LOWER WILLAMETTE RIVER ENVIRONMENTAL DREDGING AND ECOSYSTEM RESTORATION INTEGRATED FEASIBILITY STUDY AND ENVIRONMENTAL ASSESSMENT

COMMUNICATION

FROM

THE ASSISTANT SECRETARY OF THE ARMY, CIVIL WORKS, THE DEPARTMENT OF DEFENSE

TRANSMITTING

THE CORPS' LOWER WILLAMETTE RIVER ENVIRONMENTAL DREDGING AND ECOSYSTEM RESTORATION INTEGRATED FEASIBILITY STUDY AND ENVIRONMENTAL ASSESSMENT FOR JULY 2015

MARCH 22, 2017.—Referred to the Committee on Transportation and Infrastructure and ordered to be printed

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HOUSE DOCUMENT NUMBER 115-20

DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
CIVIL WORKS
108 ARMY PENTAGON
WASHINGTON DC 20310-0108

JAN 18 2017

Honorable Paul Ryan
Speaker of the House of Representatives
U.S. Capitol Building, Room H-232
Washington, DC 20510-0012

Dear Mr. Speaker:

Under the authority of the House of Representatives Resolution Docket 2687, adopted on June 26, 2002, the Secretary of the Army supports the authorization and construction of the Lower Willamette Environmental Dredging and Ecosystem Restoration project in Portland, Oregon for the purpose of aquatic ecosystem restoration. The proposal is described in the report of the Chief of Engineers, dated December 14, 2015, which includes other pertinent documents. The Secretary of the Army plans to implement the project at the appropriate time, considering National priorities and the availability of funds. The Water Resources Development Act of 2016 (Public Law 114-322) authorized the recommended project in section 1401(7).

This project study was conducted to analyze and formulate restoration of aquatic ecosystem habitat and functions in the Lower Willamette River, Portland, Oregon. In 2000, Portland Harbor was added to the Environmental Protection Agency's (EPA) National priorities list for Superfund sites. EPA's clean-up directive, Environmental Impact Statement, and Record of Decision (ROD) are not anticipated until later in 2017. The U.S. Army Corps of Engineers (Corps) determined not to pursue the environmental dredging until the EPA ROD is issued and the responsible parties have conducted appropriate clean up actions. In 2013, the Corps project was reformulated to focus only on ecosystem restoration. The recommended plan is the National Ecosystem Restoration plan. The recommended plan includes restoration of habitat at five sites in the Lower Willamette Basin Watershed: Kelley Point Park, Oaks Crossing, the Bureau of Environmental Services treatment plant, Kenton Cove, and Tryon Creek. The restoration measures include the following:

a) Placement of large woody debris;
b) Re-vegetation of the riparian area;
c) Removal of invasive species;
d) Re-connection of floodplain habitats to the river;
e) Development of off-channel habitat; and,
f) Removal of fish barriers.

Based on October 2016 (Fiscal Year (FY) 2017) price levels, the estimated project first cost is $30,376,000. The estimated total project first cost for the aquatic ecosystem restoration features is $28,951,000, and the estimated total project first cost for the separable recreation features is $1,425,000. The total project first cost includes $2,212,000 for Pre-construction Engineering and Design, $18,166,000 for construction of the ecosystem restoration features and recreation features, $1,881,000 for construction management, $86,500 for monitoring, $91,500 for adaptive management and $9,390,000 for the value of any lands, easements, rights-of-way, relocations and disposal areas.

The City of Portland is the non-Federal cost-sharing sponsor for all features. The estimated Federal and non-Federal shares of the total project first cost for the recommended plan are $19,530,650 and $10,845,350, respectively (which equates to 64 percent Federal and 36 percent non-Federal), as apportioned in accordance with the cost sharing provisions of section 103 of the Water Resources Development Act of 1986, as amended (33 U.S.C. 2213). The ecosystem restoration features' total project first costs of $28,951,000 are cost shared at 65 percent Federal and 35 percent non-Federal. The recreation features' total project first costs of $1,425,000 are equally cost shared between the Federal government and non-Federal sponsor. Operation, maintenance, repair, replacement, and rehabilitation expenses are estimated to be approximately $3,600 per year and are the responsibility of the non-Federal sponsor.

Based on FY 2017 price levels, a 2.875 percent discount rate, and a 50-year period of economic analysis, the total equivalent average annual costs of the ecosystem restoration features are estimated to be $1,132,000. The recommended plan is estimated to restore 59.96 average annual habitat units of non-monetary benefits. The recommended plan will restore 74 acres of floodplain and aquatic habitat and 2.7 miles of stream habitat. The recommended plan will restore aquatic habitat for seven fish species listed under the Endangered Species Act (ESA) of 1973, as amended. The recommended plan will also provide unique tidally influenced habitat to support wildlife linkages and provide wintering and breeding habitat for waterfowl, shorebirds, and neo-tropical migrants along the Pacific Flyway. The average annual costs of the recreation features are estimated to be $55,000. The average annual equivalent benefits are estimated to be $85,000. The average annual net benefits are $30,000. The benefit-to-cost ratio for the recreation features of the recommended plan is 1.5 to 1.

An Environmental Assessment (EA) was prepared in accordance with the National Environmental Policy Act. The recommended plan has been identified as the environmentally preferred plan. Adverse environmental impacts have been avoided and minimized where practicable. The EA resulted in a Finding of No Significant Impact to the environment, therefore, preparation of an Environmental Impact Statement is not required. No compensatory mitigation is required.

In accordance with ESA, the National Marine Fisheries Service issued a Biological Opinion on May 23, 2014 that determined that the project will not jeopardize the existence of Federally listed species or modify designated critical habitat. All terms and conditions resulting from these consultations shall be implemented in order to minimize take of endangered species.

The Office of Management and Budget (OMB) advises that there is no objection to the submission of the report to Congress. A copy of OMB's letter, dated January 17, 2017, is enclosed. I am providing a copy of this transmittal and the OMB letter to the Subcommittee on Water Resources and Environment of the House of Representatives Committee on Transportation and Infrastructure, and the Subcommittee on Energy and Water Development of the House of Representatives Committee on Appropriations. I am also providing an identical letter to the President of the Senate.

Very truly yours,

Jo-Ellen Darcy

Jo-Ellen Darcy
Assistant Secretary of the Army
(Civil Works)

Enclosures

5 Enclosures

1. Report of the Chief of Engineers, December 14, 2015
2. OMB Clearance Letter, January 17, 2017
3. Finding of No Significant Impact, January 19, 2017
4. Summary of State and Agency Review
5. Integrated Feasibility Report and Environmental Assessment, July 2015

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF MANAGEMENT AND BUDGET
WASHINGTON, D.C. 20503

January 17, 2017

The Honorable Jo-Ellen Darcy
Assistant Secretary of the Army (Civil Works)
108 Army Pentagon
Washington, DC 20310-0108

Dear Ms. Darcy:

As required by Executive Order 12322, the Office of Management and Budget has reviewed a January 2014 Army Corps of Engineers (Corps) feasibility report that proposes to authorize and construct an aquatic ecosystem restoration project at Lower Willamette River, Oregon, with a first cost of $29.774 million (October 2015 pricing levels). The Congress authorized this project for construction in Public Law 114-322.

We appreciate this effort by the Corps, which identified aquatic ecosystem restoration opportunities in the Lower Willamette River Basin. Each of the five features proposed in this study would likely have a positive environmental effect; some of them could also benefit federally-listed species, including the Chinook salmon, Coho salmon, Steelhead, Bull trout, and North American green sturgeon. The Corps identified these features through the type of collaborative, systems-based planning that the Administration supports.

While the proposed plan would likely benefit this ecosystem, the study currently provides an insufficient basis for the Corps' involvement in the construction of this project. While design for this project uses successful techniques employed by the Corps and other federal, state and local entities, the need for restoration stems at least in part from the effects of development and industrialization over the past 150 years including actions undertaken by local communities, private landowners, and others, and construction and maintenance of a navigation channel, maintained in part by the federal government, and the majority of total project benefits relate to a culvert replacement for a railroad bridge at one of the five project sites.

With the tight competition for Federal funds, ecosystem significance, connectivity, species diversity and a determination on which entities are best equipped to do the work will continue to be a paramount issue. However, we are encouraged that the Corps is working to better define its role in aquatic ecosystem restoration and are interested in continuing discussions with you on this issue as it relates to both authorization and budgeting of projects. The Office of Management and Budget does not object to you submitting this report to Congress.

ENCL 2

However, when you do so, please advise the Congress that the project would need to compete with other proposed investments for funding in future budgets.

Sincerely,

John Pasquantino
Deputy Associate Director
Energy, Science, and Water

United States Department of the Interior
OFFICE OF THE SECRETARY
Washington, DC 20240

OCT 16 2015

9043.1
PEP/NRM

ER 15/0519

Theodore A. Brown, P.E.
Chief, Planning and Policy Division
Headquarters US Army Corps of Engineers
CECW-P (SA)
7701 Telegraph Road
Alexandria, VA 22315-3860

RE: Chief of Engineers and the Report of the District Engineer on the Lower Willamette River Environmental Dredging and Ecosystem Restoration Project, OR

Dear Mr. Brown:

The U.S. Department of the Interior (Department) has reviewed the U.S. Army Corps of Engineers (USACE), Chief of Engineers Report, and supporting documents on the Lower Willamette River Environmental Dredging and Ecosystem Restoration Project to be implemented in Portland, Oregon.

Our National Park Service (NPS) Pacific West Region has provided information relating to your project scope. At least four of the parks identified as part of this project (Kelley Point, Sellwood Riverfront, Tryon Creek, and Cathedral) were acquired, developed, or both acquired and developed with grant funding from the NPS through the Land and Water Conservation Fund (LWCF) state and local assistance program. The LWCF requires that funded properties are managed for public outdoor recreation in perpetuity, or else suitable compensatory mitigation must be provided by the city and approved by NPS as described further in 36 CFR Part 59.

The Department generally supports the efforts of the USACE to restore riparian ecosystem quality along the Willamette River and in the city's parks. However, the Department must ensure that the proposed activities do not significantly contravene the original intent of the relevant LWCF grants that public outdoor recreation will remain the primary purpose of these sites, ensuring that there is no transfer of rights or execution of long term management agreements that would be in conflict with program requirements for local agency control and tenure.

The Department recommends that the USACE work closely with the Oregon Parks and Recreation Department, which administers LWCF on our behalf in the state of Oregon. The Governor appointed LWCF State Liaison Officer (SLO) is Director Lisa Sumption. She can be

ENCL 4

reached at 503-986-0729 or lisa.sumption@oregon.gov. The NPS contact for LWCF in Oregon is Heather Ramsay. She can be reached at 206-220-4123 or heather_ramsay@nps.gov.

The Department remains confident that our agencies can work within LWCF requirements to achieve the goals of both USACE and the city of Portland to restore this critical environment without triggering a compliance issue. We appreciate the opportunity to provide comments.

Sincerely,

Mary Josie Blanchard

for Willie R. Taylor
Director, Office of Environmental Policy
and Compliance

cc: Email to: heather_ramsay@nps.gov, lisa.sumption@oregon.gov

lower-willamette-chiefs-report@usace.army.mil
theodore.a.brown@usace.army.mil

From: Bee, Patricia L HQ02
To: Dunn, Angela E HQ; Matusiak, Mark HQ02
Subject: FW: Lower Willamette, OR (UNCLASSIFIED)
Date: Wednesday, October 28, 2015 9:09:34 AM
Attachments: image003.png
image004.png
image005.png
image006.png
image007.png
image008.png
image009.png

Classification: UNCLASSIFIED
Caveats: NONE

FYI...

-----Original Message-----
From: Allnutt, David [mailto:Allnutt.David@epa.gov]
Sent: Tuesday, October 27, 2015 7:01 PM
To: Bee, Patricia L HQ02
Cc: McLerran, Dennis; Pirzadeh, Michelle; Littleton, Christine; Grandinetti, Cami
Subject: [EXTERNAL] FW: Lower Willamette, OR (UNCLASSIFIED)

Ms. Bee – EPA Region 10 has reviewed this proposed report and does not have any comments at this time. Thank you for the opportunity to review.

R. David Allnutt, Director
Office of Ecosystems, Tribal and Public Affairs
U.S. EPA, Region 10
1200 Sixth Avenue, Suite 900
Seattle, Washington 98101-3140
(206) 553-2581

Classification: UNCLASSIFIED
Caveats: NONE

XII

From:	Bee, Patricia L HQ02
To:	Dunn, Angela E HQ; Matusiak, Mark HQ02
Subject:	FW: Lower Willamette River Environmental Dredging and Ecosystem Restoration Project (UNCLASSIFIED)
Date:	Wednesday, October 21, 2015 10:20:42 AM

Classification: UNCLASSIFIED
Caveats: NONE

FHWA response.

-----Original Message-----
From: Kreig.Larson@dot.gov [mailto:Kreig.Larson@dot.gov]
Sent: Thursday, October 15, 2015 2:58 PM
To: LOWER-WILLAMETTE-CHIEFS-REPORT
Subject: [EXTERNAL] Lower Willamette River Environmental Dredging and Ecosystem Restoration Project

Attention: Gail L. Saldana, Project Manager, Portland District

Ms. Saldana – This is to inform you that I have no comments to offer on the documentation for the project noted above.

Thank you – Kreig

Kreig Larson

Project Development Specialist

Office of Project Development &

Environmental Review (HEPE)

FHWA HQ

202-366-2056

kreig.larson@dot.gov

PS – My apologies for excluding the tilde from your last name – couldn't figure out how to do it in Outlook.

Classification: UNCLASSIFIED
Caveats: NONE

REPLY TO
ATTENTION OF

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS
441 G STREET, NW
WASHINGTON, DC 20314-1000

DEC 08 2015

Mr. Bret Brownscombe
Natural Resource Policy Advisor
254 State Capitol
Salem, Oregon 97301-4047

Dear Mr. Brownscombe:

This letter is in response to your November 5, 2015, comment letter on the U.S. Army Corps of Engineers final Feasibility Report (FR) and Environmental Assessment (EA) for the Lower Willamette River Environmental Dredging and Ecosystem Restoration Project. Your letter stated that the State of Oregon supports efforts to conduct habitat restoration work with specific comments on several of the proposed restoration sites outlined in the Report of the Chief of Engineers for this overall project.

You made several recommendations regarding the Tryon Creek Highway 43 culvert replacement project. Regarding your recommendation to integrate terrestrial wildlife passage into the final culvert design, the opened bottom of the proposed culvert is designed to simulate and accommodate the natural streambed dimension at high water allowing for, sediment and debris to pass downstream unimpeded. This width and natural streambed plus the gentler slope of the culvert will not only enhance fish passage but will also allow for terrestrial wildlife passage. In regards to recreational considerations, recreation was not a project goal at this location but with the improvements to aquatic and related riparian habitat conditions we believe that this will improve passive recreational use of the area. With the estimated increase of passive recreational use of this area, safety will be a major component of the culvert design criteria as the project moves into the design and construction phases. Regarding the larger site-wide approach to habitat restoration at this site, the culvert replacement and associated riparian restoration builds on and enhances other restoration efforts in this watershed by other partners. Consistent with these other restorations projects within this watershed, replacement of the culvert includes the removal of invasive species and planting native riparian plant species in the streambed and banks immediately upstream and downstream of the new culvert. Areas beyond those depicted in the design for restoration effort are either being done by others or restrained by land ownership issues.

You also provided a number of other comments and recommendations pertaining to boating access and safety at several restoration sites within the project area, including Kelley Point Park, Bureau of Environmental Services Treatment Plant and Kenton Cove. All of these restoration sites were designed with a specific objective of not impeding access or navigation through the area. Slopes will be laid back for improved shallow water habitat and will allow for a more diverse paddling and viewing experience. At the Oaks Crossing and Sellwood Park site you express concern about conflict of use for a future plan for a transient dock and debris boom in the area. As this site moves into design the Portland District and the City of Portland will continue to coordinate with all surrounding stakeholders and land owners to collaborate on activities on-going, and planned in the surrounding areas. Further, placement of all large wood at all the restoration sites will be designed to be out of the navigation channel and to not pose a hazard to navigation. Shoreline slopes will be laid back prior to placement of the large wood well out of the navigational channel. Coordination with the Oregon State Marine Board will be part of our stakeholder outreach during the design process.

You note in your letter that implementation of the projects in the Chief's Report will likely require consultation with and authorization from the Oregon Department of State Lands (DSL) under Oregon's Removal-Fill Law, and for necessary easements. As part of this study report, a thorough real estate appraisal was performed and coordinated with our local sponsor. Further refinements of land ownership, easement requirements and permitting will be initiated as the project moves into design. The Portland District and DSL have a history of collaboration and cooperation regarding regulatory compliance and protection of waters in the State of Oregon. We anticipate continuing that engagement throughout the implementation of this project.

Lastly, you request continued coordination with the DSL, Oregon Marine Board, Department of Fish and Wildlife, and other agencies early in the design process. The Portland District will continue to meet and consult with all the resource agencies as we progress through our design process.

Thank you for your comments on the Corps Lower Willamette River Environmental Dredging and Ecosystem Restoration Project. If you have additional questions or concerns, please contact Mr. Steven Kopecky, Deputy Chief, Northwestern and Pacific Ocean Divisions Regional Integration Team, at (202) 761-4527.

Sincerely,

Theodore A. Brown

Theodore A. Brown, P.E.
Chief, Planning and Policy Division
Directorate of Civil Works

KATE BROWN
Governor

November 5, 2015

Headquarters
U.S. Army Corps of Engineers (USACE)
CECW-P (SA)
7701 Telegraph Road
Alexandria, VA 22315-3860

Submitted via email to Lower-willamette-chiefs-report@usace.army.mil and mark.matusiak@usace.army.mil

RE: Willamette Environmental Dredging and Ecosystem Restoration Project, Oregon

To Whom It May Concern:

Thank you for providing the State of Oregon with an opportunity to comment on the US Army Corps of Engineers' (USACE) Willamette Environmental Dredging and Ecosystem Restoration Project. Through the Governor's Natural Resources Office, we have conferred with the State's various natural-resource related agencies. No significant concerns exist based on the information the State has at this point in time on the projects outlined in the Report of the Chief of Engineers of the US Army Corps of Engineers. The State of Oregon supports efforts to conduct habitat restoration work where appropriate. With that in mind, we appreciate the efforts of the USACE and offer the following more specific comments:

Tryon Creek Highway 43 project:

Regarding the Tryon Creek Highway 43 culvert replacement project (one of the five proposed projects presented in the Chief's Report), we offer our support and several recommendations. In particular, Oregon Parks and Recreation Department (OPRD) is charged with the mission of providing and protecting outstanding natural, scenic, cultural, historic, and recreational sites for the enjoyment and education of present and future generations. OPRD pursues this mission through several programs and activities, including the State Scenic Waterways program, management of natural resources on our properties, work with partners to improve natural resources regionally, and providing excellent recreational opportunities to the public. Restoration of unhindered fish passage to Tryon Creek is consistent with OPRD's mission and our natural resource and recreation objectives for the Tryon Creek State Natural Area. It is also consistent with the State's fish passage laws and objectives, as overseen by the Oregon Department of Fish & Wildlife (ODFW)

While supportive of this project, Oregon offers the following recommendations for USACE's consideration:

1. While recognizing and appreciating that the primary objective of the project is to enhance fish passage, we encourage USACE to also integrate terrestrial wildlife passage intentionally into the

254 STATE CAPITOL, SALEM OR 97301-4047 (503) 378-3111 FAX (503) 378-8970
WWW.GOVERNOR.OREGON.GOV

final design. The current draft culvert design appears wide enough to accommodate terrestrial wildlife passage. However, we encourage intentional consideration of this goal to ensure that it receives adequate attention.

2. Consistent with OPRD's mission as well as that of other agencies including ODFW, we encourage consideration of recreation as a project goal. Tryon Creek State Natural Area is managed to inspire nature-based recreation consistent with OPRD's natural resource protection objectives. OPRD expects and encourages recreational uses along Tryon Creek, which could include activities such as hiking, fishing, and nature viewing. Designing the culvert so that these and other recreational uses would be facilitated would benefit park users and help forward state objectives for this park. Furthermore, integration of a trails component to improve the system of pathways at Tryon Creek State Natural Area could provide an enhanced experience to the natural beauty of the park and restored habitats for trail walkers, nature viewers and education groups. At a minimum, we encourage USACE to include human safety as an objective to ensure that the final culvert design minimizes risks to potential park users.
3. The State believes a larger site-wide approach to habitat restoration would be valuable to consider and implement. In particular, providing expanded non-native species eradication, native species plantings, and stream enhancements up/down stream from the culvert would expand the project benefits substantially. It is likely that significant ecosystem gains could be achieved by expanding the habitat enhancement components of the project at relatively nominal additional costs. Partnership opportunities may exist in addressing any such additional costs.

Boating Access and Safety comments

The projects outlined in the Chief's Report propose modifications to the Willamette waterway at Kelley Point Park, BES Treatment Plant Banks, and Kenton Cove, including plantings and placement of large woody debris. Kelley Point Park includes a canoe launch providing access to the Columbia Slough. The Oregon State Marine Board requests that the USACE ensure project work maintains or improves existing access and maintains open navigation from the Kelley Point Park launch to Columbia Slough and the Willamette River. The Columbia Slough has seven other paddler access launches, and we recognize none of those public access points are in the immediate BES Treatment Plant Banks or Kenton Cove project area vicinity. However, USACE should ensure the overall project work is designed and implemented in a manner that does not restrict paddler access through the project sections of Columbia Slough.

The USACE also proposes modifications to the waterway at Oaks Crossing/Sellwood Riverfront Park. The proposed work includes native plantings and placement of large woody debris. The project site has previously been identified in the Oregon State Marine Board Six-Year Plan as the proposed location of the new Oaks Park City of Portland transient dock and debris boom, which is necessary to fill the need for additional recreational boat moorage. The Marine Board requests the project be designed and implemented in a manner that does not hinder implementation of the dock installation plan or restrict access to or from the proposed dock.

In carrying out the project work outlined in the Chief's Report, the USACE proposes to install large woody debris by excavating the streambank to allow trunks or stumps to be keyed into the bank. Typical large wood installation would consist of one or two pieces of large wood installed at each location, anchored with vertical posts, boulders, and cables. The Marine Board is charged with the responsibility of boater safety. Safe boat passage should be maintained through the project area. Any structures added to the waterway, including large wood, boulders, or other habitat restoration or enhancement features, must be installed and maintained in a manner that provides safe boat passage for typical boats, at typical water levels. Any design that does not accommodate safe boat passage is unsafe and would constitute a potential safety hazard.

Consultation, Coordination, and Conclusion:
Implementation of the projects outlined in the Chief's Report will likely require consultation with and authorization from the Department of State Lands (DSL) per Oregon's Removal-Fill Law protecting waters of the state [ORS 196.795-990]. The projects will also likely require easement authorization from the State of Oregon for access and use of state-owned submerged, submersible lands and filled lands. The Chief Engineer notes that the work would necessitate obtaining easements and has calculated an estimation of the costs, but in many locations in the Lower Willamette, the owners and installers of existing bridges, culverts, and other structures on or over state-owned land never obtained the appropriate authorizations to place them there in the first place. Thus, any expansions or placement of structures on state owned land may require consultation with Oregon DSL in order to both more accurately estimate cost and verify exact property boundaries for such an authorization. DSL grants easements according to Oregon Administrative Rules of Chapter 141 division 122. DSL and USACE have a history of collaboration and cooperation regarding regulatory compliance and protection of the waters of the state and United States, and DSL looks forward to further engagement with USACE in the advancement of the described projects.

Finally, Oregon respectfully requests inclusion in the design process for the projects outlined in the Chief's Report. Inclusion of DSL, ODFW, the Oregon Marine Board early in the design phase will, we believe, result in enhanced project outcomes. With respect to the Tryon Creek Highway 43 project in particular, we also request engagement of OPRD directly in the design process. The state agencies commit to engaging the design process with comments, suggestions, and technical capacity that will help ensure a final Willamette Environmental Dredging and Ecosystem Restoration Project that successfully meets USACE project objectives in synchronicity with the State's various missions, statutes, rules and objectives related to fish passage; habitat restoration; boater safety; submerged, submersible and filled lands; waters of the state, recreation, and the Tryon Creek State Natural Area.

Oregon looks forward to working with USACE on the important and valuable projects outlined in the Chief's Report. Thank you for the opportunity to provide comments and we look forward to the USACE's response.

Sincerely,

Brett Brownscombe
Natural Resource Policy Advisor

DEPARTMENT OF THE ARMY
CHIEF OF ENGINEERS
2600 ARMY PENTAGON
WASHINGTON, DC 20310-2600

DEC 14 2015

DAEN

SUBJECT: Lower Willamette River Environmental Dredging and Ecosystem Restoration Project, Oregon

THE SECRETARY OF THE ARMY

1. I submit, for transmission to Congress, my report on the study of ecosystem restoration along the Willamette River, near Portland, Oregon. It is accompanied by the reports of the district and the division engineers. This report is an interim response to a resolution by the Committee on Transportation and Infrastructure of the United States Senate, adopted June 26, 2002. This resolution authorized the Chief of Engineers 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 ecosystem 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." Preconstruction engineering and design (PED) will continue under the authority cited above.

2. The reporting officers recommend authorizing a plan to restore ecosystem functions by reconnecting floodplain habitats to the rivers and improving fish and wildlife habitats in the vicinity of Portland, Oregon. The recommended plan for ecosystem restoration includes restoration at five sites in the Lower Willamette Basin Watershed, including Kelley Point Park, Oaks Crossing, the Bureau of Environmental Services (BES) treatment plant, Kenton Cove, and Tryon Creek. Restoration measures include large woody debris, riparian re-vegetation, invasive species removal, floodplain reconnecting, off-channel habitat development, and fish barrier removal. The recommended plan provides restoration on a total of 74 acres of riparian, wetland, shallow water, and backwater habitat as well as 2.7 stream miles, substantial benefits to fish and wildlife and the ecosystem. Additional research and documentation of existing sampling data or the collection of new sampling data sufficient to confirm that there is a minimal risk of hazardous substances (HTRW) at Kelley Point Park will be completed during the PED phase of the project. Inclusion of Kelley Point Park in the project that will be constructed is conditioned on the analysis of this additional data confirming that the HTRW risk is minimal. The non-federal sponsor assumes complete financial responsibility for all necessary cleanup if HTRW are found at this site. Minor adverse environmental effects will be avoided and minimized during construction by the use of conservation measures and best management practices. The long-term effects are beneficial. The recommended plan also includes post-construction monitoring and adaptive management to be performed by the sponsor for a period of 10 years to ensure project performance. 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. Since the recommended plan would not have any significant adverse effects, no mitigation (beyond avoidance and use of best management practices) or compensation measures are required. The recommended plan also includes the construction of three pedestrian bridges at Kelley Point Park to facilitate access to existing trails in the vicinity of the restoration project and to enhance the experience of recreational visitors including bird watchers, trail walkers, and educational groups.

3. The recommended plan is the National Ecosystem Restoration plan. All features are located within the state of Oregon. The city of Portland is the non-federal cost-sharing sponsor for all features. Based on March 2015 price levels, the estimated total project first cost of the plan is $29,774,000. In accordance with the cost sharing provisions of the Water Resources Development Act (WRDA) of 1986, as amended, the total first costs for ecosystem restoration features is $28,375,000 with the federal share being $19,143,000 (64 percent) and the non-federal share of $10,631,000 (34 percent). The cost of lands, easements, rights-of-way, relocations, and disposal is $9,232,000. The costs for recreation facilities are $1,399,000. In accordance with the cost sharing provisions of the WRDA 1986 the federal share of recreation costs is $699,500 (50%), and the non-federal share is $699,500 (50%). The city of Portland would be responsible for the operation, maintenance, repair, replacement, and rehabilitation of the project after construction, a cost currently estimated at approximately $3,500 per year. Over a 10-year period of time monitoring cost is $85,000 and $90,000 for adaptive management.

4. Cost effectiveness and incremental cost analysis techniques were used to evaluate the alternative plans to ensure that a cost effective ecosystem restoration plan was recommended. The cost of the recommended restoration features is justified by restoring 59.96 average annual habitat units on 74 acres of floodplain and aquatic habitats as well as 2.7 stream miles in a nationally and regionally significant watershed and ecosystem. The restored aquatic habitat would increase habitat for Endangered Species Act listed fish species: Chinook salmon, coho salmon (Upper Columbia spring-run and Snake River spring/summer-run), steelhead, bull trout (Upper Columbia, Snake and Upper Willamette), North American green sturgeon, Pacific lamprey and coastal cutthroat trout. Important wildlife linkages provided in this tidally influenced area are unique to the project area, providing wintering and breeding habitat for waterfowl, shorebirds, and neotropical migrants along the Pacific Flyway. The recommended plan restores an average of 59.96 habitat units annually at an average annual cost of $1,062,925 and average annual cost per average annual habitat unit of $17,727. The recreational features are expected to provide average annual benefits of $83,600 with average annual costs of $58,300, resulting in a benefit to cost ratio of about 1.4.

5. The recommended plan was developed in coordination and consultation with various federal, state, and local agencies using a systematic and regional approach to formulating solutions and evaluating the benefits and impacts that would result. Risk and uncertainty were addressed during the study by completing a cost and schedule risk analysis, a sensitivity analysis that evaluated the potential impacts of a change on economic assumptions, as well as potential effects of sea level change. The effects of sea level change were evaluated through year 2070 for low, intermediate, and high conditions resulting in water surface elevations that ranged from a

DAEN
SUBJECT: Lower Willamette Environmental Dredging and Ecosystem Restoration Project, Oregon

negligible change of less than an inch, to about 5 inches and 1.92 feet, respectively. The recommended plan includes a range of native plant species so communities can adapt to changed hydrologic and climatic conditions and remain resilient to the effects of sea level change.

6. In accordance with the Corps' guidance on review of decision documents, all technical, engineering, and scientific work underwent an open, dynamic, and rigorous review process to ensure technical quality. This included an Agency Technical Review (ATR), and a Corps Headquarters policy and legal review. All concerns of the ATR have been addressed and incorporated into the final report. A waiver from Independent External Peer Review was received on April 2014.

7. Washington level review indicates that the plan recommended by the reporting officers is environmentally justified, technically sound, cost effective, and socially acceptable. The plan complies with all essential elements of the U.S. Water Resources Council's Economic and Environmental Principles and Guidelines for Water and Land Related Resources Implementation Studies. The recommended plan complies with other administration and legislative policies and guidelines. The views of interested parties, including federal, state and local agencies were considered. Comments received during preparation of the integrated draft report and environmental assessment included comments by the U.S. Fish and Wildlife Service (USFWS), the Oregon State Historical Preservation Office (SHPO), and the National Marine Fisheries Service (NMFS). The National Environmental Policy Act process resulted in a finding of no significant impact as a result of the recommended plan. The USFWS and NMFS agreed with the use of best management practices and continued coordination during design and implementation. Further, the SHPO concurred with the Area of Potential Effect and proposed management plan for implementation of the recommended plan. No additional stakeholder comments were received during public coordination of the draft report.

8. I concur with the findings, conclusions, and recommendations of the reporting officers. Accordingly, I recommend that the plan to restore the ecosystem of the Lower Willamette River near Portland, Oregon, be authorized in accordance with the reporting officers' recommended plan at an estimated project first cost of $29,774,000. My recommendation is subject to cost sharing, financing, and other applicable requirements of federal and state laws and policies, including Public Law 99-662, WRDA 1986, as amended, and in accordance with the required items of local cooperation that the non-federal sponsor shall, prior to project implementation, agree to comply with applicable federal laws and policies, including but not limited to:

a. Provide 35 percent of total ecosystem restoration costs as further specified below:

1. Provide the required non-federal share of design costs allocated by the government to ecosystem restoration in accordance with the terms of a design agreement entered into prior to commencement of design work for the ecosystem restoration features;

2. Provide, during the first year of construction, any additional funds necessary to pay the full non-federal share of design costs allocated by the government to ecosystem restoration;

DAEN
SUBJECT: Lower Willamette Environmental Dredging and Ecosystem Restoration Project, Oregon

3. 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 all as determined by the government to be required or to be necessary for the construction, operation, and maintenance of the ecosystem restoration features;

4. Provide, during construction, any additional funds necessary to make its total contribution for ecosystem restoration equal to 35 percent of total ecosystem restoration costs;

b. Provide 50 percent of total recreation costs as further specified below:

1. Provide the required non-federal share of design costs allocated by the government to recreation in accordance with the terms of a design agreement entered into prior to commencement of design work for the recreation features;

2. Provide, during the first year of construction, any additional funds necessary to pay the full non-federal share of design costs allocated by the government to recreation;

3. 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 all as determined by the government to be required or to be necessary for the construction, operation, and maintenance of the recreation features;

4. Provide, during construction, any additional funds necessary to make its total contribution for recreation equal to 50 percent of total recreation costs;

c. Provide, during construction, 100 percent of the total recreation costs that exceed an amount equal to 10 percent of the federal share of total ecosystem restoration costs;

d. 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 ecosystem restoration features, hinder operation and maintenance of the project, or interfere with the project's proper function;

e. Shall not use the ecosystem restoration features or lands, easements, and rights-of-way required for such features as a wetlands bank or mitigation credit for any other project;

f. Keep the recreation features, and access roads, parking areas, and other associated public use facilities, open and available to all on equal terms;

g. For so long as the project remains authorized, operate, maintain, repair, rehabilitate, and replace the project, or functional portions of the project, including any mitigation features, 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;

h. Hold and save the United States free from all damages arising from the 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;

i. 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;

j. 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;

k. 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

9. The recommendation contained herein reflects the information available at this time and current departmental policies governing formulation of individual projects. It neither reflects 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.

DAEN
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Consequently, the recommendation may be modified before it is transmitted to the Congress as a proposal for authorization and implementation funding. However, prior to transmittal to Congress, the non-federal sponsor, the state, interested federal agencies and other parties will be advised of any significant modifications, and will be afforded an opportunity to comment further.

THOMAS P. BOSTICK
Lieutenant General, USA
Chief of Engineers

Finding of No Significant Impact
Lower Willamette River Ecosystem Restoration
Feasibility Study and Integrated Environmental Assessment

The U.S. Army Corps of Engineers, Portland District (Corps), has conducted an environmental analysis in accordance with the National Environmental Policy Act (NEPA) of 1969, as amended. The Corps assessed the effects of the following actions in the Final Feasibility Study and Integrated Environmental Assessment, dated July 2015, for the Lower Willamette River Ecosystem Restoration Project, Portland, Oregon, which is incorporated herein by reference. The recommended plan includes restoration of approximately 101 acres of riparian habitat at five sites in the Lower Willamette Basin Watershed: Kelley Point Park, Oaks Crossing, the Bureau of Environmental Services treatment plant, Kenton Cove, and Tryon Creek. The restoration measures include the following:

- Placement of large woody debris;
- Re-vegetation of the riparian area;
- Removal of invasive species;
- Re-connection of floodplain habitats to the river;
- Development of off-channel habitat; and,
- Removal of fish barriers.

In addition, the "no action" alternative and eight other "best buy" alternatives of varying levels of restoration across five project sites were evaluated. The recommended plan was identified as the National Ecosystem Restoration plan, the environmentally preferred alternative and the least cost, environmentally acceptable, technically feasible alternative that accomplishes all the project objectives. The recommended plan will benefit multiple fish and wildlife species, including species listed under the Endangered Species Act of 1973, as amended (ESA). The restoration of off-channel, floodplain aquatic, riparian and wetland habitats, particularly hydrologic connectivity and fish access, will enhance natural floodplain processes including habitat formation. All practicable means to avoid and minimize adverse environmental effects have been incorporated into the recommended plan. No compensatory mitigation is required.

In accordance with ESA, the National Marine Fisheries Service issued a Biological Opinion on May 23, 2014 that determined that the project will not jeopardize the existence of Federally listed species or modify designated critical habitat. All terms and conditions resulting from these consultations shall be implemented in order to minimize take of endangered species.

Technical, environmental, and cost-effective criteria used in the formulation of alternative plans were those specified in the Water Resource Council's 1983 Economic and Environmental Principles for Water and Related Land Resources Implementation Studies. All applicable laws, executive orders, regulations, and local government plans were considered in the evaluation of the alternatives. Based on the results of the impacts, it has been determined that no significant impacts would occur as a result of implementing the proposed action. The proposed action would not have any unavoidable adverse effects, nor would it result in the irreversible or irretrievable commitment of resources. Proceeding with the recommended plan would not significantly or adversely impact the affected environment. Additionally, no significant cumulative effects would be expected.

I have reviewed the Lower Willamette River Ecosystem Restoration, Oregon, Integrated Feasibility

Report and Environmental Assessment, the information provided by interested parties, and the information provided in this Finding of No Significant Impact, and I find that the recommended plan will not significantly affect the quality of the human environment. Therefore, preparation of an Environmental Impact Statement pursuant to Section 102(2)(c) of the National Environmental Policy Act of 1969, as amended, is not required.

Date: 20170119

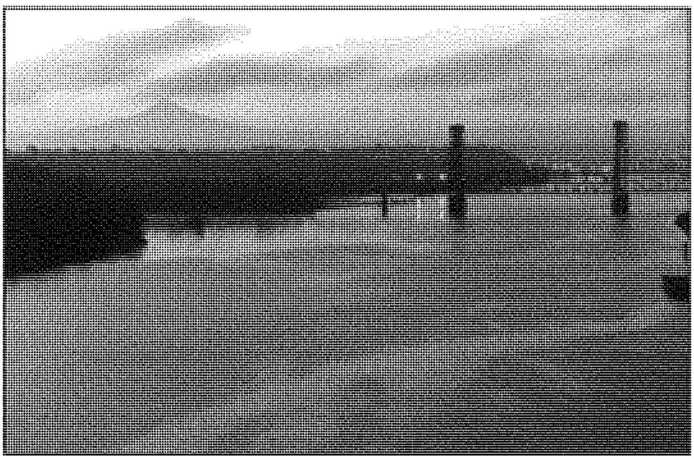
Jose L. Aguilar
Colonel, Corps of Engineers
District Commander

LOWER WILLAMETTE RIVER ENVIRONMENTAL DREDGING AND ECOSYSTEM RESTORATION PROJECT

INTEGRATED FEASIBILITY STUDY AND ENVIRONMENTAL ASSESSMENT

FINAL REPORT

July 2015
(ERRATA Corrections included 2-Mar and 11-Feb-2016)



US Army Corps of Engineers
Portland District
BUILDING STRONG.

ENVIRONMENTAL SERVICES
CITY OF PORTLAND
working for clean rivers

Prepared by:

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EXECUTIVE SUMMARY

This Integrated Feasibility Study and Environmental Assessment (FS-EA) evaluates ecosystem restoration actions in the Lower Willamette River, led by the U.S. Army Corps of Engineers (Corps) and the non-federal sponsor, the City of Portland (City). The study area encompasses the Lower Willamette River Watershed and its tributaries, from its confluence with the Columbia River at 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.

This report contains a summary of the feasibility study from plan formulation through selection of a Recommended Plan, 35 percent designs and cost estimating, a description of the baseline conditions, and description of impacts that may result from implementation of the Recommended Plan. This integrated report complies with requirements of the National Environmental Policy Act of 1969, as amended (NEPA). Sections 1500.1(c) and 1508.9(a)(1) of NEPA 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 Willamette River watershed 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 RM 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 and wetland habitat areas. Despite best efforts, fish and wildlife populations, especially those protected under the Endangered Species Act, have undergone dramatic declines.

Based on an assessment of the problems and opportunities in the project area, a set of goals and objectives were established for this feasibility study. These are:

- Reestablish riparian and wetland plant communities;
- Improve aquatic and riparian habitat Complexity and diversity; and
- Restore floodplain function and connectivity.

