LOWER WILLAMETTE RIVER ECOSYSTEM RESTORATION PROJECT

FEASIBILITY STUDY AND INTEGRATED ENVIRONMENTAL ASSESSMENT

DRAFT REPORT

September 2014

Prepared for:

US Army Corps of Engineers ®
Portland District
BUILDING STRONG®

ENVIRONMENTAL SERVICES
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EXECUTIVE SUMMARY

This Feasibility Study/Environmental Assessment (FS-EA) assesses ecosystem restoration actions in the Lower Willamette River, led by the U.S. Army Corps of Engineers (USACE) along with its non-Federal sponsor, the City of Portland (City). The study area encompasses the Lower Willamette River and its tributaries, from its confluence with the Columbia River at River Mile (RM) 0 to Willamette Falls, located at RM 26. The goal of this study is to identify a cost effective ecosystem restoration plan that maximizes habitat benefits while minimizing impacts to environmental, cultural, and socioeconomic resources. The period of analysis for this study is 50 years from the end of the first construction season.

This report contains a summary of the feasibility study from plan formulation through selection of a recommended plan, 35% designs and cost estimating, a description of the baseline conditions, and description of impacts that may result from implementation of the recommended plan. This document is an integrated feasibility report with an Environmental Assessment (EA) to comply with NEPA requirements. Sections 1500.1(c) and 1508.9(a) (1) of the National Environmental Policy Act of 1969 (as amended) require federal agencies to "provide sufficient evidence and analysis for determining whether to prepare an environmental impact statement or a finding of no significant impact" on actions authorized, funded, or carried out by the federal government to insure such actions adequately address "environmental consequences, and take actions that protect, restore, and enhance the environment."

The study area for the purposes of this study includes the Lower Willamette River Watershed, as well as tributaries Tryon Creek and Columbia Slough. Most of the study area is within the city limits of Portland. The Willamette River watershed in the Portland area was once an extensive and interconnected system of active channels, open slack waters, emergent wetlands, riparian forests, and adjacent upland forests. Modifications needed to provide ship access to Portland Harbor required construction and maintenance of a navigation channel between RM 0 and 11.6. The development of navigational channels, docking facilities, and bulkheads reduced the amount and quality of native floodplain habitats. In addition, the river became heavily polluted beginning in the early 1900s from industrial and urban waste discharges.

In the 1960s, the river was targeted for remediation and protection, and more recently, habitat and natural resources restoration efforts have been undertaken. However, the river continues to suffer from poor water and sediment quality, diminished riparian zones, and reduced shallow water habitat areas. Despite best efforts, fish and wildlife populations, especially those protected under the ESA, have undergone dramatic declines.

Based on an assessment of the problems and opportunities along with the City-wide watershed framework and in consideration of USACE ecosystem restoration mission, a set of goals and objectives were established for this feasibility study.

- **Reestablish Riparian and Wetland Plant Communities:** Remove invasive species and minimize disturbance of native habitats. Revegetate riparian zones and wetlands with an appropriate mix of native species. Restore hydrological aspects of each site to encourage survival of appropriate plant communities.

- **Improve Aquatic and Riparian Habitat Complexity and Diversity**: Restore streambeds by placing wood and debris jams for habitat diversity. Encourage or install communities of overhanging streamside vegetation to reduce solar gain, stabilize shorelines, and provide

wildlife cover. Reconnect side channels and backwater wetlands to streams and rivers where possible. Remove barriers to fish access to spawning and rearing areas.

- **Restore floodplain function and connectivity**: Slope steepened banks to a gentler angle to allow floodwaters to spread out and to provide shallow water habitat. Remove revetments and fill, and use bioengineering methods for bank stabilization where possible.

Numerous possible restoration sites were initially proposed for restoration planning by the City, many of which were included in the conceptual watershed management plans developed by various City entities for the Lower Willamette River Basin. Of an initial list of approximately 50 sites, 45 sites were selected for additional investigation because they were consistent with USACE policy for ecosystem restoration and initially appeared to have the potential to help achieve the project's objectives. These sites were identified as a result of characterization work by, and in consultation with, various City bureaus, including Parks, Planning, Portland Development Commission (PDC), and Environmental Services' Watershed Team. Several screening iterations followed, ultimately resulting in the selection of the preferred alternative.

Habitat value was determined using a Habitat Evaluation Procedure (HEP), which uses ecological modeling to assign an output value to an existing or future habitat condition. Given the variety of aquatic, terrestrial, and transitional habitat types present across the spectrum of the original sites under consideration, the HEP model was selected as the most appropriate model to quantify habitat benefits. Habitat benefits were evaluated using a modified HEP for the following six species or groups of species: western pond turtle, beaver, wood duck, yellow warbler, native amphibians, and salmonids. These species were selected to represent the range of riparian, aquatic and/or shallow water riverine habitats that would be encountered in the study area.

Cost-effectiveness and incremental cost (IC) analyses (CE/ICA) were performed using the certified Institute for Water Resources (IWR)-Planning Suite software version 1.0.11.0; an evaluation tool which considers and identifies the relationship between changes in cost and changes in quantified, but not monetized, habitat benefits. The evaluation is used to identify the most cost-effective alternative plans to reach various levels of restoration output and to provide information about whether increasing levels of restoration are worth the added cost. The CE/ICA allows determination of the "best buy" plans, or the alternatives that provide the highest habitat value output for the least cost.

Following the iterative screening process and CE/ICA, the project team identified a Tentatively Recommended Plan (TRP). It includes restoration components at five separate locations, including two on the Willamette River, two on the Columbia Slough, and one at the confluence of the Willamette and Columbia Rivers. This combination of restoration sites has a total cost of $26,527,000 and provides an increase of 3,339 habitat units over the 50-year life of this project. An estimated 153 acres of riparian, wetland, and backwater habitat will be improved under this plan. Below is a description of the components of the TRP. The locations of the various sites appear in Figure ES 1.1, and conceptual restoration features are shown in Figures ES 1.2 – ES 1.6.

- **BES Plant** (Off-Channel and Riparian Restoration, Bank Restoration): The intent of this site plan is to excavate a more frequent connection to a floodplain backwater/swale area and restore the riparian zone along Columbia Slough. Steepened bank angles would be reduced and large wood (LW) added along the banks to increase habitat complexity. Habitat quality is currently moderate to good, but opportunities to improve and expand wetland and backwater habitats exist in several parts of the project site. Off-channel rearing and high-water refugia would be restored by excavating a connection from Columbia Slough to the

low swale at the southeast end of the site and by excavating an alcove at the base of the slope near the northwest end of the site. Habitat value would be increased by removing invasive species and revegetating with native trees and shrubs. Pond turtle habitat would be restored by addition of LW and boulders near the mouth of the channel between the slough and the low swale.

- **Kenton Cove** (Off-Channel and Riparian Restoration): Most of this site is surrounded by a highly maintained levee, with a natural riparian floodplain zone along Columbia Slough. The dominant species include black cottonwood, Himalayan blackberry, and reed canarygrass. The intent of this site plan is to diversify instream habitat in this backwater cove with LW, remove invasive species, and revegetate with native trees and shrubs. Because the edges of the cove are very even and offer very little habitat complexity, the conceptual plan recommends creating small habitat islands at the location of each woody debris jam, with the wood as the centerpiece of the habitat island.

- **Kelley Point Park** (Off-Channel and Riparian Restoration, Floodplain Restoration): The intent of this site plan is to excavate two off-channel backwater areas, remove invasive plants, revegetate with native species, regrade steep banks for floodplain restoration, and place LW to restore habitat complexity. Trails throughout the park would be adjusted to allow for restoration. To reduce the amount of fill to be removed, rather than excavating large areas of floodplain, meandering channels would be cut along existing swales to allow for off-channel refugia. Habitat value in Kelley Point Park is moderate, but implementation of the project would result in the creation of approximately 5,000 linear feet of side channels to allow rearing and refugia for juvenile salmonids. Habitat complexity and riparian vegetation would be restored on approximately 5,000 feet (10.9 acres) of shoreline by grading banks to a gentler gradient, removing invasive species, and revegetating with riparian shrubs and trees. Canopy cover would be most dense after 10 years, after which the understory layer may diminish somewhat due to shading.

- **Oaks Crossing/Sellwood Riverfront Park** (Off-Channel and Riparian Restoration, Wetland Restoration): The intent of this site plan is to restore salmonid habitat in the floodplain of this area by connecting off-channel habitat to the river, removing invasive species, and revegetating with native floodplain and riparian species. Habitat at this site consists of gallery forest lined with native and invasive species. Dominant species in the riparian zone include black cottonwood, willows, cedars, Himalayan blackberry, English ivy, and reed canarygrass. Sandy beach habitat would be restored by addition of LW.

- **Highway 43 Tryon Creek Culvert** (Culvert replacement for fish passage): The intent of this site plan is to replace the culvert under Highway 43 and the train line, which is a fish barrier under most flow conditions. The construction area would be revegetated with native riparian species, and structures that may include boulders or wood would be installed in the streambed within the culvert to reduce velocities and facilitate fish passage. The new culvert would simulate the natural stream dimensions, allowing for sediment and debris to pass through and give fish unhindered passage beneath the roadway and railroad line. Implementation of this project would allow unhindered fish passage into approximately 2.9 miles of stream within Tryon Creek State Natural Area (TCSNA).

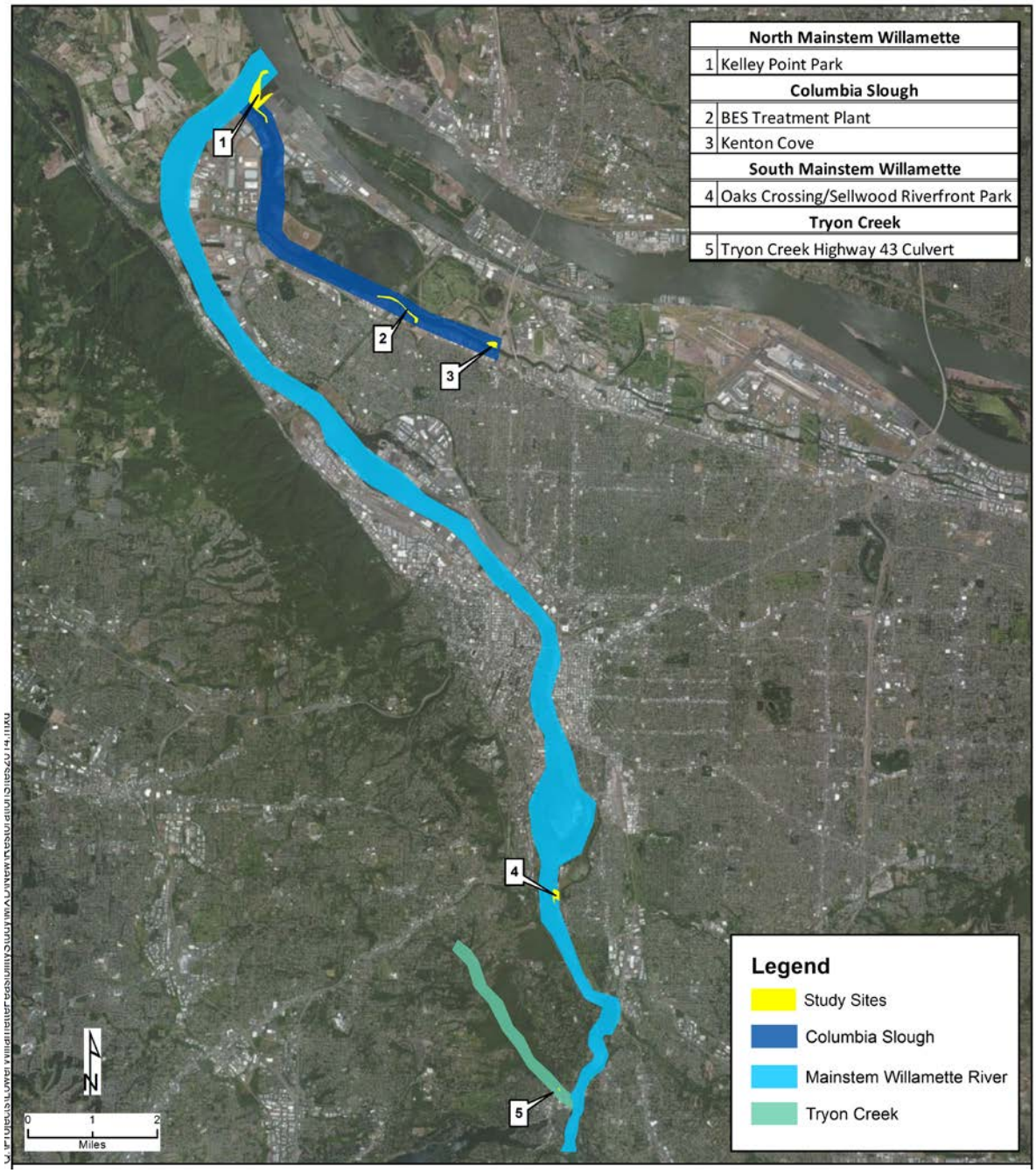

Figure ES. 1.1. Proposed Restoration Site Locations

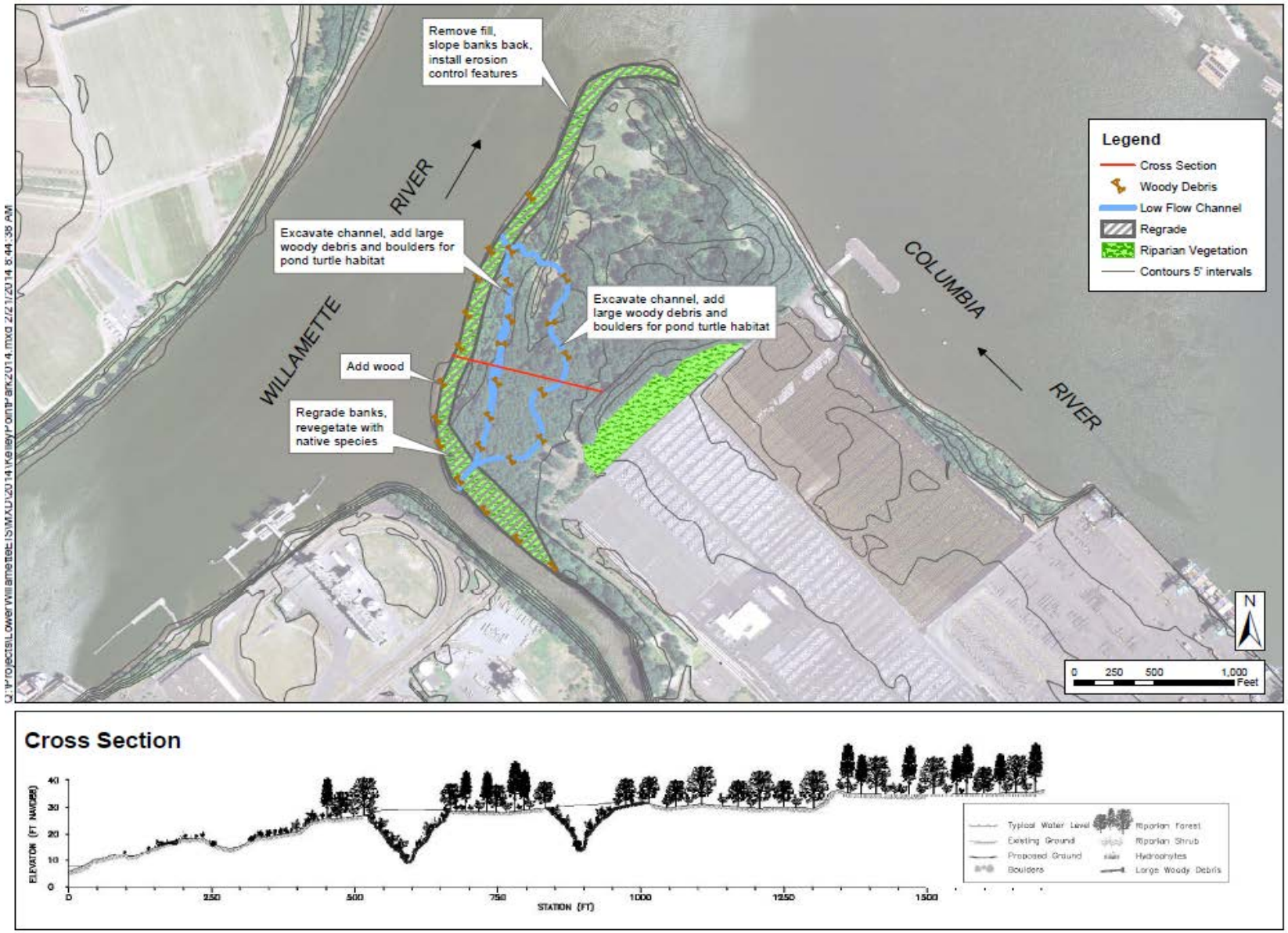

Figure ES. 1.2. Kelley Point Park Conceptual Restoration Plan

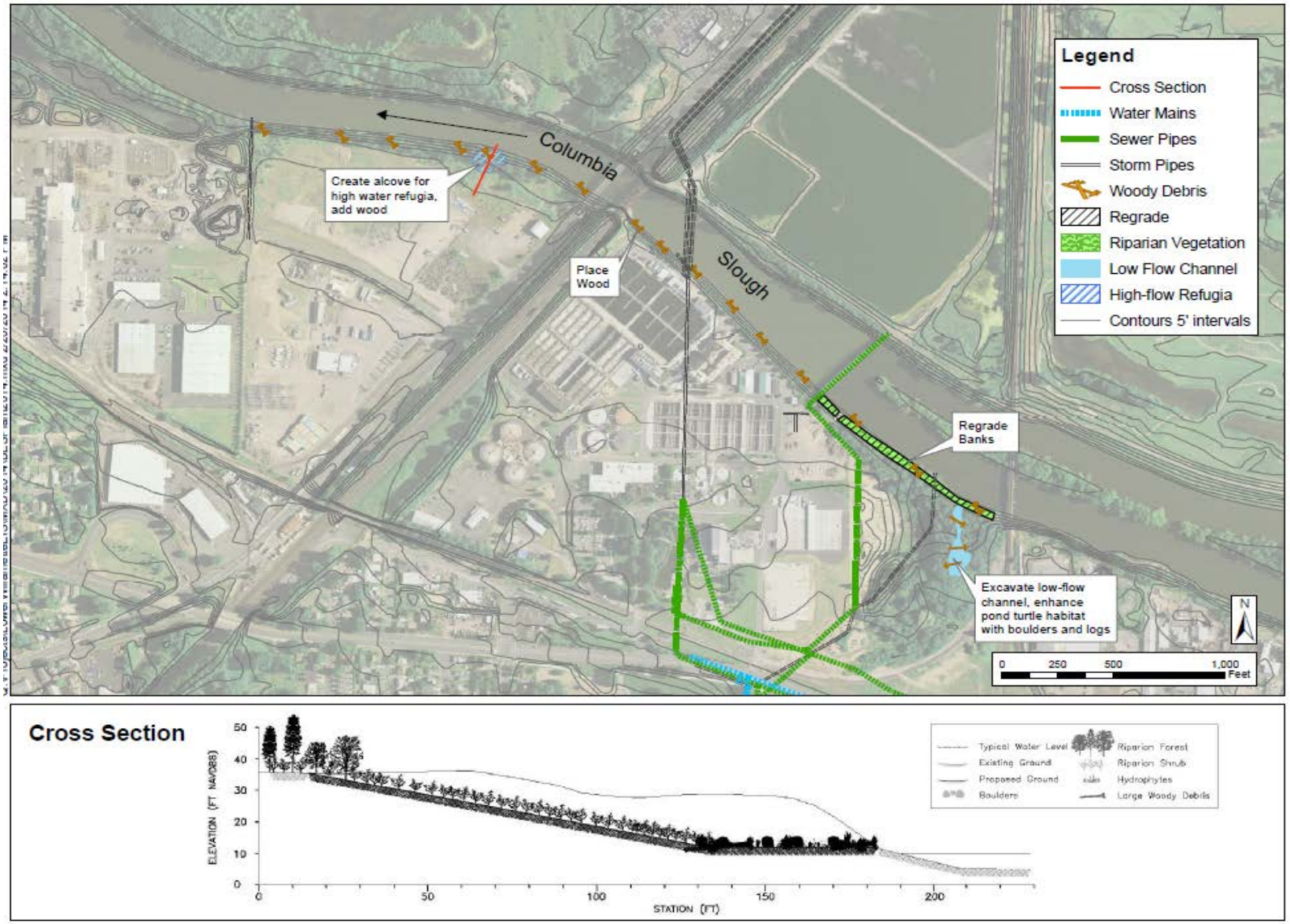

Figure ES. 1.3. BES Plant Conceptual Restoration Plan

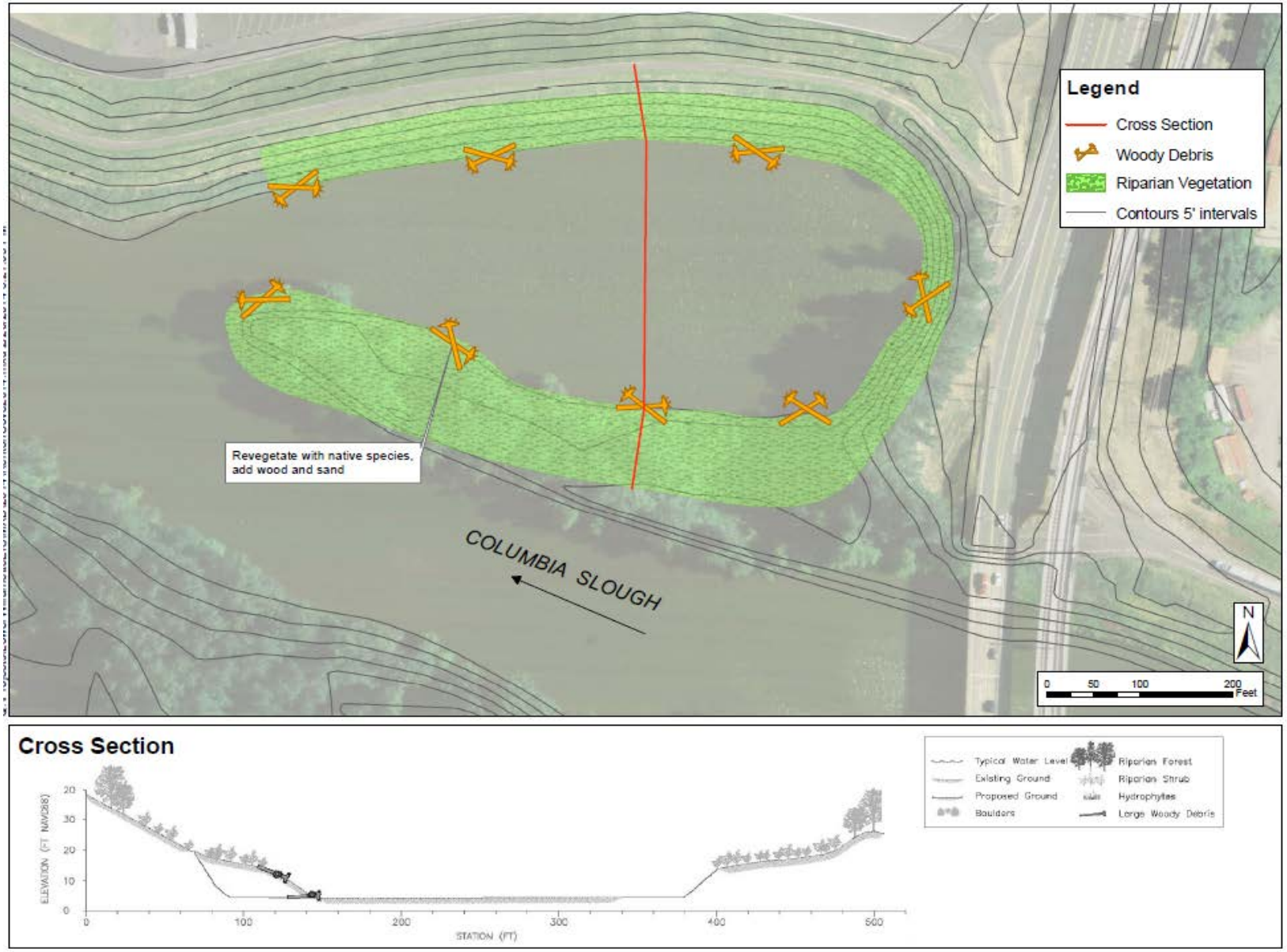

Figure ES. 1.4. Kenton Cove Conceptual Restoration Plan

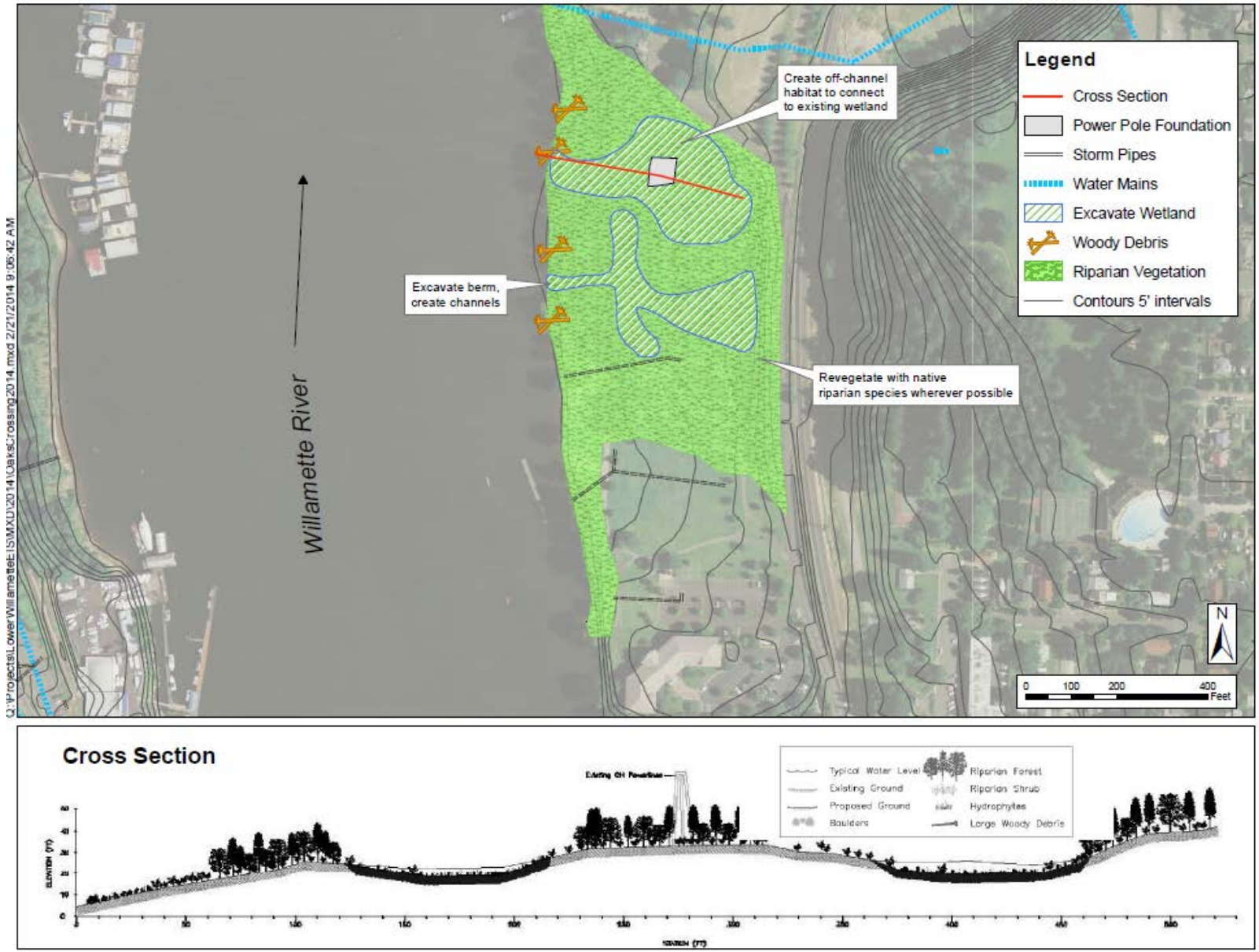

Figure ES. 1.5. Oaks Crossing/Sellwood Riverfront Park Conceptual Restoration Plan

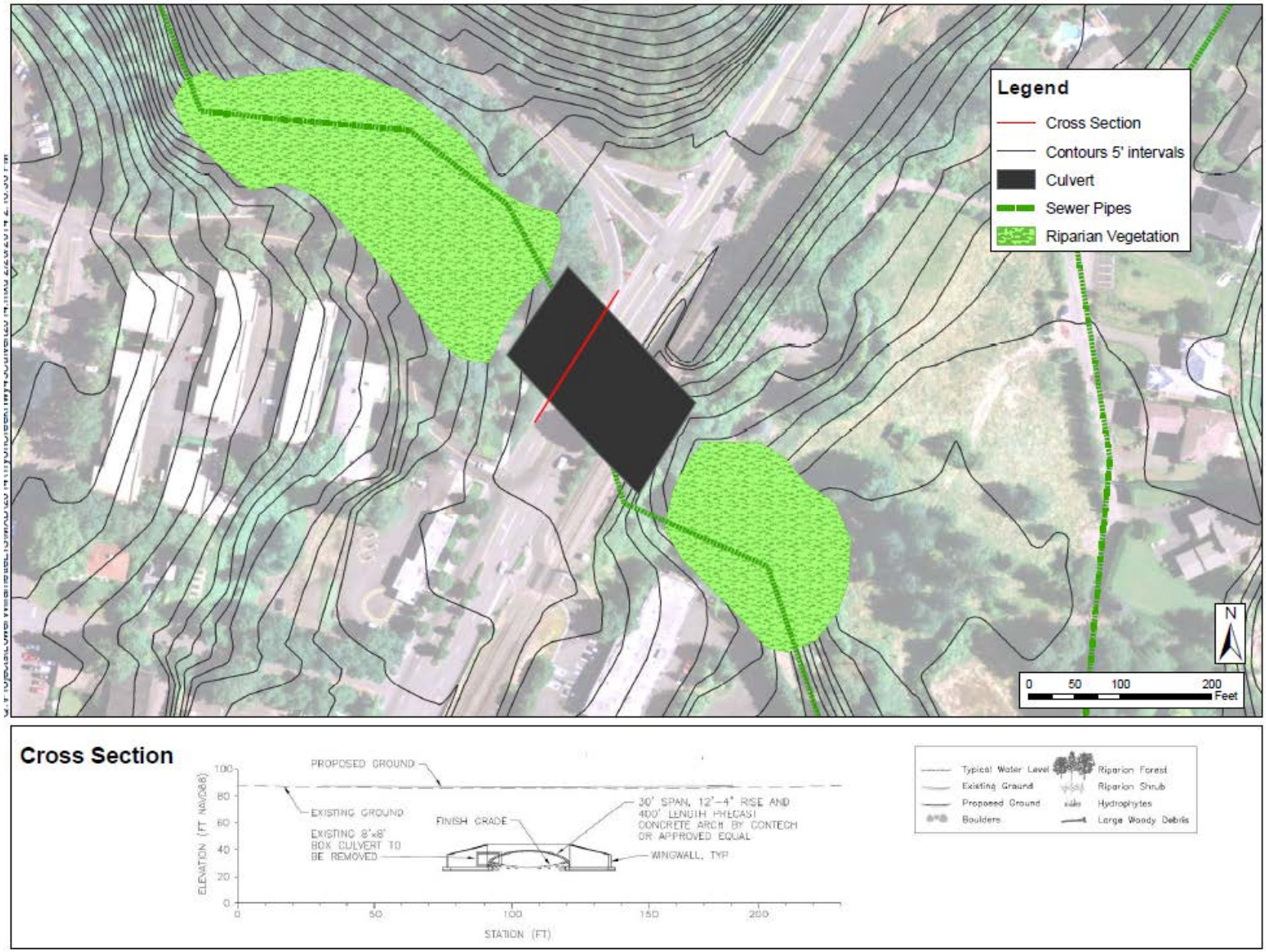

Figure ES. 1.6. Tryon Creek/Highway 43 Culvert Conceptual Restoration Plan

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ACRONYMS AND ABBREVIATIONS

AAHUs	Average Annual Habitat Units
AOI	Area of interest
AQCR	Air Quality Control Regions
AQMA	Air Quality Management Area
APE	Area of Potential Effects
ASA	Assistant Secretary of the Army
BA	Biological Assessment
BES	Bureau of Environmental Services (also listed as PBES)
BiOp	Biological Opinion
BMP	Best management practices
BNSF	Burlington Northern Santa Fe
BPA	Bonneville Power Administration
CAR	Coordination Act Report
CE/ICA	Cost Effectiveness/Incremental Cost Analysis
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cfs	Cubic feet per second
City	City of Portland
CNN	Central Northeast Neighbors
CO	Carbon monoxide
CRBG	Columbia River Basalt Group
CSO	Combined Sewer Overflow
CWA	Clean Water Act
dB	Decibels
dBA	A-weighted decibels
DDE	dichlorodiphenyldichloroethylene
DDT	Dichlorodiphenyltrichloroethane
DPS	Distinct Population Segment
EA	Environmental Assessment
ECO-PCX	Center of Expertise for National Ecosystem Planning USACE
EDR	Environmental Data Resources
EFH	Essential fish habitat
EIS	Environmental Impact Statement
ELJs	Engineered log jams
EO	Executive Order
EPA	U.S. Environmental Protection Agency
EPNO	East Portland Neighborhood Office
EQ	Environmental Quality

ER	Engineering Regulation
ESA	Endangered Species Act
ESU	Evolutionarily significant units
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FONSI	Finding of No Significant Impact
FS-EA	Feasibility Study and Environmental Assessment
FWCA	Fish and Wildlife Coordination Act
FY	Fiscal year
GDP	Gross Domestic Product
GIS	Geographic Information System
GPS	Global Positioning System
GSI	Green stormwater infrastructure
HEP	Habitat Evaluation Procedure
HQ	Headquarters
HSI	Habitat suitability index
HTRW	Hazardous, toxic, and radioactive waste
HU	Habitat Unit
HWTM	Hazardous Wastes and Toxic Materials
IC	Incremental cost
IDC	Interest During Construction
IDEP	Illicit Discharge Elimination Program
IPCC	Intergovernmental Panel on Climate Change
ITS	Incidental Take Statement
IWR	Institute for Water Resources
LERRD	Land, Easements, Rights of Way, Relocation, and Disposal Areas
LW	Large woody debris
MCACES	Microcomputer Aided Cost Estimating System
Metro	Metro Council
MS4	NPDES Municipal Separate Storm Sewer System
MSA	Metropolitan Statistical Area
NAAQS	National Ambient Air Quality Standards
NECN	Northeast Coalition of Neighborhoods
NED	National Economic Development
NEPA	National Environmental Policy Act
NER	National Ecosystem Restoration
NGVD	National Geodetic Vertical Datum
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration Fisheries Service
NPCC	National Policy Consensus Center
NPDES	National Pollutant Discharge Elimination System
NPNS	North Portland Neighborhood Services
NRDA	Natural Resources Damage Assessment
NWI	National Wetlands Inventory
NWNW	Neighbors West/Northwest
O_3	Ozone
O&M	Operations and maintenance
OAR	Oregon Administrative Rules
ODA	Oregon Department of Agriculture
ODEQ	Oregon Department of Environmental Quality
ODFW	Oregon Department of Fish and Wildlife
ODOT	Oregon Department of Transportation
ODSL	Oregon Division of State Lands
OEA	(Oregon) Office of Economic Analysis
OHW	Ordinary High Water
OSE	Other Social Effects

P&G	Principles and Guidelines
PAHs	Polycyclic aromatic hydrocarbons
PBES	(City of) Portland Bureau of Environmental Services
PBPS	Portland Bureau of Planning Services
PCBs	Polychlorinated biphenyls
PDC	Portland Development Commission
PDT	Project development team
PDX	Portland International Airport
PED	Preconstruction engineering and design
PM	Particulate matter
Port	Port of Portland
PPR	Portland Parks and Recreation
PROJECTS	Programmatic Restoration Opinion for Joint Ecosystem Conservation by the Services
PRP	Primary Responsible Party
PWRR	Portland and Western Railroad
RED	Regional Economic Development
RM	River mile
ROD	Record of Decision
RPA	Reasonable and Prudent Alternative
S&A	Supervisory and administrative
SEUL	Southeast Uplift Neighborhood Coalition
SHPO	State Historic Preservation Office
SIP	State Implementation Plan
SMART	Specific, measurable, attainable, relevant and time-sensitive
SVOCs	Semi volatile organic compounds
SWNI	Southwest Neighborhoods Inc.
TCSNA	Tryon Creek State Natural Area
TMDL	Total maximum daily load
TMP	Transportation management plan
TRP	Tentatively Recommended Plan
TPH	Total petroleum hydrocarbons
UGB	Urban Growth Boundary
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VOC	Volatile organic compounds
WQI	Water Quality Index
WRDA	Water Resources Development Act
µg/L	Micrograms per liter

1. STUDY INFORMATION

1.1 Study Overview

This Feasibility Study/Environmental Assessment (FS-EA) assesses ecosystem restoration actions in the Lower Willamette River, led by the U.S. Army Corps of Engineers (USACE) along with its non-Federal sponsor, the City of Portland (City). The study area encompasses the Lower Willamette River and its tributaries, from its confluence with the Columbia River at River Mile (RM) 0 to Willamette Falls, located at RM 26. The goal of this study is to identify a cost effective ecosystem restoration plan that maximizes habitat benefits while minimizing impacts to environmental, cultural, and socioeconomic resources. The period of analysis for this study is 50 years from the end of the first construction season.

1.2 Study Authority

The first component of this study was the *Lower Willamette River Ecosystem Restoration Reconnaissance Analysis* (USACE 2000a), dated December 2000 and amended in July 2002, which served as the basis for scoping the feasibility phase studies. Specific authority for the Willamette River, Oregon was added when the Willamette River was listed as a priority site in Section 224 of WRDA 1999.

The original reconnaissance analysis primarily identified issues relative to environmental dredging and coordination with the ongoing Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Remedial Investigations/Feasibility studies. The July 2002 amendment expanded the scope of the study to include ecosystem restoration within the Lower Willamette River watershed. The reconnaissance analysis also described a need and a federal interest for an overarching project to identify, evaluate, prioritize, and coordinate ecosystem restoration opportunities within the Lower Willamette River.

This study is now being conducted under the authority of House Resolution Docket 2687, adopted June 26, 2002, by the U.S. House of Representatives, Committee on Transportation and Infrastructure, and entitled *Lower Willamette River Watershed, Oregon*. The text of the resolution is as follows:

> *Resolved by the Committee on Transportation and Infrastructure of the United States House of Representatives, that the Secretary of the Army is requested to review the report of the Chief of Engineers on the Columbia and Lower Willamette Rivers below Vancouver, Washington and Portland, Oregon published as House Document Number 452, 87th Congress, 2nd Session, and other pertinent reports, to determine the feasibility of providing ecosystem restoration measures in the Lower Willamette River watershed from the Willamette Locks to [the] confluence of the Willamette River with the Columbia River through the development of a comprehensive restoration strategy development in close coordination with the City of Portland, Port of Portland, the State of Oregon, local governments and organizations, Tribal Nations and other Federal agencies.*

Although the environmental dredging component of the reconnaissance study will not be implemented, the City and the USACE have used this authority to prepare plans to restore habitat functions in the Lower Willamette River and two of its tributaries. Since no specific ecosystem

restoration sites or strategies were recommended in the reconnaissance report, these features were developed later.

1.3 Study Purpose and Need

The Lower Willamette River has experienced the effects of development and industrialization over the past 150 years. Historically, the Willamette River watershed in the Portland area was an extensive and interconnected system of active channels, open slack waters, emergent wetlands, riparian forests, and adjacent upland forests. Modifications to the river to improve navigation and provide ship access to Portland Harbor included construction and maintenance of a navigation channel between RM 0 and 11.6. Extensive alterations in natural riverine and floodplain processes have occurred in the study area, and are generally related to development of floodplain habitats, improper management of aquatic ecosystems, removal of woody debris in the river and tributaries, and altered flow patterns from upstream dams. The construction of docking facilities and bulkheads created steep, armored shorelines. The associated development of navigational channels, along with shoreline development, greatly reduced the amount and quality of open slack water areas, side channels, and wetland habitats. As a result, both the availability and quality of habitats that sustain fish and wildlife populations is reduced.

The purpose of this project is to restore ecosystem structure and function, to the degree possible, within the Lower Willamette River watershed in accordance with the USACE's mission statement. The purpose of this FS-EA is to: (1) identify and evaluate substantial ecosystem degradation problems in the Lower Willamette River; (2) formulate, evaluate, and screen potential solutions to these problems; and (3) recommend solutions that are in the federal interest and are supported by a local entity or entities willing to provide the items of local cooperation (*i.e.*, a non-Federal sponsor).

This project is needed to help restore the ecosystem structure, function, and dynamics that have been lost in the Lower Willamette River watershed due to the practices identified above. These functions include providing fish and wildlife habitat, groundwater recharge, flood storage, and sediment and erosion processes. Dynamics in this case refers to the interrelationship of hydrology, vegetation, water quality, and habitat diversity that formerly combined to make the Lower Willamette River watershed a highly productive ecosystem that supported numerous fish and wildlife species during all or part of their life history. Under current conditions, the dynamic relationships in the watershed must include the extensive past and ongoing changes to the watershed that have occurred over the previous 150 years, which have upset the balance that formerly created a stable and rich environment for plants, fish, and wildlife.

This project will help to address the need to restore wetland and off-channel habitat to contribute to the recovery of sensitive fish and wildlife species that depend on properly functioning conditions in the Lower Willamette River for all or part of their lifecycles. Reconnection of side channels and floodplains, addition of large wood, and revegetation of riparian areas is needed to restore the natural formation of habitats and provide important off-channel rearing and refuge habitats for multiple species and to address the problems identified in Section 3.

This project is not intended to fulfill the requirements of any Biological Opinions (BiOp) or recovery plans that have been prepared for listed species, although it is expected that these species may benefit from the actions of this project.

1.4 Study Stakeholders and Other Coordinating Agencies

Stakeholders include the State of Oregon, local governments and organizations, Tribal Nations, and other federal agencies. The study area is within the following congressional districts:

Senators	**Representatives**
Jeff Merkley (D)	Susan Bonamicci (D) 1st District, Portland
Ron Wyden (D)	Earl Blumenauer (D) 3rd District, Portland
	Kurt Schrader (D) 5th District, West Linn

On February 14, 2014, a workshop was held with staff from US Fish and Wildlife Service (USFWS) to discuss project features, possible effects, and methods of describing the project and potential effects. Recommendations from that workshop have been incorporated into this FS-EA. To date, the only other stakeholder that has taken an active role in planning for this study is Metro Council (Metro), which is the elected regional government for the Portland metropolitan area. Metro has continued to be involved with planning for shared natural resources that could be improved through the actions assessed in this study.

1.5 Study Sponsorship

The non-Federal sponsor for the *Lower Willamette River Ecosystem Restoration General Investigation Feasibility Study* is the City of Portland Bureau of Environmental Services (PBES). A Feasibility Cost Sharing Agreement was executed on September 22, 2003, which stated that the City is willing to cost-share this study. The City has met a portion of their cost-sharing requirement through work-in-kind.

1.6 Resources of National Significance

This study will propose a plan to restore habitats in the Lower Willamette River. The Willamette River is a major tributary of the Columbia River, accounting for 12 to 15 percent of the Columbia's flow. The Willamette River drains a total of 11,475 square miles, which is approximately 12 percent of the total area of Oregon.

1.6.1 Institutional Significance

The importance of the Willamette River as an environmental resource is recognized institutionally through a plethora of laws, adopted plans, and other policy statements of public agencies, tribes and private groups.

Federally, several laws provide environmental protection of the Willamette River. Though these laws were not enacted specifically for the Willamette River, their frequent application by state and federal regulatory agencies with regulate use of and impacts to the Willamette River support the river's institutional significance. The Endangered Species Act of 1973 and the Anadromous Fish Conservation Act of 1965 protect several species of plant and animals that rely on the Willamette River for habitat.

The Willamette River Valley is a major contributor to the Pacific Flyway and birds migrating via this flyway are protected under the Migratory Bird Treaty Act of 1918. Its wetlands provide essential habitat for migrating and wintering ducks, geese swans, and many shorebirds and wading

birds. Also, the Willamette River from Springfield, Oregon, north to Portland has been designated as an American Heritage River under Executive Order 13061.

The State of Oregon has enacted several laws to protect flows that support water allocations, pollution. In addition, the Willamette River Legacy Program was initiated in 2004. Governor Ted Kulongoski announced that his, "...top environmental priority over the next 3 years is to clean up the crown jewel of Oregon's river system, the Willamette River, from the headwaters east of Eugene all the way to the Columbia." Kulongoski identified three priority areas of focus for the *Willamette River Legacy Program*, including;

1. Repair – Clean up the industrial pollutants and toxins that have contaminated the river.
2. Restore – Return the river to its natural state, restoring its abundant wildlife and pristine riverbanks.
3. Recreate – Address the role that the Willamette River plays in Oregon's quality of life so Oregonians can enjoy the many activities the river offers, and to do so responsibly so that it will be here for future generations.

Regionally, several plans are in existence to study, protect and restore the natural resources of the Willamette River. The *Willamette River Basin Planning Atlas* is a product of the Pacific Northwest Ecosystem Research Consortium, a regional research consortium involving researchers at Oregon State University, the University of Oregon, the University of Washington, and the EPA supported under cooperative agreement between the U.S. Environmental Protection Agency (EPA) and the universities (Hulse *et al.* 2002). The intent of the research is to: (1) create a regional context for interpreting trajectories of landscape and ecosystem change, (2) identify and understand critical ecological processes, and (3) develop approaches for evaluating outcomes of alternative future land and water use, management, and policy. The Planning Atlas provides current available information about critical natural and cultural factors influencing land and water use decisions in the Willamette River Basin. The information was used to create a set of mapped depictions of plausible future configurations of land and water use for the basin in the year 2050. These alternative futures were then scientifically evaluated for their effects on important environmental and ecological processes.

River Renaissance Initiative is a citywide initiative to reclaim the Willamette River as Portland's uniting community centerpiece. River Renaissance engages the public, connects community partners, coordinates the City's river-related work, and creates innovative urban solutions. Central to this initiative approach is the belief that urban development, healthy natural systems, and a sustainable economy are complementary goals**.** The River Renaissance Initiative celebrates the Willamette River by promoting a comprehensive approach to river issues, enhancing public awareness of critical issues, and highlighting progress and achievements. The initiative is led by a collaborative team of city bureaus including Planning, Environmental Services, Parks & Recreation, Sustainable Development, Transportation, Development Services, Water, and the Portland Development Commission.

The River Plan is a comprehensive multi-objective plan for land along the Willamette River. It is an update of the Willamette Greenway Plan, zoning code and design guidelines, which serve as Portland's compliance with State Planning Goal 15 and were last updated in 1987. The width of the planning area varies from place to place but generally includes all land within approximately 0.25 mile of the river.

1.6.2 Public Significance

The Willamette River is recognized as publically important as an environmental resource. Along the Willamette River Valley, which hosts 70% of the state of Oregon's population, there exists a strong citizen involvement in the uses and activities of the river. The Willamette River is one of ten rivers included in the Sustainable Rivers Project between the USACE and the Nature Conservancy. A wide variety of groups have interest in protecting the habitat along the Willamette River, for the purpose of protecting fish and wildlife, but also to improve recreational and aesthetic value of the river, which is a centerpiece of sociocultural activities in Portland. Local interest groups will be given the opportunity to review proposed ecosystem restoration plans and will benefit from completion of these plans.

1.6.3 Technical Significance

The Willamette River is recognized as technically important and is one of the top environmental resources researched in the Pacific Northwest and in the State of Oregon. Numerous scientific analyses and long-term studies through Oregon State University and the University of Oregon have documented the significance of the resources in the Willamette River basin, of which the *Willamette Basin Planning Atlas* provides the most comprehensive review of how resources have been lost, while laying out scenarios to guide future development for restoring natural resources.

1.7 Report Contents

This report contains a summary of the feasibility study from the description of baseline conditions, to plan formulation through selection of a recommended plan, and development of the feasibility designs and cost estimating. This document is an integrated feasibility report with an Environmental Assessment (EA) to comply with National Environmental Policy Act (NEPA) requirements.

Chapter 1 includes the general description of the study authorization, study purpose and scope, and study sponsorship. Chapter 2 describes the study area and identifies other Federal, state and local programs and projects operating within the study area. Chapter 3 identifies the problems and restoration opportunities in the study area. Chapter 4 describes the existing and likely future without project conditions within the study area. Chapter 5 describes the plan formulation process. Chapter 6 describes the recommended restoration plan. Chapter 7 describes the potential effects of the recommended restoration plan on the environment. Chapter 8 describes public and agency involvement efforts conducted to date. Chapter 9 describes the status of environmental compliance. Chapter 10 describes the proposed monitoring plan. Chapter 11 provides conclusions and recommendations from the study.

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2. PROJECT OVERVIEW

2.1 Project Location

The Lower Willamette River, the focus of this study, is generally defined as the area downstream, and north, of Willamette Falls, which occurs at RM 26.6 in Oregon City. The study area also includes two key tributaries; Tryon Creek and Columbia Slough. Most of the study area is within the city limits of Portland (Figure 2.1). To more effectively describe the conditions in the Lower Willamette River mainstem and its tributaries, the study area has been broken into the reaches outlined below and shown in Figure 2.1. Reaches have been distinguished from each other primarily to orient the reader to the location of the proposed restoration sites and to allow more specific descriptions of conditions in the area surrounding the site locations.

- Lower Willamette Mainstem This reach stretches from RM 0 to Willamette Falls. The floodplain widens from north to south in this reach, but also becomes highly developed from south to north. The main exception to this is Kelley Point Park, which is relatively undeveloped and publically owned. Habitat is generally less disturbed a in the south end of this reach. Portland Harbor, generally located between RMs 2 and 11, is a Superfund cleanup site, and numerous sites in need of remediation are found there.
- Columbia Slough This reach extends along the Columbia Slough from near its confluence with the Willamette River to Kenton Cove (RM 0 to RM 9.0). Columbia Slough is a former side channel of the Columbia River that now drains localized areas to the northeast of the Willamette River and enters the Willamette at RM 1. Most of the northern end of Columbia Slough is relatively undeveloped, although floodplains in most areas appear to have been filled or otherwise modified and the slough is typified by high, steep banks.
- Tryon Creek This reach consists of Tryon Creek from its confluence with the Willamette River to Boones Ferry Road (RM 0 to RM 2.9), which is a fish barrier. The Tryon Creek reach offers the most undeveloped area for restoration of any of reach in the project area.

