City of Portland, Oregon
TMDL IMPLEMENTATION PLAN FOR THE WILLAMETTE RIVER AND TRIBUTARIES
February 28, 2014

1. INTRODUCTION

1.1 Purpose

This Total Maximum Daily Load (TMDL) *Implementation Plan* identifies management strategies the City of Portland will use to reduce TMDL pollutants from nonpoint sources in order to restore and protect water quality in the Willamette River and tributaries. It updates the City's existing *TMDL Implementation Plan* of March 2008. The City will implement these strategies within the City of Portland's urban services boundary during the five-year *Implementation Plan* cycle (March 1, 2014 - March 1, 2019). Table 1 shows the subbasins and TMDL parameters the *Implementation Plan* addresses.

Table 1
Portland TMDL Sub-basins and Parameters

Basin Name	Sub-basin(s)	TMDL Parameter(s)	Year TMDL Set
Columbia River	Lower Columbia	Dioxin[1]	1991
Willamette River	Lower Willamette	Mercury[2], bacteria, temperature	2006
	Columbia Slough	DDT/DDE, dieldrin, dioxin, PCBs, lead, phosphorus, bacteria, dissolved oxygen, pH, chlorophyll a;	1998
	Columbia Slough	Temperature	2006
	Johnson Creek & tributaries	DDT, dieldrin, bacteria, temperature	2006
	Springbrook Creek	Bacteria	2006
	Willamette Tributaries	Bacteria[3]	2006
Tualatin River	Fanno Creek and Tributaries	Bacteria, temperature, phosphorus, dissolved oxygen	2001
	Rock Creek	Bacteria, temperature, phosphorus, dissolved oxygen	2001

[1] A dioxin TMDL was set by EPA for the lower Columbia River and included the lower Willamette River. Wastewater treatment plants and stormwater are discussed in that TMDL, but due to lack of data, loads from these sources are considered part of the reserve capacity, and no allocation was made.
[2] The mercury TMDL is a phased TMDL. Reduction targets were set in 2006, but LAs and WLAs were not established.
[3] Applies to all Willamette tributaries that do not have an explicit bacteria TMDL.

Table 2 summarizes the general sources that impact water quality and general strategies for improving water quality for each TMDL or group of pollutants. The management strategies in this *Implementation Plan* incorporate all of the general strategies shown in Table 2.

Table 2
TMDL General Sources and Management Strategies

TMDL Parameter	General Sources	General Strategies/ Best Management Practices(BMPs)
Bacteria	Bacteria are carried to waterways in stormwater, overland flow, and pipes systems.	Reduce inputs of bacteria by various means including riparian protection, erosion control and stormwater control and treatment, low impact development, septic maintenance and various domestic and agricultural practices.
Dissolved Oxygen	In-stream sediment from runoff and stream bank erosion and high nutrient loads. Wastewater or stormwater effluent.	Reduce sediment delivered to streams by various means including riparian protection, soil erosion control and storm/wastewater control and treatment, low impact development and reduce nutrient loads.
Mercury and Toxics	In-stream sediment from runoff and stream bank erosion; air deposition. Legacy sources (mercury, DDT, etc.)	Reduce sediment delivered to streams by various means including riparian protection, soil erosion control and stormwater control and treatment, low impact development.
Phosphorus and chlorophyll	In-stream sediment from runoff and stream bank erosion; delivery of excess nutrients to surface water; wastewater discharges	Reduce sediment delivered to streams by various means including riparian protection, soil erosion control and stormwater control and treatment, low impact development and reduce nutrient loads. Manage fertilization and irrigation to reduce nutrient runoff.
Temperature	Removal of trees and other shade-producing woody vegetation from stream banks; reduced flow or altered hydrology; wastewater discharges.	Increase effective shade through restoration and protections; Restore natural stream hydrology and cool water refuges and wetlands; Increase natural stream flow.

Source: *TMDL Implementation Guidance, Fifth Year Review Report Template for City and County Designated Management Agencies.* April 2013. State of Oregon Department of Environmental Quality.

1.2 Background

The Willamette River and numerous tributaries do not currently meet several water quality standards. These standards ensure that beneficial uses of the river and tributaries (such as swimming, fish consumption, and fish rearing) are protected. When water quality standards are not met, the federal Clean Water Act requires a total maximum daily load (TMDL) to be established. A TMDL determines how much pollution can be added to the river without exceeding water quality standards.

The Oregon Department of Environmental Quality (DEQ) issued the Willamette Basin TMDL in September 2006 and developed a Willamette Basin TMDL Water Quality Management Plan (WQMP) to describe the overall framework for implementing the Willamette Basin TMDL. DEQ also issued a TMDL WQMP for the Tualatin Subbasin in August 2012. The WQMPs describe activities, programs, legal authorities and other measures for which DEQ and other

designated management agencies (DMAs) have regulatory responsibility. A DMA is a federal, state or local governmental agency that has legal authority of a sector or source contributing pollutants and is identified as such by DEQ in a TMDL. As a DMA, the City of Portland has prepared this *Implementation Plan* in response to the *Willamette Basin TMDL WQMP* and *Tualatin Subbasin TMDL WQMP*.

Oregon Administrative Rule (OAR) 340-042-0080(3)(a) requires the *Implementation Plan* to include the following elements:

- Identify the management strategies the DMA will use to achieve load allocations and reduce pollutant loading.
- Provide a timeline for implementing management strategies and a schedule for completing measurable milestones.
- Provide for performance monitoring with a plan for periodic review and revision of the implementation plan.
- To the extent required by ORS 197.180 and OAR Chapter 340, division 18, provide evidence of compliance with applicable statewide land use requirements.
- Provide other analyses or information specified in the WQMP.

In addition, the DMA must implement and revise the plan as needed. This *Implementation Plan* updates the existing plan that the City has been implementing since March 2008.

1.3 Relationship to City NPDES Permits

This *Implementation Plan* addresses nonpoint sources of pollution that are not covered by other permits.

The City holds the following DEQ-issued National Pollutant Discharge Elimination System (NPDES) permits for point source discharges to surface waters. These permits and their associated management plans serve to reduce point source pollutants and help restore and protect water quality.

- Tryon Creek Wastewater Treatment Plant (WTP) and Columbia Boulevard WWTP permits
- Municipal Separate Storm Sewer System (MS4) discharge permit
- General stormwater permit for the Columbia Boulevard WTP (1200-COLS)

The annual compliance reports required by these permits provide information about implementation of the management plans.

1.4 Funding

The City of Portland has invested more than $1.01 billion in stormwater management services and facilities since 1995.[1] The revenue requirements for fiscal year FY 2012-2013 totaled approximately $101 million.