Restoration management measures were developed that could be applied to potential sites and achieve project objectives. These include:

- 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;
- Restore streambeds by placing wood and debris jams for habitat diversity;

- Encourage or install communities of overhanging streamside vegetation to reduce water temperatures and provide nutrients/food source, 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;
- Slope steepened banks to a gentler angle to allow floodwaters to spread out and to provide shallow water and wetland habitat; and
- Remove revetments and fill by excavation, and use bioengineering methods for bank stabilization where possible.

Many restoration sites which were included in the conceptual watershed management plans developed by the City for the Lower Willamette River Basin were initially proposed for restoration in this study. Of an initial list of approximately 45 sites, after several iterations evaluating and comparing sites' potential for benefits, availability, and cost effectiveness, 5 sites were evaluated, determined to be best buys, and carried forward as the Recommended Plan.

Given the variety of aquatic, terrestrial, and transitional habitat types present across the spectrum of the 50 original sites under consideration, the Habitat Evaluation Procedure (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 analyses (CE/ICA) were performed using the certified Institute for Water Resources-Planning Suite software version 1.0.11.1. The evaluation identified the most cost-effective alternative plans to reach various levels of restoration output, and provided information about whether increasing levels of restoration are worth the added cost. The "best buy" plans, or the alternatives providing the highest habitat value output for the least cost, were considered as final alternatives for evaluation.

Following the iterative evaluation process and CE/ICA, the project team identified a Recommended Plan. 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. Provided below is a description of the Recommended Plan by site.

- **Kelley Point Park** (off-channel and riparian restoration, floodplain restoration). 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. Implementation of the project would create approximately 4,500 linear feet of side channels to allow rearing and refugia for juvenile salmonids and fish usage. Habitat complexity and riparian vegetation would be restored on approximately 5,000 feet of shoreline by grading banks to a gentler gradient, removing invasive species, and revegetating with riparian shrubs and trees.
- **Oaks Crossing/Sellwood Riverfront Park** (off-channel and riparian restoration, wetland restoration). This site plan would restore the floodplain habitat for salmonids and other wildlife by reconnecting off-channel habitat to the river, removing invasive species, and revegetating with native floodplain and riparian species. Sandy beach habitat diversity would be improved by the addition of large wood.
- **BES Plant** (off-channel and riparian restoration, bank restoration). This site plan would improve the hydroperiod to a floodplain backwater/swale area, and restore the riparian zone along

Columbia Slough. Bank slopes would be reduced and large wood added along the banks to increase habitat complexity. Off-channel rearing and high-water fish 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 quality would be increased by removing invasive species and revegetating with native trees and shrubs. Pond turtle habitat would be restored by addition of large wood and boulders near the mouth of the channel between the slough and the low swale.

- **Kenton Cove** (off-channel and riparian restoration). This site plan would diversify instream habitat in this backwater cove by adding large wood, removing invasive species, and revegetating with native riparian species. Because the edges of the cove are very even and offer very little habitat complexity, the plan includes creating small habitat islands at the location of each woody debris jam, with the wood as the centerpiece of the habitat island.
- **Tryon Creek Highway 43** (stream and side channel connectivity for fish passage). This site plan would replace the culvert under Highway 43 and the train line, which is a fish barrier under most flow conditions and restore fish passage and natural stream functions. The construction area would be revegetated with native riparian species, and rocks would be placed in the streambed to create natural weirs for grade control 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 2.7 miles of stream within Tryon Creek State Natural Area.

The recommended restoration plan, with the five site components, has total project first cost of $29,774,000 to be cost-shared between the Corps and the City of Portland. This plan provides an increase of 1,430 habitat units over the 50-year life of this project. An estimated 74 acres of riparian, wetland, and backwater habitat and 2.7 stream miles would be improved. The plan restores an average of 59.96 habitat units annually at an average cost of 1,062, 925 and average annual cost per average annual habitat unit of $1,772. The project will be implemented in two construction phases from 2017 through 2018; Kelley Point Park, BES Plant, Kenton Cove and Oaks Crossing beginning in 2017 and Tryon Creek Highway 43 beginning in 2018. The plan includes three pedestrian bridges at the Kelley Point Park site which facilitates recreational access and enhanced experience to the park and restoration area for trail walkers, birdwatchers and educational groups. These recreational facilities are expected to provide annual benefits of $83,600 with average annual cost of $57,163, resulting in a benefit to cost ratio of 1.4.

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ACRONYMS AND ABBREVIATIONS

AAC	Average annual cost
AAHU	Average annual habitat unit(s)
AOI	Area of interest
AQCR	Air Quality Control Regions
AQMA	Air Quality Management Area
APE	Area of Potential Effects
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
C&LW	Columbia and Lower Willamette Rivers
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
Corps	U.S. Army Corps of Engineers
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	Ecosystem Planning Center of Expertise
EDR	Environmental data resources
EFH	Essential fish habitat
ELJ	Engineered log jam
EO	Executive Order
EPA	U.S. Environmental Protection Agency
EQ	Environmental Quality
ER	Engineer Regulation
ESA	Endangered Species Act
ESU	Evolutionarily significant units
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FONSI	Finding of No Significant Impact
FR	Federal Register
FS-EA	Feasibility Study and Environmental Assessment
FWCA	Fish and Wildlife Coordination Act
FY	Fiscal year

ACRONYMS AND ABBREVIATIONS (continued)

GDP	Gross domestic product
GIS	Geographic information system
GPS	Global positioning system
HEC-RAS	Hydrologic Engineering Center's River Analysis System
HEP	Habitat evaluation procedure
HSI	Habitat suitability index
HTRW	Hazardous, toxic, and radioactive waste
HU	Habitat unit(s)
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	Lands, easements, rights-of-way, relocation, and disposal areas
LWD	Large woody debris
MCACES	Microcomputer Aided Cost Estimating System
Metro	Metro Regional Government
MS4	Municipal separate storm sewer system
MSA	Metropolitan statistical area
NAAQS	National Ambient Air Quality Standards
NAVD	North American vertical datum
NED	National Economic Development
NEPA	National Environmental Policy Act
NER	National Ecosystem Restoration
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPCC	Northwest Power and Conservation Council
NPV	Net present value
NPDES	National Pollutant Discharge Elimination System
NRDA	Natural Resources Damage Assessment
NWI	National Wetlands Inventory
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 Transportatiou
ODSL	Oregon Division of State Lands
OEA	(Oregon) Office of Economic Analysis
OHW	Ordinary high water
OMRR&R	Operation, maintenance, repair, replacement, and rehabilitation

ACRONYMS AND ABBREVIATIONS (continued)

P&G	Principles and Guidelines
PAH	Polycyclic aromatic hydrocarbon(s)
PBDS	Portland Bureau of Development Services
PBES	Portland Bureau of Environmental Services
PBPS	Portland Bureau of Planning Services
PCBs	Polychlorinated biphenyls
PCE	Primary constituent element(s)
PDC	Portland Development Commission
PDT	Project Delivery Team
PED	Preconstruction engineering and design
PM	Particulate matter
PPA	Project Partnership Agreement
PPR	Portland Parks and Recreation
PROJECTS	Programmatic Restoration Opinion for Joint Ecosystem Conservation by The Services
PRP	Primary responsible party
PWR	Portland and Western Railroad
RM	River mile
ROD	Record of Decision
RPA	Reasonable and prudent alternative
S&A	Supervisory and administrative
SHPO	State Historic Preservation Office
SIP	State Implementation Plan
SMART	Specific, Measurable, Attainable, Risk Informed, Timely (planning process)
SVOCs	Semivolatile organic compounds
TMDL	Total maximum daily load(s)
TMP	Transportation management plan
TPH	Total petroleum hydrocarbons
µg/L	Micrograms per liter
UDV	Unit day value
UGB	Urban growth boundary
UP	Union Pacific Railroad
USACE	U.S. Army Corps of Engineers
U.S.C.	United States Code
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

1. STUDY INFORMATION

1.1. STUDY OVERVIEW

This Feasibility Study/Environmental Assessment (FS-EA) evaluates ecosystem restoration actions in the Lower Willamette River, in collaboration with U.S. Army Corps of Engineers (Corps) 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

Below are the study authorities that initiated the *Lower Willamette River Environmental Dredging and Ecosystem Restoration Study* Section 905(b) Analysis. This feasibility study is an interim response to the study authorization.

General authority for environmental dredging is contained in Section 312 of the Water Resources Development Act (WRDA) of 1990 as amended by Section 205 of WRDA 1996 and Section 224 of WRDA 1999. 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 combined text of the three legislative acts is as follows:

ENVIRONMENTAL DREDGING:

(a) OPERATION AND MAINTENANCE OF NAVIGATION PROJECTS - Whenever necessary to meet the requirements of the Federal Water Pollution Control Act, the Secretary, in consultation with the Administrator of the Environmental Protection Agency, may remove and remediate, as part of operation and maintenance of a navigation project, contaminated sediments outside the boundaries of and adjacent to the navigation channel.

(b) NONPROJECT SPECIFIC -

(1) IN GENERAL - The Secretary may remove and remediate contaminated sediments from the navigable waters of the United States for the purpose of environmental enhancement and water quality improvement if such removal and remediation is requested by a non-Federal sponsor and the sponsor agrees to pay 35 percent of the cost of such removal and remediation.

(2) MAXIMUM AMOUNT - The Secretary may not expend more than $50,000,000 in a fiscal year to carry out this subsection.

(c) JOINT PLAN REQUIREMENT - The Secretary may only remove and remediate contaminated sediments under subsection (b) in accordance with a joint plan developed by the Secretary and interested Federal, State, and local government officials. Such plan must include an opportunity for public comment, a description of the work to be undertaken, the method to be used for dredged material disposal, the roles and responsibilities of the Secretary and non-Federal sponsors, and identification of sources of funding.

(d) DISPOSAL COSTS - Costs of disposal of contaminated sediments removed under this section shall be a shared as a cost of construction.

(e) LIMITATION ON STATUTORY CONSTRUCTION - Nothing in this section shall be construed to affect the rights and responsibilities of any person under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980.

(f) PRIORITY WORK - In carrying out this section, the Secretary shall give priority to work in the following areas:

(1) Brooklyn Waterfront, New York.
(2) Buffalo Harbor and River, New York.
(3) Ashtabula River, Ohio.
(4) Mahoning River, Ohio.
(5) Lower Fox River, Wisconsin.
(6) Passaic River and Newark Bay, New Jersey.
(7) Snake Creek, Bixby, Oklahoma.
(8) Willamette River, Oregon.

The Portland District of the U.S. Army Corps of Engineers conducted the reconnaissance phase of study and developed a Project Study Plan for the feasibility phase.

The Section 905(b) report, *Willamette River Environmental Dredging, Oregon (Environmental/Ecosystem Restoration)* was completed in 2000; the identified non-federal sponsor at the time was the Port of Portland. The 905(b) report determined there was a "...Federal interest in pursuing environmental dredging for ecosystem restoration and for reduction in navigation maintenance costs. Optimization and incremental cost and benefit analyses will be developed in the cost-share feasibility phase of study."

Specific recommendations were not made in the reconnaissance report for addressing contaminated sediments or conducting ecosystem restoration studies. However, the report did specify that:

Environmental dredging authority for general ecosystem restoration, otherwise known as 312(b), could be used in any location in the study area to remediate ubiquitous contamination that is orphaned and not allocable to specific parties under the cleanup authorities. Use of this authority in conjunction with a cleanup under CERCLA authority will potentially allow for remediation of a greater volume of sediments and potentially manage the material in such a manor to improve aquatic habitats.

The 905(b) report, initiated under Section 312(b) of WRDA 1990, also identified issues relative to environmental dredging and coordination with the ongoing Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Remedial Investigations/Feasibility studies, and 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.

In 2002, additional study authority was provided for ecosystem restoration measures within the Lower Willamette River watershed, 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 ecosystem 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.*

The study expanded to be a mix of aquatic ecosystem restoration and Section 312(b) sites and both the Port of Portland and the City of Portland were the non-federal sponsors of the feasibility study.

In December 2000, Portland Harbor was added to U.S. Environmental Protection Agency (EPA) National Priorities List (Superfund). The current Superfund study area extends from the Columbia Slough to the Broadway Bridge. The EPA and the Oregon Department of Environmental Quality are working with potentially responsible parties to clean up contaminated sediment and control sources of additional contamination. The EPA Record of Decision is anticipated in 2017.

In 2008, the National Marine Fisheries Services (NMFS) produced a Biological Opinion (BiOp) for the Willamette Basin for fish species listed on the Endangered Species Act (ESA). The listing of a portion of the study area by EPA as a Superfund site, the listing of ESA species by NMFS, and the changes to the Corps planning proeess have caused significant delays in the completion of this Feasibility study. This study has moved between the former (Legacy) planning process to the SMART planning process under the 3x3x3 rule, then back to the Legacy planning process. In 2012, a Charrette was conducted with the Corps, the Port of Portland and the City Portland. One outcome of the Charrette was to seek elear guidance on whether the Corps was willing to continue with this feasibility study using Section 312(b) authority on sites that are designated Superfund sites in the Lower Willamette River.

On May 10, 2013, the Corps determined that the feasibility should not include Section 312(b) sites, but could continue with only ecosystem restoration sites; as a result, on September 20, 2013, the Port of Portland withdrew as a non-federal sponsor.

The remainder of this report will only describe the process related to the reduced scope of ecosystem restoration in the Lower Willamette River.

1.3. STUDY PURPOSE AND NEED

The study area for this Feasibility study was established in the authority cited above and is defined as the Lower Willamette River watershed from the Willamette Locks to the confluence of the Willamette River with the Columbia River, approximately RM 26.6. The watershed boundaries include the Willamette River, Columbia Slough, Johnson Creek, Tryon Creek and Fanno Creek.

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 RM 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 Corps' 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, enhancing floodplain connectivity, and reducing 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 woody debris (LWD), 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 Chapter 3.

This project is not intended to fulfill the requirements of any BiOps or recovery plans prepared for ESA-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 Bonamici (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 U.S. 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. A similar meeting was held with staff from NMFS on March 4, 2014, and similar recommendations were given. To date, the only other stakeholder that has taken an active role in planning for this study is the Metro Regional Government (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.

For the Tryon Creek Highway 43 site, Corps staff attended Tryon Creek Watershed Council meetings in fall 2013 for stakeholders and public discussions on the removal of this barrier to fish. Many project stakeholders including the City of Lake Oswego, Oregon Department of Transportation (ODOT), Watershed Council members, and surrounding communities view removal of this fish barrier as a critical part of opening the watershed to ESA-listed species. There is long standing, strong support for removing this fish barrier. Majority concern was support for a bridge in lieu of culvert replacement; however, the culvert replacement meets Corps criteria at the least cost. In addition, several meetings were held with ODOT, the Watershed Council president, and Lake Oswego to coordinate and discuss study progress.

In October 2014, this FS-EA report went through the public review process, with notices sent to all project stakeholders including all identified property owners, and our non-federal sponsor's list of interested parties. No adverse comments were received.

1.5. STUDY SPONSORSHIP

The non-federal sponsor for the *Lower Willamette River Environmental Dredging and Ecosystem Restoration General Investigation Feasibility Study* is the City of Portland, Bureau of Environmental Services (PBES). The Feasibility Cost Sharing Agreement was executed on September 22, 2003.

1.6. RESOURCES OF NATIONAL SIGNIFICANCE

The Willamette River Basin is a nationally and regionally significant watershed and ecosystem. In 1987 it was designated a National Natural Landmark because the basin has 713 acres remaining of unplowed native grassland, the largest in the Pacific Northwest. In 1998, it was named an American Heritage River, 1 of 14 in the Nation. In 2012, the Willamette River was awarded the Thiess International Riverprize as a high profile watershed for restoration. The Willamette River Basin is one of four national migratory bird flyways.

The Willamette River is the 10th largest river in the United States based on average annual flow. The basin drains 12,000 square miles of Oregon (12 percent), is one of the largest tributaries to the Columbia River and is the home for about 70 percent of Oregon's population. The Willamette Valley provides critical floodplain and wetland habitat and ecosystem functions and processes. This is important, because nationally over half of the original wetlands in the lower 48 states drained and converted to other uses, and substantial loss of floodplain connections on all major U.S. rivers that have reduced floodplain storage, sediment erosion and deposition, water quality functions and habitats.

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. 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 units (ESU), composed of seven different species, may use or migrate through watercourses in the study area. All ESA Willamette Basin stocks pass through and use this reach of the basin through multiple life stages.

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 ESA 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.

In 1998, the Willamette River from Springfield, Oregon, north to Portland was 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).

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. 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 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 (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.

The River Renaissance Initiative is a citywide initiative to reclaim the Willamette River as Portland's uniting community centerpiece. The initiative 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 Corps 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. The Lower Willamette River, the focus of this study, is generally defined as the area downstream and north of Willamette Falls, which is located at RM 26.6 in Oregon City. This portion of the Willamette River connects the Willamette Basin to the Columbia River and is essential to out-migration of the following ESA-listed fish species: Chinook salmon, coho salmon (Upper Columbia spring-run and Snake River spring/summer-run), steelhead, bull trout (Upper Columbia, Snake and Upper Willamette), North American green sturgeon, Pacific lamprey and coastal cutthroat trout. Important wildlife linkages provided in this tidally influenced area are unique to the project area, providing wintering and breeding habitat for waterfowl, shorebirds, and neotropical migrants along the Pacific Flyway (Aldolfson Associates 2000).

1.7. REPORT CONTENTS

This report contains a summary of the feasibility study and an integrated feasibility report with an Environmental Assessment (EA) to comply with National Environmental Policy Act (NEPA) requirements. The purpose of the feasibility study is to identify the plan that reasonably maximizes ecosystem restoration benefits, is technically feasible, and preserves environmental and cultural values. The purpose of the EA portion of the report is to identify and present information about environmental effects of the alternatives and to incorporation environmental concerns into the decision-making process. The six steps of the Corps planning process each align with a NEPA requirement. The planning steps are listed in Table 1-1 with the document chapter and NEPA element to which they relate.

Table 1-1. Contents of the FS-EA

Planning Step	Document Chapter and Analogous NEPA Requirement
Step One – Specify Problems and Opportunities	Appears in Chapter 3, as described in the purpose and need for action.
Step Two – Inventory and Forecast Conditions	Appears in Chapter 4, which describes existing conditions of the study area and the likely future without-project conditions (No Action Alternative).
Step Three – Formulate Alternative Plans	Appears in Chapter 5 in the description of the screening process and the formulation of alternative plans.
Step Four – Evaluate Effects of Alternative Plans	Appears in Chapter 5 with the analysis of how each alternative plan improves habitats and continues to Chapter 7 describing the potential effects of the recommended ecosystem restoration plan on the environment.
Step Five – Compare Alternative Plans	Appears in Chapter 5 with the comparison of how each alternative plan improves fish and wildlife habitats.
Step Six – Select Recommended Plan	Appears in Chapter 5 with a discussion of plan selection and in Chapter 6, which describes the Recommended Plan in detail.

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 four key tributaries; Columbia Slough, Johnson Creek, Tryon Creek and Fanno Creek. 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 ecosystem 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 RM 2 and RM 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.
- Johnson Creek: This reach extends from the Willamette River and travels approximately 26 miles through Clackamas and Multnomah counties to its headwaters in Boring Oregon. Johnson Creek passes through upland forests, farms, residential communities, and wildlife refuges, industrial enclaves, along trails and through golf courses.
- 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 ecosystem restoration of any of reach in the project area.
- Fanno Creek: This reach extends of Fanno Creek from its confluence with the Willamette River to its headwaters in the Tualatin Mountains approximately 15 miles. The watershed covers about 32 square miles in Multnomah, Washington, and Clackamas counties, including about 7 square miles within the Portland city limits. The creek supports aquatic life, including coastal cutthroat trout in its upper reaches. This reach provides opportunity to restore native vegetation in riparian zones.

This area was chosen due to the unique opportunity for ecosystem restoration in a major metropolitan area, the extensive partnerships and stakeholder involvement in restoration and the desires of the non-federal sponsor, the City of Portland.

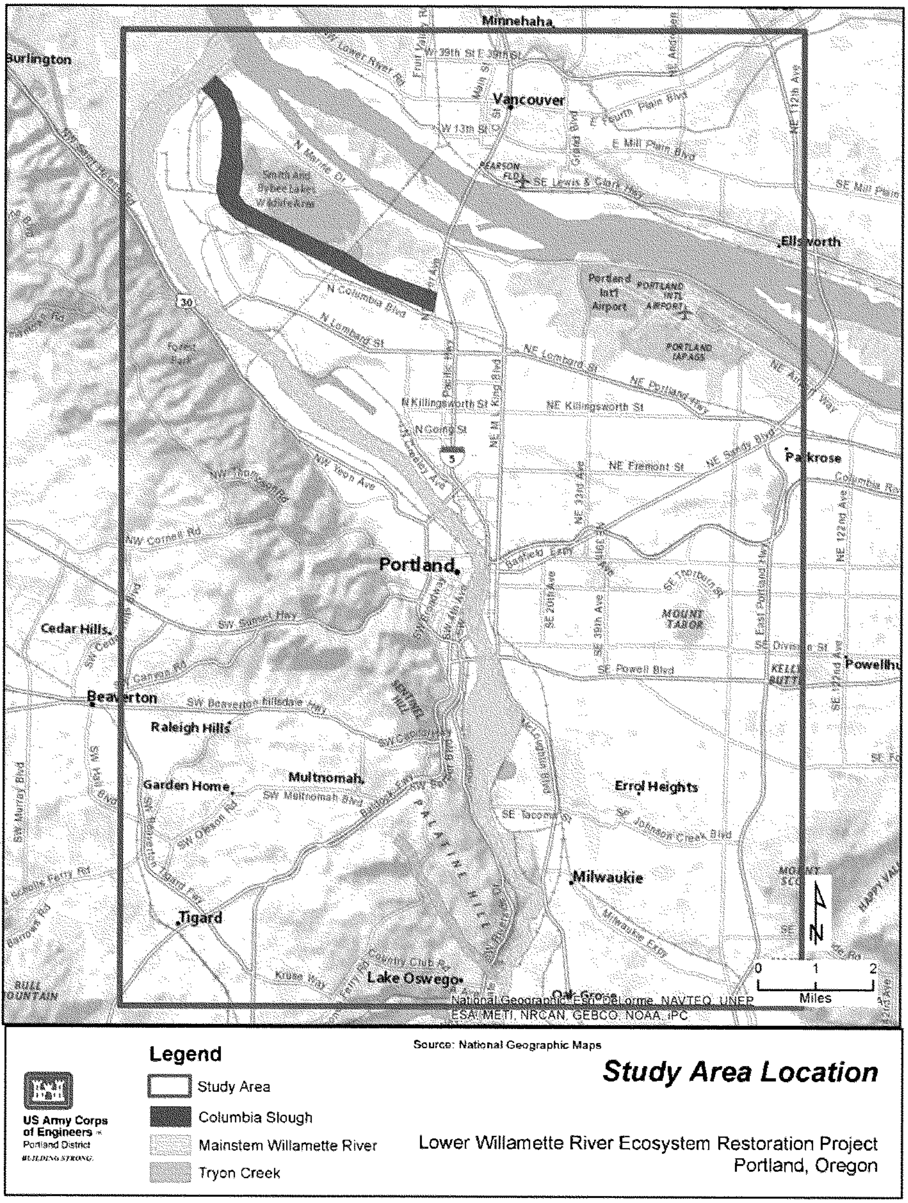

Figure 2-1. Study Area

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

Corps' Willamette Valley Projects: The Corps 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 annual weather patterns and runoff characteristics of the Willamette Basin make the multiple purpose operation of the reservoir system possible. The well-defined limits of the flood season allow the reservoirs to be drawn down in the fall and winter to catch flood flows. The reservoirs are then 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 plan (rule curve), which establishes the elevation at which the pool is to be maintained during various seasons and seasonal transitions.

The Corps coordinates an annual summer flow augmentation plan with federal, state, and local agencies. The coordination process attempts to balance the state's water management objectives for the Willamette with Corps policy, flexibility, and project authorizations. The flexibility to manage any one reservoir is influenced both by project authorizations and the Corps' discretionary authority. There also are provisions for adjustments to the state's water management objectives for flow conditions in terms of average, better, or below normal water conditions. This management of water moves through the study area and combines with the flow of the Columbia River.

Willamette Project Operations Biological Opinion: A Biological Assessment (BA) was prepared by the Corps (USACE 2000b) to assess the ongoing operation and maintenance of the Willamette projects in accordance with Section 7 of the 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 BiOp 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 BiOps 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. Although the purpose of this report is for ecosystem restoration, the action is consistent and supports the Willamette BiOp. It is not a requirement of the BiOp.

Willamette River Federal Navigation Channel: The Corps monitors and maintains a 40-foot deep navigation channel in the Lower Willamette River from the Columbia River upstream to the Broadway Bridge (RM 0 to RM 11.6) as part of the Columbia and Lower Willamette Rivers (C&LW) federal navigation project. From the Broadway Bridge to the Ross Island Bridge (RM 11.6 to RM 16) the C&LW is 30 feet deep, maintained by the Port of Portland. The Willamette River transitions to an 8 foot deep shallow draft navigation channel from the Ross Island Bridge to Oregon City at Willamette Falls Lock (RM 14 to RM 26.6). This portion of the river to its upstream extent is not maintained. The federal navigation channel extends from Oregon City to RM 132 to Corvallis. The channel transitions from the 8 foot depth to a controlling depth of approximately 3.5 feet.

Columbia Slough Section: Columbia Slough was authorized by the River and Harbors Act of 17 May 1950. It provided for a 10 foot deep channel between the mouth and Union Avenue, Portland, 7.7 miles. This project was subsequently reauthorized 20 October 1978. The Corps, in partnership with the City and the Multnomah County Drainage District #1, constructed, the Section 1135 Ecosystem Restoration Project Columbia Slough ecosystem restoration project (USACE 2001). Previously constructed Corps 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 Ecosystem Restoration Project: The Corps, in partnership with the City of Portland, 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) ecosystem 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. This project is currently anticipated for construction in 2017.

Westmoreland Park Section 206 Ecosystem 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. Construction was completed in 2014.

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 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), anticipated in 2017. This became a critical component to this study and the reason that it was re-scoped to only include ecosystem restoration sites outside of the Superfund area.

Willamette Subbasin Plan: The Northwest Power Act directs the Northwest Power and Conservation Council (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 ecosystem restoration designs in the basin.

<u>Willamette and Lower Columbia River Basins Recovery Plan</u>: The NMFS, in partnership with ODFW, developed a recovery plan for salmon and steelhead populations listed on 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. In 2008, NMFS issued a biological opinion that determined that the Action Agencies' (Corps, BPA and Bureau of Reclamation) proposed action, as described in the biological assessments would jeopardize both Upper Willamette River spring Chinook and winter steelhead. The BiOp included a Reasonable and Prudent Alternative to the proposed action, including 90 specific actions. The USFWS issued a no-jeopardy Biological Opinion, assuming that the Action Agencies' implemented the actions required by the NMFS RPA. This BiOp contained seven reasonable and prudent measures, with non-discretionary terms and conditions, to minimize take on bull trout and Oregon Chub. Although the purpose of this report is for ecosystem restoration, the action is consistent and supports the Willamette and Lower Columbia River Basin recovery plan.

2.2.2. State of Oregon

<u>Oregon Plan for Salmon and Watersheds</u>: 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 also serves as a federally recognized ecosystem restoration plan for coastal coho salmon. In December 1997, a steelhead supplement was added to the Oregon Plan and addressed salmonid ecosystem restoration within the context of watershed health.

<u>Willamette River Legacy Program</u>: On March 5, 2004 the State of Oregon adopted the Willamette River Legacy Program. The geographical extent of the plan extends from the headwaters of the Willamette River, east of Eugene to the Columbia River. The plan identified three priority areas of focus for the Willamette River 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. 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.

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 prepared the *Portland Watershed Management Plan* (PBES 2005a). The City Council adopted the plan in March 2006. This 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 framework goals of hydrology, physical habitat, water quality, and biological communities.

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.

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). This plan shows the accumulative benefits for the actions being conducted across the study area.

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. This framework was instrumental to the development of sites evaluated under this feasibility study.

<u>Watershed Characterization Reports</u>: 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 ecosystem restoration. Similarly, the characterizations identify key limiting factors that are used to guide the development and prioritization of management objectives and actions.

<u>Combined Sewer Overflow Program</u>: 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.

3. NEED FOR AND OBJECTIVE 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 RM 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 ecosystem 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

Ecosystem restoration is one of the primary missions of the Corps Civil Works program. Guidance in Engineer Regulation (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 ecosystem 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 (Principles and Guidelines), 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 selection criteria.*

The aquatic and riparian ecosystem 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.

- **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 Corps 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 Willamette River. Problems within tributaries include:

- **Changes in bank gradient and channel substrate.** Due to development of the urbanized watersheds in which tributaries are found, the streams' hydrographs have been altered significantly. Stream velocities are high relative to original conditions, and water surface elevations increase and decrease far more rapidly than under undeveloped conditions. The altered hydrograph has led to channel incision in most tributaries, with corresponding steepened banks and coarser substrate.
- **Excessive sediment deposition.** Alterations of landforms and development of the watershed described above have altered sediment transport patterns, causing excessive erosion of the stream channel and banks, with consequent high sediment loads during high flows. Excessive sediment loads are deposited where stream energy dissipates, often leading to excessive fine sediment in pools and glides.
- **A lack of species and structural diversity within all habitat types in too narrow riparian corridors.** Historic logging and development patterns have narrowed riparian areas and in many

cases only a low ground layer and a canopy layer are found in the riparian zones, where several layers of structure would normally be expected. A fully functioning riparian zone would have mid-story layers to support neotropical migrant songbirds and contribute to deposition of materials into the stream.

- **Limited connection or linkage between riparian habitats and upland habitats.** Channel dredging, development in the riparian transition zone, and steepened banks have contributed to reduced linkage between upland and riparian habitats. Numerous species move regularly between riparian and upland areas as part of their lifecycle, a process that is interrupted when the linkage between these habitats is lost.
- **Disturbance due to the proximity of urban development, domestic animals, and recreational trails.** Development has encroached on the upland and riparian buffers surrounding tributaries to the Willamette River, leading to increased habitat disturbance from traffic noise, recreational users, dogs, feral cats, and other users. In addition to disturbance from noise and presence of humans and dogs, users accessing streams can also negatively affect bank stability or increase turbidity by entering the streams directly.
- **Presence of fish barriers.** Fish barriers in the form of perched culverts, utility pipelines, streets, and small dams limit fish passage in various tributaries. In many cases, the original design of these structures may have allowed fish passage, but geomorphological changes in the stream may have reduced direct connectivity to culverts or exposed buried pipelines.

3.2.2. Opportunities

While numerous problems have been identified, there are also many opportunities for ecosystem 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 ecosystem 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.

Opportunities for habitat ecosystem restoration in the Lower Willamette River watershed include:

- Improve performance of a degraded, channelized floodplain by increasing the acreage available for inundation during high flows;
- Reconnect adjacent lands to the Lower Willamette River to allow for inundation and creation of wetland and off-channel habitat;
- Improve access for fish and wildlife to existing habitat;
- Add complexity to diminished riverine and riparian habitats; and
- Reestablish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem, and improves habitat complexity that increases biodiversity.
- The metropolitan area is highly urbanized; there are small unique areas available for restoration.

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 Corps 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 2018 and ends in 2067.

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 ecosystem 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 ecosystem 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 ecosystem restoration measures that have been developed to help accomplish this objective include:

- Restore streambeds by placing LWD 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: Improved habitat complexity as measured by habitat units.

3.3.3. Restore Floodplain Function and Connectivity

Reconnecting floodplains to the river will help to attenuate flows and contribute organic matter, substrate, and LWD 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 ecosystem 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: Reconnect 2.9 stream miles to the mainstem Willamette River. This is some of the last opportunities in this highly developed study area.

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 ecosystem 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 ecosystem restoration measures implemented as part of this project should not negatively affect the Superfund site.
- **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.** Periods in aquatic environments will be limited to in-water work windows that have been designated for each water body. The in-water work window for the Main stem Willamette is July 1 through October 31, Tryon Creek is July 15 through September 30, and Columbia Slough is Jun 15 through September 15.

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.

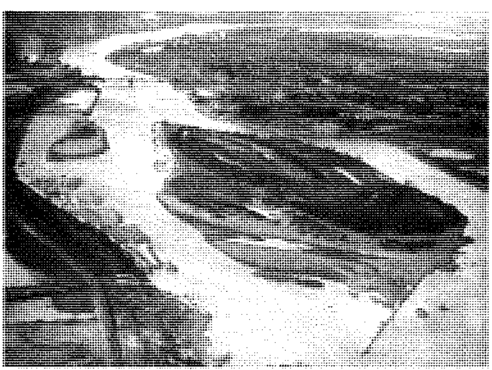

Figure 4-1. Swan Island in 1920

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 River 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 Corps 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 break lines digitized and interpolated from U.S. Coast and Geodetic Survey, 1888, Columbia River chart (Fales Landing to Portland) and Corps 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 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 Columbia River Basalt Group 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 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. 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.

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 Bed and Sediment Transport. The historical channel bed material characteristics of the Lower Willamette River are not known, but they were likely comprised of sand and fine-grained sediments along much of its length. The extensive changes in flow patterns, construction of dams, and extensive changes in channel structure and floodplain connection in both the Columbia and Willamette have likely had an effect on sediment transport and deposition through the lower river, but the data to verify or quantify these potential changes are lacking (PBES 2006).

Because the stretch of river encompassed in this study is a slow moving and tidally influenced, it is considered a deposition reach. This means that any coarse materials that erode and move through upstream stretches of the Willamette River system into the study area will mostly settle out in the study reach, with only fine sediments passing completely through the system. Evidence of this historic trend is found in the gravel islands that historically formed in the Lower Willamette, including Ross Island, located at RM 15.

The processes by which any coarse materials erode and move through the Willamette River system and into the Lower Willamette have been compromised by bank armoring and construction of dams on tributaries to the Willamette. As an example, one of the main tributaries to the Willamette River, the North Santiam River, is sediment-starved downstream of a large dam that creates Detroit Lake, and a smaller re-regulating dam just downstream of Detroit Dam called Iron Cliff Dam. Because most coarse sediments settle out into Detroit Lake, spawning-sized gravel no longer enters the system in quantities great enough to sustain spawning beds or to perform other habitat-forming functions such as gravel bar formation. This trend affects channel bed formation throughout all parts of the system downstream of the dams.

Presently, the 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 with the majority of the bedrock located between Willamette Falls and Portland (PBES 2006).

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. Approximately 26 percent consists 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 near the confluence of the Columbia River. 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).

Additional data regarding geomorphology of the specific ecosystem restoration areas is given in Appendix A, Geomorphology.

4.2.4. Soils

Five soil types are found within the study area:

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 in the floodplain will likely degrade due to erosion from natural and human forces, and will not be replaced to the degree that they would under an un-regulated system that would inundate floodplains annually. This will lead to soil degradation over time. No substantial changes to geological layers or topography are anticipated to occur during the planning horizon. 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.

Sediment transport processes will continue to be interrupted as a result of upstream revetments and dams. This will continue the trend of allowing less coarse sediment to move through the system, with one result being that sediments transported into the study area will continue to be comprised of a higher percentage of fines than of coarse sediments. Formation of gravel bars and islands in the Lower Willamette, which occurred under conditions previous to regulation of the Willamette River system, will likely be very minimal.

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. For this report, all elevations use the North American Vertical Datum of 1988 (NAVD88).

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 the remaining 5 percent occurs from July through September.

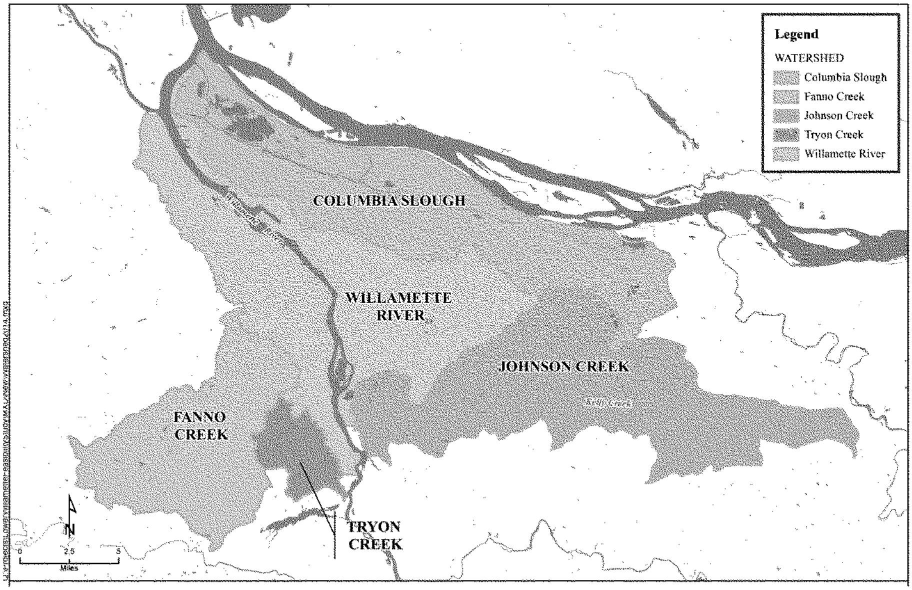

Figure 4-2. Watershed Boundaries in the Project Area

The average annual daily discharge in the Lower Willamette River, as recorded at USGS Gage No. 14211720, Willamette River at Portland (Morrison Bridge) from 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 the Corps beginning in the 1960s, in addition to various bank protection structures for flood control and hydropower production (Willamette Ecosystem 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 15.5 feet NAVD88 and is most pronounced when harbor stages are less than 8.5 feet NAVD88; 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 of 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.

Johnson Creek

The Johnson Creek Watershed varies from heavily developed urban areas in the lower and middle reaches (Milwaukie, Portland and Gresham) to rural and agricultural areas in the upper watershed. The area north of the Johnson Creek mainstem is mostly flat, with large floodplain areas, particularly in Lents. These floodplains are thought to be a remnant of large glacial floods that occurred about 15,000 years ago. Johnson Creek floods on average every other year. It is one of the last free-flowing streams in the Portland area and provides important habitat for coho and Chinook salmon, steelhead and cutthroat trout. During the last 200 years, people have altered the Johnson Creek watershed in an attempt to reduce flood impacts and to make it easier to develop the land near the creek. In the 1930s, the Works Progress Administration widened, deepened and rock-lined 15 miles of Johnson Creek in an effort to prevent future flooding. Despite that effort, Johnson Creek has flooded 39 times in the last 60 years. Current efforts to restore Johnson Creek focus on restoring its natural resource functions. This type of restoration provides flood storage, water quality benefits, and increases fish and wildlife habitat by returning some of the natural historic conditions and functions to the watershed. While these species still exist in Johnson Creek and its tributaries, their long-term survival depends on our ability to restore habitat and improve water quality (PBES 2005b).

Fanno Creek

Fanno Creek was eliminated from the study based on size, potential opportunities, multiple municipal jurisdictions, private land holdings and not entirely within the boundaries governed by the City of Portland.

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 percent coverage of impervious surfaces throughout the Tryon Creek watershed (Rhodes 2002, PBES 2005b). However, total impervious area is likely higher than 25 percent, 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 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.