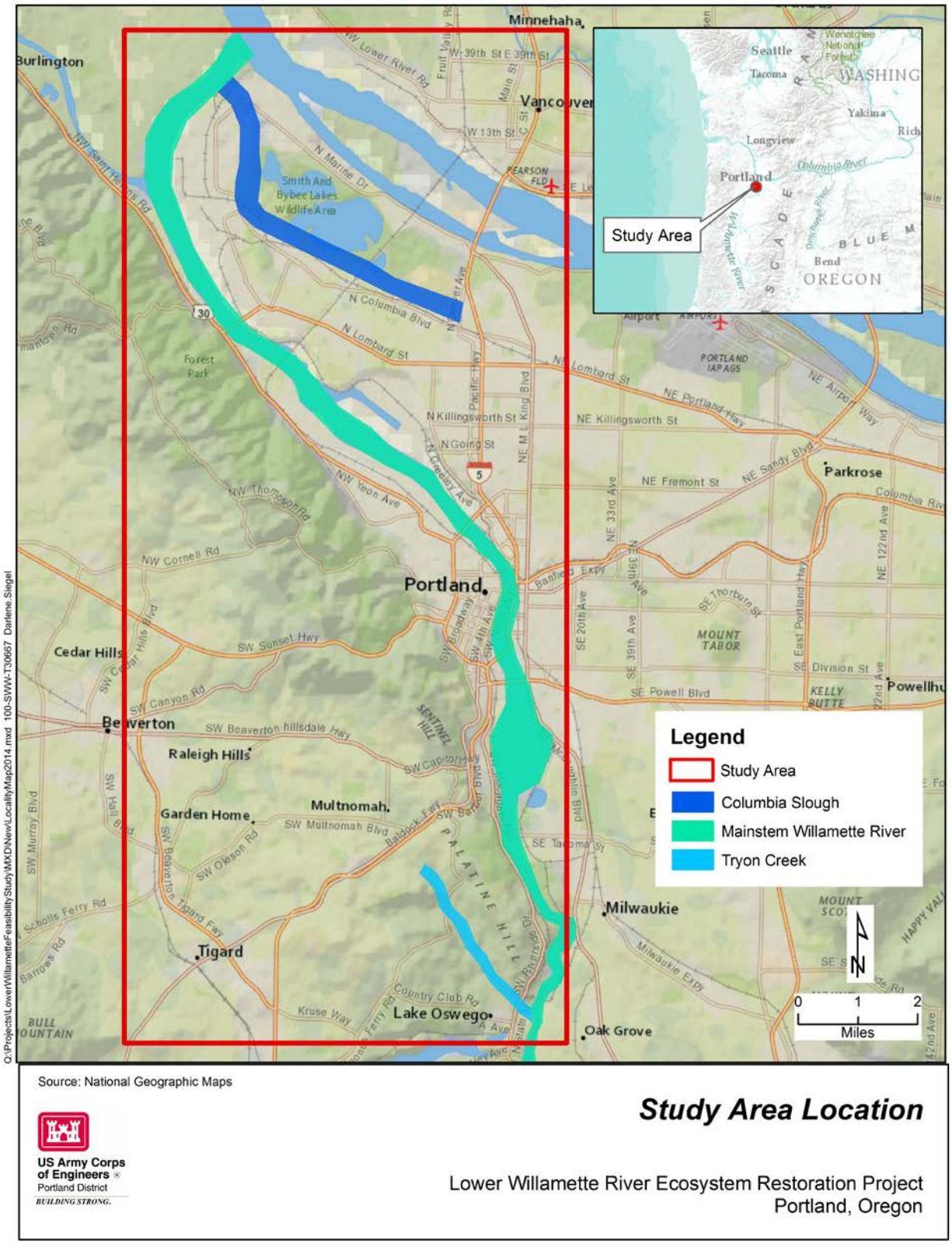

Figure 2.1. Study Area

2.2 Prior Reports, Projects, Initiatives, and Activities

The following is a list of recent or ongoing programs and studies in the study area that are relevant to ecosystem restoration of the Lower Willamette River watershed.

2.2.1 Federal

USACE Willamette Valley Projects The USACE manages a system of 13 multiple purpose dams and reservoirs in the overall Willamette River Basin. The projects are Big Cliff, Blue River, Cottage Grove, Cougar, Detroit, Dexter, Dorena, Fall Creek, Fern Ridge, Foster, Green Peter, Hills Creek, and Lookout Point. Each project contributes to an overall water resource plan designed to preserve the quality of the valley's environment, providing flood damage reduction, power generation, irrigation, recreation, and navigation on the Willamette River and many of its tributaries (USACE 2006). The reservoirs are filled in the spring and held full as long as possible in the summer so that water stored in, or released from, the reservoirs can serve a variety of beneficial uses. Each reservoir is operated on the basis of a Water Control Manual, which specifies operation procedures and establishes the elevation at which the pool is to be maintained during various seasons and seasonal transitions.

Willamette Project Operations Biological Opinion A Biological Assessment (BA) was prepared by the USACE (USACE 2000b) to assess the ongoing operation and maintenance of the Willamette projects in accordance with Section 7 of the Endangered Species Act (ESA). The BA included the Bureau of Reclamation and Bonneville Power Administration (BPA) as action agencies. The BA evaluated the likely effects of the Willamette projects for species listed under the ESA and their critical habitats. The BA concluded that continued operation and maintenance of the projects was likely to adversely affect several listed species. On the basis of this finding, the action agencies requested formal Section 7 consultation with the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS).

The services prepared a draft joint Biological Opinion in 2000. In 2001 and 2002, the services worked with the action agencies to define a Reasonable and Prudent Alternative (RPA) that would reduce effects on listed species. In 2003, the services determined that they should prepare separate Biological Opinions for the project and included an Updated Proposed Action proposed by the action agencies. Revised draft Biological Opinions were completed in 2003 and 2004. A supplemental BA was prepared in 2007 (USACE 2007).

The NMFS and USFWS completed final separate but coordinated Biological Opinions (BiOp) in 2008 addressing the effects of the operation and maintenance of the Willamette Project on the respective listed species for which they are responsible (NMFS 2008, USFWS 2008). In its BiOp, NMFS determined that the continued operation of the Willamette Project was likely to jeopardize continued existence of the Upper Willamette spring Chinook and winter steelhead and adversely modify their critical habitat. Thus, this required the development and inclusion of a RPA to the proposed action. The USFWS agreed to use the RPA developed by NMFS in the preparation of its BiOp. The following measures have been included in the RPA for the action agencies to implement in addition to those actions already proposed in the BA. A total of 10 major components were included:

1. Creation and coordination of a multi-agency action team for ecosystem restoration to oversee flow management activities and other interim measures to avoid jeopardy to the listed species.

2. Operational modifications to modify flows to provide more natural seasonal fluctuations and access to riverine/floodplain habitats and provide suitable flows for out-migrating juveniles in the spring and summer and also to provide adequate rearing habitat and temperatures for fish during the summer/fall months. Additional monitoring activities such as the installation of new gages and instream flow studies will help to inform and revise minimum flow targets in future years.
3. Evaluate and update water contracts and require fish screening at all diversions receiving federally provided water.
4. Provide fish passage at the dams through a variety of methods including outplanting, trap and haul, fish collection, downstream passage through dams, and other methods to be identified through the development of a Willamette Fish Operations Plan. Upgrade facilities to comply with the plan.
5. Improve water quality downstream of the dams by operational activities and facility upgrades/construction at dams to provide more normative water temperatures and reduced total dissolved gas in the tributaries and mainstem Willamette.
6. Evaluate and modify hatchery operations through Hatchery and Genetic Management Plans and other measures such as upgrades to facilities and mass-marking of hatchery releases.
7. Implement habitat mitigation and restoration measures throughout the basin (at both off-site and on-site locations). Collect and make large woody debris (LW) available and restore habitat at existing USACE revetments. Funding to be provided through existing funding programs such as the:
    - Columbia Basin Fish and Wildlife Program,
    - Continuing Authorities Programs,
    - General Investigation Studies (applicable GI studies include the Willamette Floodplain Restoration Study, Eugene-Springfield Metro Area Watershed Feasibility Study, and Lower Willamette Ecosystem Restoration Feasibility Study),
    - Planning Assistance to the States,
    - Upper Willamette Watershed Ecosystem Restoration Authority (Section 3138, Water Resources Development Act [WRDA] 2007),
    - Ecosystem Restoration and Fish Passage Authority (Section 4073, WRDA 2007), and
    - Sustainable Rivers Partnership with The Nature Conservancy.
8. Conduct ESA compliance and coordination activities with NMFS and USFWS.
9. Develop and implement a comprehensive research, monitoring and evaluation plan.
10. Identify fish protection maintenance needs.

Willamette River Federal Navigation Channel The USACE monitors and maintains the navigation channel in the Lower Willamette River from the Columbia River upstream to the Broadway Bridge (RM 0 to 11.6) as part of the Columbia and Lower Willamette Rivers federal navigation project. Upstream of the federal navigation channel, from RM 11.6 to RM 14 (Ross Island), the channel is maintained by the Port.

Columbia Slough Section 1135 Restoration Project The USACE Portland District, in partnership with the City and the Multnomah County Drainage District #1, constructed the Columbia Slough ecosystem restoration project (USACE 2001). Previously constructed USACE levees and other channelization and development had caused ecosystem degradation in the Columbia Slough portion of the Columbia River floodplain. Project elements included reshaping the slough's straight channel, and creating wetland benches and islands planted with native plants. The changes to the channel created a greater diversity of habitats, increased the water flow, and restored the riparian buffer along the slough.

Oaks Bottom Section 206 Restoration Project The USACE Portland District, in partnership with the City, is preparing an ecosystem restoration study at the Oaks Bottom Wildlife Refuge within the floodplain of the Lower Willamette River, southeast of Ross Island. Objectives include: (1) providing salmonid access to suitable habitats and reducing entrapment and mortality of salmonids caused by existing infrastructure, (2) restoration of fish and wildlife habitat, (3) control of non-native or pest populations, and (4) maintaining an open water and mudflat area for waterbirds.

Westmoreland Park Section 206 Restoration Project Westmoreland Park is located along Crystal Springs Creek, which is a tributary to Johnson Creek. The purposes of this project, which has been completed, are: (1) to provide juvenile fish passage from Johnson Creek to the upper end of Westmoreland Park, (2) improve aquatic habitat for salmonid rearing and refuge, (3) provide riparian corridor and wetland habitat for wildlife, and (4) improve water quality conditions by eliminating a duck pond (which causes heating of water), reducing excessive waterfowl use, and reducing runoff of other contaminants by providing a buffer for the creek and wetlands.

Portland Harbor Comprehensive Environmental Response, Compensation and Liability Act (CERCLA or Superfund) Portland Harbor, a roughly 10-mile stretch of the Lower Willamette River, was added to the U.S. Environmental Protection Agency (EPA) National Priorities List in December 2000 due to the discovery of highly contaminated sediments. A draft Feasibility Study was published in March 2012, which presented alternatives to the clean-up and management of contaminated soil and river sediments (Lower Willamette Group 2012). The next steps in the process include the issuance of a proposed plan, the opportunity for public comment, and issuance of a Record of Decision (ROD).

Willamette Subbasin Plan The Northwest Power Act directs the National Policy Consensus Center (NPCC) to develop a program to protect, mitigate, and enhance fish and wildlife of the Columbia Basin and to make annual funding recommendations to BPA for projects to implement the program. The NPCC designated the Willamette Partnership as the lead entity for developing the *Willamette Subbasin Plan*, which was completed in May 2004. The plan includes a compendium of current knowledge about basin conditions, particularly fish and wildlife and their habitats, an inventory of existing plans and programs, and strategies and actions to implement the plan. This plan identifies overall objectives for the recovery of fish and wildlife and is the basis for developing more detailed studies and restoration designs in the basin.

Willamette and Lower Columbia River Basins Recovery Plan National Oceanic and Atmospheric Administration Fisheries Service (NMFS), in partnership with Oregon Department of Fish and Wildlife (ODFW), developed a recovery plan for salmon and steelhead populations listed under the ESA in the Northwest Region. The Willamette/Lower Columbia recovery domain includes the Willamette River Basin and all Columbia River tributaries from Hood River downstream in Oregon and from the White Salmon River downstream in Washington. Recovery planning for listed salmon and steelhead started in the summer of 2000, when the Willamette/Lower Columbia Technical Recovery Team was formed. The Executive Committee for Lower Columbia and Willamette River Salmonid Recovery, a coordinating policy forum, began work on recovery planning in the summer of 2001.

American Heritage River The Willamette River from Springfield, Oregon, north to Portland has been designated as an American Heritage River. The American Heritage Rivers initiative was established in 1997 by Executive Order (EO) 13061 and is administered by EPA. The American Heritage Rivers initiative has three objectives: (1) natural resource and environmental protection, (2) economic revitalization, and (3) historic and cultural preservation. The initiative is an innovative

response to assist communities seeking federal resources to protect their local river environments (EPA 2003).

2.2.2 State of Oregon

Statewide Planning Goals Since 1973, Oregon has maintained a strong statewide program for land use planning. The foundation of that program is a set of 19 Statewide Planning Goals. The goals express the state's policies on land use and related topics, such as citizen involvement, housing, and natural resources management. State law requires each city and county to adopt a comprehensive plan, and develop the zoning and land-division ordinances needed to put the plan into effect. The local comprehensive plans must be consistent with the Statewide Planning Goals.

Oregon Plan for Salmon and Watersheds In April 1997, the Oregon Legislature adopted the *Oregon Plan for Salmon and Watersheds* (the Oregon Plan). The Oregon Plan represents commitments on behalf of government, interest groups, and citizens from all sectors of the state to protect and restore watersheds for the benefit of salmon, and the economy and quality of life in Oregon. The Oregon Plan originally evolved from two components: (1) the Healthy Streams Partnership, a cooperative effort among landowners, government, and interest groups aimed at improving and preserving water quality in water quality limited streams in Oregon, and (2) the Coastal Salmon Restoration Initiative, which guides habitat restoration efforts for coastal coho salmon in an effort to restore populations to sustainable levels. The Oregon Plan also serves as a federally recognized restoration plan for coastal coho salmon. In December 1997, a steelhead supplement was added to the Oregon Plan and addressed salmonid restoration within the context of watershed health.

Willamette River Legacy Program On March 5, 2004, Governor Ted Kulongoski announced that his, "...top environmental priority over the next 3 years is to clean up the crown jewel of Oregon's river system, the Willamette River, from the headwaters east of Eugene all the way to the Columbia." Kulongoski identified three priority areas of focus for the Willamette River Legacy Program, including;

1. Repair – Clean up the industrial pollutants and toxins that have contaminated the river.
2. Restore – Return the river to its natural state, restoring its abundant wildlife and pristine riverbanks.
3. Recreate – Address the role that the Willamette River plays in Oregon's quality of life so Oregonians can enjoy the many activities the river offers, and to do so responsibly so that it will be here for future generations.

2.2.3 Regional Plans

Metro Regional Framework Plan Metro is a directly elected regional government that serves residents in Clackamas, Multnomah and Washington counties, and the 25 cities in the Portland metropolitan area. The *Metro Regional Framework Plan*, updated in 2011, unites all of Metro's adopted land use planning policies and requirements including: the Regional Urban Growth Goals and Objectives, 2040 Growth Concept, Metropolitan Greenspaces Master Plan, and Regional Transportation Plan. The Metro 2040 Growth Concept defines regional growth and development in the Portland metropolitan region. Policies in the 2040 Growth Concept encourage efficient use of land, protection of farmland and natural areas, a balanced transportation system, a healthy economy, and diverse housing options. It includes land use and transportation policies that will allow Portland metropolitan area cities and counties to manage growth, protect natural resources, and make improvements to facilities and infrastructure while maintaining the region's quality of life.

Willamette River Basin Planning Atlas The Willamette River Basin Planning Atlas (Hulse *et al.* 2002) is a product of the Pacific Northwest Ecosystem Research Consortium, a regional research consortium involving researchers at Oregon State University, the University of Oregon, the University of Washington, and the EPA supported under cooperative agreement between the EPA and the universities. The intent of the research is to: (1) create a regional context for interpreting trajectories of landscape and ecosystem change, (2) identify and understand critical ecological processes, and (3) develop approaches for evaluating outcomes of alternative future land and water use, management, and policy. The Planning Atlas provides current available information about critical natural and cultural factors influencing land and water use decisions in the Willamette River Basin. The information was used to create a set of mapped depictions of plausible future configurations of land and water use for the basin in the year 2050. These alternative futures were then scientifically evaluated for their effects on important environmental and ecological processes.

2.2.4 City of Portland

The City of Portland, as the non-Federal sponsor, has previously taken steps to identify a citywide approach to improving watershed health in the Lower Willamette River. The *Framework for Integrated Management of Watershed Health* (PBES 2005a) establishes four citywide watershed health goals. Based on the framework, the City developed *Actions for Watershed Health, 2005 Portland Watershed Management Plan* (PBES 2005a). Based on the watershed characterizations, the City of Portland and its partners, along with public input, prepared the Portland Watershed Management Plan (PBES 2005a). The City Council adopted the plan in March 2006. The Portland Watershed Management Plan describes the priority strategies being used to improve watershed health through the work of the PBES Watershed Services Group, River Renaissance, other City bureaus, agencies, and citizens' groups, all of which share the watershed health goals described in the framework. The plan also includes citywide objectives based upon the framework goals (Table 2.1).

Table 2.1. Portland Watershed Management Plan Citywide Goals and Objectives (2005)

Goals	Objectives
Hydrology Move toward normative flow conditions to protect and improve watershed and stream health, channel functions, and public health and safety.	**Stream Flow and Hydrologic Complexity** Increase rainfall interception, infiltration, and detention to normalize stream hydrographs, reduce stormwater input into the sewer systems, and reduce basement flooding. **Channel and Floodplain Function** Protect and restore the extent, connectivity, and function of streams, other open drainage ways, wetlands, riparian areas, and floodplains to improve stability and natural hydrologic functions and reduce risk to development and human safety. **Stormwater Conveyance** Maintain stormwater collection and conveyance infrastructure capacity.
Physical Habitat Protect, enhance, and restore aquatic and terrestrial habitat conditions to support key ecological functions and improve productivity, diversity, capacity, and distribution of native fish and wildlife populations and biological communities.	**Aquatic Habitat** Protect and improve aquatic, riparian, and floodplain habitat extent, quality, and connectivity that support the persistence of native fish and wildlife communities. **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.

Water Quality Protect and improve surface water and groundwater quality to protect public health and support native fish and wildlife populations and biological communities.	**Stream Temperature** Protect and improve stream temperatures, dissolved oxygen, and pH to levels that protect ecological health and achieve applicable water quality standards. **Pathogens** Maintain and manage sewer infrastructure, 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. **Urban Pollutants** Manage the sources and transport of industrial and non-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.
Biological Communities Protect, enhance, manage, and restore native aquatic and terrestrial species and biological communities to improve and maintain biodiversity in Portland's watersheds.	**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. **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 where they do not compete with native species.

River Renaissance Initiative River Renaissance Initiative is a citywide initiative to reclaim the Willamette River as Portland's uniting community centerpiece. River Renaissance engages the public, connects community partners, coordinates the City's river-related work, and creates innovative urban solutions. Central to this initiative approach is the belief that urban development, healthy natural systems, and a sustainable economy are complementary goals. The River Renaissance Initiative celebrates the Willamette River by promoting a comprehensive approach to river issues, enhancing public awareness of critical issues, and highlighting progress and achievements. The initiative is led by a collaborative team of city bureaus including Planning, Environmental Services, Parks & Recreation, Sustainable Development, Transportation, Development Services, Water, and the Portland Development Commission.

River Plan The River Plan is a comprehensive multi-objective plan for land along the Willamette River. It is an update of the Willamette Greenway Plan, zoning code and design guidelines, which serve as Portland's compliance with State Planning Goal 15 and were last updated in 1987. The width of the planning area varies from place to place but generally includes all land within approximately 0.25 miles of the river.

The River Plan is divided into three reaches of the Willamette River: the North Reach, Central Reach, and South Reach. The North Reach of the Willamette was the first to receive detailed planning, and the City Council adopted the River Plan North Reach in 2010. The South and Central Reach plans will follow, allowing the River Plan to synchronize with projects and planning efforts that affect specific reaches such as Portland Harbor Superfund cleanup (North Reach), Central City planning (Central Reach), and the acquisition of Ross Island (South Reach) (PBES 2012a).

Framework for Integrated Management of Watershed Health The *Framework for Integrated Management of Watershed Health* describes Portland's scientific foundation for managing the

conditions and ecological functions of its urban-area watersheds (PBES 2005a). The framework describes a science-based approach to:

- Generate information to guide City government decisions that affect watershed health.
- Integrate the City's responses to regional, state, and federal environmental laws.
- Establish goals, objectives, measurable indicators of watershed health, and target values and benchmarks for each indicator.
- Guide the identification, analysis, selection, implementation, and monitoring of actions to improve watershed health.
- Ensure that City activities not directly related to improving environmental conditions are consistent with the City's watershed health goals.

The framework documents the City's definition of healthy urban watersheds, a vision for the future of Portland's watersheds, and watershed health goals related to hydrology, physical habitat, water quality, and biological communities. Salmon are of particular interest because of their special legal, economic, and cultural status in the Pacific Northwest. The framework process also applies to riparian and terrestrial wildlife and habitats.

Watershed Characterization Reports Based on the scientific guidance provided by the framework, Portland developed a series of watershed characterization reports for the Fanno and Tryon Creeks (PBES 2005b), Johnson Creek (PBES 2005c), Columbia Slough (PBES 2005d), and Willamette River (PBES 2006) watersheds. The characterizations describe existing and historic conditions in each drainage area within the City of Portland, and highlight areas of remaining high quality that warrant continued and/or additional protection and areas that represent the best opportunities for restoration. Similarly, the characterizations identify key limiting factors that are used to guide the development and prioritization of management objectives and actions.

Combined Sewer Overflow Program In 2011, the City's Combined Sewer Overflow (CSO) program was completed, reducing CSOs to the Columbia Slough by 99 percent and Willamette River by 94 percent (PBES 2011). During a CSO, stormwater quickly fills the combined sewers, which carry both sanitary sewage and runoff from streets, parking lots, and rooftops. The overflows carried bacteria from the untreated sewage as well as other pollutants in the stormwater directly into the river, and would occur every time it rained. About half of Portland's residents are served by combined sewers and overflows occur nearly every time it rains. Under the program, instead of overflowing nearly every time it rains, combined sewers overflow to the river only during major rain storms, which happen on average four times each winter and once every third summer. The program includes projects to remove stormwater runoff from sewers and construct facilities to collect and convey combined sewage to the Columbia Boulevard Wastewater Treatment Plant.

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3. NEED FOR AND OBJECTIVES OF ACTION

The Willamette River watershed in the Portland area was once an extensive and interconnected system of multiple active channels, sloughs and slack waters, sandflats, emergent wetlands, riparian forests, and adjacent upland forests. The settlement and development of the City of Portland modified and removed many of these habitats. Modifications needed to provide ship access to Portland Harbor required construction and maintenance of a navigation channel between RM 0 and 11.6. The development of navigational channels, docking facilities, and bulkheads reduced the amount and quality of native floodplain habitats. In addition, the river became heavily polluted beginning in the early 1900s from industrial and non-industrial waste discharges, resulting in an almost dead river by the 1930s (Dean Smith & Associates 1998). In the 1960s, the river was targeted for remediation and protection, and more recently, habitat and natural resources restoration efforts have been undertaken. However, the river continues to suffer from poor water and sediment quality, diminished riparian zones, and reduced shallow water habitat areas. Despite best efforts, fish and wildlife populations, especially those protected under the ESA, have undergone dramatic declines.

3.1 National Objectives

As stated above, ecosystem restoration is one of the primary missions of the Corps Civil Works program. Guidance document ER 1165-2-501 states:

"The purpose of the Civil Works ecosystem restoration activities is to restore significant ecosystem function, structure, and dynamic processes that have been degraded...The intent of restoration is to partially or fully reestablish the attributes of a naturalistic, functioning, and self-regulating system."

The Federal objectives for the ecosystem restoration mission differ slightly from other missions. Evaluation and comparison of ecosystem restoration alternatives necessitates both monetary and nonmonetary metrics. As such, the guidance in ER 1165-2-501 states:

"Consistent with the analytical framework established by the P&G, plans to address ecosystem restoration should be formulated and recommended, based on their monetary and non-monetary benefits. These measures do not need to exhibit net national economic development (NED) benefits and should be viewed on the basis of non-monetary outputs compatible with the P&G (Planning and Guidance) selection criteria."

The aquatic and riparian restoration evaluated in the study is consistent with the Corps ecosystem restoration mission, as well as the Federal objective.

3.2 Problems and Opportunities

3.2.1 Problems

Numerous studies cited in this report have identified the limiting factors contributing to a lack of habitat for fish and wildlife in the Lower Willamette River and its tributaries. Key factors adversely affecting natural riverine functions in the mainstem of the river are:

- **Altered Hydrology** The marked reduction in peak flows from upstream dams and other water uses has altered the timing, size, and frequency of runoff and flood events that are critical for maintaining healthy riparian, floodplain, in-channel, and off-channel habitats. Increases in base flows have also occurred.

- **Loss of Habitat Complexity** Dredging, channel straightening, and bank stabilization have all changed the main channel of the Willamette River from a multiple channel, structurally complex system dominated by shallow water areas to a deep, steep-banked channel with little diversity in structure or depth. Loss of channel complexity, woody material, and shallow water habitats adversely affect a wide range of fish and wildlife species. In many locations, invasive species have replaced diverse native plant communities, with a resulting decrease in ability to support a wide diversity of fish and wildlife species or species that are highly specialized.

- **Loss or Degradation of Off-channel Habitats** Extensive fill, development in the floodplain, and alterations in channel banks have destroyed or degraded floodplain and off-channel habitats by filling them or by reducing or eliminating the frequency with which floodplain habitats are inundated.

- **Reduction in Nutrients and Woody Material** As a result of the loss of riparian vegetation, stabilization of shorelines, and the development of the floodplain, the input of naturally derived nutrients and woody debris has been reduced. Reduced input of woody debris is detrimental to aquatic habitat quality as wood provides habitat diversity, cover, and sediment retention. There has also been a loss of nutrient input from salmonid carcasses, although this source of nutrient input would generally occur in the tributaries or higher in the Willamette River system where spawning grounds are found.

- **Degraded Water Quality** Water quality has been adversely affected by urbanization and agricultural land uses over the last 150 years. Industrial and non-industrial wastes, along with contaminants in agricultural and urban runoff have contributed to degraded water quality. Water temperatures have also increased due to impacts from major dams, reservoirs, and loss of riparian vegetation. Warming water temperatures have contributed to the decline of cold water fisheries (*i.e.*, salmonids), while favoring non-native warm water species (*i.e.*, northern pike, crappie, and bass).

- **Contaminated Sediments** Portland Harbor was added to EPA's National Priorities List of contaminated sites in December 2000 because river sediments are contaminated with metals, pesticides, polychlorinated biphenyls (PCBs), and petroleum products. Ecosystem restoration work proposed under this study will be coordinated with the Portland Harbor superfund site and comply with USACE guidance for Civil Works projects with hazardous, toxic, and radioactive wastes (*e.g.*, ER 1165-2-132).

Tributaries to the Lower Willamette River also have contributing factors that affect the health of the mainstem river. Problems within tributaries include:

- Changes in bank gradient and channel substrate,
- Excessive sediment deposition,
- A lack of species and structural diversity within all habitat types in too narrow riparian corridors,
- Limited connection or linkage between riparian habitats and upland habitats,
- Disturbance due to the proximity of urban development, domestic animals, and recreational trails, and
- Presence of fish barriers.

3.2.2 Opportunities

While numerous problems have been identified in reports cited within this document, there are also many opportunities for restoration to benefit fish and wildlife. Numerous sites within the Lower Willamette River watershed have been identified by the non-Federal sponsor and others as offering opportunities for implementation of restoration measures that would make substantial, measurable improvements in watershed health and habitat quality. Given that numerous such projects are being implemented by the City of Portland, watershed groups, and other federal agencies, there is clearly public support for such projects. Some examples of the types of restoration measures that could be successfully implemented are listed below:

- **Increase Floodplain Connectivity** This type of restoration involves enhancing or reconnecting existing floodplain areas, which may include side channels, backwaters, or wetlands, that have been disconnected in some manner. Floodplain restoration can also include placement of large wood (LW) in the floodplain to provide habitat and cover during high flow events, and planting of riparian vegetation. These types of opportunities exist on the mainstem Willamette River as well as Columbia Slough, and would help to address the problems of loss of off-channel habitat and reductions in nutrients and woody material.

- **Riparian Restoration and Non-native Vegetation Removal** This type of restoration is for river bank, side channel, tributary, and floodplain areas that either lack riparian vegetation or have extensive non-native vegetation populations. Implementing this type of restoration would help to address the problems of loss of habitat complexity, and reduction in nutrients and woody material.

- **Side Channel Creation and Restoration** This type of restoration involves creating, restoring, and/or reconnecting side channel or slough features, or improving the quality of an existing side channel. Side channel restoration may be part of other project types. The scale and restoration approach may also vary from project to project. The simplest type of project would involve minor excavation to remove deposited materials to reconnect a side channel. More extensive project types include excavation of new side channels in areas where there is a paucity of off-channel habitat, or where levees or berms have been placed between the historic side channel and the main channel to which it was once connected. Restoration can involve measures such as restoring historic overflow connections that are currently blocked, and restoration may involve general features such as placement of LW, riparian plantings, or species-specific measures such as placement of wood clusters for pond turtles. Other types of side channel restoration includes placement of LW at the entrances or within side channels to improve habitat complexity and cover or to provide scour to keep the entrance open. Side channel restoration would help to address the problems of loss of off-channel habitat, reductions in nutrients and woody material, and reduced wild stocks of salmon.

- **Tributary Restoration** Tributaries to the Lower Willamette River that are included in this report include Tryon Creek and Columbia Slough. Tryon Creek has historically provided a range of habitats for migrating fish, and both tributaries had rich riparian zones that supported wildlife habitat, floodwater attenuation, nutrient input, and other functions. Implementing this type of restoration would address the problems of loss of off-channel habitat, reductions in nutrients and woody material, reduced wild stocks of salmon, and problems listed in Section 3.4.1 regarding problems within tributaries.

- **Fill Removal** This type of restoration is specifically related to the removal of fill materials that were placed in the floodplain of the Lower Willamette River. Implementing this type of

restoration would help to address the problems of loss of off-channel habitat, reductions in nutrients and woody material, and reduced wild stocks of salmon.

3.3 Goals and Objectives

Based on an assessment of the problems and opportunities along with the City-wide watershed framework and in consideration of USACE ecosystem restoration mission, a set of primary project goals and key objectives were established for the Lower Willamette feasibility study. These objectives are intended to be met over the 50-year planning horizon set for this study, which commences in 2017 and ends in 2066.

The overall goal of this project is to improve aquatic habitat structure and function. A fundamental component of meeting this goal is to reestablish, in measurable terms, the dynamic balance between the physical, chemical, and biological habitat components that formerly existed in the watershed. Although the watershed has been modified extensively and it is unlikely that the habitat that once existed can be fully restored, the functions that arise from the interplay of the habitat components can be restored. The objectives and actions that are proposed to achieve this goal are described below.

3.3.1 Reestablish Riparian and Wetland Plant Communities

The diversity and extent of native plant communities throughout the study area have been diminished through past and current land use practices including deforestation and development, and by competition from invasive plant species. Restored native plant communities will benefit wildlife by providing greater diversity of forage, cover, and breeding habitat; support a more diverse and stable food web; and benefit aquatic organisms by providing increased and more diverse nutrient input. Specific restoration measures that have been developed to help accomplish this objective include:

- Remove invasive species and minimize disturbance of native habitats,
- Revegetate riparian zones and wetlands with an appropriate mix of native species, and
- Restore hydrologic aspects of each site to encourage survival of appropriate plant communities.

Measures of Success: Restore mix of understory and canopy species that reflect conditions in control locations (areas with relatively undisturbed habitat), and maintain at least 75 percent native species in restored areas.

3.3.2 Increase Aquatic and Riparian Habitat Complexity and Diversity

The study area wetlands, aquatic zones, and riparian areas support a variety of species that were once widespread throughout floodplain wetlands along the mainstem Willamette River and its tributaries. Active restoration at these sites will return much of the complexity and diversity of wetland types, transitional zones, and plant communities that are needed to support a stable fish and wildlife community, including several listed species. Specific restoration measures that have been developed to help accomplish this objective include:

- Restore streambeds by placing large wood for habitat diversity.
- Encourage or install communities of overhanging streamside vegetation to reduce solar gain, stabilize shorelines, and provide wildlife cover.
- Remove barriers to fish access to spawning and rearing areas.

Measures of Success: Sediments are retained in the streambed to allow for natural mix of fines, gravel, cobble, and larger rock. Stream channels are free from unnatural headcuts, toe erosion, incision, and bank failure. Fish can access all restored spawning and rearing areas during normal winter flows.

3.3.3 Restore Floodplain Function and Connectivity

Reconnecting floodplains to the river will help to attenuate flows and contribute organic matter, substrate, and large wood to the stream system. Sloping back banks and creating side channels will allow for the development of a wider riparian zone, more shallow water habitat, and more natural formation of aquatic functions. Specific restoration measures that have been developed to help accomplish this objective include:

- Slope steepened banks to a gentler angle to allow floodwaters to spread out and to provide shallow water habitat.
- Remove revetments and fill, and use bioengineering methods for bank stabilization where possible.
- Reconnect side channels and backwater wetlands to streams and rivers where possible.

Measures of Success: All restored side channels are directly connected to the Willamette River or Columbia Slough at normal winter flows. Banks angles in restored areas are no greater than 3:1, preferably angled at 5:1 where appropriate.

3.4 Planning Constraints

Constraints and assumptions were identified early in the planning process to form the sideboards in which the alternatives would be developed. The general criteria below were considered as constraints when formulating the restoration measures:

- **Infrastructure** Project features should not permanently affect the function of infrastructure such as drainage outlets, sewer lines, bike or hiking trails, roads, etc.

- **Aesthetics** Features should be designed to minimize negative impacts on aesthetics.

- **Hazardous, Toxic, and Radioactive Waste** Features cannot cause disturbance of hazardous, toxic, and radioactive waste (HTRW), and project planning must minimize and prevent federal liability under the CERCLA. Any restoration measures implemented as part of this project should be able to function fully within the context of any known HTRW.

- **Flood Elevations/Damages** Project features must not increase flood elevations or the potential for flood damages.

- **Water Quality** Project features must not degrade water quality conditions.

- **Construction** Construction periods in aquatic environments will be limited to in-water work windows that have been designated for each water body.

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4. CHARACTERIZATION OF BASELINE CONDITIONS

The following sections provide descriptions of each resource area or existing condition. The information provided in this section provides an overview of conditions throughout the study area as the context for plan formulation.

4.1 Historic Conditions

The landscape of the Lower Willamette River Basin has been shaped primarily by events of the Pleistocene and Holocene periods, extending 2.5 million years into the past. This includes repeating glacial advance and retreat, and catastrophic flooding. Over time, the Lower Willamette River evolved into a braided, low gradient river with tidal influence.

Fur traders and trappers begin inhabiting the Lower Willamette River area in the early 1800s and Fort Vancouver was constructed in 1824. Farming began to develop in the area including a dairy on Sauvie Island to support Hudson's Bay Company employees and their families (Ellis *et al.* 2005). In the mid-1800s, the first Europeans settled in Portland because the site offered deep water moorage for sailing ships journeying up the Columbia River (PBPS 2001). Portland was platted in 1844-1845 and the floodplain was cleared for buildings and fields.

Figure 4.1. Swan Island in 1920

Historically, the lowlands adjacent to the Willamette River consisted of a series of ponds, lakes, sloughs, and wetlands, which were often prone to flooding (Figure 4.1). Seasonal flooding of the Willamette resulted in the development of flood control works by towns along the river by the late 1800s, including revetments and other bank treatments. In the 1930s, industrial, commercial, and agricultural interests had joined forces with local political leaders and the USACE to promote the Willamette Plan. The plan called for a system of dams on the Willamette and its major tributaries for flood control, irrigation, and power. Over the next 40 years dam construction changed the natural flow regime of the basin, eliminating both the flood waters of the winter and spring, and the low flows of the summer and fall (PBES 2006).

Most of the historic off-channel habitat (*i.e.*, side channels, oxbow lakes, and marshes) have long since been cut off from the channel and filled. The width and area of the river have both declined, as a result of diking and filling of shallow areas and navigational dredging. More importantly, in the lower reach of the river the amount of shallow areas (less than 20 feet) has declined by about 80 percent while the amount of deep water habitat (more than 20 feet) has increased by about 195 percent (Table 4.1).

In Table 4.1, changes to the amount of shallow water habitat in the Willamette River were determined by comparing original reference points and breaklines digitized and interpolated from U.S. Coast and Geodetic Survey, 1888, Columbia River chart (Fales Landing to Portland) and USACE 1895 surveys of the Upper Willamette to current information on bathymetry in the Willamette River from the City's Bureau of Environmental Services and Bureau of Planning.

Table 4.1. Summary of Changes in Lower Willamette River Habitats[1]

Measurement	Existing	1881	Change
Total Length (mi.)	18.6	19.0	-2%
Total Area (sq. ft.)	144,989,601	170,124,319	-15%
Total Shallow (sq. ft.)	27,386,401 (19%)	130,056,733 (76%)	-79%
Total Deep (sq. ft.)	117,603,200 (81%)	40,067,585 (24%)	194%
Average Width (ft.)	1,479	1,698	-13%

[1]From the mouth of Johnson Creek to the Columbia River. PBES 2006.

4.2 Geology, Topography, Geomorphology and Soils

4.2.1 Geology

The geologic units found in the vicinity of the study area are described below, in chronological order of deposit (Beeson *et al.* 1991, Swanson *et al.* 1993).

The northern two-thirds of the Willamette Valley is underlain by Columbia River Basalt that flowed over southern Washington and northern Oregon during the Miocene era, between 16.5 and 12 million years ago. The Columbia River Basalt Group (CRBG) reaches the surface in many places in the Willamette Valley, and may form the bed of the river in some instances. The top of this unit is found to occur at greater depths as distance from the river increases (Beeson *et al.* 1991).

Sandy River Mudstone is a fine-grained equivalent of the lower Troutdale Formation that overlies the CRBG in the center of the basin and at the margins of the basin away from the axis of the Columbia River. The lower Troutdale Formation/Sandy River Mudstone is present in places under the Lower Willamette River (Swanson *et al.* 1993) and borders the Portland Hills, but is not considered a substantial hydrogeologic unit within the study area.

The upper Troutdale Formation in the vicinity of the Lower Willamette River includes cemented and uncemented alluvial sand, gravel, and cobbles deposited by the ancestral Willamette and Columbia Rivers. The Troutdale Formation comprises the Troutdale Gravel Aquifer hydrostratigraphic unit. This unit is present in some places on the west side of the study area to thicknesses of 100 feet and is present along the entire length of the east side of the study area at thicknesses of up to 200 feet (Swanson *et al.* 1993).

Human modification of the river and its surroundings has resulted in the placement of fill materials throughout much of the lowland. Dredged river sediment of fine and silty sands was used to fill portions of the floodplain in order to facilitate development. Doane Lake, Guild's Lake, Kittridge Lake, Mocks Bottom, Rivergate, and a number of sloughs and low-lying areas were completely or partially filled. Fill also was used to connect Swan Island to the east shore of the Willamette River, and to further elevate or extend much of the Willamette River banks along both sides of the riverfront. Rocks, gravel, sand, and silt also were used to fill low-lying upland and bank areas. The thickness of fill generally ranges from 0 to 20 feet, but may be much deeper. The permeability varies with the type of dredged or fill material. Where composed of clean dredge fill sand, permeability is higher than the natural fine-grained alluvium, but where silt or a silty matrix in the sand fill is present, permeability is reduced.

4.2.2 Topography

The Lower Willamette River watershed within the study area encompasses approximately 61 square miles. The west side of the Lower Willamette River watershed covers a drainage area of about 25 square miles and includes the steep-sided feature of the Tualatin Mountains (West Hills). The east side has a drainage area of approximately 36 square miles and has relatively flat topography except for volcanic features such as Mt. Tabor and Rocky Butte. Several tributaries join the Lower Willamette River, including Tryon Creek and the Columbia Slough, and most of the tributaries flow through pipes, culverts, or other flow modification features before they reach the river.

The west side of the Lower Willamette River watershed covers a drainage area of about 25.5 square miles and includes the steep-sided feature of the Tualatin Mountains. The land cover and use associated with the west side includes forested areas with rural residential and natural parks, as well as the urbanized Portland downtown. Several tributaries concentrate flow contributions from the west side of the Lower Willamette River, including Tryon Creek, for which the confluence is located just north of the City of Lake Oswego; most of the tributaries flow through pipes or culverts before they reach the river. The east side has a drainage area of approximately 36 square miles and has relatively flat topography except for volcanic features such as Mt. Tabor and Rocky Butte.

Tryon Creek, with a watershed area of approximately 6.5 square miles, can be divided into approximately five separate reaches with varying geomorphic characteristics such as stream gradients and valley widths. Typical stream gradients range from 0.6 percent to 2.9 percent, with the exception of a short stretch of the Highway 43 culvert that is sloped at 5.94 percent.

The Columbia Slough has a watershed area of 51 square miles and flows through a relatively uniform topography, which gives a very gentle stream gradient of less than 1 percent.

4.2.3 Geomorphology

Riverine and floodplain morphology is developed by the natural processes of sediment erosion and deposition. Spatial and temporal patterns of erosion and deposition come from a combination of controlling factors: hydrologic regime, sediment and wood supply, and bed and bank erodability. River movement and fluvial landform and bedform development result from a combination of these controlling factors. Native species are adapted to, or dependent upon, an array of habitat types that are formed and reformed by the natural fluvial geomorphic regime of a river.

Human activities have changed riverine and floodplain habitats by altering the controlling factors. For example, dams have reduced peak flood flows which diminish a river's capacity to erode, transport and deposit sediment; riprap hardens banks reducing sediment supply; and gravel mining also removes the sediment supply and changes the channel morphology. Disruptions to the natural hydrologic and sediment regimes change the rate and types of habitat forming processes.

Channel Form The Lower Willamette River is currently a single-thread river channel with low gradients, and limited lateral changes. The extensive braiding, islands, and sloughs of the historic delta are mostly gone. The lower reach of the Willamette River has remained relatively constant geomorphically over the last 150 years (Hulse *et al.* 2002). However, current and past human activities in the study area have altered the geomorphic processes. The riverbanks of the mainstem Willamette in the project area are mostly non-natural: rip rap, structures, unclassified fill, and sea walls which comprise approximately 72 percent of the existing bank. Twenty-six percent consist of natural and river beach banks. Bio-technical and bio-engineered banks constitute only two percent of existing bank types (PBPS 2001).

There are a number of tributaries that join the Willamette at the North Segment. The largest of these by far is the Columbia Slough, a 19-mile waterway with a 32,700 acre watershed. The watershed was originally a large series of wetlands, lakes and channels which formed the floodplain of the Columbia mainstem and the Willamette Mouth. Although the slough has undergone extensive structural alterations, historic records indicate that a channel existed in the approximate location of the present confluence with the Willamette (PBES 2006).

Sediments Sediments throughout the Lower Willamette River vary from coarse sand in the upstream portions near its confluence with the Clackamas River to mainly sandy mud near the mouth where it joins the Columbia River. Sand, sandy mud, and muddy sand comprise the vast majority of the sediment types, accounting for over 80 percent of the sediment composition through the lower river (Hill and McLaren 2001). Bedrock comprises 10 percent of the bottom, though the majority of this is located in the reaches below Willamette Falls and upstream of Portland (PBES 2006).

Additional data regarding geomorphology of the specific restoration areas is given in the geomorphology appendix (Appendix A).

4.2.4 Soils

Five soil types are found within the study area. A map of soil types in the study area is provided below.

Pilchuck-Urban Land Complex, 0-3 Percent Slopes Pilchuck-Urban Land Complex, 0 to 3 percent slopes (33A), soils consist of excessively drained soil on floodplains of the Columbia and Willamette Rivers, formed in sandy alluvium or sandy dredge spoils (Farrelly 2008).

Sauvie-Rafton-Urban Land Complex, 0-3 Percent Slopes This soil type consists of very deep, poorly drained Sauvie soils and very poorly drained Rafton soils (Farrelly 2008).

Sauvie Silt Loam These soils are found on floodplains along the lower Columbia River and its tributaries. The soils formed in recent alluvium with some mixing with volcanic ash (USDA 2013).

Laurelwood Silt Loam, 15-30 Percent Slope This soil consists of very deep, well drained soils with slow to rapid runoff and moderate permeability. Laurelwood soils are on hills with long, convex, slopes that are gently sloping to very steep and have gradients of 3 to 60 percent and elevations of 200 to 1,600 feet (National Cooperative Soil Survey 2006).

Xerochrepts and Haploxerolls, Very Steep This soil type complex consists of deep, well drained soils with moderate to moderately slow permeability. Slopes range from 20 to 60 percent. These soils formed in colluvium derived from igneous rock and occur on terrace escarpments. Xerochrepts and Haploxerolls are used for timber production, wildlife habitat, and home sites (USDA 2013).

4.2.5 Future Without Project Conditions

Soils will continue to degrade naturally through erosion and as a result of human modifications within the project area. No substantial changes to geological layers or topography are anticipated to occur in the future.

4.3 Water Resources

4.3.1 Hydrology

The study area is located within U.S. Geological Survey (USGS) Hydrologic Units 1709007, 17090011, and 17090012. Detailed hydrology by reach is provided below. Watershed boundaries are shown in Figure 4.2, below.

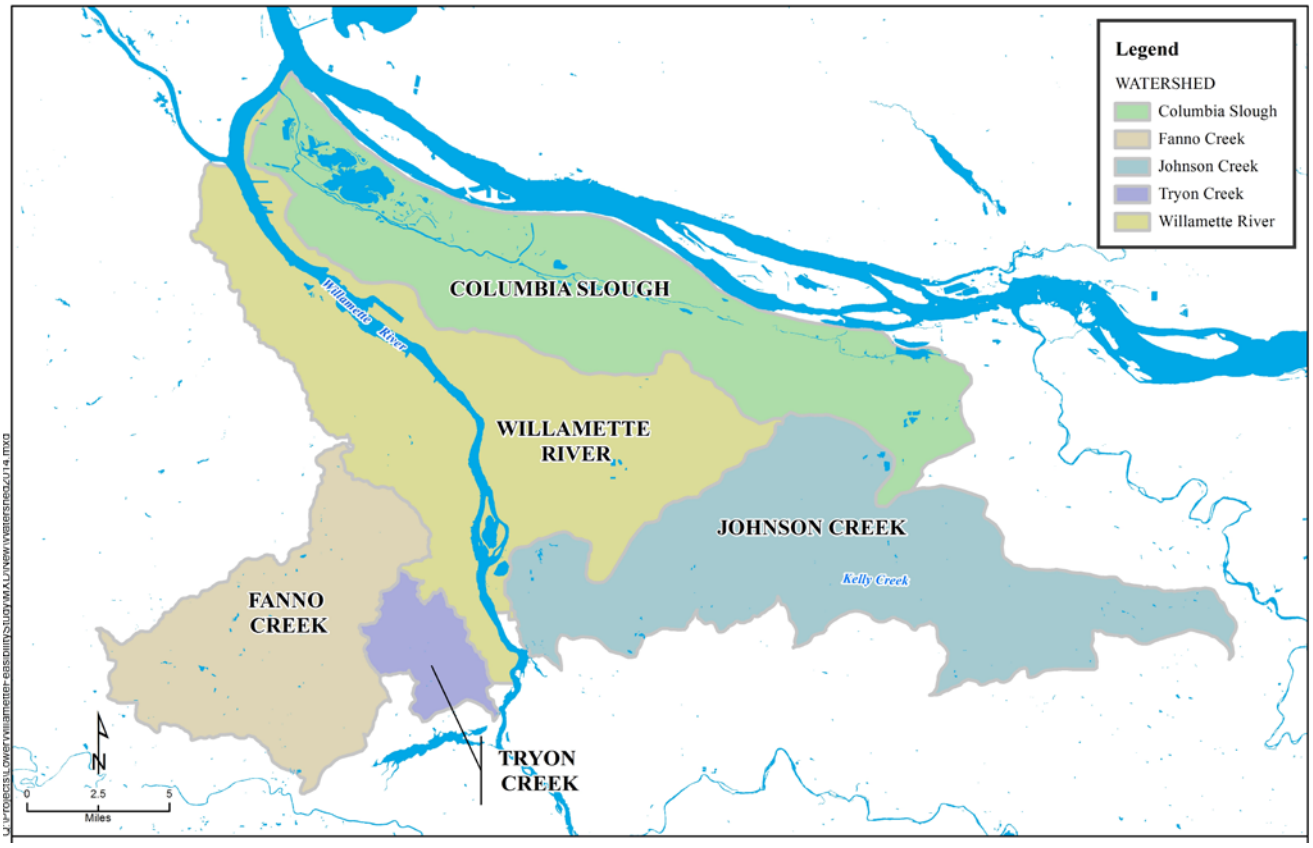

Figure 4.2. Watershed Boundaries in the Project Area

Lower Willamette River

Hydrology in both study reaches of the Lower Willamette River is driven by upstream reservoir regulation of the Willamette and Columbia Rivers, natural stream flows, climatic patterns, and tidal effects. The degree to which these variables affect hydrologic conditions in the watershed varies by season and the nature and magnitude of storm events (USACE 2004). Nearly all precipitation within the area of interest (AOI) falls as rain, although a few isolated snow events can occur. Average annual precipitation is 40 to 45 inches. Approximately 95 percent of annual precipitation occurs from October through June and about the remaining 5 percent occurs from July through September.

The average annual daily discharge recorded at USGS Gage No. 14211720, Willamette River at Portland (Morrison Bridge) for water years 1973 to 2011 is 33,160 cubic feet per second (cfs). A maximum discharge of 420,000 cfs was recorded on February 9, 1996, and a minimum discharge of

4,200 cfs was recorded on July 10, 1978 (USGS 2012a). Peak flows after heavy rains can range from 200,000 to 400,000 cfs (Hulse *et al.* 2002).

Hydrologic processes in the Lower Willamette River have changed in response to construction of dams, irrigation diversions, and dredging for navigation. Winter flood flows have been reduced and summer low flows have increased (PBES 2004). Wetland losses, diking and bank hardening, vegetation removal, impervious surfaces and regional changes in hydrology have altered the temporal and spatial patterns of groundwater inflows and in general reduced levels of groundwater input, although there is little quantitative information to assess the specific nature of these changes.

There are dozens of federal, local, utility, private, and state dams and reservoirs in the greater Willamette River Basin with a collective storage capacity of over 2.7 million acre-feet (Hulse *et al.* 2002). Most notable of the federal projects is the Willamette River Basin Project, which consists of 13 dams built by USACE beginning in the 1960s, in addition to various bank protection structures for flood control and hydropower production (Willamette Restoration Initiative 2004).

The Lower Willamette River is a tidally influenced freshwater estuary that is influenced by Pacific Ocean tidal fluctuations transmitted upstream in the Columbia River. When the water surface level of the Columbia River exceeds that of the Lower Willamette River, water from the Columbia River enters the Willamette River and the net flow direction of the Willamette River is negative (upstream). This condition occurs when Portland Harbor stages are less than 12 feet National Geodetic Vertical Datum of 1929 (NGVD 29) and is most pronounced when harbor stages are less than 5 feet NGVD29; the latter stages commonly occur in late summer and early fall (USACE 2009). Tidal influences in the Lower Willamette River extending to the Morrison Bridge typically fluctuate between 0 to 3 feet mimicking the mixed semi-diurnal ocean tide patterns (two unequal high tides and two unequal low tides daily) (Limno-Tech 1997).