Eighty-six percent of revenue requirements are financed through direct monthly user fees[2]. The remaining revenue sources include direct charges for new private development (system development charges), service charges, permit fees, and regulatory charges and penalties. Details on City revenues are provided in NPDES MS4 Annual Compliance Reports available at http://www.portlandoregon.gov/bes/50289.

1.5 Legal Authority

The City of Portland's legal authority to implement TMDL management strategies is provided by relevant Oregon State Constitution sections, Oregon state statutes, and City of Portland charter and code, as summarized below.

State Constitution
The City operates pursuant to a city charter granted by the State of Oregon in 1903, as amended by the legal voters of the City. City voters may further amend the Portland City Charter subject to the Constitution and criminal laws of the State of Oregon (Or Const art XI, § 2).

Oregon State Statutes
Oregon Revised Statute (ORS) 30.315 grants authority to any incorporated city to enforce its ordinances and resolutions.

City Charter
Sections 2-104, 2-105, and 2-106 of the City Charter empower the City to exercise authority to regulate and establish laws for the protection of persons and property and provide for the health, cleanliness, safety and good order of the City.

Section 11-303 authorizes the City to prohibit discharge of sewage or harmful matter or impurities into any stream or river within the City.

Portland City Code
- City Code Section 3.13.020 provides authority to the Director of the City's Bureau of Environmental Services to adopt rules, procedures and forms to implement Code sections relevant to the Bureau's responsibilities.

---

[1] NPDES MS4 Annual Compliance Report No. 18. November 1, 2013. Prepared for Oregon Department of Environmental Quality. Submitted by City of Portland and Port of Portland. Covers permit year 2012-13 (July 1, 2012 to June 30, 2013).
[2] Ibid

- City Code Section 3.30.040 provides authority to the Director of the City's Bureau of Development Services to adopt written policies and procedures for the enforcement of applicable Code provisions and laws, including Building Regulations (Title 24) and Planning and Zoning Regulations (Title 33).

- City Code Section 10.10.030.A.1 provides authority to the Director of the City's Bureau of Development Services to administer and enforce requirements for permitted ground disturbing activities related to private development.

- City Code sections related to *Implementation Plan* strategy implementation include:

  - Title 10, Erosion and Sediment Control Regulations, requires all sites conducting ground disturbing activity to control onsite erosion and sediment.

  - Title 17, the public works code, regulates public improvements, including sewer and stormwater collection systems. Specifically:

    - Chapter 17.38 requires post-development stormwater management facilities related to new development and redevelopment.
    - Chapter 17.39 provides the City with authority to control discharges to the City storm sewer and drainage systems.

  - Title 24, Building Regulations, establishes standards for building and construction, including clearing, grading, earthwork, and erosion control on private property.

  - Title 33, Planning and Zoning, establishes the City's land use regulations, including provisions for establishing environmental protection and conservation zones.

1.6 Compliance with Land Use Requirements

All of the management strategies included in this *Implementation Plan* are consistent with the City's land use plans and requirements. The City will evaluate and maintain consistency with local and statewide land use laws in any future actions related to TMDL implementation.

2. PERFORMANCE MONITORING AND PERIODIC PLAN REVIEW/ REVISION

The City uses an adaptive management approach for its TMDL program to determine if the Implementation Plan needs to be modified to improve effectiveness. As summarized below, this includes both an annual process and a more comprehensive longer-term process. Together, these two elements incorporate both types of performance monitoring described in OAR 340-042-0080(3)(a)(C): implementation monitoring and effectiveness monitoring.

2.1 Annual Process

The City conducts an annual adaptive management process in conjunction with preparing its annual TMDL status report. This annual review is used to determine if the City's TMDL program is being implemented in accordance with the Implementation Plan (implementation monitoring) and identify whether any program adjustments are needed.

The City submits its status report to DEQ each year by November 1. The annual status reports identify any program issues or modifications that were identified as part of the annual review.

2.2 Comprehensive Process

The City will conduct a more comprehensive evaluation process (effectiveness monitoring) to identify proposed program modifications in conjunction with preparing its *TMDL Implementation Plan Fifth Year Report*. This will include evaluating in-stream water quality trend analyses for TMDL parameters for which data are available. If significant trends show declining water quality, the adaptive management process will be used to identify potential sources and reassess the current program.

The City will also consider effectiveness evaluations developed for the City's MS4 program (e.g., the MS4 *Fourth Year Annual Compliance Report* due to DEQ on November 1, 2014 and the MS4 permit renewal submittal due to DEQ on July 30, 2015). These submittals include evaluating progress toward TMDL WLAs and setting future pollutant load reduction targets (benchmarks).

3. CITYWIDE MANAGEMENT STRATEGIES

Table 3 identifies the City's key management strategies to reduce TMDL pollutants and improve water quality. Many of these strategies are based on the City's Stormwater Management Plan (SWMP), which describes the best management practices (BMP) the City implements to reduce the discharge of pollutants from the municipal separate storm sewer system (MS4) to receiving waters. Although the SWMP addresses discharges from point sources (the MS4), many of the SWMP strategies are applied citywide and are relevant to reducing pollution from nonpoint sources as well.

Most of these management strategies are ongoing and will be implemented throughout the five-year *Implementation Plan* cycle.

(Additional strategies that specifically address temperature, including cold water refugia, are discussed separately in Section 4, below.)

Table 3
Citywide Management Strategies

	KEY STRATEGIES	TMDL Parameters Addressed					
		Bacteria (E. coli)	Dissolved Oxygen	Mercury	Toxics (DDT, PAH, PCB)	Phosphorus & Chlorophyll	Temperature
Public Involvement (PI)							
1	Provide water quality education and curriculum resources for K-12 students.	×	×	×	×	×	
2	Educate the public about stormwater and surface water quality protection/pollution prevention and riparian and wetland protection via websites, workshops, fact sheets, and other outreach materials.	×	×	×	×	×	
3	Involve citizens in water quality improvement activities through community events, stewardship projects, and restoration projects.	×	×	×	×	×	×
4	Implement Multnomah County's pet waste pick-up ordinance in City parks.	×	×			×	
5	Promote carpooling, use of public transportation, walking and biking.				×		
6	Coordinate and implement education and outreach programs and strategies with other jurisdictions.	×	×	×	×	×	×
7	Post the TMDL Implementation Plan and annual reports on the City website.	×	×	×	×	×	×
Operations and Maintenance (OM)							
1	Implement an inspection, maintenance, and repair program for public stormwater collection and treatment systems.	×		×	×	×	
2	Implement an inspection program for private stormwater management facilities.	×		×	×	×	
3	Review BES stormwater facility operations and maintenance practices and update them as necessary.	×		×	×	×	

Table 3 (continued)

