed Characterization Summary Technical Memorandum 2.3
- Carolina-Terwilliger Subwatershed Stakeholder Input Technical Memorandum 3.2
- Carolina-Terwilliger Subwatershed Improvement Strategies Development Technical Memorandum 4.5

- Carolina-Terwilliger Subwatershed Improvement Strategies Evaluation Technical Memorandum 5.5



Southwest Subwatersheds Improvement Strategies

Memo

To: S.W. Subwatershed Project Team
 From: Willamette Watershed Planning Team
 Task ID: IS Evaluation: Opportunities Ranking Process
 Date: 4/28/2009 5:43:00 PM
 Subject: **Improvement Strategies Task 5.1**

The subwatershed improvement strategy opportunity ranking process demonstrates how to assign a relative value to each opportunity (i.e., a project or program in a specific location) for improving subwatershed health conditions. The process does not take into consideration any feasibility or implementation factors. The rankings are not intended to represent a set order in which to implement projects or programs. Rather, they will inform the selection and implementation processes to guide which projects to pursue as opportunities become available.

The following steps were used to complete the ranking of improvement strategy opportunities for the Marquam-Woods, California, and Carolina-Terwilliger subwatersheds in 2008-2009, and can be replicated for future use:

1. **Develop a list of assets and problem areas** for the subwatershed based on literature review, inventories, and stakeholder input.
2. **Conduct field assessments to evaluate actions** (i.e., potential projects and programs) in areas identified through Step 1 for watershed improvement strategies. The necessary information for each action is stored in a database maintained by Willamette Watershed staff. Information collected and recorded for each action includes:
 - General information on the site assessed, staff involved, ownership, location, zoning, etc.
 - Description of the type of action proposed - size, location, potential actions etc.
 - Implementation considerations – limitations, coordination factors, etc.

The field information documented for each site is used in the steps that follow to help quantify the degree to which potential actions will help improve watershed conditions.

3. **Select opportunities** from the identified actions based on the following objectives in the 2005 Portland Watershed Management Plan (PWMP):

1. Stream Flow and Hydrologic Complexity
 2. Channel and Floodplain Function
 3. Stormwater Conveyance
 4. Aquatic Habitat
 5. Terrestrial Habitat
 6. Stream Temperature
 7. Human Pathogens
 8. Urban Pollutants
 9. Fish and Other Aquatic Organisms
 10. Terrestrial Wildlife and Vegetation
4. **Rank PWMP objectives** based on their contribution to subwatershed health through a review of results in Steps 1-3, and the Willamette Watershed technical team's best professional judgment. Use the following process to rank the PWMP objectives to show which are most important for improving subwatershed conditions. First, each team member assigns a grade for the current subwatershed condition associated with each PWMP objective. Five grade levels are possible
- low = 1 point
 - low average = 2 points
 - average = 3 points
 - high average = 4 points
 - good = 5 points

Second, obtain a consensus grade based on group discussion for the current subwatershed condition associated with each objective. Some of the chief considerations leading to the graded results in the Southwest subwatersheds were:

- These subwatersheds are part of the combined sanitary and stormwater infrastructure.
- The characterization results provided by the BES Systems Analysis team determined that the combined system infrastructure in these subwatersheds has problems related to capacity.
- There are large natural areas that provide habitat for wildlife and likely for aquatic organisms (not fish).
- The streams in the subwatersheds do not reach the Willamette River, stormwater is directed to the Columbia Treatment Plant.
- There are 25 Environmental Cleanup Site Inventory (ECSI) sites in the South Waterfront redevelopment area.
- The natural areas are degraded by invasive plant species [Portland Parks and Recreation (PP&R), Ecohealth assessment.

The grade levels assigned are the inverse of the Final Ranks. That is, objectives that received the lowest grade were given the highest rank of importance for their contribution to Southwest subwatershed improvement. The following table lists the final ranked objectives for the Southwest subwatersheds:

SW Subwatersheds Objectives Ranking Results

SW Subwatersheds Health Objectives	Final Rank
Stream Flow and Hydrologic Complexity: Protect and increase rainfall interception areas, create infiltration and detention areas to normalize stream hydrographs, reduce stormwater flow to sewer systems, and reduce basement flooding.	1
Aquatic Habitat: Protect and improve aquatic, riparian, and floodplain habitat extent, quality, and connectivity that supports the persistence of native fish and wildlife communities.	2
Urban Pollutants: Manage the sources and transport of urban stormwater and industrial pollutants and nutrients to limit surface water, groundwater, soil, and sediment contamination to levels that protect ecological and human health and achieve applicable water quality standards.	3
Channel and Floodplain Function: Protect and restore the extent, connectivity, and function of streams, other open drainageways, wetlands, riparian areas and floodplains to improve bank stability and natural hydrologic functions and reduce risk to development and human safety.	4
Fish and Other Aquatic Organisms: Implement watershed actions to maximize the persistence of native Willamette and Columbia River fish and other aquatic organisms and assist with species recovery and potential population productivity by protecting and improving hydrology, habitat, and water quality.	5
Terrestrial Wildlife and Vegetation: Implement watershed actions to restore populations of terrestrial organisms to healthy, self-sustaining levels, protect and restore the composition and structure of native vegetation communities, and reduce populations of non-native plants and organisms to levels that do not compete with native species.	6
Terrestrial Habitat: Protect and improve upland habitat extent, quality, and connectivity that support the persistence of native terrestrial communities and connectivity to aquatic and riparian habitat.	7
Human Pathogens: Maintain and manage sewer infrastructure and stormwater inputs and runoff to limit sewage overflow and the delivery of pathogens to waterways and achieve applicable water quality and sewer design manual standards.	8
Stream Temperature: Protect and improve stream temperatures, dissolved oxygen, and pH levels that protect ecological health and achieve applicable water quality standards.	9
Stormwater Conveyance: Maintain stormwater collection and conveyance infrastructure capacity.	10