The extent of impervious surfaces is an important consideration, since it may extensively alter the hydrology of a river system. Paved roads, driveways and parking lots prevent rainfall from seeping into the soil and moving subsurface toward streams and rivers. Instead, stormwater is conveyed rapidly and at much higher volume, impacting the natural flow and altering physical and biological conditions. Within the Lower Willamette River watershed, intensive urbanization has resulted in a high percent of impervious surfaces. However, the impact of impervious surfaces on the hydrology of the Lower Willamette River is muted by the more substantial influence of the upstream dams, large river volume and tides. The tributaries of the Willamette River are more affected by impervious surfaces.

Tryon Creek

The historic hydrology of Tryon Creek is typical of a low to moderate gradient Willamette River Valley stream, with steep landscape slopes that have been modified by the effects of development and urbanization. The annual hydrograph for Tryon Creek reflects local precipitation patterns, with high flows and frequent storm flow events during the wet period from approximately October through May, followed by low flows during the summer dry period (June through September) (PBES 2005b).

Tryon Creek hydrology has been altered due to the increase in impervious surfaces throughout the watershed. Although there are no quantified historic data to compare to, it can be inferred from similar streams in the Pacific Northwest that the climatic precipitation pattern has not changed. Instead, daily and monthly stream flow events and volumes likely have changed due to land development. Extensive urbanization has created an estimated 23% coverage of impervious surfaces

throughout the Tryon Creek watershed (Rhodes 2002, PBES 2005b). However, total impervious area is likely higher than 25%, if including smaller features such as driveways and sidewalks. Further, "effective" impervious area is still higher, because areas converted to lawns or where forest cover have been removed also increase runoff, acting as less permeable areas that contribute to the total "effective impervious area" (Rhodes 2002). An impervious surface results in a rapid delivery of stormwater from watershed to creek; in turn resulting in a hydrograph that rises steeply during rain events, creating a "flashy" system. Sudden high water flows mean increased chances of flooding, unnatural erosion and changes to creek morphology, adverse effects to native fish and wildlife, and increased input of pollutants into the system from unfiltered stormwater runoff.

The average annual daily discharge recorded at USGS Gage No. 14211315 (Tryon Creek near Lake Oswego) for water years 2002 to 2011 is 8.7 cfs. A maximum discharge of 1,210 cfs was recorded on December 9, 2010, and a minimum discharge of 0.09 cfs was recorded on September 4, 5, and 12, 2002 (USGS 2012b). Figure 4.3 is a hydrograph that displays median mean daily discharge rates for Tryon Creek for a 10-year period starting in 2002.

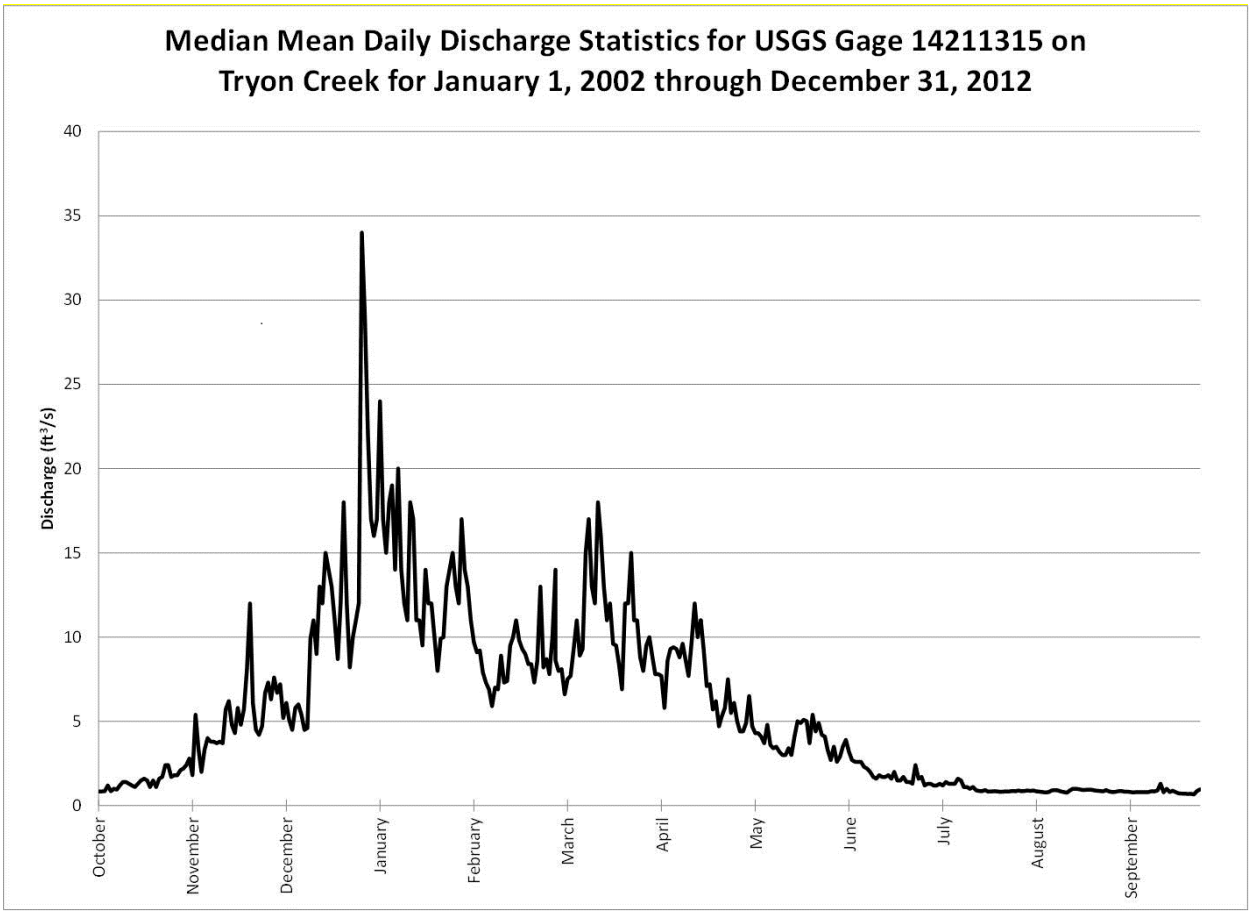

Figure 4.3. Median Mean Daily Discharge Statistics

Columbia Slough

Hydrology within the Columbia Slough watershed has also changed from historic conditions. Levee construction; filling of lakes and wetland complexes with dredge materials; draining of wetlands

and other adjacent low-lying areas; and heavy industrial, commercial, residential, and agricultural development have all occurred within and around the slough (PBES 2005d).

Again, a high percentage of impervious surfaces occur within the area. A 1999 study estimated that 54 percent of the Columbia Slough watershed consists of paved surfaces (Evonuk 1999). The impacts to hydrology include a disconnection of the slough from its floodplain and a much reduced connection to the Columbia River (only seasonal). Impervious surfaces have also contributed to diminished water quality in the slough.

Average annual daily discharge and stage (water elevation) have been recorded at USGS Gage No. 14211820 (Columbia Slough at Portland) for water years 1990 to 2009, although these data have not been recorded continuously. A maximum water elevation of 27.26 was observed on February 9, 1996 (USGS 2012c), which corresponds to record flooding.

4.3.2 Oregon Water Quality Index

The EPA delegated authority to the Oregon Department of Environmental Quality (ODEQ) to implement the federal Clean Water Act (CWA) and parts of the federal Safe Drinking Water Act in Oregon. Per this authority, ODEQ maintains the Oregon Water Quality Index (WQI), which sets the limits of pollution in waters of Oregon, and maintains hundreds of water quality sampling sites to monitor regulated pollutants.

The WQI analyzes a set of water quality parameters and produces a score describing general water quality. Those parameters include temperature, dissolved oxygen, biochemical oxygen demand, pH, total solids, ammonia and nitrate nitrogen, total phosphorous, and fecal coliform. Index scores range from 0-100. Scores of less than 60 are considered indicative of very poor water quality, 60-79 are poor, 80-84 are fair, 85-89 are good, and 90-100 are excellent (ODEQ 2009).

Among the many water quality monitoring sites, four have been selected as representative of water quality conditions within the mainstem Willamette River and Columbia Slough. Three sites are within the mainstem of the Willamette River, including the Swan Island Channel midpoint (RM 0.5), Southern Pacific Railroad Bridge (RM 7.0), and the Hawthorne Bridge (RM 13.2). A fourth site is located on the Columbia Slough at Landfill Road (RM 2.6). The latest Ambient Water Quality Index Results (ODEQ 2010) scores and tracks trends for each of these sites using data collected between 2001 and 2010 (Table 4.2).

Table 4.2. Ambient Water Quality Index Results

Station	RM	Station Number	1986-1995 WQI	2001-2010 WQI	2001-2010 Description
Willamette R. @ Swan Island Channel	0.5	10801	63	77	Poor
Columbia Slough @ Landfill Rd.	2.6	11201	22	45	Very Poor
Willamette R. @ SP&S RR Br.	7.0	10332	74	83	Fair
Willamette R. @ Hawthorne Br.	13.2	10611	74	84	Fair
Source: ODEQ 2010					

Results for the 2001 to 2010 water years show that water quality ranges from fair to very poor in the project area, generally decreasing downstream. However, when compared to the period from 1986 to 1995, water quality has improved (Table 4.2). The greatest increases have occurred where sites had the most room for improvement (ODEQ 2010). Though it has not been substantial enough to

reclassify any of the indices into the next higher category, the improvement has been a continuing trend (ODEQ 2010). This improvement is the direct result of the actions taken by a variety of government and local agencies responsible for water quality. The watershed approach presented in the *Portland Watershed Management Plan*, guides activities of all City of Portland bureaus and programs that affect watershed health. Specific measures taken include those by the ODEQ, which has worked to establish a total of 10 Total Maximum Daily Loads (TMDL) for the watershed that specify pollutant loading limits and require pollution reduction programs for pollutant sources.

In addition, the City of Portland has recently completed a complete retrofit of their combined sewer outfalls (CSOs), reducing sewage and other stormwater pollutants entering the rivers by 99.6 percent. The City has also invested in aggressive revegetation efforts, naturescaping to create catchment basins that filter water, and citywide public outreach and education. The Multnomah Country Drainage District partnered with the USACE to complete an 1135 project, restoring fish and wildlife habitat along the Columbia Slough. The Port of Portland (Port) has worked with ODEQ to reduce pollution entering the slough as a result of de-icing at the Portland Airport. Each of these agencies has worked together and along with local groups, such as the Columbia Slough and Fairview Creek Watershed Councils, to protect and improve water quality. Although these efforts are not necessarily coordinated, they are all being performed to address and reduce the various causes of compromised water quality in the Lower Willamette River watershed.

4.3.3 Beneficial Uses

Beneficial uses for the Willamette Basin include those uses that are supported given the water quality conditions. These are set in the Oregon Administrative Rules (OAR) 340-041-0340. Each of the following beneficial uses has been identified as applicable in the Willamette River through the study area: public domestic water supply, private domestic water supply, industrial water supply, irrigation, livestock watering, fish and aquatic life, wildlife and hunting, fishing, boating, water contact recreation, aesthetic quality, hydropower, and commercial navigation and transportation. Tributaries of the Willamette River within the study area are also subject to the same beneficial uses, except for commercial navigation and transportation (OAR 2012).

4.3.4 Total Maximum Daily Load

Each water body on the CWA 303(d) list requires preparation of a TMDL. The purpose of a TMDL is to identify sources of a pollutant, determine level of exceedance, determine how much pollutant the water body can assimilate before criteria are exceeded, determine pollutant load allocations for all sources, and then assign pollutant loads or percent reductions to sources. Meeting waste load and load allocations ensures that water quality standards are attained. Several TMDLs are in place for waterbodies within the proposed project area, as shown in Table 4.3 (ODEQ 2006) and Figure 4.4.

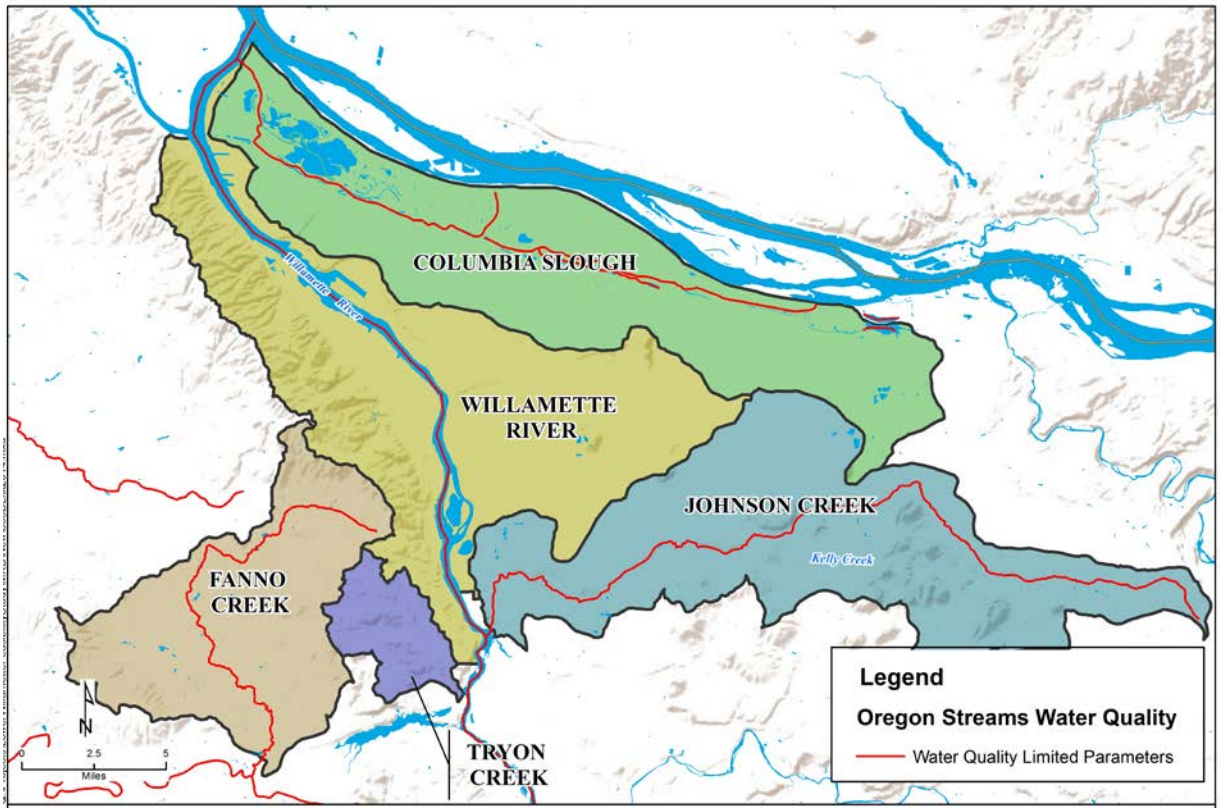

Figure 4.4. 303(d) Listed Waterbodies

In addition to the pollutants addressed in the approved TMDLs, there are a number of additional pollutants of concern in the study area. Heavy metals (including copper, lead, and zinc) have attracted long-standing attention with regard to potential effects on salmonids and other fish. Of these, copper is the most toxic to salmonids as it causes reduced growth and survival rates and altered blood chemistry, respiration, and physiology plus reproductive effects. Researchers at the NOAA Northwest Fisheries Science Center have recommended a salmonid effect threshold for dissolved copper found in stormwater effluent of 5 micrograms per liter (µg/L) (N. Scholz, NOAA, pers. comm. with M. Reed, City of Portland, February 7, 2006). Sampling performed by the City in 2005-2006 found that pollutants were below threshold values in all but one sample (PBES 2006).

Table 4.3. Approved TMDLs within Proposed Study Area

Waterbody Segment	RM	Parameter	Season
Willamette River (1991)	0 to 187	Dioxin	Annual
Columbia Slough (1998)	Entire Length	Bacteria	Annual
		pH	Spring – Fall
		Dissolved Oxygen	Annual
		Nutrients	Spring – Fall
		Phosphorous	Spring – Fall
		Temperature	Spring – Fall
		Lead	Annual
		DDE, DDT	Annual
		PCBs	Annual
		Dioxin	Annual
Willamette River (2006)	0 to 24.8	Fecal Coliform	Fall – Spring
	0 to 24.8	Mercury	Annual
	0 to 24.8	Temperature	Summer
	24.8 to 54.8	Fecal Coliform	Fall – Spring
	24.8 to 54.8	Mercury	Annual
	24.8 to 54.8	Temperature	Summer
Tryon Creek (2006)	0 to 5	Temperature	Summer

Source: ODEQ 2006
Note: DDE = dichlorodiphenyldichloroethylene; DDT = dichlorodiphenyltrichloroethane; PCBs = polychlorinated biphenyls

4.3.5 Stormwater

In addition to measurable water quality parameters, there are other considerations important to water quality in the Lower Willamette River and its tributaries within the Willamette Plan Area. These include discharge of industrial wastewater under the National Pollutant Discharge Elimination System (NPDES), discharges identified through the City's Illicit Discharge Elimination Program (IDEP), combined sewer overflows, stormwater discharges, and stormwater sumps, also known as underground injection control wells (PBES 2006b).

Stormwater from streets and developed areas is difficult to manage because it comes from countless diffuse sources. It is also called non-point source pollution. In addition to direct discharges to waterways, stormwater is managed through a system of more than 9,000 sumps and test wells located in many parts of Portland's Willamette watershed. Protecting and improving the quality of stormwater entering sumps helps protect groundwater, which often returns to local waterways.

PBES owns and operates more than 2,200 miles of pipes and 93 pump stations that transport sewage to two treatment plants and has the responsibility of coordinating the City's actions to reduce stormwater pollution as required for a federal stormwater permit issued by ODEQ. This permit is directed under the federal CWA and is formally titled the Phase I NPDES Municipal Separate Storm Sewer System (MS4) Permit. The only stormwater or sewage structure identified as occurring at the

restoration sites in this study is a sewage pipeline that runs parallel to the Highway 43 Tryon Creek culvert.

4.3.6 Navigation

The Willamette River is navigable 100 miles upstream from its mouth. Navigation facilities in the basin include the Willamette Falls Locks and the Navigation Channel (Portland Harbor) in the lower basin. Farther upstream, the Willamette River carries shallow-draft river traffic. Water stored in reservoirs upstream can be released to maintain navigation depth in the downstream reaches.

4.3.7 Future Without Project Conditions

Continued development in the watershed and operation of dams in the Willamette River Basin will affect hydrology as described above into the future. However, the City and a host of other municipal, regional, state, and tribal agencies, as well as conservation organizations (*e.g.*, Willamette Partnership, The Nature Conservancy) have been working to reduce, restrict, and/or mitigate stormwater and hydrologic effects within the Lower Willamette and greater Willamette and Columbia River watersheds.

The City has prioritized implementation of green stormwater infrastructure (GSI), riparian and aquatic restoration, and CSO control projects in order to address hydrologic and other watershed-health issues. The City's Grey to Green initiative, a 5-year, $55 million program, is aimed at constructing vegetated "ecoroofs" and green streets, acquiring and protecting sensitive natural areas, planting trees and controlling invasive plants, and replacing culverts that block fish passage (PBES 2012b). Within the Tryon Creek watershed there are more than 15 stormwater management projects ongoing (PBES 2012c). While continued dam and reservoir operation within the greater Willamette and Columbia River Basins will ultimately still regulate flows, comprehensive restoration efforts planned and already implemented throughout the river network will help restore some hydrologic processes.

The potential effects of climate change may include sea level rise, which would affect tidal processes within the Columbia and Lower Willamette Rivers. The average sea-level rise prediction based on numerical modeling by the International Panel on Climate Change and adjusted by the Climate Impacts Group range is approximately 11 inches for the northern Oregon/southern Washington Pacific Ocean coasts by the year 2100 (Mote *et al.* 2008).

Water quality conditions and uses will continue to be addressed through federal, state, and local legislation and efforts. Remediation of sediment is expected to continue into the future, resulting in improvements of sediment and water quality over time. Small scale restoration efforts will also add incrementally to the improvement of water quality. Overall, concerted efforts by a wide variety of agencies and local groups will ensure that water quality will remain as is or continue to improve into the future. However, improvements will continue to be slow and may not result in WQI scores that reflect conditions above fair for many years.

4.4 Biological Resources

Four segments of the Lower Willamette River were described in the Willamette River Inventory (Adolfson Associates 2000). Two of those are key to this study, including the North and South Segments. The North Segment begins at the confluence of the Columbia and Willamette Rivers and extends upstream (south) 6 miles to the Saltzman Creek confluence (RMs 0 to 8). The North Segment provides diverse and extensive habitat types as a result of its location at the juncture of two

major river systems (PBES 2006b). Habitat types present in the segment include bottomland forest, scrub/shrub, and grassland. Within this reach, seven areas were identified that provide extensive high quality habitat in the North Segment including: the Willamette River Confluence, Kelley Point Park, Terminal 5 Riparian Forest, South Rivergate Corridor, Harborton Forest and Wetland, Edison Street Forest, and Willamette River-Linnton (Adolfson Associates 2000).

The Willamette River Inventory identified the important wildlife linkages provided by this segment that offer wintering and breeding habitat for waterfowl, shorebirds, and neotropical migrants along the Pacific Flyway. The presence of waterfowl and shorebirds including sandhill cranes (*Grus canadensis*) in this tidally influenced North Segment is unique to the study area. Bottomland forests and wetlands in places like Kelley Point Park, Sauvie Island, and Smith and Bybee Lakes offer wintering and/or breeding habitat for waterfowl, shorebirds, and neotropical migrants. Kelley Point Park and Smith and Bybee Lakes provide critical breeding and nesting habitat for declining populations of neotropical birds. The travel corridors along Columbia Slough are important for dispersion of mammalian species such as deer, coyote, fox, and beaver, as well as reptilian species (Adolfson Associates 2000).

The South Segment extends from the Ross Island Bridge to the Urban Services Boundary south of the Sellwood Bridge (RMs 14 to 16.5). Within the South Segment major habitat areas include Oaks Crossing, the River View Cemetery, Ross Island, and Oaks Bottom complexes. This segment provides one of the largest contiguous stretches of riparian forest in the Lower Willamette watershed, found on the east bank south of the Sellwood Bridge, and also contains a large, off-channel wetland complex at Oaks Bottom. On the right bank, a relatively narrow stretch of riparian forest is found between the ordinary high water (OHW) mark and Highway 43. These sites are frequent stopover and forage sites for many wildlife species (Aldolfson Associates 2000). Along the banks of the river, many large and small holes above the ordinary high water mark indicate the utilization of the shoreline by common river birds and mammals.

General vegetation types in the south and north segments of the study area are shown in Figures 4.5 and 4.6.

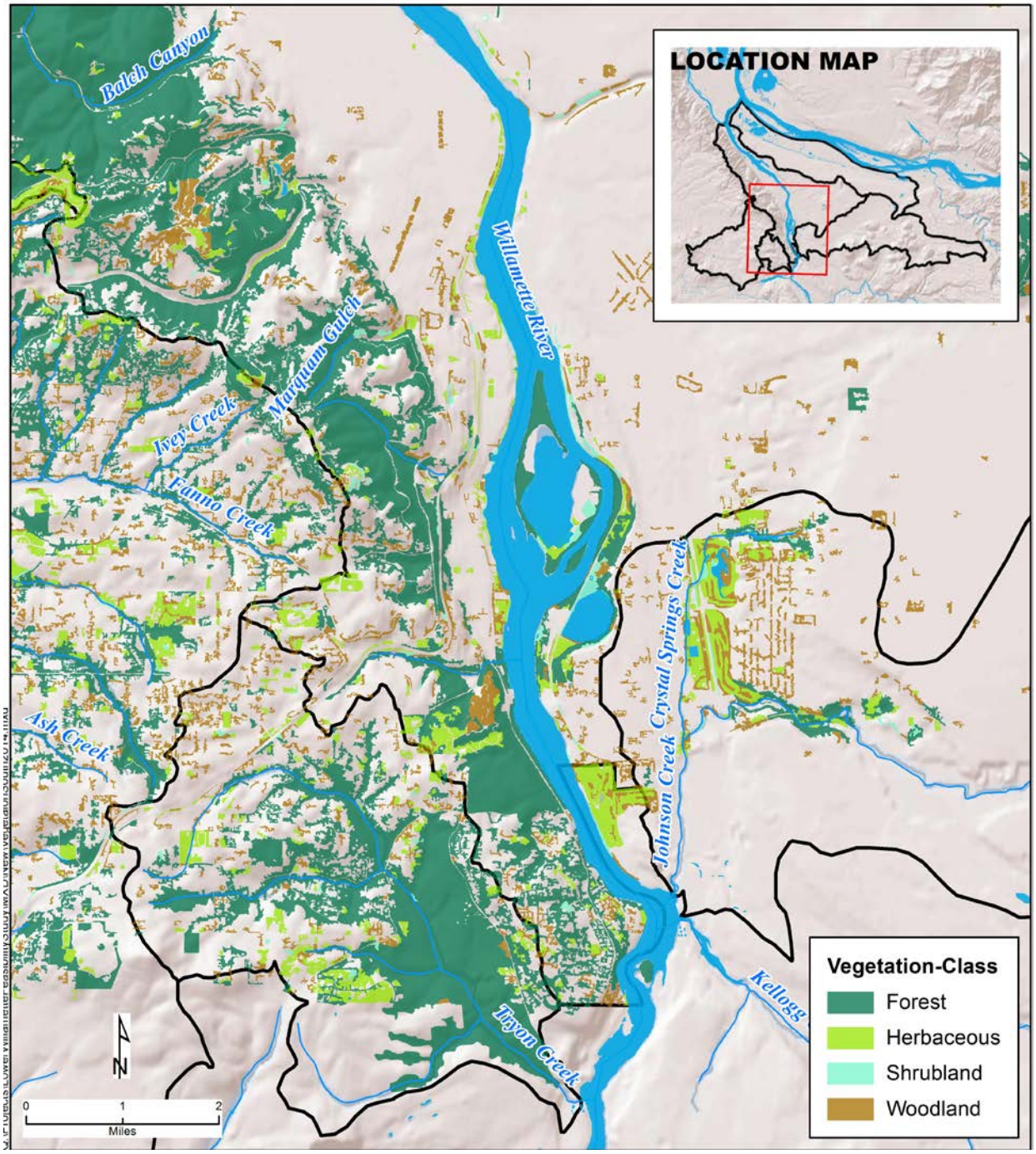

Figure 4.5. Vegetation Types, South Segment of Study Area

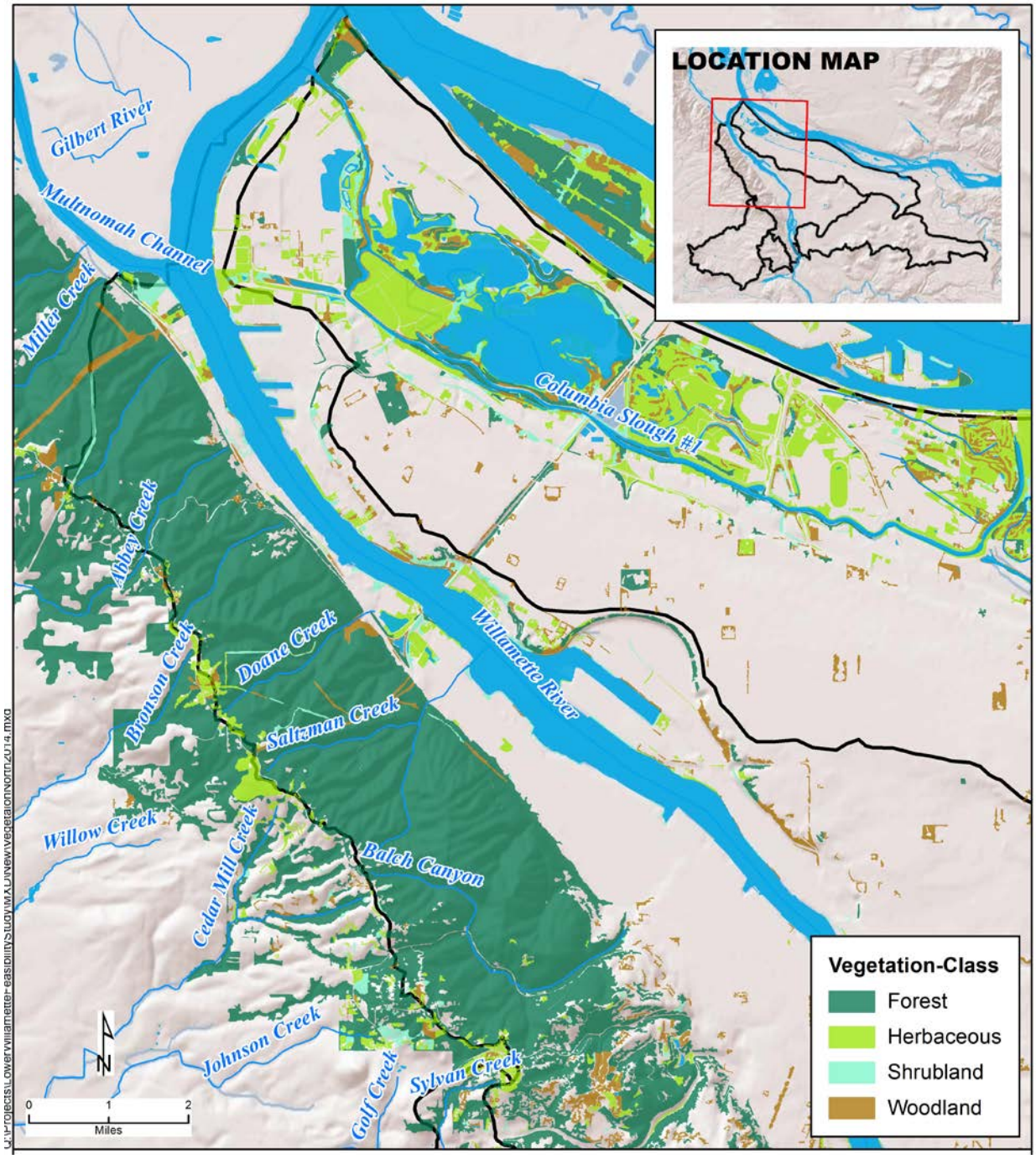

Figure 4.6. Vegetation Types, North Segment of Study Area

4.4.1 Aquatic Habitat

The draft Willamette Subbasin Plan and corresponding analysis identified key limiting factors in the Lower Willamette River subbasin, including a lack of habitat diversity and quantity, and chemical pollutants (NPCC 2004).

Quality habitat for salmonids and other native fish species is limited in the Lower Willamette River. Key habitat types and features such as off-channel habitat, shallow water habitat, channel and bank complexity and large woody debris are insufficient to support the migratory and rearing life stages of the focal species. Spawning habitat for coho and steelhead exists in Tryon Creek and other tributaries to the Lower Willamette, but often times, as in Tryon Creek, access to this habitat is partially blocked by barriers. Rearing habitat is found in Columbia Slough and the mainstem Willamette River. Changed flow regimes and water temperature patterns have altered the availability and quality of off-channel habitat including backwater sloughs, floodplain ponds, and other slow-moving side-channel habitat. Overall, native species that are adapted to a fast moving river of cooler temperatures have declined in the warmer, slower moving river (ODFW 2001, 2002; Farr and Ward 1993).

4.4.2 Wetlands and Riparian Zones

Wetlands exist in all of Portland's watersheds and contribute an invaluable function to the general health of the environment in the area. Wetlands serve important functions including intercepting and storing surface runoff and groundwater, and containing floodwaters. By moderating stream flows, wetlands can reduce bank erosion (City of Portland 2010). They also store and filter sediments, cycle nutrients, decompose organic waste and prevent heavy metals from entering streams. Evaporation from wetlands contributes to maintaining local humidity levels and air and soil temperatures. Forested wetlands contribute large wood to nearby streams offering habitat for wildlife. Wetlands provide food, water, refuge from summer heat, shelter from winter cold, and cover for a variety of wildlife including juvenile salmon amongst other species (City of Portland 2010).

Formal importance has been put on wetlands in and around Portland. The City has established policies that recognize the importance of wetlands in its Comprehensive Plan and in the Portland Watershed Management Plan (PBES 2006) and has established zoning to protect wetlands. The Willamette Subbasin Plan identifies focal habitats in the Willamette Basin. Focal habitats are land cover or vegetation classes that are considered to be the most important in the basin because of their scarcity, rate of decline from their historical extent, exceptional wildlife or plant diversity, and/or consistent use by a relatively large number of plant and wildlife species that are threatened, endangered, sensitive, or declining in the basin. The following focal habitats are or historically were present in the project area: perennial ponds and their riparian areas; and riparian areas of rivers and streams.

Perennial Ponds and Riparian Areas This habitat type includes all lentic (non-flowing) areas that are inundated year-round, extending spatially to include riparian and floodplain areas that are inundated seasonally by other lentic water bodies or by rivers. It includes natural ponds, sloughs, lakes, and perennially-inundated marshes, as well as lakes, regulated reservoirs, irrigation ponds, log ponds, beaver-created ponds, and other human-created ponds. This habitat type also includes riparian vegetation (woody or herbaceous) (NPCC 2004).

Ponds and most other lentic waters have not been accorded a priority for protection and restoration in ecological assessments for the Willamette Basin. This may be due to their relative abundance, lack of evidence of major decline from historical extent, apparent absence of any endemic species,

and lack of ecological survey effort. Nevertheless, ponds and their riparian areas provide a remarkable contribution to regional biodiversity (NPCC 2004).

Ponds, lakes, sloughs, and other lentic waters of the Willamette Basin have been ecologically degraded to varying degrees. Exotic species of fish (especially bass, carp) and wildlife (bullfrog, nutria) are believed to be at least partly responsible for decline of some native species (e.g., Oregon spotted frog). Some of the ponds also have become degraded by invasive aquatic weeds (NPCC 2004).

Riparian Areas of Rivers and Streams This habitat type includes all lotic (flowing water) areas and their adjoining riparian areas, as well as natural and artificial channels (rivers, streams, and ditches; NPCC 2004). The importance of perennial streams, rivers, and riparian areas for aquatic animals (notably salmon and trout) are widely recognized by laws, policies, and science for the Willamette Basin (NPCC 2004). Less often noted is the importance of this habitat type for wildlife.

As a result of river regulation and land development, major changes in wildlife habitat have occurred within the channels and riparian zones of many of the basin's rivers and streams. In addition, although there has been considerable success in protecting and restoring riparian areas on public lands (e.g., the Willamette River Greenway), riparian protection on private lands not under active forest management has been limited (NPCC 2004).

Wetland locations in the study area were compiled and mapped primarily from National Wetlands Inventory (NWI) Geographic Information System (GIS) data (USFWS 2011) and also from the City (City of Portland 2010) and Metro (Metro 2004, Metro 2009) GIS data. Tetra Tech staff verified wetland conditions at reconnaissance site visits between 2009 and 2011. Figure 4.7 displays wetland areas mapped by NWI.

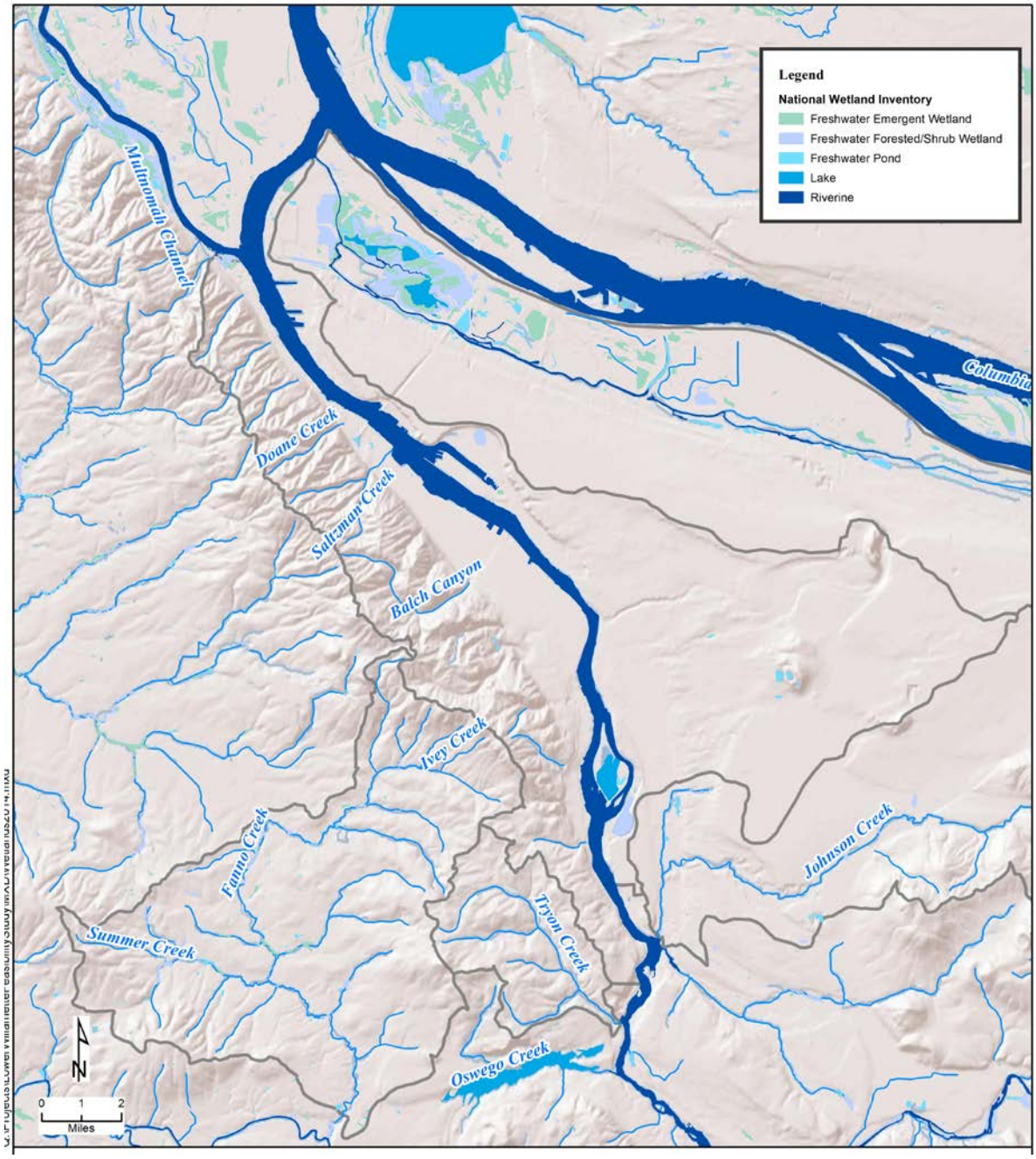

Figure 4.7. NWI Wetlands and Other Waters in the Study Area

The mainstem Willamette River hosts a diversity of habitats including various wetlands. A freshwater forested/shrub wetland has been mapped near the confluence of the Willamette River and Columbia Slough. Although no other wetland has been mapped in the northern part of this reach, two riverine aquatic habitats are present. These include riverine tidal unconsolidated shore regularly flooded and riverine tidal unconsolidated shore seasonal tidal. Both likely host fringe riparian wetlands. Freshwater emergent wetlands, freshwater forested/shrub wetland, and riverine habitat are mapped in the south end of the mainstem Willamette reach.

No wetlands have been mapped on Tryon Creek. However, NWI maps would generally not identify wetlands in an area such as Tryon Creek that is covered by a riparian canopy, so these data are inconclusive. Reconnaissance-level surveys have identified areas that have strong wetland indicators at this site, including fringing fresh emergent wetlands and riparian wetlands.

Freshwater emergent wetlands and freshwater forested/shrub wetlands are found along Columbia Slough. Most soils in the area are hydric. Although not a designated wetland, Columbia Slough is mapped as a riverine system and fringing wetland has been observed along its shores.

4.4.3 Terrestrial Habitat

Terrestrial habitat in the study area has been extensively modified from its historical condition and distribution. Historically, dense riparian gallery forests lined the Willamette River and its tributaries with associations of Douglas-fir, Oregon ash, black cottonwood, alder, bigleaf maple, western red cedar, and willows. Dense patches of Douglas-fir forest and oak forest were locally found in ravines, on hillslopes, and on the floodplain (Hulse *et al.* 2002). On average, these forests ranged from one to two miles wide throughout the basin, except for areas where the floodplain of the Lower Willamette River was confined by steep hills. Today, approximately 20 percent of the area occupied by riparian vegetation remains, and much of it is only one to two tree lengths in width. According to the Willamette Subbasin Plan (NPCC 2004), the loss of habitat has been and continues to be among the most important factors that limit terrestrial wildlife populations in the Willamette River Basin. Fragmentation and of terrestrial habitat and human disturbance are also common in the study area, and contribute to the degradation of ecosystem quality.

4.4.4 Fish

A diverse assemblage of fish utilizes the habitats within the Lower Willamette River. These species include anadromous or resident and native or non-native species (Figure 4.8). ODFW and the City conducted a 4-year study of fish species in the Lower Willamette River (PBES 2006). In the first 2 years of the study, 37 native fish species were found from 15 families, along with 17 introduced species from 7 families (ODFW 2001, 2002). The list of species is provided in Table 4.4.

Table 4.4. Fish Species of the lower Willamette River

FAMILY	SPECIES	COMMON NAME	NATIVE
Petromyzontidae	*Lampetra tridentata*	Pacific lamprey	Native
	Lamptra ayresi	River lamprey	Native
	Lampetra pacifica	Pacific brook lamprey	Native
	Lampetra richardsoni	Western brook lamprey	Native
Acipenseridae	*Acipenser transmontanus*	white sturgeon	Native
	Acipenser medirostris	green sturgeon	Native
Clupeidae	*Alosa sapidissima*	American shad	Non-native
Salmonidae	*Oncorhynchus tshawytscha*	chinook salmon	Native
	Oncorhynchus kisutch	coho salmon	Native
	Oncorhynchus nerka	sockeye salmon	Native
	Oncorhynchus mykiss	steelhead, rainbow trout	Native
	Oncorhynchus clarki	cutthroat trout	Native
	Prosopium williamsoni	mountain whitefish	Native
Cyprinidae	*Ptychocheilus oregonensis*	northern pikeminnow	Native
	Mylocheilus caurinus	peamouth	Native
	Acrocheilus alutaceus	chiselmouth	Native
	Cyprinus carpio	common carp	Non-native
	Ctenopharyngodon idella	grass carp	Non-native
	Carassius auratus	goldfish	Non-native
	Richardsonius balteatus	redside shiner	Native
	Rhinichthys cataractae	longnose dace	Native
	Rhinichthys osculus	speckled dace	Native
Osmeridae	*Thaleichthys pacificus*	Eulachon	Native
Catostomidae	*Catostomus macrocheilus*	largescale sucker	Native
	Catostomus commersoni	bridgelip sucker	Native
	Catostomus platyrhynchus	mountain sucker	Native
Ictaluridae	*Ameiurus natalis*	yellow bullhead	Non-native
	Ameiurus nebulosus	brown bullhead	Non-native
	Ictalurus punctatus	channel catfish	Non-native
Gasterosteidae	*Gasterosteus aculeatus*	threespine stickleback	Native
Percopsidae	*Percopsis transmontana*	sand roller	Native
Poeciliidae	*Gambusia affinis*	western mosquitofish	Non-native
Cyprinodontidae	*Fundulus diaphanus*	banded killifish	Non-native
Centrarchidae	*Pomoxis annularis*	white crappie	Non-native
	Pomoxis nigromaculatus	black crappie	Non-native
	Micropterus dolomieu	smallmouth bass	Non-native
	Micropterus salmoides	largemouth bass	Non-native
	Lepomis macrochirus	bluegill	Non-native
	Lepomis gibbosus	pumpkinseed	Non-native
	Lepomis gulosus	warmouth	Non-native
Percidae	*Stizostedion vitreum*	walleye	Non-native
	Perca flavescens	yellow perch	Non-native
Cottidae	*Cottus asper*	prickly sculpin	Native
	Cottus bairdi	Mottled sculpin	Native
	Cottus beldingi	Paiute sculpin	Native
	Cottus confuscus	Shorthead sculpin	Native
	Cottus gulosus	Riffle sculpin	Native
	Cottus perplexus	Reticulate sculpin	Native
	Cottus rhotheus	Torrent sculpin	Native
Plueuronectidae	*Platichthys stellatus*	starry flounder	Native
ODFW 2001, 2002, Farr and Ward 1993			

Several fish passage barriers are present in the study area. Access to the middle and upper Columbia Slough is prevented by the Multnomah County Drainage District dike and pumping system. It is not known whether fish historically could access this portion of the slough during non-flood periods, since the historic channel configuration of the slough is unknown (PBES 2006). A fish ladder installed at Willamette Falls allows fish that move through the Lower Willamette to pass upstream of the falls, allowing introduced salmon stocks to enter the upper basin. Historically, only spring Chinook and winter steelhead could naturally pass the falls.

Culverts on Tryon Creek at (from downstream to upstream) Highway 43, Boones Ferry Road, and on its tributary, Arnold Creek, partially or completely block fish passage into the upper reaches of these streams. The most extensive of these obstructions is the Highway 43 culvert on Tryon Creek, which was classified in 2005 as a high priority for fish passage improvements by the Oregon Department of Transportation (ODOT). Subsequently, this culvert has been retrofitted with baffles intended to improve fish passage and a roughened chute was designed and installed downstream of the culvert outfall to create a backwater into the lower entrance of the culvert and eliminate an entrance jump barrier. Ongoing USFWS initiated field surveys have found adult lamprey and fish only below the culvert, and juvenile fish above the culvert, but also did so prior to culvert reconstruction (USFWS 2012).

Reduction of native fish populations has resulted in the listings of many Lower Willamette River fish species under the ESA. A total of 15 fish evolutionarily significant unit's (ESU) composed of seven different species may use or migrate through watercourses in the study area (Figure 4.8).

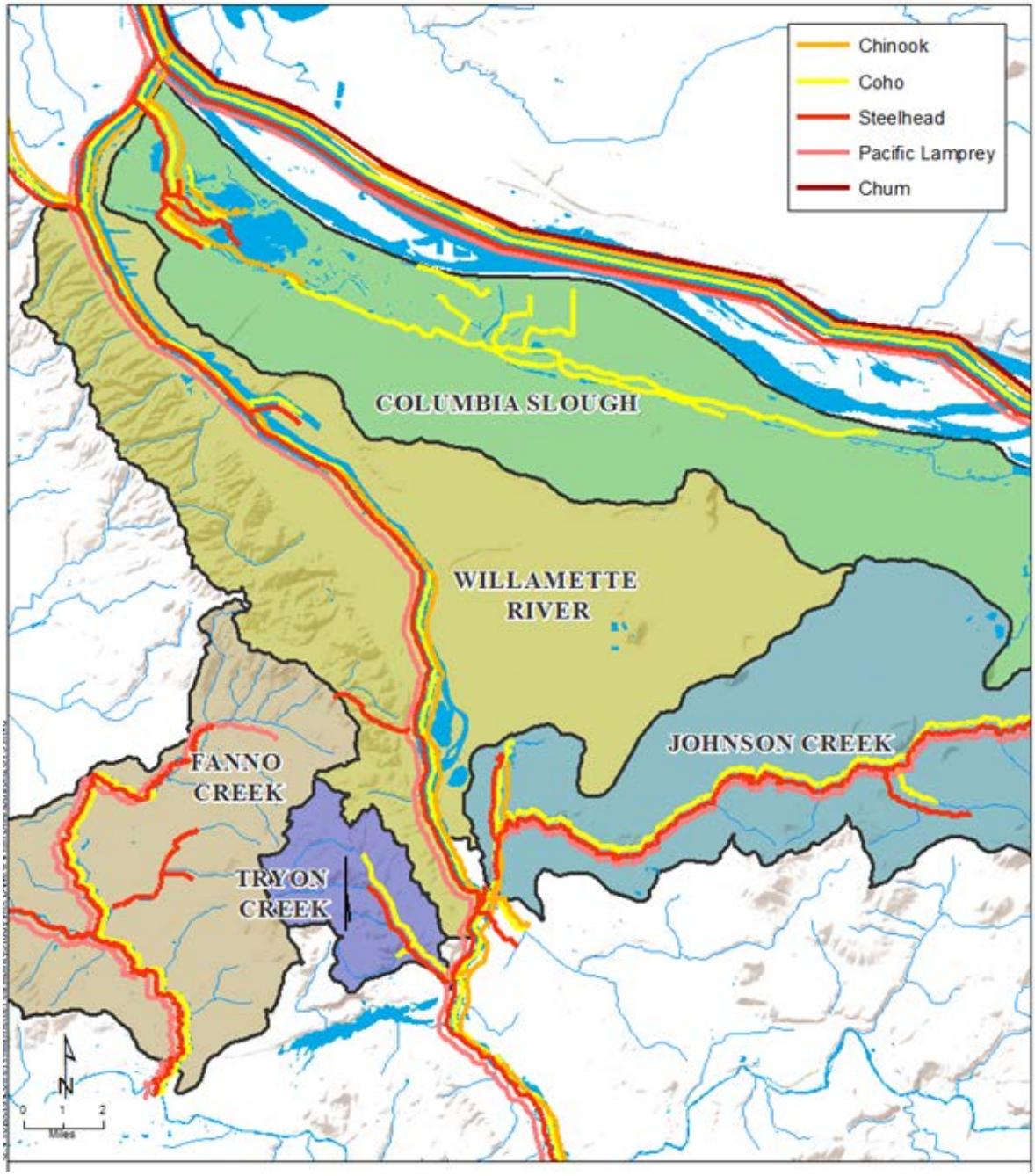

Figure 4.8. Anadromous species distribution in the Study Area.

4.4.5 Wildlife

The Lower Willamette River floodplain once had a rich variety of terrestrial animal and plant species due to its extensive wetlands, riparian forests, and upland transition zones. It is estimated that approximately 18 species of amphibians, 15 reptile species, 154 bird species, and 69 mammal species are native to the basin (Hulse *et al.* 2002). A number of species have sharply declined, including over 60 percent of amphibian species, and are now the focus of conservation concerns. The area suffering the greatest divergence from native conditions is likely the urban environment of the City of Portland. Some typical species in the area include mammals such as raccoon (*Procyon*

lotor), coyote (*Canis latrans*), striped skunk (*Mephitis mephitis*), river otter (*Lontra canadensis*), North American beaver (*Castor canadensis*), and moles (Talpidae); birds including American crow (*Corvus brachyrhynchos*), western scrub-jay (*Aphelocoma californica*), black-capped chickadee (*Poecile atricapillus*), dark-eyed junco (*Junco hyemalis*), red-tailed hawk (*Buteo jamaicensis*), Cooper's and sharp-shinned hawk (Accipitridae), osprey (*Pandion haliaetus*), and Canada goose (*Branta canadensis*); and amphibians and reptiles including pacific tree frog (*Pseudacris regilla*), rough-skin newt (*Taricha granulosa*), and common garter snake (*Thamnophis sirtalis*). Several terrestrial wildlife species currently residing in the Willamette Basin are non-native. It has been estimated that approximately 17 non-native wildlife species have been introduced (Hulse *et al.* 2000) and include wild turkey (*Meleagris gallopavo*), ring-necked pheasant (*Phasianus colchicus*), European starling (*Sturnus vulgaris*), house sparrow (*Passer domesticus*), eastern gray squirrel (*Sciurus carolinensis*), nutria (*Myocastor coypus*), and bullfrogs (*Rana catesbeiana*) (Hulse, *et al.* 2000; Willamette Partnership 2004).