	KEY STRATEGIES	TMDL Parameters Addressed					
		Bacteria (E. coli)	Dissolved Oxygen	Mercury	Toxics (DDT, PAH, PCB)	Phosphorus & Chlorophyll	Temperature
4	Operate and maintain public streets and roads in a manner that reduces the discharge of pollutants in stormwater.	×		×	×	×	
5	Provide employee training on maintenance and construction practices to protect water quality.	×	×	×	×	×	×
6	Implement the City's Integrated Pest Management (IPM) program to minimize the use and application of fertilizers, herbicides, and pesticides on publicly owned properties.		×	×	×	×	
7	Maintain pet waste stations and signage in parks.	×				×	
8	Incorporate electric vehicles into the transportation fleet.				×		
	Illicit Discharge Detection and Elimination (ILL)						
1	Require new development or properties using nonconforming sanitary sewer connections to connect to the public sewer system when a public sanitary sewer is available.	×	×		×	×	
2	Limit infiltration of seepage from the sanitary sewer system to the MS4.	×					
3	Implement and enforce designated prohibitions on discharges to the City MS4.	×	×	×	×	×	×
4	Identify, respond to, and eliminate illicit discharges and cross connections.	×	×		×	×	×
5	Require Porta-potties at parks for public events and sporting events.	×					

Table 3 (continued)

	KEY STRATEGIES	TMDL Parameters Addressed					
		Bacteria (E. coli)	Dissolved Oxygen	Mercury	Toxics (DDT, PAH, PCB)	Phosphorus & Chlorophyll	Temperature
	New Development Standards (ND) (During Construction and Post-Construction)						
1	Implement an erosion and sediment control program for ground-disturbing activities.	×		×	×	×	
2	Require erosion and sediment control plans, when applicable, during the building permit application phase.	×		×	×	×	
3	Require BMPs to prevent and control erosion and construction-associated pollutants.	×			×	×	
4	Implement a hillside development protection code to minimize soil erosion from steep slopes.	×		×	×	×	
5	Through the City's Stormwater Management Manual, implement stormwater management requirements for new development and redevelopment to treat stormwater and control post-development peak runoff rates to levels similar to pre-development levels.	×		×	×	×	
6	Require new development and redevelopment to manage stormwater onsite to the maximum extent practicable.	×	×	×	×	×	×
7	Promote the use of low-impact development techniques such as bioswales, rain gardens, and other vegetated stormwater management techniques	×		×	×	×	
8	Promote and incorporate the use of green street facilities in public and private development.	×	×	×	×	×	
9	Continue to review and update the Stormwater Management Manual.	×	×	×	×	×	
10	Enforce stormwater ordinances that protect water quality.	×		×	×	×	

Table 3 (continued)

	KEY STRATEGIES	TMDL Parameters Addressed					
		Bacteria (E. coli)	Dissolved Oxygen	Mercury	Toxics (DDT, PAH, PCB)	Phosphorus & Chlorophyll	Temperature
Natural Systems (NS)							
1	Implement provisions of City Code that protect floodways and floodplains.	×	×	×	×	×	×
2	Implement programs to protect riparian buffers and corridors, headwaters, springs and seeps, wetlands, and native vegetation.	×	×	×	×	×	×
3	Restore riparian buffers by removing invasive species and planting with native shrubs and trees.	×	×	×	×	×	×
4	Implement an invasive species removal program, including education and outreach.		×			×	×
5	Implement tree protection ordinances that provide stormwater benefits and mitigate urban heat island effects.						×
6	Implement a Revegetation Program.	×	×	×	×	×	×
7	Implement a street tree planting program.	×	×	×		×	×
8	Work with watershed partners to support and coordinate tree planting and riparian restoration programs.	×	×	×	×	×	×
9	Implement stream restoration projects and provide floodplain reconnection.	×	×	×		×	×
10	Work with public and private partners on culvert replacement, stream and wetland restoration projects.	×	×			×	×
11	Identify and protect cold water refugia in the Willamette River.						×

Table 3 (continued)

	KEY STRATEGIES	TMDL Parameters Addressed					
		Bacteria (E. coli)	Dissolved Oxygen	Mercury	Toxics (DDT, PAH, PCB)	Phosphorus & Chlorophyll	Temperature
12	Use updates to the citywide *Natural Resource Inventory* to inform zoning and planning updates.	×	×	×		×	×
	Structural Controls (STR)						
1	Implement retrofits to the existing storm drainage system, including use of green infrastructure.	×		×	×	×	
2	Identify, prioritize, and construct new stormwater management facilities.	×		×	×	×	
3	Maintain stormwater conveyance system maps and database to track system components and conditions.	×		×	×	×	
4	Develop a comprehensive Stormwater System Plan.	×	×	×	×	×	×
Program Management (PM)							
1	Develop annual reports by November 1 that provide an overview of the TMDL Implementation Plan status.	Not applicable					
Monitoring							
1	Implement a monitoring program that includes stormwater and surface water.	×	×	×	×	×	×

4. TEMPERATURE MANAGEMENT STRATEGIES

4.1 Shading

The 2006 Willamette Basin TMDL notes that increased solar radiation from the removal of riparian vegetation is a major cause of the rise in water temperatures.[3] The Willamette Basin TMDL also notes that protecting and restoring riparian vegetation is the principal means of achieving system potential shading. The City's programs for riparian protection and revegetation are described below.

To evaluate the current shading from vegetative cover and determine the potential for future shading, the City conducted GIS analyses using a 100-foot buffer from top of bank on each side of streams within the City limits. Table 4 shows the area covered by the 100-foot buffer for each major watershed. The Willamette River with its many small westside tributaries has the greatest area within the 100-foot buffer, followed by the Columbia Slough, Johnson Creek, Tryon Creek, and Fanno Creek.

Table 4
Area within 100-foot Stream Buffer, by Watershed

Watershed	Area Within 100-Foot Stream Buffer (Acres)	Percentage [1] (%)
Willamette River, incl. westside streams	3,926	43
Columbia Slough	2,335	25
Johnson Creek	1,317	14
Tryon Creek	837	9
Fanno Creek	792	9
Total Stream Buffer Area in all Watersheds	9,207	100

[1] Percentages are calculated as percent of total stream buffer area in all watersheds.

Riparian Protection

The City protects riparian vegetation through natural resource inventories, protection plans, and environmental overlay zones. The environmental overlay zone code (City Code Chapter 33.430: Environmental Zones) is intended to protect and conserve natural resources values and functions, including water quality and fish and wildlife habitat. The City's adopted natural resource inventories and protection plans identify features to which the environmental overlay zones are applied; those features include riparian and upland vegetation and water bodies (streams, drainageways, and wetlands).

[3] Willamette Basin Total Maximum Daily Load. Chapter 4: Temperature-Mainstem TMDL and Subbasin Summary. September 2006. Oregon Department of Environmental Quality.