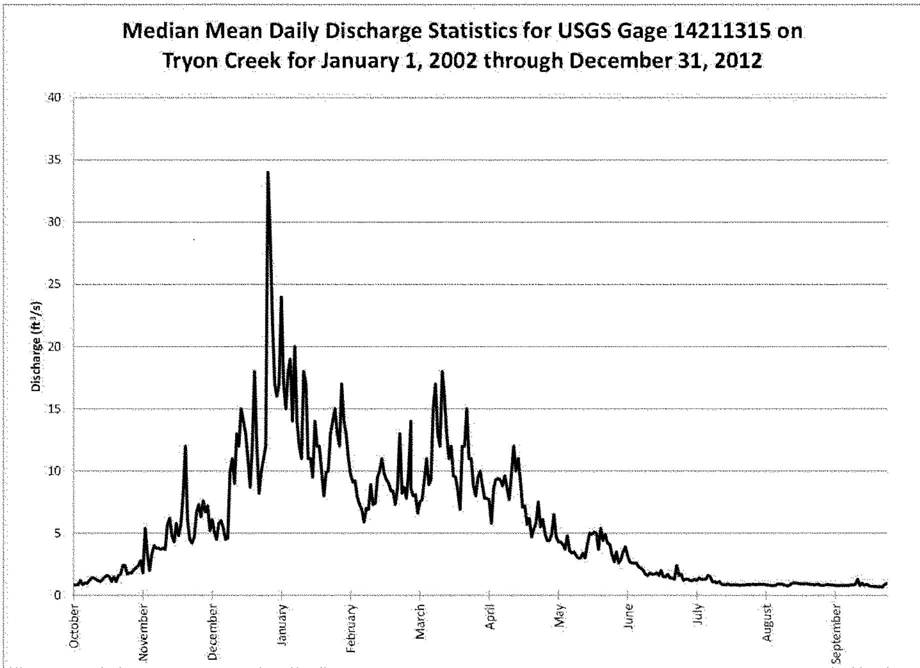

Figure 4-3. Median Mean Daily Discharge Statistics

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 years 1990 to 2015, although these data have not been recorded continuously. A maximum water elevation of 27.26 feet was observed on February 9, 1996 (USGS 2015), 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. Water quality is generally degraded in the baseline.

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 Hawthorne Bridge (RM 13.2). A fourth site is located on the Columbia Slough at Landfill Road (RM 2.6). The latest ambient WQI 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					

The WQI results from 2001 to 2010 show that water quality ranges from fair to very poor in the project area. 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), and in some cases the changes have been substantial enough to reclassify the indices into the next higher category (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 ODEQ, which has worked to establish a total of 10 Total Maximum Daily Loads (TMDLs) for the watershed that specify pollutant loading limits and require pollution reduction programs for pollutant sources (Table 4-3).

Table 4-3. Approved TMDLs in the 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

There are a number of pollutants of concern in the study area. The 303(d) listed waterbodies in the project area are shown in Figure 4-4. 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 National Oceanic and Atmospheric Administration (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).

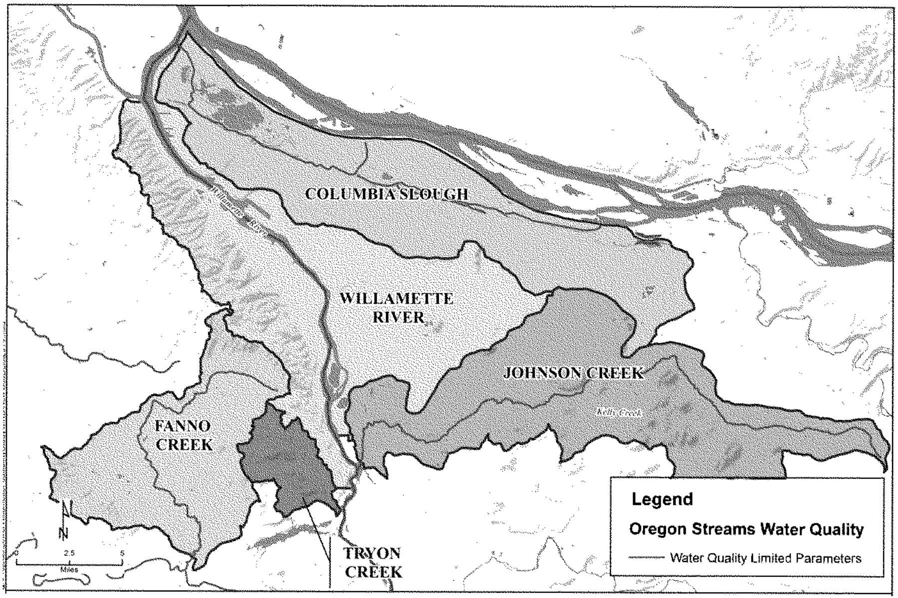

Figure 4-4. 303(d) Listed Waterbodies

The City recently finished 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 Corps to complete a Section 1135 project to restore fish and wildlife habitat along Columbia Slough. The Port of Portland 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. 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 study 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), CSOs 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.

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

The City invested millions of dollars and completed a 20-year CSO Control Program in December 2011. The program reduced CSOs into Columbia Slough by more than 99 percent and into the Willamette River by 94 percent. Instead of an average of 50 Willamette River CSO events each year, there are now an average of four CSO events each winter and one event every third summer during only very heavy rain storms. The city met all of its required CSO program milestones on. The City completed Columbia Slough CSO projects in 2000. They included the Columbia Slough Big Pipe, a 3.5-mile long, six and 12-foot diameter pipeline to collect combined sewage and transport it to the Columbia Boulevard Wastewater Treatment Plant. The City expanded plant capacity to accommodate the extra flow. The slough projects controlled 13 CSO outfalls and reduced CSOs to the slough by 99 percent.

The City completed the West Side Big Pipe and the Swan Island CSO Pump Station in 2006 to control 16 CSO outfalls on the west side of the Willamette River. The 3.5-mile, 14-foot diameter tunnel carries combined sewage to Swan Island and the CSO pump station pumps it to the Columbia Boulevard Wastewater Treatment Plant. Also in 2006, the City began construction of the East Side Big Pipe, a six-mile long, 22-foot diameter tunnel to collect sewage from the east side of the Willamette. The City completed tunneling in October 2010 and completed connecting combined sewers to the east side tunnel in September 2011 to control the 19 remaining Willamette River CSO outfalls.

4.3.4. Navigation

The Willamette River is navigable 132 miles upstream from its mouth. Navigation facilities in the basin include the Willamette Falls Locks (now closed to navigation due to the degraded condition of the infrastructure) 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.

The Lower Willamette River is used for navigation by pleasure craft, small fishing boats, local drayage companies, barges hauling wheat, gravel, and other materials into Portland Inner Harbor, and by ocean-going cargo ships. Although most heavy cargo ships use the Port of Portland facilities located on the Columbia River upstream of the confluence with the Willamette River, between 30-45 grain ships navigate to grain silos located just downstream of the Broadway Bridge each year. Three terminals, including T-2, T-4, and T-5 are located on the Willamette River.

The Lower Willamette River is dredged periodically between its confluence with the Columbia River (RM 0) and the Broadway Bridge, located at RM 11.6, which is the extent of the federal navigation channel maintained by the Corps. The federal navigation channel is maintained to a depth of 40 feet, with 2 feet of advanced maintenance to assure the reliability of the channel, which at 600-feet wide is intended to allow two-way shipping traffic. Dredging operations last occurred in 2011, when 50,000 cubic yards of materials were dredged and taken to the dredge material placement facility at West Hayden Island, located on the Columbia River at RM 105 (Port of Portland 2014). This site was selected because it is authorized to accept materials dredged from the Portland Harbor Superfund site. Materials dredged from the Superfund site are not used for habitat features at ecosystem restoration sites, as they would need to be extensively sampled before they could be approved for use in habitat areas. Any sand or gravel needed for habitat features in the study area is imported from upstream of the Superfund site, or brought in from outside of the area.

4.3.5. 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, riparian and aquatic ecosystem 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 ecosystem 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). The Corps's Sea Level Change Curve Calculator (USACE 2014) presents sea level rise estimates corresponding to 3 different scenarios: low, intermediate, and high. Under the low rise scenario, and assuming project construction is completed in 2020, sea levels at the NOAA Astoria, Oregon gauge (Gauge 9439040) would decrease by 0.05 feet relative to NAVD88 by 2070; would increase by 0.42 feet NAVD88 by 2070 under the intermediate scenario; and increase by 1.92 feet NAVD88 by 2070 under the high scenario.

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) 8 miles to the Saltzman Creek confluence (RM 0 to RM 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 (RM 14 to RM 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 river banks, many large and small holes above the OHW mark indicate the utilization of the shoreline by common river birds and mammals.

The general vegetation types located in the south and north segments of the study area are shown in Figures 4-5 and 4-6.

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 LWD are insufficient to support the migratory and rearing life stages of the focal species, including numerous federal and state listed 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

Wetland plant communities differ between the various sites depending on their location relative to the river. Riparian wetland plant communities are found at Kelley Point Park and Oaks Crossing, and are dominated by black cottonwood and Oregon ash. Fringing wetlands are generally found at or near the mean higher high water line in the riverine areas, and are dominated by small willows, sedges and rushes, with occasional patches of cattails or bulrush where shallow water predominates. Off-channel wetlands occur where water ponds from runoff or where there is a high water table, for example in the off-channel swale at the BES Plant site. Such wetlands are dominated by spikerush (*Eleocharis* sp.) and reed canarygrass (*Phalarus arundinacea*). Reed canarygrass, a widespread invasive weed, is found at most sites from just above the waterline to the uplands.

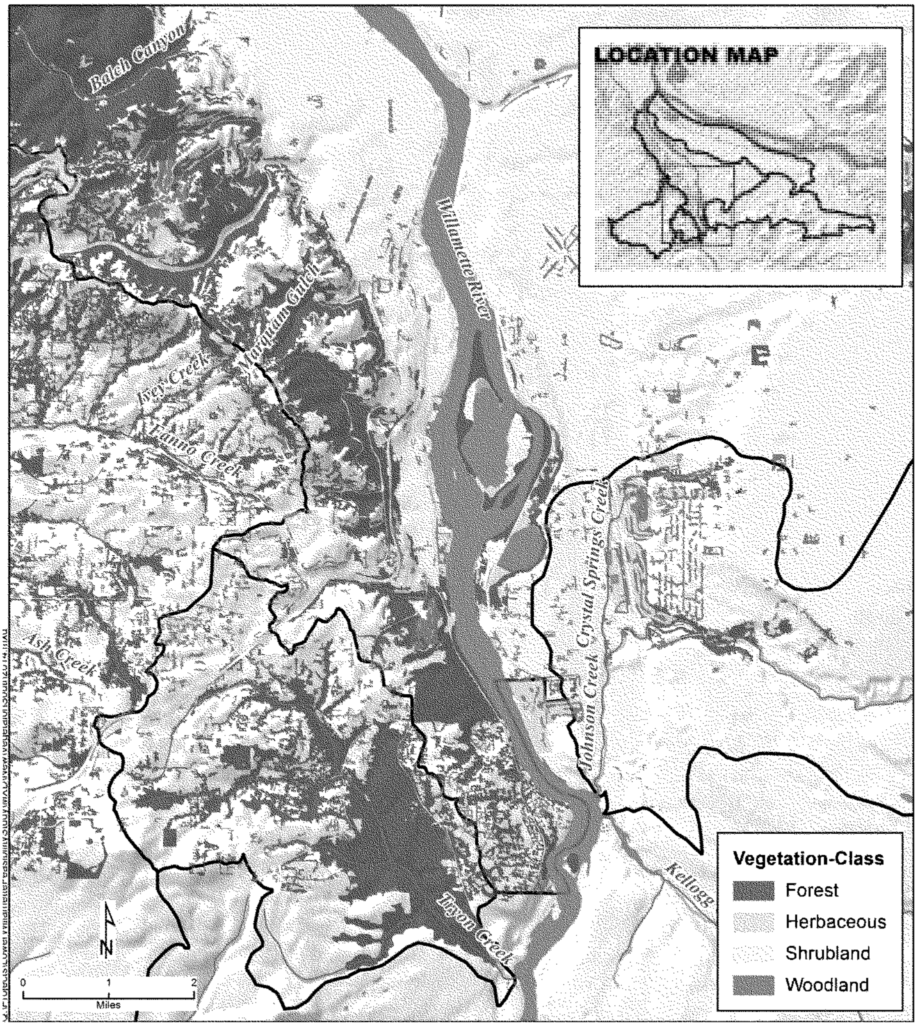

Figure 4-5. Vegetation Types, South Segment of Study Area

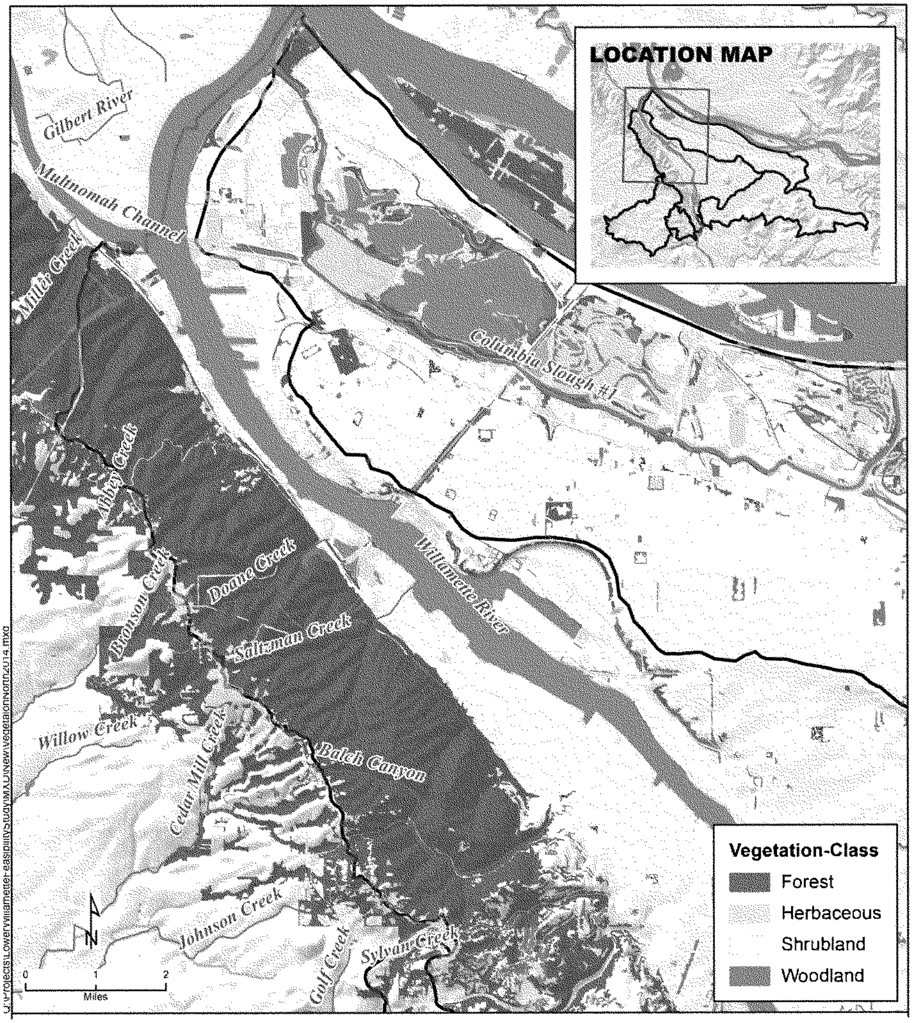

Figure 4-6. Vegetation Types, North Segment of Study Area

The riparian plant community surrounding and upstream of the Tryon Creek Highway 43 is typical for floodplains of small streams, and is dominated by alders (*Alnus* sp.), black cottonwood (*Populus trichocarpa*), and Oregon ash (*Fraxinus latifolia*). The understory is dominated by sword fern, salal, and other species that can thrive in areas with low amounts of direct sunlight. 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 ecosystem 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 using Geographic Information System (GIS) data from National Wetlands Inventory (NWI; USFWS 2011), as well as GIS data from the City (City of Portland 2010) and Metro (Metro 2004, 2009). Tetra Tech staff verified wetland conditions at reconnaissance site visits between 2009 and 2011. Figure 4-7 displays wetland areas mapped by NWI.

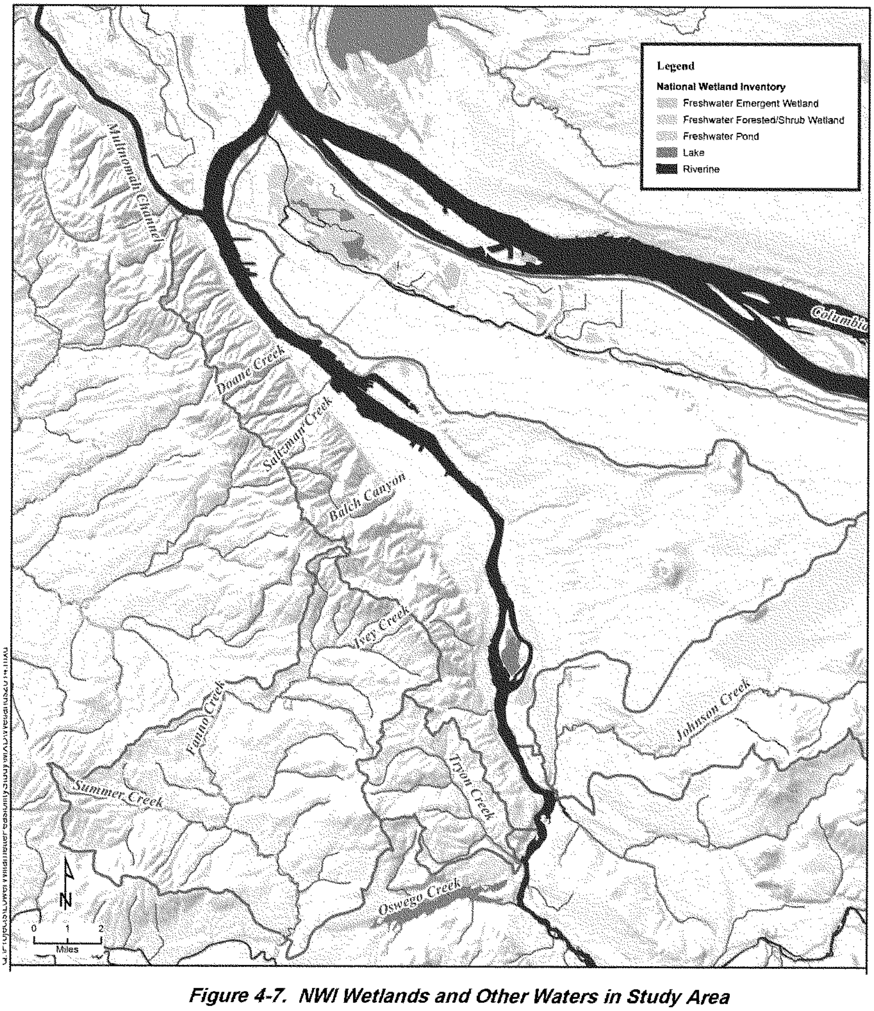

Figure 4-7. NWI Wetlands and Other Waters in Study Area

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 (*Pseudotsuga menziesii*), Oregon ash, black cottonwood, alder, bigleaf maple (*Ace macrophylum*), western red cedar (*Thuja plicata*), and willows (*Salix* sp.). 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 Basin. Fragmentation 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). The 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.

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 (downstream to upstream) at Highway 43 (creek mile 0.2), Boones Ferry Road (creek mile 2.9), and on its tributary, Arnold Creek (Arnold Creek mile 0.1) partially or completely block fish passage into the upper reaches of the streams (in all, about 7 miles of spawning and rearing habitat is blocked). The most extensive obstruction is the Highway 43 culvert. In 2005, ODOT attempted to partially improve fish passage at the culvert during high water events (ODOT did not have a compliance requirement). They retrofitted the bottom of the culvert with baffles, and a roughened chute was installed downstream of the culvert's outfall to create a backwater into its lower entrance to eliminate an entrance jump barrier. In 2011, the City installed a boulder weir below the culvert's mouth to raise the water surface elevation (the City did not have a compliance requirement). These projects were intended to restore fish passage to the 2.7 mile stretch of Tryon Creek between the Highway 43 and Boones Ferry culverts. The projects were small in scale and have not been shown to significantly increase fish passage.

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			

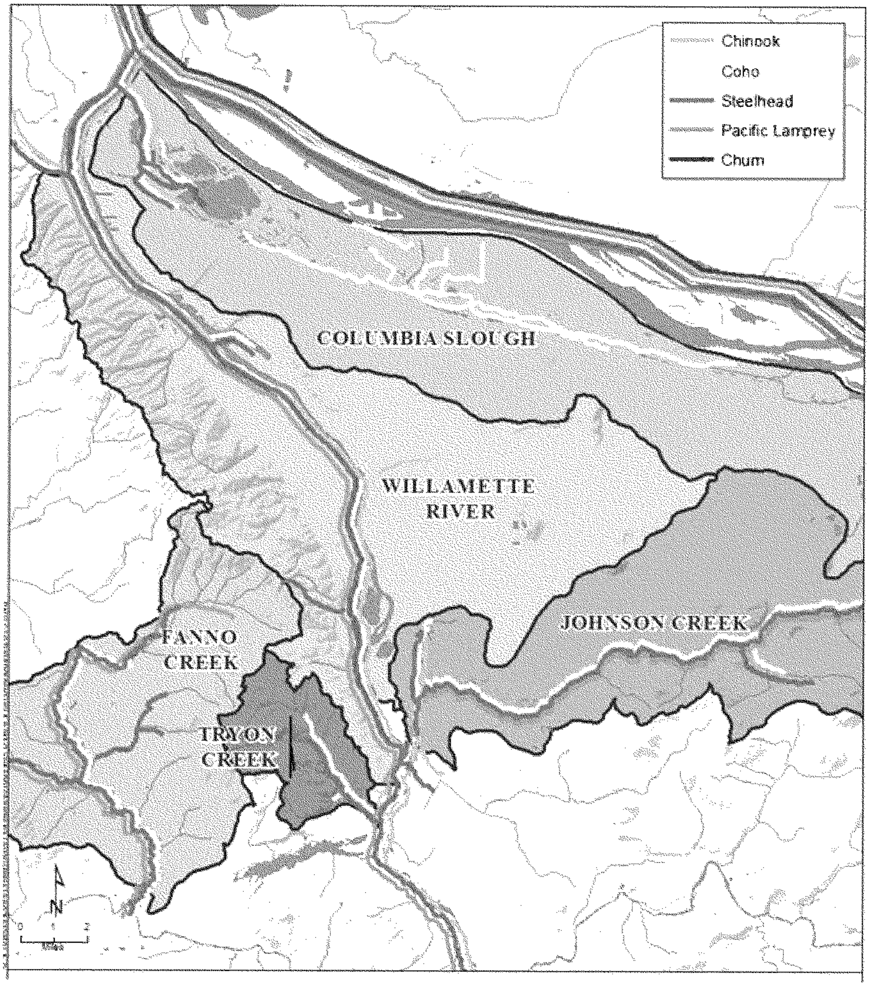

Figure 4-8. Anadromous Fish Species Distribution in the Study Area

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). A study by ODFW and PBES found that no fish passed the culvert (ODFW and PBES 2002), and a report from 2007 also indicated no fish passage at the culvert (Henderson Land Services 2007). A monitoring study by USFWS found that although some fish entering Tryon Creek from the Willamette River could pass the culvert, most were blocked (USFWS 2012). Furthermore, it is not clear from the USFWS study under what flow conditions fish were able to pass the culvert, or what life stages may pass, and some of the fish detected above the culvert in the USFWS study may have been resident fish that did not pass the culvert. Therefore, although it does appear that some fish may pass through the culvert under optimal flow conditions, under most flow conditions the culvert is considered impassible.

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 ESUs composed of seven different species may use or migrate through watercourses in the study area (Figure 4-8).

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.

Table 4-5. Species Likely to be Present in Study Area (Non-native Species are Identified)

American bittern	Golden-crowned kinglet	Raccoon
American crow	Golden-crowned sparrow	Red crossbill
American goldfinch	Great blue heron	Red-breasted sapsucker
American kestrel	Hammond's flycatcher	Red-eyed vireo
American robin	Hermit thrush	Red-legged frog
Bank swallow	Hermit warbler	Red-tailed hawk
Barn swallow	Herring gull	River otter
Beaver	Hoary bat	Rock dove (non-native)
Belted kingfisher	Hooded merganser	Rufous-sided towhee
Bewick's wren	House sparrow	Sandhill crane
Black-capped chickadee	House wren	Sharp-shinned hawk
Black-headed grosbeak	Hutton's vireo	Short-eared owl
Black-throated grey warbler	Lesser goldfinch	Song sparrow
Brown creeper	Lincoln's sparrow	Starling (non-native)
Bufflehead	Long toed salamander	Swainson's thrush
Bull frog (non-native)	Macgillivray's warbler	Townsend's solitaire
Bullock's oriole	Mallard	Townsend's warbler
Bushtit	Merlin	Varied thrush
Canada goose	Mink	Vaux's swift
Chipping sparrow	Mourning dove	Warbling vireo
Common garter snake	Mule deer	Western red-backed salamander
Common merganser	Nashville warbler	Western scrub-jay
Coyote	Northern flicker	Western tanager
Dark-eyed junco	Northern harrier	Western wood-pewee
Double-crested cormorant	Northwestern garter snake	White-breasted nuthatch
Douglas' squirrel	Nutria	White-crowned sparrow
Downy woodpecker	Orange-crowned warbler	Widgeon
Dunlin	Osprey	Wilson's warbler
Dusky flycatcher	Pacific chorus frog	Winter wren
Field mice	Pacific-slope flycatcher	Woodrat
Fox	Pine siskin	Yellow warbler
Fox sparrow	Pocket gopher	Yellow-rumped warbler
Gadwall	Purple finch	

4.4.6. Listed and Sensitive Species

The ESA is intended to conserve endangered and threatened species and the ecosystems on which they depend as key components of America's heritage. A protected species is listed in one of two categories; endangered or threatened, depending on its status and the degree of threat it faces. An "endangered species" is one that is in danger of extinction throughout all or a significant portion of its range. A "threatened species" is one that is likely to become endangered in the foreseeable future throughout all or a significant portion of its range.

Several ESA-listed species are identified for Multnomah County; however, only the fish species listed in Table 4-6 and discussed below have potential to be present in the proposed project area. Given the best scientific information available (ODA 2010, ODFW 2010, USFWS 2010, NMFS 2011, NOAA 2014), it was determined that either extant populations or the necessary habitat requirements for all other ESA-listed species (presented in Table 4-6 along with state-listed species) are not present in the project area and individuals are therefore absent. Therefore, there are no listed plants, amphibians, reptiles, or mammals known to occur or that have the potential to occur in the study area.

Table 4-6. ESA Listing Status of Species Likely to Occur in 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
Coho salmon	*Oncorhynchus kisutch*	Lower Columbia / Southwest Washington	Threatened
Steelhead	*Oncorhynchus mykiss*	Lower Colnmbia	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 Federal Register (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 CFR 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).

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 CFR 223); critical habitat has been designated for this species (50 CFR 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. Protected Species Unlikely to Occur in the Project Area

Table 4-7 presents other ESA-listed and/or state-listed species identified as potentially occurring in the project area. All federally protected ESA-listed species identified below are unlikely to occur in the project area and were not considered further in the BA prepared for this project (Appendix C).

4.4.9. Future Without-Project Conditions

In the future without-project condition, small-scale habitat restoration actions by a variety of state and local agencies and groups would continue to occur. The federal Action Agencies will continue 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. 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 Corps will take actions to improve habitats as required for compliance with the 2008 BiOps (NOAA 2008; USFWS 2008), these actions will primarily be focused on actions that compensate for adverse effects from dam operations. 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.

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

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 ecosystem 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 ecosystem restoration.

4.5. CULTURAL RESOURCES

4.5.1. Summary

The following is a 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 B.C. to 1775 A.D.

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 island's west side 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).

4.5.2. 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 below.

- <u>Open Space.</u> This category includes parks, greenways, and undeveloped areas. These areas are generally accessible for public uses.
- <u>Commercial.</u> This land use category identifies activities associated with retail trade and services for the general public, offices, and lodging.
- <u>Industrial (General and Heavy).</u> 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.
- <u>Residential.</u> 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.

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).

4.7.1. 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 of Portland's Terminal 6. Barge transportation extends farther upriver on the Willamette and Columbia Rivers. The Port of Portland 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 of Portland is the largest port 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.

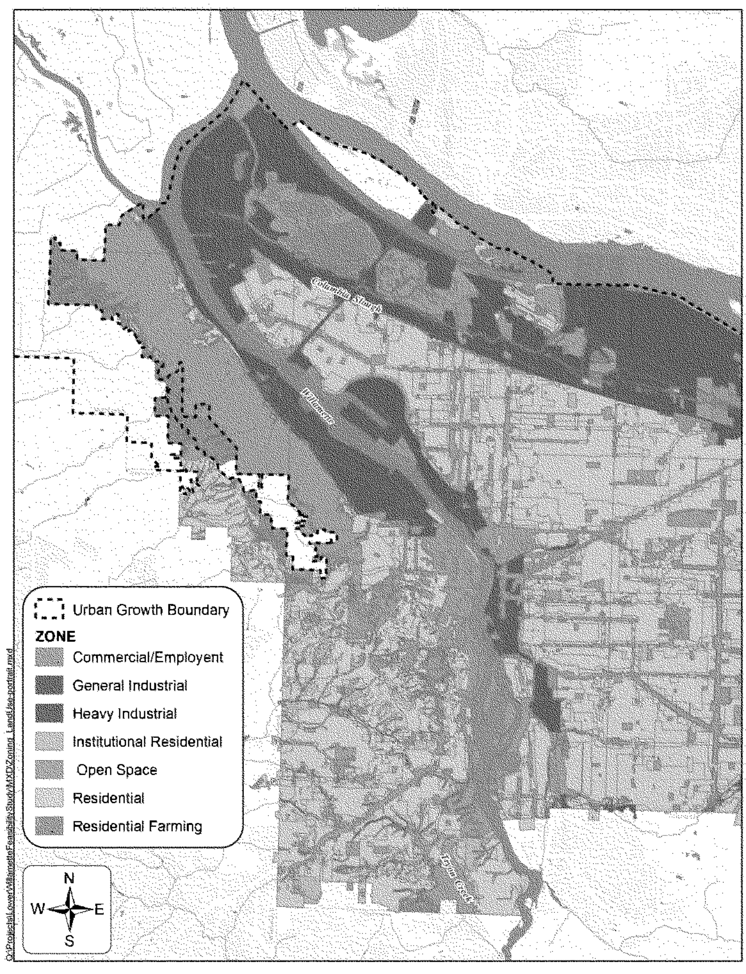

Figure 4-9. Zoning Designations in the City of Portland (PBPS 2006)

4.7.2. 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.

4.7.3. 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. In addition to the two interstate highways, Oregon Highway 43 crosses over Tryon Creek and serves as a major artery for traffic from suburban communities south of Portland traveling into the downtown metropolitan area.

4.7.4. 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.

4.7.5. 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 latest report from Oregon's Office of Economic Analysis (OEA) 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 4-8 summarizes projected population through 2020.

Table 4-8. Observed and Projected Population Growth in the Portland MSA

County	Observed Growth*			Projected Growth**			
	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							

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.

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 FY 2010 (Oregon OEA 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).

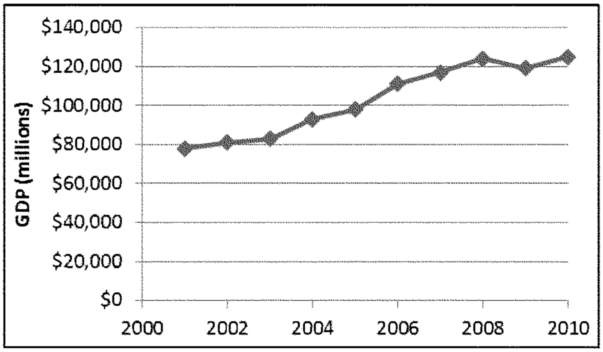

Figure 4-10. Portland MSA GDP Summary (U.S. Bureau of Economic Analysis 2012)

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, larger shares of children under the age of 18 are now living in poverty (U.S. Census Bureau 2010b).

4.8.4. Environmental Justice

Executive Order 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 in Figure 4-11.

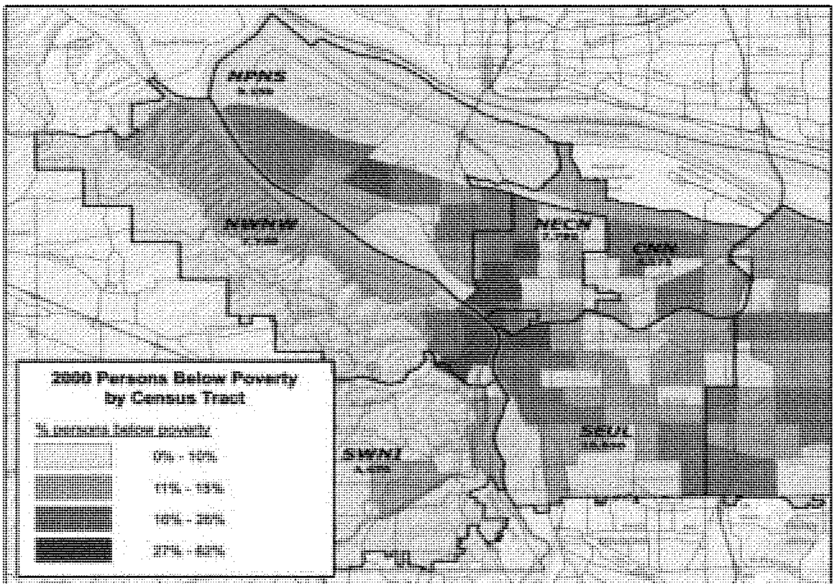

Figure 4-11. Portland Poverty by Census Tract and Neighborhood (City of Portland 2012)

Key: The four-letter neighborhood name codes shown in bold type are 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 numbers 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

4.9.1. Park Facilities

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).

4.9.2. 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.

4.10. AIR QUALITY

4.10.1. Air Quality Standards

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).

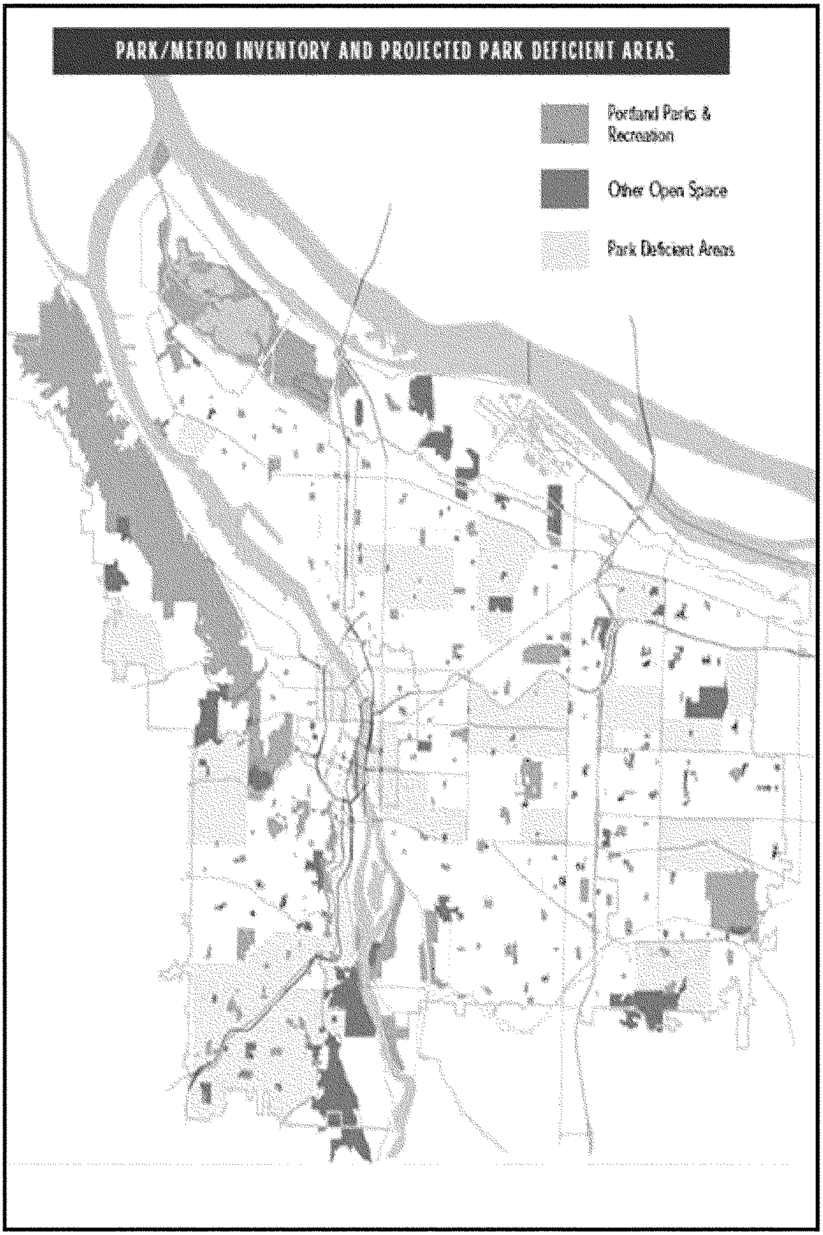

Figure 4-12. Parks and/or Open Space and Amenities Found in the Study Area

Table 4-11. **National EPA Ambient Air Quality Standards**

Pollutant	Average Time	National Ambient Air Quality Standard (NAAQS) Violation Determination	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				

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.

In response to these NAAQS, the State of Oregon Clean Air Act Implementation Plan (SIP) was adopted under Oregon Administrative Rules (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 and carbon monoxide. 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. In addition, according to the 2010 annual report, particulate matter (PM) levels (for PM2.5) are regularly above 25 ug/m^3, making the Portland/Vancouver AQMA an area of concern.

4.10.2. 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

4.11.1. Ambient Noise Levels

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 ecosystem restoration project footprint includes railways, freight corridors, I-5 traffic, and Portland International Airport (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 airport's 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). Air traffic resulted in measurements within the study area over 70 dB (The Greenbusch Group, Inc. 2008).

4.11.2. 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

4.12.1. Contaminated Areas and Sources

Because of the levels of pollution in Lower Willamette River sediment from 100(+) years of industrial activities, Portland Harbor was added to the federal Superfund cleanup list in December 2000. The Portland Harbor Superfund site is designated as being from RM 1.9 up to downtown Portland at RM 11.8. As a result of a the policy decision in May 2013 to exclude sites that were identified as potential contaminated sites (referred to as Section 312b sites), all sites that were within the Portland Harbor area were removed from this project. Pollutants generated throughout the Portland Harbor area including industrial discharges, toxics carried by stormwater, and other sources have contributed to highly elevated levels of DDT, PCBs, polycyclic aromatic hydrocarbons (PAHs) and heavy metals in the Lower Willamette River sediment. A comprehensive investigation of the entire lower Willamette River area has been conducted by the Lower Willamette Group in the past two decades assuring that the designated Portland Harbor CERCLA site is well defined with appropriate best management practices in place on monitoring, regulations, and clean up protocol.

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 the Portland Harbor CERCLA site. 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), semivolatile organic compounds (SVOCs), PAHs, PCBs, total petroleum hydrocarbons (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, 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.

For the ecosystem restoration sites included in this study, a phase 1 site assessment for HTRW was conducted to determine if there is any current and/or historical contamination that could adversely influence the implementation of any future planned ecosystem restoration measures identified in this study. An HTRW professional conducted this phase 1 site assessment in accordance to ASTM E 1527.05, which included an environmental database search and site inspections. 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. Complete findings are included in Appendix E. The Kelley Point Park site is downstream of the Portland Harbor area and concerns about contamination from the superfund site is considered to be low due to the strict restrictions placed on any type of disturbance or activities occurring in this area. The contaminated sediment in the Portland Harbor area is stable unless disturbed through dredging type activities, which is being strictly regulated by EPA. The Record of Decision (ROD) on the Portland Harbor CERCLA is estimated to be issued in late 2017. Any Portland Harbor CERCLA current or future cleanup action will require the site to be fully contained and controlled to prevent offsite migration of contaminants. Potential ecosystem restoration locations that were identified as having potential HTRW issues were removed during the screening process. Sites remaining in this study were determined through the phase 1 site evaluation to have a low potential for significant HTRW presence. Additional research and documentation of existing sampling data or the collection of new samples sufficient to confirm that there is a minimal risk of HTRW at any of the sites during the Planning, Engineering and Design (PED) phase of the project.