The Willamette River Inventory (Adolfson Associates 2000) summarizes the most recent detailed description of the wildlife and wildlife habitat throughout the study area. Wildlife observations through the study area between summer 1999 and January 2000 documented birds, reptiles, amphibians, and mammals, which are listed in Table 4.5, below.

Table 4.5. Species Likely to be Present in the Study Area

American Bittern	House Sparrow	Western Tanager
American Crow	House Wren	Western Wood-Pewee
American Goldfinch	Hutton's Vireo	White-breasted Nuthatch
American Kestrel	Lesser Goldfinch	White-crowned Sparrow
American Robin	Lincoln's Sparrow	White-tailed Kite
Bank Swallow	MacGillivray's Warbler	Widgeon
Barn Swallow	Mallard	Wilson's Warbler
Belted Kingfisher	Merlin	Winter Wren
Bewick's Wren	Mourning Dove	Yellow Warbler
Black-capped Chickadee	Nashville Warbler	Yellow-rumped Warbler
Black-headed Grosbeak	Northern Flicker	
Black-throated Grey Warbler	Northern Harrier	
Brown Creeper	Orange-crowned Warbler	
Bufflehead	Osprey	Bats
Bullock's Oriole	Owls	Beaver
Bushtit	Pacific-slope Flycatcher	Coyote
Canada goose	Pine Siskin	Deer
Chipping Sparrow	Purple Finch	Field Mice
Common Merganser	Red-eyed Vireo	Fox
Cormorants	Red Crossbill	Mink
Dark-eyed Junco	Red-breasted Sapsucker	Nutria
Double-crested Cormorant	Red-tailed Hawk	Pocket Gopher
Douglas' Squirrel	Rock Dove	Raccoon
Downy Woodpecker	Rufous-Sided Towhee	River Otter
Dunlin	Sandhill Crane	Squirrel
Dusky Flycatcher	Sharp-shinned Hawk	Woodrat
Fox Sparrow	Short-eared Owl	
Gadwall	Song Sparrow	

Golden-crowned Kinglet	Starling	
Golden-crowned Sparrow	Swainson's Thrush	
Great Blue Heron	Townsend's Solitaire	Bull Frog (nonnative)
Hammond's Flycatcher	Townsend's Warbler	Common Garter Snake
Hermit Thrush	Varied Thrush	Long Toed Salamander
Hermit Warbler	Vaux's Swift	Northwestern Garter Snake
Herring Gull	Warblers	Pacific Chorus (Tree) Frog
Hooded Merganser	Warbling Vireo	Red-legged Frog
Hoary Bat	Western Scrub-jay	Western Red-backed Salamander

4.4.6 Listed and Sensitive Species

ESA-listed species that are known to occur in the project area include the fish species described below (Table 4.6). Although there are no listed plants, amphibians, reptiles, birds, or mammals known to occur or that have the potential to occur in the study area, otherwise sensitive species that may occur are listed in Table 4.7 (ODA 2010, ODFW 2010, USFWS 2010). Summary details of each of the listed fish species as well as other sensitive species that may occur in the project area are provided below.

Table 4.6. ESA Status of Key Fish Species Found in the Study Area

Species	**Scientific Name**	**Evolutionarily Significant Unit**	**ESA Listing Status**
Chinook salmon	*Oncorhynchus tshawytscha*	Lower Columbia	Threatened
		Upper Columbia Spring-run	Endangered
		Upper Willamette	Threatened
		Snake Spring/ Summer-run	Threatened
		Snake Fall-run	Threatened
Chum salmon	*Oncorhynchus keta*	Columbia	Threatened
Coho salmon	*Oncorhynchus kisutch*	Lower Columbia / Southwest Washington	Threatened
Sockeye	*Oncorhynchus nerka*	Snake	Endangered
Steelhead	*Oncorhynchus mykiss*	Lower Columbia	Threatened
		Middle Columbia	Threatened
		Upper Columbia	Threatened
		Upper Willamette	Threatened
		Snake	Threatened
Bull trout	*Salvelinus confluentus*	Willamette Recovery Unit	Threatened
North American green sturgeon	*Acipenser medirostris*	Southern Distinct Population Segment	Threatened
Pacific lamprey	*Lampetra tridentate*	NA	Species of Concern
Coastal cutthroat trout	*Oncorhynchus clarkii clarkii*	NA	Species of Concern
NOAA 2011, PBES 2006			

4.4.7 ESA Listed Fish Species

Lower Columbia River Coho Salmon ESU (*Oncorhynchus kisutch*) The Lower Columbia coho salmon ESU was listed as threatened on June 28, 2005 (70 FR 37160); critical habitat is currently under development for this species. The ESU includes all naturally spawned populations of coho salmon in the Columbia River and its tributaries in Washington and Oregon, from the mouth of the Columbia up to and including the Big White Salmon and Hood Rivers, the Willamette River to Willamette Falls, Oregon, as well as 25 artificial propagation programs (NOAA 2005).

Lower Columbia River Chinook Salmon ESU (*Oncorhynchus tshawytscha*) and Upper Willamette River Chinook Salmon ESU (*Oncorhynchus tshawytscha*) Both the Lower Columbia River Chinook salmon ESU and Upper Willamette River Chinook salmon ESU were listed as threatened on March 24, 1999 (64 FR 14329) with the threatened status reaffirmed on June 28, 2005 (70 FR 37160); critical habitat for these ESUs was designated on September 2, 2005 (70 FR 542488). The Lower Columbia River Chinook ESU includes all naturally spawned populations of Chinook salmon from the Columbia River and its tributaries from its mouth at the Pacific Ocean upstream to a transitional point between Washington and Oregon east of the Hood River and the White Salmon River, and includes the Willamette River to Willamette Falls, Oregon, exclusive of spring-run Chinook salmon in the Clackamas River (64 FR 14208) (NOAA 2005). The Upper Willamette River Chinook salmon ESU includes all naturally spawned populations of spring-run Chinook salmon in the Clackamas River and in the Willamette River and its tributaries above Willamette Falls, Oregon, as well as seven artificial propagation programs (64 FR 14208) (NOAA 2005).

Upper Willamette River steelhead ESU (*Oncorhynchus mykiss*) and Lower Columbia River steelhead ESU (*Oncorhynchus mykiss*) The Upper Willamette River steelhead ESU and Lower Columbia River steelhead ESU were listed as a threatened species on March 19, 1998 (50 C.F.R. Part 227) and the threatened status was reaffirmed on January 5, 2006; critical habitat for these ESUs was designated on September 2, 2005 (70 FR 542488). The Upper Willamette River steelhead ESU includes all naturally spawned populations of winter-run steelhead in the Willamette River, Oregon, and its tributaries upstream from Willamette Falls to the Calapooia River, inclusive. The Lower Columbia River steelhead ESU includes all naturally spawned populations of steelhead (and their progeny) in streams and tributaries to the Columbia River between the Cowlitz and Wind Rivers, Washington, inclusive, and the Willamette and Hood Rivers, Oregon, inclusive. Excluded are steelhead in the Upper Willamette River Basin above Willamette Falls, Oregon, and from the Little and Big White Salmon Rivers, Washington (NOAA 2005).

Bull Trout Willamette River Recovery Unit (*Salvelinus confluentus*) The Klamath River and Columbia River segments of the bull trout population were listed as a threatened species on June 10, 1998 (63 FR 31647) and the entire co-terminus U.S. population of bull trout was confirmed as threatened on November 1, 1999 (64 FR 58910). Critical habitat was designated on October 6, 2004 (69 FR 59996) and revised on October 18, 2010 (75 FR 63898). Critical habitat includes the mainstem Columbia River and Columbia Slough in the action area. The historic bull trout range extended throughout the Columbia River Basin, east to western Montana, south to the Jarbidge River in Nevada, the Klamath Basin in Oregon, and the McCloud River in California, and north to Alberta, British Columbia and possibly southeastern Alaska. The main populations existing in the lower 48 states today are in Montana, Idaho, Oregon, and Washington. Bull trout were historically present in the Willamette River and its tributaries, including the Middle Fork Willamette, McKenzie River, Santiam River, and Clackamas River (USFWS 1998).

Southern DPS of North American Green Sturgeon (*Acipenser medirostris*) The southern Distinct Population Segment (DPS) of North American green sturgeon was listed as threatened on October 9, 2009 (50 C.F.R. 223); critical habitat has been designated for this species (50 C.F.R. 226). The

DPS includes all coastal U.S. marine waters within 60 fathoms depth from Monterey Bay, California (including Monterey Bay), north to Cape Flattery, Washington, including the Strait of Juan de Fuca, Washington, to its United States boundary; the Sacramento River, lower Feather River, and lower Yuba River in California; the Sacramento-San Joaquin Delta and Suisun, San Pablo, and San Francisco bays in California; the lower Columbia River estuary (to upstream to Bonneville Dam); and certain coastal bays and estuaries in California (Humboldt Bay), Oregon (Coos Bay, Winchester Bay, Yaquina Bay, and Nehalem Bay), and Washington (Willapa Bay and Grays Harbor) (NOAA 2006).

4.4.8 Other Sensitive Species

Table 4.7 displays other sensitive species that may occur in the project area. ESA-listed species identified below are considered unlikely to occur in the study area, and were not considered further in the Biological Assessment prepared for this project (Appendix C).

Table 4.7. Other Sensitive Species That May Occur in the Study Area

Species	Federal Status	State Status
Birds		
Bald eagle (*Haliaeetus leucocephalus*)	Fully Protected, De-listed	Threatened
Band-tailed pigeon (*Patagioenas fasciata*)	Species of Concern	N/A
Northern goshawk (*Accipiter gentilis*)	Species of Concern	N/A
Olive-sided flycatcher (*Contopus cooperi*)	Species of Concern	N/A
Oregon vesper sparrow (*Pooecestes gramineus affinis*)	Species of Concern	N/A
Purple martin (*Progne subis*)	Species of Concern	N/A
Streaked horned lark *(Eremophila alpestris strigata)*	Threatened	N/A
Tricolored blackbird (*Agelaius tricolor*)	Species of Concern	Species of Concern
Yellow-billed cuckoo (*Coccyzus americanus occidentalis*)	Threatened	N/A
Yellow-breasted chat (*Icteria virens*)	Species of Concern	N/A
Mammals		
Camas pocket gopher (*Thomomys bulbivorus*)	Species of Concern	N/A
Columbian white-tailed deer (*Odocoileus virginianus leucurus*)	Endangered	Endangered
Fringed myotis (*Myotis thysanodes*)	Species of Concern	N/A
Long-eared myotis (*Myotis evotis*)	Species of Concern	N/A
Long-legged myotis (*Myotis volans*)	Species of Concern	N/A
Pacific western big-eared bat (*Corynorhinus townsendii*) (AKA Townsend's big-eared bat)	Species of Concern	N/A
Yuma myotis (*Myotis yumanensis*)	Species of Concern	N/A
Reptiles and Amphibians		
Coastal tailed frog (*Ascaphus truei*)	Species of Concern	N/A
Northern red-legged frog (*Rana aurora*)	Species of Concern	N/A
Northwestern pond turtle (*Actinemys marmorata marmorata*)	Species of Concern	N/A
Invertebrates		
California floater mussel (*Anodonta californiensis*)	Species of Concern	N/A
Columbia Gorge neothremman caddisfly (*Neothremma andersoni*)	Species of Concern	N/A
Columbia pebblesnail (spire snail) (*Fluminicola fuscus / F. columbianus*)	Species of Concern	N/A
Oregon giant earthworm (*Driloleirus macelfreshi*)	Species of Concern	N/A
Plants		
Cold-water corydalis (*Corydalis aquae-gelidae*)	Species of Concern	N/A

Howell's bentgrass (*Agrostis howellii*)	Species of Concern	N/A
Nelson's checker-mallow (*Sidalcea nelsoniana*)	Threatened	N/A
Oregon fleabane (*Erigeron oreganus*)	Species of Concern	N/A
Pale larkspur (*Delphinium leucophaeum*)	Species of Concern	N/A
Peacock larkspur (*Delphinium pavonaceum*)	Species of Concern	Endangered
Thin-leaved peavine (*Lathyrus holochlorus*)	Species of Concern	N/A
Water howellia (*Howellia aquatilis*)	Threatened	N/A
Whitetop aster (*Sericocarpus rigidus*)	Species of Concern	N/A
Willamette Valley larkspur (*Delphinium oreganum*)	Species of Concern	N/A

4.4.9 Future Without Project Conditions

In the future without-project condition, it is likely that habitat restoration actions by a variety of agencies and groups would continue to occur. The USACE will continue to be required to implement a number of restoration actions associated with compliance with the 2008 Biological Opinions (NOAA 2008, USFWS 2008), and the City will play a key role in establishing priorities on the Lower Willamette. However, the schedules for these actions have become protracted, making it unclear when and if they will be initiated. The Oregon Watershed Enhancement Board would continue to provide funding and technical assistance for watershed and stream restoration projects in the study area.

Additional factors will continue to degrade habitats, such as continued growth and development, likely continued armoring of river and tributary channels to protect residences and infrastructure, and climate change. Even though the USACE will take actions to improve habitats as required for compliance with the 2008 Biological Opinions (NOAA 2008; USFWS 2008), these actions will primarily be focused on actions that compensate for adverse effects from dam operations. Without this separate ecosystem restoration study, more comprehensive actions to restore floodplains are not likely to occur. On balance, it is likely that the future without-project condition will slightly improve localized areas, but not likely to the level required to recover fish and wildlife species. The *Willamette River Basin Planning Atlas* (Hulse *et al.* 2002) scenarios predict that aquatic habitat quality and quantity will stay about the same, or improve somewhat (20 to 60 percent) depending on whether a development-oriented or conservation-oriented future scenario occurs.

Thus, the key assumptions that are made in this study regarding the likely future condition of habitat conditions is that trees and shrubs in the riparian zone and floodplain will continue to mature and get larger, but non-native invasive species will continue to expand their range, density, and size. Large wood recruitment into the river will continue to be limited compared to natural conditions as a result of land clearing and development and native trees will be unable to recruit into areas dominated by non-native species. In areas where localized restoration occurs, these areas will contribute large wood to the rivers within the 50-year period of analysis, but this is expected to be much less than would occur with more extensive floodplain and riparian restoration.

4.5 Cultural Resources

A comprehensive analysis of the cultural resources of the Lower Willamette River was conducted as part of the CERCLA work for the Portland Harbor Superfund Site. The following is summary of the history of the area based on information in the *Cultural Resource Analysis Report for the Portland Harbor Superfund Site, Portland, Oregon* (Ellis *et al.* 2005).

In North America, the Paleo-Indian stage represents the earliest known settlement of humans in the New World. Artifacts associated with the Paleo-Indian stage have been found in the Willamette

Valley, but no evidence of their presence has been found in the Portland Basin. Data suggest that the first human groups in the area were small, mobile bands of hunter-gatherers about 9,000 to 10,000 years ago, corresponding to the Archaic stage. Rectangular houses in the Portland Basin date back to about 2,000 years ago. This is believed by some researchers to be evidence of sedentary villages and the development of the Formative stage. The period following the Archaic stage is the Pacific period, which recognizes the change to a complex hunter-gatherer society with permanent villages, social hierarchies and status differences, and extensive networks of kinship and exchange between communities. The people shifted from being more foragers (not storing food and being opportunistic) to being collectors. The Pacific period ranges from 4400 BC to 1775 AD.

A number of archaeological sites in the Portland Basin have been identified and the artifacts radiocarbon-dated. The oldest of these sites are all along the Columbia River floodplain near the mouth of the Willamette River, with the oldest being 3,510 years before present. A fairly extensive record of the past 2,000 years exists with the identification of a number of sites. Information on the past 1,500 years is well represented with evidence of villages on the banks of the Columbia and Clackamas Rivers, and along the major drainages of the Columbia River floodplain.

The Lower Willamette River lies within the traditional homeland of the Chinookan people, while most of the Willamette Valley upstream of the falls was the homeland of Kalapuyan groups. The Chinookans occupied the Columbia River Valley from the Pacific Ocean up to The Dalles. Two groups occupied the Portland area, the Multnomah and the Clackamas. Multnomah villages were concentrated on Sauvie Island, along the Multnomah Channel, and along the northern bank of the Columbia River downstream of the mouth of the Willamette River. The Clackamas were found primarily along the Clackamas River, at Willamette Falls, and along the Lower Willamette River. Some evidence suggests both groups occupied the areas around the mouth of the Willamette River and the southern shore of the Columbia River between the Willamette and Sandy Rivers. At the time of Lewis and Clark, native populations in the Portland Basin were estimated to be about 3,400, with seasonal fluctuations to just over 8,000. During the 19th century, disease spread throughout all of the Pacific Northwest native populations.

In the middle part of the 19th century, the Willamette Valley's fertile soils, pleasant climate, and abundant water attracted thousands of settlers from the eastern United States, mainly the borderlands of Missouri, Iowa, and the Ohio Valley. Many of these emigrants followed the Oregon Trail, a 2,170-mile trek across western North America that began at Independence, Missouri, and ended at various locations near the mouth of the Willamette River. Subsequently, settlers were increasingly encroaching on Native American lands in the Willamette Valley. Skirmishes between natives and settlers resulted in the Oregon state government removing the natives by military force.

In the early 1840s, Oregon City began to grow and in 1848, became the first capital of the Oregon Territory. Oregon City prospered because of the paper mills that were run by the water power of the Willamette Falls. Beginning in the 1850s, steamboats began to ply the Willamette, but Willamette Falls formed an almost impassable barrier to river navigation. In 1873, the construction of the Willamette Falls Locks bypassed the falls and allowed easy navigation between the upper and lower river. The capital was moved to Salem in 1852.

The original claim for Portland was filed in 1844 and the first 16 blocks were surveyed in 1845. After Portland was incorporated in 1851, it quickly grew into Oregon's largest city. The low areas and sloughs on the east side of the river were filled as the city grew, especially after the consolidation of East Portland and Albina into Portland in 1891. Portions of Mocks Bottom and Swan Island were filled to facilitate industrialization of these areas. The east bank of the Willamette moved westward, and the river channel narrowed through downtown. Swan Island was once a real

island that separated two channels of the Willamette River. Prior to 1920, the eastern, deeper Swan Channel was the river's main channel. The current channel on the west side of the island was wide and shallow. A massive dredging project shifted the river channel and filled the causeway that now connects Swan Island to North Portland (Ellis *et al.* 2005).

4.5.1 Future Without Project Conditions

Appropriate cultural resource protective measures, to be determined, will be developed prior to project implementation. These measures, including avoidance, establishment of buffer areas and/or mitigation, will be designed in consultation with SHPO, affected Tribes and property owners, to ensure that existing cultural resources are preserved to the extent possible. Federal, state, and local laws require identification, analysis, protection where possible, and full documentation of important cultural resources where disturbances are unavoidable. These efforts will be designed to help minimize impacts to archaeological and historic resources, identify important historic properties and ensure their protection into the future.

4.6 **Land Use and Zoning**

4.6.1 Land Use

Land use and zoning categories are found in Portland's Comprehensive Plan (PBPS 1980, with revisions through 2011). Only categories that occur in the study area are described in the following paragraphs.

Open Space This category includes parks, greenways, and undeveloped areas. These areas are generally accessible for public uses.

Commercial This land use category identifies activities associated with retail trade and services for the general public, offices, and lodging.

Industrial (General and Heavy) This category identifies activities associated with repair or service related to machinery, equipment, products, or by-products. Waterfront examples identified in the inventoried area include ship repair, barge services, and dredge facilities.

Residential This category identifies activities associated with household and group living facilities where tenancy is arranged on a month-to-month or longer basis, including houseboats.

Institutional This category identifies activities associated with community services (typically by public or non-profit providers), including schools, colleges, medical centers, parks and open spaces, and religious institutions.

4.6.2 Zoning

Zoning is the legal designation placed on the land that determines what types of land uses can be developed on specific pieces of property. Zoning designations by Portland and other jurisdictions within Metro are to be consistent with the Urban Growth Boundary (UGB) (Figure 4.9). Zoning designations for the affected reaches of the Lower Willamette River and Columbia Slough are described as follows:

The North Zoning Reach is primarily zoned for heavy industrial land uses in the immediate river corridor with the exception of Kelley Point Park. Just outside of the immediate river corridor, zoning is primarily for open space on the west bank with pockets of residential zoning, and transitions from industrial to residential zoning toward the south end of the east bank.

The South Zoning Reach exhibits more diversity in zoning than in the downstream reaches. Lands adjacent to the river's west bank are zoned for commercial, medium density residential, single-family residential and open space. Zoning designations for lands adjacent to the river's east bank include commercial, industrial, residential, and open space land uses. Lands designated as open space within this reach include Sellwood Riverfront Park, Oaks Bottom Wildlife Refuge, and Ross Island.

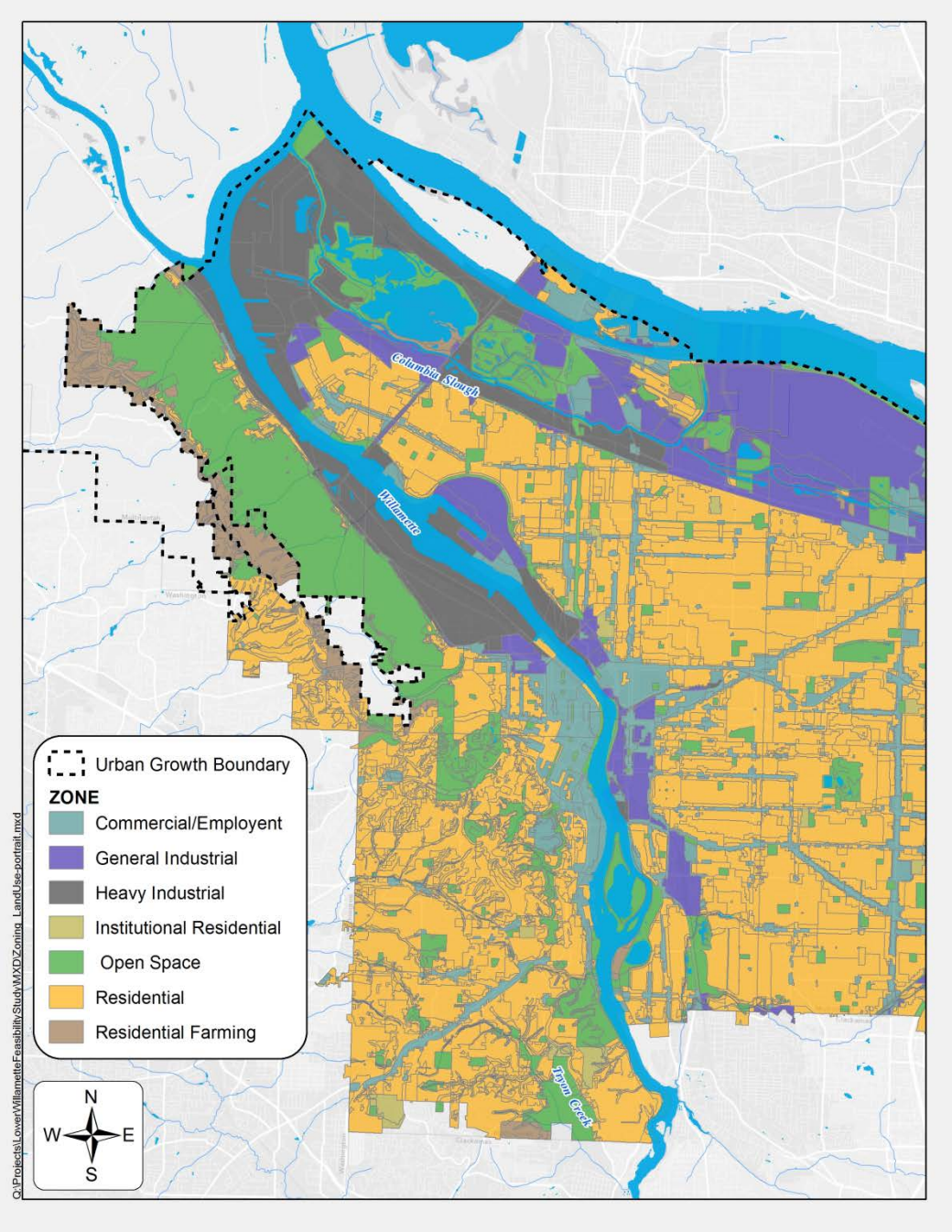

Figure 4.9. Zoning Designations in the City of Portland (PBPS 2006)

4.6.3 Future Without Project Conditions

Control of urban growth, promotion of urban renewal, and protection of open space are components of the Portland Comprehensive Plan. As the population increases over the 50-year horizon, zoning needs may change. The Portland Comprehensive Plan will continue to evolve with population growth, defining the UGB, and aiding in determining the best possible land uses and zoning options for the city. If population grows rapidly without these protections, open space and other protected natural areas may decline, while high pressure land uses increase (*e.g.*, high density or heavy industrial).

4.7 Transportation

The study area's transportation system integrates local access, highway, railroad, airport, and river barge facilities to support commercial and public transportation needs. The transportation network in the river corridor by study reach is shown in the zoning and land use maps presented above. The following transportation infrastructure data comes from local mapping and Portland Development Commission (PDC 2006).

Navigation Portland Harbor's 40-foot-deep shipping channel for ocean-going vessels is maintained along the Willamette River to the Broadway Bridge, encompassing about two-thirds of the Willamette River's length through Portland, and along the Columbia River to the Port's Terminal 6. Barge transportation extends farther upriver on the Willamette and Columbia Rivers. The Port owns four marine terminals and industrial property adjacent to the harbor. Rail and highway networks efficiently service harbor facilities. Containers may be loaded directly from ship to railcar, eliminating cross-town drayage expenses. The Port is the largest one in Oregon, largest auto port on the West Coast, fourth largest auto port in the U.S., largest wheat export port in the U.S., and third largest port in total tonnage on the west coast. Supporting Portland's economic role as an industrial and freight distribution center, the working harbor area is a hub for marine, rail, and truck transportation.

Freight Rail The Portland metropolitan region is the western terminus for the east-west rail corridor that runs along the Columbia River. The region is served by two transcontinental railroads, including Burlington Northern Santa Fe (BNSF) Railway and Union Pacific. Portland handles vast quantities of all types of cargo, including containers, automobiles, and bulks (agricultural and mineral), as well as all merchandise cargo.

Highways and Trucking Two major interstate highways, I-5 and I-84, pass through the region. I-5 is the main north-south route from Canada to Mexico, connecting Seattle, Portland, Sacramento, Los Angeles and San Diego. I-84 is the principal route east from Portland to Salt Lake City, Utah, and on to the Midwest and East Coast.

Public Transportation Network The region is an interconnected system of cities, counties, and states linked by a public transportation system serving Multnomah, Clark, Clackamas, and Washington counties. TriMet provides public transportation service and serves 575 square miles of the Portland metropolitan area. Ridership has increased in each of the past 17 years, to the current record level of 96 million rides per year. TriMet operates the 44-mile MAX light rail line, along with 92 bus routes and additional services for seniors and people with disabilities.

4.7.1 Future Without Project Conditions

The transportation network within the project area is expected to expand to accommodate a growing population under the future without-project condition. In particular, highways and public transportation will continue to need expansion and upgrades. Navigation through the Willamette River will also continue, requiring ongoing dredging. Expansion of transportation and dredging activities are all regulated by federal, state, and local agencies and adverse effects require mitigation.

4.8 Socioeconomics and Environmental Justice

4.8.1 Current and Future Population

The Portland-Vancouver-Beaverton, OR-WA Metropolitan Statistical Area (Portland MSA) consists of Clackamas, Columbia, Multnomah, Washington, and Yamhill Counties of Oregon; and Clark and Skamania Counties of Washington. The 2010 population of the MSA is 2,226,000 and the largest population center is in Portland, with approximately 584,000 residents (2010 Census estimate). The next four largest cities are much smaller than Portland, with between 90,000 and 162,000 residents. The Portland MSA supports strong manufacturing, distribution, information, and finance industries. The U.S. Bureau of Economic Analysis estimates approximately 1.3 million people are employed in the Portland MSA, making it the 23rd largest MSA in the country (U.S. Bureau of Economic Analysis 2010).

The regional population grew rapidly in the 1980s and 1990s, but has experienced slower growth since 2000 (Table 4.8). The State of Oregon Office of Economic Analysis's (OEA's) latest report indicates that the recent recession was responsible for the slowdown in growth in the region, with the slow economy, small net migration, and high unemployment all contributing to low population growth. However, recovery is beginning and growth is forecasted between 2010 and 2020. The most recent estimates of future growth for the State of Oregon are 0.5 percent growth in 2011, 0.8 percent in 2012, 0.9 percent in 2013, and about 1.25 percent annually thereafter through 2020 (Oregon OEA 2012). Applying these state-level estimates to the Portland MSA, Table 4.9 summarizes projected population through 2020.

It is projected that the Portland MSA will have a population of 2,482,000 in 2020, an increase of about 256,000 people, or 11.5 percent over the population in 2010. This projection indicates higher growth from 2010-2020 than observed from 2000-2010, but it is not projected to reach the high levels observed in the 1980s and 1990s.

Table 4.8. Observed and Projected Population Growth in the Portland MSA

	Observed Growth*			**Projected Growth****			
County	**1980-1990**	**1990-2000**	**2000-2010**	**2012**	**2013**	**2015**	**2020**
Clackamas (OR)	15%	21%	8%	381,000	384,000	394,000	419,000
Columbia (OR)	5%	16%	8%	50,000	50,000	52,000	55,000
Multnomah (OR)	4%	13%	-1%	745,000	752,000	771,000	820,000
Washington (OR)	27%	43%	11%	537,000	541,000	555,000	591,000
Yamhill (OR)	18%	30%	3%	100,000	101,000	104,000	111,000
Clark (WA)	24%	45%	16%	431,000	435,000	446,000	474,000
Skamania (WA)	5%	19%	4%	11,000	11,000	12,000	12,000
MSA Total	14%	27%	7%	2,255,000	2,275,000	2,333,000	2,482,000
*U.S. Census Bureau 2010a, 2010b **Oregon OEA 2012							

4.8.2 Demographic Trends

A Portland State University study of demographics in the Portland MSA in May 2010 documented important demographic trends in Portland and the region, including an increase of the Hispanic population (Table 4.9), a shift from family to non-family households within the city, a decline in the number of households with children, the overall decline in median household size, and a downward shift in the median age of residents in Portland neighborhoods. It also noted patterns in distribution of age and race across the Portland MSA (Sprague *et al.* 2010; U.S. Census Bureau 2010a).

Table 4.9. Portland MSA Race Demographics

County	Race [1]					
	White	**Black or African American**	**Am. Indian and Alaska Native**	**Asian**	**Native Hawaiian /Other Pacific Islander**	**Other**
Clackamas (OR)	91.1%	1.4%	1.9%	4.8%	0.5%	3.7%
Columbia (OR)	95.8%	0.9%	3.2%	1.8%	0.4%	1.6%
Multnomah (OR)	80.5%	7.1%	2.5%	8.2%	0.9%	5.9%
Washington (OR)	80.4%	2.7%	1.7%	10.6%	0.9%	8.4%
Yamhill (OR)	88.5%	1.4%	2.9%	2.4%	0.4%	7.9%
Clark (WA)	89.1%	3.1%	2.1%	5.5%	1.1%	3.6%
Skamania (WA)	95.7%	0.8%	3.4%	1.4%	0.3%	1.6%

[1]Utilizes "alone or in combination" race data and may not add to 100%.
Source: U.S. Census Bureau 2010b

4.8.3 Economy

As measured by the Bureau of Economic Analysis, in 2010 the Portland metropolitan region had the 21st largest economy in the U.S. at $121.7 billion Gross Domestic Product (GDP; O'Connor 2012). As experienced across the country, the late-2000s recession affected the Portland MSA economy (Figure 4.10). Census figures estimated a 12 percent unemployment rate for the Portland MSA in 2010 (U.S. Census Bureau 2010). However, the most recent reports from the Oregon Office of Economic Analysis indicate that positive growth has resumed slowly, led by gains in business investments and exports. Oregon is not expected to recover all of the jobs lost in the recession until the end of 2014. However, recent gains in employment are led by the Portland MSA, with the most gains seen in the construction, manufacturing, business services, and trade/ transportation/utilities sectors. The City of Portland unemployment rate in the fourth quarter of fiscal year (FY) 2011 was 7.7 percent, down from 9.2 percent in the fourth quarter of FY2010 (Oregon OEA 2012).

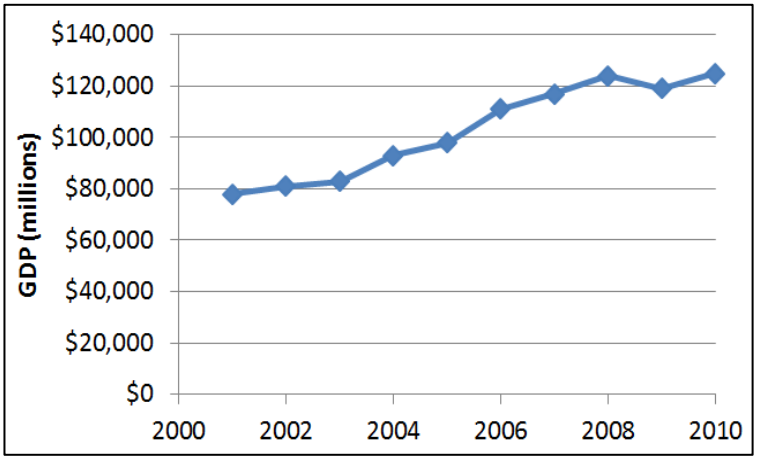

Figure 4.10. Portland MSA GDP Summary (U.S. Bureau of Economic Analysis 2012)

Median household income increased by 14 percent between 2005 and 2010 to approximately $56,000 (U.S. Bureau of Economic Analysis 2010, Table 4.10).

Table 4.10. Median Household Income in Portland/Vancouver MSA

County	2000	2005	2010
Washington (OR)	$55,000	$53,000	$63,000
Clackamas (OR)	$53,000	$54,000	$62,000
Clark (WA)	$50,000	$51,000	$58,000
Columbia (OR)	$47,000	$50,000	$55,000
Yamhill (OR)	$45,000	$46,000	$52,000
Multnomah (OR)	$43,000	$43,000	$50,000
Skamania (WA)	$41,000	$43,000	$49,000
U.S. Bureau of Economic Analysis 2010			

As a result of the region's economic expansion in the 1990s and early 2000s, the average personal income in Portland exceeded the national average (U.S. Bureau of Economic Analysis 2010). Despite this strong growth, the total number of people living in poverty increased in many Portland neighborhoods, particularly in east Multnomah County as well as in inner ring suburbs west and east of the city. Overall, however, the percentage of the total city population living in households below the poverty line declined slightly from 13 percent in 2000 to 11.9 percent in 2010. Despite this decline, a larger share of children under the age of 18 are now living in poverty (U.S. Census Bureau 2010b).

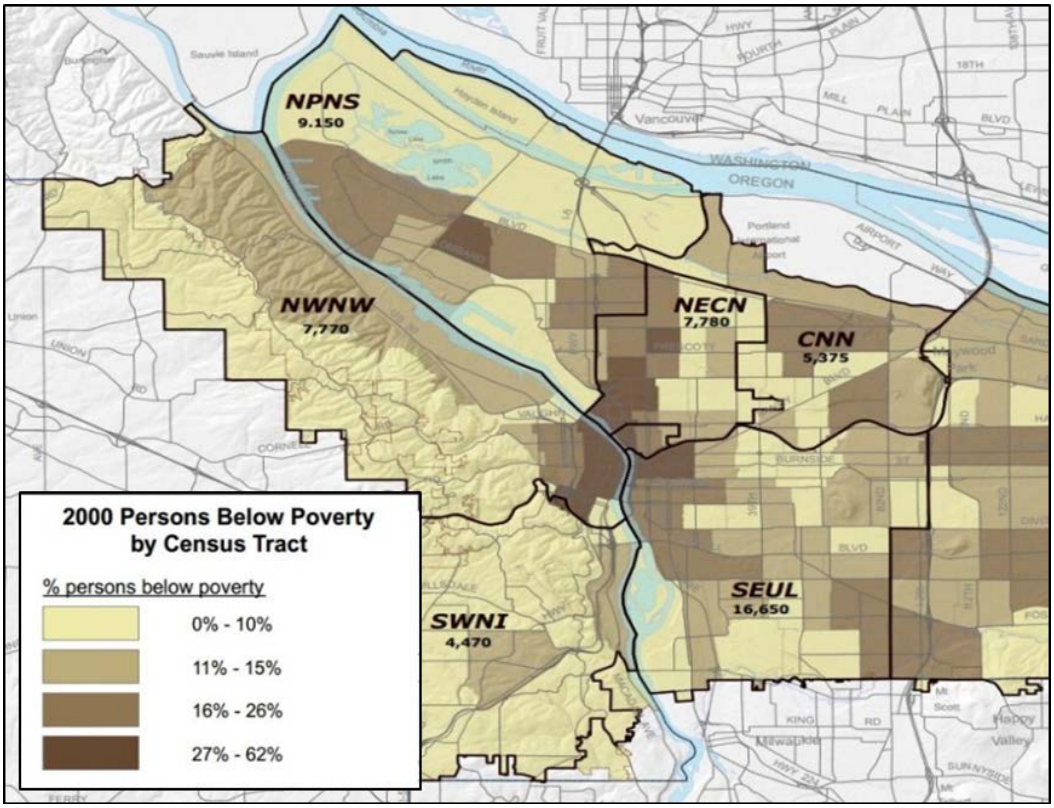

Figure 4.11. City of Portland Poverty by Census Tract and Neighborhood (City of Portland 2012)

4.8.4 Environmental Justice

Executive Order (EO) 12898 requires federal agencies to identify and address disproportionate impacts to minority and low-income populations to the degree possible. This section summarizes existing data regarding low-income populations in the study area.

Poverty by census tract for the City of Portland (based on 2000 Census data) is shown graphically in Figure 4-11. The four-letter neighborhood name codes are shown in bold type and include NPNS (North Portland Neighborhood Services), NWNW (Neighbors West/Northwest), NECN (Northeast Coalition of Neighborhoods), CNN (Central Northeast Neighbors), SWNI (Southwest Neighborhoods Inc.), SEUL (Southeast Uplift Neighborhood Coalition), and EPNO (East Portland Neighborhood Office). Beneath the names are the number of people in poverty in that neighborhood.

4.8.5 Future Without Project Conditions

The analysis of existing and future conditions does not indicate any specific resource constraint on continued growth. As described in the previous sections, the Portland MSA is expected to continue a trend of positive growth in population, employment, and income throughout the period of analysis.

4.9 Parks and Recreation

Figure 4.12 displays parks and those areas designated as "Park Deficient." Portland Parks and Recreation (PPR) has developed a vision for future park development in the city called the *Parks 2020 Vision* (PPR 2000). In the report, the value of area parks is emphasized as Portland is a destination for visitors seeking outdoor experiences and is also home to a population that values its outdoor opportunities. In general, the Parks 2020 Vision illustrates that the City of Portland has a wide variety and large area of parks, but that optimum conditions remain to be achieved. Specifically, two of the main concerns include the aging infrastructure at many of Portland's parks and the inaccessibility of parks in many of Portland's neighborhoods, particularly those that have a high percentage of residents living below the poverty level. In 2009, a review of progress of that vision was made and it was found that the City has made successful strides in adding to the acreage of parks, but that accessibility of parks to all Portlanders remained a challenge (PPR 2009).

4.9.1 Future Without Project Conditions

The Portland Plan's medium estimate of growth projects an increase of 46 percent in the number of households by 2035 compared to 2005 data (City of Portland 2012). While the North Reach is expected to grow slightly slower than the rest of the City, it is expected that park visitation will continue to grow through the period of analysis. Demand for park facilities and access to open space is strong among residents of Portland, and is not expected to decline, suggesting that an increase in population is likely to result in proportional increase in visitation to local parks in the future, and a potentially declining ability to maintain availability and condition of parks to keep up with the pace of growth.

Projections indicate that the communities around the parks in the south end of the study area will continue to grow and become denser over the period of analysis. As such, continued and increased use of the parks is expected in the without-project condition.

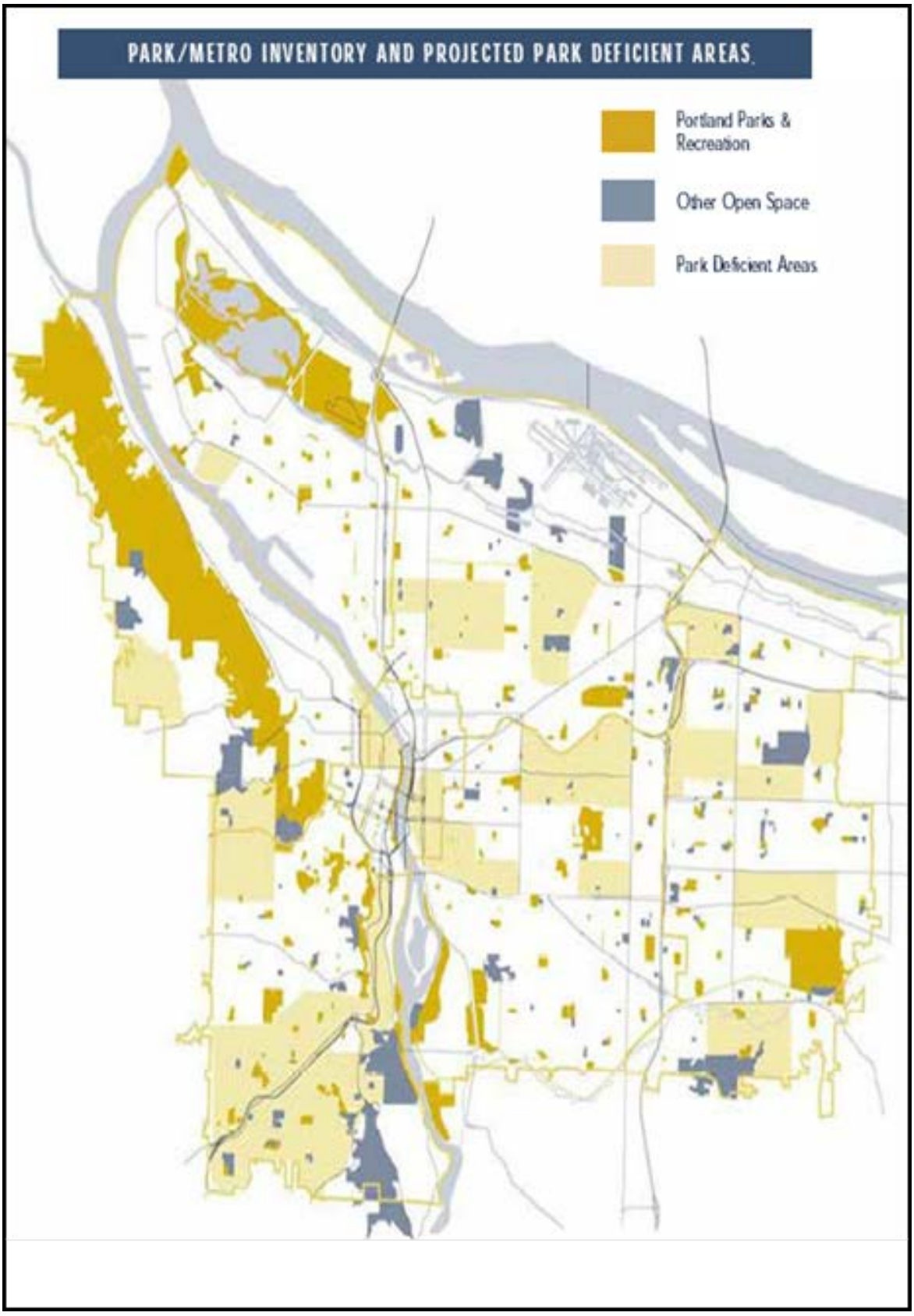

Figure 4.12. Parks and /or open space and amenities found in the Study Area.

4.10 Air Quality

The EPA sets national air quality standards for six common pollutants (also referred to as "criteria" pollutants. These standards, known as National Ambient Air Quality Standards (NAAQS), are shown in Table 4.11. Areas where air quality conditions violate these standards are classified as "non-attainment" and are subject to special air quality controls. Though non-attainment areas do occur in Oregon and previously have occurred in the study area (for both ozone and carbon monoxide), the current conditions of the study area are entirely within attainment of these standards (ODEQ 2013).

The Air Quality Index provides a daily account of air quality based on levels of particulate matter (PM), ozone, and carbon monoxide (EPA 2012). For the Portland-Vancouver-Beaverton area, during calendar years 2010 through 2012 (1,096 days total) there were 169 days of moderate air quality and only 12 days of air quality considered to be unhealthy for sensitive groups (EPA 2012). All other days were considered to have good air quality.

Table 4.11. National EPA Ambient Air Quality Standards

Pollutant	**Average Time**	**National Ambient Air Quality Standard (NAAQS) Violation Determination1**	**Federal Primary Health Standard (NAAQS) Exceedance Level**	**State Standard Exceedance Level**
Carbon monoxide	1-hour	Not to be exceeded more than once/year	35 ppm	35 ppm
	8-hour	Not to be exceeded more than once/year	9 ppm	9 ppm
Lead	Calendar Quarter	Quarterly arithmetic mean	0.15 µg/m3	0.15 µg/m3
	Annual	Annual arithmetic mean	53 ppb	53 ppb
Nitrogen dioxide	1-hour	3-year average of the maximum daily 98th percentile one hour average	100 ppb	NA
	8-hour	3-year average of the annual 4th highest daily maximum 8-hour average concentration	75 ppb	75 ppb
Ozone	24 hour	98th percentile of the 24-hour values determined for each year. 3-year average of the 98th percentile values.	35 µg/m3	35 µg/m3
	Annual Average	3-year average of the annual arithmetic mean	15 µg/m3	15 µg/m3
PM2.5	24 hour	The expected number of days per calendar year with a 24-hour average concentration above 150 µg/m3 is equal to or less than 1 over a 3-year period.	150 µg/m3	150 µg/m3
	1 hour	3-year average of the maximum daily 99th percentile one hour average	75 ppb	NA
PM10	1-hour	Not to be exceeded more than once/year	35 ppm	35 ppm
	8-hour	Not to be exceeded more than once/year	9 ppm	9 ppm
Sulfur dioxide	Calendar Quarter	Quarterly arithmetic mean	0.15 µg/m3	0.15 µg/m3
	Annual	Annual arithmetic mean	53 ppb	53 ppb
Source: EPA 2013				

In response to these NAAQS, the State of Oregon Clean Air Act Implementation Plan (SIP) was adopted under OAR 340-200-0040 (ODEQ 2013). It defines the Air Quality Control Regions (AQCR) and Air Quality Maintenance Areas (AQMA) throughout the state. Portland is within the

Portland Interstate AQCR. In previous years, air quality conditions in Portland resulted in its classification as non-attainment for ozone (O_3) and carbon monoxide (CO). As a result, though these areas are now in attainment, they are classified as an area that must be maintained (e.g. AQMA). The study area is within the Portland/Vancouver AQMA, and as such, is subject to specific air quality standards for ozone and carbon monoxide (CO). In addition, according to the 2010 annual report, particulate matter (PM) levels (for PM2.5) are regularly above 25ug/m3, making the Portland/Vancouver AQMA an area of concern.

4.10.1 Future Without Project Conditions

Air quality programs have resulted in the improvement of air quality through the Air Quality Management District. Existing conditions are expected to continue through on-going air quality monitoring and control programs.

4.11 **Noise**

Throughout the project area, noise levels can vary widely. Ambient noise levels may be intermittently high in urban areas, particularly near industrial and commercial uses and highways, but consistently low or moderate elsewhere, depending on suburban and rural population, wind levels, aircraft traffic, and recreation, forest, or agricultural activities (PBDS 2013).

The sustainability of Portland's residential communities relies on planning decisions based on a well-defined understanding of the sound characteristics of the community. Community noise is defined by the World Health Organization as "noise emitted from all sources except noise at the industrial workplace. Main sources of community noise include road, rail and air traffic, industries, construction and public work, and the neighborhood."

In 2008, a noise study was conducted that involved collecting sound measurements in North Portland to document and quantify the dominant sources of sound in the North Portland neighborhood (The Greenbusch Group, Inc. 2008). The noise study areas overlapped to some degree with this study's footprint, including areas east of the Willamette River from the confluence of the Columbia River south to downtown Portland and around Columbia Slough. The study reports that the most common loud noise sources in the restoration project footprint includes railways, freight corridors, I-5 traffic, and Portland International Airport (PDX) (The Greenbusch Group, Inc. 2008). Noises that were recorded above 60 decibels (dB) included train brakes, and air traffic, while events greater than 70 dB included train horns, roadway traffic, and fireworks.

The PDX noise contours overlap a small portion of the study area at the confluence of the Willamette with the Columbia River and are adjacent to the study area near the upstream portion of the Columbia Slough (PBDS 2013). PDX air traffic resulted in measurements within the study area over 70 dB (The Greenbusch Group, Inc. 2008).

4.11.1 Future Without Project Conditions

Noise conditions are not expected to change noticeably under future without-project conditions. Population growth and increased use of railways or roadways in the project area may incrementally increase noise levels. However, City noise ordinances will continue to ensure that ambient noise does not increase over time.

4.12 Hazardous Waste and Toxic Materials

Pollutants in water often bind to sediment. Because of the level of pollution in Lower Willamette River sediments, the Portland Harbor from downtown Portland to the confluence with the Columbia River was added to the federal Superfund cleanup list in December 2000. Pollutants generated throughout the Willamette River Basin, including industrial discharges, toxics carried by stormwater, and other sources, have contributed to highly elevated levels of dichlorodiphenyltrichloroethane (DDT), polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs) and heavy metals in Lower Willamette River sediment.

A search of potentially contaminated areas and sources in the study area revealed several sources and locations of sediment contaminants, primarily from industrial sources within Portland Harbor. Areas of ship-related activities including building (1800s–present), repair (1800s–present), and dismantling (1960s–1979) located within and outside the harbor are known to have deposited chemicals such as volatile organic compounds (VOCs), Semi volatile organic compounds (SVOCs), PAHs, PCBs, TPH, copper, zinc, chromium, lead, mercury, phthalates, and butyltins. The anti-fouling paint applied to ships locally during World War I contained extensive amounts of both zinc oxides and mercury oxides. The wood product and treating industry was largely responsible for the deposition of phenol-formaldehyde resin, sodium hydroxide, and petroleum hydrocarbons such as oil, diesel, and kerosene in plywood manufacturing. Other chemical byproducts from this industry include VOCs, SVOCs, total petroleum hydrocarbons (TPH), and various metals, as well as possibly pesticides and fungicides. Many of the same chemicals also were deposited into sediments by other industry such as chemical manufacturing and distribution, metal recycling, production, and fabrication, manufactured gas production, electrical production and distribution, bulk fuel distribution, storage and asphalt manufacturing, steel milling, smelters, and foundries, and commodities.

A preliminary HTRW investigation was conducted to determine if there is any current and/or historical contamination that could adversely influence the implementation of any future planned restoration measures. Relevant environmental databases included lists compiled by EPA and the State of Oregon (EDR 2009). The Environmental Data Resources (EDR) database results indicated that HTRW sites are found in all reaches of the study area as shown in Figure 4.13. Database search details are provided in Appendix E. Potential restoration locations that were identified as having potential HTRW issues were removed during the screening process.