Natural resource management plans provide the means to evaluate the cumulative effects of development and mitigation proposed at different times and in different places within the same large ecosystem. These plans are of particular value in areas of multiple ownership. These plans also provide opportunities for coordination with, or joint adoption by, other local governments; special districts; and regional state, and federal agencies.

The following Plan Districts and Natural Resource Management Plans have additional regulations that may supersede or supplement the environmental zoning regulations of Chapter 33.430:

- The Balch Creek Watershed (see Chapter 33.563, Northwest Hills Plan District)
- The Columbia South Shore within the Columbia Corridor (see Chapter 33.515, Columbia South Shore Plan District)
- Johnson Creek Basin (see Chapter 33.537, Johnson Creek Basin Plan District)
- Northwest Hills Natural Areas (see Chapter 33.563, Northwest Hills Plan District)
- Skyline West Conservation Plan area (see Chapter 33.563, Northwest Hills Plan District)
- East Columbia Neighborhood Natural Resources Management Plan
- Smith and Bybee Lakes Natural Resources Management Plan
- Forest Park Natural Resources Management Plan
- Natural Resources Management Plan for the Peninsula Drainage District No. 1

The environmental zone regulations require proposed development to meet development standards, avoid adversely affecting natural resources where practicable, and/or mitigate for unavoidable impacts. The environmental overlay zone is an important tool that will help in TMDL implementation, particularly the temperature TMDL.

The environmental zone regulations also help meet other City goals, along with other regional, state, and federal goals and regulations. There are two environmental overlay zones:

- The Environmental Protection (EP) zone provides the highest level of protection to the most important resources and functional values. Development will be approved in the environmental protection zone only in rare and unusual circumstances.
- The Environmental Conservation (EC) zone conserves important resources and functional values in areas where the resources and functional values can be protected while allowing environmentally sensitive urban development.

Table 5 shows the total area of EC and EP zones within the 100-foot buffer within each watershed. Because large portions of these zones overlap in areas, the percent coverage of the total 100-foot buffer within each watershed is calculated separately for EC and EP zones. Most watersheds have 20 to 31 percent EC coverage and 26 to 39 percent EP zone coverage. The exception is the Willamette Watershed, which has 13 percent EC zone coverage and 55 percent EP zone coverage. Because the 100-foot buffer of the mainstem of the Willamette River within the City limits is developed, the environmental zone coverage is primarily along the westside tributaries in Forest Park (as shown on Figure 1).

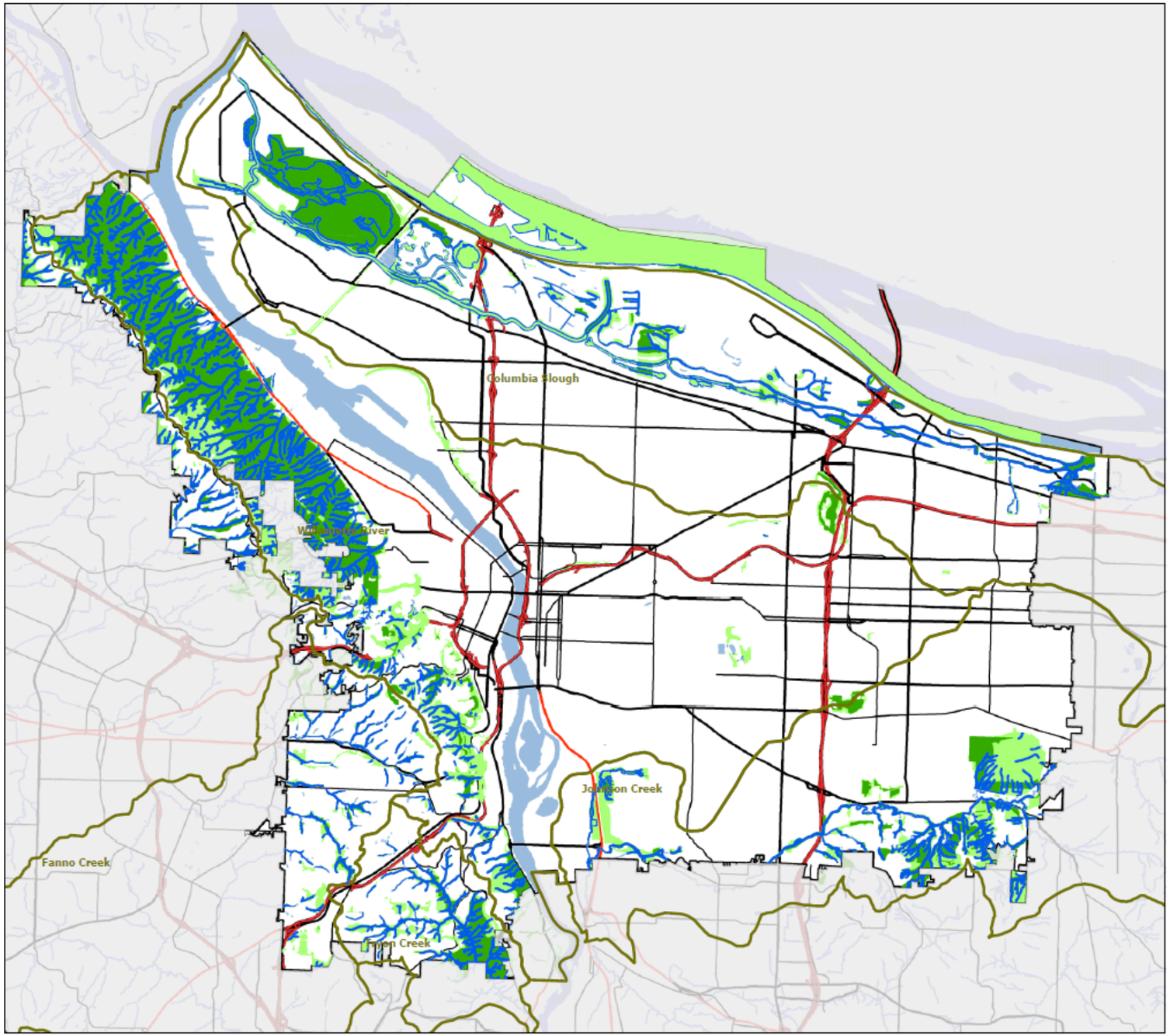

Figure 1 Environmental Zones (e-zone) Overlay for all Streams

Legend

- City of Portland Waterbodies
- BES Topographic Watersheds
- Conservation Zone (c)
- Protection Zone (p)
- E-zone within Buffer