4.12.2. Future Without-Project Conditions

In the future, it is anticipated that conditions will improve with the ongoing remediation efforts associated with the Portland Harbor CERCLA site. Because the primary contaminated sites have been identified, actions that may lead to downstream contamination from re-suspension of contaminants will be avoided. This is a high profile area with federal, state, and local protection protocols and regulations in place that will assist in preventing new sources of HTRW from entering the system.

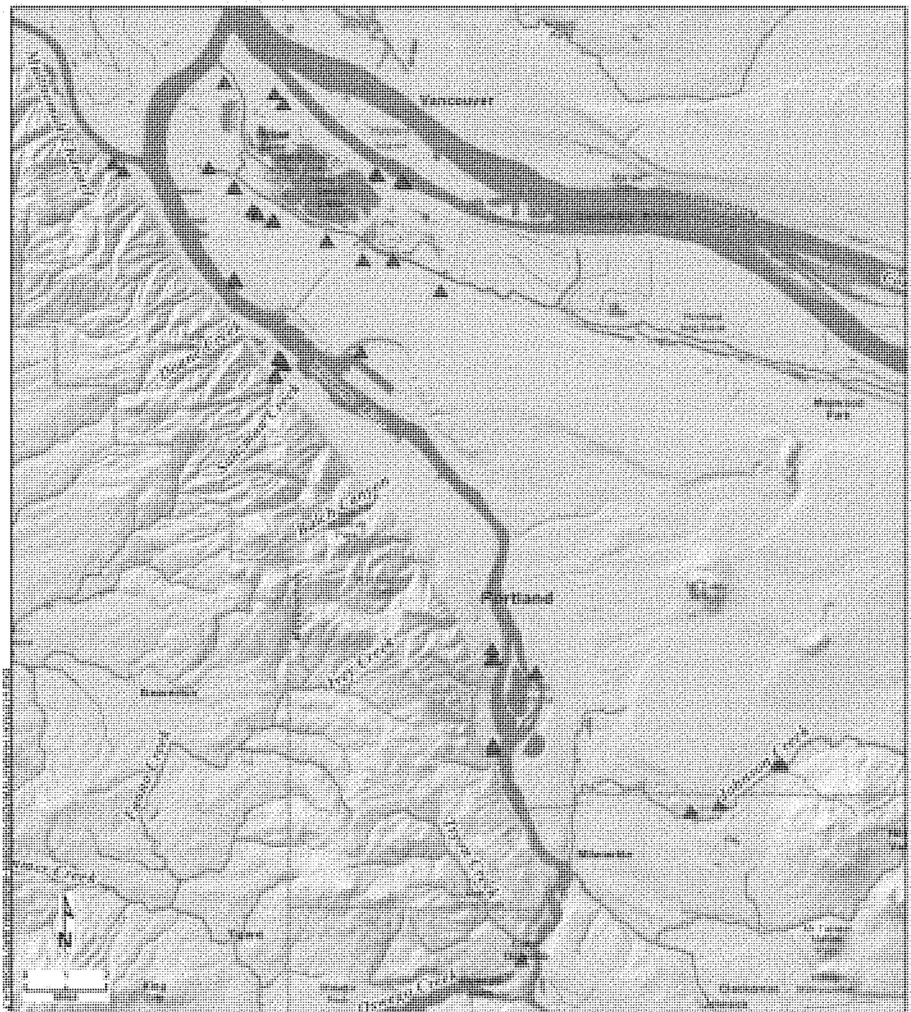

Figure 4-13. HTRW Sites Identified in the Study Area

4.13. VISUAL RESOURCES

4.13.1. Aesthetic Conditions

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 provided in Section 7.13.

4.13.2. 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.

5. PLAN FORMULATION

Plan formulation is the process of identifying specific ways to achieve planning objectives while avoiding constraints so as to solve the problems and realize opportunities identified earlier in this report. This step of the planning process produces solutions that achieve all or part of one or more of the planning objectives.

In addition to the problems, opportunities and constraints, Corps Planning Principles and Guidelines (P&G) were considered during the plan formulation process. Per ER 1105-2-100, plans should be evaluated for completeness, effectiveness, efficiency, and acceptability.

- **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.
- **Completeness.** A plan must provide and account for all necessary investments or other actions needed to ensure the realization of the planned ecosystem 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 ecosystem restoration objective. Real estate, operations and maintenance (O&M), monitoring, and sponsorship factors must be considered. Where there is uncertainty concerning the functioning of certain ecosystem restoration features and an adaptive management plan has been proposed it must be accounted for in the plan.
- **Effectiveness.** An ecosystem restoration plan must represent a cost effective means of addressing the ecosystem restoration problem or opportunity. It must be determined that the plan's ecosystem restoration outputs cannot be produced more cost effectively by another agency or institution.
- **Efficiency.** An ecosystem restoration plan must make a substantial contribution to addressing the specified ecosystem restoration problems or opportunities.

5.1. PRELIMINARY SITE IDENTIFICATION AND SCREENING

Numerous possible ecosystem restoration sites were initially proposed by the City of Portland. Many of the sites were included in the conceptual watershed management plans developed for the Lower Willamette River watershed (Section 2.2.4). Forty-five sites were selected for additional investigation based on ecological restoration opportunities present that matched project objectives. Consideration of how each site fits into the overall watershed and the unique or functional opportunities that each site can obtain that may not be feasible to restore or retain at other sites. These project sites were then reviewed to ensure they did not violate project planning constraints. The initial array of preliminary ecosystem restoration sites are summarized in Table 5-1 and displayed in Figure 5-1.

Table 5-1. Initial Array of Possible Ecosystem Restoration Sites

Site Number	Site	General Location	Opportunities
Mainstem Willamette River			
1	Kelley Point Park	Willamette Mainstem	Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
2	Miller Creek Confluence	Willamette Mainstem	Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
3	Powerline Crossing	Willamette Mainstem	Reconnect adjacent lands to the Lower Willamette River to allow for inundation and creation of wetland and instream habitat. Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
4	Doane Creek	Willamette Mainstem	Daylight lower stream. Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
5	MarCom	Willamette Mainstem	Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
6	Cathedral Park	Willamette Mainstem	Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
7	Willamette Cove	Willamette Mainstem	Reconnect adjacent lands to the Lower Willamette River to allow for inundation and creation of wetland and instream habitat.
8	Saltzman Creek	Willamette Mainstem	Daylight mouth of creek. Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
9	Balch Creek	Willamette Mainstem	Daylight lower Balch Creek. Reconnect adjacent lands to the Lower Willamette River to allow for inundation and creation of wetland and instream habitat. Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
10	Swan Island Beach South	Willamette Mainstem	Maintain habitat values at this site. Reconnect adjacent lands to the Lower Willamette River to allow for inundation and creation of wetland and instream habitat.
11	Waterfront Park Bowl	Willamette Mainstem	Improve performance of a degraded, channelized floodplain by increasing the acreage available for inundation during high flows. Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
12	Centennial Mills	Willamette Mainstem	Improve performance of a degraded, channelized floodplain by increasing the acreage available for inundation during high flows. Daylight Tanner Creek. Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.

Site Number	Site	General Location	Opportunities
13	Woods Outfall	Willamette Mainstem	Reconnect adjacent lands to the Lower Willamette River to allow for inundation and creation of wetland and instream habitat. Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
14	Eastbank Crescent	Willamette Mainstem	Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
15	Oregon Yacht Club	Willamette Mainstem	Reconnect adjacent lands to the Lower Willamette River to allow for inundation and creation of wetland and instream habitat. Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
16	Oaks Bottom Wildlife Refuge	Willamette Mainstem	Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
17	Willamette Park	Willamette Mainstem	Improve performance of a degraded, channelized floodplain by increasing the acreage available for inundation during high flows. Reconnect adjacent lands to the Lower Willamette River to allow for inundation and creation of wetland and instream habitat. Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
18	Oaks Amusement Park	Willamette Mainstem	Reconnect adjacent lands to the Lower Willamette River to allow for inundation and creation of wetland and instream habitat. Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
19	Stephens Creek Mouth	Willamette Mainstem	Maintain off-channel habitat; expand on existing high quality functions.
20	Oaks Crossing/Sellwood River front Park	Willamette Mainstem	Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
21	Powers Marine Park	Willamette Mainstem	Reconnect adjacent lands to the Lower Willamette River to allow for inundation and creation of wetland and instream habitat. Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
22	Elk Rock/Spring Park	Willamette Mainstem	Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
Columbia Slough			
23	City Banks opposite Kelley Point	Columbia Slough	Reconnect adjacent lands to tributaries to allow for inundation and creation of wetland and instream habitat. Location at major confluence provides important connections to both Willamette and Columba River fish populations.
24	Ramsey Refugia	Columbia Slough	Reconnect adjacent lands to rivers or streams to allow for inundation and creation of wetland and instream habitat. Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribnition to the ecosystem and improves habitat complexity that increases biodiversity.

Site Number	Site	General Location	Opportunities
25	Smith and Bybee Lakes	Willamette Mainstem	Improve access for fish and wildlife to existing habitat. Re-establish of native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
26	Blind Slough	Columbia Slough	Valuable off-channel habitat with good existing riparian canopy and shrub vegetation. Increase habitat value by increasing habitat complexity, increasing area of off-channel habitat, and improving vegetation diversity.
27	St. John's Landfill Boat Launch	Columbia Slough	Reconnect adjacent lands to rivers or streams to allow for inundation and creation of wetland and instream habitat. Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
28	BES Plant Banks	Columbia Slough	Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity. Reconnect adjacent lands to rivers or streams to allow for inundation and creation of wetland and instream habitat.
29	Wright and Moore Islands	Columbia Slough	Reconnect adjacent lands to rivers and streams to allow for inundation and creation of wetland and instream habitat. Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
30	Kenton Cove	Columbia Slough	Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
Johnson Creek			
31	Crystal Springs Culvert Replacements	Johnson Creek	Improve access for fish and wildlife to existing habitat.
32	Westmoreland Park	Johnson Creek	Improve access for fish and wildlife to existing habitat.
33	Errol Creek Confluence	Johnson Creek	Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity. Reconnect adjacent lands to rivers and streams to allow for inundation and creation of wetland and instream habitat.
34	Errol Creek Headwaters	Johnson Creek	Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
35	Bell Station	Johnson Creek	Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
36	West Lents	Johnson Creek	Improve performance of a degraded, channelized floodplain by increasing the acreage available for inundation during high flows. Reconnect adjacent lands to rivers or streams to allow for inundation and creation of wetland and instream habitat.
37	Freeway Land Company/East Lents	Johnson Creek	Improve performance of a degraded, channelized floodplain by increasing the acreage available for inundation during high flows. Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.

Site Number	Site	General Location	Opportunities
38	Lower Powell Butte	Johnsou Creek	Improve performance of a degraded, channelized floodplain by increasing the acreage available for inundation during high flows. Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
39	Alsop-Brownwood	Johnson Creek	Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
Tryon Creek			
40	Tryon Creek Confluence	Tryon Creek	Reconnect adjacent lands to the Lower Willamette River to allow for inundation and creation of wetland and instream habitat. Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
41	Tryon Creek Highway 43 Culvert	Tryon Creek	Improve access for fish and wildlife to existing habitat.
42	Middle Tyron Creek State Natural Area Habitat Ecosystem Restoration	Tryon Creek	Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
43	Marshall Park Channel Ecosystem Restoration	Tryon Creek	Improve performance of a degraded, channelized floodplain by increasing the acreage available for inundation during high flows. Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.
44	Boones Ferry Culvert Retrofit	Tryon Creek	Improved access for fish and wildlife to existing habitat.
45	Arnold Creek Culvert	Tryon Creek	Improve access for fish and wildlife to existing habitat. Re-establish native vegetation that supports habitat for native aquatic species, increases nutrient contribution to the ecosystem and improves habitat complexity that increases biodiversity.

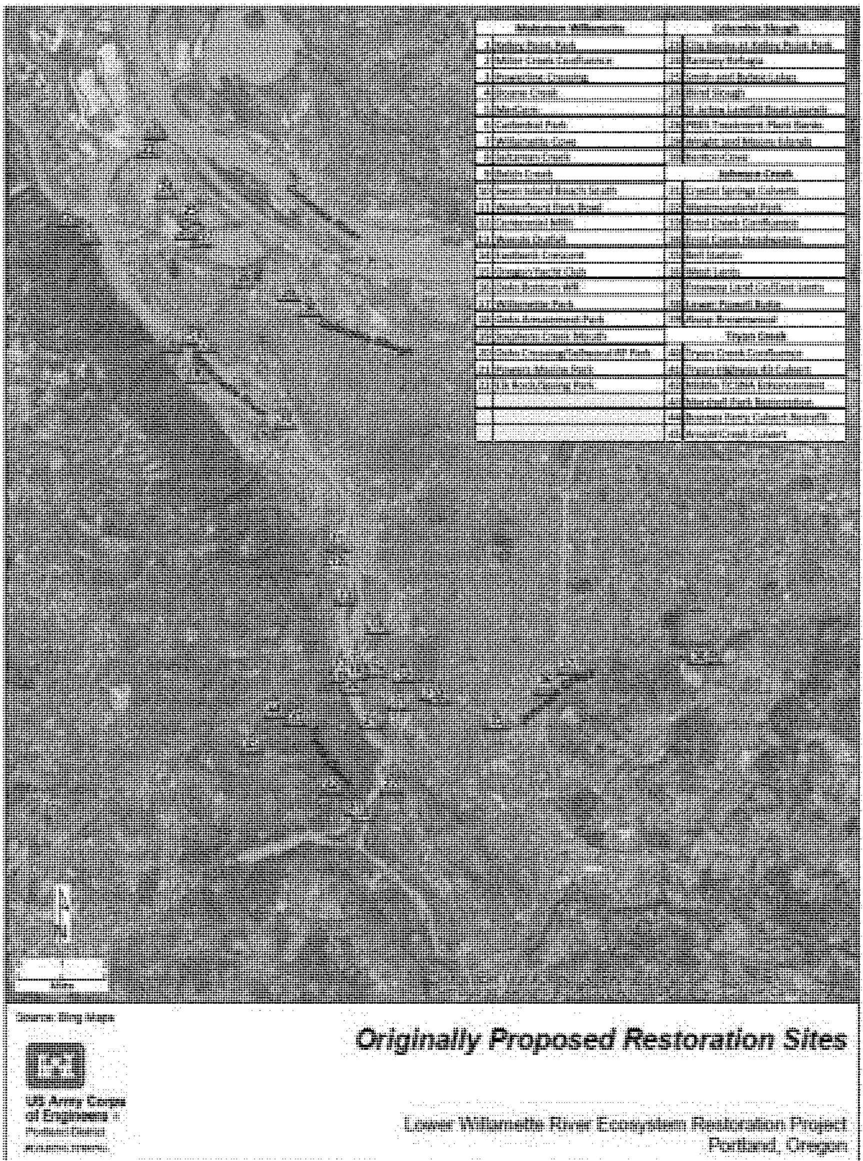

Figure 5-1. Originally Proposed Ecosystem Restoration Sites

5.2. PRELIMINARY SCREENING OF SITES

Initial criteria were developed to screen 45 sites. It included; potential real estate concerns, whether or not the sites potentially lend themselves to proven ecosystem restoration techniques with a proven long-term success, whether or not other entities had already planned or had construction underway at the site, and constructability concerns or problems. Table 5-2 summarizes the screening criteria and description. Any site that violates one of these criteria was removed from further consideration.

Table 5-2. Initial Site Screening Criteria

Screening Criteria	Description
Real estate	Lands under multiple ownership, where owners were clearly not supportive of implementation of ecosystem 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 ecosystem restoration potential (long-term success)	Several sites initially appeared to offer opportunities for ecosystem restoration, but upon closer inspection were fonnd 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 ecosystem restoration would be otherwise limited.
Work underway by others	In some cases, sites were found to be under planning for ecosystem restoration by other entities, or ecosystem restoration measures had already been implemented.
Constructability	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. Not Cost effective

Two events occurred during the course of this General Investigations study: (1) in 2000, the Willamette River, Portland Harbor was listed as a Superfund site, and (2) in 2008, the NMFS produced a BiOp for the Willamette Basin for ESA-listed fish species. Both of these events resulted in an extended planning process due to the time it took to determine how those decisions affected this study.

Members of the Project Delivery Team (PDT), which also included project stakeholders, conducted reconnaissance-level surveys at all 45 sites. The purposes of the surveys were to gather data to establish baseline conditions and to conduct secondary screening to eliminate sites where constraints made ecosystem restoration potential limited or clearly infeasible.

Field investigations began in November to December, 2007. Table 5-3 indicates the primary reasons and challenges that led the PDT to screen sites from further analysis in the FS-EA.

Table 5-3. Sites Eliminated from Consideration

Site	Reason for Removal from Consideration	Initial Screening Criteria Violated
Mainstem Willamette		
2. Miller Creek Confluence	Private ownership	Real estate
3. Powerline Crossing	Land owned by unwilling landowner	Real estate
4. Doane Creek/Railroad Corridor	Environmental contamination; private ownership; high cost of ecosystem restoration	Limited ecosystem restoration potential (long-term success); constructability
5. MarCom	Site showed limited ecosystem restoration potential and high possibility of need for remediation	Limited ecosystem restoration potential (long-term success); constructability
7. Willamette Cove	Emerging evidence of contamination rendered this site infeasible until remediation had been completed	Constructability
9. Balch Creek	Environmental contamination; minimal ecosystem restoration opportunities	Limited ecosystem restoration potential (long-term success); constructability
10. Swan Island Beach South	Site was slated for remediation, poor water quality	Limited ecosystem restoration potential (long-term success); constructability
11. Waterfront Park Bowl	Land use and recreation requirements minimized area of potential ecosystem restoration to less than desirable.	Limited ecosystem restoration potential (long-term success)
12. Centennial Mills	Site was planned for redevelopment, future of restored habitat could not be guaranteed	Limited ecosystem restoration potential (long-term success)
13. Woods Outfall	Site showed limited ecosystem restoration potential and likely high maintenance requirements over time	Limited ecosystem restoration potential (long-term success)
14. Eastbank Crescent	Site did not appear to offer substantial potential for successful ecosystem restoration	Limited ecosystem restoration potential (long-term success)
15. Oregon Yacht Club	Land owned by multiple unwilling landowners	Real estate
16. Oaks Bottom Wildlife Refuge	Project was moved forward as a separate Corps Section 206 ecosystem restoration project	Work underway by others
17. Willamette Park	Site considered for ecosystem restoration as part of separate project	Work underway by others
18. Oaks Amusement Park	Perceived issues due to private ownership.	Real estate
19. Stephens Creek Mouth	Very limited ecosystem restoration potential	Limited ecosystem restoration potential (long-term success)
21. Powers Marine Park	Site showed very limited ecosystem restoration potential	Limited ecosystem restoration potential (long-term success)
22. Elk Rock Island	Site did not appear to offer substantial potential for successful ecosystem restoration	Limited ecosystem restoration potential (long-term success)
Columbia Slough		
23. City Banks opposite Kelley Point Park	Ecosystem restoration measures were implemented under a separate project	Work underway by others
24. Ramsey Refugia	Work already completed by Portland Bureau of Environmental Services	Work underway by others

Site	Reason for Removal from Consideration	Initial Screening Criteria Violated
25. Smith and Bybee Lakes	Ecosystem restoration work already occurring under separate contract	Work underway by others
26. Blind Slough	Limited ecosystem restoration potential	Limited ecosystem restoration potential (long-term success)
29. Wright and Moore Islands	Site showed very limited ecosystem restoration potential and difficult construction access	Limited ecosystem restoration potential (long-term success); constructability
Johnson Creek		
31. Crystal Springs Culvert Replacement	Culvert replaced as part of separate project	Work underway by others
32. Westmoreland Park	Project was moved forward as a separate Corps Section 206 ecosystem restoration project	Work underway by others
33. Errol Creek Confluence	Ecosystem restoration measures were implemented under a separate project	Work underway by others
34. Errol Heights (Headwaters)	Ecosystem restoration measures were implemented under a separate project	Work underway by others
35. Bell Station	Private ownership; requires purchase of property and residential relocation for floodplain project	Real estate
36. West Lents	Private ownership would require purchase of property and residential relocation for floodplain project	Real estate
37. Freeway Land Company	Site was subsequently considered for a flood control project rather than an ecosystem restoration project	Limited ecosystem restoration potential (long-term success)
38. Lower Powell Butte	Some landowners did not appear to be willing to participate in the proposed project	Real estate
39. Alsop-Brownwood	Ecosystem restoration measures were implemented under a separate project	Work underway by others
Tryon Creek		
40. Tryon Creek Confluence	Ecosystem restoration measures were implemented under a separate project	Work underway by others
42. Middle Tyron Creek State Natural Area	Ecosystem restoration measures were implemented under a separate project	Work underway by others
43. Marshall Park	Ecosystem restoration measures were implemented under a separate project	Work underway by others
44. Boones Ferry Culvert	Culvert retrofit being designed as part of a separate project	Work underway by others
45. Arnold Creek Culvert	City considering this project under a different program	Work underway by others

The mainstem Willamette started with 22 sites. Four sites were screened out for real estate concern. Two of the original sites have ecosystem restoration measures implemented or are being planned as separate projects and are no longer available for consideration. Twelve sites were screened out for limited ecosystem restoration potential (long-term success) or constructability, leaving four sites for further consideration. These four sites are Kelley Point Park, Cathedral Park, Saltzman Park and Oaks Crossing.

Columbia Slough started with eight sites. No sites were screened out for real estate concern. Three of the original sites have ecosystem restoration measures implemented or are being planned as separate projects and are no longer available for consideration. Two sites were screened out for limited ecosystem restoration potential (long-term success) or constructability, leaving three sites for further consideration. These three sites are St John's Landfill, BES Plant, and Kenton Cove.

Johnson Creek started with nine sites. Three sites were screened out for real estate concern. Five of the original sites have ecosystem restoration measures implemented or are being planned as separate projects and are no longer available for consideration. One site was screened out for limited ecosystem restoration potential (long-term success) or constructability, leaving no sites available for further consideration.

Tryon Creek started with six sites. No sites were screened out for real estate concern. Five of the original sites have ecosystem restoration measures implemented or are being planned as separate projects and are no longer available for consideration. No sites were screened out for limited ecosystem restoration potential (long-term success) or constructability, leaving one site for further consideration. This site is Tryon Creek, Highway 43.

The eight sites carried forward for further consideration are shown in Figure 5-2.

5.3. DEVELOPMENT OF ECOSYSTEM RESTORATION MEASURES

Ecosystem restoration measures were developed supporting the following three planning objectives:

- Reestablish riparian and wetland plant communities;
- Increase aquatic and riparian habitat complexity, connectivity and diversity; and
- Restore floodplain function and connectivity.

Each of these objectives is proposed to address a problem or take advantage of an opportunity introduced earlier in Chapter 3 within the project area. The measures listed in Table 5-4 were identified as measures that could be implemented at the eight remaining sites to achieve these planning objectives. These measures would help achieve one or more of the planning objectives, were scaled using the Habitat Evaluation Procedures (HEP) model (see Section 5.4.3) for each site, were proven to be effective at other similar projects covering the range of life stages for fish and wildlife species in the study area, and were implementable given the size of the available ecosystem restoration area at the site.

As opposed to a single large ecosystem restoration site, this study includes numerous small sites throughout the lower Willamette River watershed area where the cumulative effect of implementing numerous projects would be significant on a watershed scale. Scalability in application of the measures was achieved with the use of the HEP model.

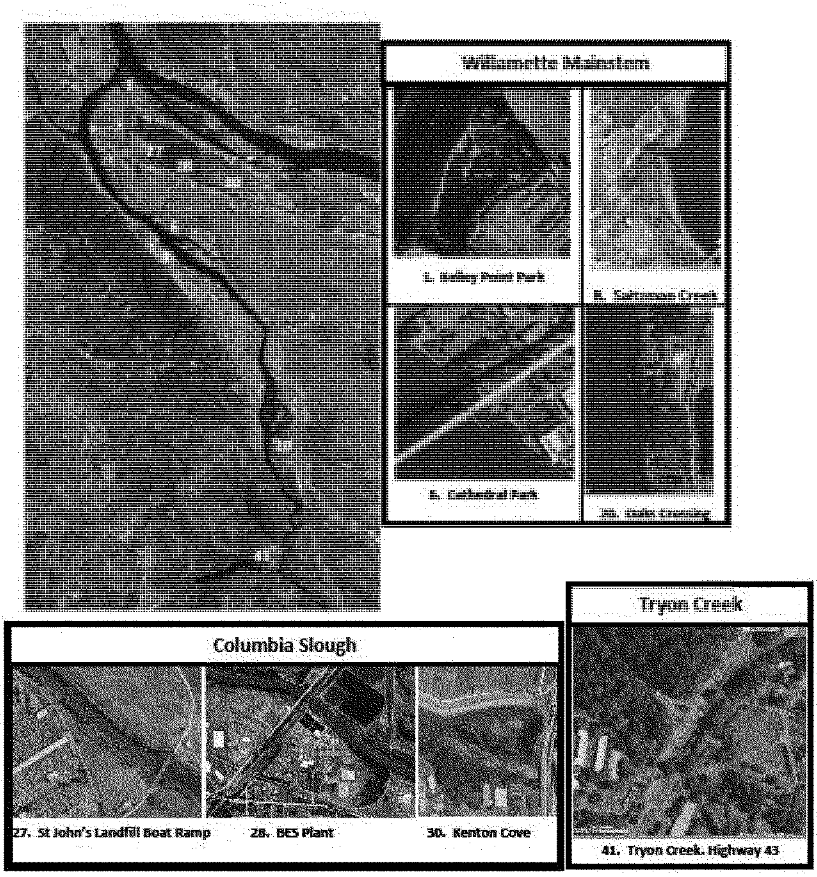

Figure 5-2. Eight Sites Carried Forward for Further Consideration

Table 5-4. Ecosystem Restoration Measures

Measure	General Description	Objective Achieved
Large wood placement	LWD is a naturally occurring component of streams in the Lower Willamette River ecosystem. Large wood 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 LWD 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 ecosystem restoration (PBES 2006). Strategic placement of LWD 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.	Increase aquatic and riparian habitat complexity and diversity
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 LWD 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.	Reestablish riparian and wetland plant communities Increase aquatic and riparian habitat complexity and diversity Restore floodplain function and connectivity
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 ecosystem restoration measure would involve the active removal of non-native vegetation, including Himalayan blackberry, reed canarygrass, 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 risk of contamination to waterways is limited.	Reestablish riparian and wetland plant communities Increase aquatic and riparian habitat complexity and diversity
Floodplain reconnection	Connected floodplains attenuate high flows, store water and recharge groundwater tables, and both retain and contribute organic matter, substrate, and LWD 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.	Restore floodplain function and connectivity
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.	Reestablish riparian and wetland plant communities Increase aquatic and riparian habitat complexity and diversity Restore floodplain function and connectivity
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.	Restore floodplain function and connectivity

5.4. DEVELOPMENT OF CONCEPTUAL ECOSYSTEM RESTORATION SITE PLANS

To help determine the potential ecological lift at each site, the PDT mapped each site and recorded data regarding vegetation, hydrologic features, topography, substrate, and land use on a standard data sheet. Base maps were obtained from the City or created for the river, floodplain, and tributary sites using aerial photographs and topographic maps. Specific features such as locations of wetland features were recorded by use of Geographic Positioning System (GPS) equipment. Geographic Information System base layers showing the project locations and boundaries were later modified to reflect more precise boundaries or areas of influence for the ecosystem restoration features.

The PDT conducted additional site visits at each of the eight sites and identified what project objective(s) could be reasonably obtained and what measures (listed in Table 5-4) could be applied to achieve those objectives. Of the eight sites, at least two of the three project objectives could be reached at each site, with four sites meeting all three objectives (Table 5-5).

Table 5-5. Ecosystem Restoration Measures Applied to Meet Objectives

Site	Objective 1	Objective 2			Objective 3
	Revegetation	Large Wood	Off-channel Habitat	Fish Barrier Removal	Floodplain Reconnection
Willamette Mainstem					
Kelley Point Park	X	X	X		X
Cathedral Park	X	X	X		
Saltzman Creek	X	X	X		
Oaks Crossing	X	X	X		X
Columbia Slough					
St. Johns Landfill Boat Launch	X	X	X		X
BES Plant	X	X	X		X
Kenton Cove	X	X			
Tryon Creek					
Tryon Creek Highway 43	X			X	

Initial identification of measures that could be applied at each site was to establish the minimum area, lineal feet, lump sum, and acres, of that measure that could be applied at that site to register a meaningful change in habitat scoring from its existing condition. Most of the measures identified by the team to be effective for habitat benefit were dependant on application of other measures at the site to optimize those benefits. Measures, or combinations of measures, were considered appropriate for each site if they: (1) had the potential to address one or more of the habitat ecosystem restoration objectives; (2) could be implemented at a scale to cause a measurable difference in the habitat value at that site; and (3) were ecological feasible, defined as having high ecosystem restoration opportunity using known scientific effectiveness.

The small size of a number of the sites made incremental analysis of each measure per site not meaningful when applied separately for habitat benefits. Measures recommended at each site are dependent on each other to restore the range of habitat values that each site offers, and, cumulatively, to achieve restoration of habitat components on a watershed scale. In areas where implementation of measures could reasonably be measured incrementally or separate from other measures HEP analysis were performed and noted in the site descriptions.

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. The HEP model was used to determine the extent of adding additional measures at each of the eight sites. The PDT added the next logical measure incrementally to attain additional measurable ecological output from the HEP model. 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.

In order to establish the maximum measures, the HEP model and professional judgment was used. For example, when considering revegetation, the PDT started with the minimum measures at the site, and then incrementally added plantings until the ecological outputs diminished. This represented the maximum measures per site. At Kenton Cove, areas around the water were considered necessary for riparian plantings, as compared to those areas farther up the slope. At Tryon Creek, the primary issue affecting habitat quality was lack of access by adult fish into the stream so the primary ecosystem restoration measure of culvert replacement was developed to facilitate passage of this life stage into the stream.

5.4.1. Dependency of Measures Applied to Meet Project Objectives

In many cases, measures that were recommended for application at a site were tied into the application of another measure, thus being dependent on each other to obtain the habitat benefit potential at the site. At the same time, the full range of measures developed for this study are not proposed at each site, generally because they would not be cost effective, would be redundant, were not needed to meet the objectives for the site, or because the site's size does not allow them to be implemented at a scale that would be effective. Therefore, measures at each site were identified by the PDT to be dependent or independent of each other and analyzed with HEP and incremental cost analysis based on this dependency. This methodology was the main component for achieving the most effective habitat value per site and on a watershed scale.

5.4.2. Mainstem Willamette Sites

Kelley Point Park

Kelley Point Park (Figure 5-3) is owned and operated by PPR. This 100-acre park is located at the tip of a peninsula bounded by the Columbia slough on the south, the Willamette River on the west and the Columbia River on the North. Adjacent surrounding lands are primarily used for industrial purposes. Ecosystem restoration portion at this site is 47.37 acres. A recreation component includes providing pedestrian access by placement of bridges over constructed swales that otherwise would limit park uses.

Kelley Point Park was once a very complex, tidally influenced wetland-riparian area of high importance due to its location at the confluence of the Willamette and Columbia Rivers. Historic placement of fill and its conversion to a park have reduced this complexity and steepened its banks, diminishing the riparian corridor and blocking fish from accessing the interior area of the site and its historic tidal sloughs.

Habitat components that would be improved at this site include the banks and riparian areas along the Willamette River, and a large component of the interior of the park where tidal channels and riparian habitat would be constructed. Both of these areas at Kelley Point Park will provide for much needed off-channel and high flow refugia for juvenile anadromous fish that may be moving downstream from either the Willamette River or the Columbia River and enhance ecosystem functions to support other target species and guilds that may rely on riparian areas found on the Willamette River and inland tidal areas.

Proposed at Kelley Point Park are the construction of tidal channels and their associated riparian areas, layback of the bank along the Willamette River, riparian planting, LWD and boulder placement. Additional benefits were assumed where restored riparian plantings would provide shading, detrital input, and contribution of woody debris outside of the construction footprint. Using these areas, the total restored area would be approximately 47.37 acres.

The primary component of restoring off-channel habitat for juvenile fish is to create access to areas that have been cut off from river flow due to placement of fill, channel incision, or other geomorphological changes. In this instance, the primary feature is to excavate tidal channels in existing swales found in the interior of the site. Although tidal channels are the primary component, they do not provide all the features needed to support juvenile fish. Other habitat features (measures) are necessary to provide cover, forage, thermal regulation, and other variables that collectively contribute to an environment that will support juvenile fish. A healthy riparian zone is needed to provide shading, detrital input, LWD, edge cover, and to assist with sediment retention. Without a healthy riparian zone, fish in the side channels may find some refugia from high-flows in the mainstem, but the other features needed for the side channels to provide temporary rearing will not be present. Large wood is needed within the channels to moderate channel velocities, provide cover from predators, and create scour pools that may support small fish during low tides. Large wood is also needed along the edges of Kelley Point Park to support small fish by providing cover when the tidal channels are not accessible.

In the mainstem Willamette River, locations for high flow refugia needed to support juvenile salmonids is limited; laying back of bank slopes, placement of LWD, and riparian plantings are needed for this projects target species. Kelley Point Park has the potential to provide for this rare opportunity; in conjunction with these sites, it also provides for the off-channel habitat listed above and the combination of these measures would create a huge ecological benefit.

For the benefit of other target species and guilds that are likely present at this site, side channels may provide some benefits, but once the species are present, other habitat components are necessary to fully support them and their lifecycles. As an example, the western pond turtle relies on boulders by water or surrounded by water for haul out sites and mating, therefore side channels, while good for overall pond turtle habitat they do not provide the required habitat benefit that large wood/boulders would provide. Amphibians including salamanders and various frog species rely on healthy riparian areas that provide leaf litter and downed wood for cover and forage, in proximity to water sources.

In all of these cases, implementing only a single measure would not provide the habitat features needed to fully support these species. Excavating side channels and restoring riparian forest would more fully meet the habitat requirements of the target species, but would not provide the instream structure needed to support fish and turtles and other amphibians. Only by implementing all three restoration measures can the objectives at this site be met. Anything less than this combination of measures may initially attract these species, but if they do not find fully functioning habitat, partial implementation could prove to be detrimental to species that try to survive there.

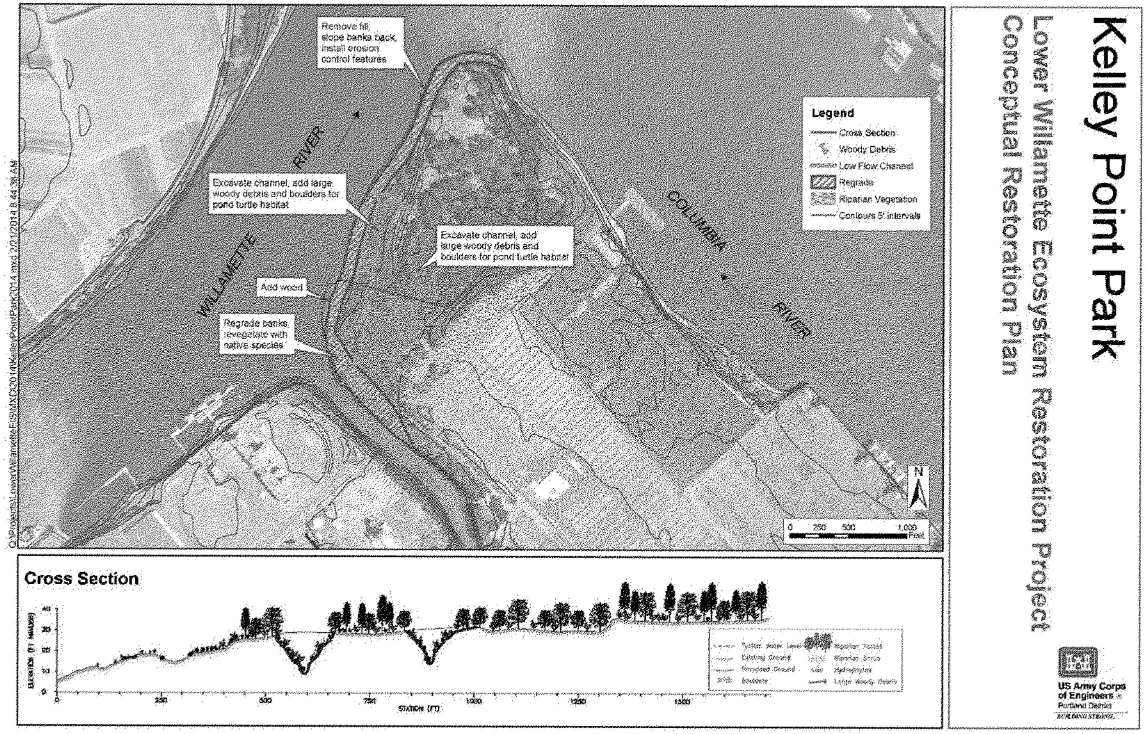

Figure 5-3. Kelley Point Park

Cathedral Park

Cathedral Park (Figure 5-4) is located on the east bank of the Willamette at RM 6 and is situated beneath the historic St Johns Bridge. It is a 23-acre park owned by the City of Portland. Currently, the site is a public park and green space with multiple uses. The project area encompasses 3.79 acres.

Cathedral Park's habitat complexity has been diminished due to its conversion to a park. Runoff is channelized and historic swales, which would have supported seasonal wetland habitat and stored stormwater runoff, have been converted to lawn; topographic features allow runoff to flow directly to the mainstem Willamette River. The historic riparian and wetland areas near the banks of the river have also been diminished or removed. 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.

Habitat components that would be created or restored at this site include ecosystem restoration of approximately 0.75 acre of riparian forest, 1.1 acres of created wetlands, grading to convert drainage into a swale where seasonal wetlands would form over approximately 0.75 acre, and addition of root wads along the Willamette River (area of influence approximately 0.5 acre). Additional benefits were assumed where restored riparian plantings would provide shading, detrital input, and contribution of woody debris outside of the construction footprint. Cumulatively, these improvements total approximately 3.79 acres.

The main objectives of implementing restoration measures at Cathedral Park are to take advantage of existing contours to restore wetlands for amphibian species and water quality; provide critical riparian habitat, which is lacking in this reach of the Willamette River; and to provide structure to shelter small fish during high-flow events.

Historically, the site on which Cathedral Park is now located supported off-channel wetlands in swales that gathered and retained storm runoff. Although the swale topography is still present, the swales have been drained and vegetation within them has been replaced by lawn and ornamental species.

Restoration of wetlands will provide aquatic habitat required by amphibians, species which would generally not enter a large water body such as the Willamette River. However, such species also require riparian habitat for cover once they leave the wetlands; to provide detrital input for food-web support; and to provide nesting and breeding habitat. For this reason, the actions of restoring wetlands and restoring riparian forest are interdependent. Implementing one action without the other would not provide the habitat characteristics necessary to support these species.

Since this reach of the Willamette River has been heavily industrialized, most of the riparian habitat and structure at the edge of the river has been removed. Fish and neotropical migrant bird species have little habitat for forage or cover. Therefore, the PDT recommended that LWD be added to the edge of the river in combination with restoration of riparian forest. Large wood jams or root wads will provide cover to fish during high flows, and the restored riparian forest is deemed necessary to contribute LWD over time, to provide detrital input, and to provide cover in addition to the large wood.