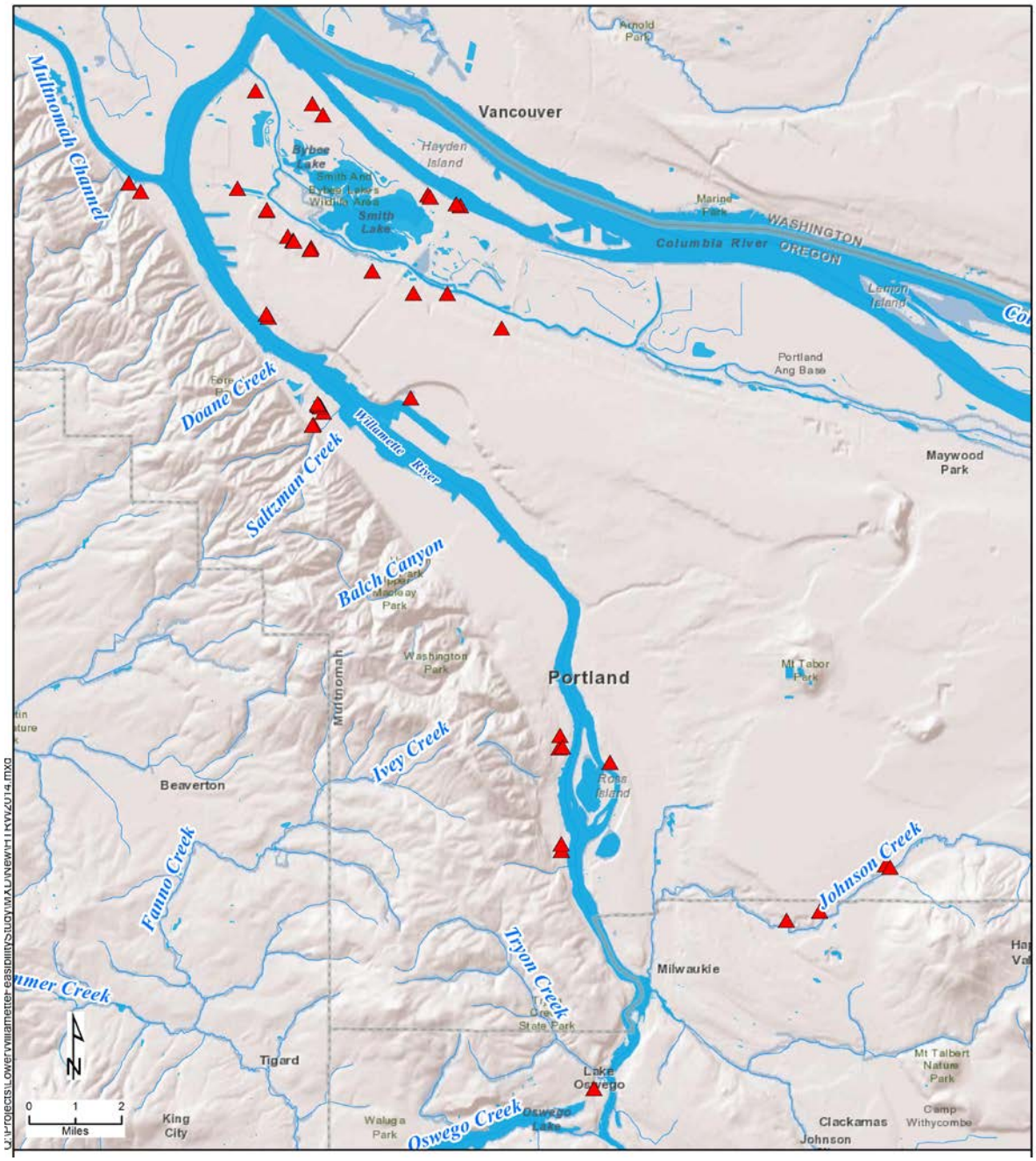

Figure 4.13. HTRW Sites identified in the Study Area

4.12.1 Future Without Project Conditions

Hazardous and toxic wastes and materials may continue to be present in the study area into the future. Additional hazardous materials may also be introduced as a result of ongoing dredging. However, remediation of existing hazardous wastes is ongoing, and in the future it is anticipated that conditions will improve with these efforts. Federal, state, and local protection protocols will assist in preventing new sources of HTRW from entering the system.

4.13 Visual Resources

The project area aesthetics are driven by a variety of factors and vary from site to site. On a local scale, the Lower Willamette River and Columbia Slough both flow through highly developed portions of Portland where urbanization and commercialization have dramatically changed the visual resources from their historic condition. Both waterways have narrow or absent riparian zones and developments frequently built right up to the edge of the river. On a grander scale, views from the river and slough may include the City of Portland and its bridges, Forest Park and the West hills, the City of Vancouver or even the distant Cascade Mountains dominated by Mt. Hood. Detailed aesthetic conditions of the study area are given in Section 7.13.

4.13.1 Future Without Project Conditions

Visual resources throughout the study area will continue to degrade without specific measures taken to protect their condition. Continual maintenance to remove non-native plants will be necessary to protect habitat and aesthetic value and areas without regular maintenance will become less and less attractive. The cumulative loss of natural conditions will continue to affect aesthetic values.

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5. PLAN FORMULATION

Sites were identified for restoration based on the potential opportunity to meet project objectives, but site-specific planning also included consideration of how each site fits into the overall watershed and could provide unique features or functions that may not be feasible to restore or retain at other sites. Restoration measures were developed to restore habitat function as feasible within the ongoing constraints. Factors limiting the ultimate restoration of floodplain and riparian function on the mainstem include the regulation of flows in the river by several large dams upstream of the study area, development in the lower watershed, development of the floodplain and subsequent reduction in size of riparian zones and off-channel habitat areas, and a patchwork pattern of land ownership and land uses along the Lower Willamette and its main tributaries.

5.1 Preliminary Screening

5.1.1 Initial Screening of Sites

Numerous possible restoration sites were initially proposed for restoration planning by the City, many of which were included in the conceptual watershed management plans developed for the Lower Willamette River watershed. Of an initial list of approximately 50 sites, 45 sites were selected for additional investigation because they were consistent with USACE policy for ecosystem restoration and initially appeared to have potential to achieve the project's objectives. These project sites are summarized in Table 5.1, and displayed in Figures 5.1 and 5.2.

Table 5.1. Initial Array of Possible Restoration Sites

Site	General Location	Possible Restoration Actions
Alsop-Brownwood	Johnson Creek	Create off-channel habitat for salmonids and water quality improvements. Create flood storage to mitigate nuisance flooding.
Arnold Creek Culvert	Tryon Creek	Retrofit culvert on Arnold Creek just upstream from the confluence with Tryon Creek to provide fish passage to Arnold Creek. Restore riparian zone in vicinity of culvert.
Balch Creek	Willamette Mainstem	Daylight lower Balch Creek, regrade steep banks to create floodplain, deposit sand for shallow water habitat, revegetate and place LW.
Bell Station	Johnson Creek	Create off-channel habitat. Purchase frequently flooded properties and create flood storage to mitigate nuisance flooding. Address exposed sewer pipe crossing creek.
BES Plant Banks	Columbia Slough	Lay back banks, increase amount and quality of vegetation, add anchored wood. Create small off-channel wetlands (if site uses and existing habitat can be protected).
Blind Slough	Columbia Slough	Valuable off-channel habitat with good existing riparian canopy and shrub vegetation. Increase habitat value by adding large wood, increasing area of off-channel habitat, and minor revegetation.
Boones Ferry Culvert Retrofit	Tryon Creek	Retrofit culvert to provide passage from Tryon Creek State Natural Area to Marshall Park and Upper Tryon Creek.
Cathedral Park	Willamette Mainstem	Revegetate banks; retrofit parking lot and existing swale; create off-channel wetland habitat (includes increase in shallow water habitat), LW placement.

Centennial Mills	Willamette Mainstem	Demolition or redevelopment of this site provides the opportunity to improve banks and floodplain. Daylight Tanner Creek and create off-channel cool water confluence habitat.
City Banks opposite Kelley Point	Columbia Slough	Pull back banks and create small alcoves. Location at major confluence provides important connections to both Willamette and Columba River fish populations.
Crystal Springs Culvert Replacements	Johnson Creek	Replace culverts at Tacoma and Tenino Streets and improve passage under private carport to improve access to restored habitat at Westmoreland Park.
Doane Creek	Willamette Mainstem	Daylight lower stream, place LW, revegetate riparian zone, excavate off-channel marsh area, replace three culverts with fish-passable design.
Eastbank Crescent	Willamette Mainstem	Regrade and revegetate banks; increase shallow water habitat; incorporate stormwater treatment.
Elk Rock/Spring Park	Willamette Mainstem	Add wood, increase vegetation and restore existing habitat. Acquire property from willing sellers to increase complexity of off-channel habitat.
Errol Creek Confluence	Johnson Creek	Create backwater wetland/riparian zone in grassland at confluence, replace culvert under nearby road with fish-passable design, revegetate riparian zone upstream on banks of Johnson Creek
Errol Creek Headwaters	Johnson Creek	Revegetate headwaters and streambanks with native riparian species, add LW to diversify stream habitat
Freeway Land Company/East Lents	Johnson Creek	Create off-channel habitat for salmon and water quality improvement. Create flood storage to mitigate nuisance flooding. Purchase homes to move residents out of floodplain.
Kelley Point Park	Willamette Mainstem	Remove invasive plants and plant native species; create off-channel habitat
Kenton Cove	Columbia Slough	Add wood to restore habitat complexity in this off-channel habitat.
Lower Powell Butte	Johnson Creek	Purchase frequently flooded properties from willing sellers. Restore floodplain and create off-channel habitat.
MarCom	Willamette Mainstem	Lay back banks, add large wood, revegetate riparian area
Marshall Park Channel Restoration	Tryon Creek	Improve channel conditions along Marshall Park by stabilizing banks with bio-engineering and adding instream complexity to improve habitat and water quality.
Middle TCSNA Habitat Restoration	Tryon Creek	Restore habitat by controlling erosion along the tributaries to protect mainstem habitat, replacing culverts, and increasing instream complexity along the mainstem.
Miller Creek Confluence	Willamette Mainstem	Slope back steep banks, relocate mouth of Miller Creek, extend riparian zone, revegetate riparian zone and upland transition zone.
Oaks Amusement Park	Willamette Mainstem	Excavate existing side channel to connect to Willamette River during low-flow, place LW, revegetate floodplain
Oaks Bottom Wildlife Refuge	Willamette Mainstem	Restore off-channel habitat; control invasive plant species; improve banks.
Oaks Crossing/Sellwood Riverfront Park	Willamette Mainstem	Improve amount and quality of vegetation in floodplain. Create off-channel and additional shallow water habitat that are consistent with park uses.

Oregon Yacht Club	Willamette Mainstem	Excavate channels to create backwater wetlands, revegetate wetland and upland areas.
Powerline Crossing	Willamette Mainstem	Reconnect seasonal tributary to Willamette River by removing berm, remove invasive species and revegetate, place LW, slope banks of river to connect to floodplain
Powers Marine Park	Willamette Mainstem	Remove invasive plant species, revegetate, establish wood jams, create off-channel habitat at the confluences of the seasonal streams flowing off the hillside.
Ramsey Refugia	Columbia Slough	Restore 5 acres of floodplain forest and backwater slough habitat by restoring hydrologic connectivity between Ramsey Lake Wetland and the Columbia Slough.
Saltzman Creek	Willamette Mainstem	Daylight mouth of creek and create riparian zone, revegetate, place LW, add sand to create shallow water habitat
Smith and Bybee Lakes	Willamette Mainstem	Revegetate areas along the lakes. Upgrade water control structure to allow more natural hydrology and salmon access.
St. John's Landfill Boat Launch	Columbia Slough	Pull back banks and create wetland benches, create off-channel wetland habitat, and plant vegetation to create wildlife habitat.
Stephens Creek Mouth	Willamette Mainstem	Maintain off-channel habitat; expand on existing high quality functions.
Swan Island Beach South	Willamette Mainstem	Maintain habitat values at this site. Pull back banks, increase vegetation and wood, and restore floodplain.
Tryon Creek Confluence	Tryon Creek	Pull back steepened banks, improve composition of floodplain and frequency of inundation, vegetate banks, improve complexity of channel, add wood.
Tryon Highway 43 Culvert	Tryon Creek	Improve passage and channel conditions to improve access to one of the largest contiguous high quality habitats in the city, Tryon Creek State Natural Area.
Waterfront Park Bowl	Willamette Mainstem	Remove rip rap, plant native vegetation, create shallow water habitat, and increase bank complexity. Provide moorage to discourage anchoring on banks.
West Lents	Johnson Creek	Create off-channel habitat. Create flood storage to mitigate nuisance flooding. Purchase frequently flooded properties to move people out of the floodplain.
Westmoreland Park	Johnson Creek	Improve fish and wildlife habitat and fish passage in Crystal Springs and Westmoreland Park.
Willamette Cove	Willamette Mainstem	Restore consistent with site master plan. Create off-channel habitat. Remove riprap and regrade banks to expand shallow water habitat and floodplain. Increase vegetation on banks and floodplain.
Willamette Park	Willamette Mainstem	Improve over-steepened and hardened banks; revegetate, protect and restore shallow water habitat; create off-channel habitat.
Woods Outfall	Willamette Mainstem	Excavate channel to high-flow level, slope banks to reconnect to floodplain, revegetate riparian zone, add LW.
Wright and Moore Islands	Columbia Slough	Restore existing habitat by adding wood and looking for opportunities to excavate off-channel wetland habitat. Lay back banks at Heron Lakes to create wetland benches.

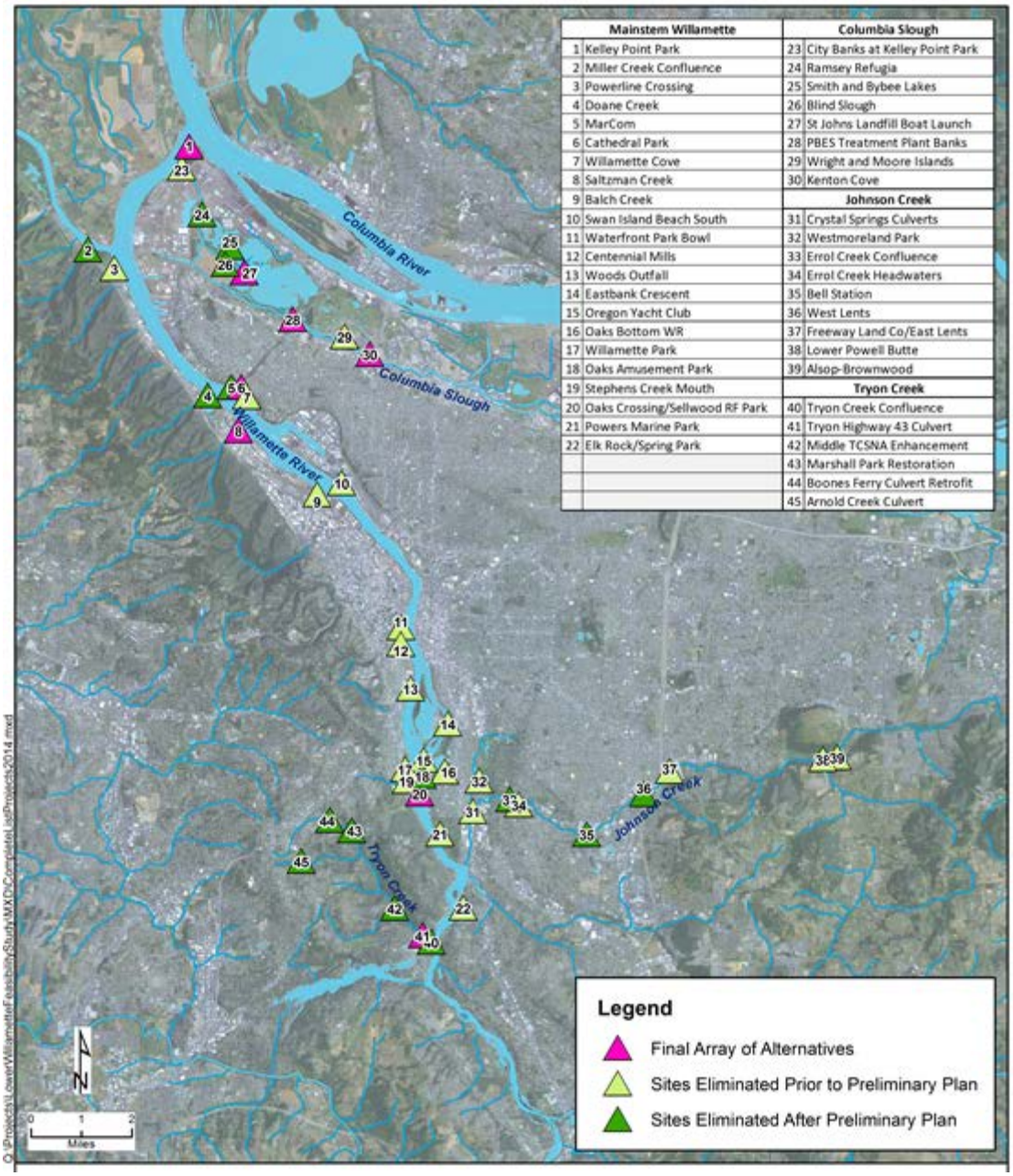

Figure 5.1. Originally Proposed Restoration Sites

Initial site screening was performed by the PDT to screen out those sites that did not appear to offer viable opportunities to efficiently meet the objectives. Screening criteria included:

- **Real Estate:** Lands under multiple ownership, where owners were clearly not supportive of implementation of restoration measures, or where the long-term preservation of restored habitat was in question, were removed or site plans were scaled back to exclude such areas.
- **Limited Restoration Potential:** Several sites initially appeared to offer opportunities for restoration, but upon closer inspection were found to be compromised by issues including poor water quality, poor sediment quality, upstream conditions that compromised habitat

quality and which were beyond the reach of the proposed project, or where the benefits of restoration would be otherwise limited.

- **Site Availability:** In some cases, sites were found to be under planning for restoration by other entities, or restoration measures had already been implemented.
- **Other Constraints:** Sites where construction would be very complicated, where access would be especially difficult, or where it appeared that contamination may be present were removed from consideration.

Members of the PDT conducted reconnaissance-level surveys at all of the sites remaining after the initial screening was completed. The purposes of the surveys were to gather data to establish baseline conditions and to conduct secondary screening to eliminate sites where constraints made restoration potential limited or clearly infeasible. The site surveys also allowed the team to identify specific restoration measures appropriate for each site.

By the time initial field investigations began in November and December, 2007, additional screening by the PDT had resulted in removal of eight sites from the list. After the field surveys were completed, the PDT reviewed the data and eliminated six additional sites from further consideration. Over the ensuing years since the site visits occurred, additional screening resulted in further reduction of the number of sites. Screening attempted to balance the team's ability to pursue these sites with the other current fiscal and workload requirements presented by planning for the ongoing Portland Harbor Superfund Site remediation and the associated Natural Resource Damages Assessment (NRDA) effort. After evaluating screening factors, the PDT narrowed the list further to sites that, if funded, still provided environmental restoration benefits in areas considered critical to meeting the project objectives. Table 5.2 indicates the primary reasons and challenges that led the PDT to remove these sites from further analysis in the Feasibility Study. Also, in the years between initial plan formulation and preparation of this Feasibility Study, restoration measures have been implemented or are being planned as separate projects at the additional sites listed below, therefore they are no longer available for consideration under this plan.

Table 5.2. Sites Eliminated from Consideration

Site	Reason for Removal from Consideration
Alsop-Brownwood	Restoration measures were implemented under a separate project
Arnold Creek Culvert	City considering this project under a different program
Balch Creek	Environmental contamination; minimal restoration opportunities
Bell Station	Private ownership; requires purchase of property and residential relocation for floodplain project
Blind Slough	Limited restoration potential
Boones Ferry Culvert	Culvert retrofit being designed as part of a separate project
Centennial Mills	Site was planned for redevelopment, future of restored habitat could not be guaranteed
City Banks opposite Kelley Point Park	Restoration measures were implemented under a separate project
Crystal Springs Culvert Replacement	Culvert replaced as part of separate project
Doane Creek/Railroad Corridor	Environmental contamination; private ownership; railroad right-of-way; high cost of restoration
Eastbank Crescent	Site did not appear to offer substantial potential for successful restoration

Elk Rock Island	Site did not appear to offer substantial potential for successful restoration
Errol Creek Confluence	Restoration measures were implemented under a separate project
Errol Heights (Headwaters)	Restoration measures were implemented under a separate project
Freeway Land Company	Site was subsequently considered for a flood control project rather than an ecosystem restoration project
Lower Powell Butte	Some landowners did not appear to be willing to participate in the proposed project
MarCom	Site showed limited restoration potential and high possibility of need for remediation
Marshall Park	Restoration measures were implemented under a separate project
Middle TCSNA	Restoration measures were implemented under a separate project
Miller Creek Confluence	Private ownership; railroad right-of-way prevents restoration plan implementation
Oaks Amusement Park	Perceived issues due to private ownership.
Oaks Bottom Wildlife Refuge	Project was moved forward as a separate USACE Section 206 ecosystem restoration project
Oregon Yacht Club	Land owned by multiple unwilling landowners
Powerline Crossing	Land owned by unwilling landowner
Powers Marine Park	Site showed very limited restoration potential
Ramsey Refugia	Work already completed by PBES
Smith and Bybee Lakes	Restoration work already occurring under separate contract
Stephens Creek Mouth	Very limited restoration potential
Swan Island Beach South	Site was slated for remediation, poor water quality
Tryon Creek Confluence	Restoration measures were implemented under a separate project
Waterfront Park Bowl	Land use and recreation requirements minimized area of potential restoration to less than desirable.
West Lents	Private ownership would require purchase of property and residential relocation for floodplain project
Westmoreland Park	Project was moved forward as a separate USACE Section 206 ecosystem restoration project
Willamette Cove	Emerging evidence of contamination rendered this site infeasible until remediation had been completed
Willamette Park	Site considered for restoration as part of separate project
Woods Outfall	Site showed limited restoration potential and likely high maintenance requirements over time
Wright and Moore Islands	Site showed very limited restoration potential and difficult construction access

5.2 Development of Restoration Measures

Different restoration features are proposed at each site, depending on the problems to be addressed and the opportunities each site offers. These features, described below, include engineered and ecological solutions to the problems identified in Section 3.4, and seek to minimize use of hard structure except where necessary (primarily to reconstruct or build a fish-passable culvert).

- Install Large Wood LW is a naturally occurring component of streams in the Lower Willamette River ecosystem. LW has been removed from streams for a variety of reasons including improved navigation, reduction of flow resistance, flood control, and perceived fish passage problems (Fischenich and Morrow 1999). Placement of LW is proposed as a technique to restore stream channel morphology and fish and wildlife habitat forming functions such as pool creation, sediment and organic matter retention, and habitat

complexity and refugia restoration (PBES 2006). Strategic placement of LW can promote channel scour or bar formation, or can be used to protect restored bank features from the full force of the river's current.

- Riparian Revegetation Riparian areas shade streams, moderate stream temperatures, provide overhead cover, filter sediments and runoff, control streambank erosion, and provide a terrestrial source of organic matter and insects that support aquatic food chains (PBES 2006). Riparian plantings along river banks and floodplains also restore natural recruitment of large woody debris to the system. Urbanization and development of riparian areas have reduced the quantity and quality of riparian zones throughout the Lower Willamette Basin. Riparian plantings would include tree, shrub, and herbaceous species as appropriate for site conditions.

- Invasive Species Removal The composition, age, and spatial structure of tree and shrub species are important indicators of the health of a riparian area. Properly functioning riparian ecosystems have the appropriate combination of mature and developing vegetation, species diversity, and levels of structure, all of which can be disturbed by the presence of invasive species. Invasive species often out-compete native species, reducing the productivity and function of riparian areas, altering wildlife habitat, and in some instances changing soil characteristics. Invasive species removal is proposed in combination with riparian planting projects to fully restore riparian function. This restoration measure would involve the active removal of non-native vegetation, including Himalayan blackberry, reed canary grass, yellow flag iris, holly, and English ivy from the riparian zone and floodplain. Removal could be done by mechanical means (plowing, disking, and mowing), hand removal (cutting), and/or spot applications of herbicides where the risk of contamination of waterways is limited.

- Floodplain Reconnection Connected floodplains attenuate high flows, store water and recharge groundwater tables, and both retain and contribute organic matter, substrate, and large wood to the stream system. Steepened banks are often a result of fill placement, bank stabilization and channelization activities, which cause channel incision and floodplain disconnection. Grading banks to gentler slopes is proposed to allow for restored floodplain connections and increased floodplain area with shallow water habitat, and to allow riparian and aquatic habitats to form more naturally along the river corridor.

- Off-Channel Habitat Development Side channel and off-channel habitats are important feeding, resting, and rearing areas for aquatic species and, by providing protected areas with lower flow velocities, serve as key refugia during flood events. A study by the Oregon Department of Fish and Wildlife and the City of Portland (Friesen 2005) found that all off-channel habitats currently present along the Lower Willamette River were used by juvenile salmonids for forage and refuge. The creation and reconnection of side channels, alcoves, and backwater habitats is proposed to increase the quantity of this important habitat to aquatic species. To be most effective, this measure should be combined with other measures including invasive species removal and revegetation with native species.

- Fish Barrier Removal Undersized or poorly designed culverts or other artificial fish passage barriers affect the number of salmonids that can return to spawn, the temporal and spatial distribution of salmonids throughout a subbasin and, ultimately, the nutrient balance of that freshwater system (PBES 2006). This measure would remove fish passage barrier culverts and replace them with a new wider culvert meeting ODFW fish passage rules.

5.2.1 Development of Site Plans

Some combination of the restoration measures described above was developed for each site to address the key habitat issues that were found there. In general, sites were relatively small so not all of the measures were included in the conceptual restoration plans. Measures, or combinations of measures, were considered appropriate for each site if they appeared to have the potential to address one or more of the habitat restoration objectives; if they could be implemented at a scale to cause a measurable difference in the habitat value at that site; and if they were technically feasible. The focus of the combination of measures at each site was to enhance habitat value for the life stage or stages of the species that were most likely to be found at the site. For example, sites on the mainstem Willamette River were assumed to support juvenile salmonids during their outmigration period, therefore measures recommended for implementation at these sites included features that would provide forage opportunities, high-flow refugia, and cover for small fish. On Tryon Creek, the primary issue affecting habitat quality was lack of access by adult fish into the stream; therefore the primary restoration measure of culvert replacement was developed to facilitate passage of this life stage into the stream. In addition, measures were combined at each site to try to provide improvements to habitat for all key species that may be found there, so combinations of measures that would improve conditions in aquatic areas, understory, and canopy zones were considered.

5.2.2 Evaluation of Preliminary Conceptual Restoration Plans

After conceptual plans had been prepared for the sites that remained after screening, habitat scores were developed for each site using the Habitat Evaluation Procedure (HEP) model. The HEP rates habitat based on its potential to support each species or group of species during part of all of their lifecycle. This potential is reported as Habitat Units (HUs). HUs occurring under without project conditions are compared to estimated HUs that would occur under the with-project condition at set time intervals, in this case 5 years, 10 years, and 25-50 years, to calculate the rise in ecological output due to project implementation. Because this model was prepared to evaluate resource conditions at a watershed scale, it takes into account that various habitat types at any given site may overlap, and is therefore integrative of all habitat types found at any given site. This process is summarized in Section 5.4.1.

After developing the HEP model and developing preliminary cost estimates, each alternative was evaluated according to a Cost Effectiveness/Incremental Cost Analysis (CE/ICA) model. The CE/ICA is an evaluation tool which considers and identifies the relationship between changes in cost and changes in quantified, but not monetized, habitat benefits. The evaluation is used to identify the most cost-effective alternative plans to reach various levels of restoration output and to provide information about whether increasing levels of restoration are worth the added cost. The CE/ICA is a planning tool to help identify cost-effective plans which provide a certain level out habitat output at the least cost. The software expedites this effort of testing each combination of measures and tabulating the resulting costs and environmental benefits. This process is described in greater detail in Section 5.4.2.

5.2.3 Final Array of Site Plans

After all rounds of screening were completed, the project sites described below were identified as the final array. These sites were chosen as a result of the above screening process, and were carried forward for additional analysis and development of alternatives. A wide variety of restoration measures were developed and applied to each of the original sites as needed to address one or more of the planning objectives. The extent to which measures could be effectively implemented at most

sites in the study area was limited by constraints including urban development, competing land uses, and multiple ownership.

The PDT considered formulating additional site plans with more measures or with different combinations of measures. However, the PDT reached the conclusion that additional measures development would not measurably add to benefits and in most cases, additional measures were not technically feasible or violated site constraints. The PDT further concluded that creating additional (alternative) site plans would not affect the cost effectiveness output for each site. The recommended site plans offer highly effective and efficient restoration actions that make every effort to achieve all three objectives for sites that are generally simple in nature. Only the measures that were deemed necessary to achieve the objectives remain in the conceptual plans.

Highway 43 Tryon Creek Culvert (Culvert replacement for fish passage): The intent of this project is to replace the culvert under Highway 43 and the railroad line, which is a fish passage barrier under most flow conditions. The new culvert would simulate the natural stream dimensions, allowing for water, sediment and debris to pass downstream and give fish unhindered passage beneath the roadway and railroad line. Implementation of this project would allow unhindered fish passage into the TCSNA, where fish habitat has been restored recently and is of high quality. Without this project, the benefits of stream and riparian restoration projects that have been implemented or are planned for implementation in TCSNA and in Marshall Park would be greatly diminished.

Oaks Crossing/Sellwood Riverfront Park (Off-Channel and Riparian Restoration, Wetland Restoration): The intent of this project is to restore and reconnect salmonid habitat in the floodplain by connecting off-channel habitat to the river, removing invasive species, and revegetating with native floodplain and riparian species. Habitat at this site consists of gallery riparian forest with both native and invasive understory species. Sandy beach habitat would be improved by addition of LW.

Cathedral Park (Off-Channel, Riparian, and Wetland Restoration, Bank Bioengineering): The intent of this project is to revegetate river banks with native trees and shrubs, increase stormwater retention, and create off-channel wetland habitat. The parking lot and existing swale would be modified to detain stormwater runoff and provide additional wetland habitat. Vegetated wetland deltas would be created at the mouth of the swale and at a similar location just north of the mouth of the swale to provide off-channel refugia for juvenile fish.

Saltzman Creek (Shallow Water and Riparian Restoration): The intent of this project is to slope back banks of fill along Saltzman Creek at its confluence with the mainstem Willamette River to create a wider creek corridor and floodplain, as well as a restored riparian vegetation community. The riparian zone would be restored and LW would be placed at the confluence for habitat complexity and cover. Restoring the riparian zone would involve recontouring the banks to a gentler gradient to prevent bank erosion, removing invasive species, and revegetating with native species.

St. Johns Landfill Boat Ramp (Bank layback, Riparian Restoration): The intent of this project is to slope back the steep banks, add LW to improve aquatic habitat complexity, improve marsh habitat, and revegetate the riparian zone with native species. The entire site borders an industrial area. Although marshy habitat exists at the site, it is of poor quality.

BES Plant (Off-Channel and Riparian Restoration, Bank Improvement): The intent of this project is to excavate a more frequent connection to a floodplain backwater/swale area and restore the riparian zone along Columbia Slough. Steepened bank slopes would be reduced and LW added along the

banks to increase habitat complexity. Habitat quality is currently moderate to good, but opportunities to improve and expand wetland and backwater habitats exist in several parts of the project site. Off-channel rearing and high-water refugia would be restored by excavating a connection from Columbia Slough to the low swale at the southeast end of the site and by excavating an alcove at the base of the slope near the northwest end of the site. Habitat value would be increased by removing invasive species and revegetating with native trees and shrubs. Pond turtle habitat would be improved by addition of LW and boulders near the mouth of the channel between the slough and the low swale.

Kenton Cove (Off-Channel and Riparian Restoration): Most of this site is surrounded by a maintained levee, with a natural riparian floodplain zone along Columbia Slough. The intent of this alternative is to increase complexity with LW, remove invasive species, and revegetate with native trees and shrubs. Because the edges of the cove are very uniform and offer very little habitat complexity, small habitat islands are proposed at the location of each woody debris jam, with the wood as the centerpiece of the habitat island.

Kelley Point Park (Off-Channel and Riparian Restoration): The intent of this project is to excavate two off-channel backwater areas, remove invasive plants, revegetate with native species, regrade steep banks, and place LW to increase habitat complexity. To reduce the amount of fill to be removed, rather than excavating large areas of floodplain, meandering channels would be cut along existing swales to allow for off-channel refugia.

Table 5.3 identifies the problems that would be addressed by implementation of restoration measures at each of the sites. Conceptual overview figures for proposed restoration measures included in the final array of sites appear in Appendix G-1.

Table 5.3. Final Array of Site Plans

Site	Potential Restoration Measures	Problems Addressed	Objectives Addressed
BES Plant	• Reconnect or create side channel or backwater features • Install LW • Grade banks with gradual slopes to provide a suitable area for planting • Install species-specific features such as wood clusters for pond turtles	• Loss or Degradation of Off-channel Habitats • Reduction in Nutrients and Woody Material	• Reestablish riparian and wetland plant communities • Increase aquatic and riparian habitat complexity and diversity. • Restore floodplain function and complexity.
Kenton Cove	• Install LW • Revegetate with native riparian and wetland species	• Loss of Channel Complexity • Reduction in Nutrients and Woody Material	• Reestablish riparian and wetland plant communities • Increase aquatic and riparian habitat complexity and diversity.

Kelley Point Park	• Revegetate with native riparian and wetland species • Reconnect or create side channel or backwater features • Grade banks with gradual slopes to provide a suitable area for planting • Install LW	• Loss or Degradation of Off-channel Habitats • Reduction in Nutrients and Woody Material	• Reestablish riparian and wetland plant communities • Increase aquatic and riparian habitat complexity and diversity. • Restore floodplain function and complexity.
Oaks Crossing/Sellwood Riverfront Park	• Revegetate with native riparian and wetland species • Reconnect or create side channel or backwater features • Install LW	• Reduction in Nutrients and Woody Material • Loss or Degradation of Off-channel Habitats	• Reestablish riparian and wetland plant communities • Increase aquatic and riparian habitat complexity and diversity. • Restore floodplain function and complexity.
Tryon Creek Highway 43 Culvert	• Culvert removal • Plant riparian vegetation • Restore streambed conditions	• Reduction in Nutrients and Woody Material • Diminished health of tributaries	• Increase aquatic and riparian habitat complexity and diversity.
Cathedral Park	• Revegetate with native riparian and wetland species • Reconnect or create side channel or backwater features • Grade banks with gradual slopes to provide a suitable area for planting • Install LW	• Loss or Degradation of Off-channel Habitats • Reduction in Nutrients and Woody Material	• Reestablish riparian and wetland plant communities • Increase aquatic and riparian habitat complexity and diversity. • Restore floodplain function and complexity.
St. Johns Landfill Boat Launch	• Install LW • Grade banks with gradual slopes to provide a suitable area for planting • Revegetate with native riparian and wetland species	• Loss or Degradation of Off-channel Habitats • Reduction in Nutrients and Woody Material	• Reestablish riparian and wetland plant communities • Restore floodplain function and complexity.
Saltzman Creek	• Create shallow water habitat • Install LW • Grade banks with gradual slopes to provide a suitable area for planting • Revegetate with native riparian and wetland species	• Loss of Channel Complexity • Reduction in Nutrients and Woody Material • Loss or Degradation of Off-channel Habitats	• Reestablish riparian and wetland plant communities • Increase aquatic and riparian habitat complexity and diversity.

5.3 Development of Conceptual Alternatives

A team of experienced habitat restoration professionals developed measures which 1) would help to achieve the objectives; 2) were scaled for each site; 3) were proven to have been effective on other, similar projects; 4) covered the range of life stages that would occur in the study area; and 5) were implementable given the constraints of what were generally small sites.

Alternative plans, which comprised one or more of the sites, were then developed. Although alternatives for many ecosystem restoration projects are developed by putting together different combinations of individual measures, this project has formulated alternatives by looking at various combinations of sites, for the following reasons:

- Because of the large number of individual sites and measures that were initially being evaluated, the derivation of all possible combinations was impossible. The number of possible combinations was calculated to be over 134 million.
- For most projects to be effective in addressing the problems and meeting the objectives (to be "worth it"), multiple measures need to be implemented.

5.4 Evaluation of Alternatives

In order to evaluate potential restoration alternatives for this study, it was necessary to develop a method to measure the benefits expected from the restoration projects identified above. Furthermore, USACE requires that a cost-effectiveness and incremental cost analysis (CE/ICA) be conducted on all restoration plans to help inform the decision on what level of environmental outputs are "worth it." An evaluation method that quantifies habitat benefits and estimates outputs is necessary to conduct the CE/ICA. Preliminary cost estimates were developed for each project using standard unit costs and estimates of project lengths, widths, and potential depths of excavation required based on the field reconnaissance. Preliminary estimates of costs to acquire fee title or easements on the land were also incorporated. These cost estimates, which include O&M costs for the life of the project, were intended to be preliminary to allow comparisons between alternatives. Unit costs, quantity estimates, assumptions, and markups used to develop the cost estimates are shown in the Design Report (Appendix H).

5.4.1 Habitat Evaluation Procedure

Given the variety of aquatic, terrestrial, and transitional habitat types present across the spectrum of the original sites under consideration, the Habitat Evaluation Procedures (HEP) model was selected as the most appropriate model to quantify habitat benefits. Habitat benefits were evaluated using a modified HEP for the following six species or groups of species: western pond turtle, beaver, wood duck, yellow warbler, native amphibians, and salmonids. These species were selected to represent the range of riparian, aquatic and/or shallow water riverine habitats that would be encountered in the study area.

The selection of species to include in the HEP model was based on several criteria. First and foremost, the species' geographic range had to include the project area. The species must also utilize the habitat type or types that are currently present, or are proposed for restoration. Species with existing HSI models were preferred, and use of previously developed and verified models provided a greater level of scoring certainty. Suitable HSI models also had to include habitat variables for which data collection was possible, given the availability of time and resources. Finally, variables

also had to show a change in score between the existing and proposed condition. If the project did not affect the SI score for a species, it was not possible to quantify an effect. Habitat variables that did not meet the above requirements were omitted. Additional information regarding selection of species to represent the habitat types at the proposed restoration sites is given in the HEP report, Appendix F.

In some cases, the models were modified to only include individual variables that were relevant to the resources found in the study area, and to eliminate those that were not present. The HEP was submitted to Center of Expertise for National Ecosystem Planning USACE (ECO-PCX) for planning model review and policy compliance, and all models have been approved for one-time use on this project (Appendix F). Also, in the case of the Tryon Creek Highway 43 Culvert project, only habitat variables for the adult fish (tributary) model were scored, since replacing the culvert would not make a measurable difference in the life stage of any of the other species included in the HEP model.

5.4.2 Future Without Project Condition Assumptions

The assumptions used to score the future without project conditions of the restoration sites are as follows:

- **Vegetation** The composition of the riparian community would remain similar to existing conditions. Although riparian zones are dynamic ecosystems, most areas surveyed either displayed stable, mature ecosystems (for example, sites along Tryon Creek) that are unlikely to change extensively over the projected time period without an event such as devastating wildfire, massive flood, or infestation by disease or pest, or are so constrained by revetments, development, and hardscape in the floodplain that the natural cycle of regeneration and maturation no longer occurs.

- **Water Quality** Although localized water temperature decreases may occur as a result of increased canopy cover along some stretches of stream, overall water temperatures are expected to increase by up to 1 degree due to continued development of the watershed and climate change effects. Other water quality parameters including level of dissolved oxygen, turbidity, and pollution from stormwater and industrial outputs are expected to improve over time due to increased regulation of water resources and better management of stormwater.

- **Large Wood** LW accumulation would remain similar to existing conditions. Narrow riparian zones in most areas do not promote woody debris recruitment, and although some woody debris may accumulate over the projected time period, a net gain of LW is not expected.

- **Percent Ground Cover at Water's Edge** The percentage of ground cover composed of materials such as logs and brush at the waters' edge is not expected to increase extensively.

- **Side Channels and Alcoves** Available off-channel habitat would remain the same as existing conditions or would decrease as streams further incise or further development occurs.

- **Fish Passage Barrier Removal** Fish passage would remain partially blocked as no other plans for removal/replacement exist.

5.4.3 With Project Condition Assumptions

The assumptions used to establish the future with project conditions of the restoration sites after implementation of restoration measures are as follows:

- **Revegetation** Five years after construction, a rapid increase in the number of small diameter trees, canopy cover and density, and understory shrub height over current conditions is expected. This increase is expected to continue for approximately 10 years, after which the rate of increase of these parameters would likely decrease. Shrub canopy growth would not increase as rapidly due to the lower amount of sunlight coming through the upper canopy, and shrub heights would not increase. Maximum cover over the stream and along the water's edge would be expected by this time. The increase in cover over the stream will produce a minimal reduction in the localized water temperature.

- **Water Temperature** Water temperature benefits are not expected to occur as a result of project alternatives, due to their limited size in comparison to the size of the waterbodies. Other water quality parameters including level of dissolved oxygen, turbidity, and pollution from stormwater and industrial outputs may be slightly improved on a site-specific scale by the proposed restoration measures, but these improvements are not expected to be measureable.

- **Large Wood** Upon implementation of the project, complexity and instream cover is expected to increase substantially with the placement of LW. Pools would scour in association with the wood and sediment and debris deposition would also occur, locally reducing channel incision and maintaining or improving connections to the floodplain. Over time, additional instream cover would develop with the potential of additional debris collecting in the piles and further recruitment of gravels as pools developed. Recruitment of LW would increase during this time period due to revegetation of the riparian zone during project construction. Instream cover would further increase.

- **Percentage of Ground Cover at Water's Edge** The percentage of ground cover would increase substantially in some areas immediately upon completion of the project due to placement of LW and revegetation, and is expected to further increase as restored vegetation matures and fills in available spaces.

- **Side Channels and Alcoves** Immediately upon project implementation, additional habitat would be created for fish rearing during high water events. Communities of hydrophytic plant species would be developing in these areas. Twenty-five years after the project, habitat would still be available for fish rearing during high-flow events. Further development of hydrophytic plant communities would be observed in these areas.

- **Fish Passage Barrier Removal** Immediately upon project implementation, fish access would be restored to habitat upstream for both rearing and spawning. The fish passage barrier removal project on Tryon Creek was scored by assessing the existing conditions of the habitat upstream that would be made accessible to salmonids. Since this project is specifically a fish passage project, the only habitat suitability index (HIS) that the project was evaluated for was tributary salmonids. It is not assumed that additional restoration of the habitat upstream would occur, therefore the project conditions remained constant over the 50 year projected life cycle of the project.

For each group of species, a HSI was derived (between 0 and 1). For this project, the HSI scores for the species were then averaged. The overall resulting index score was multiplied by the acreage of the alternative to yield habitat units. Because this plan is being formulated as an ecosystem restoration project and is not focused on restoring habitat for any given species or group of species, scores were not weighted. HSIs were calculated for existing conditions, conditions at 1-5 years, 6-10 years, and at 11-50 years without the project; and at 1-5 years, 6-10 years, and 11-50 years after restoration.

Table 5.4 summarizes the scores under existing conditions and after restoration. The highest possible index score is a 1.0 and indicates the best possible conditions for each group of species. Scores between 0.7 and 1.0 indicate good to excellent quality habitat. Sites scoring below 0.3 are not considered to have suitable habitat for the species selected.

Table 5.4. HSI Scores Under Existing Conditions and After Restoration

Project Site	**Existing HSI**	**HSI After Restoration (11-50 years)**	**Acres**
Mainstem Willamette River			
Kelley Point Park	0.48	0.86	57.54
Cathedral Park	0.40	0.61	6.43
Saltzman Creek	0.37	0.69	3.49
Oaks Crossing/Sellwood Riverfront Park	0.44	0.73	10.44
Columbia Slough			
St. Johns Landfill Boat Ramp	0.29	0.54	4.23
BES Plant	0.41	0.70	13.65
Kenton Cove	0.40	0.60	7.20
Tryon Creek			
Tryon Highway 43 Culvert			
Reach 1	0.00	0.93	13.00
Reach 2	0.00	0.65	24.10
Reach 3	0.00	0.63	11.90

5.4.4 Cost - Effectiveness and Incremental Cost Analysis

For ecosystem restoration, rather than putting a monetary value on habitat benefits, the focus of the alternatives evaluation is on the relationship of habitat benefits to project costs to ensure cost-effective and justified plans are put forth for recommendation for implementation. This process is described below. Cost-effectiveness and incremental cost analyses (CE/ICA) were performed using the IWR-Planning Suite software version 1.0.11.0. The analysis was conducted in the following steps:

1. Tabulate average annual cost and average annual environmental outputs of each restoration alternative.
2. Identify any sites whose implementation is dependent upon implementation of others.

3. Identify any sites that are not combinable with others.
4. Identify all potential combination of sites.
5. Calculate cost and output estimates for each alternative.
6. Identify any sites that provide the same output at greater cost than other combinations.
7. Identify any sites that provide less output at the same or greater cost as other combinations.
8. Evaluate changes in incremental costs for remaining combinations.
9. Identify most efficient set of remaining combinations ("best-buys").
10. Display changes in incremental cost for best-buy combinations.

Annualization was performed within the IWR Planning Suite Annualizer Module. The Annualizer is intended to be a consistent method of estimating Average Annual Habitat Units (AAHUs). It provides an interface where the habitat output for a site is entered for multiple years of the period of analysis. The software will plot these points as a curve and compute the AAHU's. Therefore, for any given site, the inputs are point estimates of habitat output across the period of analysis, which are entered into the Annualizer, and the output is AAHU's. These AAHU's are then inputs to the CE/ICA module of IWR-Plan.

For each site, both future without project, and future with project Average Annual Habitat Units (AAHU's) were calculated within the Annualizer. Then, in Excel, the difference between the future without and future with AAHU's was calculated to yield the net AAHU value for each site which was used in the CE/ICA.

To calculate the AAHU's in the Annualizer, three Habitat Units (HU) control points were used: the existing HU's (Year 0), the HU's in Year 5, and the HU's in Year 25. These three control points were entered into the Annualizer, and the Year 25 HU value was set as the "Max Output" in the Initial Terms box of the Annualizer screen. The period of analysis was set at 50 years, and the Annualizer was set to calculate by Linear Interpolation.

5.4.5 Costs/Output

This section summarizes the cost estimates and environmental output estimates associated with implementation of restoration measures at each of the restoration sites. The cost estimates, summarized in Table 5.5 and shown in Appendix H, account for the following:

- **Preconstruction engineering and design (PED)** This cost item includes preparation of final plans and specifications, geotechnical investigations, permitting, preconstruction surveying, staking, and preparation of as-built drawings, and was estimated at 20% of construction costs, including site preparation markups.
- **Construction, supervisory and administrative (S&A) support** This cost item includes construction oversight, inspections, administration, and engineering during construction, and was estimated at 15% of construction costs, including site preparation markups.
- **Operation and maintenance (O&M)** This cost item includes inspections, maintenance, revegetation, replacement, and operations, and was estimated at 9% of construction costs, including site preparation markups. No features included in the conceptual designs would require operation, and replacement of features is likely to be minimal. Maintenance and revegetation assumptions are included in the Monitoring and Adaptive Management Plan (Section 10).
- **Monitoring** This cost item includes development of site specific monitoring plans, annual monitoring surveys, and annual reporting, and was estimated at 1% of construction costs, including site preparation markups. Items to be monitored may include revegetated areas,

flows through side channels, fish passage, and wildlife use. Additional details of monitoring and adaptive management are included in Section 10.

- **Generalized costs associated with real estate acquisition, easements, or rights of way** Real estate costs were estimated for most sites using assessor's parcel numbers and property values available through the assessor's office. The exception to this is at Kelley Point Park, where the entire area is owned by the non-Federal sponsor. In this instance, it was assumed that a long-term easement would be put into place at an estimated cost of $100,000.00. A more specific estimate of costs associated with real estate acquisition, easements, or rights of way is being developed by the USACE.
- **Interest during construction (IDC).** IDC and annualization calculations were performed using the FY13 rate of 3.75%. IDC was not applied to the initial cost estimate, but was added to the cost as a component of the CE/ICA.

Preliminary cost estimates were prepared for the conceptual restoration plans in 2007, as shown in Table 5.5. Costs were estimated in spreadsheet format using established prices and assumptions that had been used for other, similar projects.

Table 5.5. Tentatively Recommended Plan Conceptual Cost Estimate (2007 Price Indices)

Location	Site Preparation	Restoration Construction Cost	General Markups	Real Estate	Total Estimated Costs, Including O&M
BES Plant	$68,471	$229,137	$217,451	$66,770	$582,099
Kelley Point Park	$1,048,957	$3,496,522	$3,318,200	$100,000	$7,963,679
Kenton Cove	$3,840.00	$102,560.00	$77,672.00	$47,250.00	$231,322.00
Oaks Crossing/Sellwood Riverfront Park	$30,398.00	$320,541.00	$256,186.00	$44,090.00	$651,215.00
Tryon Creek/Highway 43 Culvert	$1,526,311.00	$6,808,103.00	$6,083,029.00	$63,455.00	$14,481,297.00
Total	**$2,677,977**	**$10,956,863**	**$9,952,538**	**$321,565**	**$23,909,612**

It was assumed that construction would be completed at all sites in a 12-month period, except at the Tryon Creek/Highway 43 Culvert site, where a 24-month construction period was assumed. Base year for the construction estimate was 2017. No indirect or opportunity costs were identified.

Output estimates are measured in habitat units, which provide quality- and quantity-based estimates of environmental benefits at each potential restoration site. Table 5.6 summarizes the cost and 50-year output estimates for restoration at each of the sites in the final array of site plans.

Table 5.6. Cost and Output of Restoration at Each Site in the Final Array of Site Plans

Project Site	*AAC ($)*	*AAHUs**	*NPV Cost ($)*	*Total HU*
Kenton Cove	$10,300	1.22	$231,300	61
Oaks Crossing/Sellwood Riverfront Park	$29,000	2.69	$651,200	134
BES Treatment Plant South	$25,900	3.50	$582,100	174
Kelley Point Park	$355,000	19.04	$7,963,700	952
Tryon Highway 43 Culvert	$642,700	36.00	$14,417,900	1850
Saltzman Creek	$25,300	1.03	$568,100	51
Cathedral Park	$50,900	1.35	$1,141,300	67
St. Johns Landfill Boat Ramp	$46,900	0.94	$1,053,100	47

*Reflects net increase of AAHUs over future without project conditions

5.4.6 Relationships

Under the current array of alternatives, all sites are fully combinable with any other site. In most cases, these measures have been designed to build upon each other, meaning that increased functionality is a product of the interactions of all measures proposed at a given site. At each of the sites in the final array of site plans, each of the recommended measures is needed to fully meet the objective or objectives that will be addressed at that site. For example, at the Oaks Bottom site, if the wetland restoration component were implemented but construction of swales to allow fish to access the restored wetland was not included; the objective of restoring floodplain connections would not be met. As another example, if the only measure implemented at the Kenton Cove site was riparian revegetation, the objective of increasing aquatic and riparian habitat complexity and diversity would only be partially met. Examples like these could be given for each site, and underscore the point that anything less than implementing all of the recommended measures at each site will not be sufficient to meet the goals and objectives.