0 0.5 1 2 3 4 Miles

N W E S

BES
Pollution Prevention Services

Environmental Compliance MS4 Section

Sheet No. 1 OF 1

Date Printed: 2/28/2014

Table 5 Area of Environmental Protection (EP) and Environmental Conservation (EC) Overlay Zones, by Watershed				
Watershed	**EC Zoned Area (acres)**	**Percent EC Zoned Area of Total Watershed 100-Foot Buffer Area**	**EP Zoned Area (acres)**	**Percent EP Zoned Area of Total Watershed 100-Foot Buffer Area**
Willamette River incl. westside streams	523	13	2,167	55
Columbia Slough	726	31	696	30
Johnson Creek	377	29	509	39
Tryon Creek	169	20	292	35
Fanno Creek	166	21	205	26
Total within 100-Foot Stream Buffer	3,869	21	1,961	42

Revegetation Program

Riparian vegetation planting is the most effective approach for reducing stream temperature, especially in smaller tributaries. The City began implementing a Revegetation Program in 1995 that focuses on restoring riparian and water quality beneficial properties by removing non-native vegetation and revegetating with native trees and plants. Since its inception, this program has revegetated approximately 2,927 acres, or 32 percent of the 100-foot City stream buffers (Table 6 and Figure 2).

Table 6 Revegetated Areas within 100-Foot Stream Buffer, by Watershed		
Watershed	**Revegetated 100-Foot Buffer Area (Acres)**	**Percent of 100-Foot Buffer Area Revegetated**
Willamette River, incl. westside streams	1,024	26
Columbia Slough	902	39
Johnson Creek	793	60
Tryon Creek	79	9
Fanno Creek	129	16
Total within Stream Buffer	2,927	32

During the last five years, the City has planted over 170,000 deciduous and coniferous trees on over 1,050 acres (Table 7). The City's Revegetation Program is currently developing a five-year implementation plan to guide future revegetation. Implementation levels are expected to be similar to those for the past five-years.

Table 7
Summary of Revegetation Program Plantings by Watershed
FY 08/09 – FY12/13

	FY 08-09	FY 09-10	FY 10-11	FY 11-12	FY 12-13	Total (5 years)
Deciduous Trees Planted	8,279	31,960	34,061	29,232	25,450	**128,982**
Coniferous Trees Planted	3,002	16,474	7,388	7,520	8,332	**42,716**
Shrubs Planted	29,482	63,639	51,240	101,854	89,602	**335,817**
No. of Acres Planted	182	284.5	136.75	223.97	224.6	**1,051.82**

Table 8 shows the percentage of the 100-foot stream buffer area that currently has forest and woodland cover. Figure 3 shows the forest and woodland cover within the 100-foot stream buffer. With the exception of the Columbia Slough, all watersheds have 51 percent or more forest and woodland cover within the 100-foot stream buffer area. Tree planting in the 100-foot buffer in the Columbia Slough is constrained by industrial development along the slough and restrictions on tree planting on flood protection levees.

Table 8
Forest and Woodland Cover within 100-Foot Stream Buffer

Watershed	Area of 100-Foot Buffer with Forest and Woodland Cover (acres)	Forest and Woodland Cover as Percentage of Total 100-Foot Buffer (%)
Willamette River, incl. westside streams	2,942	75
Columbia Slough	604	26
Johnson Creek	711	54
Tryon Creek	448	54
Fanno Creek	400	51
Total Forest and Woodland Cover within Stream Buffer	5,104	55

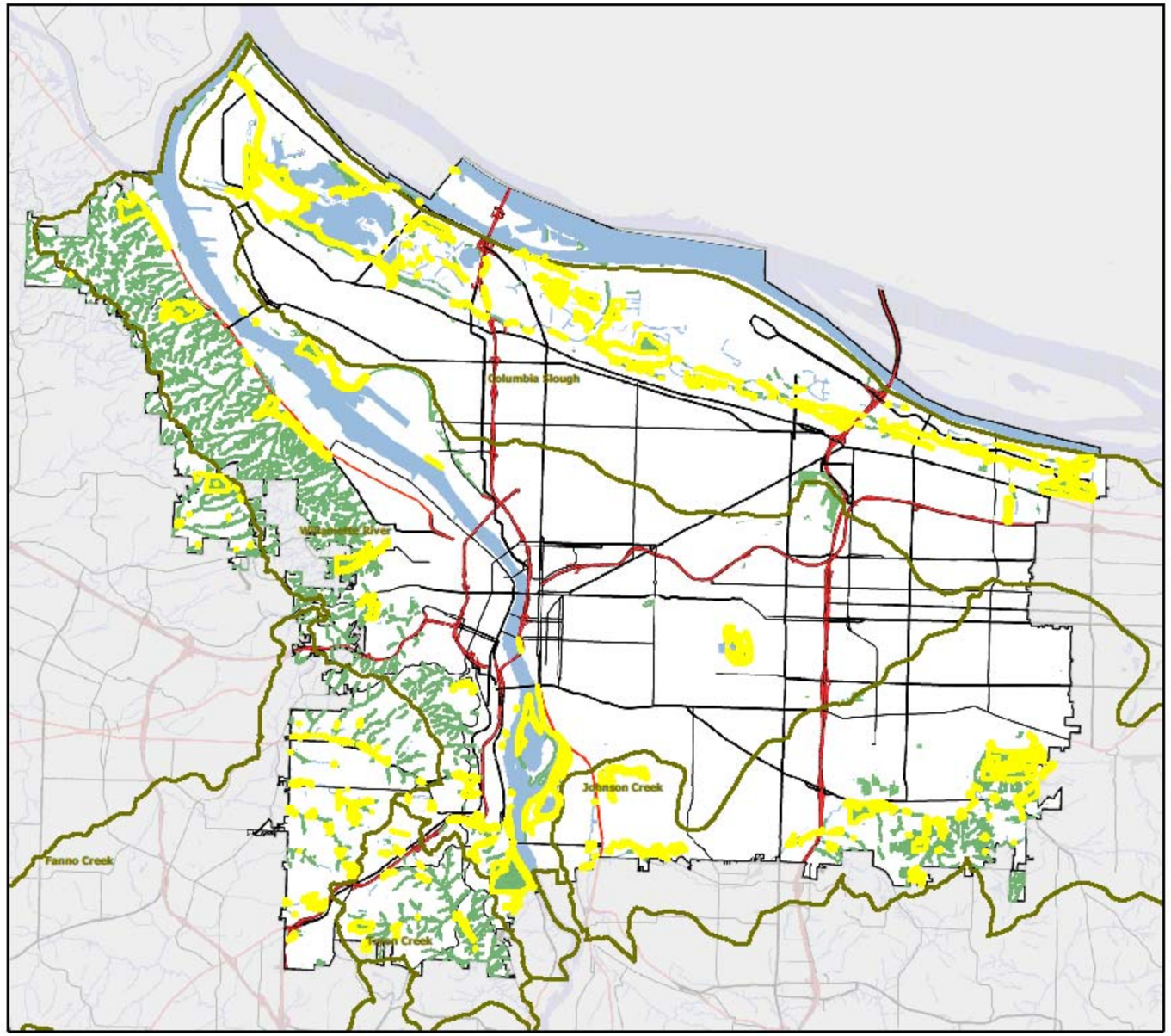

Figure 2
Revegetation Project Locations

Legend

- BES Topographic Watersheds
- City of Portland Waterbodies
- Revegetation Projects
- Revegetation within the Buffer