The PDT assessed the possibility of expanding the areas to be restored as wetlands and riparian forest, but this was deemed infeasible due to other uses of the site. Additional LWD was considered but the PDT determined that significant habitat benefits would occur by adding the amount of wood currently recommended, and the benefits of adding more wood would not be significant.

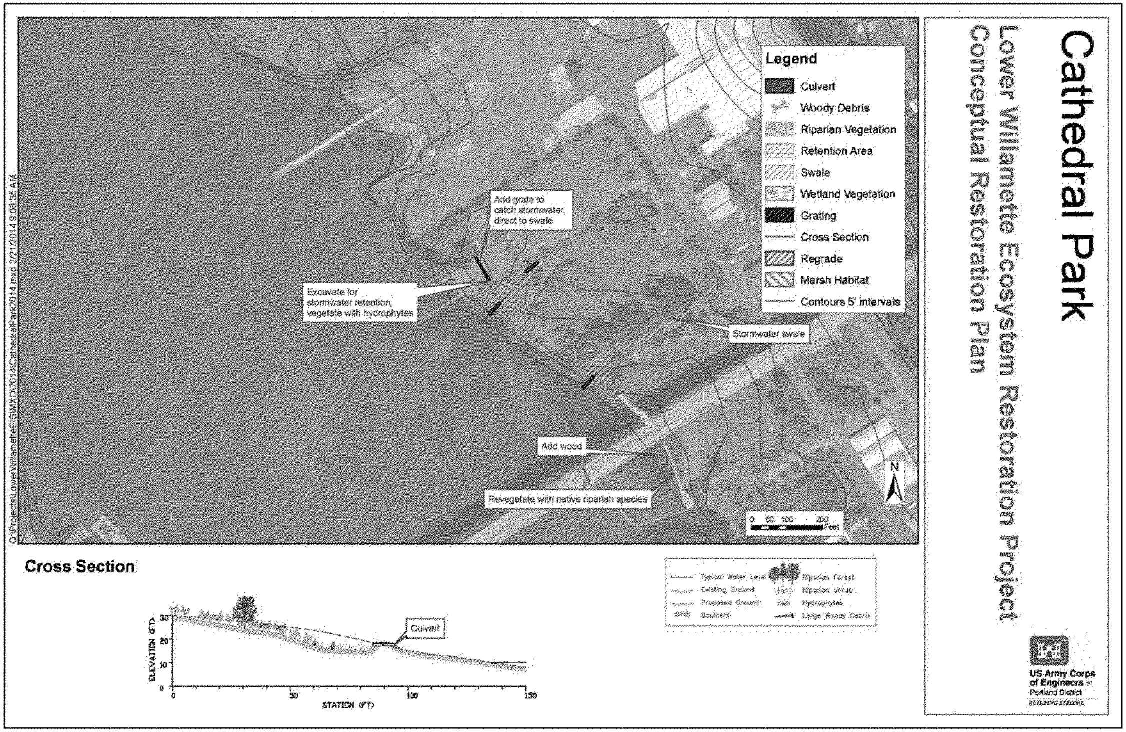

Figure 5-4. Cathedral Park

Saltzman Creek

The Saltzman Creek site (Figure 5-5) is located on west bank of the mainstem Willamette River at RM 8. The creek flows between two large areas of fill with a narrow corridor into the Willamette River. It is bordered to the west by a highly developed industrial area. Total project area is 5 acres with the area above ordinary high water in private ownership; below OHW the site is owned by Oregon Department of State Lands.

Saltzman Creek has been channelized and its banks have been drastically steepened by fill. It currently has no riparian area or wetlands, and virtually no habitat complexity. A small inlet off of the Willamette River at the mouth of Saltzman Creek would offer very good habitat for juvenile fish seeking shelter from the current in the mainstem thalweg, but the quality of this inlet is diminished due to its having little shallow water habitat preferred by juvenile fish. 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; and to restore shallow water habitat. The riparian zone would be restored and LWD would be placed at the confluence for habitat complexity and cover. Restoring the riparian zone would involve re-contouring the banks to a gentler gradient to prevent bank erosion, removing invasive species, and revegetating with native species.

Habitat components that would be created or restored at this site include 0.75 acre of invasive species removal and revegetation with native riparian species of existing habitat, creation of 0.5 acre of shallow water habitat, laying back the banks of Saltzman Creek and revegetating over 0.5 acre, and addition of root wads along the edge of the Willamette River and Saltzman Creek (area of influence of approximately 0.15 acre). Additional benefits were assumed where restored riparian plantings would provide shading, detrital input, and contribution of woody debris outside of the construction footprint. Cumulatively, these improvements would occur over approximately 5.0 acres.

The primary objectives of implementing restoration measures at the Saltzman Creek site are to support juvenile fish by providing off-channel stream habitat and enhancing shallow water habitat, and to restore critical riparian forest habitat in a stretch of the mainstem Willamette where such habitat is lacking. The Saltzman Creek site offers a rare opportunity for such restoration, given that it is effectively a cove that is protected from high flows of the mainstem and because a small tributary stream (Saltzman Creek) enters the river at this location.

Four primary restoration measures were proposed for this site. Those include grading banks to create shallow water habitat and to create bank angles that are gentle enough to allow establishment of riparian vegetation; addition of LWD; revegetation with native riparian species; and addition of sand and gravel to create proper substrate for juvenile fish to thrive. These measures are considered dependent on each other since the range of objectives at this site is narrow, and all of these measures are needed to meet the objectives.

Bank angles along Saltzman Creek are approximately 1:1, which is too steep to plant into and also too steep to support large riparian species, which are typical under normal conditions. Therefore, the measure of grading the banks is considered essential. Restoration of riparian and wetland habitat along the stream channel is considered essential to restoring habitat for fish along the available stretch of Saltzman Creek since the stretch now has virtually no riparian habitat and receives no shading, detrital input, contribution of LWD, or sediment stabilization or other critical riparian functions; and to provide habitat for neotropical migrant species, beavers, and amphibians.

The addition of LWD is necessary to shelter small fish in Saltzman Creek during high flows and to provide habitat diversity in what is now an impoverished stretch of stream; to moderate flows and reduce damage to the stream channel during high flows; and to provide cover for small fish in the shallow water habitat that will be enhanced at this site. Without addition of LWD, fish that may enter the cove at the mouth of Saltzman Creek, or enter the stream itself, will find habitat that is not suitable to fully support them during the key life stage during which they would likely be present.

The addition of sand and gravel at and below the waterline of the cove is necessary to improve substrate that will allow small fish to hide from predators, allow formation of benthic communities that will serve as prey species, and help to provide some hyporheic benefits to water quality. These qualities will attract small fish, but to retain them and provide the minimum habitat requirements for the target life stage, addition of LWD is needed immediately and contribution of LWD will be needed to sustain the habitat value over time, meaning that the long-term value of the site is dependent on establishment of a riparian zone.

The PDT assessed the possibility of scaling up the amount of shallow water habitat to be created and the amount of LWD to be placed, but found that since the primary site objectives could be met by enhancing a relatively small amount of shallow water habitat and adding the minimum amount of wood as specified in the proposed plan, increasing the scale of the measures would not significantly increase HEP scores.

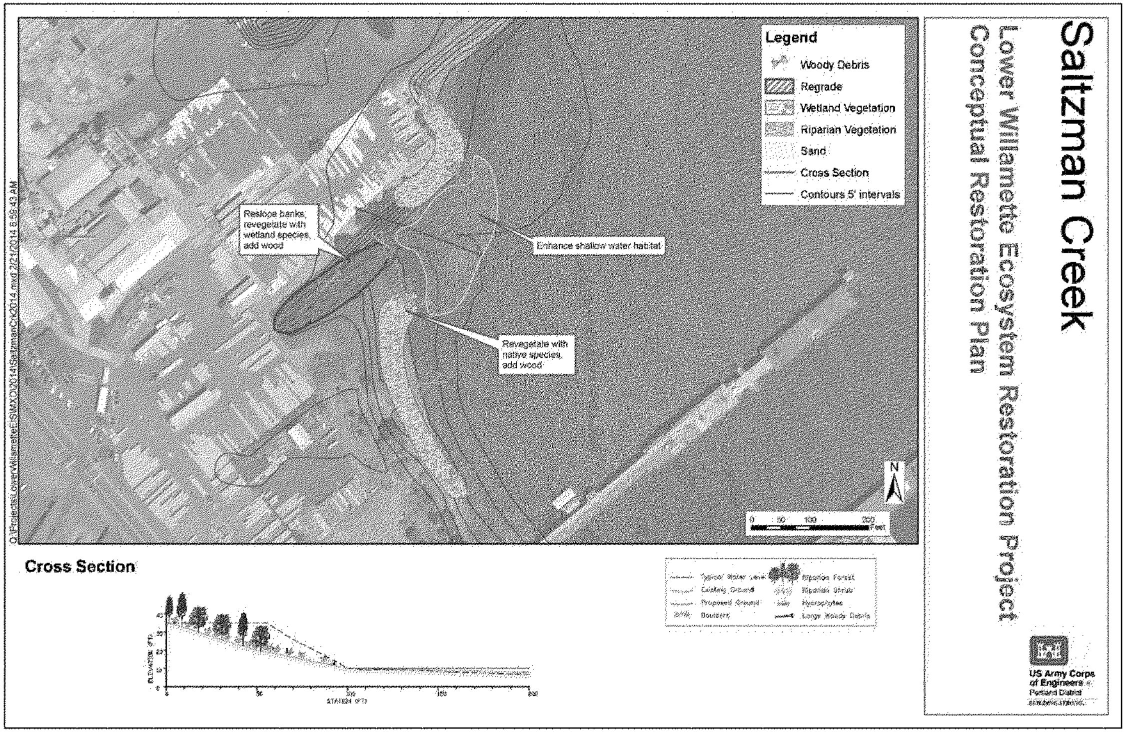

Figure 5-5. Saltzman Creek

Oaks Crossing/Sellwood Riverfront Park

The Oaks Crossing/Sellwood Riverfront Park site (Figure 5-6) is located on the east bank of the Willamette River at RM 16, within a multi-use park setting. Ownership is mainly the City of Portland, with METRO and a small parcel owned by the adjacent Oaks Park Association. The site is in close proximity to Oaks Bottom Wildlife Refuge and even though there is no hydrologic connection between these two sites, migration of amphibians and waterfowl is likely to occur between the two areas.

The former floodplain areas of the Lower Willamette have been significantly reduced in size and complexity. There are few opportunities to restore them since most of the floodplain areas have been developed. The Oaks Crossing/Sellwood Riverfront Park site offers a contiguous area of approximately 10 acres where off-channel habitat could be restored but has been cut off due to berms and changes to hydrology in the lower river. 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 for birds, amphibians, and other guilds that may access this site during various lifecycle stages. 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 large wood.

Habitat components that would be created or restored at this site include excavation of side channels, revegetation of wetlands and riparian forest, and installation of root wads along the Willamette River. Additional benefits were assumed where restored riparian plantings would provide shading, detrital input, and contribution of woody debris outside of the construction footprint. Cumulatively, these areas total approximately 10 acres.

At this site, benefit scoring assumed that existing off-channel wetlands and ponds would be connected to the river by excavating side channels. In addition to providing access to the existing off-channel areas, the side channels themselves are intended to rearing habitat and high-flow refugia for juvenile fish. Similarly to Kelley Point Park, side channels alone only provide partial habitat value, and structure is needed within the channels to moderate flow velocity, provide cover from predators, and diversify substrate conditions. Therefore, the PDT determined that it was necessary to add LWD to the side channels. Since this area is within the tidal zone, the side channels may be inaccessible during very low tides so some addition of LWD on the edge of the Willamette River was also deemed necessary to provide refugia from river currents if juvenile fish are forced out of the side channels into the mainstem Willamette River. Additionally, a functional riparian zone is needed to provide cover at the edge of the channels, contribute detritus and LWD, and provide shading. Collectively, these three measures will provide the habitat features needed to support juvenile fish, but implementation of any one or two of them would only partially meet the objectives at this site.

The lengths of the side channels recommended at this site are largely due to the need to excavate far enough to access the off-channel wetlands and to take advantage of existing contours. The extent of riparian revegetation was determined based on the need to provide shading, leaf litter, downed logs, and detrital input across the side channels and wetlands, and across areas that would normally support salamanders and neotropical migrant birds.

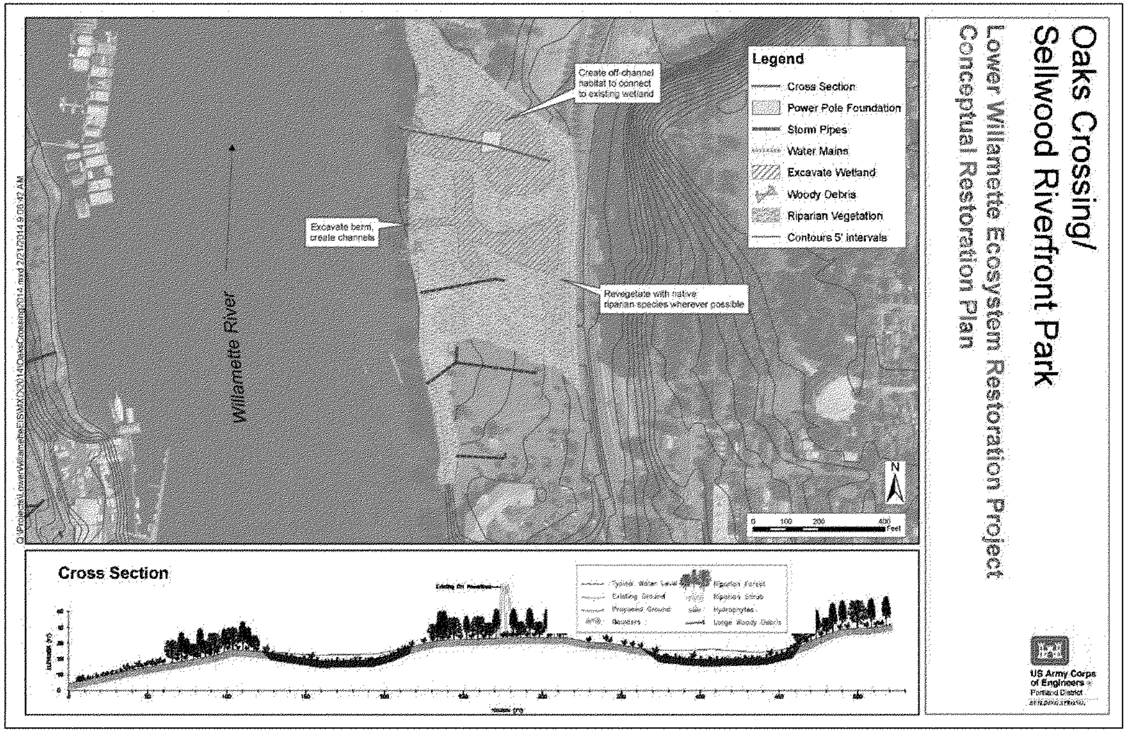

Figure 5-6. Oaks Crossing/Sellwood Riverfront Park

5.4.3. Columbia Slough Sites

Columbia Slough enters the Willamette River at RM 1 and runs east paralleling the Columbia River. It is a narrow waterway about 19 miles long in the floodplain of the Columbia River and is a remnant of the historic wetlands between the mouth of the Sandy River to the east and the Willamette River to the west. Levees surround much of the main slough and tidal fluctuation causes reverse flow on the lower slough which is where the following three sites are located.

St. Johns Landfill Boat Launch

St. Johns Landfill Boat Launch (Figure 5-7) is located on the west bank of the Columbia Slough at RM 3 from its confluence with the Willamette River. The ramp located here provides for kayak and canoe launching to access the slough and the nearby Smith and Bybee Lakes wetlands. The entire site borders an industrial area and reclaimed landfill. Most of the property is owned by METRO and the City of Portland with a few private ownership parcels. The restoration site at this location is 7 acres.

Columbia Slough, on which this site is located, has been disconnected from its floodplain in many locations by placement of fill on the banks. Fish and aquatic wildlife in Columbia Slough have little off-channel habitat, as is needed during various life stages. This site is currently undeveloped and offers an opportunity to create off-channel wetland habitat. Although marshy habitat exists at the site, it is of poor quality. Similarly to the proposed BES Plant site, the measures proposed for the St. Johns Boat Launch site are intended to restore off-channel habitat and shallow water habitat for juvenile fish and improve habitat conditions for amphibians, beavers, songbirds, and waterfowl. Measures proposed at this site include bank laybacks, installation of LWD, riparian and wetland revegetation, and excavation of sediments to restore off-channel wetlands.

Habitat components that would be created or restored at this site include bank layback and riparian revegetation along approximately 1,100 linear feet of Columbia Slough (1.3 acres), addition of root wads at the edge of Columbia Slough (area of influence approximately 1.0 acre) , and excavation of approximately 0.5 acre of off-channel wetland habitat. Additional benefits were assumed where restored riparian plantings would provide shading, detrital input, and contribution of woody debris outside of the construction footprint. Cumulatively, these improvements would occur over approximately 3.10 acres.

The success of these measures is largely dependent on the implementation of the other measures. Restoring off-channel habitat by excavating sediments is necessary to provide juvenile fish with high-flow refugia and to provide turtles and amphibians with accessible aquatic habitat in proximity to riparian vegetation. Restoring aquatic habitat for amphibians would only provide part of the habitat they would need to complete their lifecycles; without access to leaf litter, downed logs, and other riparian functions, the action of restoring aquatic habitat would be only of moderate value. Likewise, restoring off-channel habitat for juvenile fish would be of moderate value for juvenile fish in and of itself, but is of high value when combined with actions to create shallow water habitat and structure to allow juvenile fish to survive when tides are low and the off-channel habitat is inaccessible. Revegetation with riparian species in the bank layback areas is necessary to complete the habitat needs of juvenile fish, and will create overhanging vegetation needed by fledging wood ducks. Without restored riparian forest, newly-restored shallow water habitat will not have detrital input, long-term contribution of woody debris, and provision of shade needed to sustain habitat quality for fish, amphibians, and birds.

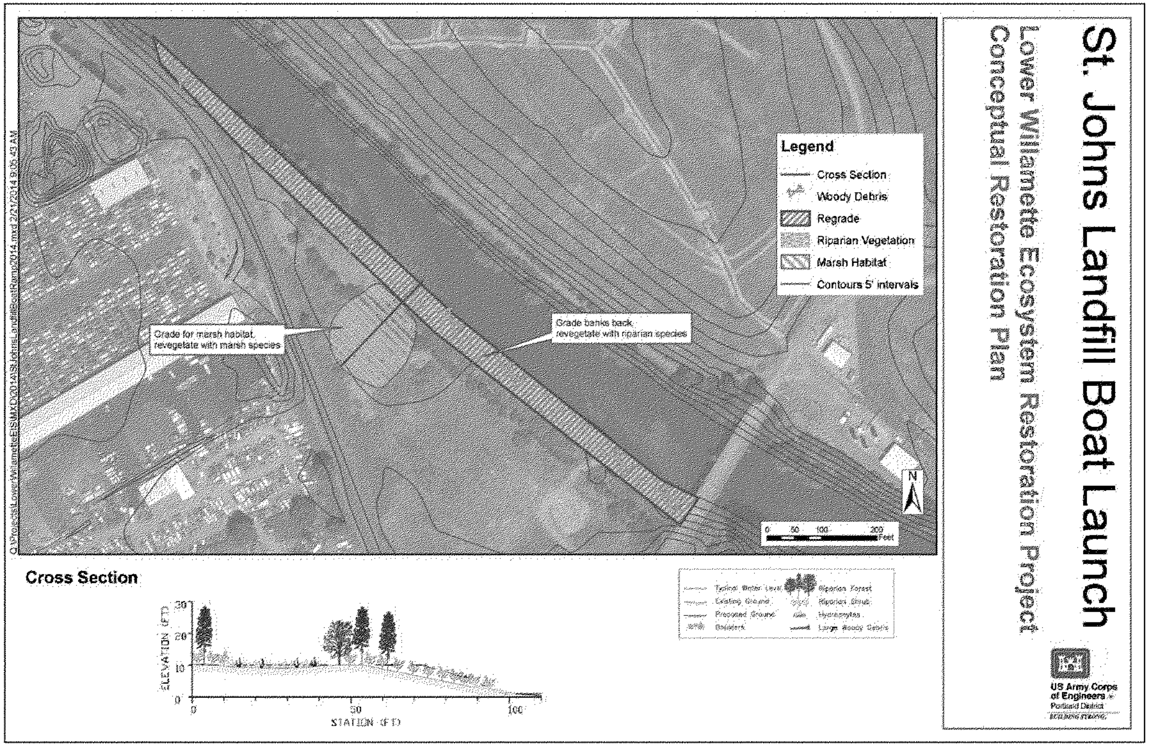

Figure 5-7. **St. Johns Landfill Boat Launch**

BES Plant

The BES site (Figure 5-8) is located on the west bank of the Columbia Slough at RM 5 from its confluence with the Willamette River. The site consists of a City-owned trail and park that parallels the slough. The property is owned by Multnomah County and the City of Portland. The restoration site at this location is 11.6 acres.

The BES Plant site has been altered from historic conditions by placement of fill, including an access road and culvert which have isolated it from Columbia Slough. The banks along the slough at this location have been steepened by placement of fill, reducing shallow water habitat and diminishing its riparian zone. The intent of this project is to excavate a more frequent connection to a floodplain backwater/swale area and restore the riparian zone along the slough. Steepened bank slopes would be reduced and LWD 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 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 LWD and boulders near the mouth of the channel between the slough and the low swale.

Habitat components that would be created or restored at this site include banks that would be laid back along the Columbia Slough, riparian plantings at the bank lay back location, reconnection of a wetland area and surrounding riparian area, creation of an alcove for high flow, and addition of root wads along the Columbia Slough and boulder placement. Additional benefits were assumed where restored riparian plantings would provide shading, detrital input, and contribution of woody debris outside of the construction footprint. Cumulatively, these areas of restored habitat totaled approximately 11.6 acres.

This site is located on Columbia Slough, where the key factors that limit habitat value for fish and other target guilds are lack of shallow water habitat on the slough itself and off-channel refugia. Bank angles are too steep for turtles and amphibians to access the water and then return to the riparian zone where they may find cover in leaf litter and downed trees. An existing swale cut off from the slough can easily be made accessible to fish, turtles, and amphibians by removing a small culvert and berm at the edge of the slough. However, the swale contains no structures that would provide cover for fish or haul out sites for turtles, and there is little riparian canopy around the swale. Therefore, simply reconnecting the swale to the slough hydraulically would only provide a portion of the off-channel habitat needs of these species. Large wood and boulders need to be installed to provide haul out sites and cover, and riparian forest is needed to contribute detritus and large wood to maintain habitat value over time. Therefore, restoring flow to this swale by itself would only provide partial habitat value, while adding large wood and boulders and restoring riparian habitat will provide little benefit if flow is not restored to this swale.

Shallow water habitat would be provided by laying back the banks of the slough, and excavating a small alcove to a level near the normal winter water surface elevation. The amount of bank layback recommended is relatively minimal compared to the available area in which this measure could be implemented. However, the PDT determined that the amount of shallow water habitat created or restored by implementing this measure at the scale recommended would be sufficient to support populations of juvenile fish, assuming that large wood would be added throughout the bank layback area. In this case, the habitat benefits calculated at this site were based on the assumption that laying the banks back was sufficient to create the additional shallow water area, but shallow water in itself is not sufficient to support these fish. Likewise, adding LWD to a near-vertical bank will do little to support small fish, but will be very effective if implemented in combination with creation of shallow water.

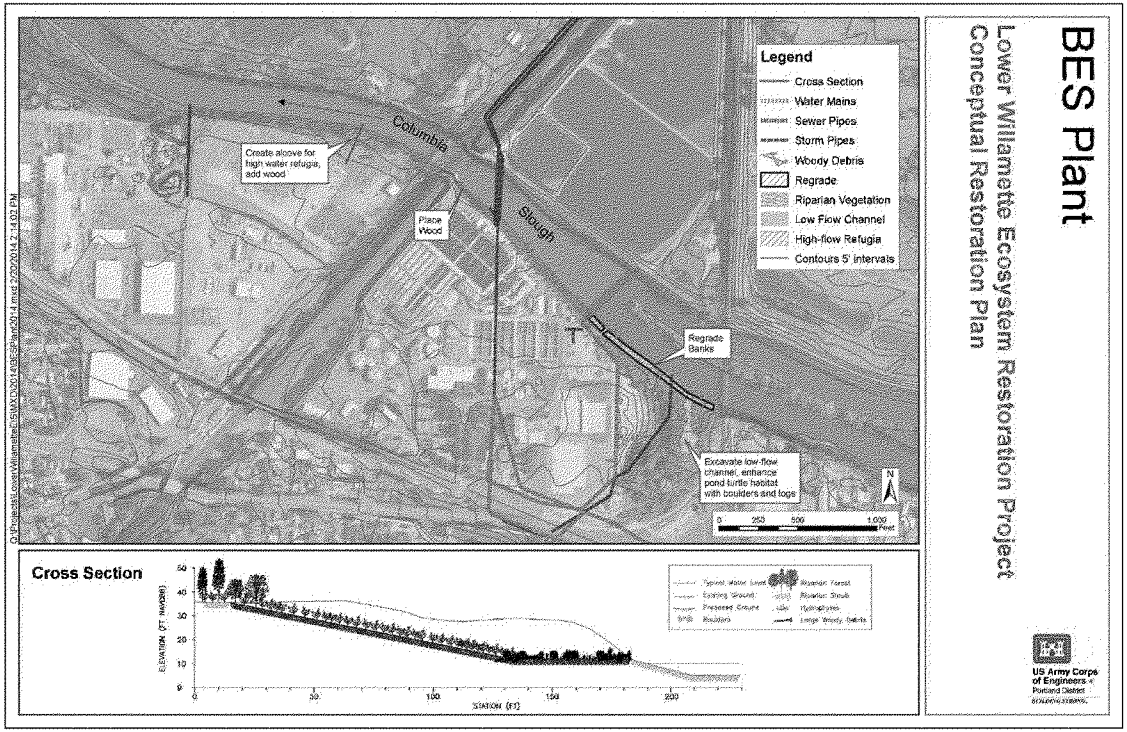

Figure 5-8. BES Plant

Kenton Cove

The Kenton Cove site (Figure 5-9) is located on the east bank of the Columbia Slough at RM 7. It is bounded by Interstate 5 and Portland International Raceway. The site consists of open channel cove connecting to the slough. The property is owned by the City of Portland and small portion is in private ownership. The restoration site at this location is 3.1 acres.

Kenton Cove offers refugia from high-flows due to its location off of Columbia Slough. However, there is no habitat complexity within the cove due to historic efforts to remove woody debris, and the riparian zone which once allowed for contribution of wood to the cove and other functions has been removed. In this condition, it offers low-quality habitat for juvenile fish, birds, and aquatic wildlife. The intent of this alternative is to increase complexity with LWD, 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 wood cluster, with the wood as the centerpiece of the habitat island.

Habitat components that would be created or restored at this site include a restored riparian zone, creation of wetland islands, and enhancement of shallow water habitat. Installation of root wads and a mixture of sand and gravel will create wetland islands, enhance shallow water habitat, and create a safe zone for juvenile fish. Additional benefits were assumed outside of the construction footprint due to shading, detrital input, and contribution of woody debris provided by the restored riparian zone. Cumulatively, these features total approximately 5.9 acres.

For Kenton Cove, placement of LWD substrates would not cause induced flooding of neighboring commercial properties because this is a backwater slough area and the addition of LWD substrates are considered to be inconsequential given the conveyance of the water storage in this area (refer to Appendix C for the analytical data).

Habitat value at Kenton Cove is impoverished due to lack of structure and diversity within the aquatic area and lack of functions that would normally be provided by an intact riparian forest. These functions include detrital input, shading, and contribution of woody debris over time.

Addition of large wood and enhanced substrate around the large wood will attract and shelter juvenile fish, but in order for the habitat at this site to fully support juvenile fish over time, a restored riparian forest that contributes detritus and large wood, and provides shading, is necessary. The minimum amount and scale of large wood determined by the PDT as being necessary to provide a measurable degree of aquatic habitat complexity at this site was recommended, and since the width of the area around the cove that would be restored with riparian forest is much narrower than what is normally recommended for a riparian zone on western streams, the entire width available was deemed necessary for revegetation. Without restoration of the riparian forest around the cove, HEP scores for future with-project conditions would be lower. Without addition of LWD and varied substrate, the instream habitat would continue to be impoverished, so fish that would normally benefit from the measure of restoring riparian forest would not likely stay in the area to begin with. In either case, eliminating any restoration measure from this site would provide only partial habitat value for the target species and would not support key life stages.

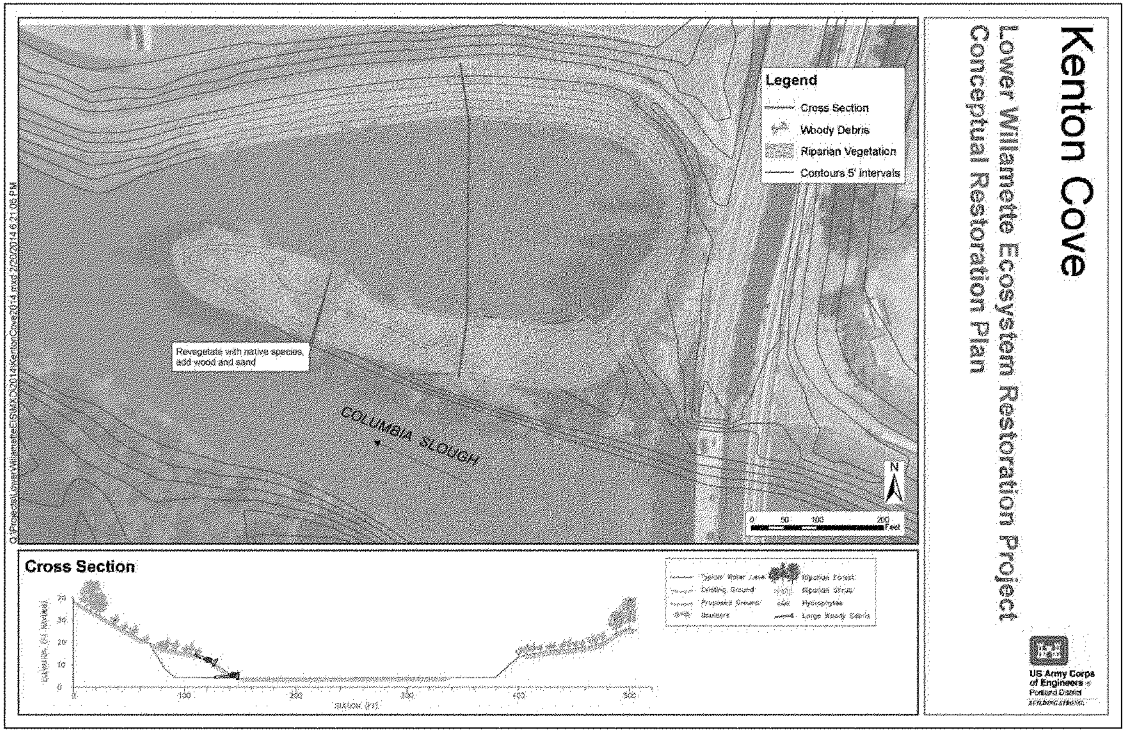

Figure 5-9. Kenton Cove

5.4.4. Tyron Creek Sites

Tryon Creek Highway 43

The Tryon Creek Highway 43 site (Figure 5-10) is located on the west bank of Willamette River at RM 20. The Tryon Creek reach includes an area ¼ mile upstream of the confluence with the Willamette River upstream to Marshall Park, above which the headwaters are highly developed. Although the primary restoration action on Tryon Creek will occur where Tryon Creek passes beneath Highway 43, near the mouth, the proposed action at this site will allow fish access to the rest of the stream up to Marshall Park and Arnold Creek. The property is owned by the City of Portland, City of Lake Oswego, METRO, State of Oregon, and a small portion is in private ownership. The restoration site begins downstream of the existing culvert and extends upstream about 2.7 miles.

The Tryon Creek Highway 43 site offers extensive spawning and rearing habitat that is very rare in Lower Willamette River watershed. This stream was once a highly productive anadromous fish habitat, but with the installation of a four hundred foot long, 8-foot by 8-foot box culvert in the 1930's this has become a full barrier to fish passage under most conditions. There is extensive public interest in restoring fish passage to this area, and some small-scale projects have been implemented to address this issue, with little success. The intent of this project is to replace the culvert under Highway 43 and the railroad line. 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 Tryon Creek State Natural Area, where high quality fish habitat remains. The culvert designs are consistent with the State of Oregon's fish passage criteria based on the stream simulation option for an open-bottomed, road-stream crossing structure (OAR 2013a); this criteria was used as a guideline for design. Hydraulic models have been performed for existing and proposed conditions, and indicate that the water depths and velocities predicted inside of the proposed culvert fall within the range of the surrounding stream. The hydraulic models also indicate that, due to a gentler slope within the culvert and addition of bed roughening features, stream velocities will be reduced under median summer, median winter, and median annual flows. The complete hydraulic models are found in Appendix B and project drawings are in Appendix H.

Habitat components at this site include the stream bed and banks, and the riparian zone on either side of the stream. Habitat benefits would occur throughout the 2.7-mile stretch of stream found between the mouth of the Highway 43 culvert and the next fish barrier upstream. Based on multiple field visits and GIS mapping, the functional riparian zone including the stream bed and banks averaged approximately 150 feet wide. This width takes into account the active channel, the channel migration zone, and riparian forest on either side of the stream. This measure only includes the portion of the riparian zone that can reasonably provide shading, detrital input, and water quality benefits, and which will contribute LWD into the stream over time. Multiplying this width by the length of the reach that would become accessible to fish indicated that approximately 49 acres of habitat, which represents the area for functional value, would be restored by this action.

This is the last stream in the Portland area to be opened up. The Tryon Creek Watershed spans approximately 4,200 acres across two cities including 3,300 acres in Southwest Portland and 900 acres in Lake Oswego; it is the largest forested urban watershed in Oregon that can support anadromous and resident native migratory fish. Restoring fish passage to this watershed is vitally important to establish rearing habitat to ESA-listed species.

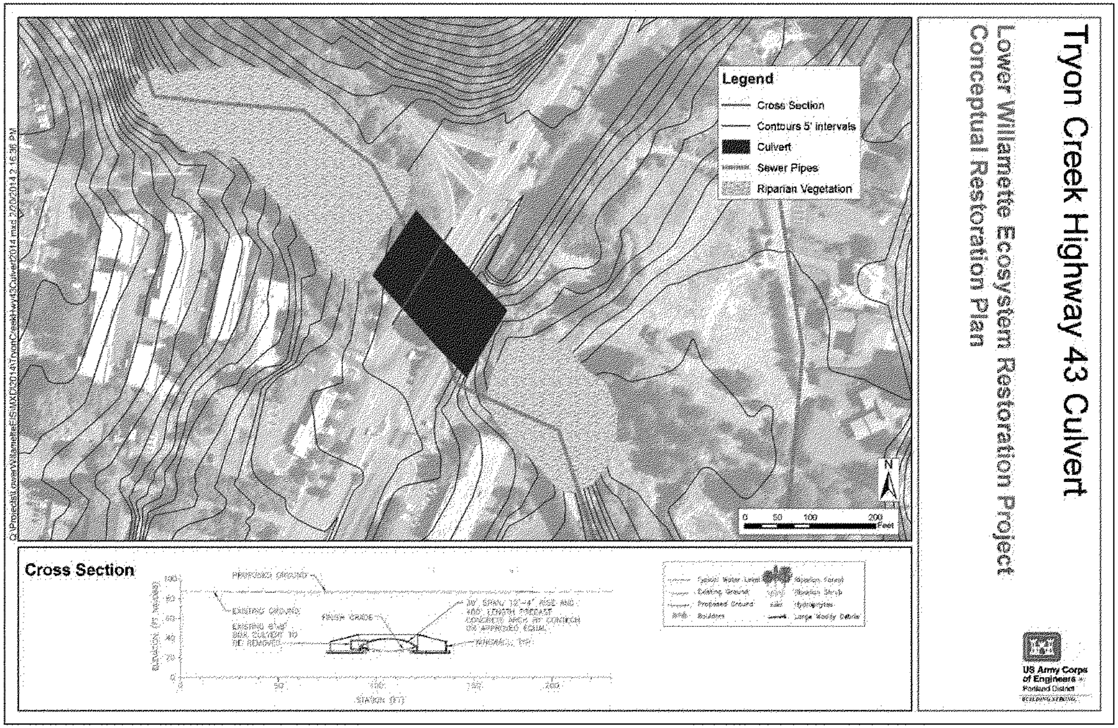

Figure 5-10. Tyron Creek Highway 43

5.5. EVALUATION OF FINAL PROJECT SITES

5.5.1. Final Array of Site Plans

Table 5-6 provides a summary of the ecosystem restoration measures at each of the final project sites, as well as the problems and objectives addressed.

Table 5-6. Ecosystem Restoration Measures for Final Sites

Site	Restoration Measures	Problems Addressed	Objectives Addressed
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 LWD	• 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.
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 LWD	• 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.
Saltzman Creek	• Create shallow water habitat • Install LWD • 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.
Oaks Crossing/Sellwood Riverfront Park	• Revegetate with native riparian and wetland species • Reconnect or create side channel or backwater features • Install LWD	• 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.
St. Johns Landfill Boat Launch	• Install LWD • 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.

Site	Restoration Measures	Problems Addressed	Objectives Addressed
BES Plant	• Reconnect or create side channel or backwater features • Install LWD • 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 LWD • Revegetate with native riparian and wetland species	• Loss of channel complexity • Reduction in nutrients and woody material	• Reestablish riparian and wetland plaut communities • Increase aquatic and riparian habitat complexity and diversity.
Tryon Creek Highway 43	• 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.

In order to evaluate potential ecosystem restoration alternatives for this study, and identify cost effective solutions, the PDT conducted a cost-effectiveness and incremental cost analysis (CE/ICA) to identify the best investment decision for the ecological output. The HEP model was used to quantify habitat benefits and estimates outputs to input into CE/ICA. Field reconnaissance were done at each site along with gathering other pertinent site information such as topography, soils and hydrology maps to determine the project objectives and associated measures that could be applied at the individual sites. Preliminary cost estimates were developed based on this information and standard unit costs and estimations for applying each measure using the following: area, length, width, density and potential depths of excavation. Preliminary estimates of costs to acquire fee title or easements on the land and the O&M for the life of the project were also incorporated. These cost estimates, 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, sub-Appendix C, *Preliminary Cost Estimate*).

5.5.2. 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. The HEP provides a measure of how each site plan performs with regard to planning objectives. 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 ecosystem restoration. Species with existing Habitat Suitability Indices (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 suitability index (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 ecosystem restoration sites is given in the HEP report, Appendix F. For the feasibility study the following six species or groups of species were used: 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 HEP rates habitat based on its potential to support each species or group of species during part of, or all of their lifecycle. This potential is reported as habitat units (HUs). Habitat units 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.

Typically, input variables were measured at multiple locations on the project site and then averaged to yield an overall percent canopy cover, diameter of trees, water depth, water velocity, number of pieces of downed wood, vegetation composition, or similar value. These measured variables were then assigned an SI value (unitless number from 0 to 1) based on the suitability curve or discreet suitability values or thresholds developed in the model. Acreages for the model were developed by mapping the area at each site where ecosystem restoration actions were both implementable and would affect habitat quality. In many cases, ecosystem restoration measures influence conditions beyond the construction footprint, and this increased area was included in the acreage tabulations. For example, riparian revegetation provides shading, detrital input, and woody debris beyond the immediate limits of construction.