At the same time, the full range of measures that has been developed for this project are not proposed at each site, generally because they would not be cost effective, would be redundant and were not needed to meet the objectives for that site, or because the size of the site would not allow them to be implemented at a scale that would be effective. As an example, the main objective that would be met by implementing measures at the Tryon Creek Highway 43 Culvert site is to restore aquatic and riparian habitat complexity and diversity. Since riparian zone complexity in Tryon Creek was not identified as a limiting factor but fish access to upstream areas is a limiting factor, by far the most effective measure that could be implemented at this site is to replace the culvert with one that allows for fish passage. Therefore, additional measures such as upstream riparian restoration would not have substantially helped to meet the objectives and were not recommended for this site.

5.4.7 Cost Effectiveness Analysis

The cost effectiveness analysis is the first step in the CE/ICA, and compares the Average Annual Habitat Units (AAHUs) potentially achieved by each alternative to the cost of each alternative to generate a "cost per AAHU." This cost provides a means to compare the cost-effectiveness of each plan. The three criteria used for identifying non-cost effective plans or combinations include (1) the same level of output could be produced by another plan at less cost; (2) a larger output level could be produced at the same cost; or (3) a larger output level could be produced at the least cost. Cost-effectiveness is one of the criteria by which all plans are judged and plays a role in the selection of

the National Ecosystem Restoration (NER) Plan. Non-cost effective combinations of plans are dropped from further consideration.

A total of 255 possible plans were identified in the CE/ICA model run. Of these, 35 plans were cost effective but not best buys, and nine plans were best buy plans, including the No Action (Table 5.7). Figure 5.2 shows all 255 plans graphically by identifying the not cost effective, cost effective, and best buy plans on a scatter plot of average annual output versus average annual cost.

Table 5.7. Cost Effective and Best Buy Plans

*Plan Name**	*AAHUs*	*Type*	*AAC ($)*	*AAHUs*	*Type*
No Action Plan	0	3	$0	0	best buy
B0G0H0K0Z0A0P0O1	0.9425	1	$10,311	1.223	cost effective
B0G0H0K0Z0A1P0O0	1.0275	1	$25,947	3.499	best buy
B1G0H0K0Z0A0P0O0	1.223	2	$36,258	4.722	best buy
B0G0H0K0Z0A0P1O0	1.3525	1	$54,974	6.1905	cost effective
B0G0H0K0Z0A1P0O1	1.97	1	$65,285	7.4135	best buy
B1G0H0K0Z0A0P0O1	2.1655	1	$90,610	8.441	cost effective
B1G0H0K0Z0A1P0O0	2.2505	1	$116,158	8.766	cost effective
B0G0H0K0Z0A0P1O1	2.295	1	$137,550	9.3835	cost effective
B0G0H0K0Z0A1P1O0	2.38	1	$141,483	9.7935	cost effective
B1G0H0K0Z0A0P1O0	2.5755	1	$188,423	10.736	cost effective
B0G1H0K0Z0A0P0O0	2.6915	1	$354,975	19.0425	cost effective
B1G0H0K0Z0A1P0O1	3.193	1	$365,286	20.2655	cost effective
B0G0H0K0Z0A1P1O1	3.3225	1	$380,922	22.5415	cost effective
B0G0H1K0Z0A0P0O0	3.499	3	$391,233	23.7645	cost effective
B1G0H0K0Z0A0P1O1	3.518	1	$409,949	25.233	cost effective
B1G0H0K0Z0A1P1O0	3.603	1	$420,260	26.456	cost effective
B0G1H0K0Z0A0P0O1	3.634	1	$445,585	27.4835	cost effective
B0G1H0K0Z0A1P0O0	3.719	1	$471,133	27.8085	cost effective
B1G1H0K0Z0A0P0O0	3.9145	1	$492,525	28.426	cost effective
B0G1H0K0Z0A0P1O0	4.044	1	$496,458	28.836	cost effective
B0G0H1K0Z0A0P0O1	4.4415	1	$543,398	29.7785	cost effective
B0G0H1K0Z0A1P0O0	4.5265	1	$642,666	37	cost effective
B1G0H0K0Z0A1P1O1	4.5455	1	$652,977	38.223	cost effective
B0G1H0K0Z0A1P0O1	4.6615	1	$668,613	40.499	cost effective
B1G0H1K0Z0A0P0O0	4.722	3	$678,924	41.722	cost effective
B0G0H1K0Z0A0P1O0	4.8515	1	$697,640	43.1905	cost effective
B1G1H0K0Z0A0P0O1	4.857	1	$707,951	44.4135	best buy
B1G1H0K0Z0A1P0O0	4.942	1	$733,276	45.441	cost effective
B0G1H0K0Z0A0P1O1	4.9865	1	$758,824	45.766	cost effective
B0G1H0K0Z0A1P1O0	5.0715	1	$780,216	46.3835	cost effective
B1G1H0K0Z0A0P1O0	5.267	1	$784,149	46.7935	cost effective
B0G0H1K0Z0A1P0O1	5.469	1	$831,089	47.736	cost effective
B1G0H1K0Z0A0P0O1	5.6645	1	$997,641	56.0425	cost effective
B1G0H1K0Z0A1P0O0	5.7495	1	$1,007,952	57.2655	cost effective
B0G0H1K0Z0A0P1O1	5.794	1	$1,023,588	59.5415	cost effective
B0G0H1K0Z0A1P1O0	5.879	1	$1,033,899	60.7645	cost effective
B1G1H0K0Z0A1P0O1	5.8845	1	$1,052,615	62.233	cost effective
B0G1H0K0Z0A1P1O1	6.014	1	$1,062,926	63.456	best buy

B1G0H1K0Z0A0P1O0	6.0745	1	$1,088,251	64.4835	best buy
B0G1H1K0Z0A0P0O0	6.1905	2	$1,113,799	64.8085	cost effective
B1G1H0K0Z0A0P1O1	6.2095	1	$1,135,191	65.426	cost effective
B1G1H0K0Z0A1P1O0	6.2945	1	$1,139,124	65.836	best buy
B1G0H1K0Z0A1P0O1	6.692	1	$1,186,064	66.7785	best buy

*B=Kenton Cove
G=Oaks Crossing
H=BES Plant
Z=Tryon Creek Highway 43 Culvert
K=Kelley Point Park
A=Saltzman Creek
P=Cathedral Park
O=St. John's Landing

5.4.8 Incremental Cost Analysis

The incremental cost analysis portion of the CE/ICA compares the incremental costs for each additional unit of output from one cost effective plan to the next to identify "best buy" plans. The first step in developing "best buy" plans is to determine the incremental cost per unit. The plan with the lowest incremental cost per unit over the No Action Alternative is the first incremental best buy plan. Plans that have a higher incremental cost per unit for a lower level of output are eliminated. The next step is to recalculate the incremental cost per unit for the remaining plans. This process is reiterated until the lowest incremental cost per unit for the next level of output is determined. The intent of the incremental analysis is to identify large increases in cost relative to output. The cost and output information presented in the previous section is the input for cost effectiveness and incremental cost analyses to evaluate the relative effectiveness and efficiency of the proposed restoration at sites and combinations of sites relative to producing environmental outputs (in Habitat Units).

Incremental cost per unit output was calculated for the best buy plans by ranking them in order of increasing average annual output, as shown in Table 5.8. Figure 5.3 compares incremental cost of the best buy plans graphically with a box plot, which compares the incremental increase in average annual habitat units to the increase in incremental cost per unit output.

Table 5.8. Incremental Cost Analysis – Best-Buy Combinations of Restoration Sites

Plan Code	*Description*	*AAHUs*	*Inc. AAC ($)*	*Inc. AAHUs*	*Inc. Cost per HU ($)*
1	No Action	0.0	$0	0.0	$0
2	BES Plant	3.5	$26,400	3.5	$7,600
3	Plan 2 + Kenton Cove	4.7	$10,500	1.2	$8,600
4	Plan 3 + Oaks Crossing	7.4	$29,600	2.7	$11,000
5	Plan 4 + Tryon Hwy 43 Culvert	44.4	$668,500	37.0	$18,100
6	Plan 5 + Kelley Point Park	63.5	$368,500	19.0	$19,400
7	Plan 6 + Saltzman Creek	64.5	$26,300	1.0	$25,600
8	Plan 7 + Cathedral Park	65.8	$52,800	1.4	$39,100
9	Plan 8 + St. John's Landfill	66.8	$48,700	0.9	$51,700

Figure 5.2. All Plans Summary: Annual Cost vs. Annual Output

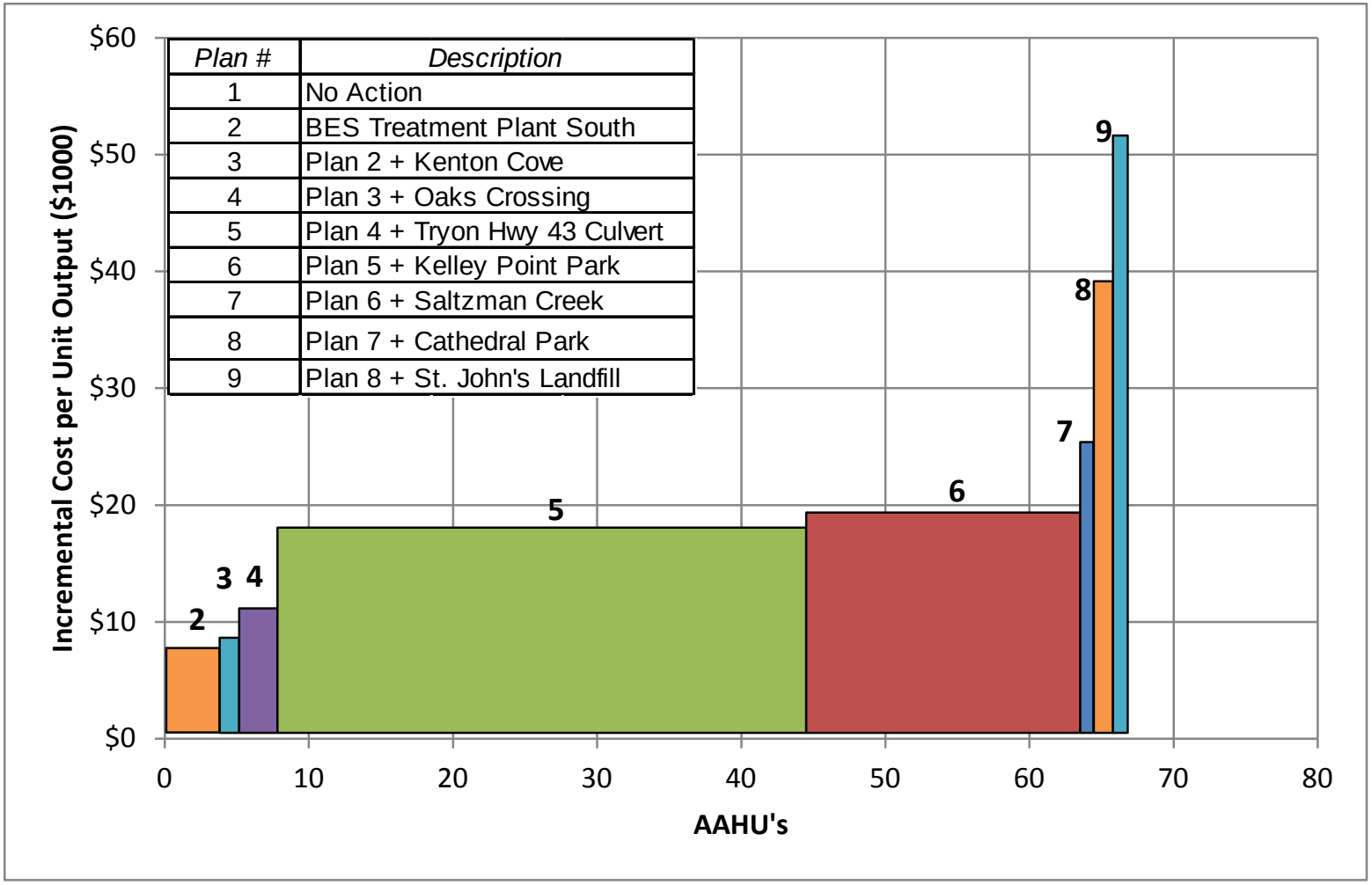

Figure 5.3. Best Buy Plans Incremental Cost Box Plots

5.5 Selection of the National Ecosystem Restoration (NER) Plan

After discussions with the project sponsors, Plan 6 was selected as the NER plan based on the total cost, the projects' distribution throughout the City's priority habitat areas, and consistency with the selection criteria described in Section 5.7. It is also the City's preferred alternative. At all of these sites, restoration efforts would complement previous or ongoing restoration efforts implemented by the sponsors or other entities, and in the case of the Tryon Creek Highway 43 Culvert project, would allow the habitat benefits at upstream restoration sites to be more fully realized. Plans 7-9, although best buy plans, offer minimal additional habitat benefits at a relatively high cost compared to Plan 6, therefore they are not considered worth the additional expenditure.

5.6 Tentatively Recommended Plan

The Tentatively Recommended Plan (TRP) is Plan 6, which would implement 5 restoration projects in the Lower Willamette Basin, as shown in Figure 5.4 and Table 5.8. This combination of restoration sites has a total cost of $26,527,000 and provides an increase of 3,339 habitat units over the 50-year period of analysis starting in 2017, ending in 2066. An estimated 152 acres of riparian, wetland, and backwater habitat will be restored under this plan. Descriptions of the recommended measures for each site are given below, and conceptual overview figures for proposed restoration features at each site are included in Appendix G.

Compared to ecosystem restoration projects occurring in different parts of the country, the average annual cost of $1,062.000 for the TRP is relatively high. The relatively high costs are associated with constructing in an urbanized environment, high costs of real estate and labor compared to more rural or less developed areas, and high mobilization/demobilization costs associated with constructing at multiple sites rather than a single site.

This project is a crucial component of efforts to restore habitat for aquatic and riparian species that were once commonplace here. The project's location near the confluence of the Willamette and Columbia Rivers makes it extremely important for species that will make their upriver to spawn or which will need stable habitat in which to rest, forage and rear before entering the increasingly saline environment in the Columbia River estuary. Although this project is not directed towards BiOp compliance for the Columbia River or Willamette River systems, it will provide extensive habitat benefits for listed species and will complement other recovery efforts for listed salmon runs in the area.

Measures applied at each site to achieve the objectives are shown in Table 5.9. These measures reflect the best and highest use of each site, and will achieve the objectives if all measures are implemented.

Table 5.9. Measures Applied at Each Site to Meet the Objectives

Site	Objective 1	Objective 2			Objective 3
	Revegetation	LWD	Off-channel habitat	Fish barrier removal	Floodplain reconnection
Kelley Point Park	X	X	X		X
BES Plant	X	X	X		
Kenton Cove	X	X			
Oaks Crossing	X	X	X		X
Tryon Creek/Hwy 43	X			X	

5.7 Planning Guidance Criteria

Per ER 1105-2-100, recommended plans should be evaluated for completeness, effectiveness, efficiency, and acceptability. The recommended plan can be implemented as a stand-alone restoration project and is not dependent on actions by other agencies or stakeholders. It will function in perpetuity and allow the natural formation of riverine, riparian, and floodplain habitats. Culvert removal, side channel restoration, addition of large wood, and bank layback projects have been successfully implemented in multiple locations throughout the Pacific Northwest for watershed restoration and have been demonstrated to be effective. Therefore, the recommended plan has a high probability of achieving the project goals and objectives in a cost-effective manner.

The planning team compared all of the "best buy" and "cost-effective" plans using the four evaluation criteria. The results are as follows:

- **Acceptability** An ecosystem restoration plan should be acceptable to State and Federal resource agencies, local governments and stakeholders in the area. There should be evidence of broad based public consensus and support for the plan. A recommended plan must be acceptable to the non-Federal cost-sharing partner. However, this does not mean that the recommended plan must be the locally preferred plan. The recommended plan meets all of the project objectives, including: 1) Reestablishing riparian and wetland plant communities; 2) Increasing aquatic and riparian habitat complexity and diversity; and 3) Restore floodplain function and complexity. The recommended plan meets these objectives, will not cause adverse effects to existing habitats, and is constructible. The cost-share partner has expressed a high level of support for the recommended plan.

- **Completeness** A plan must provide and account for all necessary investments or other actions needed to ensure the realization of the planned restoration outputs. This may require relating the plan to other types of public or private plans if these plans are crucial to the outcome of the restoration objective. Real estate, O&M, monitoring, and sponsorship factors must be considered. Where there is uncertainty concerning the functioning of certain restoration features and an adaptive management plan has been proposed it must be accounted for in the plan. The recommended plan will realize the predicted habitat outputs by providing the complete mix of measures that ensures that hydrologic, fish passage, wildlife, and vegetation objectives are met. O&M will be required, but is primarily focused on the first 5 years after implementation and conducting invasive species removal/control efforts and replanting as appropriate. This is to ensure that invasive non-native species are controlled for the long-term and do not reoccupy the majority of the project sites, as they currently do. Experience by many entities in the watershed has indicated that maintenance efforts for up to 5 years is appropriate to ensure that invasive species are adequately controlled. Once the native vegetation can become established and start to provide shading of the understory, invasive species become reduced in vigor. Temporary controls such as mowing and spot application of herbicide to the invasive species may be necessary for native species to become fully established. Also, it is typical in most revegetation efforts that some replanting is necessary as not all planted stock survives. Once a plant has survived 1-2 years, it can typically then persist and grow suitably over time. It is not intended that large wood will be replaced or maintained as it is being installed to provide up to 25 years of cover and habitat formation until the riparian zone can begin to mature and start naturally recruiting large and small wood to the river system. Channel openings will be monitored, but are expected to be sustainable because they are primarily backwater

connections. In the case of a flow-through side channel at Kelley Point Park, maintenance sediment removal may be needed occasionally to keep the entrances open.

- **Effectiveness** An ecosystem restoration plan must represent a cost effective means of addressing the restoration problem or opportunity. It must be determined that the plan's restoration outputs cannot be produced more cost effectively by another agency or institution. The recommended plan will provide substantial benefits at a reasonable cost. These benefits cannot be realized more effectively by the non-Federal sponsor or other stakeholders because they do not have the funds to construct the primary elements of the project that restore fish access or side channels.

- **Efficiency** An ecosystem restoration plan must make a substantial contribution to addressing the specified restoration problems or opportunities. As identified above under acceptability, the recommended plan will contribute substantially towards the primary objectives of the study. The types of restoration measures proposed have been used in many locations and shown to be effective, including providing access to off-channel habitats, installation large wood, and restoring riparian plant communities.

5.7.1 Other Evaluation Accounts

The Planning Guidance Manual requires evaluation of alternatives according to several evaluation accounts including the National Economic Development (NED), Regional Economic Development (RED), Environmental Quality (EQ), and Other Social Effects (OSE). Ecosystem restoration projects are also evaluated for NER benefits. The plans formulated and evaluated for this project were all developed to provide ecosystem restoration benefits. There is no evaluation for a NED or RED plan as benefits are not monetized and no measurable economic benefits would accrue.

"Other social effects" describes the potential effects of project alternatives in other areas not explicitly in the other accounts. This would include effects on the community, health and safety, displacement, energy conservation, environmental justice, and other non-monetary effects. Other social effects are summarized briefly by a variety of categories, below, but generally result in no measureable changes to other social considerations.

- **Displacement/Impacts to Residences** There would be no displacement of residences as implementing the TRP would not require removing any residences from the floodplain.

- **Displacement/Impacts to Minority or Low Income Populations** There would be no displacement effects on minority or low income populations as implementing the TRP would not require removing existing structures or residences.

- **Public Health and Safety** There would be very minor benefits to public health and safety under both the NER plans as a result of removal of debris and trash from the sites. The No Action alternative would maintain the existing condition with debris and trash on some sites. The installation of engineered log jams (ELJs) in the river will be designed to avoid effects to public health and safety (i.e. by positioning to allow boaters to get around the feature and not leaving sweeper logs, branches, etc. that could snag boaters).

- **Displacement/Impacts to Businesses** There would be no displacement or other effects on businesses as none of the TRP sites would be located on parcels with businesses and the

project is designed to not increase the flood water surface elevations of the river or tributaries.

- **Displacement/Impacts to Recreation** Recreational use occurs on some of the sites considered. The project would not change any recreational uses, but maintain existing compatible recreational uses.

- **Community Growth** There would be continued community growth under the No Action and TRP, but this growth is not related to any action. The restoration of aquatic habitats would have incremental benefits to the community and future development by maintaining and improving fish and wildlife populations.

- **Community Well Being** The No Action alternative would not change community wellbeing. The TRP would provide restored aquatic habitats, some of which would be publicly accessible, that could provide improved educational opportunities and also fishing opportunities.

- **Aesthetics** The No Action alternative would not change existing aesthetics. The restoration alternatives would restore most sites to more natural looking riparian and wetland habitats.

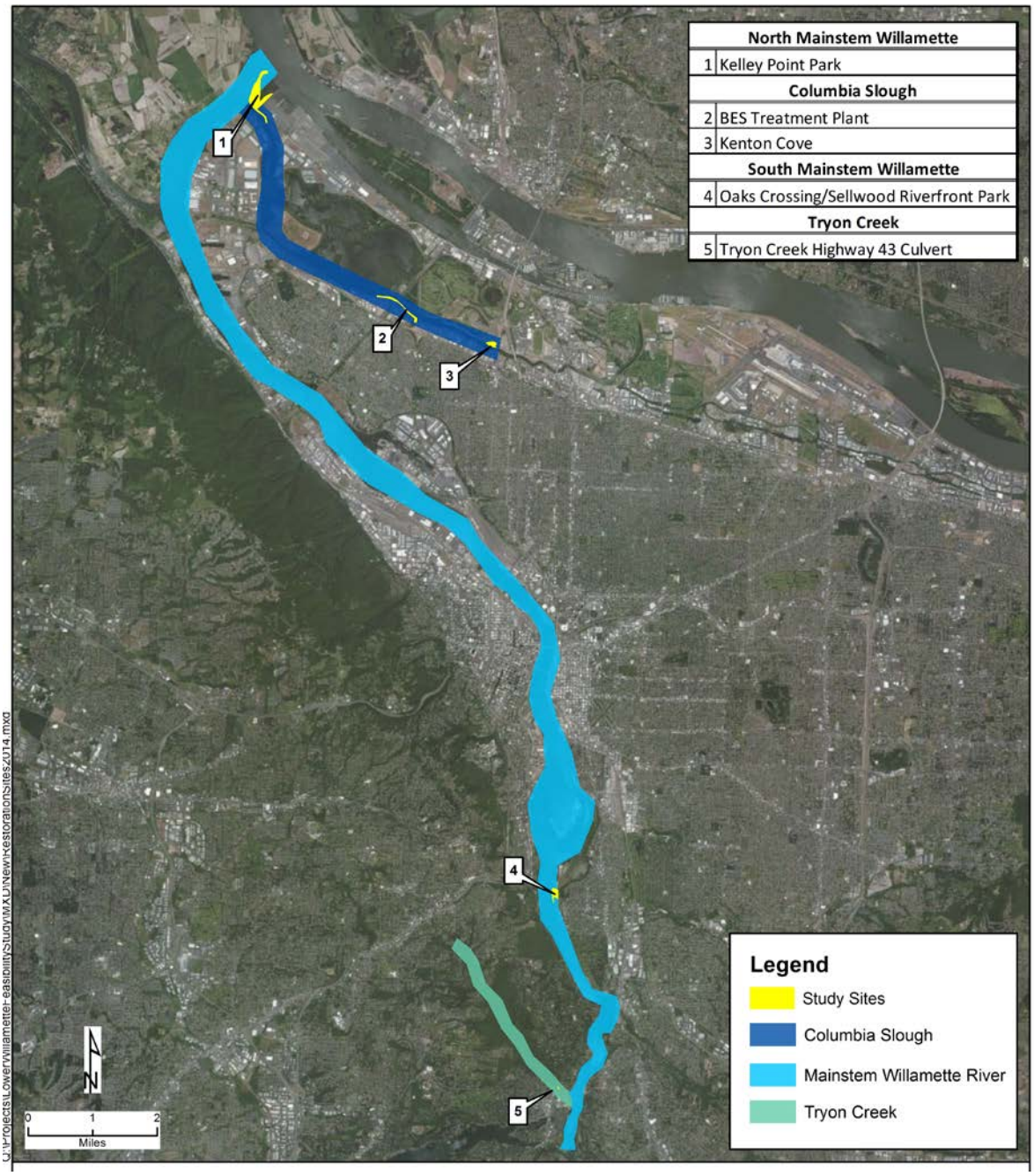

Figure 5.4. Restoration Sites included in the Tentatively Recommended Plan

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6. RECOMMENDED PLAN

6.1 Design Features

Feasibility level designs were created for each site. The design features are displayed in detail in the design plans that are included as Appendix H.

6.1.1 Clearing

Clearing includes the removal of large rocks, boulders, riprap, and debris from land for access and in advance of vegetative restoration. Although removal of invasive species may occur incidentally as a result of clearing, it is described in greater detail below.

Clearing will be accomplished by hydraulic excavators, dozers, front end loaders, and dump trucks. Unusable rocks and debris will be removed to an off-site landfill or reuse site.

6.1.2 Removal of Invasive Vegetation

The purpose of removing invasive vegetation is to allow native vegetation to gain a competitive foothold in the project area. To this end, it is neither generally feasible nor necessary to remove all invasive vegetation, but its density and areal extent must be reduced to the point where native vegetation can establish itself as the dominant vegetation type.

Hand labor and small equipment will be used to cut and/or pull to remove invasive vegetation, and solarization may be used in areas where cutting or pulling are not appropriate. Spot application of herbicide is appropriate after cutting to kill or reduce the vigor of the invasive plant stems, while also minimizing any potential for spills or over-application. The removed vegetation will be disposed of off-site, such as at a compost facility, or chipped and composted on-site. It is expected that this would occur prior to planting, and then maintenance to continue to cut and/or apply herbicide to the invasive species would be conducted for up to 5 years following construction.

6.1.3 Excavation

Excavation will occur where it is needed to remove a culvert, to develop side channels and backwater connections and to regrade bank slopes to more natural angles. Excavation limits are determined by the design details at each restoration site or where sensitive cultural or natural resources prohibit grading.

Excavation will be accomplished by hydraulic excavators, dozers, front end loaders, and dump trucks. Excavated materials will be placed at both on-site and off-site disposal locations. Care and diversion of water will be needed for excavations that are in or adjacent to water. This will be accomplished by placement and maintenance of temporary coffer dams and pumps. Best management practices for erosion control will be placed and maintained to avoid excessive turbidity in adjacent waterways. Except at the Highway 43 Tryon Creek Culvert site, work areas will generally be isolated from the rivers, with final connections made during the allowed in-water work windows (coordination with ODFW will be required to determine site-specific in-water work windows).

6.1.4 Construction of Side Channels and Backwaters

Side channel construction involves the placement of one or more of the following: bank stabilization measures, streambank vegetation restoration, and riparian vegetation restoration. Channel invert grades are designed to provide a backwater connection during the typical winter/spring flows (November to June) at the channel outlets, so grade control measures are unnecessary. Bank stabilization is accomplished using vegetation, large woody debris and root wads, and fabric as necessary. Bank and riparian restoration will include the planting of local, native vegetation species.

Backwater connections such as those that will be created at the BES Plant and Oaks Crossing/Sellwood Riverfront Park sites include the elements of side channel construction, but are typically shorter because they will be designed to achieve a backwater connection or connections between ponds using existing topographic features (following overflow channels or other existing channels), and may not typically include riparian restoration features if an existing overflow channel is simply widened and/or deepened. These channels may include roughness features to slow velocities.

Construction of the side channel and backwater habitat elements will be staged to follow clearing and excavation. Bed material will be placed with excavators, front end loaders, and dump trucks. Large woody debris, root wads, and native rock materials will be placed by using a combination of machines and hand labor. Streambank and riparian vegetative plantings will be accomplished using hand labor during the fall after other construction activities are complete.

6.1.5 Placement of Large Wood in Floodplains and Backwater Areas

Large wood will be placed in floodplain areas to provide habitat diversity and cover for amphibians, reptiles, and other wildlife species. Wood will be anchored with large rock or keyed into banks. This wood will provide cover for fish species as well as perching or basking habitat for wildlife.

Rootwads and large woody debris, cut to specified dimensions, will be obtained from a local source. The rootwads will be placed using an excavator, dump truck, small equipment, and hand labor. Large woody debris will be placed using small equipment and hand labor.

6.1.6 Riprap Installation

Riprap may be used, only as necessary, to protect the footing of the culvert at the Highway 43 Tryon Creek site. Riprap will only be used following the guidelines in PROJECTS. Riprap will be placed using a hydraulic excavator.

6.1.7 Culvert Installation

At the Highway 43 Tryon Creek site, the stream will continue to be passed under the road in a culvert. The existing culvert will be replaced by one of sufficient size to allow woody debris to pass, improve hydraulic capacity, and provide a natural bottom and room for the channel to meander slightly. The culvert size will be determined with hydraulic design calculations and will meet the State of Oregon's and NMFS's recommendations for fish passage.

Culvert construction will be staged during the appropriate in water work window. Culvert installation will be conducted with mechanized equipment, and when necessary will include the

pouring of concrete footings below the soil surface. Traffic control plans and designs will require approval by Oregon Department of Transportation (ODOT).

6.1.8 Vegetative Plantings

Native vegetation species will be planted at all sites. The primary plant community that will be planted will be the riparian community, dominated by black cottonwood, red alder, Oregon ash, incense cedar, Douglas-fir, and a variety of shrub species. At sites with extensive tree cover, currently, the invasive understory will be removed and then replanted with appropriate riparian underplantings of shrub and conifer species. The shallow water and wetland zones will be planted with native emergent wetland vegetation.

6.1.9 Crossing Structures

Two small crossing structures will be placed to allow foot access over the side channels at Kelley Point Park. Existing trails may be isolated by construction of the side channels, limiting access to hikers and other recreational users. Crossing structures would likely be wooden or prefabricated and would be placed near the ends of the side channels.

6.2 Monitoring and Adaptive Management

Monitoring and adaptive management will be incorporated into all projects. Features that may be monitored for include fish passage, wildlife use, invasive plant species, and flows through side channels. An adaptive management plan will be developed in instances where features are not performing as expected or where the outcome does not appear to be meeting the objectives for that site. Additional information about monitoring and adaptive management appears in Section 10.

6.3 Cost Estimate

A cost estimate using the USACE's Micro-Computer Aided Cost Estimating System (MCACES) was developed in 2013 and is attached to the Design Report (Appendix H). Real estate costs have been estimated on a preliminary basis, but a gross appraisal and estimate of Lands, Easements, Rights-of Way, Relocation, and Disposal Sites (LERRDs) is being developed by the USACE (Appendix G). The preliminary cost estimate for implementation of the TRP is shown in Table 6.1. Federal and non-Federal costs are shown in Table 6.1.

Table 6.1. Federal and Non-Federal Costs

Item	Federal	Sponsor	Total
ECOSYSTEM RESTORATION			
Design & Construction	$17,218,000	$9,309,000	$26,527,000
LERRDs*	TBD	TBD	TBD
Total Cost-Shared Implementation Costs**			$26,527,000
Percentage of Total Cost-Shared Amount – Ecosystem Restoration: Per Section 210 of WRDA 1996, the non-Federal cost for ecosystem restoration projects is 35 percent of all construction costs, except for recreation features which are cost-shared at 50%, and 100 percent of OMRR&R.	65%	35%	100%

*LERRDs costs will be inserted upon completion of estimate.
** Total Cost-Share to be updated upon completion of LERRDs estimate.

6.4 Construction Issues

Construction is anticipated to be relatively straightforward at all sites, with the exception of the Highway 43 Tryon Creek Culvert site. All sites are accessible to heavy construction machinery and staging areas are available at or near all sites.

Due to the heavily used highway that passes over the Tryon Creek Highway 43 culvert, as well as the train tracks, construction at this site is likely to temporarily impact car and rail traffic. Although construction can likely be accomplished without completely closing the highway, it will likely need to be narrowed to one lane in each direction or possibly one lane used alternately by traffic traveling in opposite directions. Further coordination with the Portland and Western Railroad is required to determine acceptable measures during construction.

6.5 Elements for Detailed Design

Several design elements need to be developed in order to advance the project from feasibility to final design. These elements include but are not limited to the following;

- Supplemental bathymetric and topographic surveying
- Detailed hydraulic analysis for:
    - LW sizing and placement
    - Sizing of side channels
- Detailed design of the Highway 43 Tryon Creek culvert
- Detailed planting plans
- Traffic control plan

6.6 Schedule

Final review and approval of the project is expected in early 2015, followed by planning, engineering, and design (PED) in 2016 and groundbreaking in 2017. An estimate schedule for remaining planning tasks, PED, and construction appears in Table 6.2.

Table 6.2. Tentative Planning and Construction Schedule

Milestone	2014	2015	2016	2017	2018
District Quality Control/Alternatives Technical Review (DQC/ATR)					
Alternatives Formulation Briefing (AFB)					
Public Draft Feasibility Report/EA					
Final Feasibility Report/EA					
Civil Works Review Board					
Project Approval					
Project Partnership Areement (PPA) Signed					
planning, Engineering, and Design (PED)					
Construction Phase 1					
Construction Phase 2					

6.7 Risk and Uncertainty

A certain degree of risk and uncertainty is inherent in any restoration project. Risk in terms of public health and safety is reduced to the degree possible during the planning and design process, and known risks are described in associated environmental documentation. Uncertainty is found where some factors are beyond the control of the project design team, for example precipitation rates, new types of invasive species, or changes in human use of the site. Risk and uncertainty translate to project constraints, which provide the sideboards that guide the extent to which restoration can occur.

6.7.1 Risk Register

Earlier in the planning process, a risk register was developed to serve as a tool for identifying risks throughout the feasibility study and implementation. The risk register is a spreadsheet where the risks associated with the study outputs and project outcomes are documented based on input from the PDT and feedback from a risk specialist and other vertical team members.

The main item identified as a risk in the risk register for the ecosystem restoration project was in regard to screening that resulted in the original list of projects being narrowed from 45 possible sites to the final array of eight sites. The identified risk was that the list of sites would narrow even further. This risk is low, since the current list of projects included in the recommended plan are those that the City considers to be critical to meeting its objectives in the Lower Willamette River watershed.

Although not identified in the risk register, the items below present topics that have been considered as risks in the planning study, and have been incorporated into the design and planning of this project.

Invasive Species Reed canary grass is widespread in the Lower Willamette River study area and without active intervention will likely outcompete native species after the sites are disturbed during construction. This species is very competitive and can out-compete most native species without active intervention. The most feasible and successful measures to control of reed canary grass are incorporated into the design and construction features of each plan, and long-term measures designed to track populations and keep them under control will be developed during preparation of a long-term monitoring and adaptive management plan.

Contaminated Sediments Three of the proposed restoration sites are located downstream of the Portland Harbor Superfund site, which contains numerous “hotspots” of sediments contaminated with PCBs, industrial solvents, and other by-products of industrial activities and shipbuilding in the harbor. Although no contamination was identified at the restoration sites identified in the recommended plan, disturbance of upstream sediments during dredging, remediation, or restoration of other sites can mobilize contaminants and allow them to settle in downstream areas. The risk of contamination occurring at the restoration sites from mobilization of contaminated sediments is considered to be low due to containment requirements during sediment-disturbing actions.

Several areas near the Oaks Crossing/Sellwood Riverfront Park site are known to contain DDT residue from past pest-control practices. Sediment testing conducted as part of the Oaks Bottom Restoration Project indicated that DDT is present in the sediments at that site, which is located

within a mile of the Oaks Crossing/Sellwood Riverfront Park site. DDT residue has also been identified in sediments excavated during dredging at the nearby Oaks Bottom Yacht Club. Sampling of fish tissue collected at the Oaks Bottom site has been performed by NOAA Fisheries, and results indicated that concentrations of DDT were below threshold levels and therefore did not constitute a threat to fish using that particular area.

Changed Climatic Conditions Causing Changed Hydrologic Conditions Possible effects of climate change include increased average tidal elevations, which would affect all sites included in this plan except for the Tryon Creek Highway 43 site. The restoration plan includes a range of native plant species so communities can adapt to changed hydrologic and climatic conditions. In general, it is expected that wetland and riparian plant communities will respond to higher tidal elevations by forming at higher elevations in the floodplain.

Potential Adverse Effects on Species or Water Quality Conditions During Construction The risk of harm to anadromous fish species will be reduced to the degree possible by working within specified work windows, when fish are least likely to be present. Best management practices will be implemented to ensure water quality standards are met during construction. For other sensitive species, protection plans will be developed during later stages of design and during the permitting phase and implemented during construction.

Potential for Failure of Project Features Restoration measures proposed in this plan are established and have been implemented at numerous sites around the Pacific Northwest and elsewhere. A geomorphic assessment of the proposed project sites that was performed to identify geomorphic features that may contribute to failure of any restoration measures found a low risk of failure at all sites (Appendix A). Additional detailed hydraulic modeling and engineering during design will further refine the features to withstand anticipated flows and velocities.

Competing Uses Kelley Point Park is a popular location for walking, bird-watching, and other forms of recreation. Construction of channels at this location has been mentioned as a potential user conflict, with the premise that the channels would reduce the area available for pedestrians or other users. Crossing structures will be provided wherever necessary.

Competition for Restorable Sites Risk to the implementation of ecosystem restoration projects at the selected sites is related to competition for viable aquatic restoration sites in the Lower Willamette River. Due to extensive pending Natural Resource Damage Assessment (NRDA) mitigation needs by entities that are identified by EPA as Primary Responsible Parties (PRPs) for cleanup in the Portland Harbor Superfund site, competition amongst the PRPs for sites that provide opportunities for restoration and thus mitigation credits may increase as EPA gets closer to issuing its final ROD. This increases the risk that over time, some of the sites that are now part of the recommended plan could be purchased or placed under an easement by a PRP, which would eliminate it as an ecosystem restoration site under this plan.

Water Quality in Columbia Slough Poor water quality in Columbia Slough may reduce the efficacy of restoration projects in this water body. Problems that were identified in this water body include high pH levels, low dissolved oxygen levels, high water temperatures, and algal blooms (Wells 1997). The ODEQ listed the Columbia Slough as water quality limited for beneficial uses including salmonid rearing, resident fish and aquatic life, wildlife and hunting, fishing boating,

recreation, and aesthetic quality and subsequently developed TMDLs for Chlorophyll A, pH, phosphorus, dissolved oxygen, bacteria, DDE, DDT, PCBs, dioxin, and lead (USACE 2001). Stormwater runoff, leaching septic system contributions to base and shallow groundwater flows, combined sewer overflow events have been identified as sources for the constituents that trigger poor water quality. Development and urbanization within the Columbia Slough watershed has caused a loss of riparian vegetation and pervious surface area which has resulted in a reduction of the assimilation capacity associated with the vegetative buffer area that historically would have been present around Columbia Slough. Some of these issues are seasonal and occur primarily in the summer. Efforts to restore ecosystem functions in the Columbia Slough watershed have been made by the USACE and the City, and ongoing efforts to improve water quality throughout the Lower Willamette River basin may help to alleviate this issue. The proposed projects at BES Plant and Kenton Cove are not extensive enough to make a difference in these issues on their own, but will add to the cumulative effect of other, more comprehensive efforts to improve water quality.

Rail Disruption Although the USACE has commenced discussions with the Portland and Western Railroad regarding potential disruptions to rail traffic as a result of replacing the culvert at Tryon Creek/Highway 43, the Railroad to date has not given permission to use their property in such a manner. Therefore, there is a risk that permission will not be granted and this project will not be possible as designed. Additional design options may exist that would be less disruptive to rail service, including use of a temporary rail bridge during construction rather than possible temporary closure of the rail lines. This risk will be reevaluated periodically during the planning process, as talks with the railroad are ongoing. If the Railroad does not agree to allow construction at this location, the project objectives would still be met, but not to the extent that they would be with this project.

6.8 Significance of the Recommended Plan

Non-monetary values associated with ecological resources are required to be documented per ER 11-5-2-100 Appendix C. These values are based on technical, institutional, and public recognition of the ecological, cultural and aesthetic attributes of resources within the study area. Per this direction, this section provides narrative and tabular descriptions of non-monetary values (Table 6.3).

The recommended plan will create or restore off-channel habitats at Kelley Point Park, Oaks Crossing, Kenton Cove, and BES Plant, reconnect upstream habitat through culvert replacement at Tryon Creek, and restore aquatic habitat at all sites through placement of wood and revegetation with native species. These measures will expand and restore essential rearing and refuge habitats for multiple ESA listed fish and wildlife species and species of concern that occur in the Lower Willamette Basin and contribute toward their recovery. Of primary focus are the species included in the HEP analysis; including those species dependent on suitable aquatic conditions such as salmonids and Western pond turtle, and riparian dependent wildlife such as beaver and wood duck, yellow warblers, and native amphibians.

Specifically, the types of improvements that this project will make to their habitats include provision of fish access to off-channel habitats, improvements in quality to the off-channel habitats including provision of more suitable off-channel water depths that vary naturally with the seasons (deeper depths in winter, shallower water in summer), improvements in cover and shading,

increases in large wood and small woody debris, removal of invasive species and revegetation with native species, and interspersion of habitat types.

Key agencies, including NOAA Fisheries, USFWS, EPA, ODFW, and others are looking to projects such as this to provide valuable habitat and process restoration. This project, as proposed, would provide key aquatic habitat restoration projects along the Lower Willamette River and contribute to the recovery of sensitive species.

6.8.1 Institutional Significance

Institutional recognition is based on the significance of resources acknowledged in laws, adopted plans and policy statements by agencies both public and private. The plans and programs listed in Section 2 demonstrate the significance of the resources to multiple agencies.

This project will restore and reconnect off-channel and floodplain habitats for several species listed under the ESA, including the following ESUs; Lower Columbia Chinook salmon, Upper Columbia spring-run Chinook salmon, Upper Willamette Chinook salmon, Snake spring and summer-run Chinook salmon, Snake fall-run Chinook salmon, Columbia Chum salmon, Lower Columbia/Southwest Washington Coho salmon, Snake Sockeye, Lower Columbia steelhead, Middle Columbia steelhead, Upper Columbia steelhead, Upper Willamette steelhead, Snake steelhead, Willamette Recovery Unit bull trout, Southern Distinct Population Segment (DPS) of North American green sturgeon, and species of concern including the Pacific lamprey and Coastal cutthroat trout. The project will improve habitat, in some cases including habitat designated as critical, and contribute toward their recovery. In addition, this project will restore suitable floodplain and riparian habitats for species of concern identified by the USFWS, including Western pond turtle and Pacific lamprey. This project will also contribute toward meeting key objectives of the *Willamette Subbasin Plan* (NPCC 2004) developed as part of Phase 1 of this study, but involving multiple federal, state, regional, and local agencies to set priorities for fish and wildlife conservation throughout the basin. Key aquatic habitat strategies that this project will address include: 1) increase interaction of rivers and floodplains; 2) increase and restore off-channel and wetland habitat; and 3) control the most damaging terrestrial and aquatic invasive species (NPCC 2004).

6.8.2 Public Significance

Public significance means that some segment of the public recognizes the importance of an environmental resource. In the case of the Willamette River Valley, which hosts 70% of the state of Oregon's population, there exists a strong citizen involvement in the uses and activities of the river. The Willamette River is one of ten rivers included in the Sustainable Rivers Project between the USACE and the Nature Conservancy. A wide variety of groups have interest in protecting the habitat along the Willamette River, for the purpose of protecting fish and wildlife, but also to improve recreational and aesthetic value of the river, which is a centerpiece of sociocultural activities in Portland. Local interest groups will be given the opportunity to review proposed ecosystem restoration plans and will benefit from completion of these plans.

6.8.3 Technical Significance

Technical significance of the ecosystem restoration is determined through review of relevant published and non-published literature and documents that provide a scientific (or technical) basis for the value of the proposed restoration. Numerous scientific analyses and long-term studies through Oregon State University and the University of Oregon have documented the significance of the resources in the Willamette River basin, of which the *Willamette Basin Planning Atlas* provides

the most comprehensive review of how resources have been lost, while laying out scenarios to guide future development for restoring natural resources.

The recommended plan will restore connectivity between the deepwater channels of the Lower Willamette River and Columbia Slough and the off-channel habitats that they have become separated from. This connectivity is a key component of natural processes that have been substantially altered by the presence and operation of upstream dams, revetments, land use and infrastructure. Ecosystem restoration will also provide improvements to water quality and riparian habitat, which will further improve fish and wildlife habitat.

Table 6.3. Non-monetary Significance of Ecosystem Restoration in the Lower Willamette River

Resources Along Lower Willamette River (RM 0-17), Columbia Slough, and Tryon Creek	**Sources of Significance**		
	Institutional Recognition	**Public Recognition**	**Technical Recognition**
ESU Salmonids	ESA listing of numerous ESUs of salmon throughout the Lower Willamette River and its tributaries. House Resolution Docket 2687 identified the importance of ecosystem restoration along the Lower Willamette River watershed. USACE has prepared a BA in coordination with NOAA and USFWS to evaluate the impacts of the operation of the Willamette projects on species listed under the ESA. Magnuson-Stevens Fishery Conservation and Management Act requires measures to protect essential fish habitat during any water resources development project.	Historically, the area has supported an important recreational fishery. Component of local tribal value, both culturally and economically. The public has become increasingly aware that protection of threatened and endangered fish is an essential component of greater overall sustainability of fish and wildlife habitat throughout the region.	Reduced stocks of salmon have been extensively documented and resulted in listing of particular stocks as protected. Project area is essential migratory route for all ESA recognized ESUs of salmon. Upstream passage above culverts is essential to restoring lost spawning grounds.
Resources Along Lower Willamette River (RM 0-17), Columbia Slough, and Tryon Creek	**Sources of Significance**		
	Sources of Significance	**Resources Along Lower Willamette River (RM 0-17), Columbia Slough, and Tryon Creek**	**Sources of Significance**

Fish and Wildlife Habitat; Floodplains, Wetlands and Off-Channel Aquatic Habitat	EO 11998 requires agencies to take steps to restore and preserve the natural and beneficial values served by floodplains, which includes off-channel habitats. EO 11990 requires protection of wetlands. Fish and Wildlife Coordination Act requires habitat conservation to be equally considered along with water resources development projects.	There is an increasing understanding that flooding damage results from altered river systems and loss of floodplain connectivity. Willamette Riverkeeper and partner associations include thousands of volunteer river advocates who work for conservation and protection of fish and wildlife habitat.	Floodplain connectivity is essential to exchange of nutrients, recruitment of wood, flood buffering, and preservation of dynamic natural processes that create native habitat complexity and diversity and support fish and wildlife. Off channel aquatic habitat and wetlands provide refugia and rearing habitat for native fish and wildlife essential for support of all life cycles. Wetlands provide habitat, water cycling, and flood buffering.
Water Quality	Portland Harbor has been added to EPA's National Priorities List of contaminated sites (Superfund). TMDLs have been developed for EPA's 303(d) listed stream segments with pollutant exceedances.	Organizations such as Willamette Riverkeeper, Citizens for Safe Water, and others bring the health of the river into the political spotlight.	Clean water is essential for drinking, municipal, agricultural, and other human uses. It is also needed for protection of fish and wildlife species. The ODEQ reports that water quality in the AOI is very poor to fair, based on a suite of water quality parameters.
Cultural	National Historic Preservation Act provides for protection of culturally valuable sites and artifacts.	River Renaissance Initiative is citywide collaboration for returning Willamette waterfront to cultural centerpiece.	Data from a variety of sources indicates that artifacts and structures of historic value may be present.
Aesthetic	Oregon Statewide Planning Goals 5 and 15 guide the protection of aesthetic qualities in the city of Portland and along the Willamette River Greenway.	The Greenway Plan and advocates for open space demonstrate the public's sense of valuing natural spaces for their aesthetic appeal.	Visual appeal of outdoor spaces has been shown to improve the health of those who have the opportunity to experience it regularly.

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7. ENVIRONMENTAL EFFECTS OF THE RECOMMENDED PLAN

NEPA Sections 1500.1(c) and 1508.9(a) (1) require federal agencies to "provide sufficient evidence and analysis for determining whether to prepare an environmental impact statement or a finding of no significant impact" on actions authorized, funded, or carried out by the federal government to insure such actions adequately address "environmental consequences, and take actions that protect, restore, and enhance the environment." This section identifies the expected environmental effects of implementing the recommended plan, which are primarily beneficial, although there will be short-term adverse effects during construction.

7.1 Soils and Geology

Under the No Action Alternative, no construction would be undertaken and therefore, no direct impacts would affect soils or geology. Natural erosive forces, such as tidal action, high flows, or storms would erode soils locally, particularly along river banks or where vegetation is not well established and cannot stabilize soil. Over time, river banks in project areas that are steep will continue to erode, further disconnecting wetlands from riverine influence. Riverbanks that are not yet eroded may become steepened as well.

The geomorphic assessment performed for the feasibility study (Appendix A) indicates that the proposed restoration sites are generally stable and not subject to streambed, bank, or floodplain change under the current conditions. Additionally, this assessment determined that the potential for change of the streambed, adjacent banks, and floodplains is relatively low for the proposed conditions. However, localized bank failure was noted downstream of the proposed Highway 43 culvert site on Tryon Creek due to the undersized channel and alignment of the overbank flow path. It is anticipated that this failure will continue with no action applied. As cited in the geomorphic assessment, the Lower Willamette River generally has a low-gradient single channel thread that is confined by development including bank and floodplain modifications and stability projects. Changes to the flow regime due to dams and development have likely impacted sediment transport and deposition within the Lower Willamette River, a condition that is likely to persist under the no action alternative.

Under the recommended plan, construction of proposed restoration will require use of heavy equipment for clearing vegetation, excavating channels and wetlands, removing the Tryon Creek culvert, and relocating excavated materials. These activities will result in exposed soils, potentially leading to erosion or dust generation. If in-water machinery is used for bank sloping or if terrestrial equipment is operated in nearshore locations, the potential for soils to enter the water column and create turbidity is increased. Fish and wildlife would be indirectly affected by turbid waters that block sunlight and reduce sight for foraging, or impede respiration in fish. This effect will be offset by isolating the work area to the degree possible, and containing erosion using a combination of methods including silt fences, straw bales or berms, temporary dewatering, and surface stabilization including use of mulches. Implementation of these methods along with turbidity monitoring by an on-site observer will reduce this effect to less than significant.

Operation of the restored sites will not have direct effects on soils or geology. Once fill is removed from the site, the physical condition of remaining soils will only change incrementally as natural erosive forces occur; however, establishment of vegetation will be designed as part of restoration to stabilize soils wherever necessary. Indirect effects on soils may include chemical changes from increased hydrologic connection and increased erosion due to increased visitation. Over time, non-wetland soils that become newly located adjacent to backwater channels or ponds will take on

characteristics of wetland soils, ultimately beginning to exhibit hydric qualities. If restored areas result in increased visitation, particularly where restoration sites are already popular recreational spots (Kelley Point Park and Oaks Crossing), it is possible that trampling of vegetation or off-trail hiking could lead to increased soil erosion.