0 0.5 1 2 3 4 Miles

N W E S

BES
Pollution Prevention Services

Environmental Compliance MS4 Section

Sheet No.	*Date Printed:*
1 OF 1	2/28/2014

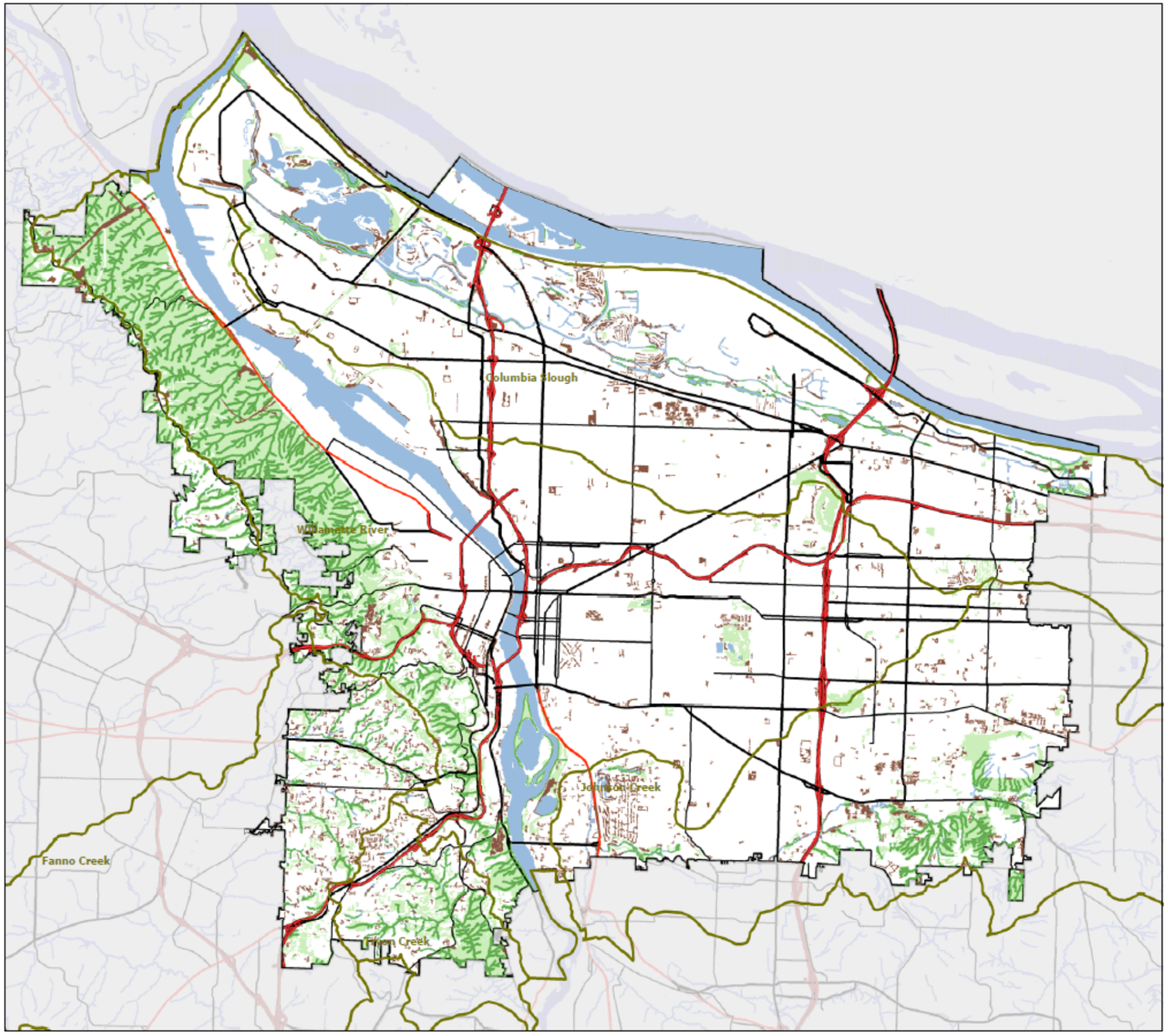

Figure 3
Forest and Woodland Cover

Legend

- BES Topographic Watersheds
- City of Portland Waterbodies
- Woodland
- Forest

0 0.5 1 2 3 4 Miles

N W E S

BES
Pollution Prevention Services

Environmental Compliance MS4 Section

Sheet No. 1 OF 1

Date Printed: 2/28/2014

To assess how much woodland and forest cover will be present in the future, the existing woodland and forest cover shown in Table 8 was combined with an estimate of future cover from revegetation projects. Because the revegetation program began almost 20 years ago, approximately 40 percent of the planted vegetation in Johnson Creek, Tryon Creek, and Fanno Creek has matured to a point where it is considered woodland or forest cover. To account for this in future projections and to avoid double counting (i.e., these areas are already accounted for in Table 8), the revegetated 100-foot stream buffer areas in those watersheds (Table 6) were reduced by 60 percent. Because the revegetation program began in the Columbia Slough and Fanno Creek watersheds in 1995, 50 percent of the plantings are mature enough to be considered forest and woodland cover. The revegetated areas for those watersheds (Table 6) were reduced by 50 percent.

With the exception of the Columbia Slough, the future projected forest and woodland cover in the 100-foot buffer of all watersheds is at or above 57 percent (Table 9). As mentioned previously, opportunities to create a shade-generating tree canopy in the Columbia Slough are limited because of the levees along the lower Slough and existing industrial and commercial development built very close to top of bank.

Table 9
Future Estimated Forest and Woodland Cover within 100-Foot Stream Buffer

Watershed	Estimated Future Area of 100-Foot Buffer with Forest and Woodland Cover (acres)	Estimated Future Forest and Woodland Cover as Percentage of Total 100-Foot Buffer (%)
Willamette River, incl. westside streams	3,454	88
Columbia Slough	1,055	45
Johnson Creek	1,028	78
Tryon Creek	480	57
Fanno Creek	452	57
Total Within Stream Buffer	6,468	70

The projected future forest and woodland cover in the 100 foot buffer (Table 9), the preservation of existing buffer vegetation by e-zones, and continued buffer revegetation will continue to improve stream shading.