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 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.

After developing the HEP model and developing preliminary cost estimates, each alternative was evaluated according to a 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 ecosystem restoration output and to provide information about whether increasing levels of ecosystem restoration are worth the added cost. The CE/ICA is a planning tool to help identify cost-effective plans which provide a certain level of 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 5.5.5.

5.5.3. Future Without-Project Condition Assumptions

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

- **Vegetation.** Riparian and wetland zones are dominated by invasive species which limits the habitat complexity and cover potential of the sites. Dominant invasive species that are present throughout the project area include Himalayan blackberries, English ivy and reed canarygrass. 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.** Large wood 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 large wood 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 mostly blocked as no other plans for removal/replacement exist.

5.5.4. With-Project Condition Assumptions

The assumptions used to establish the future with-project conditions of the ecosystem restoration sites after implementation of ecosystem 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 with the planting and re-establishment of native species. 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 ecosystem 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 large wood. 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 large wood 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 large

wood 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 (HSI) that the project was evaluated for was tributary salmonids. It is not assumed that additional ecosystem 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 ecosystem restoration.

Table 5-7 summarizes the scores under existing conditions and after ecosystem 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 5-7. HSI Scores for Existing Conditions and After Ecosystem Restoration

Project Site	Existing HSI (No Action)	HSI After Ecosystem Restoration (11-50 years) (With Project)	Habitat Benefit Acres	Real Estate Acres Required
Mainstem Willamette River				
Kelley Point Park	0.48	0.86	47.37	47.37
Cathedral Park	0.40	0.61	3.79	3.79
Saltzman Creek	0.37	0.69	5.00	5.00
Oaks Crossing/Sellwood Riverfront Park	0.44	0.73	9.97	9.97
Columbia Slough				
St. Johns Landfill Boat Launch	0.29	0.54	7.0	7.0
BES Plant	0.41	0.70	11.6	11.6
Kenton Cove	0.40	0.60	5.9	3.1
Tryon Creek				
Tryon Creek Highway 43	0.00	0.82	49[1]	2.7

[1] This represents the area for functional value.

5.5.5. Cost Effectiveness and Incremental Cost Analysis

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. A CE/ICA was performed using the Institute for Water Resources (IWR) Planning Suite software version 1.0.11.1. The analysis was conducted in the following steps:

1. Tabulate average annual cost and average annual environmental outputs of each ecosystem 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 (AAHU). It provides an interface where the habitat output for a site is entered for multiple years of the period of analysis. The software plots these points as a curve and computes the AAHUs. 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 AAHUs. These AAHUs are then inputs to the CE/ICA module of IWR-Plan.

For each site, both future without-project, and future with-project AAHUs were calculated within the Annualizer. Then, in Excel, the difference between the future without and future with AAHUs was calculated to yield the net AAHU value for each site which was used in the CE/ICA.

To calculate the AAHUs in the Annualizer, three HU control points were used: the existing HUs (year 0), the HUs in year 5, and the HUs 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.

5.5.6. Costs/Output

This section summarizes the cost estimates and environmental output estimates associated with implementation of ecosystem restoration measures at each of the ecosystem restoration sites. The cost estimates, are summarized in Table 5-8 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 percent 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 percent of construction costs, including site preparation markups.
- **Operations and Maintenance (O&M).** This cost item includes inspections, maintenance, revegetation, replacement, and operations, and was estimated at 9 percent 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 (Chapter 10).
- **Monitoring.** This cost item includes development of site specific monitoring plans, annual monitoring surveys, and annual reporting, and was estimated at 1 percent 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 Chapter 10.
- **Generalized Costs Associated with Real Estate Acquisition, Easements, or Rights of Way.** Real estate costs are from the Baseline Cost Estimates for Lands, Easements and Right-Of-Ways, and relocations summarized in Appendix I.
- **Interest During Construction (IDC).** The IDC and annualization calculations were performed using the FY 2013 rate of 3.375 percent. The IDC was not applied to the initial cost estimate, but was added to the cost as a component of the CE/ICA.

It was assumed that construction would be completed at all sites in a 12-month period, except at the Tryon Creek Highway 43 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 ecosystem restoration site. Table 5-8 summarizes the cost and 50-year output estimates for ecosystem restoration at each of the sites in the final array of site plans.

Table 5-8. Cost and Output of Ecosystem Restoration by Project Site

Site	Average Annual Costs (AAC) ($)	AAHUs	Net Present Value (NPV) Cost ($)	Total HUs
Kelley Point Park	$354,975	14.93	$13,030,000	804.58
Cathedral Park	$50,873	0.74	$1,141,317	36.92
Saltzman Creek	$25,325	0.59	$568,143	29.43
Oaks Crossing/Sellwood Riverfront Park	$29,027	2.69	$1,263,000	134.58
St. Johns Landfill Boat Launch	$46,940	0.69	$1,053,078	34.65
BES Plant	$25,946	1.69	$3,756,000	84.68
Kenton Cove	$10,311	1.00	$725,000	50.10
Tryon Creek, Highway 43	$642,666	39.65	$11,000,000	1982.65

For the final 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.

For each site, the PDT developed the minimum measures that would be needed to register a meaningful change in the HEP scores. The PDT then looked at additional measures that could be implemented at each site, and found that implementing them would lead to diminishing returns, and would not be effective from a biological and economic standpoint. At each of the sites in the final array of site plans, each of the recommended measures is designed to be combined with other measures to meet the objective or objectives that will be addressed at that site. For example, at the Oaks Bottom site, if the wetland ecosystem restoration component were implemented but construction of swales to allow fish to access the restored wetland was not included, then 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 measures recommended in this report 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 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 ecosystem restoration would not have substantially helped to meet the objectives and were not recommended for this site.

Measures recommended at each site are dependent on each other to restore the range of habitat values that each site offers, and, cumulatively, to achieve ecosystem restoration of habitat components on a watershed scale. As an example, at the Kenton Cove site, addition of large wood and enhanced substrate around the large wood will attract and shelter juvenile fish. The minimum amount and scale of wood determined by the PDT as being necessary to provide some degree of habitat complexity at this site was recommended, but it is assumed that in order for the habitat value at this site to reach its full potential as modeled in the HEP, additional wood would be contributed by the restored riparian area around the cove, and detrital input from the riparian canopy would increase as the restored riparian forest matures. Without ecosystem restoration of the riparian forest around the cove, HEP scores for future with-project conditions would have been lower. At the BES Plant site, laying back steepened banks along Columbia Slough is considered necessary to provide shallow water habitat and to provide a suitable base for revegetating with riparian and wetland species. Excavating a channel to what is now an inaccessible swale would allow fish access to the swale, but woody debris and revegetation is needed to provide suitable habitat for fish that do access this site. In these instances, the PDT determined that these were the minimum measures that would be needed to make a measurable change in HEP scores, and although additional measures such as excavation of a larger off-channel ponded area were considered, they were not incorporated as they did not appear to offer cost-effective benefits.

5.5.7. Cost Effectiveness Analysis

The cost effectiveness analysis is the first step in the CE/ICA, and compares the 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, 41 plans were cost effective but not best buys, and nine plans were best buy plans, including the No Action (Table 5-9). The incremental cost analysis compares the rate of increase in cost and the rate of increase in output between the cost effective plans providing the least output to all other cost effective plans producing more output. The larger plan that provides the greatest increase in output for the least increase in cost is identified as the "best buy." Figure 5-11 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 AAC.

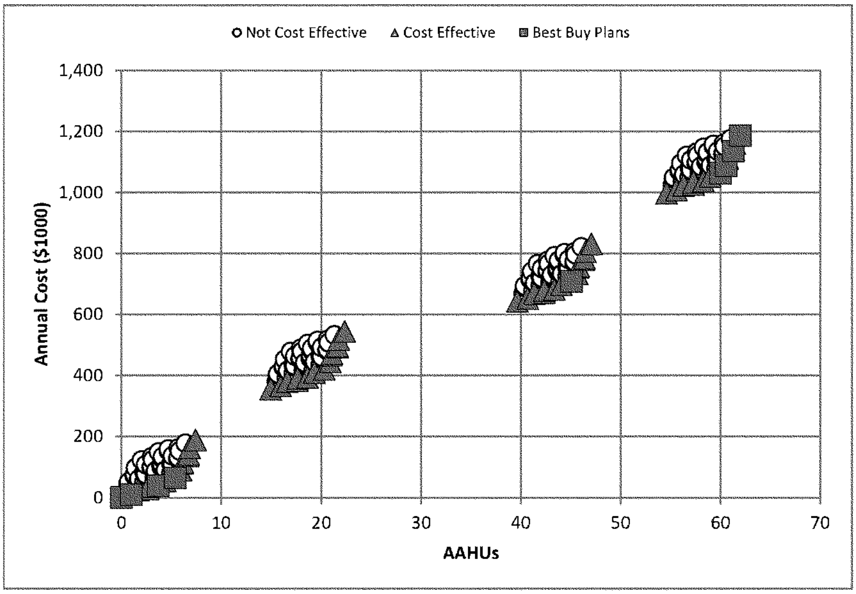

Figure 5-11. All Plans Summary – Annual Cost vs. Annual Output

Table 5-9. Cost Effective and Best Buy Plans

Plan Name	AAC ($)	AAHUs	Type
No Action Plan	$0	0.0000	best buy
B1	$10,311	1.0020	best buy
H1	$25,947	1.6935	cost effective
G1	$29,027	2.6915	cost effective
B1H1	$36,258	2.6955	cost effective
B1G1	$39,338	3.6935	best buy
G1H1	$54,974	4.3850	cost effective
B1G1H1	$65,285	5.3870	best buy
B1G1H1A1	$90,610	5.9760	cost effective
B1G1H1O1	$112,225	6.0800	cost effective
B1G1H1P1	$116,158	6.1255	cost effective
B1G1H1A1O1	$137,550	6.6690	cost effective
B1G1H1A1P1	$141,483	6.7145	cost effective
B1G1H1P1O1	$163,098	6.8185	cost effective
B1G1H1A1P1O1	$188,423	7.4075	cost effective
K1	$354,975	14.9300	cost effective
B1K1	$365,286	15.9320	cost effective
H1K1	$380,922	16.6235	cost effective
G1K1	$384,002	17.6215	cost effective
B1H1K1	$391,233	17.6255	cost effective
B1G1K1	$394,313	18.6235	cost effective
G1H1K1	$409,949	19.3150	cost effective
B1G1H1K1	$420,260	20.3170	cost effective
B1G1H1K1A1	$445,585	20.9060	cost effective
B1G1H1K1O1	$467,200	21.0100	cost effective
B1G1H1K1P1	$471,133	21.0555	cost effective
B1G1H1K1A1O1	$492,525	21.5990	cost effective
B1G1H1K1A1P1	$496,458	21.6445	cost effective
B1G1H1K1P1O1	$518,073	21.7485	cost effective
B1G1H1K1A1P1O1	$543,398	22.3375	cost effective
Z1	$642,666	39.6530	cost effective
B1Z1	$652,977	40.6550	cost effective
H1Z1	$668,613	41.3465	cost effective
G1Z1	$671,693	42.3445	cost effective
B1H1Z1	$678,924	42.3485	cost effective
B1G1Z1	682004	43.3465	cost effective
G1H1Z1	697640	44.038	cost effective
B1G1H1Z1	$707,951	45.0400	best buy
B1G1H1Z1A1	733276	45.629	cost effective
B1G1H1Z1O1	754891	45.733	cost effective
B1G1H1Z1P1	$758,824	45.7785	cost effective
B1G1H1Z1A1O1	$780,216	46.3220	cost effective
B1G1H1Z1A1P1	784149	46.3675	cost effective
B1G1H1Z1P1O1	805764	46.4715	cost effective
B1G1H1Z1A1P1O1	$831,089	47.0605	cost effective
K1Z1	$997,641	54.5830	cost effective
B1K1Z1	$1,007,952	55.5850	cost effective
H1K1Z1	1023588	56.2765	cost effective
G1K1Z1	$1,026,668	57.2745	cost effective
B1H1K1Z1	$1,033,899	57.2785	cost effective
B1G1K1Z1	$1,036,979	58.2765	cost effective
G1H1K1Z1	1052615	58.968	cost effective
B1G1H1K1Z1	$1,062,926	59.9700	best buy
B1G1H1K1Z1A1	$1,088,251	60.5590	best buy
B1G1H1K1Z1O1	$1,109,866	60.6630	cost effective
B1G1H1K1Z1P1	$1,113,799	60.7085	cost effective
B1G1H1K1Z1A1O1	$1,135,191	61.2520	best buy
B1G1H1K1Z1A1P1	$1,139,124	61.2975	cost effective
B1G1H1K1Z1P1O1	$1,160,739	61.4015	cost effective
B1G1H1K1Z1A1P1O1	$1,186,064	61.9905	best buy

Legend for Table 5-9

Project Site	Code
Kenton Cove	B
Oaks Crossing/Sellwood Riverfront Park	G
BES Treatment Plant South	H
Kelley Point Park	K
Tryon Highway 43 Culvert	Z
Saltzman Creek	A
Cathedral Park	P
St. Johns Landfill Boat Ramp	O

5.5.8. 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 ecosystem restoration at sites and combinations of sites relative to producing environmental outputs (in HUs).

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 5-10. Figure 5-12 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 5-10. Incremental Cost Analysis – Best-Buy Combinations of Project Sites

Plan Code	*Plan #*	*Description*	*Inc. AAC ($)*	*Inc. AAHUs*	*Inc. Cost per HU ($)*
No Action	1	No Action	$0	0.00	$0
B	2	Kenton Cove	$10,311	1.00	$10,290
B + **G**	3	Plan 2 + Oaks Crossing	$29,027	2.69	$10,785
B + G + **H**	4	Plan 3 + BES Treat. Plant South	$25,947	1.69	$15,322
B + G + H + **Z**	5	Plan 4 + Tryon Hwy 43 Culvert	$642,666	39.65	$16,207
B + G + Z + H + **K**	6	Plan 5 + Kelley Point Park	$354,975	14.93	$23,776
B + G + Z + H + K + **A**	7	Plan 6 + Saltzman Creek	$25,325	0.59	$42,997
B + G + Z + H + A + K + **O**	8	Plan 7 + St. Johns LF/BR	$46,940	0.69	$67,734
B + G + Z + H + A + K + O + **P**	9	Plan 8 + Cathedral Park	$50,873	0.74	$68,887

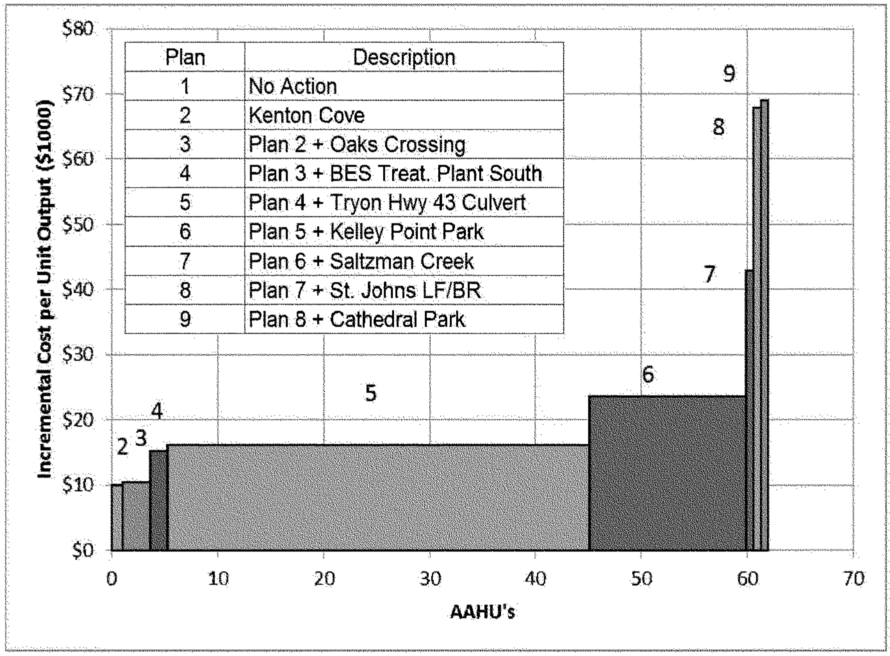

Figure 5-12. Best Buy Plans Incremental Cost Box Plots

5.6. RECREATIONAL BENEFITS

To maintain the same access opportunities throughout Kelley Point Park that exist today, the non-federal sponsor requested three pedestrian bridges be installed over the proposed side channels for the ecosystem restoration project at Kelley Point Park. The bridges have been classified as recreational features, as the bridges would allow for safe fish and wildlife viewing and other territorial views. The bridges would also provide opportunities for recreators to remain on pathways to avoid potential degradation and damage to the surrounding habitat supporting the ecosystem restoration project. Currently, the public has full opportunities to use either asphalt or gravel pathways throughout the park to access the river frontage of either the Willamette or Columbia rivers. There are six picnic sites and two restrooms serving visitors to the park. Some recreators use the park to launch small personal craft, such as canoes and kayaks, while others use the park for swimming and wading along the shoreline. A viewpoint exists at the confluence of the Willamette and Columbia rivers, near the location of a former lighthouse that once served the area. It is estimated approximately 2,000 lineal feet of river frontage would be lost to existing recreational opportunities should the proposed pedestrian bridges not be built. Moreover, approximately 1,000 feet of gravel pathway within the park would be lost due to construction of the three proposed side channels, thereby impairing access to two picnic areas. The following evaluation is based on a comparison of improved recreational experience as a result of the restoration project, which includes the construction of the side channels and installation of the pedestrian bridges in comparison to recreational opportunities without the bridges installed.

5.6.1. Methods

The benefits of recreation features are measured through approximation of a visitor's willingness to pay for the recreation resource. Willingness to pay is assumed to represent the economic value, in dollars, that a visitor places on recreation resources. Measuring the economic value of the recreation resource without the bridges first, then measuring with the bridges in place allows for the calculation of net recreation benefits due to construction of the recreational features.

The unit day value (UDV) method for evaluating recreation benefit was used for the recreational analysis of Kelley Point Park. When applying the UDV methodology, two categories of outdoor recreation days, general and specialized, may be differentiated for evaluation purposes (USACE, Economic Guidance Memorandum 15-03, Unit Day Values for Recreation, Fiscal Year 2015). The recreational opportunities and amenities available at Kelley Point Park both in the with- and without-project conditions fall under the "general" category. The general amenities available at Kelley Point Park include picnic tables, paved and unpaved paths, public art, restrooms, and a vista point.

5.6.2. Projected Visitation

No official visitor counts are available by activity for Kelley Point Park. However, coordination with representatives of PPR yielded sufficient data to characterize present and potential future use of the site. Because Kelley Point Park has been operational for quite some time and because it is located within an already densely populated urban area, significant visitation growth due to implementation of the proposed recreational features is expected to be small. Thus, visitation growth was estimated conservatively. Growth was estimated proportionally to projected population growth in the Portland area at 1.11 percent in both the without and with-project conditions. Projected growth rates were based on values published by the City's population and employment range forecasts and the U.S. Census Bureau statistics for the Portland Metropolitan area. For purposes of this recreation analysis, population growth was applied over the first 25 years of the period of analysis and then flat lined through the end of the period of analysis (2069). The base year is assumed to be 2019, when project benefits would begin to accrue.

5.6.3. Existing Project Condition

Three categories of users are defined for purposes of analysis: bird watchers and nature observers, school groups and events, and trail walkers. Although these categories of recreationists are not exhaustive for the types of users of the park, theses categories are representative of the types of users affected by the proposed recreational features. Existing amenities are assumed to remain the same for the life of the project. Based on discussions with park managers, a number of day use recreationists come from the industrial businesses within close proximity of the park to take advantage of the trails and vistas. There are no plans by the City for future development of the site. Based on best professional judgment and conversations with representatives from PPR, annual visitation for bird watchers and nature observers range from approximately 4,500 to 5,000 visits per year; for school groups and other event based groups, annual visitation is estimated to be 5,000 to 6,000 per year; and for trail walkers, usage is estimated to range between 9,000 to 10,000 visitors per year (Table 5-11).

Table 5-11. Existing Project Visitation Summary

User Group	Estimated Annual Visits (2019)	Estimated Annual Visits (2044)	Estimated Annual Visits (2069)	Average Annual Visits
Birders/Nature Observers	4,500 to 5,000	5,660 – 6,390	5,660 – 6,390	--
Groups/Events	5,000 to 6,000	6,290 – 7,100	6,290 – 7,100	--
Trail Walkers	9,000 to 10,000	11,320 – 12,780	11,320 – 12,780	--
Total	18,500 – 21,000	23,270 – 26,270	23,270 – 26,270	23,270 – 26,270

Note: Estimates for 2044 and 2069 are the same because population growth adjustment is capped at year 25.

5.6.4. Without-Project Condition (Without Bridges)

For purposes of analysis, the without-project condition assumes ecosystem restoration features (construction of side channels to restore ecosystem function) are constructed at the site; the following economic analysis will be based on whether or not the proposed recreational features (three pedestrian bridges) are economically justified for construction and installation.

If no bridges are constructed to maintain pedestrian access to the existing recreational opportunities within Kelley Point Park, the three categories of recreational users mentioned above are expected to decrease by approximately 30 percent due to construction of the proposed ecosystem restoration channels impairing access to areas within the park. Approximately one-third of the available river frontage and approximately 25 percent of the park would no longer be accessible as it exists today. Table 5-12 displays visitation estimates based on the areas of the park being cut off from recreational opportunities due to the proposed constructed side channels.

Table 5-12. Without (Bridge) Project Visitation Summary

User Group	Estimated Annual Visits (2019)	Estimated Annual Visits (2044)	Estimated Annual Visits (2069)	Average Annual Visits
Birders/Nature Observers	3,150 – 3,500	4,470 – 4,970	4,470 – 4,970	--
Groups/Events	3,500 – 4,200	4,970 – 5,960	4,970 – 5,960	--
Trail Walkers	6,300 – 7,000	8,945 – 9,940	8,945 – 9,940	--
Total	12,950 – 14,700	18,385 – 20,870	18,385 – 20,870	16,567 – 18,806

Note: Estimates for 2044 and 2069 are the same because population growth adjustment is capped at year 25.

5.6.5. With-Project Condition

Kelly Point Park currently is a woodsy, waterside area with picnic tables located at the confluence of the Willamette and Columbia Rivers. The abundance of water, cottonwood trees, and sandy beaches along the Willamette and Columbia Rivers makes this park a scenic treasure within Portland City Parks. People visit the park to relax along the sandy shoreline, swim, fish, launch personal craft such as canoes and kayaks, and view the natural beauty of two of the largest rivers in the Pacific Northwest merging.

Construction of the three proposed bridges will provide for a vastly different recreational experience than present day visitors experience. Along with admiring the expanse of the confluence of two large river systems, the proposed project with its new channels provide for other opportunities for the public to experience at this site. The ecosystem restoration project would increase the purpose for visitors to come to the park by providing bridges that not only allow historical access into the park but also will provide for viewing the newly created riverine vegetation along the new channel stream banks that will provide salmonid rearing habitat and also support a variety of other wildlife including pond turtles, amphibians, waterfowl, and beaver.

Visitation to Kelley Point Park is predicted to increase as a result of the proposed project features due to diversifying the recreational opportunities at the park, increased awareness of the park via City public relation efforts once construction is complete, population growth in the metropolitan area, on-going revitalization of the surrounding neighborhoods, and the continuing effort of local governments and organizations to connect surrounding recreational opportunities. Educational opportunities for school groups to learn about the interaction of a large river system and restoring old floodplain channels will make this site unique in the Portland area.

All user groups had growth in visitation applied in proportion to the projected population growth. Due to the particular attractiveness of the pedestrian bridges as viewing platforms for viewing nature, it was assumed visitation for bird watching and school groups would grow by an additional 5 percent per year for 5 years, and then level off after that. Table 5-13 summarizes visitation in the with-project condition for the years 2019 (base), 2044 (midpoint) and 2069 (last year of period of analysis). For purposes of being conservative in the visitation estimate in future years, the population is assumed to remain unchanged after 25 years of growth.

Table 5-13. With-Project Visitation Summary

User Group	Estimated Annual Visits (2019)	Estimated Annual Visits (2044)	Estimated Annual Visits (2069)	Average Annual Visits
Birders/Nature Observers	4,500 to 5,000	7,630 – 8,480	7,630 – 8,480	--
Groups/Events	5,000 to 6,000	8,480 – 10,180	8,480 – 10,180	--
Trail Walkers	9,000 to 10,000	15,270 – 16,960	15,270 – 16,960	--
Total	18,500 – 21,000	31,380 – 35,620	31,380 – 35,620	23,667 – 26,865

Note: Estimates for 2044 and 2069 are the same because population growth adjustment is capped at year 25.

5.6.6. Unit Day Value Scoring/Point Assignment

An interview was conducted by the Portland District with PPR staff to rate the recreation experience of Kelley Point Park for the future without-project and with-project conditions. Points were assigned to specified criteria and the points were tallied for each condition and compared. The points were then converted to a dollar value based on the FY 2015 unit day value conversion table (USACE, Economic Guidance Memorandum 15-03, Unit Day Values for Recreation, Fiscal Year 2015) and multiplied by an estimated annual visitation number in order to arrive at an annual economic benefit of the park.

Members of PPR were the primary experts chosen to participate in the assignment of UDV scores for the without- and with-project conditions. Two scores were created:

1. General recreation without project (with ecosystem restoration and without recreational facilities); and
2. General recreation with project (with ecosystem restoration and with recreational facilities)

The five UDV criteria from the Economic Guidance Memorandum for which points are assigned include the following items (Table 5-14):

1. Recreation Experience: Score increases in proportion to the number of available activities at the recreation site.
2. Availability of Opportunity: Score is based on availability of substitute sites; the fewer the sites in the region that offer comparable recreation experience, the higher the score.
3. Carrying Capacity: Score rates level of facilities at the site to support the activities.
4. Accessibility: Score rates ease of access to the site.
5. Environmental: Rates the aesthetic/environmental quality of the recreation site/activities.

Table 5-14. Guidelines for Assigning Points for General Recreation

Criteria	Judgment Factors				
Recreation Experience[1]	Two general activities [2]	Several general activities	Several general activities; one high quality value activity[3]	Several general activities: more than one high quality value activity[3]	Numerous high quality value activities; some general activities
Point Value:	0-4	5-10	11-16	17-23	24-30
Availability of Opportunity[2]	Several within 1 hr. travel time; a few within 30 min. travel time	Several within 1 hr. travel time; none within 30 min. travel time	One or two within 1 hr travel time; none within 45 min. travel time	None within 1 hr. travel time	None within 2 hr. travel time
Point Value:	0-3	4-6	7-10	11-14	15-18
Carrying Capacity[3]	Minimum facility for development for public health and safety	Basic facility to conduct activity (ies)	Adequate facilities to conduct without deterioration of the resource or activity experience	Optimum facilities to conduct activity at site potential	Ultimate facilities to achieve intent of selected alternative
Point Value:	0-2	3-5	6-8	9-11	12-14
Accessibility	Limited access by any means to site or within site	Fair access, poor quality roads to site; limited access within site	Fair access, fair road to site; fair access, good roads within site	Good access, good roads to site; fair access, good roads within site	Good access, good roads to site; fair access, good roads within site
Point Value:	0-3	4-6	7-10	11-14	15-18
Environmental	Low aesthetic[4] factors that significantly lower quality[5]	Average aesthetic quality; factors exist that lower quality to minor degree	Good access, good roads to site; fair access, good roads within site	High aesthetic quality; no factors exist that lower quality	Outstanding aesthetic quality; no factors exist that lower quality
Point Value:	0-2	3-6	7-10	11-15	16-20

[1] Value for water-oriented activities should be adjusted if significant seasonal water level changes occur.
[2] Likelihood of success at fishing and hunting.
[3] Value should be adjusted for overuse.
[4] Major esthetic qualities to be considered include geology and topography, water, and vegetation
[5] Factors to be considered to lowering quality include air and water pollution, pests, poor climate, and unsightly adjacent areas.
Source: USACE Economic Guidance Memorandum 15-03, Unit Day Values for Recreation, Fiscal Year 2015.

Scoring was based on the group of general recreation activities identified at the site that are relevant to the proposed recreation features, including nature and wildlife viewing, swimming and wading along the shoreline, the launching of small personal craft, picnicking, photography, etc. Table 5-15 summarizes the scores assigned. In the sections following the table, the rationale is provided for the point assignments according to the five UDV criteria.

Table 5-15. Unit Day Value Score Summary

Unit Day Value Criteria	General Recreation	
	Without Project	With Project
Recreation Experience	13	15
Availability of Opportunity	2	3
Carrying Capacity	5	8
Accessibility	12	15
Environmental	4	6
Total Score	36	47

Recreation Experience (30 possible points)

Without-project conditions = 13 out of 30; With-project conditions = 15 out of 30

Kelley Point Park has several general recreational activities such as picnicking, trail walking, wildlife viewing, swimming, use of small personal craft, and public art for recreationists. The without-project recreation experience falls a bit on the low side because of the park exists within an industrial portion of the city which is not as appealing nor accessible as other recreational opportunities located elsewhere within Portland; Kelley Point Park also does not provide amenities, such as a boat ramp, found at other parks providing access to the river. With-project conditions will likely move the recreation experience to a 15 due to the proposed pedestrian bridges adding a slightly higher quality value to the park experience. With slightly improved recreational experience, along with the increase in population over time, it is expected more people will visit the park.

Availability of Opportunity (18 possible points)

Without-project conditions = 2 out of 18; With-project conditions = 3 out of 18

This criterion scored low because of the park's location near several similar recreational opportunities within an hour's travel time and a few within a 30-minute travel time. The opportunity is slightly improved under the with-project conditions because of the additional environmental education component associated with the pedestrian bridges.

Carrying Capacity (14 possible points)

Without-project conditions = 5 out of 14; With-project conditions = 8 out of 14

The current conditions of Kelley Point Park offer basic facilities such as picnic tables and trails. So long as the pedestrian bridges are constructed and installed in the proposed locations, there is not an anticipated change in carrying capacity of the park between the with-project condition and the existing condition. However, the without-project condition assumes the proposed ecosystem restoration features are constructed and the recreational features (pedestrian bridges) are not constructed, resulting in the loss of approximately 2,000 lineal feet of beach front and approximately 1,000 lineal feet of existing gravel trails.

Accessibility (18 possible points)

Without-project conditions = 12 out of 18; With-project conditions = 15 out of 18

Kelley Point Park has excellent access with good roads to the site. The increase in value under with-project conditions is due to improvements that would be made to interior trails to enhance the recreational experience while protecting the vegetation serving to provide habitat for the ecosystem.

In the without-project condition, significant loss would occur without the bridges. With the bridges, the park will return to existing conditions.

Environmental (20 possible points)

Without-project conditions = 4 out of 20; With-project conditions = 6 out of 20

Currently, there is a lack of opportunity to view fish and fish habitat inside the park boundaries, except for the beaches along the Willamette and Columbia rivers. Due to the proposed side channels, these conditions are improved under the with-project condition because of the improvements in the quality of the habitat. With the side channels in place, the ability to see more diverse wildlife and fish actually would be an environmental improvement.

5.6.7. Unit Day Value Conversion

The total point score for general recreation at Kelley Point Park was 36 under without-project conditions and 47 under with-project conditions. This score was converted to a UDV using the UDV conversion table for general recreation values specified in the FY 2015 EGM (Table 5-16). Because the conversion table is broken into increments of 10, the general recreation values were interpolated to get an accurate conversion to the unit day value corresponding to the project's scores. The resulting UDV for the general recreation score was $6.74 without-project and $8.00 with-project. This UDV serves as an estimate of general recreational users' willingness to pay for one day's recreation at the site.

Table 5-16. Unit Day Value Conversion Table for General Recreation Values

Point Values	General Recreation Values
0	3.91
10	4.64
20	5.13
30	5.86
40	7.32
50	8.30
60	9.03
70	9.52
80	10.50
90	11.23
100	11.72

5.6.8. Expected General Recreation Benefits

The unit day value figures of $6.74 (without project) and $8.00 (with project) were multiplied by the annual visitation estimated range of 17,836 to 20,246 for the without-project condition and 25,480 to 28,923 for the with-project condition. This calculation results in an estimate of the annual value of the project area for with- and without-project conditions. The difference in the values for these two conditions is the additional benefit that the project would have on the project area. The annual value of the project area under the without-project condition ranges from $120,215 (low end of visitation projection) to $136,460 (high end of visitation projection). The annual value under the with-project condition is $203,841 (low end of visitation projection) to $231,387 (high end of visitation projection), which is a difference of $83,626 to $94,926 of additional recreational value per year.

The present values amortized over a 50-year period at the current federal discount rate for water resource projects of 3.125% range from $2,101,525 million to $2,385,513 million

5.6.9. as demonstrated in Table 5-17.Benefit Cost Analysis

Based on the results of the creation analysis, general recreational benefits would be between $2,101,525 and $2,385,513 in present value terms. The present value of first costs for the recreational features are estimated at $1,436,511. In this analysis, benefits exceed the cost at the federal discount rate using 3.125%. The benefit-cost ratio would range from 1.46 to 1.66 to 1. Based on the more conservative estimate the recreational features are expected to provide average annual benefits of $83,600 with average annual cost of $57,163 resulting in a benefit to cost ratio of about 1.46.

Table 5-17. Expected General Recreation Benefits

Annual Visitation Estimate	Unit Day Value	Annual Benefit	Present Value of Benefits	Annual Costs	Present Value of Costs	Benefit to Cost Ratio
Without Project Conditions						
17,836	6.74	$120,215	$3,021,012			
20,246	6.74	$136,460	$3,429,250			
With Project Conditions						
25,480	8	$203,841	$5,122,539			
28,923	8	$231,387	$5,814,773			
Difference Between Without and With-Project Condition to Calculate BCR						
7,644	1.27	$83,626	$2,101,525	$57,163	$1,436,511	1.46
8,677	1.27	$94,927	$2,385,513	$57,163	$1,1436,511	1.66

5.7. SELECTION OF THE NATIONAL ECOSYSTEM RESTORATION (NER) PLAN

Plan 6 was selected as the NER plan based on the total costs, the projects' distribution throughout the City's priority habitat areas and recreational benefits. It is also the City's preferred alternative. At all of these sites, ecosystem restoration efforts would complement previous or ongoing ecosystem restoration efforts implemented by the sponsors or other entities, and in the case of the Tryon Creek Highway 43 culvert project, ecosystem restoration of fish passage may provide the impetus for stakeholders to complete additional ecosystem restoration projects in the watershed above the culvert. Plans 7 to 9, although best buy plans, would offer minimal additional habitat benefits at a relatively high cost as compared to Plan 6.

5.8. RECOMMENDED PLAN

The Recommended Plan is Plan 6, which includes 5 site plans in the Lower Willamette Basin Watershed, as shown in Figure 5-12, Figure 5-13 and Table 5-10. This combination of ecosystem restoration sites has a total project first cost of $29,774,000 [using the Corps' Micro-Computer Aided Cost Estimating System (MCACES)], and provides an increase in habitat units from 1,627 under existing conditions to 3,057 habitat units over the 50-year period of analysis starting in 2018 and ending in 2068. An estimated 74 acres of riparian, wetland, shallow water, and backwater habitat, as well as 2.7 stream miles, will be restored under this plan. Descriptions of the recommended measures for each site are given below, and conceptual overview figures for proposed ecosystem restoration features at each site are included in Appendix G.

The Recommended Plan has an average annual cost of $1,062,000 and average annual cost per AAHU of $17,727. The 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.

Construction of the Tryon Creek culvert is the single item that most contributes to the high average annual costs. The costs associated with replacement of this structure are unavoidable due to the extensive overburden that would need to be excavated and replaced during construction, and because its location below a busy roadway and railroad line would require extensive traffic control and possible rail diversions. Coordination has occurred with Portland and Western Railroad and they have no objections to the temporary rail diversion. Replacement of this culvert would also offer the greatest degree of beneficial effects in terms of the number of habitat units that would be restored under this project. Furthermore, there is considerable public interest in replacing the culvert, due to the high-value fish habitat that would become fully accessible if it were replaced. This will benefit upstream project that are either pending or completed, Boones Ferry Culvert Replacement, Tryon Creek State Natural Area Habitat Enhancement, and Arnold Creek Culvert Replacement.

This project is a crucial component of efforts to restore habitat that has mostly disappeared from this watershed for use of 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 specific endangered species recovery, 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 5-6. These measures reflect the best and highest use of each site, and will achieve the objectives if all measures are implemented.

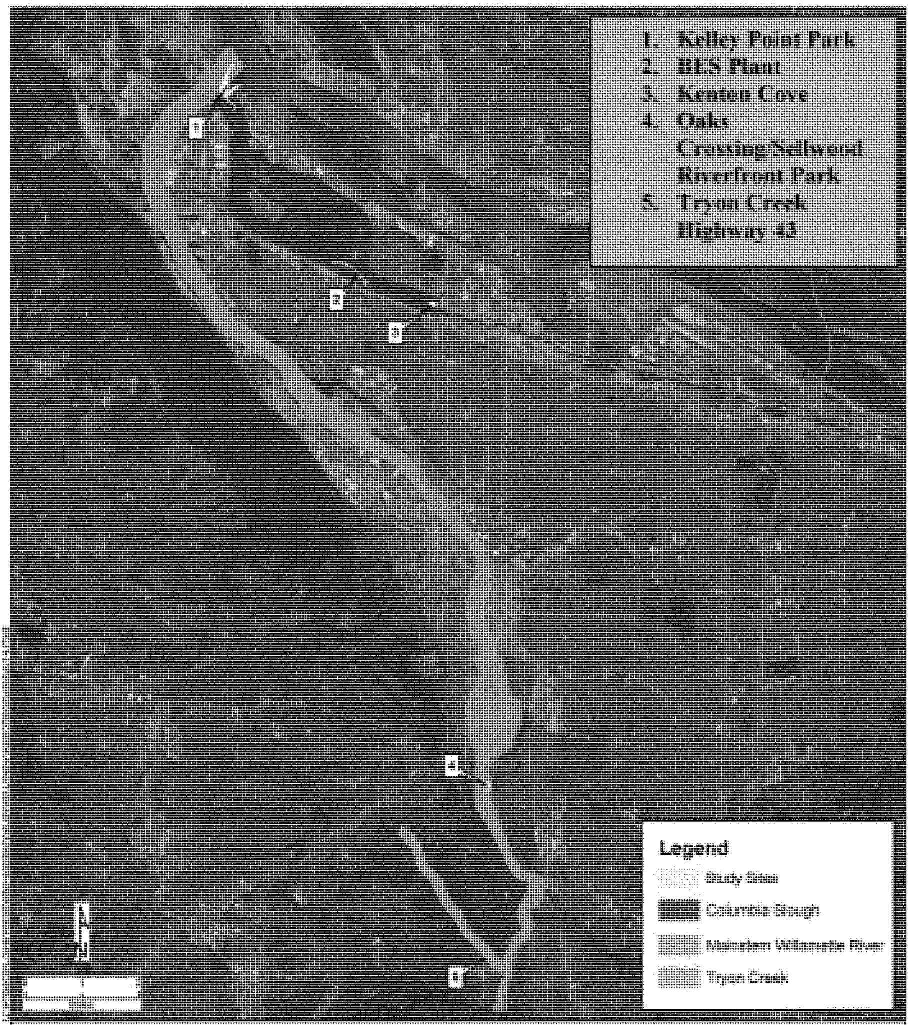

Figure 5-13. Ecosystem Restoration Sites Included in the Recommended Plan

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. Results of Hydrologic Engineering Centers River Analysis System (HEC-RAS) modeling and additional hydraulic analysis is provided in Appendix B.