The proposed action is intended to restore off-channel and floodplain habitat that is effective at flows greater than those that create water surface elevations higher than 6 inches below the median winter water surface elevation, and for the Highway 43 culvert site on Tryon Creek to restore fish passage. These features are not intended to increase geomorphic change of Columbia Slough, the Mainstem Willamette River, or Tryon Creek. The geomorphic assessment performed for the feasibility study indicated that although the two sites along Columbia Slough have remained relatively stable over the last 30 years, there is a potential for sediment deposition for the side channel connections and particularly so at the confluence of these connections with Columbia Slough. Occasional maintenance to remove deposited sediment may be required to ensure these connections remain open. Similar potential effects at the two Willamette River sites were noted, due to substantial amounts of sand observed at these sides and in the vicinity of the proposed inlets and outlets of the side channels. Maintenance may be required at these two sites, and careful consideration of the side channel design, including gradient of the channels, should be applied to ensure that the connections and side channels are not blocked by deposited sand. For the Highway 43 culvert site, the geomorphic assessment indicated that the channel and banks of Tryon Creek upstream and downstream of the culvert are stable.

Boulders and streambed material for the bottom of the Tryon Creek/Highway 43culvert bottom will meet state and federal regulations and guidance. The streambed will be designed so that it is stable, and thus require a minimal amount of maintenance and minimize adverse erosion and scour effects. Both energy dissipation and fish passable step-pools will be designed to meet stability and fish passage criteria. The boulders will protect the base of the culvert and the streambed material from erosion during high flow events, and is not washed downstream out of the culvert. Step-pools will be constructed of boulders to provide slower moving holding water areas that fish can rest in during upstream or downstream migratory passage through the culvert.

7.2 Water Resources

7.2.1 Water Quality

Under the No Action Alternative, minimal changes in water quality conditions would occur under future without-project conditions. The TMDLs developed for the Lower Willamette River will improve water quality conditions in the subbasin. Continued development in the watershed may lead to minor reductions in water quality, by increasing the potential for chemicals and sediment to be conveyed from street, sidewalk, and lawn areas into stream and riparian habitat areas. An increase in the supply and concentration of chemicals and sediment to streams and riparian areas can result in siltation of spawning gravels.

Under the recommended plan, while water quality improvements are not a project purpose, there may be some incidental water quality improvements that occur as a long-term result (i.e. localized reduced temperatures and increased dissolved oxygen concentrations). These benefits are not considered to be measurable at the scale of assessment provided in this EA, and the overall water quality and temperature regimes in the river will not be substantially changed as a result of the recommended restoration plan.

Temporary impacts to water quality, mainly turbidity, may occur during construction of the project, due to sediment disturbance. Impacts on fish and other aquatic organisms will be temporary and will occur during the in-water work window, which for the lower Willamette River begins on July 1 and ends on October 31 of each year, to avoid adverse effects. These impacts will be further minimized by isolating construction activities from adjacent receiving waters by primarily working on the sites prior to making connections to the rivers and implementing construction best management practices (BMPs) to the maximum extent practicable. These BMPs will likely include surface stabilization (i.e. mulches), silt fence and other sediment barriers, and maintaining booms, silt curtains, and absorbent pads on site and implementing a source-control program to prevent the generation or release of potential pollutants. Water quality monitoring will take place during and after construction to meet permit requirements. If the standards are exceeded then construction will be halted until additional measures can be installed to ensure standards are met.

Construction equipment may release small amounts of pollutants into the water, including oils and grease or other contaminants, as a result of spills and leakages or the existence of contaminants on machinery that is used within the water column. Staging areas will be contained by straw bales or berms to ensure that sediment-laden or contaminated runoff does not leave the site. Pollution prevention plans will be used to identify methods and procedures to control contaminants from entering the water through leaks or spills. Prior to construction site use, machinery used for restoration will be cleaned of harmful chemicals, soil from offsite areas, and invasive weed seeds to prevent negative and adverse impacts associated with the introduction of these pollutants to the restoration sites. Materials selected for construction of the restoration measures, not limited to plants specified for revegetation plans, LW and habitat logs, boulders and streambed rock, and soils will originate from pre-approved sources to minimize the potential for import of pollutants to the site that may be adhered to these materials. During the design phase, detailed erosion and pollution control plans will be developed for each site.

7.2.2 Hydrology/Hydraulics

Under the No Action Alternative, analyses of hydrologic and hydraulic conditions, including statistical and physically based numerical modeling to understand seasonal, annual, and peak discharge and water surface elevations were prepared as Appendix B to the feasibility study. Implementing the no action alternative will result in continuation of current hydrologic and hydraulic conditions present at each of the restoration sites. The no action alternative will provide no change to flood storage and conveyance. Without the proposed alternative action the inundation of side channels and floodplains will be less frequent, and to lesser extents and depths, than with the proposed alternative action.

For the recommended plan, alteration of hydrologic and hydraulic features at each site is limited to those actions needed to restore habitat. No large-scale alterations are proposed. Direct hydrologic effects at individual sites include more frequent inundation, and greater extents and depths of inundation. The increased frequencies, extents, and depths of inundation are targeted for the proposed floodplain, side channel, off-channel, wetland, and riparian restored habitat area actions. Activation of these restored habitat areas is designed to occur at and above median wintertime discharge of 34,000 cfs for the lower Willamette River and 10 cfs for Tryon Creek. During the wintertime native fish are migrating within the lower Willamette River. The inundation anticipated is for newly created side channel and off channel habitat areas that will be developed using the design criteria developed from the hydrologic and hydraulic analyses presented in Appendix B and detailed in Appendix H. The proposed minimum elevation design criteria for side channels and floodplain connections is specified as 6 inches below the median winter water surface elevation. This is a positive benefit for creating habitat by increasing flood frequency of the side channel and

off channel areas. The off channel habitat and side channel areas will also provide minor reductions to flood flows and water surface elevations. These reductions are anticipated due to detention, or the short term storage of water volume, associated with flows high enough to inundation these areas.

Water velocities in these designed habitat areas are expected to be minimal since these areas are not aligned with the primary flow direction of either the lower Willamette River or Columbia Slough. The proposed habitat areas will be inundated by backwater and slower moving water along the sides of the Willamette River and Columbia Slough. Similarly, scour or erosion at these sites is not expected to be an issue, but rather deposition of sand sediment may occur at these sites and particularly at the connection point of these sites to the mainstem Willamette River or Columbia Slough. Deposition of sediment may necessitate maintenance of the connection points by mechanical removal, and further analyses at later stages of design will evaluate the potential for deposition and frequency of maintenance.

7.2.3 Floodplains

Under the No Action Alternative, the direct effect of not performing the alternative action at the restoration sites is continuation of the same flood levels, storage, and conveyance.

Implementing the recommended plan at the restoration sites will increase backwater and side channel storage volumes which will likely cause minor reductions in base flood elevations. The connection elevations and excavation quantities for off-channel and side-channel areas are not intended to serve the purposes of flood control or reduction. For the current level of design, the criteria used to specify the connection elevations was the median winter water surface elevation, and flood elevations and discharges have not been evaluated. Later stages of design may need to investigate the direct effects of these habitat features on flood levels and conveyance in accordance with 44 C.F.R. 60.3(d) (3).

In accordance with 44 C.F.R. 60.3(d) (3), projects and design elements that are specified within the regulatory floodway delineated by the most recent Federal Emergency Management Agency (FEMA) Flood Insurance Study for the City of Portland (FEMA 2010) require an encroachment review, or a review of potential negative impacts on conveyance of the 100 year flood or increases in the water surface elevation associated with the 100 year flood. This analysis is commonly referred to as a no-rise analysis and entails detailed hydrologic and hydraulic analyses utilizing the models used to specify the regulatory floodway and comparing the with and without project conditions. Executive Order (EO) 11988, issued in 2012, requires federal agencies to avoid to the extent possible the long-term and short-term adverse impacts associated with occupancy or modification of floodplains and avoiding support of floodplain development if there is a practical alternative. No permanent structures are proposed for the floodplain other than installation of large wood, and floodplain modifications in general are designed to take advantage of existing swales or disconnected side channels. Thus, any work in the floodplain associated with the recommended alternative will be consistent with the EO.

The Lower Willamette River has a defined floodway that encompasses design elements at the Kelley Point Park and Oaks Bottom/Sellwood Park sites. Base flood elevations, defined by the water surface elevations associated with the 1-percent annual chance flood also commonly referred to as the 100-year flood elevation, delineate the outer boundary of the flood plain. The floodway is defined as an area that can fully contain and convey the 1-percent annual chance flood without raising the associated flood elevation more than one foot above the base flood elevation. For waterways that have regulatory floodways, the areas between the floodway and the outer boundary of the base flood elevation are defined as the flood fringe. The flood fringe is an area defined such

that development projects do not increase flood heights, and therefore encroachment review of projects and design elements within the flood fringe do not need to be assessed for impacts on flood flows or water surface elevations. Project sites that contain elements within the flood fringe include Kenton Cove, BES Plant banks, and Tryon Creek Highway 43.

7.3 Biological Resources

7.3.1 Wetlands

Under the No Action Alternative, no new wetland areas will be created and no improvements will be made to degraded wetlands. Over time, continued degradation will directly result in the loss of additional abundance and diversity of native fish, wildlife, and plant species. Indirect effects of diminishing wetland area and function may result in reduced water quality. The health and function of known wetlands in the project area have not been assessed. Loss and degradation of wetland habitat throughout the lower Willamette River system has been a substantial cause of fish and wildlife decline, reductions in water quality, and increase in non-native species. The remaining wetlands in the project area are fragmented, small, disconnected from the river, and may not provide the beneficial functions typically associated with wetlands.

The recommended plan includes the creation of a variety of wetland types or the rehabilitation of existing wetland habitat at each of the 5 proposed sites. New wetlands will be created through excavating new emergent wetlands, low flow channels, and high-flow refugia. In addition, steep slopes will be graded to facilitate gentler transitions from upland to backwater or river flows and large wood will be placed to restore wetland habitats. These measures will directly improve the essential rearing and refugia habitat that benefits native fish assemblages in the river, as well as increases habitat for native wildlife that rely on riparian and wetland habitats. As increased wetland areas provide water filtering and flood buffering, water quality may be indirectly and incrementally improved as well.

According to NWI maps, few existing wetlands occur where construction is proposed. However, site reconnaissance indicates that additional wetlands may be present. If construction occurs in areas where wetlands already exist, construction could adversely affect the quality and functioning of the wetland. Clearing of vegetation, particularly mature trees, would remove existing habitat and excavating soils would alter hydrologic wetland conditions. Other direct impacts could occur if construction equipment oils and grease were released into the wetlands, or if erosion caused turbidity in backwater or wetland waters.

Overall, wetlands that may be impacted by construction are very small at all sites and/or are not providing substantial habitat or function. The construction of larger wetlands vegetated with native plants will substantially improve habitat where small and fragmented wetlands are now present. At larger wetlands, such as those at Oaks Crossing, mature trees will be protected, or if removed, will be utilized as large woody debris. Long-term beneficial impacts are expected to result for wetlands and their associated species as a result of restoration.

Mitigation for wetland losses or impacts typically requires the construction of additional wetland acreage as compensation. In this case, wetland creation is one of the purposes of the project and therefore, no mitigation would be necessary. Any loss to existing wetlands or function would be immediately compensated for through the construction of new wetlands. However, the implementation of several BMPs would be necessary to protect wetlands from direct and indirect adverse impacts that may result during construction. These include construction during the dry

season, placement of erosion controls, and establishment of spill remediation protocols prior to construction. With proper construction phasing design and controls, impacts to wetlands will be temporary and minor.

7.3.2 Vegetation

Under the No Action Alternative, the condition of vegetation would remain unchanged, in a degraded state with most of the riparian areas affected by invasive species, steepened banks, or revetments.

Ongoing development of the Lower Willamette River watershed would continue to negatively affect conditions in riparian zones. However, other restoration programs in the study area are intended to restore habitat structure, function, and processes. As a result, there is potential for both negative and positive influences on native habitat in the project area.

During construction of the recommended plan, required vegetation clearing may reduce the availability of foraging, resting, or nesting habitat. Any clearing conducted for the purpose of access would be carefully planned, leaving important trees or communities intact, whenever possible. Under the recommended plan, mature trees will be protected to the extent possible. Trees removed during construction would be used to create an in-stream or terrestrial habitat structure whenever possible. Sensitive habitats and species that must be protected, including trees, would be clearly marked. Additional native riparian trees and shrubs will be planted in floodplain, riparian, and wetland habitats. To the extent possible, staging areas would be located in areas of non-native vegetation or where little or no native vegetation would have to be cleared. Due to these measures, impacts to vegetation are expected to be less than significant.

A Biological Assessment (BA) has been completed for the recommended plan and is included as Appendix C. No special status vegetation species are likely to be found in the project area. The proposed restoration plan is intended to help restore habitats and natural processes that form habitats for listed and proposed species, and will therefore help contribute to the recovery of these species. Therefore the indirect effects of this project will be positive.

During construction there will likely be short-term adverse effects from vegetation clearing that may temporarily reduce the quality and function of habitat. However, any clearing conducted for access would be carefully planned, leaving important trees or communities intact, whenever possible. All disturbed areas will be replanted with native vegetation supporting a community of higher quality habitat and function.

7.3.3 Fish and Wildlife Species

Under the No Action Alternative, fish and wildlife habitat in the watershed will continue to degrade from the effects of development and ongoing regulation or flows. However, ongoing restoration actions conducted by the City of Portland and other organizations will improve the condition of fish and wildlife habitat. These actions will reduce toxins, partially restore floodplain connectivity, riparian vegetation, and more natural hydraulic and morphologic conditions; reduce bank erosion and sedimentation; create off-channel habitat; improve in-stream structure; and remove fish passage barriers.

During construction of the recommended plan, most work will be phased to isolate the construction area from adjacent receiving waters in order to protect aquatic biota (i.e. avoid connections to the

rivers until other work is complete). In addition, construction stormwater best management practices (BMPs) will be implemented to the maximum extent practicable in order to preserve local water quality, especially with respect to turbidity effects. These BMPs will include surface stabilization (i.e. mulching), silt fence and other sediment barriers, and a source-control program to prevent the generation or release of potential pollutants.

All work in-water work will take place only during work windows designated by the Oregon Department of Fish and Wildlife (ODFW) to minimize possible harm to fish species. Fish salvage and removal will occur as necessary. Overall, adverse impacts to fish during construction are expected to be minor and temporary. Although fish may be temporarily excluded from habitats, the areas of exclusion would be minimal and restrictions to passage up- and down-stream would be short-term. Overall, long-term benefits to fish and aquatic habitats from the restoration plan are expected. Specifically in regards to the focal wildlife species in this study including native amphibians, pond turtles, and migratory bird species, this plan will restore habitats that are limited for all of these species such as off-channel habitat, wetlands, riparian habitats, cover and large wood.

During construction, terrestrial wildlife may be affected by the action alternatives primarily by disturbance. Construction equipment, human presence, and increased noise may disturb resident wildlife or discourage migrating wildlife from utilizing the surrounding habitats. Wildlife may also be affected if their habitats are altered during the construction process. Vegetation clearing, earthwork, and debris removal may directly impact foraging or nesting grounds for amphibians, reptiles, birds, and small mammals.

Construction activities may require wildlife exclusion or protection. Additionally, during the design phase, supplemental environmental documents would be completed for each project site to identify construction phasing and likely wildlife that may be encountered on each site, and to provide a set of guidelines for their protection. In this way, disturbance to species present in the area proposed for restoration can be avoided or reduced. Wildlife would have many available habitats to disperse to temporarily and would return once construction is complete.

Overall, although there may be minimal displacement of resident wildlife and temporary exclusion of wildlife during construction, there are not expected to be significant adverse impacts. The riparian plantings would increase the habitat value of the site by creating additional opportunities for foraging, nesting, cover, and refuge for a wide variety of species.

7.3.4 Threatened, Endangered, Candidate, and Rare Species

Under the No Action Alternative, continued development of the Lower Willamette River watershed would continue to negatively influence conditions for protected fish and wildlife species. However, other restoration programs within the project area intend to restore habitat structure, function, and processes within the Lower Willamette basin. Overall, cumulative effects are expected to be beneficial to salmonids and other native species found in the project area.

A BA has been completed for the recommended plan and is included as Appendix C. Most listed and candidate species that may occur in Multnomah County do not occur in the study area. Of those that do occur in the study area, the recommended plan may have direct, adverse effects on Chinook salmon, coho salmon, and steelhead as a result of construction. Restoration measures proposed as part of this study align with the 18 project categories of aquatic restoration actions covered under the Programmatic Restoration Opinion for Joint Ecosystem Conservation by the Services (PROJECTS) program (NMFS 2013a). The PROJECTS Biological Opinion (BiOp) is a joint

programmatic conference and biological opinion prepared by the National Marine Fisheries Service (NMFS) pursuant to section 7(a)(2) of the Endangered Species Action consultation on the effects of implementing aquatic restoration actions proposed to be funded or carried out by the USFWS and the NOAA Restoration Center in the States of Oregon, Washington and Idaho. Limited incidental take is allowed under this BiOp, therefore these types of impacts are less than significant.

The proposed restoration plan is intended to help restore habitats and natural processes that form habitats for listed and proposed species, and will help contribute to the recovery of these species. Therefore the indirect effects of this project will be positive. The NMFS and USFWS are charged with recovery of these species and this plan is not intended to be the primary element of that recovery, but will contribute to their recovery.

Construction activities will likely cause short-term adverse effects such as temporary increases in turbidity, fish salvage and handling, and general disturbance. BMPs will be implemented during construction to avoid and minimize potential effects, such as work area isolation by the use of coffer dams and/or silt curtains, requiring that fish salvage be conducted in accordance with an approved fish salvage plan and Scientific Collection Permit by experienced fish biologists, installation of erosion and pollution control measures, and compliance with all permit requirements.

A summary of the preliminary determination of effects to listed species is provided in Table 7.1, below.

Table 7.1. Determination of Effects to Listed Species in the Study Area

Species	**ESA Status**	**Effect Determination**	**Critical Habitat Determination**
Coho salmon (*Oncorhynchus kisutch*); Lower Columbia River ESU	Threatened	May affect, likely to adversely affect	May affect, not likely to adversely affect
Chinook salmon (*Oncorhynchus tshawytscha*); Lower Columbia River ESU	Threatened	May affect, likely to adversely affect	May affect, not likely to adversely affect
Chinook salmon (*Oncorhynchus tshawytscha*); Upper Willamette River ESU	Threatened	May affect, likely to adversely affect	May affect, not likely to adversely affect
Steelhead (*Oncorhynchus mykiss*); Lower Columbia River DPS	Threatened	May affect, likely to adversely affect	May affect, not likely to adversely affect
Steelhead (*Oncorhynchus mykiss*); Upper Willamette River DPS	Threatened	May affect, likely to adversely affect	May affect, not likely to adversely affect
North American green sturgeon (*Acipenser medirostris*); Southern DPS	Threatened	No effect	N/A
Bull trout (*Salvelinus confluentus*); Mainstem Lower Columbia River (Unit 8)	Threatened	No effect	No effect
Bull trout (*Salvelinus confluentus*); Clackamas River NEP	Non-Essential	No effect	No effect

7.4 Cultural and Historic Resources

Under the No Action Alternative, potential impacts on cultural resources that may be associated with the proposed ecosystem restoration project would not occur. There would be no potential impacts resulting from the ground disturbing activities and alterations of infrastructure at these locations. Cultural resource compliance actions would continue for other projects and ongoing operations and maintenance channel and infrastructure actions that are Federal undertakings or that require NEPA review. For these actions, surveys would be conducted (as needed), impacts would be assessed, and avoidance measures would be developed.

In 2010 a record search and site reconnaissance was conducted at the locations of the original 23 potential habitat restoration projects. Confidential site and survey records relevant to each potential project location were reviewed and each location was visually inspected by an archaeologist for surface archaeological resources and the likelihood for encountering buried archaeological deposits. No excavations or other subsurface investigations were conducted. The scope of the investigation did not include Oregon State Historic Preservation Office (SHPO) or Native American consultation, consideration of the built environment, or delineation of the full extent of potential disturbance areas that would be associated with the restoration project construction and operation (Tetra Tech 2013).

None of the five locations have been surveyed in their entirety to the level needed for SHPO consultation. Similarly, none of the locations have been coordinated with interested Tribes to determine if any of them may contain areas of traditional and/or substantial cultural interest. Three have been partially surveyed. Based on the reconnaissance in 2010, the archaeologist concluded that two of the locations had a low probability of retaining intact archaeological deposits that could be disturbed by restoration projects, and two of the locations had a moderate probability. One of the locations has a high probability to retain intact archaeological materials and/or features due to the presence of known archaeological resources and potential for buried resources in unexamined areas (Tetra Tech 2013).

Four prehistoric archaeological sites have been recorded: Site 35MU47 is described as a deposit of two 5-10 cm bands of charcoal and thermally altered rock interspersed with a 10 to 15 cm thick layer of silt. Portions of the site were excavated in 1983 with the conclusion that this may have been a seasonally used village site, based on the variety of artifacts found in the thin deposits. Materials recovered included an array of different kinds of burned animal bones and plant foods, projectile points, tools and chipping waste of diverse stone, ocher pigment, and fire-cracked rock (Woodward 1983).

Sites 35MU48 and 35MU49 were originally recorded in 1979 as two discrete seasonal campsites consisting of light scatters of fire-cracked rock and charcoal. When the area was examined in 1983, these sites could not be relocated where mapped. The researcher at that time concluded that there may have been an error in mapping or that the sites observed years earlier had subsequently eroded. Because of their proximity, he considered these sites as components of Site 35MU50 (Woodward 1983). However, none of these three sites were remapped, nor were the site forms updated.

Site 35MU50 was originally recorded in 1979 as a seasonal campsite consisting of a small, discrete cluster of fire-cracked rock. Based on an attempt to reconcile previous site records, the presumed dimensions of site were enlarged to include Sites 35MU48 and 35MU49. Portions of the site were excavated in 1983. A small number and variety of worked stone artifacts were recovered, but the bulk of the cultural material was fire-cracked rock and charcoal. One feature is consistent with use as a pit oven of the type known ethnographically for roasting bulbs. Another hearth feature with burned animal bone fragments was also recorded (Woodward 1983).

None of these sites have been evaluated for listing on the National Register of Historic Places, although it appears that material was recovered that could contribute to addressing regional research questions about time of occupation, subsistence, settlement, and season of use. It is not apparent from the record search whether there was further analysis of recovered materials. Evidence of these sites was not observed during the reconnaissance in 2010, but vegetation has grown back over the sites and likely hides any cultural materials from view.

Potential impacts on cultural resources could result from ground or streambed disturbance associated with the implementation of the recommended plan and removal of infrastructure. Ground or streambed disturbance could result from site preparation, installation of LW, removal of invasive species, bank lowering and grading, off-channel habitat development, culvert removal and revegetation. If prehistoric or historic archaeological sites are present, ground disturbance can directly damage artifacts and features or alter the spatial relationship of artifacts, features, and other deposits and destroy their research potential. This can result in the permanent loss of information relevant to the site function, dates of use, plants and animals used, past environments, ethnicity and other important research questions. Ground and streambed disturbance can also damage unmarked burials or other sites that may be important to contemporary Native Americans as ancestral locations or for traditional cultural or religious purposes. Infrastructure planned for removal has not been evaluated, but does not appear to be historic.

As outlined in Section 4.5, cultural resource identification efforts to date have consisted of a record search and site visits in 2009 to gather initial information regarding the known presence or absence of historic properties at the potential restoration locations. The goal was to document the status of identification and evaluation efforts, assess the potential for encountering unrecorded or subsurface archaeological resources and provide information about the types of resources that may be encountered (See Appendix D, Tetra Tech 2013). This represents a phased approach to compliance with the National Historic Preservation Act (NHPA) and other cultural resource requirements that parallel the USACE restoration feasibility study. As such, additional required cultural resource identification, evaluation, effects determination and resolution of any adverse effects are anticipated in subsequent phases. No excavations or other subsurface investigations were conducted. The scope of the investigation did not include Native American consultation by the USACE, consideration of effects on the setting of building or structures or the delineation of the full extent of potential disturbance areas and depths that would be associated with restoration projects construction and operation. No historic properties have been identified to date.

Inventory, identification and evaluation of the cultural resources that may be encountered are incomplete and a fully-informed assessment of impacts on historic properties is not possible. Based on the work to date, the following preliminary assessments have been made regarding the possibility of disturbing intact archaeological resources that may be at the proposed restoration areas.

Areas of low probability of disturbance of cultural materials include Kenton Cove on the basis of partial archaeological survey with negative results and Tryon Creek Culvert because of previous extensive subsurface disturbances. Areas of moderate probability of disturbance of cultural materials include the PBES Plant on the basis of minimal previous subsurface disturbances and the Oaks Crossing/Sellwood Riverfront Park because of minimal subsurface disturbances and possible historic-era archaeological resources nearby. The Kelley Point Park site is considered a high probability area for the disturbance of cultural materials because of nearby prehistoric archaeological resources.

Impacts on cultural resources are possible. The Section 106 process for implementing these proposed restoration measures requires further inventory and evaluation efforts to determine whether historic properties are present and would be adversely affected. The USACE, in consultation with the Oregon State Historic Preservation Officer (SHPO) and other parties defined in 36 C.F.R. 800, would resolve any identified adverse effects and complete the Section106 process, reducing or avoiding any significant impacts on cultural resources. No adverse effects are anticipated from the long-term operation or maintenance of the ecosystem restoration projects, after resolution of construction-related adverse effects.

7.5 Land Use and Zoning

Land uses are primarily regulated at the local level through general and specific plans, site-specific zoning, overlay zones and districts, and other state and local policies. Under the doctrine of federal supremacy, actions of the federal government are not subject to state or local land use or zoning regulations unless specifically consented to by Congress. However, the federal government is subject to federal regulations requiring consideration of impacts on the environment and does take into account state and local land use and zoning policies in order to avoid conflicts where possible. Four of the five alternative sites are within the City of Portland and are subject to Portland planning and zoning policies. The Highway 43/Tryon Creek Culvert alternative is located just south of the Portland city limits in Lake Oswego, which has its own planning and zoning policies.

Land use and zoning impacts are assessed by analyzing and comparing current land use with the proposed change in land use. The proposed land use is also compared to uses that are specified in planning documents or policies, or local zoning maps. The objective is to identify whether there are any incompatibilities or inconsistencies with adjacent land uses or with adopted land plans or policies.

The area of consideration for direct impacts on land use minimally includes the proposed restoration project sites, construction support areas, and adjacent properties.

Under the No Action Alternative, potential positive and negative impacts on land use and zoning that may be associated with the proposed ecosystem restoration projects would not occur. Land use and zoning would continue to be guided by existing planning documents and regulations in the two jurisdictions. To the extent that current planning and existing zoning is consistent with habitat restoration, these benefits would not be realized through these projects. Other actions would likely be taken by the federal government or other entities on an incremental basis to implement river restoration and conservation land use planning goals.

The recommended plan includes feasibility level designs of an array of restoration measures tailored to each site. The design features are displayed in detail in the plans that are included as Appendix H. The analysis of the potential direct impacts on land use and zoning is based on these plans and the level of information available for each of the sites. During construction there would be temporary impact on land use resulting from construction activity in the immediate vicinity of the restoration sites.

The PBES Plant site is located adjacent to the Columbia Slough and is zoned as Heavy Industrial with an Environmental Conservation Overlay Zone. The southeastern part of the site is a mostly undeveloped floodplain backwater/swale which includes a portion of the Columbia Slough Trail. The western part of the site is in the undeveloped riparian zone adjacent to the slough north of the plant. The site is owned by the City of Portland and the Port of Portland. Adjacent zoning is primarily Heavy Industrial and land uses include the wastewater utility, a rail line, a sewage lagoon

north of the slough and an island in the slough within an Environmental Preservation Overlay Zone. Although the site is zoned for Heavy Industrial, the proposed restoration measures would have a positive effect on land use by enhancing the current conservation land uses on the site. Current utility and industrial uses on adjacent lands would not be impacted by the restoration.

The small Kenton Cove site is located off-channel along the north side of the Columbia Slough. It is zoned as Open Space and is within the Environmental Conservation Overlay Zone. The Columbia Slough Trail passes through the site. The site is owned by the City of Portland. Adjacent zoning includes Open Space/Conservation, and General and Heavy Industrial. Adjacent land uses include the Portland International Raceway, parklands, paved parking areas and roads. The proposed restoration measures would have a positive effect on land use by enhancing the current conservation land uses on the site. Land uses on adjacent lands would not be impacted by the restoration.

The Kelley Point Park site is located at the confluence of the Willamette and Columbia Rivers. The southern part of the site includes the confluence of the Columbia Slough with the Willamette River. It is zoned as Open Space within the River Recreation and Water Quality Greenway Overlay Zones. The current land use is as a city park with trails, roads and some facilities. The site is owned by the City of Portland and the Port of Portland. Adjacent zoning includes Open Space and Heavy Industrial. Adjacent land uses include parking, marine cargo, warehousing, railroads, and industrial services. The proposed restoration measures include features such as crossing structures that would maintain recreational access while improving habitat and water quality. The restoration would have a positive effect on land use. Land uses on adjacent lands would not be impacted by the restoration.

The Oaks Crossing/Sellwood Riverfront Park site is located on the east bank of the Willamette River. It is zoned as Open Space within the River Recreation and Water Quality Greenway Overlay Zones. The current land use is as a park with a boat ramp and limited amenities. The Willamette Greenway Trail passes through the site, which is owned by the City of Portland. Adjacent zoning includes Open Space, Residential Farm and Forest, Commercial Office, and Mixed Commercial /Residential. Adjacent land uses include parkland, offices and an amusement park Wetland and floodplain habitat would be restored and have a positive effect on water quality. Land uses on adjacent lands would not be impacted by the restoration.

The Highway 43/Tryon Creek culvert site is located just west of the Willamette River on its tributary, Tryon Creek. The site is zoned primarily as Park/Natural Areas but includes small portions zoned as Residential and Industrial. Infrastructure right-of-ways by the Oregon Department of Transportation, Portland & Western Railway, and the City of Lake Oswego occur at this location. With limited exceptions, Tryon Creek's entire lower reach is in public ownership from the Willamette River confluence upstream through the Tryon Creek State Natural Area. Downstream of Highway 43 to the Willamette River, adjacent lands are both publicly and privately owned. Adjacent zoning is Park/Natural Areas, Residential, and Industrial. Adjacent land uses also include commercial, transportation and utilities. The proposed restoration measures would have a positive effect on land use by enhancing the natural areas and recreational opportunities at the park. Current transportation and utility uses may be inhibited during construction but would be reinstated after restoration. Other land uses on adjacent lands would not be impacted by the restoration.

Indirect effects could occur if it is reasonably foreseeable that the restoration projects would induce or inhibit growth or result in future changes in land use on or near the sites. The proposed restoration work is largely consistent with current zoning, land uses and plans. Environmental restoration is likely to decrease potential growth and density in the affected areas, although there may be some conversion of existing uses such as from industrial to commercial or residential in the long-term resulting from enhancing habitat and recreational opportunities. More recreational use

may increase demand near the sites for parking, security and other services. Potential impacts are speculative and would generally be positive if they do not displace high value industries or activities along the river and slough.

7.6 Transportation

Area of potential impact to transportation includes those roadways, river channel, and trails that are 1) within the project footprint, 2) outside of the project footprint but used during construction efforts, and 3) outside of the project footprint but impacted by changes in circulation resulting from the project. Under the No Action Alternative, no construction would occur and no changes or impacts to traffic or circulation would result.

Direct impacts of the recommended plan may occur to transportation facilities during construction as a result of construction vehicles using the roadways within or adjacent to the site. In the event that barges or other river vehicles are used to access the sites during construction, direct impacts could occur to traffic navigating along the river. If local trailways are present, construction may temporarily impact their use. There are no indirect effects expected to result from construction.

Operation of the project could directly impact transportation if there are substantial changes to the access roads leading to the restored sites. If roads are expanded or reduced in size or redirected during construction, it may result in detrimental slowing of circulation. If the final condition of the restored site is more attractive to visitors, it may indirectly draw a greater number of visitors and thereby increase traffic in the area. Permanent changes to access roads are not planned at this stage of design, and substantial increases in human use of these sites are not likely to occur as a result of the proposed restoration measures. Therefore, significant adverse impacts from these sources are not likely to occur.

In most cases, construction access points are well defined and construction routes will be along roadways that will easily accommodate the extra construction equipment and vehicles without creating changes to circulation. Kelley Point Park, the BES Plant site, Kenton Cove, and Oaks Crossing are easily accessible by local roads that can accommodate additional construction traffic. Furthermore, staging areas are available in close proximity and can be located in areas that will not obstruct traffic or circulation.

The exception is at the Tryon Creek Highway 43 culvert site. Due to the heavily used highway that passes over the Tryon Creek Highway 43 culvert, as well as the train tracks, construction at this site is likely to be disruptive to car and rail traffic. Although construction can likely be accomplished without closing the highway entirely, it will likely need to be narrowed to one lane in each direction or possibly one lane used alternately by traffic traveling in opposite directions. Rail traffic may need to be re-routed during construction. Based on preliminary design plans, the estimated project duration for replacement of the Tryon Creek Highway 43 culvert is approximately 6 months.

Though Highway 43 may experience delays to vehicular traffic or closures to rail traffic, this direct impact will be both short-term and temporary, reducing its impact to less than significant. A traffic control plan will be created to reduce potential delays at all times, and particularly during key times such as the morning and evening commute. The traffic control plan will also contain measures to minimize traffic impacts on surrounding roadways.

It is possible that river-based transport will require access to some of the sites in order to slope banks of the river or slough and to place large woody debris. If barges are used for restoration

construction, it will be necessary to coordinate with the Port of Portland to ensure that shipping channels are not obstructed.

Prior to breaking ground, a construction management plan would be prepared and submitted to ODOT for approval. The plan would include the following measures to minimize impacts to traffic and circulation:

- Designated routes and access points for construction vehicles and equipment including terrestrial and in river machinery, as necessary,
- Travel time restrictions to avoid peak travel periods on selected roadways, and
- Designated staging and parking areas for workers and equipment.

With implementation of a traffic management plan and traffic control plan, and the appropriate BMPs, additional construction traffic and temporary closures and diversions would have a minimal impact on affected roadways and intersections. Following completion of the projects, if it is determined to be necessary, access parking and trails will be created and clearly marked to control increased traffic resulting from visitation.

7.7 Socioeconomics

Under the No Action Alternative, no construction would occur. Socioeconomic conditions would continue per the future without project condition and no direct or indirect effects would occur from the project.

The recommended plan includes ecosystem restoration and associated construction at each site. Construction funds expended in the regional economy may result in minor temporary beneficial socioeconomic income and employment effects for contractors and related industries. These benefits would last until construction was complete.

At the Hwy 43 Tryon Creek site, construction may result in temporary disruption of road and rail traffic along the highway where culvert placement must take place. Temporary lane or track closures would likely result in delays to vehicles and trains. Detours, if required, might induce additional operating costs. Any adverse effects from detour and delay would be temporary.

The recommended plan may result in beneficial indirect socioeconomic effects in the form of increased quality of recreation adjacent to the restoration sites. These effects would likely be minor, as some project sites already offer recreation opportunities, and the recommended plan does not include a component to construction additional recreation features where none exist currently.

7.8 Environmental Justice

Under the No Action Alternative, no construction would occur. Environmental justice conditions would continue per the future without project condition and no direct or indirect effects would occur from the project.

It is not expected that the recommended plan will directly affect environmental justice communities in the project area because the recommended plan focuses on sites currently in open space or existing parks. Restoration construction in these areas is not expected to directly or indirectly affect income, employment, or other socioeconomic indicators disproportionately in environmental justice communities. Improvements in the Elliott and St. Johns neighborhoods, which have a higher proportion of minority and Hispanic residents than the City as a whole, would have a long-term

beneficial effect on environmental justice communities, though there may be some minor temporary construction-related effects.

7.9 Parks and Recreation

As the purpose of this study is ecosystem restoration and not recreation improvement, the area of consideration for parks and recreation is limited to those parks or open spaces that could be impacted by construction of the proposed project.

Under the No Action Alternative the areas identified for restoration under this study will not be restored with aquatic and terrestrial habitat improvements. The areas that already serve as park or open space, such as Kenton Cove, Kelley Point, Oaks Crossing, or Tryon Creek sites, will remain as they are.

No new parks will be created as a result of the recommended plan. However, at sites that are comprised of parkland, such as Kelley Point Park, Kenton Cove, and Oaks Crossing, ecosystem restoration will provide direct benefits to recreation seekers. At each of these sites, restoration of aquatic habitat and removal of invasive species will provide the benefit of improved aesthetic condition and increased habitat value, which translates into an improved recreation experience. However, since this project is not intended to create new recreation areas, there will be no direct benefit of improving park availability in park-deficient neighborhoods.

Construction efforts may temporarily impact recreational use of PBES Plant lands, Kelley Point Park, and Oaks Crossing, and may also discourage use of Tryon Creek State Park. While construction vehicles are onsite they may obstruct trailways and create noise and dust conditions that would deter visitors from enjoying the park's recreational opportunities. In the case of the Tryon Creek Highway 43 Culvert, an extended period of road construction may deter those who would normally visit the park. The Willamette Greenway Trail, which passes through the Oaks Crossing/Sellwood Riverfront Park site, may be temporarily closed or diverted during construction, along with a nearby boat ramp. Other opportunities for similar recreational access are found nearby, therefore these impacts are expected to be temporary and less than significant. Other proposed sites do not actively promote visitation for recreation and would not experience changes to recreational use due to construction.

7.10 Air Quality

The project areas are located within the Portland CO and ozone maintenance areas, making the primary pollutants of concern CO and ozone creating compounds such as NOx and VOCs. Other pollutants of concern include fine particulate matter and air toxics. No long-term impacts to air quality are expected from implementing the No Action Alternative.

During the construction phase, there are likely to be short-term air quality impacts resulting from temporary changes in traffic patterns, construction equipment emissions, and dust generated during earthwork. Traffic congestion increases idling times and reduced travel speeds, which increases vehicle emission levels. However, traffic congestion and the presence of construction traffic are not expected to substantially raise emissions in the proposed restoration areas, where current roadway use is heavy and is already contributing to emissions. If there is a high potential for traffic congestion, particularly at Highway 43, road or lane closures should be restricted to non-peak traffic periods when possible. In all restoration areas, additional construction emissions are not expected to substantially increase the already high emissions of the area.

Additionally, BMPs would be put in place to ensure that fugitive dust would be limited to acceptable levels as defined by current air quality standards and attainments for the region. Construction plans will comply with state regulations requiring mitigation of fugitive dust (OAR 340-208-0210). These measures may include applying water or other dust suppressants during dry weather, as well as maintaining clean construction equipment to prevent the transport of dust and dirt from construction areas to nearby roads.

No long-term impacts to air quality are expected from implementing the recommended restoration plan. Air quality will continue to be monitored and maintained by ODEQ into the future and no changes to air quality conditions are expected. The completed restoration would not result in increased traffic or changes to traffic patterns and therefore would not result in impacts to air quality.

7.11 Noise

Title 18 of the City of Portland Code and Charter provides noise control guidelines (City of Portland 2014). Maximum permissible sound levels set in the code are divided by land use of source and receiver of noise (Table 7.2). Noise sensitive receivers are defined as any residential home or dwelling, schools, churches, hospitals, and libraries; maximum permissible sound levels are designed to reduce noise impacts to these sensitive receivers.

Construction noise is subject to the same levels (Chapter 18.10.060), but is not allowed to occur outside of the hours between 7am and 6pm on weekdays and Saturday (City of Portland 2014). No Sunday or holiday construction is permitted. Maximum permissible construction noise level is 85dBA when measured at 50 feet from the source; exemptions include trucks, pile drivers, pavement breakers, scrapers, concrete saws and rock drills. Exemptions are only allowed during permissible construction hours as noted above. Variances to these rules may be permitted.

Table 7.2. Permissible Sound Levels

Zone Categories of Source	Zone Categories of Receiver (7am-10pm, otherwise minus 5 dBA)			
	Residential	Open Space	Commercial	Industrial
Residential	55	55	60	65
Open Space	55	55	60	65
Commercial	60	60	70	70
Industrial	65	65	70	75

No substantial changes in noise levels are expected under the recommended plan. Noise levels may rise in the future due to increasing population and the resulting increases in air and road traffic.

Noise associated with construction equipment, similar to road maintenance or utility projects, would affect localized areas for limited time periods as restoration is implemented. Sensitive receptors that could be affected by construction noise include adjacent residents and protected wildlife. Sensitive species in the construction areas are primarily fish species, which can easily move away from the noise source. Construction activity noise levels at and near the study area would fluctuate depending on the particular type, number, and duration of uses of various pieces of construction equipment. Construction related material haul trips and construction workers commuting to the project site could raise ambient noise levels along haul routes and area roadways. However, in comparison to

current noise levels and because these effects would be temporary and short-term, they are not considered significant.

The Tryon Creek Highway 43 culvert is located beneath a roadway that receives continual or intermittent traffic near residential, open space, and commercial land uses. Sensitive receptors in the area include residential homes and the Lake Oswego Public Library. The PBES Plant restoration site is adjacent to heavily industrialized land, as well as North Portland Road, a railroad line, and near the Moore Island City Park open space and Heron Lakes Golf Club. Kelley Point Park is a somewhat more isolated site, though the potential for increased noise levels occurs at the Port of Portland, located to the southeast. Kenton Cove is immediately adjacent to the Portland International Raceway and Interstate 5, which are two of the greatest sources of noise pollution in the Portland area (The Greenbusch Group, Inc. 2008). At Oaks Crossing, ambient noise levels are determined by traffic levels along nearby local access roads, including SE Oaks Park Way and the Sellwood Bridge, and on the Willamette River. Sensitive receivers include the open space of Sellwood Riverfront Park and Oaks Pioneer Church, as well as the Riverview Cemetery and Willamette Moorage Park across the river.

In areas where sensitive receivers are present, the proposed construction zone is generally at least 100 feet from any dwellings, churches, libraries, or hospitals; a distance that allows for adequate attenuation of noise that may result from construction (FHWA 2006). In all cases, with adherence to noise control regulations, construction is not expected to substantially increase the level of ambient noise beyond threshold levels. Protection of sensitive species and sensitive receptors will be managed through proper seasonal, weekly, and daily construction scheduling per Title 18 (City of Portland 2014).

7.12 Hazardous Waste and Toxic Materials

Hazardous Waste and Toxic Materials (HWTM) impacts are assessed by first identifying where there have been recent or historical unauthorized releases of hazardous materials or hazardous waste, where hazardous materials may have been used or stored, or locations that may be generators and/or transporters of hazardous wastes. The proposed restoration actions are then assessed to determine whether implementation would be inhibited or delayed by the presence of the materials, whether implementation could result in exposures to existing hazardous materials, or whether implementation would interfere with ongoing or planned site remediation. The analysis also takes into account the potential for hazardous waste generation resulting from restoration construction.

Appendix E details the methods and results of a database investigation of the study area and visits to each proposed restoration site for current and/or historical contamination that could adversely influence the implementation of the planned restoration measures (EDR 2009). It should be noted that the same locations and releases can be recorded on multiple databases. The investigation includes an assessment of the database information to determine those locations that are most relevant to the restoration project sites and that would warrant additional investigation prior to implementation. The intent of these additional investigations would be to compile additional information such as: (a) the nature and type of hazardous materials involved; (b) the potential for contamination at these sites to limit or eliminate the possibility of habitat restoration actions; (c) the current regulatory status of each site, as applicable; and (d) the extent and type of remedial action that has been or is being taken, or may be planned at these sites. In addition to documented releases or the known presence of hazardous materials, consideration is also given to the potential for unknown sources to be present and the potential for hazardous releases or exposure to result from restoration construction.

The area of consideration for direct impacts on and from HWTM minimally includes the proposed restoration project sites, construction support areas, material disposal and borrow areas, and adjacent properties and waterways. A broader area was assessed to determine possible indirect effects at some of the restoration sites.

Under the No Action Alternative, potential positive and negative impacts that may be associated with the proposed ecosystem restoration projects would not occur. The regulations governing the reporting and remediation of hazardous sites would continue and the known sites would not be disturbed by construction. There would be no potential for hazardous releases or exposure resulting from construction. Further investigations and possible remedial actions at known site in the vicinity of the proposed sites would not occur in support of this effort. No indirect effects are anticipated under the No Action Alternative.

The recommended plan includes feasibility-level designs of an array of restoration measures tailored to each site. The current design features are displayed in the plans that are included as Appendix I. The analysis of the potential direct impacts on and from Hazardous Waste and Toxic Materials is based on these plans and the level of information available for each of the sites from the database search.

The PBES Plant site is primarily in an industrial zone adjacent to the Columbia Slough. Actions proposed at PBES Plant site include bank laybacks, installing LW, invasive species removal, native plant revegetation and excavations to provide a more frequent connection to a floodplain backwater/swale area. Excavation, bank lowering, grading, channel alteration and plant removal would result in the disturbance of soils and movement of sediments. The search of available environmental databases for potential hazardous materials indicates 43 initial findings in the broad vicinity of the restoration site. However, none of these sites were closer than one-quarter mile from the limits of excavation of the restoration project, therefore no further investigation is recommended.

The Kenton Cove site is an off-channel cove surrounded by a maintained levee along the north side of the Columbia Slough. Actions proposed at this site include adding habitat complexity by creating small habitat islands using LW and revegetating the shore with native riparian plants. Placement of LW and planting could result in minor disturbance of soils and movement of sediments. The search of available environmental databases for potential hazardous materials indicates 14 initial findings in the broad vicinity of the restoration site. However, none of these sites were closer than one-quarter mile from the limits of excavation of the restoration project, therefore no further investigation is recommended.

The Kelley Point Park site is located at the confluence of the Willamette and Columbia Rivers. The southern part of the site includes the confluence of the Columbia Slough with the Willamette River. Much of the park is built on fill and is surrounded by industrial uses along the waterways. Actions proposed at this site include excavation of two off-channel backwater areas, removal of invasive plants, revegetation with native species, bank lowering and placement of LW. Excavation, bank lowering, grading, channel alteration and plant removal would result in extensive disturbance of soils and movement of sediments. The search of available environmental databases for potential hazardous materials indicates 12 initial findings in the broad vicinity of the restoration site. However, none of these sites were closer than one-quarter mile from the limits of excavation of the restoration project, therefore no further investigation is recommended.

The Oaks Crossing/Sellwood Riverfront Park site is located along on the east bank of the Willamette River. Actions proposed at this site include excavation to create off-channel habitat,

placement of LW and revegetation with native riparian species. Excavation, grading, and planting removal would result in the disturbance of soils and movement of sediments. The search of available environmental databases for potential hazardous materials indicates 25 initial findings in the broad vicinity of the restoration site. However, none of these sites were closer than one-quarter mile from the limits of excavation of the restoration project, therefore no further investigation is recommended.

The Highway 43/Tryon Creek culvert site is located just west of the Willamette River on its tributary, Tryon Creek. The culvert replacement would pass under and existing highway and rail lines. Actions proposed at this site include creation of a wider channel for Tryon Creek, excavation of a low flow channel and riparian revegetation above and below the culvert. Excavation, grading, and planting would result in the disturbance of soils and movement of sediments. The search of available environmental databases for potential hazardous materials indicates 17 initial findings in the broad vicinity of the restoration site. However, none of these sites were closer than one-quarter mile from the limits of excavation of the restoration project, therefore no further investigation is recommended.

Once the final design and all construction support areas, material disposal and borrow areas are defined for each of the proposed sites, subsequent environmental reviews should be conducted to further characterize potential impacts from HWTM. Impacts could occur if subsequent environmental reviews identify the presence of hazardous materials at the restoration sites that would preclude habitat restoration, result in exposure to or transport of the materials, or would interfere with ongoing or planned site remediation.

Construction and maintenance of the restoration of the project would involve the use of hazardous materials, such as fuel, oil, solvents, and lubricants. During these activities, the public and workers could come into contact with or be exposed to hazardous materials during the routine transport, use, or disposal of hazardous materials, or as a result of an accidental release. However, standard operating procedures and best management practices would be implemented and would minimize the potential for impacts.

7.13 **Visual Quality**

Area of consideration for visual quality includes the specific project sites as observed from within and from a distance. It is as essential to protect the visual quality within the local area as it is to protect the aesthetic appeal of the landscape as a whole.

Over time, lack of restoration efforts under the No Action Alternative at the proposed sites will result in continued degradation of visual quality. Growth of non-native plants and the spread of weeds will directly reduce the aesthetic appeal of all sites. As the sites become less appealing, it is possible that indirect effects could include additional trash or debris found in the area, graffiti, or trampling of soils and river banks and increases in erosion.

The BES Plant site is along the south bank of the Columbia Slough. From the project footprint, one may see the North Portland Road (State Route 120) and its adjacent railway passing over the site, the narrow and mostly immature riparian zone on both banks, and the BES Plant itself. The Columbia Slough Trail bridge also passes over the slough and a second set of railroad tracks marks the furthest east that the project footprint extends. A narrow vegetated island occurs in the center of the slough between the trail bridge and east rail bridge. Those that observe the site include employees of the plant, other local landowners, recreationists at the Heron Lake Golf Club, and those traveling through the site by roadway, boat, or rail.

Kelley Point Park is a green space at the convergence of the Willamette and Columbia Rivers. Riparian vegetation, forested wetland, and the two rivers are the dominant visual resources from within the park. The park has a high percent of forest cover, except where park grass, cleared areas, and banks of sand, gravel, and cobble slope down to the rivers. Several commercial or private docking facilities can be seen within both rivers from the park and commercial developments are visible south of the park. Observation of the site from outside the project footprint occurs from water traffic on either river, vehicle traffic on North Lombard Street and North Marine Drive, from commercial enterprises to the south of the park, and from mostly privately owned farmland on the far banks of the rivers to the north.

Kenton Cove lies on the north shore of the Columbia Slough, just west of North Denver Avenue (Figure 7.1). From within the cove, visual resources include gently to moderately sloping banks covered with grasses or riparian forest that lead down to the backwater cove, as well as the adjacent Columbia Slough Trail, North Denver Avenue, MAX light rail line, and the Portland International Raceway. An overhead power line also runs to the east of the cove along the roadway. Distant views to the west are of the West Hills. Aesthetic condition at the site can be viewed by those passing along the various traffic corridors or via boat on the slough.

Figure 7.1. View of Kenton Cove Looking Southwest from Denver Ave.

The Oaks Crossing/Sellwood Riverfront Park site is on the north shore of the Willamette River (Figure 7.2). Local views are of greenspace, the river, and the traffic corridor comprised of SE Oaks Parkway, the Springwater bicycle trail, and rail line. Businesses and commercial developments are also visible from within the site, looking in every direction. The Sellwood Bridge crosses the river and dominates views to the south. The project footprint is comprised mostly of forest cover with small patches of bare ground or grass/lawn. Distant

Figure 7.2. View of Oaks Crossing/Sellwood Riverfront Park on Right Looking Downstream

views include the City of Portland and River View Cemetery on the west shore of the river. Those observing the site include local residents and business employees, those visiting the park and those passing through via road, bicycle, rail, or boat.

Aesthetics at the Tryon Creek Highway 43 Culvert site are defined primarily by the complex intersection of SW Terwilliger Blvd and SW Riverside Drive (Hwy 43). Also visible around this intersection are the trees that comprise Tryon Creek State Park to the west, vegetation along Stampher Road to the east, and the rail line along the east side of Highway 43. Distant views are limited from within the site due to trees and the topography. Some local businesses and neighborhoods may also be visible from portions of the site. Those that view the site on a regular basis include the local residents of Lake Oswego and those traveling through the area via roadway.