4.2 Coldwater Refugia

The Willamette Basin temperature TMDL designates the mainstem of the Willamette from its confluence with the Columbia River upstream to river mile 50 as a salmon and steelhead migration corridor. The TMDL establishes numeric [20.0°C (68.0°F)] and narrative criteria (cold water refugia) for migration use.[4] The Willamette Basin TMDL WQMP requires relevant DMAs to address cold water refugia in their implementation plans.

OAR 340-041-0002(10) defines cold water refugia as "those portions of a water body where or times during the diel temperature cycle when the water temperature is at least 2 degrees Celsius colder than the daily maximum temperature of the adjacent well-mixed flow of the water body." In addition to the comprehensive measures the City is implementing to reduce overall stream temperatures (Section 4.1, above), the City is implementing approaches to identify, preserve, and enhance cold water refugia. These include:

- Bathymetry survey in the Portland Harbor
- Thermal infrared imagery (TIR) survey
- Tributary confluence survey and enhancement projects

Bathymetric Survey

The City of Portland participates in the Lower Willamette Group (LWG), a group of potentially responsible parties that have voluntarily stepped forward for the initial phase of the Portland Harbor Superfund Site work. The LWG conducted a bathymetry survey in the Portland Harbor Superfund area and submitted the results to EPA Region 10 in the *Portland Harbor RI/FS Remedial Investigation Report*, Draft Final, dated August 29, 2011. This document was prepared for the LWG by Integral Consulting Inc., Windward Environmental LLC, Kennedy/Jenks Consultants, and Anchor QEA, LLC. The bathymetric data identify deep pools in the Willamette River where cold water has the potential to remain throughout the summer season. Besides cold water, these deep pools are likely to provide calm water that could be a resting place for both juvenile and adult salmonids.

Thermal Infrared Imagery (TIR) Survey

As reported in the November 1, 2012, *Total Maximum Daily Load (TMDL) Implementation Plan Fourth Annual Status Report*, the City completed a thermal infrared (TIR) survey for a portion of the Columbia River upstream of Portland, the Columbia Slough, and the Willamette River downstream of the Multnomah Channel on August 28, 2011, and for the Lower Willamette River from the Willamette Falls to the Multnomah Channel on September 2, 2011. The TIR identifies cold water inputs to the major salmonid migration corridors.

The TIR survey provided information to:

- Spatially characterize surface temperatures for portions of the Columbia River, Willamette River, and Columbia Slough.

[4] Oregon Department of Environmental Quality. September 2006. Willamette Basin TMDL. p. 4-8.

- Identify and map cool water sources and thermal refugia.

- Create GIS-compatible data layers (e.g., thermal image mosaics, spring locations, etc.) that will be used to plan future research, direct ground-based monitoring and analysis, and protect and restore critical habitat.

Results

- Data have been used to confirm temperature differences at specific locations where cold water refugia were suspected or where restoration work was either in progress or in the planning phase.

- Detailed data review will focus on both shores of the Willamette River and a portion of the Lower Columbia Slough. The purpose is to map all areas where the water temperature is at least 1°C below the ambient surface water temperature. Staff familiar with the watershed will review the information to provide background on the locations and conduct field reconnaissance where warranted.

The City will continue to use the TIR survey data to target restoration and enhancement projects.

Tributary Confluence Survey and Enhancement Projects

Tributaries to the Willamette River have the potential to provide cooler water to the mainstem during the summer months. In addition to the TIR survey, the City identified potential cool water refugia locations at tributary confluences with the Willamette River by the following surveys:

- During the summer months of 2006-2009, temperature surveys were conducted at the confluences of five tributaries to the Willamette River.

- In 2011, a FLIR® thermal imaging camera survey of 12 potential coldwater refugia locations was conducted.

The results of the confluence surveys were used to prioritize stream confluence/cold water refugia restoration projects. The following identified projects were implemented:

- Stephens Creek Stream Restoration Project (at confluence of Stephens Creek and Willamette River): To improve in-stream, riparian, and floodplain wetland habitat for the benefit of native fish and wildlife species. Completed construction FY08-09.

- Powers Marine Natural Area Restoration (west bank of the Willamette River, upstream of the Sellwood Bridge): Restoration of the floodplain forest to improve shallow-water salmon habitat. Placing large wood along the riverbank improved the amount and quality of rearing and refuge habitat for native salmon, steelhead, and lamprey. Completed summer 2009.

- Tryon Creek Habitat Enhancement Project: To create a floodplain bench along approximately 400 feet of lower Tryon Creek and regrade the floodplain at the confluence of Tryon Creek and the Willamette River to restore hydrologic connectivity; install large wood

and boulder structures along the banks to improve aquatic habitat diversity and complexity; revegetate with natives to improve near-channel floodplain and riparian habitat. Completed construction FY10-11.

Stream confluence cold water refugia restoration projects currently in the planning, predesign, or design phase include City of Portland projects and those to be implemented by or with other partners:

- One project will create confluence cover to capture cold water and create cold water refugia at the Miller Creek confluence with Willamette River.

- Two projects focus on Riverview stream confluences with the Willamette River. Riverview is a large (146-acre) forested parcel south of the Sellwood Bridge purchased by the City in 2011. Six streams drain from the property to the Willamette River at Powers Marine Park. Airborne thermal infrared remote sensing conducted in the Willamette mainstem (September 2, 2011) showed cold water (<16°C) at the confluences of these perennial streams, making these areas important cold water refugia.

  - Build off-channel habitat/cove for Willamette River salmonid habitat and create a cold water refuge for Riverview Streams #2 and #3 (as counted from downstream to upstream).

  - Enhance the confluence of Riverview Stream #6 with the Willamette River for off-channel habitat, to capture cold water from the stream and create a cold water refuge.

4.3 Land Acquisition

As discussed in Section 4.1 above, the City protects riparian areas through natural resource inventories, protection plans, and environmental overlay zones. Land acquisition is another strategy the City uses to protect and enhance floodplain, wetlands, and riparian areas. Once these properties are acquired, the City usually conducts revegetation and/or stream restoration activities. These measures benefit both water temperature and cold water refugia. Figure 4 shows all City land acquisitions.

Table 10 shows the total acreage of property the City has acquired since 1997, as well as the amount of that property that is within the 100-foot stream buffer, by watershed. Table 11 shows specific acquisitions of floodplain, wetlands, and riparian properties since 2008. The City will continue to seek opportunities to acquire additional properties in the future.