Successfully completed ecosystem restoration project at the five sites included in the Recommended Plan would have the following features:

Kelley Point Park

- Excavate approximately 4,500 linear feet of tidal channels, with 10-foot bottom widths, sloping up at bank angles of 5H:1V to existing grade. Width of channel and riparian zone is estimated to be approximately 300 feet.
- Restore 16.9 acres of riparian forest by removing invasive species and revegetating with a mix of fast-growing and slow-growing native riparian trees and shrubs.
- Slope banks to a maximum 5H:1V slope along approximately 5,000 lineal feet of the Willamette River to create shallow water habitat and platform for establishment of riparian vegetation. Approximately 100-feet wide including riparian zone. Revegetate the areas above median winter flow with riparian species.
- Install 50 root wads along the edges of the Willamette River and in the newly-created side channels. Wood would be keyed into the bank with 75 percent to 80 percent of the wood or root wad buried. Large wood elements are designed so that the maximum elevation of the center of the root wad would be approximately 1 foot below median winter flow. Additional design specifications appear in the Design Technical Memo, Appendix H.
- Install fourteen boulders in the side channel areas, with the top of each being one foot above median summer water surface elevation
- Install 3 pedestrian bridges to maintain the same access to the site. Required to maintain existing visitor access to areas of the park, and improve the recreational experience of visitors to the area of the ecosystem restoration area.

Oaks Crossing/Sellwood Riverfront Park

- Excavation of approximately 1,250 lineal feet of side channels of approximate average width of 100-feet (2.86 acres), to connect existing backwater areas to the Willamette River at median winter flows. Bottom elevations of the side channels would be set at 9.4 feet NAVD88 to allow water depths of at least 6 inches during median flows. Side channels would have a minimum 10-foot bottom width, sloping up at a 5H:1V gradient to existing ground.
- Eight root wads would be installed in the side channels to provide cover and habitat complexity, and to slow velocities in the side channels. Wood would be keyed into the bank with 75 percent to 80 percent of the wood or root wad would be buried. Large wood elements are designed so that the maximum elevation of the center of the root wad would be approximately 1 foot below median winter flow. Additional design specifications appear in the Design Technical Memo, Appendix H.

- Approximately 2.7 acres of wetland and 4.5 acres of riparian areas would be planted or revegetated with native species. Invasive species would be removed prior to revegetation. Riparian species selected for this project include fast growing species such as alders and willows, and slower-growing species such as black cottonwood and ash. The purpose of this mix is to allow riparian functions to develop quickly while the species with longer life spans, such as cottonwood and ash, are maturing.

BES Plant

- A low-flow channel would be excavated to reconnect a shallow swale to the Columbia Slough. The bottom width of the channel would be approximately 10 feet, and it would slope up at a gradient of 5H:1V to match existing grade.
- Wetland habitat would be restored in the swale by allowing inundation of this area and planting native wetland vegetation around the perimeter (0.8 acres).
- Three root wads would be installed in the shallow ponded area, with approximately 75 percent of the wood buried in the bank. An additional sixteen root wads would be installed in a similar manner along the edges of Columbia Slough approximately 3,500 lineal feet by 40-foot wide area in this stretch (3.2 acres) to diversify wetlands and help to enhance shallow water habitat.
- Fourteen boulders would be placed to create pond turtle habitat and to help anchor large wood. The boulders would be installed so that the tops of each one is at least one foot above the median summer water surface elevation.
- Banks would be excavated to an angle of 3H:1V along approximately 800 feet of Columbia Slough (1.83 acres) and revegetated with native riparian vegetation (0.8 acres). This would also help to create shallow water habitat.
- Invasive species would be removed around the swale and the area revegetated with native riparian species.

Kenton Cove

- Riparian plant species will be installed between the median winter flow elevation of 9.7 feet NAVD and 13.2 feet NAVD, restoring native riparian vegetation (3.1 acres).
- Nine wood clusters or root wads would be installed with deposition of sand and gravel mix to form habitat islands at the edges of the cove, creating wetland and shallow water habitat (2.0 acres).

Tryon Creek, Highway 43 Culvert Replacement

- Culvert slope would be constructed at a constant 3.4 percent to reduce the steeper 5.9 percent slope of the upper portion of the existing culvert, and to more closely match the previous and overall natural channel slope of 3.5 percent.
- Remove existing 8-foot by 8-foot concrete box culvert replace with a pre-cast arch culvert measuring 30 feet wide and 12 feet high by 400 feet long. This culvert will pass the 100-year discharge, and provide a minimum of 3 feet of additional freeboard. The culvert is sized to allow some lateral movement of the streambed, consistent with conditions immediately upstream and downstream of the culvert, but a wider culvert was deemed inefficient from the standpoints of cost and constructability. The downstream end of the culvert would tie into typical summer and fall water surface elevations.

- 18- to 20-inch rock, designed to withstand movement under the 100-year discharge condition, would be used to create weirs at 25-foot intervals for grade control and to help control velocities. Water passing over the weirs would create downstream scour pools conducive for fish passage over the grade control structures.
- The streambed would be natural, and finished with cobble.
- Areas immediately upstream and downstream of the culvert would be significantly disturbed during construction, and would be revegetated with native riparian plant species.

6.2. CONSTRUCTION COMPONENTS

Construction will entail the following components.

6.2.1. Clearing

Clearing includes the removal of large rocks, boulders, riprap, and debris from land for access and in advance of vegetative ecosystem 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.

6.2.2. 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.

6.2.3. 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 ecosystem restoration site or where sensitive cultural or natural resources prohibit grading. All material excavated will be used on-site or sidecast; no off-site hauling and disposal will occur.

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 maintaiued to avoid excessive turbidity in adjacent waterways. Except at the Tryon Creek Highway 43 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).

6.2.4. Construction of Side Channels and Backwaters

Side channel construction involves the placement of one or more of the following: bank stabilization measures, streambank vegetation ecosystem restoration, and riparian vegetation ecosystem 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 ecosystem restoration will include the planting of local, native vegetation species.

Backwater connections such as those that will be created at, BES Plant and Oaks Crossing/Sellwood Riverfront Park sites will include 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 ecosystem 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.

Pedestrian Bridges at Kelley Point Park

Administered by PPR, Kelley Point is a popular park and receives extensive use for hiking, bird-watching, dog-walking, outdoor education, and other uses. Although the park offers multiple uses including fish and wildlife habitat, as a facility that is actively managed for recreation, deference must be given to that use. Since the proposed side channels could restrict access to some parts of the park, the local sponsor requested that multiple bridges be installed to ensure continued access to all areas of the park. These have been included as foot bridges near the ends of the side channels. The bridges have been designed to allow pedestrian access over the side channels, and will not restrict flow through the side channels. The cost of the proposed bridges is less than 10 percent of the total construction cost.

6.2.5. 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. The LWD 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.

Root wads and large wood, cut to specified dimensions, will be obtained from a local source. The root wads 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.

6.2.6. Riprap Installation

Riprap may be used, only as necessary, to protect the footing of the culvert at the Tryon Creek Highway 43 site. Riprap will only be used following the guidelines in the Programmatic Ecosystem Restoration

Opinion for Joint Ecosystem Conservation by the Services (PROJECTS) program. Riprap will be placed using a hydraulic excavator.

6.2.7. Culvert Installation

At the Tryon Creek Highway 43 site, the stream will continue to be passed under the road in a culvert. Based on the planning restoration objectives, the culvert replacement size was based on the natural width of the stream; therefore, incremental culvert sizes were not analyzed. 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. A general discussion of the analysis and design criteria that were used to identify the size of the culvert that would be needed to pass the design flows, pass large debris that may enter the system from higher in the watershed, and maintain fish-passable velocities and depths is presented below. Additional details of the hydraulic modeling that was performed appear in the Hydrology and Hydraulics Technical Memorandum (Appendix C) and in the Design Technical Memorandum (Appendix H).

The culvert size was determined with hydraulic design calculations. The State of Oregon and NMFS recommendations for fish passage (OAR 2013a) were used as a guideline for design. This analysis is presented in the Hydrology and Hydraulics Technical Memorandum (Appendix C). The minimum criteria applicable to the open-bottomed culvert replacement design for the Tryon Creek, Highway 43 culvert on based on the stream simulation option are:

- **Velocities and Depths:** Maintain average water depth and velocities that simulate those in the surrounding stream channel.
- **Width**: Equal to or greater than the active channel width, as determined by the OAR (2013a and 2013b), and conservative guidance (ODOT 2011).
- **Minimum Vertical Clearance**: 3 vertical feet from the active channel width elevation to the inside top of the structure.
- **Maximum Jump Height**: 6 inches.
- **Minimum Jump Pool Depth**: Greater of 2 feet or 1.5 times the jump height.
- **Slope**: Equal to the slope of, and at elevations continuous with, the surrounding long-channel streambed profile.
- **Streambed Material:** Composed of material that is maintained through time, is either similar in size of composition as the surrounding stream or supplemented to address site specific needs that may include bed retention and hydraulic shadow, contain partially-buried over-sized rock since the road-stream crossing structure is greater than 40 feet in length, is mechanically placed during structure installation.
- **Debris Passage**: Active channel shall not be obstructed by trash racks or other debris accumulation structure so as to allow passage of wood and other large debris.

The fish passage criteria require the culvert to span the active channel width, which was determined from the bankfull elevations using HEC-RAS modeling of the 2-year recurrence discharge for the existing channel geometry upstream of the culvert. The active channel width was determined as 20.2 feet. Chapter 6 of the Oregon Department of Transportation's (ODOT) *Hydraulics Manual* (ODOT 2011) further specifies culvert spans to be larger than the active channel width to provide an engineering factor of safety to pass lower frequency high discharge events. The method described by Case 2 (ODOT 2011) determines the conservative culvert span as 125 percent of the active channel width plus 2 feet, which results in a minimum design span of 27.25 feet. In order to provide a more cost conscious and construction efficient preliminary design for the Feasibility Study, a pre-cast arch culvert is recommended for evaluation in the subsequent design phases for this project. The pre-cast arch culvert size was selected as readily available size large enough to accommodate the conservative width of 27.25 feet, and has a width of 30 feet with a rise of 12.3 feet (CONTECH 2013).

The selected pre-cast arch culvert was evaluated by modifying the HEC-RAS model with a cross section representative of the proposed streambed within the culvert. The streambed will be composed of oversized rock and have a substrate that will be maintained through time to meet the State of Oregon's design requirements. Streambed grade control features will be constructed of oversized rock to ensure stability. Debris passage is unobstructed for the proposed culvert design, and no trash racks or other debris accumulation structures are specified for the culvert. The proposed cross section was tested for its ability to provide a minimum vertical clearance of 3 feet between the active channel width elevation and the inside top of the structure, and it was determined to exceed this requirement.

An incipient motion analysis was conducted utilizing the HEC-RAS results for the proposed culvert that are presented in the Hydrology and Hydraulics Technical Memorandum (Appendix B of the Feasibility Study). This analysis determined that the minimum rock sizes that will resist movement within the channel were 11 inches for the 100-year and 8 inches for the 2-year discharge conditions.

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 ODOT. Additional studies that may be needed during later stages of engineering and design are described in the Design Technical Memorandum, Appendix H.

6.2.8. 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.

6.3. 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 Chapter 10.

6.4. Cost Estimate

A certified estimate using MCACES Version 2 (M2) was developed in 2014 and updated in 2015. The 2015 update included an estimated project costs at the Fiscal Year (FY) 2016 price levels. The FY2016 price levels are presented herein and in the attached Design Report (Appendix H). Real Estate costs included in the gross appraisal and estimate of the lands, easements, rights-of-way, relocations, and disposal areas (LERRDs) has been developed by the Corps (Appendix I). The cost summary for implementing the Recommended Plan is shown in Table 6-1. The project first cost estimate is

$29,774,000, including design, construction, engineering during construction, construction management, acquisition of all real estate, and contingency.

Table 6-1. Construction First Cost Summary

Construction Item	Cost ($1000)
01 Lands and Damages	6,580
Elements	
02 Relocations	498
06 Fish & Wildlife	15,202
08 Roads, Railroads & Bridges	2,154
14 Recreation Facilities	1,399
Subtotal	**$25,833**
30 Preconstruction Engineering and Design (PED)	2,130
31 Construction Management	1,811
Project First Cost	**$29,774**

The estimated federal project first cost is $19,143,000, while the non-federal first cost share is estimated to be $10,631,000. The LERRD credit, to be applied to the non-federal share, is estimated to be $9,232,000. Total LERRD credit is composed of three accounts: (1) lands and damages (01 account), which is estimated to be $6,580,000; and (2) relocations (02 and 08 accounts), which is estimated to be $2,652,000. Table 6-2 shows the cost-sharing apportionment for the project.

Table 6-2. Project First Cost Apportionment

Item *(Costs in $1,000)*	Federal	Non-Federal	Total
First Costs for Ecosystem Restoration Facilities (cost shared at 65% -35%)	$18,444	$9,931	$28,375
First Costs for Recreation Facilities (cost shared 50% - 50%)	$699.5	$699.5	$1,399
Total First Costs (from Table 6-1)			**$29,774**
Shared Implementation First Costs	$19,143	$10,631	
LERRD* Credit (to be applied to Implementation costs)			
Lands and Damages (01 account from MCACES)		$6,580	
Relocations (02 account from MCACES)		$2,652	
Total LERRD Credit (lands and damages ($6,580) + relocations ($2,652)		$9,232	
Estimated Sponsor Cash Contribution (shared implementation first costs ($10,631) less total LERRD credit ($9,232))		$1,399	
Percentage of Total Cost-shared Amount for Ecosystem Restoration Facilities (per Section 210 of WRDA 1996, the non-federal cost for ecosystem restoration projects is 35% of all construction costs, including LERRD, and 100% of OMRR&R**)	65%	35%	100%
Percentage of Total Costs - Shared for Recreational Facilities (per EP 1165-2-502, the non-federal cost for development of recreational facility is 50%)	50%	50%	100%
Total Percentage of First Cost Shared between Federal and non-Federal Partner (rounded)	64%	36%	

* LERRD = lands, easements, rights-of-way, relocations and disposal areas.
** OMRR&R = operation, maintenance, repair, replacement and rehabilitation.

Table 6-3 shows the estimated costs for OMRR&R, monitoring and adaptive management.

Table 6-3. Estimated Costs for Operation, Maintenance, Repair, Replacement and Rehabilitation (OMRR&R), Monitoring and Adaptive Management

Item *(Costs in $1,000)*	**Federal**	**Non-Federal**
Estimated Present Value Cost for OMRR&R* and Monitoring		$85
Estimated Present Value Cost for Adaptive Management ($90K)		$90
Average Annual OMRR&R and Monitoring**		$3.5
Average Annual Costs for Monitoring and Adaptive Management (if deemed necessary and cost shared at 65% -35%)**	$2.4	$1.3

* OMRR&R is a post-construction cost incurred by the non-federal sponsor and is estimated at 9% of the non-federal first construction cost.
** Costs were amortized at 3.375% for 50 years.

6.4.1. Implementation Requirements

Federal

As displayed in Table 6-4, the federal cost share for this ecosystem restoration project is 64% of the total first costs of the Recommended Plan, estimated to be $19,244,000. The Corps is responsible for project management and coordination with federal and state agencies. The Corps will submit the Feasibility Report for approval, prepare plans and specifications, execute a Project Partnership Agreement (PPA) with the sponsor, advertise and award construction contract(s), and perform construction contract supervision and administration.

Table 6-4. Project First Costs Shared Among Non-Federal and Federal Partners ($1,000)

Phase	Total Cash Contributions	Non-Federal Cash Contributions	Federal Cash Contributions	Projected Federal Cash Expenditures		
				FY 2016	FY 2017	FY 2018+
PED	2,130	145	1,984.96	150	500	1,334.96
Construction	16,601	1,130.40	15,460	0	5,000	10,470.60
Construction Management	1,811	123.31	1,687.69	0	500	1,187.69
Monitoring	85	85	0	0	0	0
Adaptive Management	90	31.50	58.50	0	0	58.50
LERRD	9,232	9,232	0	0	0	0
Totals	29,949	10,747.25	19,201.75	150	6,000	13,051.75
Total Percentage of First Cost Share	100%	36%	64%			

Non-Federal

The City of Portland (Bureau of Environmental Services) is the non-federal sponsor for this project, and as displayed in Table 6-4 is responsible for 36% of the project costs, estimated to be $10,747,250. The non-federal sponsor would like to conduct work-in-kind as large portion of their cost-sharing responsibilities. Operation and maintenance of those projects is also a non-federal responsibility. This section describes the primary non-federal sponsor responsibilities in conjunction with the Federal Government to implement the Recommended Plan.

A model PPA has been reviewed by the non-federal sponsor and its legal representative. The non-federal sponsor is aware of its responsibilities. The PPA will be modified to include work-in-kind for the non-federal sponsor following Corps guidance and process. This PPA will be reviewed and approved through the Corps' chain of command as required and executed prior to implementation.

Federal implementation of the recommended project would be subject to the non-federal sponsor agreeing to comply with applicable federal laws and policies, including but not limited to:

a. Provide 35 percent of total ecosystem restoration costs as further specified below:

   1. The required non-federal share of design costs allocated by the Government to ecosystem restoration in accordance with the terms of a design agreement entered into prior to commencement of design work for the ecosystem restoration features;
   2. Provide, during the first year of construction, any additional funds necessary to pay the full non-Federal share of design costs allocated by the Government to ecosystem restoration;
   3. 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 all as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of the ecosystem restoration features;
   4. Provide, during construction, any additional funds necessary to make its total contribution for ecosystem restoration equal to 35 percent of total ecosystem restoration costs;

b. Provide 50 percent of total recreation costs as further specified below:

   1. Provide 25 percent of design costs allocated by the Government to recreation in accordance with the terms of a design agreement entered into prior to commencement of design work for the recreation features;
   2. Provide, during the first year of construction, any additional funds necessary to pay the full non-Federal share of design costs allocated by the Government to recreation;
   3. 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 all as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of the recreation features;
   4. Provide, during construction, any additional funds necessary to make its total contribution for recreation equal to 50 percent of total recreation costs;

c. Provide, during construction, 100 percent of the total recreation costs that exceed an amount equal to 10 percent of the federal share of total ecosystem restoration costs;

d. Shall not use funds from other federal programs, including any non-federal contribution required as a matching share therefor, 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 such funds are authorized to be used to carry out the project;

e. 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 ecosystem restoration features, hinder operation and maintenance of the project, or interfere with the project's proper function;

f. Shall not use the ecosystem restoration features or lands, easements, and rights-of-way required for such features as a wetlands bank or mitigation credit for any other project;

g. Keep the recreation features, and access roads, parking areas, and other associated public use facilities, open and available to all on equal terms;

h. 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 CFR 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;

i. For so long as the project remains authorized, operate, maintain, repair, rehabilitate, and replace the project, or functional portions of the project, including any mitigation features, 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;

j. 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;

k. Hold and save the United States free from all damages arising from the 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;

l. 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 systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 Code of Federal Regulations (CFR) Section 33.20;

m. 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, entitled "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 (revising, codifying and enacting without substantial change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a *et seq.*), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 *et seq.*), and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c *et seq.*);

n. 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;

o. 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;

p. 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

q. 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 Water Resources Development Act 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.

6.4.2. Operation, Maintenance, Repair, Replacement, and Rehabilitation

The non-federal sponsor is required to operate, maintain, repair, replace, and rehabilitate (OMRR&R) the project in perpetuity following construction (outside of any adaptive management measures that may be cost-shared). The average annual cost of OMRR&R and monitoring has been estimated to be $3,500 per year. The project as designed is anticipated to have relatively low annual O&M, monitoring is estimated as described in Chapter 10. The majority of the cost and effort would occur in the first the 10 years after construction and associated with vegetation, hydraulic connections and fish passage.

6.4.3. Project Sustainability

The purpose of the Recommended Plan is 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 will restore the natural formation of habitats and provide important off-channel rearing and refuge habitats for multiple species. This study has been conducted within the context of existing development and management of the system and other actions being conducted by a variety of other stakeholders. The project team recognized early in the plan formulation process that this study could not address all problems and limiting factors in the study area and that the types of restoration measures would not be entirely self-sustaining over the long term. Plan formulation focused specifically on the three objectives of the study: (1) re-establish riparian and wetland communities, (2) increase aquatic and riparian habitat complexity and diversity, and (3) restore floodplain function and connectivity.

Several key elements relate to the overall project sustainability: (1) the long-term management of vegetation communities to promote native vegetation and natural succession, and reduce and control the dominance of invasive species; (2) the long-term recruitment of large wood to the study area to provide key elements for natural habitat formation within off-channel and floodplain habitats and long-term connections to floodplains; and (3) the long-term management of the Tryon Creek culvert to promote fish passage. These key elements are slightly different for each of the five sites in the Recommended Plan (Table 6-5).

Table 6-5. Key Elements of the Ecosystem Restoration Sites

Site	Revegetation	Large Wood	Off-channel Habitat	Floodplain Reconnection	Fish Barrier Removal
Kelley Point Park	X	X	X	X	
Oaks Crossing	X	X	X	X	
BES Plant	X	X	X	X	
Kenton Cove	X	X			
Tryon Creek Highway 43	X				X

All of the project sites include habitat where invasive species are currently dominant or could require management in the future. The primary invasive species of concern are Himalayan blackberries, English ivy and reed canarygrass. These species are widespread throughout the Pacific Northwest and there is a long history of treatment and control. Control has been more difficult due to their presence in aquatic habitats and rapidly spreading nature. These species will be managed to reduce their populations and promote hydrologic changes that will discourage their survival; by promoting seasonal flow-through and then drying down over the summer/fall, these species will have less suitable habitat. Other measures such as shading with riparian vegetation (*i.e.*, willows), spot cutting/herbicide applications, project-specific grading, and other methods will also be used to reduce their populations and diminish their effects on habitat and native species.

The proposed large wood included as restoration measures in the recommended restoration plan are intended to provide medium-term habitat function to provide a deposition site for other large wood in the system, promote formation of in-channel habitats (pools, riffles, side channels), provide in-channel cover, and provide floodplain cover and habitat for wildlife species and may also be recruited into the channel during high flow events. In conjunction with these medium-term benefits, the restored riparian zone that will extend for along each site will be growing and maturing for eventual contributions of wood into the site. The wood is not expected to create a static habitat situation over the life of the project, but promote formation of habitats in multiple locations and work in concert with environmental flows and other actions undertaken separate from this project.

The removal of the fish barrier and replacement of the precast arched culvert at Tryon Creek is intended to provide 2.7 miles of fish access to an area that they currently cannot access, and 49 acres of added ecological functional value. The sustainability of the Tryon Creek site is dependent upon keeping the culvert open and passable. The opening was designed to provide for the natural channel cross section. This site, and specifically the culvert with its 30-foot span, should aid in sustained passability over time.

6.5. Construction Issues

Construction is anticipated to be relatively straightforward at all sites, with the exception of the Tryon Creek, Highway 43 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, 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.

6.6. 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:
  - Large wood sizing and placement, and
  - Sizing of side channels;
- Detailed design of the Tryon Creek Highway 43 site;
- Detailed planting plans; and
- Traffic control plan.

6.7. Schedule

Final review and approval of the project is expected in 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 6-6.

Table 6-6. Tentative Planning and Construction Schedule

Milestones	2014	2015	2016	2017	2018
District Quality Control/Limited Agency Technical Review (DQC/ATR)	■				
Alternative Formulation Briefing (AFB)	■				
Public Review – Draft Feasibility Report/EA	■				
Agency Technical Review (ATR)		■			
Civil Works Review Board		■			
Project Approval		■			
Project Partnership Agreement (PPA) signed			■		
Planning, Engineering, and Design (PED)			■	■	
Construction Phase 1				■	■
Construction Phase 2					■

6.8. RISK AND UNCERTAINTY

6.8.1. Overview

A certain degree of risk and uncertainty is inherent in any ecosystem 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, such as 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 ecosystem restoration can occur.

6.8.2. 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 restoration components 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 canarygrass is widespread in the Lower Willamette 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 control measures have been incorporated into the design and construction features of each plan. 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 ecosystem 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 ecosystem restoration sites identified in the Recommended Plan, disturbance of upstream sediments during dredging, remediation, or ecosystem restoration of other sites can mobilize contaminants and allow them to settle in downstream areas. The risk of contamination occurring at the ecosystem 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 ecosystem 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. The 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 the NMFS, and results indicated that concentrations of DDT were below threshold levels and 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 ecosystem 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. See Sections 7.2.2 and 7.14 for a full discussion of potential impacts within the project area from sea level rise.

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. Ecosystem 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 ecosystem 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 ecosystem 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 a Primary Responsible Party (PRP) for cleanup in the Portland Harbor Superfund site, competition amongst the PRPs for sites that provide opportunities for ecosystem 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 ecosystem 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 Corps 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. At the Tryon Creek Highway 43 site, there are two railroad tracks that cross over the culvert to be replaced. The Union Pacific Railroad (UP) owns the railroad tracks and the underlying lands in fee but does not operate along the subject tracks. The Portland and Western Railroad (PWR) leases the use of the railroad tracks from UP. Another rail line lease holder runs adjacent to the PWR line; this lease is held by a consortium of local agencies that run a historic trolley car from Portland to Lake Oswego. The Corps has initiated coordination with these rail line lease holders in regards to potential construction disruptions to rail traffic as a result of replacing the culvert at Tryon Creek Highway 43. These lease holders support the project and have provided possible scenarios for temporary rail line alternatives during construction. The UP has been contacted and discussions have been initiated on this project. Further coordination with UP and lease holders will occur with regards to construction permitting, relocation actions, construction phasing for least disruption, and permission to move into implementation. There is a risk that permission will not be granted and restoration at the Tyron Creek Highway 43 site will not be possible as designed. This risk will be reevaluated periodically during the design process as talks with UP are ongoing. If an agreement with UP cannot be reached for relocation during construction, and restoration at the Tyron Creek Highway 43 site cannot be implemented, the remaining four restoration sites will still meet the overall project objectives.

Occurrence of Cultural Resources. At least three of the proposed ecosystem restoration sites may contain cultural resources. If buried cultural resources are identified during construction, construction may need to be stopped at the location of the resources until the materials can be assessed and protected. Therefore, the potential for occurrence of cultural resources poses a risk to the cost of the project, as construction teams may be shut down and need to demobilize, and conducting discovery of the extent of the resources may pose considerable expense. It also poses a risk to the schedule of the project, since it may mean that construction would need to be postponed until the resources are fully excavated and protected. Portland District has initiated consultation with the SHPO and tribes to ensure that the proposed project is in compliance with federal regulations regarding cultural resources and to ensure that cultural resources are protected from effects during construction.

6.9. SIGNIFICANCE OF THE RECOMMENDED PLAN

Non-monetary values associated with ecological resources are required to be documented per ER 1105-2-100, 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 6-7).

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 watershed 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 the 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.

Table 6-7. 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. Corps has prepared a BA in coordination with NMFS and USFWS to evaluate 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 salmon ESUs. Upstream passage above culverts is essential to restoring lost spawning grounds.
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.

Table 6-7 (continued). 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
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 area of interest 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.

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

6.9.1. 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 Chapter 2 of this report 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 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).

6.9.2. 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 percent 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 Corps 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 restoration plans and will benefit from completion of these plans.

6.9.3. 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 ecosystem 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 deep-water 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.

7. ENVIRONMENTAL EFFECTS OF THE RECOMMENDED PLAN

Sections 1500.1(c) and 1508.9(a)(1) of NEPA 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 (proposed action), which are primarily beneficial, although there will be short-term adverse effects during construction.

Because this project is at an early stage of design, certain components of the proposed ecosystem restoration projects may change during later stages of design. If these changes appear to be substantial enough to change the effects determinations below, or give reason to believe that additional effects analysis is warranted, project-specific NEPA documentation will be performed for any affected sites prior to project implementation. The environmental effects for the final array of alternatives were the same as the recommended plan unless otherwise noted.

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 the 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 ecosystem 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 Tryon Creek Highway 43 site 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 ecosystem 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 the 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 the ecosystem 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 ecosystem 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 Tryon Creek Highway 43 site 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 Tryon Creek Highway 43 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 43 culvert 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 ecosystem 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 ecosystem 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 ecosystem restoration sites. Materials selected for construction of the ecosystem restoration measures, not limited to plants specified for revegetation plans, LWD 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 ecosystem restoration sites. The No Action Alternative will provide no change to flood storage and conveyance. Without the proposed action, the inundation of side channels and floodplains will be less frequent, and to lesser extents and depths, than with the proposed 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.

Sea Level Rise

Because the proposed action is located on a tidally-influenced riverine system upstream of the Astoria gauge, from which data used to compute the sea level rise estimates reported in Section 4.3.5 were derived, a direct correlation cannot be drawn between elevations at both locations. However, assuming average water surface elevations at the project locations changed to a similar degree as reported in Section 4.3.5, the likely scenarios are as follows.

- **Low.** Under the low scenario, water surface elevations would be slightly lower and side channels would be inundated less frequently. This effect would be negligible, as bottom elevations of proposed side channels are designed to be accessible well below the median winter flow, and a change of less than one inch would not prohibit fish use or have a significant effect on the duration of inundation.
- **Intermediate.** Under the intermediate scenario, water surface elevations would increase by up to 5 inches by 2070. This increase would lengthen the period and depth of inundation of the side channels. It is expected that side channels would become inundated earlier in the winter or perhaps even in fall, and would be inundated later in the spring. This effect could be offset by smaller spring freshets, as more precipitation would fall as rain than would fall as snow. In this case, later side channel inundation in the late spring is unlikely.
- **High.** Under the high scenario, water surface elevations would increase by up to 1.92 feet by 2070. At this elevation, side channels would likely be inundated for much of the year, and parts of the floodplain areas would likely be inundated during part of the year. Depending on tidal variation, velocities in side channels may increase significantly due to increased flows through them. Increased side channel velocities would reduce or eliminate the value of these areas to juvenile salmonids. Furthermore, increased water surface elevations of this degree would narrow the riparian area by inundating what is now the lower elevation of the riparian zones and making them uninhabitable to riparian plant species. In areas where riparian zones are already narrow, this would be a significant effect.

7.2.3. Floodplains

Under the No Action Alternative, the direct effect of not performing the alternative action at the ecosystem restoration sites is continuation of the same flood levels, storage, and conveyance (see Appendix B for detailed discussion of Hydrology and Hydraulic technical analysis).

Implementing the Recommended Plan at the ecosystem 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..

In accordance with 44 CFR 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 floodplain. 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. At the four sites where LWD is being placed, two are on the Columbia Slough in largely backwater slough habitat with minimal flow and LWD will be placed in an existing ineffective flow area. On the two mainstem sites (Kelley Point Park and Oaks Crossing), the relatively small amount of wood to be placed on the banks is considered inconsequential given the conveyance of the Willamette River; at these locations, loss of conveyance and LWD impacts on flood stage increases are considered to be minimal to nonexistent.

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 National Wetland Inventory (NWI) maps, few existing wetlands occur where construction is proposed, and formal wetland delineation has not been conducted. However, site reconnaissance indicates that additional wetlands may be present beyond those identified in NWI maps, primarily as fringing wetlands found along the edges of the Lower Willamette River and Columbia Slough. If construction occurs in areas where wetlands already exist, construction could temporarily 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. It is estimated that temporary losses of wetlands during construction will total less than 1 acre, based on site surveys.

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 wood clusters and replaced in kind. Long-term beneficial impacts are expected to result for wetlands and their associated species as a result of ecosystem 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 best management practices (BMP) 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 ecosystem 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 shown in design plans have been situated 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 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 Recommended 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 ecosystem 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 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 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 proposed action 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 ecosystem 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. Ecosystem restoration measures proposed as part of this study align with the 18 project categories of aquatic ecosystem restoration actions covered under the Programmatic Ecosystem Restoration Opinion for Joint Ecosystem Conservation by the Services (PROJECTS) program (NMFS 2013a). The PROJECTS BiOp is a joint programmatic conference and biological opinion prepared by the NMFS pursuant to Section 7(a)(2) of the ESA consultation on the effects of implementing aquatic ecosystem restoration actions proposed to be funded or carried out by the USFWS and the NOAA Ecosystem Restoration Center in the Oregon, Washington and Idaho. Limited incidental take is allowed under this BiOp, therefore these types of impacts are less than significant.

The proposed ecosystem 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. The 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.

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

7.3.5. Magnuson-Stevens Fishery Conservation and Management Act

Designated critical habitat within the action area for ESA-listed salmon and steelhead consists of freshwater rearing sites and freshwater migration corridors and their essential physical and biological features or primary constituent elements (PCEs). The effects of the proposed action on these features are summarized in the BiOp, Appendix C (page 46). The adverse water quality, forage, cover and passage effects will be short-term (*i.e.*, months) during and immediately following project construction. All beneficial effects will be long-term including water quality, habitat access, habitat elements, channel dynamics, and watershed conditions. Based on these factors, this project will improve the quality and quantity of spawning, rearing, migration, and holding EFH in the project area.

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 O&M 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 ecosystem 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. Shovel tests were performed at three of the locations, where a records search indicated moderate or high probability of the occurrence of cultural resources.

The sites of the five projects included in the Recommended Plan have been surveyed in their entirety to the level needed for SHPO consultation and Section 106 of the National Historic Preservation Act for continuing consultation with interested Tribes. 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 ecosystem 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 large wood , 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 ecosystem 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 Corps ecosystem restoration feasibility study. As such, additional required cultural resource identification, evaluation, and resolution of any adverse effects are anticipated in subsequent phases.

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 ecosystem restoration areas.

Based on the results of the records search, a previous partial archaeological survey, and the reconnaissance study, areas of low probability of disturbance of cultural materials include Kenton Cove and Tryon Creek culvert, because of previous extensive subsurface disturbance associated with installing the culvert originally. 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.

In accordance with 36 CFR 800, the Corps has consulted with the Oregon state Historic Preservation Officer (SHPO) and received a letter on July 16, 2015 concurring that implementation of this project will likely have no effect on any significant archaeological objects or sites provided that the monitoring recommendations are followed. Consultation letters dated June 18, 2015 have been sent to six interested Tribes under Section 106 of the National Historic Preservation Act.; Cowlitz Indian Tribe, Confederated Tribes of the Grand Ronde Community of Oregon, Confederated Tribes of Siletz, Confederated Tribes and Bands of the Yakama Nation, Confederated Tribes of the Warm Springs Reservation of Oregon, Confederated Tribes of the Umatilla Indian Reservation, and Nez Perce Indian Tribe. To date no responses has been received from the above mentioned Tribes.

Impacts on cultural resources are possible. The Section 106 process for implementing these proposed ecosystem restoration measures requires further inventory and evaluation efforts to determine whether historic properties are present and would be adversely affected. The Corps, in consultation with the Oregon State Historic Preservation Officer (SHPO) and other parties defined in 36 CFR 800, would resolve any identified adverse effects and complete the Section 106 process, reducing or avoiding any significant impacts on cultural resources. Additionally, an archaeological monitor would be present during construction, and would have the authority to stop construction in the event that cultural resources were encountered. These processes will reduce the potential for impacts to less than significant. 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 Tryon Creek Highway 43 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 ecosystem 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 ecosystem 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 ecosystem restoration and conservation land use planning goals.

The Recommended Plan includes feasibility level designs of an array of ecosystem 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 ecosystem 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 ecosystem 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 ecosystem 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 ecosystem 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 ecosystem 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 serviees. The proposed ecosystem restoration measures include features such as crossing structures that would maintain recreational access while improving habitat and water quality. The ecosystem restoration would have a positive effect on land use. Land uses on adjacent lands would not be impacted by the ecosystem 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 ecosystem restoration.

The Tryon Creek Highway 43 culvert site is located just west of the Willamette River on its tributary, Tryon Creek. The site is zoned primarily as park/natural area but includes small portions zoned as residential and industrial. Infrastructure right-of-ways by the ODOT, 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 ecosystem 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 ecosystem restoration. Other land uses on adjacent lands would not be impacted by the ecosystem restoration.

Indirect effects could occur if it is reasonably foreseeable that the ecosystem restoration projects would induce or inhibit growth or result in future changes in land use on or near the sites. The proposed ecosystem restoration work is largely consistent with current zoning, land uses and plans. Environmental ecosystem 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 ecosystem 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 ecosystem 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.

For the Recommended Plan, there would be no displacement of residences as implementing the plan would not require removing any residences from the floodplain. There would be no displacement or other effects on businesses as none of the sites would be located on parcels with businesses, and the plan is designed to not increase the flood water surface elevations of the river or tributaries.

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 Tryon Creek Highway 43 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.

There would be very minor benefits to public health and safety under the ecosystem restoration plan as a result of removal of debris and trash from the sites. The installation of engineered log jams (ELJ) 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).

The Recommended Plan may result in beneficial indirect socioeconomic effects in the form of increased quality of recreation and community well being. These effects would likely be minor, as some project sites already offer recreation opportunities, and the plan does not include a component to construct additional recreation features where none currently exist. The plan would provide restored aquatic habitats, some of which would be publicly accessible and could provide improved educational and fishing opportunities.

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 plan focuses on sites currently in open space or existing parks. Ecosystem restoration construction in these areas is not expected to directly or indirectly affect income, employment, or other socioeconomic indicators disproportionately in environmental justice communities. There would be no displacement effects on minority or low income populations as implementing the ecosystem restoration plan would not require removing existing structures or residences. 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, although there may be some minor and 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 ecosystem 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.

The Recommended Plan would not change any recreational uses, but maintain existing compatible recreational uses. 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, ecosystem 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 carbon monoxide and ozone maintenance areas, making the primary pollutants of concern carbon monoxide and ozone creating compounds such as nitric oxide/nitrogen dioxide and volatile organic compounds. 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 ecosystem 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 ecosystem 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 ecosystem 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 ecosystem 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.

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

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.

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 ecosystem 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 ecosystem 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

The impacts to HTRW 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 ecosystem 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 ecosystem restoration construction.

None of the recommended plan sites in this study are located within the Portland Harbor Superfund site. The Lower Willamette River is one of the most sampled and studied sections of any major urban river in America. The boundary of the Portland Harbor superfund site is a result of 10(+) years and nearly $100 million in environmental sampling and data analysis. Environmental data have been collected within the Portland Harbor Site during numerous Lower Willamette Group sampling events since the inception of the Portland Harbor Remediation Investigation/Feasibility Study process in 2001. This data, along with data from historical and concurrent studies by other parties in the Lower Willamette River constitute the Portland Harbor Site Characterization and Risk Assessment (SCRA) database. The Portland Harbor SCRA database consists of over 1 million analytical results representing a variety of sample matrices dating back to 1969. The contaminated sediment in the Portland Harbor area is stable unless disturbed through dredging-type activities, which is being strictly regulated by EPA. The Record of Decision (ROD) on the Portland Harbor CERCLA is estimated to be issued in late 2017. Any Portland Harbor CERCLA current or future clean-up action(s) will require the site to be fully contained and controlled to prevent offsite migration of contaminants.

During the HTRW investigation, the principal investigator visited each potential restoration site and evaluated the potential for current or previous land uses to contribute to contaminated conditions, in accordance with Phase 1 site assessment as an ASTM requirement. The results of these surveys are incorporated into the findings for each site and are described in Appendix E. As a result of this site 1 investigation and follow-up discussions with the City of Portland, who manages most of the sites, none of the sites have existing or potential HTRW issues; therefore, contamination risk would be very low and does not warrant sediment sampling at this phase of study. In regards to properties identified in the site assessment within one mile (close proximity) of the ecosystem restoration sites, investigations show that potential HTRW contamination migrating from them to the ecosystem restoration sites would also be very low. The City of Portland, EPA, and DEQ have an extensive monitoring program for the Willamette River and Columbia slough; this program, along with all of EPA's extensive work being done in the Portland Harbor area, provides for a high level of assurance that the potential release of contamination within the ecosystem restoration study area would not be likely.