5. **Assign a weight to each objective.** Weights were calculated by applying a formula based upon the objectives' assigned ranks, to refine the analysis for determining their benefits towards improving subwatershed conditions [i.e., improving stream flow (which is ranked number 1) is not necessarily twice as beneficial as improving aquatic habitat (which is ranked number 2)] in the subwatershed.

6. **Assign a metric to each objective.** Each PWMP objective listed in Step 3 is assigned a metric that, when measured, would indicate a positive improvement in subwatershed health. Metrics are chosen based on the assets and problems specific to the subwatershed. Metrics are assigned based on PWMP objectives. In the Southwest subwatersheds the metrics have been assigned as follows:

Objective/Measure

1. Stream Flow and Hydrologic Complexity/ Effective impervious area (EIA) reduced (acres)
2. Channel and Floodplain Function/ Channel Floodplain restored or enhanced (acres)
3. Stormwater Conveyance/ Substandard stormwater pipes maintained (Y/N)
4. Aquatic Habitat/ Aquatic habitat restored/enhanced (linear feet)
5. Terrestrial Habitat/ Terrestrial Habitat protected through acquisition (acres)
6. Stream Temperature/ Stream temperature maintained/reduced (Y/N)
7. Human Pathogens/ Fecal inputs reduced (Y/N)
8. Urban Pollutants/ Urban pollutants reduced in soils or water (Y/N)
9. Fish and Other Aquatic Organisms/ Biotic measures improved (Y/N)
10. Terrestrial Wildlife and Vegetation Terrestrial/ native vegetation enhanced, restored protected through revegetation projects (acres)
11. Improve watershed health by maximizing stewardship, education and partnerships/ Opportunities for education, involvement and stewardship (Y/N)

Each objective is assigned at least one measure (i.e., there can be more than one) based on the predicted ability of the recommended action(s) to improve subwatershed health. As indicated above, measures can be based on acres, linear feet, or the detectable accomplishment (Y/N) for the recommended actions.

7. **Analyze opportunity projects using a multi-attribute utility analysis tool.** Multi-Attribute Utility Analysis (MUA) is a formal, analytic approach for evaluating and comparing alternatives for decisions with multiple objectives. This decision-making tool allows the decision-maker to incorporate objectives that are measured on different scales, and to generate a prioritized list of alternatives based upon scores.

Scores are calculated using anticipated measurable improvements (i.e., metrics) for each opportunity, and the final ranks and weights assigned to each objective by the Project Team. Each action is first assigned a value for each measure.

For example:

- Action: Create a vegetated stormwater infiltration facility that could receive water from a 0.5 acre catchment area
- Measure: Reduce Effective Impervious Area (EIA)
- Value associated with one measure: 0.5 acres

The following formula is then applied:

$$Score = \sum_{i=1}^m k_i U_i$$

where m = the initial value for the measure identified in Step 6 (in the example above, 0.5 acres)

k = the weight assigned to each objective

U = the normalized value for the measure⁴

The final score for each opportunity (i.e., project or program in a specific location) demonstrates a relative value towards improving subwatershed health conditions and does not take into consideration any feasibility, implementation, or cost factors. The scores are not intended to represent a set order in which to implement opportunities. Rather, they will inform the selection and implementation processes to pursue as resources become available.

8. A draft version of the complete scored and prioritized list of opportunities is then developed by Willamette Watershed staff and sent to the Technical Advisory Team for review. The team includes:
 - BES Revegetation (Darian Santner)
 - BES Sustainable Stormwater (Linda Dobson)
 - BES Regulatory/Policy (Dawn Hottenroth)
 - BES Maintenance (Joe Dvorak)
 - BES Engineering Systems Analysis (Alicia Lanier)
 - BES Education (Jennifer Devlin)
 - BES Science, Fish, and Wildlife (Cindy Studebaker)
 - BES Source Control (Michael Pronold)
 - BES Brownfields (Clark Henry)
 - Bureau of Maintenance (Mike Boyle)
 - Portland Department of Transportation (Nicole Blanchard)
 - Portland Parks and Recreation (Fred Nilsen, Mart Hughes, Dan Moeller & Mark Wilson)
 - Portland Water Bureau (Cherri Warnke)
 - Bureau of Planning (Mindy Brooks)
 - Mayor and Commissioners' Office
 - BES Communications staff/Office of the Director

⁴ Values for the metrics associated with each action were normalized to a 0 to 1 scale using the following formula, where U is the action's normalized score for each measure:

$$U = \frac{X - Worst}{Best - Worst}$$

The opportunities list is reviewed by city stakeholders and the Willamette Watershed Team, and is then finalized based on consideration of comments received.