The aesthetic value of the sites selected for restoration under the recommended plan will be affected during the construction period. Construction vehicles, cleared ground, vegetation removal, generation of dust or trash, turbidity, or the presence of equipment or flagging will substantially reduce the visual quality of proposed sites. This will be particularly apparent at sites that appear natural or less developed than others, such as Oaks Crossing, Kenton Cove, or Kelley Point Park.

Following construction, visual appeal will be directly improved over time through creation of native wetland and off-channel habitats. Non-native plants will be removed and sites will be restored to conditions that blend into the natural aesthetic of the riverine system. Visually appealing sites attract a greater number of visitors and may indirectly result in more debris or trash on the site, trampling of vegetation from visitors wandering off trails, and additional vehicle trips to the site.

Implementation of BMPs during construction will reduce the visual impacts to the area. Construction equipment presence will be minimized and screens may be used to shield equipment from view, if necessary. Erosion control measures will prevent or minimize loss of topsoils and construction phasing will be designed to minimize area of clearing. If necessary, signage and trail markers may be installed to discourage off-trail use or littering.

Due to the temporary nature of the aesthetic impacts and the resulting improvement in visual quality to all proposed restoration sites, impacts resulting from construction are not expected to be significant. Instead, visual appeal will improve with each year as newly established vegetation grows and matures. Where wetlands are restored, species abundance and diversity will increase over time and further improve natural sites for bird-watching and wildlife appreciation.

7.14 Cumulative Effects in Study Area

7.14.1 Definitions and Overview

A cumulative effect occurs when the effects of an action, when added to other past, present, or reasonably foreseeable future actions, results in further environmental effects. These additional actions can be taken by the same federal agency, a different agency, or a public or private entity. A cumulative effects analysis is viewed as the total effects on a resource, ecosystem, or human community of the proposed action and all other actions affecting that resource regardless of who undertakes the actions. The Council on Environmental Quality (CEQ) requires the cumulative effects be examined as part of the NEPA analysis (40 C.F.R. Parts 1500-1508).

Historically, the lowlands adjacent to the Willamette River consisted of a series of ponds, lakes, sloughs, and wetlands, which were often prone to flooding. This seasonal flooding resulted in the development of flood control works by towns along the river by the late 1800s, including revetments and other bank treatments. The Willamette Plan, developed in the 1930s, called for a system of dams on the Willamette and its major tributaries for flood control, irrigation, and power. Over the next 40 years dam construction changed the natural flow regime of the basin, eliminating both the flood waters of the winter and spring, and the low flows of the summer and fall. Most of the historic off-channel habitat have long since been cut off from the channel and filled. The width and area of the river have both declined, as a result of diking and filling of shallow areas and navigational dredging. More importantly, in the lower reach of the river the amount of shallow areas (less than 20 feet) has declined by about 80 percent while the amount of deep water habitat (more than 20 feet) has increased by about 195 percent.

7.14.2 Impacts from Cumulative Actions

The following past, present, and reasonably foreseeable future actions in the Lower Willamette study area are considered in the Cumulative Effects analysis:

Federal Navigational Channel, Present The USACE monitors and maintains the navigation channel in the Lower Willamette River from the Columbia River upstream to the Broadway Bridge (RM 0 to 11.6) as part of the Columbia and Lower Willamette Rivers federal navigation project. From RM 11.6 to RM 14 (Ross Island), the channel is maintained by the Port.

Columbia Slough Section 1135 Restoration Project, Past The project created 7.5 miles of wetland benches and a deeper meandering channel, 25 acres of emergent wetlands, 6 acres of riparian scrub-shrub habitat, 5 acres of riparian forest habitat, and 3 acres of open water habitat. Project elements included reshaping the slough's straight channel, and creating wetland benches and islands that will be planted with native plants. The changes to the channel created a greater diversity of habitats, increased the water flow, and restored the riparian buffer along the slough.

Oaks Bottom Restoration Project, Future This is an ecosystem restoration study at the Oaks Bottom Wildlife Refuge within the floodplain of the Lower Willamette River, southeast of Ross Island.

Westmoreland Park Section 206 Restoration Project, Past Westmoreland Park is located along Crystal Springs Creek and is a tributary to Johnson Creek. Past – Project elements included provision of juvenile fish passage from Johnson Creek to the upper end of Westmoreland Park, (2) improved aquatic habitat for salmonid rearing and refuge, (3) riparian corridor and wetland habitat for wildlife, and (4) improved water quality conditions by eliminating a duck pond (which causes

heating of water), reducing excessive waterfowl use, and reducing runoff of other contaminants by providing a buffer for the creek and wetlands.

Willamette River Floodplain Restoration, Future A Feasibility Study has been performed to investigate improving flood storage and restoring natural floodplain function along the Willamette River and its tributaries. The study identified opportunities for the restoration of aquatic and riparian ecosystems, recovery of proposed and listed threatened and endangered species, reduction of flood damage, and improvement of water quality. The study area is the entire Willamette River Basin. The initial planning phase, currently underway, does not overlap with the Lower Willamette River Restoration Feasibility Study area.

Portland Harbor Comprehensive Environmental Response, Compensation and Liability Act (CERCLA or Superfund) Portland Harbor, Future Portland Harbor, a roughly 10-mile stretch of the Lower Willamette River, was added to the EPA National Priorities List in December 2000 due to the discovery of contaminated sediments. A draft Feasibility Study was published in March 2012, which presented alternatives to the clean-up and management of contaminated soil and river sediments.

Willamette Subbasin Plan, Present and Future The plan, completed in 2004, includes a compendium of current knowledge about basin conditions, particularly fish and wildlife and their habitats, an inventory of existing plans and programs, and strategies and actions to implement the plan. This plan is the basis for developing more detailed studies and restoration designs in the basin.

Willamette and Lower Columbia River Basins Recovery Plan**,** Present and Future NMFS, in partnership with ODFW, is developing a recovery plan for salmon and steelhead populations listed under the ESA in the Northwest Region. The Willamette/Lower Columbia recovery domain includes the Willamette River Basin. Recovery planning for listed salmon and steelhead has been underway in this domain since the summer of 2000.

American Heritage River, Present and Future The Willamette River from Springfield, Oregon, north to Portland has been designated as an American Heritage River. The American Heritage Rivers initiative, administered by EPA, has three objectives: (1) natural resource and environmental protection, (2) economic revitalization, and (3) historic and cultural preservation.

Oregon Plan for Salmon and Watersheds, Present and Future The Oregon Plan represents commitments on behalf of government, interest groups, and citizens from all sectors of the state to protect and restore watersheds for the benefit of salmon, and the economy and quality of life in Oregon. The Plan includes several components, including (a) the Healthy Streams Partnership aimed at improving and preserving water quality in water quality limited streams in Oregon, (2) the Coastal Salmon Restoration Initiative, which guides habitat restoration efforts for coastal Coho salmon in an effort to restore populations to sustainable levels, and (3) a steelhead supplement addressing salmonid restoration within the context of watershed health.

Willamette Partnership: Willamette River Legacy, Present and Future Three priority areas of focus for the Willamette River Legacy Program, including 1) Repair (cleaning up the industrial pollutants and toxins that have contaminated the river), 2) Restore (returning the river to its natural state, restoring its abundant wildlife and pristine riverbanks), and 3) Recreate (addressing the role that the Willamette River plays in Oregon's quality of life).

River Renaissance Initiative River Renaissance, Past River Renaissance Initiative was a City of Portland initiative to reclaim the Willamette River as Portland's uniting community centerpiece.

The River Plan, Present and Future The River Plan is a comprehensive multi-objective plan for land along the Willamette River. The River Plan is divided into three reaches of the Willamette River: the North Reach, Central Reach, and South Reach. The North Reach of the Willamette was the first to receive detailed planning, and the City Council adopted the River Plan North Reach in 2010. The South and Central Reach plans will follow.

Portland Watershed Management Plan, Present and Future The Portland Watershed Management Plan, adopted in 2006, describes the priority strategies being used to improve watershed health through the work of the PBES Watershed Services Group, River Renaissance, other City bureaus, agencies, and citizens' groups, all of which share the watershed health goals described in the framework

Combined Sewer Overflow, Past In 2011, the City's CSO program was completed, reducing CSOs to the Columbia Slough and Willamette River by 94 percent.

The No Action alternative will not see the implementation of the five specific elements called for in the recommended plan. The Past, Present, and Reasonably Foreseeable Future Projects, however, would provide some positive benefits on the study area's geology, hydrology and hydraulics, water quality, fish and aquatic habitat, wetlands, and floodplains. The construction activities associated with these projects would have some short-term adverse effects and could possibly overlap with one another, though the Lower Willamette project would not contribute to these effects since it would not be implemented. Overall, the cumulative effects under the No Action alternative would be minor and positive, since the Reasonably Foreseeable Future Projects are design to provide benefits as outline above.

The timeframe for the cumulative effects analysis extends from the early developments along the river in the late 1800's to fifty years in the future, the time horizon for the feasibility study. The geographic limit of the analysis is the Lower Willamette River watershed and its tributaries. It is acknowledged that improvements upstream from the Lower Willamette, such as those proposed in the Willamette Floodplain Ecosystem Restoration Plan (USACE 2013), would also have cumulative benefits to aquatic life and habitat in the river.

The implementation of the recommended plan would incrementally reverse some of the adverse effects of past developments along the Lower Willamette River that began in the late 1800's. Specifically, the plan would address the loss or degradation of off-channel habitats, the reduction in nutrients and woody material, the loss of channel complexity, the reduced wild stocks of salmonids, and the diminished health of tributaries in one or more of the five project areas.

Construction of the recommended plan would have temporary adverse effects on water quality, but it is unlikely to have cumulative effects (such as increased turbidity, disturbance, fish handling, etc.) since other reasonably foreseeable future projects are unlikely to occur in reasonably proximity to components of the recommended plan in the same timeframe.

7.14.3 Soils and Geology

The recommended plan would minimize erosion potential in the five specific project areas. Combined with other present and reasonably foreseeable future projects along the Lower Willamette River, there is likely to be better overall erosion protection and provide improvement over past actions.

7.14.4 Water Resources

Improvement in water quality is not a project purpose, and any improvements would be minor. Other past, present and reasonably foreseeable future projects, such as the recently completed Portland CSO project, have more specific beneficial effects on water quality. Thus the cumulative effects of all projects would be beneficial.

During construction, there may be temporary adverse effects on water quality, including from the recommended plan. It is not expected that there would be temporal or geographic overlap during the construction phase of the reasonably foreseeable future projects that would amplify the temporary, minor adverse effects.

Floodplains

The direct effects of performing the recommended plan at the restoration sites will increase backwater and side channel storage volumes which will likely cause reductions in base flood elevations. This coupled with other reasonably foreseeable future projects, such as Willamette River Floodplain Restoration, and the Oak Bottom Restoration, would have cumulative beneficial effects on floodplains.

7.14.5 Biological Resources

Wetlands

The recommended plan proposed restoration project includes the restoration or creation of a variety of wetland types at each of the 5 proposed sites. When combined with other reasonably foreseeable future projects, such as the Westmoreland Park Section 206 Restoration Project, the cumulative effects will result in increase in wetland habitat along the Lower Willamette River, assuming that other unforeseen public or private developments do not adversely affect present wetlands.

H**ydrology**

The five projects within the recommended plan are expected to have minimal effects on overall river hydrology and hydrodynamics. There would be a positive benefit for creating habitat by increasing flood frequency of the side channel and off channel areas. The off channel habitat and side channel areas will also provide minor reductions to flood flows and water surface elevations. These reductions are anticipated due to detention, or the short term storage of water volume, associated with flows high enough to cause inundation of these areas. Such minor, though positive effects, would contribute to overall river hydrology when combined with other past, present and reasonably foreseeable future projects, including the Columbia Slough Section1135 Restoration Project and the Oak Bottom Restoration Plan.

Vegetation

No special status vegetation is expected to be found in the project areas. During construction there will likely be short-term adverse effects from vegetation clearing that may reduce the quality and function of habitat temporarily. Other reasonably foreseeable future projects would likely have similar effects during construction but are unlikely to occur in temporal or geographic proximity and thus not result in an adverse cumulative effect. New native vegetation, added as a result of the

habitat improvements proposed in this and other reasonably foreseeable future projects could result in a cumulative increase in vegetation and, thus, habitat along the river corridor.

Fish and Wildlife Species

Overall, long-term benefits to fish and aquatic habitats from the recommended plan are expected through restoration of habitats that are limited for existing species such as off-channel habitat, wetlands, riparian habitats, cover and large wood. Other past, present, and reasonably foreseeable future projects also have habitat restoration components, including the recently completed Columbia Slough Section 1135 Restoration and the Westmoreland Park Section 206 Restoration Projects, and the future Willamette River Floodplain Restoration project. Beneficial cumulative effects on fish and wildlife species are expected.

Threatened, Endangered, Candidate, and Rare Species

The proposed restoration plan is intended to help restore habitats and natural processes that form habitats for listed and proposed species, including Chinook salmon, Coho salmon, and steelhead, and will help contribute to the recovery of these species. The Lower Willamette project is but one of several present or reasonably foreseeable future projects that would improve habitat along the Willamette and aid in the protection and growth of the various species.

Construction effects are generally adverse to species, though BMPs are implemented to reduce adverse effects. Similar BMPS are implemented with other projects, reducing the likelihood of increased short-term adverse effects.

7.14.6 Cultural and Historic Resources

While cultural or archaeological resources may be discovered during the course of implementing the Lower Willamette project, it is unlikely that any of the other reasonably foreseeable future projects would overlap spatially with the recommended plan. Thus, no cumulative effects are anticipated.

7.14.7 Land Use and Zoning

The implementation of the recommended plan would have minor, and generally beneficial, effect on land uses at and adjacent to the five sites. All reasonably foreseeable future projects would need to be consistent with area land use plans and zoning requirements and thus no adverse cumulative effects are anticipated.

7.14.8 Transportation

Transportation effects on the recommended plan are limited to construction effects involving transport of workers, materials, and construction equipment to the sites. A transportation management plan (TMP) would be prepared prior to start of construction. Concurrent construction of any of the reasonably foreseeable future projects, though unlikely, could be reflected in the TMPs for both the recommended plan and the concurrent projects. This would mitigate to a large extent any cumulative adverse transportation effects.

7.14.9 Socioeconomics

The social and economic effects of the recommended plan are at most minor, with the possible exception of the culvert replacement at Tryon Creek. As most of the reasonably foreseeable future

projects are along the river or its tributaries, impacts on adjacent residents and businesses are likely be to minor as well, so no adverse cumulative effects are anticipated.

7.14.10 Environmental Justice

Restoration construction in the five areas proposed in the recommended plan is not expected to directly or indirectly affect income, employment, or other socioeconomic indicators disproportionately in environmental justice communities. When viewed with the present and reasonably foreseeable future projects, improvements (and the construction-related minor and temporary adverse effects) impact a variety of communities along the Willamette River with no one area singled out for disproportional effects, either beneficial or adverse.

7.14.11 Parks and Recreation

While there may be some minor disruption on access to portions of several recreational facilities during construction (Kenton Cove, Kelley Point Park, Oaks Crossing, and potentially Tryon Creek State Park), there would also be long term benefits of improved habitat and aesthetic conditions, which could lead to a more positive recreational experience. Several reasonably foreseeable future projects would have direct or indirect beneficial effects on parks and recreational facilities. These include implementation of the Willamette Subbasin Plan, the Willamette River Legacy effort, the River Renaissance Initiative, and the River Plan.

7.14.12 Air Quality

No adverse effects to air quality are expected from the completed project. A similar situation is likely for any of the reasonably foreseeable future actions; therefore, no adverse cumulative effects to air quality as expected.

During construction, there may be temporary air quality effects in terms of dust or construction vehicle emissions (The exception would be the construction of the culvert at Tryon Creek that would have more noticeable effects on air quality due to traffic capacity constraints). These would be short-term and best management practices would be implemented to reduce their effect. It is unlikely that other reasonably foreseeable future projects would have in the same temporal or spatial proximity. Should this circumstance occur, construction BMPs could be used to reduce the cumulative effect.

7.14.13 Noise

The completed projects would generate no noise, other than during periods of routine maintenance. The same would be true for most if not all of the reasonably foreseeable future actions. Thus no cumulative effects would be likely.

During construction, it is unlikely that work would occur on more than one project in one area at the same time; therefore, cumulative noise effects are also unlikely to occur.

7.14.14 Hazardous Waste and Toxic Materials

Cumulative effects on hazardous waste and toxic materials would only occur if work on multiple projects were occurring at the same or adjacent locations and at or around the same time, which is not anticipated. Any contamination that is encountered during implement of projects would be handled according to standard protocols and would result in less contaminated material still in the

ground post-construction. Implementation of the reasonably foreseeable future projects could further reduce overall incidents of contaminated materials in or near the river and its tributaries.

7.14.15 Visual Quality

Implementation of the recommended plan, in addition to reasonably foreseeable future projects such as the Willamette River Legacy effort, the River Renaissance Initiative, could result in cumulative beneficial effects on the visual environment along the Willamette River.

7.15 Relationship between Short-term Uses and Long-term Productivity

The short-term use of construction equipment and various construction materials, required for implementing the recommended plan, would have relatively minor energy, noise, air quality, and transportation effects compared to the long-term benefits of the proposed habitat restoration. The restoration sites would have increased ecological function and increased recreational use.

7.16 Unavoidable Adverse Impacts

The restoration and rehabilitation of aquatic and riparian habitats in the study area will result in an irreversible commitment of resources, as well as irretrievable use of resources. Construction activities would require the use of fossil fuels for operation of vehicles and equipment and use of water for dust abatement, both of which would be irreversible.

Construction at all proposed sites under the recommended alternative requires clearing of biological resources and earthwork that may result in losses to cultural resources. Though adherence to federal law and implementation of BMPs is intended to protect sensitive plants and animals and also to protect historic artifacts, there is some potential for incidental loss that would be irreversible. However, the completion of the proposed project is intended to restore proper functioning of biological resources, and therefore an improvement in their condition. Furthermore, this project is in compliance with all federal regulations that are intended to protect sensitive cultural, socioeconomic, and environmental resources.

Completion of the proposed restoration is intended to protect the sites from further loss of biological, recreational, and visual resources. Continued degradation of native fish and wildlife populations results from decreases in the size and function of wetlands. Under the No Action Alternative, non-native and invasive species will continue to become established and outcompete native species, while native fish and wildlife will continue to suffer from lack of suitable habitat. Under the No Action Alternative, irreversible and irretrievable losses of native species and habitats will continue.

7.17 Mitigation Measures and Best Management Practices

As there is no activity that occurs with the No Action Alternative, no mitigation is required.

The recommended alternative, as a restoration project, is itself mitigation for the existing conditions along the Lower Willamette River and its tributaries. No mitigation actions are needed after completion of the restoration; however, an operations and maintenance plan will be developed and followed post construction of the restoration sites. The operations and maintenance plan will provide guidance on the frequency and methods for inspecting the restoration sites to ensure that the design elements are functioning properly. Periodic maintenance may be required for the restoration

sites, including removal of sand sediment from the connection points of side channels and off channel habitat areas. The operations and maintenance plan will be developed during future design and planning phases for the restoration sites. BMPs that will be implemented as necessary to avoid or minimize soil erosion can include the placement of in-water silt fences to control movement of soils into water and containment of turbidity within localized areas, placement of mulch or other ground cover to reduce soil movement as dust or during rain events, and a construction design plan that minimizes the area to be cleared of vegetation.

The construction of backwater channels at Kelley Point Park could potentially reduce the area available for pedestrians or other users. Mitigation of this potential impact has been resolved through including several crossing structures in the design of the project. These structures will ensure that all areas will be accessible after the side channels are constructed and will further improve the recreational value of the site.

The USACE will continue to work with the local planning entities and stakeholders to identify any short and long term conflicts with land use and zoning issues as the final designs and construction plans are developed.

The USACE will complete ESA consultation with USFWS and NMFS prior to completion of this feasibility study process. This will include issuance of an incidental take statement consistent with actions allowed under the PROJECTS biological opinion.

As a prelude to construction, the USACE will complete the Section 106 process for implementing these proposed restoration measures in consultation with the Oregon State Historic Preservation Officer (SHPO) and other parties defined in 36 C.F.R. 800. The level of effort for assessing each restoration location would be determined based on the preliminary information that has been developed in consultation with the SHPO. Anticipated actions include:

- Further refinement of the vertical and horizontal, direct and indirect Area of Potential Effects (APE) for each restoration measure and location;
- Additional archival research into past uses and depths of previous disturbance;
- Further site-specific inventory, identification and evaluation efforts for archaeological, built environment and traditional cultural properties;
- Subsurface testing where buried resources may be anticipated and to define the boundaries of the known sites;
- Consultation with relevant Native American groups; and
- Determination of effect and resolution of adverse effect on a project basis or through an agreement document.

After completion of the Section 106 process, a discovery plan will be developed to establish protocols for handling and protecting cultural materials that may be found during construction. Components of the protocol will specify that if an accidental discovery is made during ground-disturbing activity, work will be stopped immediately, and a qualified archaeologist will assess the find and decide upon the nature and extent of future investigation and recovery. If human remains are discovered, the Multnomah County Coroner's Office will be contacted immediately.

Onsite personnel will be familiar with the discovery plan protocol and will have a copy on site. This plan will be reviewed ahead of time so the project managers may address questions regarding the identification of cultural material or the process to follow if any questionable material be encountered during construction. The unanticipated discoveries protocol will be provided to

contractors during the bid process so they are aware of this requirement when they develop their estimates. Archaeological monitoring may be warranted in areas where there is a high probability for encountering archaeological materials.

During construction, to prevent or minimize potential impacts resulting from restoration construction and maintenance the USACE will:

- Incorporate waste minimization and pollution prevention processes into the design and construction of the restoration projects.
- Require that construction contractors prepare and implement pollution prevention plans with clearly specified lines of authority and responsibility and defined procedures.
- Prepare a Spill Control plan that includes the procedures, instructions, and reporting requirements for emergency response and cleanup measures that would be used in the event of an unforeseen spill of a substance regulated by 40 C.F.R. 68, 40 C.F.R. 302, 40 C.F.R. 355, and/or regulated under State or Local laws and regulations.
- Take sufficient measures to prevent spillage of hazardous and toxic materials during dispensing.
- Segregate hazardous waste from other materials and wastes; protect it from the weather by placing it in a safe covered location, and take precautionary measures such as berming or other appropriate secondary containment measures to contain accidental spillage. All storage, packaging, labeling, marking, and placarding of hazardous waste and hazardous material should be in accordance with 49 C.F.R. 171 - 178, State, and local laws and regulations.
- Storage, fueling and lubrication of equipment and motor vehicles must be conducted in a manner that affords the maximum protection against spill and evaporation in accordance with all Federal, State, Regional, and local laws and regulations. Used lubricants and used oil to be discarded must be stored in marked corrosion-resistant containers and recycled or disposed in accordance with40 C.F.R. 279, State, and local laws and regulations.
- Storage of fuel on the project site should be avoided, but if necessary would be in accordance with all Federal, State, and local laws and regulations.
- Waste water from construction activities will not be allowed to enter water ways or to be discharged prior to being treated to remove pollutants.
- Minimize the usage of hazardous materials to the extent practicable by equivalent product substitution.
- Treat or recycle of hazardous wastes onsite, wherever feasible and allowed by regulations.
- Transport hazardous wastes to approved off-site recycling, treatment, and disposal facilities.

7.18 Environmental Operating Principles

The USACE Environmental Operating Principles were developed to ensure that USACE missions include totally integrated sustainable environmental practices. The Principles provided corporate direction to ensure the workforce recognized the USACE role in, and responsibility for, sustainable use, stewardship, and restoration of natural resources across the Nation and, through the international reach of its support missions.

Since the Environmental Operating Principles were introduced in 2002 they have instilled environmental stewardship across business practices from recycling and reduced energy use at USACE and customer facilities to a fuller consideration of the environmental impacts of USACE actions and meaningful collaboration within the larger environmental community.

The concepts embedded in the original Principles remain vital to the success of the USACE and its missions. However, as the Nation's resource challenges and priorities have evolved, the USACE has responded by close examination and refinement of work processes and operating practices. This self-examination includes how the USACE considers environmental issues in all aspects of the corporate enterprise. In particular, the strong emphasis on sustainability must be translated into everyday actions that have an effect on the environmental conditions of today, as well as the uncertainties and risks of the future. These challenges are complex, ranging from global trends such as increasing and competing demands for water and energy, climate and sea level change, and declining biodiversity; to localized manifestations of these issues in extreme weather events, the spread of invasive species, and demographic shifts. Accordingly, the USACE is reinvigorating commitment to the Environmental Operating Principles in light of this changing context.

The Environmental Operating Principles relate to the human environment and apply to all aspects of business and operations. They apply across Military Programs, Civil Works, Research and Development, and across the USACE. The Principles require a recognition and acceptance of individual responsibility from senior leaders to the newest team members. Re-committing to these principles and environmental stewardship will lead to more efficient and effective solutions, and will enable the USACE to further leverage resources through collaboration. This is essential for successful integrated resources management, restoration of the environment and sustainable and energy efficient approaches to all USACE mission areas. It is also an essential component of the USACE risk management approach in decision making, allowing the organization to offset uncertainty by building flexibility into the management and construction of infrastructure.

The recommended plan will be consistent with the current USACE Environmental Operating Principles as identified below.

1. *Foster sustainability as a way of life throughout the organization.* This project is intended to contribute to the restoration of natural habitat formation processes and reconnect off-channel habitats of the Lower Willamette River. This is to allow sustainable processes to continue into the future with limited necessary human intervention and management. This will help restore habitats for sensitive fish and wildlife species and contribute to the recovery of these species populations.
2. *Proactively consider environmental consequences of all USACE activities and act accordingly.* As identified above, this project is intended to allow natural physical processes to function more effectively to create and form habitats for fish and wildlife. This will incrementally address some of the consequences that past USACE programs have caused to aquatic and riparian habitats throughout the Willamette River system.
3. *Create mutually supporting economic and environmentally sustainable solutions.* This project will restore aquatic and riparian habitats to the study area. The project will not have adverse effects on residents or infrastructure and may incidentally increase recreational use of the restored areas.
4. *Continue to meet our corporate responsibility and accountability under the law for activities undertaken by the USACE, which may impact human and natural environments. –* This project provides restoration of watershed functions while avoiding adverse effects on cultural, socioeconomic, and natural resources.
5. *Consider the environment in employing a risk management and systems approach throughout the life cycles of projects and programs*. This project has been designed in the context of ongoing watershed processes including hydrology and sediment transport. It is designed to function over the long-term with consideration of potential changes in immediate and surrounding land uses.

6. *Leverage scientific, economic, and social knowledge to understand the environmental context and effects of USACE actions in a collaborative manner.* The recommended plan reflects the latest design and evaluation strategies for restoration of aquatic and riparian habitats, and has been reviewed and vetted by highly experienced environmental scientists as well as civil and hydraulic engineers. It reflects a collaborative approach between the USACE, the non-Federal sponsor, and federal resource agencies.
7. *Employ an open, transparent process that respects views of individuals and groups interested in USACE activities.* The USACE and the non-Federal sponsor will continue to work with stakeholders and the public to ensure that the completed project reflects the concerns of the public and those with specific understanding of the watershed processes of the Lower Willamette River and its tributaries.

8. PUBLIC INVOLVEMENT, REVIEW, AND CONSULTATION

On February 14, 2014, a workshop was held with staff from USFWS to discuss project features, possible effects, and methods of describing the project and potential effects. Recommendations from that workshop have been incorporated into the Biological Assessment (BA) and designs for this project. A similar meeting was held with staff from NMFS on March 4, 2014, and similar recommendations were given.

The BA was submitted to initiate formal consultation with USFWS and NMFS. The consultation process and results are described in Section 9.2, below.

Consultation with Portland and Western Railroad, which is the railroad company that uses the railroad tracks crossing the Tryon Creek Highway 43 Culvert project site, was initiated by the USACE in February of 2014. The intent of coordination to date is to inform the railroad of the project and start initial conversations of what the project would entail. Coordination is at a preliminary phase and is ongoing.

Consultation with the City of Lake Oswego was initiated by the USACE and occurred in August of 2014. The intent of coordination was to inform the City of the proposed project and start initial conversations of what the project would entail. Coordination will continue through the course of the planning process.

This FS-EA is being made available for a 30-day public review period starting on September 23, 2014 and expiring on October 23, 2014. At the end of the public comment period, the Corps will consider all comments received by close of business on the expiration date and make a determination of significance of impacts resulting from the proposed action. If it is determined that the proposed action results in no significant impacts to the human environment, a Finding of No Significant Impact (FONSI) would be finalized and signed by the Corps' District Commander. A draft FONSI has been prepared and is also available for review and public comment under separate cover.

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9. ENVIRONMENTAL COMPLIANCE REQUIREMENTS

This section describes some of the primary environmental regulations that the USACE and the project partners will comply with during the planning process. Table 9.1 will be updated at appropriate milestones to reflect compliance status.

9.1 National Environmental Policy Act

This EA describes environmental conditions within the study area (subbasin scale), the proposed action and alternatives, potential environmental impacts of the proposed restoration plan at the subbasin and restoration measure scale, and measures to minimize environmental impacts. No significant impacts have been identified; therefore the Corps has prepared a draft Finding of No Significant Impact (FONSI). After the public review process has occurred and comments incorporated into the document, the FS-EA/FONSI will be finalized.

9.2 Endangered Species Act

The ESA of 1973, as amended, declares that all federal agencies "…utilize their authorities in furtherance of the purposes of this Act by carrying out programs for the conservation of endangered species and threatened species listed pursuant to Section 4 of this Act." Section 7 of the ESA requires federal agencies to ensure that any agency action (any action authorized, funded, or carried out by the agency) is not likely to jeopardize the continued existence of any threatened, endangered, or proposed species.

In accordance with Section 7(a)(2) of the ESA of 1973, as amended, federally funded, constructed, permitted, or licensed projects must identify and evaluate any threatened and endangered species, and their critical habitat, that may be affected by an action proposed by that agency. A Biological Assessment (BA) has been prepared for formal consultation, and is included in Appendix C. In this BA, determinations of effects arising from the Tentatively Recommended Plan were made, and conservation measures were identified to offset adverse effects to the degree possible. Upon review of the BA, NMFS issued a Biological Opinion (BiOp) and Incidental Take Statement (ITS) that concurred with the Corps' findings that the project is likely to adversely affect listed salmonid species or their critical habitat, but is not likely to jeopardize the species (NMFS 2014). The BiOp and ITS are provided in Appendix B of the attached Biological Assessment (Attachment C).

9.3 Clean Water Act

Section 404 of the Clean Water Act authorizes a permit program for the disposal of dredged or fill material into waters of the United States, and defined conditions which must be met by federal projects before they may make such discharges. The USACE retains primary responsibility for this permit program. The USACE does not issue itself a permit under the program it administers, but rather demonstrates compliance with the substantive requirements of the Act through preparation of a 404(b)(1) evaluation. If needed, a Section 404(b)(1) evaluation will be prepared to document findings regarding this proposed restoration plan pursuant, although if the project qualifies under a Nationwide Permit (NWP) a 404(b)(1) evaluation may not be needed.

Section 401 of the Clean Water Act requires federal agencies to comply with EPA, state, or tribal water quality standards. EPA has delegated implementation of Section 401 to the ODEQ. Implementation of this project will require 401 certification from the ODEQ for compliance with

Section 401 of the Clean Water Act for work below the Ordinary High Water (OHW) line. If the proposed project moves forward under a NWP, a Section 401 certification would be pre-approved. The USACE will abide by the conditions of the water quality certification to ensure compliance with Oregon water quality standards. During the design phase, further coordination with ODEQ will be conducted to document the proposed work area isolation and dewatering plans at each individual site and to develop construction water quality monitoring plans.

Section 402 of the act requires a NPDES permit and the associated implementing regulations for General Permit for Discharges from large and small construction activities for construction disturbance over one acre. This permit will be obtained for each project site during the design phase.

9.4 Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act (16 U.S.C. 661) requires that wildlife conservation receive equal consideration and be coordinated with other features of water resource development projects. This goal is accomplished through USACE funding of a Coordination Act Report (CAR), which provides the basis for recommendations for avoiding or minimizing such impacts. Coordination with USFWS has been ongoing throughout the study process and USFWS has provided a number of proposed conditions and other recommendations in-lieu of a CAR (USFWS 2014). These recommendations have been incorporated into this FS by reference, and will satisfy USFWS's FWCA goals for the report. The recommendations are provided in Appendix C of the attached Biological Assessment (Attachment C).

9.5 National Historic Preservation Act

The National Historic Preservation Act (16 U.S.C. 470) requires that the effects of proposed federal undertakings on sites, buildings structures, or objects included or eligible for the National Register of Historic Places must be identified and evaluated. This project is a federal undertaking and a preliminary evaluation has been conducted to determine if historic structures are located within or adjacent to the undertaking area of potential effect, or if the projects are within immediate view sheds that are eligible for the National Register. Coordination is ongoing with the State Historic Preservation Office (SHPO) and affected tribes.

9.6 Magnuson-Stevens Fishery Conservation and Management Act

The evaluation of project impacts to essential fish habitat (EFH) was conducted as part of the Section 7 consultations with NMFS described in Section 9.1.2 above. Conservation measures were included as part of the proposed action in order to adequately avoid, minimize, or otherwise offset potential adverse effects to EFH. The BiOp for this project indicated that although the proposed action is likely to have adverse effects on EFH due to temporary loss of riparian vegetation, temporary loss of water quality from sediment disturbance, and harassment/displacement from disturbance caused by construction. The BiOp also indicates that many long-term beneficial effects from the proposed action are expected.

9.7 Bald and Golden Eagle Protection Act (16 U.S.C. 668-668d)

The Bald and Golden Eagle Protection Act prohibits the taking, possession or commerce of bald and golden eagles, except under certain circumstances. Amendments in 1972 added penalties for violations of the act or related regulations.

Although bald eagles may occur in the study area, no take of either bald or golden eagles is likely during project construction. No nests are known to be present. Therefore, no adverse effects to eagles are anticipated. The act's management guidelines (USFWS 2007) will be followed if any bald eagle nests are identified during the design or construction phases. Buffers of 660 feet should be maintained around nests if the construction work is visible from the nest. Buffers of 330 feet should be maintained around nests if the construction work is not visible from the nest.

9.8 Executive Order 12898, Environmental Justice

EO 12898 directs every federal agency to identify and address disproportionately high and adverse human health or environmental effects of agency programs and activities on minority and low-income populations. Environmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. The federal government has this goal for all communities and persons across this nation. It would be achieved when everyone enjoys the same degree of protection from environmental and health hazards, equal access to the decision-making process, and the opportunity to have a healthy environment in which to live, learn, and work. There are no disproportionate effects to environmental justice communities, therefore the proposed action is compliant with EO 12898.

9.9 Executive Order 11988, Floodplain Management, 24 May 1977

EO 11988 requires federal agencies to avoid, to the extent possible, the long and short-term adverse impacts associated with the occupancy and modification of the floodplain, and to avoid direct and indirect support of floodplain development where there is a practicable alternative. In accomplishing this objective, "each agency shall provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by floodplains." The proposed project will not result in development within the floodplain and modifications will result in increased water storage capacity in the floodplain, therefore the project is compliant with EO 11988.

Table 9.1 describes the environmental documents needed prior to construction, and the status of preparation of those documents.

Table 9.1. Environmental Compliance with Applicable Requirements

Relevant Law/Regulation	**Requirements**	**Compliance Status**
NEPA 42 U.S.C. 4321 et seq.	Requires federal agencies to consider the environmental effects of their actions and to seek to minimize negative impacts.	Draft EA prepared as part of this study.
CWA 33 U.S.C. 1251 et seq.; Section 404	Requires federal agencies to protect waters of the United States. Disallows the placement of dredged or fill material into waters (and excavation) unless it can be demonstrated there are no reasonable alternatives.	USACE will prepare a wetland delineation and submit it to Oregon DSL in accordance with permitting requirements. USACE will prepare a Section 404(b)(1) evaluation to assess project effects on wetlands.
CWA Section 401	Requires federal agencies to comply with state water quality standards.	A Section 401 Water Quality Certificate will be obtained from ODEQ prior to completing the final design plans. This project will likely qualify for a pre-certified 401 WQC, which is generally issued for projects covered by NWPs.
Fish and Wildlife Coordination Act 16 U.S.C. 661 et seq.	Requires federal agencies to consult with the U.S. Fish and Wildlife Service on any activity that could affect fish or wildlife.	Coordination with the U.S. Fish and Wildlife Service is complete. A set of recommendations in-lieu of a Coordination Act Report has been issued and is provided as Appendix C of the Biological Assessment.
ESA 16 U.S.C. 1531 et seq.	Requires federal agencies to protect listed species and consult with USFWS or NOAA Fisheries regarding the proposed action.	A draft BA has been prepared. Coordination with fish and wildlife agencies has occurred and a Biological Opinion and Incidental Take Statement have been issued.
Clean Air Act U.S.C. 7401	Requires federal agencies to control and abate air pollution.	Project is in compliance with the Clean Air Act.
Rivers and Harbors Acts 33 U.S.C. 403	The creation of any obstruction to the navigation of any waters of the United States is prohibited without congressional approval.	Section 10 review will occur at same time as determination of Section 404 compliance.
National Historic Preservation Act 16 U.S.C. 461	Requires federal agencies to identify and protect cultural and historic resources.	The project will be coordinated with SHPO and affected Tribes. Consultation will continue with SHPO and Tribes throughout all project phases in an effort to maintain no adverse effects to historic properties and areas of substantial cultural interest. The compliance process will continue until SHPO and Tribal concurrence has been achieved.
EO 11988, Floodplain Management, 24 May 1977	Requires federal agencies to consider how their activities may encourage future development in floodplains.	Project will not induce development in floodplains, is therefore in compliance.

Relevant Law/Regulation	**Requirements**	**Compliance Status**
EO 11990, Protection of Wetlands	Requires federal agencies to protect wetland habitats.	USACE will prepare a wetland delineation and submit it to Oregon DSL in accordance with permitting requirements. Project will avoid impacts to wetlands to degree possible, and will result in increase in amount and quality of wetland habitat. Project is in compliance.
EO 12898, Environmental Justice	Requires federal agencies to consider and minimize potential impacts on low-income or minority communities.	Project is in compliance.
EO 11593, Protection and Enhancement of the Cultural Environment	Requires federal agencies to preserve, restore, and maintain the historic and cultural environment of the U.S.	Compliance determination to be made after NEPA impact assessment and Section 106 consultation is complete.
EO 13175, Consultation and Coordination with Indian Tribal Governments	Requires federal agencies to consult and coordinate with the appropriate tribal governments.	Compliance determination to be made after NEPA impact assessment and public involvement process is complete.
Native American Graves Protection and Repatriation Act	Protects Native American and Native Hawaiian cultural items.	Compliance determination to be made after completion of NEPA impact assessment, public involvement process, SHPO and Tribal consultations and final construction implementation.
American Indian Religious Freedom Act 42 U.S.C. 1996	Requires federal agencies to insure that religious rights of Native Americans are accommodated during project planning, construction, and operation.	Compliance determination to be made after completion of NEPA impact assessment, public involvement process, SHPO and Tribal consultations and final construction implementation.
Oregon Water Quality Standards	Requires that actions that may affect water quality of waterbodies in the state comply with water quality regulations.	Will be in compliance per Section 401 Water Quality Certification.
ODFW Fish Passage Policy	Fish passage is required in all waters of this state in which native migratory fish are currently or were historically present; Projects that construct, install, replace, extend, repair or maintain, and remove or abandon dams, dikes, levees, culverts, roads, water diversion structures, bridges, tide gates or other hydraulic facilities are triggers to Oregon's fish passage rules and regulations.	Integral to this proposed project is to incorporate ODFW fish passage policy to all designs.
Oregon Threatened and Endangered Species	Requires an evaluation of effects on State-listed threatened and endangered species	The project will be coordinated with the ODFW.
Oregon Removal/Fill	Requires an evaluation of effects on	Will be in compliance per submittal of

Relevant Law/Regulation	**Requirements**	**Compliance Status**
Permit	wetlands and waterbodies within the State of Oregon	a General Authorization Notification submittal to Oregon Division of State Lands (ODSL).

10. MONITORING AND ADAPTIVE MANAGEMENT PLAN

Monitoring and adaptive management will conform to requirements of Section 2039 of WRDA 2007 and subsequent USACE implementation guidance, and monitoring will be conducted until such time as the USACE determines that the project has achieved success.

This monitoring and adaptive management plan has been developed to ensure the success of the recommended restoration plan in meeting project objectives and a process to identify if any adaptive management actions are warranted during the 10-year period. Monitoring is proposed to occur for 10 years as geomorphic changes and vegetation community conditions develop slowly and a shorter period of monitoring may not detect sufficient changes or threats to the success of the project. The proposed monitoring plan will measure the following key elements: vegetation, connector channel hydrology and hydraulics, river and floodplain morphology, wildlife, physical habitat, and fish and typical methods are described as the basis for the monitoring cost estimate in this section. Detailed protocols (including specific sampling locations) will be developed further for each site during the design phase. Photo-monitoring will also be conducted to document site changes over time including vegetation establishment and physical habitat features.

The non-Federal sponsor will conduct all monitoring activities for 10 years after completion of construction at each site as part of the total project cost-share. The total estimated monitoring costs are $85,000 and are based on actual costs from similar activities conducted during the feasibility phase. Any monitoring conducted after 10 years would not be part of the total project cost and will be 100% non-Federal costs.

This section describes the components of a monitoring plan that will be developed during the design phase. The detailed monitoring plan will be used to determine the success of the restoration measures in meeting project objectives and, if needed, to establish adaptive management measures. Methods are outlined below in Table 10.1.

Table 10.1. Specific Monitoring Plan Elements and Methods

Monitoring Element	Methods
Vegetation	• Revegetated sites will be monitored for 5 years to remove invasive plants around the base of new plantings in order to allow them to become established. • Survival rates of vegetation installed will be determined and supplemental plantings will be installed on an as needed basis. • Over several years following construction (typically during years 1, 2, 5, and 10), riparian vegetation plantings are evaluated for percent cover, canopy cover over-water, and overall percent survival.
Hydrology/Hydraulics	• Flows through the side channels will be monitored to track frequency of connections.
Physical Habitat	• Cross-sectional surveys in selected locations of the newly excavated channel connections will be conducted for 3 years after construction to determine if sediment deposition or erosion has occurred, and if so, determine the cause and magnitude. • Aquatic features such as pools and LW would be monitored to determine: (1) physical measurements (*e.g.*, maximum depth, residual depth and surface area); (2) if hydraulic conditions have been created that affect their function; and (3) if additional pools have been created.

	• LW would be monitored to determine if it has moved or caused any bank erosion or other changes. Side channels will be monitored to ensure that inlets and outlets remain open.
Wildlife	• Wildlife use of riparian areas, wetlands, side channels, and in-stream locations will be monitored. Small mammals and amphibians will be monitored to evaluate potential impacts during construction; and monthly waterfowl monitoring and nesting bird surveys will be conducted for five years.
Fish	• Pre- and post-construction fish surveys will be conducted in the project area to document assemblage data on a quarterly basis. Active sampling methods may include beach seining, and passive methods will include minnow trapping. Multiple habitat features and life stages will be targeted. • Fish passage at the Tryon Creek/Highway 43 site will be monitored during the fall and winter migration periods.

General Targets:

- Achieve 75 percent cover of native vegetation species per design at each site within 5 years post-construction and sustain through life of project.
- Reduce non-native vegetation species to less than 25 percent cover per design at each site within 5 years post-construction and sustain through life of project.
- Document changes in habitat suitability for wildlife species included in habitat model. Compare and correlate presence/absence of native fish, amphibians, and native songbirds to habitat suitability parameters.

Monitoring Protocol:

- Establish minimum of five permanent vegetation plots on each site to be representative of the plant communities and restored areas within the project site. Permanent plots shall be 33 foot diameter circular plots (centerpoint of each plot will be documented via Global Positioning System (GPS) coordinates to reoccupy in each of sampling). Percent cover will be visually assessed and documented for each strata (herbs, shrubs, trees, woody vines) and each species with more than 5 percent cover. Sampling will occur in Years 1, 3, 5, and 10 following construction. Percent survival of planted stock should be a minimum of 80 percent during Years 1 and 3 otherwise supplemental plantings will be required to replace plants that have died. Percent cover of native species will be measured in the permanent plots and should reach 30 percent in year 1, 50 percent in year 3, and >80 percent in years 5 and 10 (total percent cover in all strata). Estimated cost $10,000 per year; total $40,000.
- Map non-native vegetation species throughout restored areas on each site in Years 1, 3, and 5 after construction and document percent cover in all locations with more than 100 square feet of presence. Document average percent cover by species across the site and estimate total area of infestation. Estimated cost $5,000 per year; total $15,000.
- Conduct habitat evaluation using multi-species HEP model in Years 5 and 10 following construction at each site. Document changes from baseline. Estimated cost $5,000 per year; total $10,000.
- Conduct fish, amphibian, and songbird surveys in Years 5 and 10 following construction at each site. Standardized targeted fish survey will be followed at all times. Amphibian surveys to be conducted during breeding season to document all species observed. Conduct bird nesting surveys in summer at each site in Years 5 and 10 following construction.

Document amphibian and bird survey data to habitat model parameters (i.e., quantify water temperatures, shrub height and density and other parameters where species observed). Estimated cost $10,000 per year; total $20,000.

Adaptive Management Trigger(s):

- If native plant survival or percent cover does not meet targets in any year of monitoring then the non-Federal sponsor will undertake supplemental plantings to achieve the targets. The USACE and non-Federal sponsor will evaluate at the end of 10 years the overall quality of habitat in each restored plant community to identify if the project met this criteria.
- If average non-native invasive species cover exceeds 25 percent cover in any of the monitoring years then the non-Federal sponsor will undertake invasive species removal actions such as pulling, mowing, and spot application of herbicide.
- USACE and non-Federal sponsor to evaluate habitat suitability indices and presence/absence of native fish, amphibians, and birds and modify models as appropriate based on quantitative data of presence relative to specific model parameters.

Adaptive management would be triggered by the above identified conditions if the monitoring targets are not met. At this time, it is difficult to predict which specific triggers might not be met, but for the purposes of estimating an adaptive management cost, it is assumed that a potential condition that could result is the closure of the mouths of side channels due to sediment accretion. Thus, for purposes of estimating the potential cost of adaptive management, it has been assumed that occasional removal of sediment at each restoration site where side channels would be excavated, which include Kelley Point Park, Oaks Bottom/Sellwood Riverfront Park, and BES Plant, may be needed. The average cost of this excavation is estimated at approximately $5,000 at each of the inlets and outlets of the side channels every three years, including revegetating areas affected during the excavation. Thus, the potential cost of adaptive management is estimated at $90,000 over the 10-year period of this monitoring and adaptive management plan.

Adaptive management actions may be identified prior to completion of the 10-year monitoring, or could also be identified later during any extended non-Federal sponsor monitoring.

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11. CONCLUSIONS AND RECOMMENDATIONS

This FS-EA has presented a set of recommended restoration measures for the Lower Willamette River, Tryon Creek, and Columbia Slough based on the USACE plan formulation process. The recommended restoration plan is an incrementally justified and cost-effective approach, and meets the study objectives for ecosystem restoration of national and regionally significant resources and there is a demonstrated federal interest in restoring these resources.

Though short-term impacts could result to soils, air quality, water quality, vegetation, noise, and aesthetics, these impacts will be avoided or reduced through the implementation of BMPs and will be temporary. Long-term benefits over the life of the project are expected to result to floodplains, wetlands, wildlife populations including endangered fish species, vegetation, socioeconomics, parks and recreation, and visual quality.

The recommended restoration plan will increase the quality of aquatic and riparian habitats. The plan not only provides positive ecosystem benefits in terms of aquatic and riparian habitat restoration, but also provides a variety of social benefits in line with federal and local orders and initiatives, including improved natural quality of open spaces, visual quality, and wildlife viewing opportunities.

This plan is being recommended with such modifications thereof as in the discretion of the Commander, USACE HQ may be advisable. The recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Congress as proposals for authorization and implementation funding. However, prior to transmittal to the Congress, the sponsor, the States, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

The non-Federal sponsor shall:

- Provide 35 percent of total project costs as cash or in-kind services, as further specified below:
    - Provide the required non-Federal share of design costs in accordance with the terms of a design agreement entered into prior to commencement of design work for the project;
    - Provide, during the first year of construction, any additional funds necessary to pay the full non-Federal share of design costs;
    - Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of the project.
    - Provide, during construction, any additional funds necessary to make its total contributions equal to 35 percent of total project costs.
- Provide work-in-kind during final design and construction as well as providing the post-construction monitoring. The value of the LERRDs needed for the project will be credited against the non-Federal sponsor’s cost-sharing requirement. The sponsor anticipates

contributing the balance of funds from grant funding that will not include funds from Federal agencies.

- Not use funds from other Federal programs, including any non-Federal contribution required as a matching share therefore, to meet any of the non-Federal obligations for the project unless the Federal agency providing the Federal portion of such funds verifies in writing that expenditure of such funds for such purpose is authorized;
- Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) such as any new developments on project lands, easements, and rights-of-way or the addition of facilities which might reduce the outputs produced by the project, hinder operation and maintenance of the project, or interfere with the project's proper function;
- Not use the project or lands, easements, and rights-of-way required for the project as a wetlands bank;
- Comply with all applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended (42 U.S.C. §§ 4601-4655), and the Uniform Regulations contained in 49 C.F.R. part 24, in acquiring lands, easements, and rights-of-way required for construction, operation, and maintenance of the project, including those necessary for relocations, the borrowing of materials, or the disposal of dredged or excavated material; and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act;
- For so long as the project remains authorized, operate, maintain, repair, rehabilitate, and replace the project, or functional portions of the project, at no cost to the Federal Government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal Government;
- Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for access to the project for the purpose of completing, inspecting, operating, maintaining, repairing, rehabilitating, or replacing the project;
- Hold and save the United States free from all damages arising from construction, operation, maintenance, repair, rehabilitation, and replacement of the project and any betterments, except for damages due to the fault or negligence of the United States or its contractors;
- Keep and maintain books, records, documents, or other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, or other evidence are required, to the extent and in such detail as will properly reflect total project costs, and in accordance with the standards for financial management;
- Comply with all applicable Federal and State laws and regulations, including but not limited to: Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. § 2000d) and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army"; and all applicable Federal labor standards requirements including, but not limited to, 40 U.S.C. §§ 3141-3148 and 40 U.S.C. §§ 3701-3708;
- Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law 96-510, as amended (42 U.S.C. §§ 9601-9675), that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project. However, for lands that the Federal Government determines to be subject to the navigation servitude, only

the Federal Government shall perform such investigations unless the Federal Government provides the non-Federal sponsor with prior specific written direction, in which case the non-Federal sponsor shall perform such investigations in accordance with such written direction;

- Assume, as between the Federal Government and the non-Federal sponsor, complete financial responsibility for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project;
- Agree, as between the Federal Government and the non-Federal sponsor, that the non-Federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, repair, rehabilitate, and replace the project in a manner that will not cause liability to arise under CERCLA; and,
- Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended (42 U.S.C. § 1962d-5b), and Section 103(j) of the WRDA of 1986, Public Law 99-662, as amended (33 U.S.C. § 2213(j)), which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until each non-Federal interest has entered into a written agreement to furnish its required cooperation for the project or separable element.

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