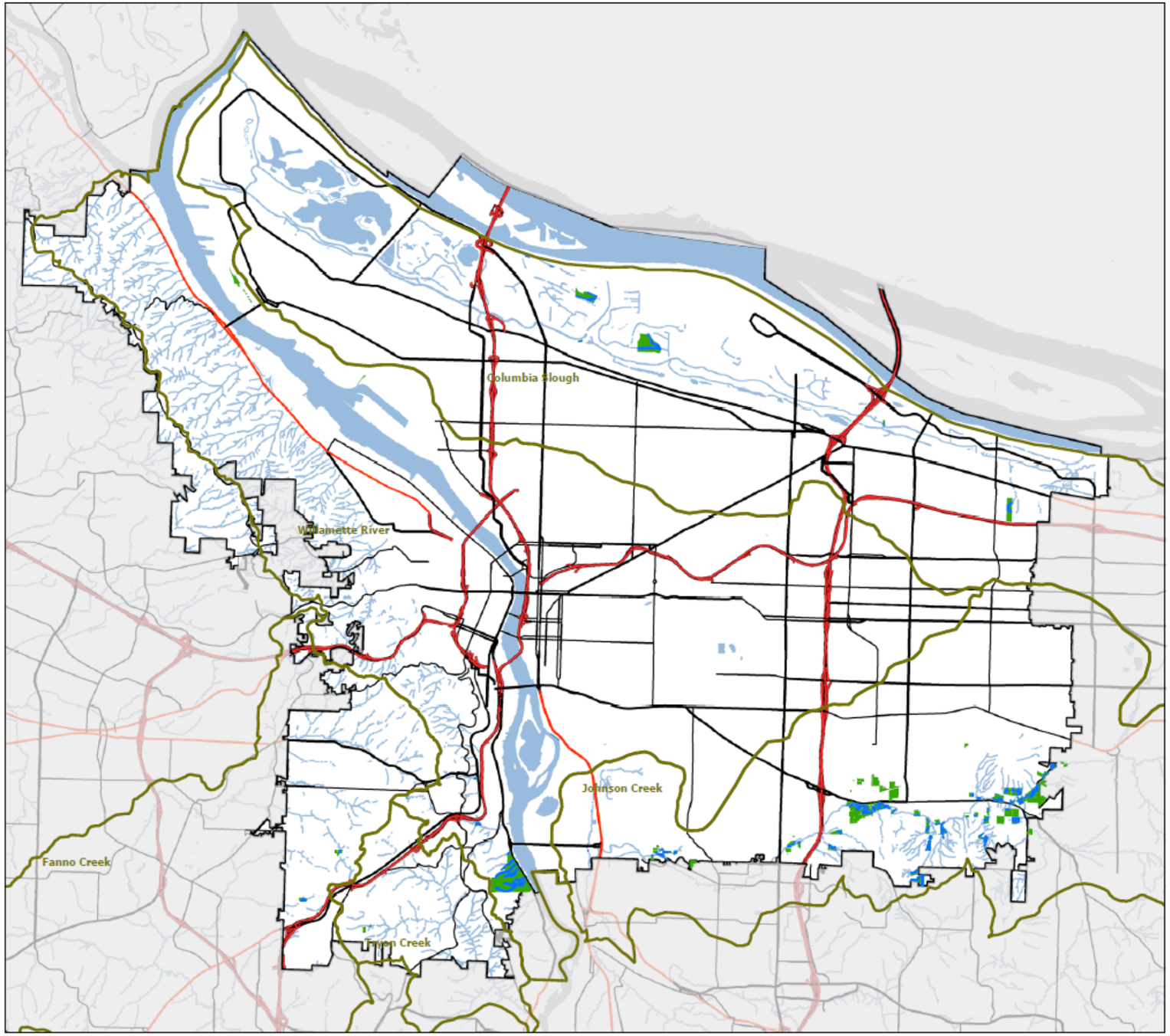

Figure 4
City of Portland Land Acquisitions

Legend

- City of Portland Waterbodies
- BES Topographic Watersheds
- Land Acquisitions
- Land Acquisitions within the Buffer

0 0.5 1 2 3 4 Miles

N W E S

BES
Pollution Prevention Services

Environmental Compliance MS4 Section

Sheet No. 1 OF 1

Date Printed: 2/28/2014

Table 10 Total City Land Acquisition since 1997 and Area within the 100-Foot Stream Buffer		
Watershed	**Land Acquisition Total Area (acres)**	**Land Acquisition Area within 100-Foot Buffer (acres)**
Willamette River, incl. westside streams	163	58
Columbia Slough	104	33
Johnson Creek	383	82
Tryon Creek	3	0.4
Fanno Creek	8	4
Total	**662**	**177.4 (26.8%)**

Table 11 Specific City Property Acquisitions since 2008			
Watershed	**Name of Property**	**Type of Property**	**Acres**
Columbia Slough	Bridgeton Slough Natural Area	Floodplain	1.92
	Catkin Marsh	Wetlands	54.00
	Columbia Slough Natural Area	Riparian	1.90
	Flyway Wetlands	Wetlands	24.00
	Name TBD (ID#R315025)	Floodplain	1.20
	Wilkes Creek Natural Area	Riparian	20.70
		Subtotal	**103.72**
Fanno Creek	Dickinson Park	Riparian	3.00
	Woods Memorial Natural Area	Riparian and upland	3.00
	Fanno Creek	**Subtotal**	**6.00**
Johnson Creek	Brookside	Riparian	2.80
	Buttes Natural Area	Riparian	8.75
	Buttes Natural Area	Riparian and upland	12.12
	Clatsop Buttes Park	Riparian	27.00
	Clatsop Confluence	Riparian	3.60
	Crystal Springs Natural Area	Riparian	0.34
	Deardorff Creek Natural Area	Floodplain and upland	3.80
	Deardorff Creek Natural Area	Riparian	9.31
	Flavel Ridge Wetlands	Wetlands	3.40
	Flavel Ridge Wetlands	Wetlands and uplands	0.68
	Indian Creek Natural Area	Riparian	6.90
	Name TBD (ID#s R337033, R3366999, R336912)	Riparian and upland	8.90
	Springwater Corridor	Floodplain	2.94
	Springwater Wetlands Complex	Wetlands	4.24

Table 11 (continued)			
Watershed	**Name of Property**	**Type of Property**	**Acres**
	Veterans Creek Natural Area	Riparian and wetlands	7.10
	Wahoo Creek Natural Area	Riparian	8.20
	Willamette Cemetery Annex	Riparian and upland	18.00
		Subtotal	**128.08**
Tryon Creek	West Portland Park Natural Area	Riparian	0.58
	Tryon Creek	**Subtotal**	**0.58**
Willamette River and Tributaries	Forest Park	Upland and wetlands	0.27
	Marquam Nature Park	Upland and riparian	0.30
	River View Natural Area	Riparian	146.00
	Springwater Corridor	Floodplain	0.79
	Stephens Creek Canyon	Riparian	3.26
	Texas Wetlands Buffer	Upland	0.51
	Waud Bluff	Upland	1.07
		Subtotal	**152.20**
		Total	**390.58**