Appendix E details the methods and results of a database investigation of the study area and visits to each proposed ecosystem restoration site for current and/or historical contamination that could adversely influence the implementation of the planned ecosystem restoration measures (EDR 2009). The investigation includes an assessment of the database information to determine those locations that are most relevant to the ecosystem 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 ecosystem 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 ecosystem restoration construction.

The areas of consideration for direct impacts on and from HTRW minimally include the proposed ecosystem 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 ecosystem restoration sites.

For 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 sites near the proposed sites would not occur in support of this effort. No indirect effects are anticipated for the No Action Alternative.

The Recommended Plan includes feasibility-level designs of an array of ecosystem restoration measures tailored to each site. 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 BES Plant site is primarily in an industrial zone adjacent to the Columbia Slough. Actions proposed at BES Plant site include bank laybacks, installing LWD, 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 ecosystem restoration site. Three sites were within a mile of the site, none of these sites were closer than one-quarter mile from the limits of excavation of the ecosystem restoration project. The Bureau of Environmental Services has a Columbia Slough Watershed management group that manages, regulates and oversees activity within this watershed area. In 2014, the City completed an ecosystem restoration activity on the opposite shore of the BES plant site and no HTRW was recorded, observed or identified.

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 LWD and revegetating the shore with native riparian plants. Placement of LWD 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 ecosystem restoration site. One site was indentified across the slough and a land peninsula from the limits of the Kenton Cove ecosystem restoration project. The Bureau of Environmental Services has a Columbia Slough Watershed management group that manages, regulates, and oversees activity within this watershed area. The potential for contamination at this site is low.

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 LWD. Excavation, bank lowering, grading, channel alteration and plant removal would result in extensive disturbance of soils and movement of sediments. The nearest upriver identified Portland Harbor Superfund site is approximately 1 mile from Kelley Point Park. This Superfund site is on the Department of Environmental Quality selected stormwater source control measures to significantly reduce potential sources of contamination to the Willamette River. These measures include end-of-pipe stormwater treatment and best management practices to prevent contaminated stormwater from entering the Willamette River. The company has performed early action cleanup measures that has removed the most contaminated soil from several areas, capped large areas of the facility, installed in-ground treatment systems, and installed onsite bioswales. With the extensive ongoing regulation, monitoring and continued sampling of the Portland Harbor Superfund sites, migration of contaminates to the Kelley Point Park site is considered low. Further information that supports this analysis concerning contaminant issues comes from the Lower Willamette Groups draft feasibility study on remedial investigation dated 2011 for the Portland Harbor Superfund site it states, " Sediments immediately downstream of the Study Area (Portland Harbor Superfund Site) in either the Willamette River main stem or Multnomah Channel show little evidence of contaminant migration from the Study Area." As further assurance of low contamination potential, the City of Portland performed a similar ecosystem restoration project at the confluence of Columbia Slough and the Willamette River, directly across the slough from Kelley Point Park (closer to the designated Portland Harbor Superfund site) and encountered no HTRW contamination issues. Additional research and documentation of existing sampling data or the collection of new samples sufficient to confirm that there is a minimal risk of HTRW at Kelley Point Park will be completed during the PED phase of the project. Inclusion of Kelley Point Park in the project that will be constructed is conditioned on the analysis of this additional data confirming that the HTRW risk is minimal.

Other properties (outside of the superfund site) were identified during the database search to be within one mile of this site. One identified site was listed for being on the underground injection control program maintained and regulated by ODEQ and one site for having a permit to discharge into the Columbia Slough via a NPDES permit, which also regulates and monitors any discharge. The other property was located across the slough with permitted and listed contaminants on the property, a NPDES permit to discharge into the Columbia Slough, the owner of the property on a voluntary clean-up program with oversight by ODEQ, and past records of spills from the 1980s and 1990s that have been remediated. The potential for contamination from these sites is low.

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 LWD and revegetation with native riparian species. Excavation, grading, and planting removal would result in the disturbance of soils and movement of sediments. This site is upstream of the Superfund site by 4.2

river miles. This site has a low potential for contamination. There are no recorded instances of contamination near this site on this side of the river. There are two sites identified on the opposite shore and approximately one mile downstream of this site. The Willamette River is a major river with a consistently strong flow year round, creating a very low potential for contamination from these sites to the Oaks Crossing/Sellwood Riverfront Park site.

The Tryon Creek Highway 43 culvert site is located just west of the Willamette River on its tributary, Tryon Creek. The culvert replacement would pass under 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. This site is also upstream of the Superfund site by about 8.2 river miles and up Tryon Creek from the Willamette River by ¼ of a mile. Tyron Creek has no record of contamination. The potentially contaminated site identified through the HTRW site investigations that may impact this site was when the study area extended to the confluence with the Willamette River. The study area has since been reduced, and the potentially contaminated site is now down-gradient of the project area, so the risk of contamination is lower than previously expected. This site has a low potential for contamination.

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 HTRW. Impacts could occur if subsequent environmental reviews identify the presence of hazardous materials at the ecosystem restoration sites that would preclude habitat ecosystem restoration, result in exposure to or transport of the materials, or would interfere with ongoing or planned site remediation.

Construction and maintenance of the ecosystem 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 ecosystem 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.

Figure 7-1. View of Kenton Cove Looking Southwest from Denver Ave.

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.

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 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.

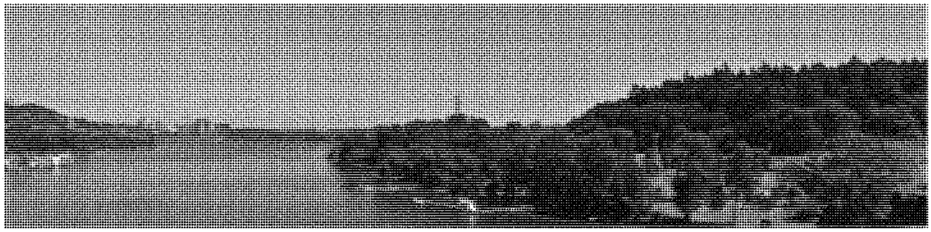

Figure 7-2. View of Oaks Crossing/Sellwood Riverfront Park on Right Looking Downstream

Aesthetics at the Tryon Creek Highway 43 Culvert site are defined primarily by the complex intersection of SW Terwilliger Blvd and SW Riverside Drive (Highway 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 ecosystem 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 ecosystem 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. CLIMATE CHANGE

The Council on Environmental Quality (CEQ) coordinates federal environmental efforts and works with agencies to develop policies and initiatives on matters relating to the environment, natural resources and energy. The CEQ has recently issued guidance explaining how climate change adaptation can be incorporated into environmental analyses, including Principles and Requirements for *Federal Investments in Water Resources* (CEQ 2013a) and the *Interagency Guidelines for Federal Investments in Water Resources* (CEQ 2013b). The Corps has recently issued policies documenting the four major climate change drivers affecting mission and operations, and has provided engineering guidance for addressing sea level rise in project planning (USACE 2011, 2012 and 2014).

Under the No Action Alternative, climate change will likely continue to occur for the 50-year planning period. Potentially occurring conditions under present rates of climate change are summarized in *Projected Future Conditions in the Lower Willamette River Subbasin of Northwest Oregon: Clackamas, Multnomah, and Washington Counties* (Hamilton *et al.* 2009). Using modeling results from the IPCC Fourth Assessment Report (IPCC 2007) and Mote and Salathe (2009), the team has developed the following predicted conditions for the Lower Willamette River Basin:

- Average summer temperatures are likely to increase by 7-9° F by 2040 and by 10-15° F by 2080. Winter months are also predicted to warmer, but to a lesser degree than summer temperatures (about 3-5°).
- A cross-section of various models all predict increased precipitation during winter months and minimal change in spring. Although results vary for summer, most models predict reduced precipitation in the summer and fall.
- Most models project a significant decline in maritime evergreen needleleaf species (coastal spruce, Hemlock, cedar, Douglas and silver fir), with replacement by temperate evergreen needleleaf species (true fir and ponderosa pine).
- A severe decrease in snow water equivalent with near disappearance (greater than 80% loss) by the end of the century.
- Stream flows are likely to become flashier in the winter and early spring due to increased temperature, more precipitation falling as rain, earlier onset of spring, and changes in groundwater and storm severity. The models predict higher high flows and more frequent and severe flooding, and lower low flows with more streams going dry.
- Both the rate of occurrence and the intensity of wildfires are likely to increase. Increased intensity of wildfires is predicted to have adverse effects on native forest species and favor the advance of invasive species.
- Increased nutrient and sediment load in area streams, combined with reduced levels of dissolved oxygen.

The Recommended Plan is unlikely to be measurably affected by climate change during construction or as a result of long term operations. Climate change will occur independent of either the Recommended Plan or the No Action Alternative, and changes to temperature, hydrology and incidence of extreme weather events is likely to occur under either scenario.

As discussed in the Hydrology and Hydraulics Technical Report (Appendix B), the proposed restoration measures are designed to be functional and meet the project objectives under most conditions that are predicted to occur over the 50-year planning period. The Recommended Plan would increase off-channel refugia for aquatic species during the high flood flows that are predicted to increase under most climate change models. Elevations of tidal sloughs and floodplain developed for the Recommended Plan would ensure increased habitat value under the "low" and "intermediate" sea level rise scenarios described in Sections 4.3.5 and 7.2.2. However, under the "high" sea level rise scenario modeled by the Corps' Sea Level Change Curve Calculator (USACE 2014), velocities in tidal sloughs resulting from increased tidal inundation may be too high to support juvenile salmonids. Furthermore, the 1.92 foot increase in the water surface elevation predicted under the "high" scenario could result in increased area of shallow-water habitat along shorelines, but could also cause constriction of the riparian area, reducing the benefits in this valuable habitat type.

Plant community response to climate change is likely to be gradual, except in the case of onset of severe drought. During the design phase, the planting palette will reflect a mix of dry adapted and wet adapted plants that can encompass the range of conditions that may occur under the various climate change scenarios. Plant communities will be monitored for survival rates and changes in community composition. Revegetation with species more appropriate to changing conditions will be implemented by the non-federal sponsor if monitoring results indicate the need for such intervention.

7.15. Cumulative Effects in Study Area

7.15.1. 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 CFR 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.

7.15.2. 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.

<u>Federal Navigational Channel - Present.</u> The Corps monitors and maintains the navigation channel in the Lower Willamette River from the Columbia River upstream to the Broadway Bridge (RM 0 to RM 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 of Portland.

<u>Columbia Slough Section 1135 Ecosystem Restoration Project - Past.</u> 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 Ecosystem Restoration Project - Future. This is an ecosystem restoration study at Oaks Bottom Wildlife Refuge within the floodplain of the Lower Willamette River, southeast of Ross Island.

Westmoreland Park Section 206 Ecosystem Restoration Project, Past. Westmoreland Park is located along Crystal Springs Creek and is a tributary to Johnson Creek. 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 Ecosystem 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 ecosystem 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 Ecosystem 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 ecosystem restoration designs in the basin.

Willamette and Lower Columbia River Basins Recovery Plan - Present and Future. The 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 Ecosystem restoration Initiative, which guides habitat ecosystem restoration efforts for coastal Coho salmon in an effort to restore populations to sustainable levels, and (3) a steelhead supplement addressing salmonid ecosystem 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 1800s to 50 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 1800s. 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 plan in the same timeframe.

7.15.3. 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.

7.15.4. 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 ecosystem 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 Ecosystem Restoration, and the Oak Bottom Ecosystem Restoration, would have cumulative beneficial effects on floodplains.

7.15.5. Biological Resources

Wetlands and Riparian Areas

The Recommended Plan includes the ecosystem restoration or creation of a variety of wetland and riparian types, including tidal sloughs, at the 5 proposed sites. The proposed project would result in the creation, reconnection, or ecosystem restoration of approximately 8 acres of wetlands, approximately 5,500 linear feet of new or reconnected tidal channels, and approximately 45 acres of riparian habitat. Additionally, shallow water habitat would be created or restored over approximately 9.5 acres cumulatively, and fish access would be restored to 2.7 miles of spawning habitat in Tryon Creek. When combined with other reasonably foreseeable future projects, such as the Westmoreland Park Section 206 Ecosystem Restoration Project, the cumulative effects will result in a significant increase in wetland, riparian, and off-channel habitat along the Lower Willamette River.

Hydrology

The five restoration components of 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 Section 1135 Ecosystem Restoration Project and the Oak Bottom Ecosystem 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 ecosystem restoration of habitats that are limited for existing species such as off-channel habitat, wetlands, riparian habitats, cover and LWD. Other past, present, and reasonably foreseeable future projects also have habitat ecosystem restoration components, including the recently completed Columbia Slough Section 1135 Ecosystem Restoration project and the Westmoreland Park Section 206 Ecosystem Restoration project, and the future Willamette River Floodplain Ecosystem Restoration project. Beneficial cumulative effects on fish and wildlife species are expected.

Threatened, Endangered, Candidate, and Rare Species

The proposed ecosystem 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.

7.15.6. Cultural and Historic Resources

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

7.15.7. 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; thus, no adverse cumulative effects are anticipated.

7.15.8. Transportation

Transportation effects of 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 TMP for both the Recommended Plan and the concurrent projects. This would mitigate to a large extent any cumulative adverse transportation effects.

7.15.9. 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.

7.15.10. Environmental Justice

Ecosystem 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.

7.15.11. 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.

7.15.12. 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 effects.

7.15.13. 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.

7.15.14. 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.

7.15.15. 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.

7.16. 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 ecosystem restoration. The ecosystem restoration sites would have increased ecological function and increased recreational use.

7.17. Unavoidable Adverse Impacts

The ecosystem 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 Plan 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 ecosystem 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 out-compete 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.

7.18. Mitigation Measures and Best Management Practices

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

The Recommended Plan, as an ecosystem 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 ecosystem restoration; however, an operations and maintenance plan will be developed and followed post construction of the ecosystem restoration sites. The operations and maintenance plan will provide guidance on the frequency and methods for inspecting the ecosystem restoration sites to ensure that the design elements are functioning properly. Periodic maintenance may be required for the ecosystem 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 design of the ecosystem restoration sites. The 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 park users. Mitigation of this potential impact has been resolved by 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 Corps will continue to work with local planning entities and stakeholders to identify any short-and long-term conflicts with land use and zoning issues as final designs and construction plans are developed.

The Corps has completed consultation with USFW/NMFS. A biological and conference opinion (BiOP) was prepared by NMFS pursuant to section 7(a)(2) of the Endangered Species Act (ESA) on the effects of this project on ESA listed species. NMFS concluded that the proposed action is not likely to jeopardize ESA listed species, and provided an incidental take statement with the opinion. The USFW service has provided a number of propose conditions and other recommendations in-lieu of a CAR (USFWS 2014). These recommendations have been incorporated into this document and provided in Appendix C.

As a prelude to construction, the Corps will continue the Section 106 consultation process for implementing these proposed ecosystem restoration measures in consultation with the SHPO and other parties defined in 36 CFR 800

The level of effort for assessing each ecosystem restoration location would be determined based on the preliminary information 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 ecosystem 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 ecosystem restoration construction and maintenance the Corps will:

- Incorporate waste minimization and pollution prevention processes into the design and construction of the ecosystem 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 CFR 68, 40 CFR 302, 40 CFR 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 CFR 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 CFR 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.

7.19. ENVIRONMENTAL OPERATING PRINCIPLES

The Corps Environmental Operating Principles were developed to ensure that the Corps missions include totally integrated sustainable environmental practices. The Principles provided corporate direction to ensure the workforce recognized the Corps role in, and responsibility for, sustainable use, stewardship, and ecosystem 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 the Corps' facilities to a fuller consideration of the environmental impacts of the Corps actions and meaningful collaboration within the larger environmental community.

The concepts embedded in the original principles remain vital to the success of the Corps and its missions. However, as the Nation's resource challenges and priorities have evolved, the Corps has responded by close examination and refinement of work processes and operating practices. This self-examination includes how the Corps 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 Corps 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 Corps. 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 Corps to further leverage resources through collaboration. This is essential for successful integrated resources management, ecosystem restoration of the environment and sustainable and energy efficient approaches to all Corps' mission areas. It is also an essential component of the Corps 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 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 ecosystem 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 Corps 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 Corps 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 Corps, which may impact human and natural environments.* – This project provides ecosystem 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 the Corps' actions in a collaborative manner.* The Recommended Plan reflects the latest design and evaluation strategies for ecosystem 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 Corps, the non-federal sponsor, and federal resource agencies.
7. *Employ an open, transparent process that respects views of individuals and groups interested in Corps' activities.* The Corps 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 designs for this project. A similar meeting was held with staff from NMFS on March 4, 2014, and similar recommendations were given. In March 2014, a BA was prepared for the proposed action and was submitted to initiate formal consultation with USFWS and NMFS. The consultation process and results are described in Section 9.2.

The draft FS-EA and a draft Finding of No Significant Impact (FONSI) were made available for a 30-day public review period from September 23, 2014 to October 23, 2014, with notices sent to all project stakeholders including all identified property owners and the non-federal sponsor's list of interested parties. At the end of the public comment period, no comments were received from the public or interested parties, and it was determined that the proposed action would result in no significant impacts to the human environment.

A regional stakeholder that has taken an active role in planning for this study is the Metro Regional Government (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.

For the Tryon Creek Highway 43 site, Corps staff attended Tryon Creek Watershed Council meetings in fall 2013 for stakeholders and public discussions on the removal of this barrier to fish. Many project stakeholders including the City of Lake Oswego, Oregon Department of Transportation (ODOT), Watershed Council members, and surrounding communities view removal of this fish barrier as a critical part of opening the watershed to fish and aquatic organisms, including ESA-listed species. There is long standing, strong support for removing this fish barrier. Majority concern was support for a bridge in lieu of culvert replacement; however, the culvert replacement meets Corps criteria at the least cost. In addition, several meetings were held with ODOT, the Watershed Council president, and Lake Oswego to coordinate and discuss study progress. Coordination will continue through the course of the design process.

The Portland and Western Railroad (PWR) leases the use of the railroad tracks that cross the Tryon Creek Highway 43 culvert site from the Union Pacific Railroad (UP). Consultation with PWR was initiated by the Corps in February 2014 and again in April 2015. Coordination has also been initiated with the other rail line lease holders that run adjacent to the PWR line. This lease is held by a consortium of local agencies that run a historic trolley car from Portland to Lake Oswego; this trolley has not been operational in the last couple of years due to funding issues. Initial consultation with this consortium was initiated in August 2014 and no opposition to the project was identified. The Corps has initiated coordination with the UP on this project and potential permitting for construction activity that may be required. The intent of coordination to date has been to inform the railroad of the project and start initial conversations of what the project would entail and what would be acceptable relocation actions during construction. Coordination is at a planning level and is ongoing.

9. ENVIRONMENTAL COMPLIANCE REQUIREMENTS

This chapter describes some of the primary environmental regulations that the Corps and the project partners will comply with during the planning process. Table 9-1, located at the end of this chapter, will be updated at appropriate milestones to reflect compliance status.

9.1. NATIONAL ENVIRONMENTAL POLICY ACT

This FS-EA describes environmental conditions within the study area (subbasin scale), the proposed action and alternatives, potential environmental impacts of the proposed ecosystem restoration plan at the subbasin and ecosystem restoration measure scale, and measures to minimize environmental impacts. No significant impacts have been identified, nor were any comments submitted during the public review period; therefore the Corps has prepared a draft Finding of No Significant Impact (FONSI).

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 BA (March 2014) was prepared for formal consultation and is included in Appendix C. In this BA, determinations of effects arising from the 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 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, during construction, but is not likely to jeopardize the species (NMFS 2014). The BiOp and ITS are provided in Appendix C.

9.3. CLEAN WATER ACT

Section 404 of the Clean Water Act authorized a regulatory 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 Corps retains primary responsibility for this permit program. The Corps does not issue itself a permit under the program it administers, but rather demonstrates compliance with the substantive requirements of the Act through an equivalency analysis of the potential effects following the procedures required under the regulatory program.

The Recommended Plan meets the criteria for qualifying under Nationwide Permit #27 for aquatic habitat restoration, establishment and enhancement activities. Within the Nationwide Permit #27 qualifying projects are pre-approved under the Section 401 Water Quality Certification and these projects should comply with the general conditions of the State's water quality program. Coordination has occurred with the Oregon Department of Environmental Quality (ODEQ) and they are supportive of the use of Nationwide Permit #27 at the five project sites, Kelley Point Park, BES Plant, Kenton Cove, Oaks Crossing/Sellwood Riverfront Park, and Tryon Creek Highway 43 as long as the proposed actions remain consistent with the general and regional permit conditions. See attachment 2. Coordination will continue with ODEQ in subsequent phases to ensure the project remains consistent with the Nationwide Permit

#27 conditions. The impact analysis of the nationwide permit has been performed on this project for Section 404(b)(1) Guidelines Impact Analysis, subparts as follows:

Substrate: Discharges of dredged or fill material into waters of the United States will result in minor changes to the substrate of those waters, Nationwide 27 authorizes activities that restore, establish, or enhance aquatic habitats. There will be beneficial changes to the physical, chemical, and biological characteristics of the substrate. The original substrate may be removed and replaced with material that will improve the growth and reproduction of vegetation or improve the aquatic habitat characteristics of the area. Temporary fills may be placed upon the substrate, but must be removed upon completion of the activity (see general condition 13). Some erosion may occur during construction, but the use of appropriate measures to control soil erosion and sediment/substrate discharges or fill material into the waters of the United States could result in minor changes to the substrate. There will be beneficial changes to the physical and biological characteristics of the substrate. Temporary, suspended particulate/turbidity, water, current patterns and water circulation, normal water level fluctuations, salinity gradients, and threatened and endangered species.

Section 402 of the Act requires a National Pollutant Discharge Elimination System (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.

Suspended Particulates/Turbidity: Depending on the method of construction, soil erosion and sediment control measures, equipment, composition of the bottom substrate, and wind and current conditions during construction, fill material placed in open waters will temporarily increase water turbidity. Particulates will be resuspended in the water column during removal of temporary fills. The turbidity plume will normally be limited to the immediate vicinity of the disturbance and should dissipate shortly after each phase of the construction activity.

Water: The activities authorized by Nationwide 27 can affect some characteristics of water, such as water clarity, chemical content, dissolved gas concentrations, pH, and temperature, but these effects are likely to be positive, with benefits to the local aquatic environment. The chemical and physical characteristics of the waterbody may be changed by aquatic habitat restoration, establishment, or enhancement activities, but such changes should be improvements or negligible adverse effects.

Current Patterns and Water Circulation: Activities authorized by Nationwide 27 may adversely affect the movement of water in the aquatic environment. The installation of water control structures and habitat features may affect current patterns and water circulation, but the adverse effects are likely to be minor.

Normal Water Level Fluctuations: The activities authorized by Nationwide 27 will have negligible adverse effects on normal water level fluctuations.

Salinity Gradients: This project will not affect salinity because it is outside of tidal influence.

Threatened and Endangered Species: This project has completed consultation and includes a project specific Biological Assessment and Biological Opinion (Appendix C).

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 USFWS producing 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-EA by reference and will satisfy USFWS's FWCA goals for the report. The recommendations are provided in Appendix 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. See attachment 1.

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

Executive Order 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

Executive Order 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.	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.	Corps will prepare a wetland delineation and submit it to Oregon DSL in accordance with permitting requirements. Corps 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.	Oregon Department of Environmental Quality concurs that the five project sites and each site's design is consistent with the general and regional permit condition for Nationwide Permit #27.
Fish and Wildlife Coordination Act 6 U.S.C. 661 et seq.	Requires federal agencies to consult with the USFWS on any activity that could affect fish or wildlife.	Coordination with the USFWS is complete. A set of recommendations in-lieu of a Coordination Act Report has been issued and is provided as Appendix C of the BA.
ESA 16 U.S.C. 1531 et seq.	Requires federal agencies to protect listed species and consult with USFWS or NMFS regarding the proposed action.	A BA has been prepared. Coordination with fish and wildlife agencies has occurred and a Biological Opinion and Incidental Take Statement have been issued.

Relevant Law/Regulation	Requirements	Compliance Status
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 Act 33 U.S.C. 403	Creation of any obstruction to navigation of any waters of the United States is prohibited without congressional approval.	PHA was conducted and determined the project is consistent with Nationwide Permit #27
National Historic Preservation Act 16 U.S.C. 461	Requires federal agencies to identify and protect cultural and historic resources.	The Corps initiated consultation 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.
EO 11990 Protection of Wetlands	Requires federal agencies to protect wetland habitats.	Corps 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.	District has initiated consultation with tribes regarding potential effects to cultural resources.
EO 13045, Protection of Children from Environmental Health Risks and Safety Risk	The fundamental goal is to ensure that all EPA actions and programs address the unique vulnerabilities of children.	This project is not related to any EPA action or program and is therefore not applicable.

Relevant Law/Regulation	Requirements	Compliance Status
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.
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 Permit	Requires an evaluation of effects on wetlands and waterbodies within the State of Oregon	Will be in compliance per submittal of a General Authorization Notification submittal to Oregon Division of State Lands (ODSL).
Coastal Zone Management Area (CZMA)	The National Coastal Zone Management Program aims to balance competing land and water issues through state and territorial coastal management programs	This project area does not fall within Oregon's CZMA.

ATTACHMENT 1

Oregon

Kate Brown, Governor

Parks and Recreation Department
State Historic Preservation Office
725 Summer St NE Ste C
Salem, OR 97301-1266
Phone (503) 986-0690
Fax (503) 986-0793
www.oregonheritage.org

RECEIVED
JUL 16 2015

July 16, 2015

Joyce Casey
USACE
PO Box 2946
Portland, OR 97208-2946

RE: SHPO Case No. 15-0705
USACE, Lower Willamette River Ecosystem Restoration Study
Identify potential riparian habitat restoration sites
Multiple Legals, Multnomah County

Dear Ms. Casey:

Our office recently received reports of archaeological investigations for the project referenced above. The reports have been assigned SHPO Report#s 27467 and 27468 and added to the SHPO Library. We have reviewed the reports and concur that a good faith effort has been implemented and the project will likely have no effect on any significant archaeological objects or sites provided that the monitoring recommendations are followed. Under state law (ORS 358.905-955 & ORS 97.740) archaeological sites, objects and human remains are protected on both public and private land in Oregon. If you have not already done so, be sure to consult with all appropriate Indian tribes regarding your proposed project. If you have any questions regarding any future discovery or this letter, feel free to contact me at your convenience.

Sincerely,

John P. Pouley

John Pouley, M.A., RPA
Assistant State Archaeologist
(503) 986-0675
john.pouley@oregon.gov

ATTACHMENT 2

Army Corps
of Engineers
Portland District

Memorandum for the Record
Current As Of: 19 May 2015
POC: Kris Lightner, PM-E (4748)

SUBJECT: Clean Water Act compliance for *Lower Willamette River Ecosystem Restoration General Investigation Study*

PRIMARY ISSUE(S): CENWP-PM-E has suggested using Nationwide Permit 27 to document compliance under CWA Sections 401 and 404 for the NEPA analysis. CENWD recently notified the District that the use of Nationwide Permits is not acceptable for GI projects and individual state water quality certifications and 404(b)(1) analyses are needed to document compliance under the CWA in the NEPA/feasibility report for GI studies. Delaying submittal of the feasibility report to revised compliance to include an individual 401 water quality certificate and prepare a 404(b)(1) analysis would delay the project schedule for delivery to the CWRD by the end of FY15 and increase the budget to facilitate preparation of a permit application and analysis.

CURRENT STATUS: On Thursday, 7 May 2015, I spoke with Sara Christensen, the 401 program manager at DEQ, and discussed the proposed project and the Corps' need for a letter of concurrence to document approval to use Nationwide Permit 27 for the project. While Sara provided verbal confirmation that DEQ supports the use of the permit, she was unable to commit to providing written confirmation until May 18th. In addition to scheduled training, the DEQ offices are moving to a new location and computers/emails are not easily accessible in the interim.

Given the temporal delay in receiving an informal written response and letter of concurrence from DEQ, CENWP-PM-E has prepared this Memorandum for the Record to document verbal approval from DEQ in advance of receiving written confirmation and support for the use of Nationwide Permit 27 for the Lower Willamette River Ecosystem Restoration General Investigation Study.

BACKGROUND/CONTEXT: The District has previously used Nationwide Permits for GI projects, minus a letter of concurrence from DEQ, which were successfully routed through CWRB (Willamette Floodplain Ecosystem Restoration General Investigation Study).

The Lower Willamette GI Study includes 5 project sites. Each of the project sites and proposed restoration actions are consistent with the general regional permit conditions of Nationwide Permit 27 and the associated 404 analysis. If the projects were evaluated individually under CAP authorities, Nationwide Permits would apply and their application would be policy compliant.

REFERENCES: An email dated 5 May, 2015 from CENWD referenced guidance for GI studies and the use of Nationwide Permits in Appendix C of ER 1105-2-100. CENWP-OC was unaware of guidance and is following-up with CENWD-Counsel.

RECOMMENDATIONS/NEXT STEPS: In order to fulfill 3x3x3 SMART Planning and take calculated risks in evaluating whether proposed projects are feasible, CENWP-PM-E suggests seeking written approval from DEQ (email, followed by a letter) expressing support for the project and indicating the use of Nationwide Permits are appropriate and acceptable to evaluate the feasibility of a GI project.

ATTACHMENTS:

Encl 1 – CENWP-PM-E email dated 8 May 2015 to DEQ seeking written approval for the use of Nationwide Permit 27 for the Lower Willamette Ecosystem Restoration General Investigation Study.

DEQ (Sara Christensen) email dated 19 May 2015 stating DEQ approves the use of 401 WQC for the nationwide permits, as long as the five project sites and each site's design is consistent with the general and regional permit conditions for NWP 27.

ENCLOSURE 1

-----Original Message-----
From: CHRISTENSEN Sara [mailto:Christensen.Sara@deq.state.or.us]
Sent: Tuesday, May 19, 2015 4:31 PM
To: Lightner, Kristine A NWP
Cc: Saldana, Gail; Griffith, David W NWP
Subject: [EXTERNAL] RE: Lower Willamette Ecosystem Restoration - Nationwide Permit 27 (UNCLASSIFIED)

Hi Kris,

As long as the proposed actions for each of the five project sites and each site's design is consistent with the general and regional permit conditions for NWP 27, DEQ approves the use of the 401 WQC for the nationwide permits. I will follow up with a hard copy shortly.

Thanks,

Sara Christensen
401 WQC Coordinator
Oregon Department of Environmental Quality
700 NE Multnomah St., Suite #600
Portland, OR 97201
503-229-6030

-----Original Message-----
From: Lightner, Kristine A NWP [mailto:Kristine.A.Lightner@usace.army.mil]
Sent: Friday, May 08, 2015 11:29 AM
To: CHRISTENSEN Sara
Cc: Lightner, Kristine A NWP; Saldana, Gail; Griffith, David W NWP
Subject: Lower Willamette Ecosystem Restoration - Nationwide Permit 27 (UNCLASSIFIED)

Classification: UNCLASSIFIED
Caveats: NONE

Hi Sara,

To follow-up on our conversation from Thursday morning, May 7, the Corps plans to use Nationwide Permit 27 (Restoration) for CWA Section 401 and 404 compliance for the Lower Willamette River Ecosystem Restoration General Investigation Feasibility Study and would like DEQ's approval/concurrence for the use and application of this NWP for the project. The study area encompasses the lower Willamette River watershed and its tributaries, from its confluence with the Columbia River at River Mile (RM) 0 to Willamette Falls, located at RM 26. Five project sites are being evaluated for restoration and the goal of the feasibility study is to identify a cost effective ecosystem restoration plan that maximizes habitat benefits while minimizing impacts to environmental, cultural, and socioeconomic resources. As we discussed, the Corps has evaluated the proposed actions for each of the five project sites and each site's design is consistent with the general and regional permit conditions for NWP 27. Consequently, the Corps plans to use the pre-certified state 401 water quality certification and associated 404 analysis to complete CWA compliance and complete the NEPA process for the feasibility study.

The five project sites and proposed restoration actions are detailed below. In our conversation Thursday, we discussed the Corps' need for written approval from DEQ to use NWP 27 for this project. Can you please respond via email, followed by a letter (as soon as time allows) with DEQ's position on the Corps' use of NWP for general investigation studies?

Thank you, and please let me know if you have any questions.
~Kris

The five project sites and proposed restoration actions include:

1. Kelley Point Park (Off-Channel and Riparian Restoration, Floodplain Restoration): This site plan would restore by excavating 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. Implementation of the project would result in the creation of approximately 4,500 linear feet of side channels to allow rearing and refugia for juvenile salmonids and fish usage. Habitat complexity and riparian vegetation would be restored on approximately 5,000 feet of shoreline by grading banks to a gentler gradient, removing invasive species, and revegetating with riparian shrubs and trees.

2. Oaks Crossing/Sellwood Riverfront Park (Off-Channel and Riparian Restoration, Wetland Restoration): This site plan would restore the floodplain habitat for salmonids and other wildlife by reconnecting off-channel habitat to the river, removing invasive species, and revegetating with native floodplain and riparian species. Sandy beach habitat diversity would be improved by the addition of LW.

3. BES Plant (Off-Channel and Riparian Restoration, Bank Restoration): This site plan would improve the hydroperiod to a floodplain backwater/swale area, and restore the riparian zone along Columbia Slough. Bank slopes would be reduced and large wood (LW) added along the banks to increase habitat complexity. Off-channel rearing and high-water fish 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 quality 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.

4. Kenton Cove (Off-Channel and Riparian Restoration): This site plan would diversify instream habitat in this backwater cove by adding LW, removing invasive species, and revegetating with native riparian species. Because the edges of the cove are very even and offer very little habitat complexity, the plan includes creating small habitat islands at the location of each woody debris jam, with the wood as the centerpiece of the habitat island.

5. Tryon Creek, Highway 43 (Stream and Side Chanel Connectivity for fish passage): This site plan would replace the culvert under Highway 43 and the train line, which is a fish barrier under most flow conditions and restore fish passage and natural stream functions. The construction area would be revegetated with native riparian species, and rocks would be placed in the streambed to create natural weirs for grade control 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 2.7 miles of stream within Tryon Creek State Natural Area (TCSNA).

Classification: UNCLASSIFIED
Caveats: NONE

Classification: UNCLASSIFIED
Caveats: NONE

Classification: UNCLASSIFIED
Caveats: NONE

Classification: UNCLASSIFIED
Caveats: NONE

Classification: UNCLASSIFIED
Caveats: NONE

10. MONITORING AND ADAPTIVE MANAGEMENT PLAN

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

This monitoring and adaptive management plan has been developed to ensure the success of the recommended ecosystem 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 percent non-federal costs.

Project objectives are:

1. Re-establish riparian and wetland communities;
2. Increase aquatic and riparian habitat complexity and diversity; and
3. Restore floodplain function and connectivity.

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 ecosystem restoration measures in meeting project objectives and, if needed, to establish adaptive management measures.

10.1. RE-ESTABLISH RIPARIAN AND WETLAND COMMUNITIES

Target(s):

1. Achieve 80 percent cover of native vegetation species per design at each site within 5 years post-construction and sustain through life of project. Target based on percent cover suitability for beaver and yellow warbler is best from 50 percent to 100 percent.
2. 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.

Monitoring Protocol:

1. Perform planned walk-through survey in post construction years. Percent cover will be visually assessed and documented for each stratum (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. Estimated cost $2,500 per year - total $10,000.
2. 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.

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. At the end of 10 years, the Corps and non-federal sponsor will evaluate the overall quality of habitat in each restored plant community. 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.

10.2. INCREASE AQUATIC AND RIPARIAN HABITAT COMPLEXITY AND DIVERSITY

Target(s):

1. At Kelley Point Park, BES Plant and Oaks Crossing, increase off-channel habitat by 25 percent by 2025, by maintaining hydrologic connection.
2. Increase LWD at all sites except Tryon Creek to 50 percent by 2025.

Monitoring Protocol:

1. At years 5 and 10 after construction, evaluate hydraulic connections using river cross-section surveys (every 200 feet from top of bank to top of bank or as appropriate). Estimated cost $5,000 each year - total $90,000.
2. Conduct a baseline survey for LWD in summer prior to construction at each site to develop baseline map/areas for comparison to all post-construction periods. Conduct post-construction assessment for LWD in years 5 and 10 after construction. Estimated cost $3,500 each year - total $7,000.

Adaptive Management Trigger(s):

1. If the target for connectivity is not achieved, the Corps and non-federal sponsor will identify location(s) where excavation is required.
2. If the targets for LWD are not achieved by the year specified, it should be installed in the river channel. The Corps and non-federal sponsor will to identify preferred location and number of pieces of wood to install to promote in-channel habitats.

10.3. RESTORE FLOODPLAIN FUNCTION AND CONNECTIVITY

Target(s):

1. Sustain floodplain connection at all site except Tryon Creek frequencies per design at each site. Target based on winter-spring primary off-channel rearing season for salmonids.
2. Ensure fish passability through channels during designated connection season (6-inch depth minimum) for life of project.
3. Document fish presence/absence to verify accessibility to all connected areas.

Monitoring Protocol:

1. Record water surface elevation in years 1, 5 and 10 following construction. Record bi-monthly intervals during designated connection season (*i.e.*, October through June). Estimated cost $10,000.
2. Conduct channel cross-section and profile surveys at all connector channels on each site (estimate 2 cross-sections on each channel) in years 1, 5, and 10 following construction. Document changes and identify frequency of connection. Identify causal factors for changes observed. Estimated cost $1,000 each year - total $3,000.
3. Conduct fish use of the off-channel and floodplain habitats surveys at each site via methods such as fyke nets, seining and/or electroshocking. Sampling will occur every month during the primary rearing and refuge connection period (*i.e.*, January through June). All fish species collected will be identified and measured for length. Sampling will occur in years 1, 3, and 5 following construction. Estimated cost $10,000 per year - total $30,000.

Adaptive Management Trigger(s):

1. If channel connection frequency and fish passage requirements are not met more than 20 percent during design flows, then the Corps and non-federal sponsor will review the data and causal factors to identify preferred management actions. Possible actions could include installation of large wood to promote scour (*i.e.*, if sediment deposition has occurred) or reduce channel velocities (via increased roughness); additional excavation if frequency targets are not met but no substantial channel deposition has occurred; reorientation of channel location (*i.e.*, if sediment deposition or erosion is caused by orientation and localized scour/deposition conditions); or additional revegetation to increase roughness or provide sediment trapping capacity.
2. If fish surveys document that salmonids are not present in specific locations, identify potential causal factors in relation to channel connection frequencies and fish passage guidelines. If any channel physical factor appears to be creating a barrier, then the Corps and the non-federal sponsor will evaluate management actions such as those described for the channels above. Also evaluate temperature data to determine suitability of habitat for native and non-native species and correlate to fish presence/absence.

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 could result in 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 ecosystem 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 $10,000 every 3 years at each of the inlets and outlets of the side channels, including revegetating areas affected during 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.

11. CONCLUSIONS AND RECOMMENDATIONS

This FS-EA has presented a set of recommended ecosystem restoration measures for the Lower Willamette River, Tryon Creek, and Columbia Slough based on the Corps plan formulation process. The recommended ecosystem 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 ecosystem 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 ecosystem 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.

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:

a. Provide 35 percent of total ecosystem restoration costs as further specified below:

    1. The required non-federal share of design costs allocated by the Government to ecosystem restoration in accordance with the terms of a design agreement entered into prior to commencement of design work for the ecosystem restoration features;
    2. Provide, during the first year of construction, any additional funds necessary to pay the full non-Federal share of design costs allocated by the Government to ecosystem restoration;
    3. 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 all as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of the ecosystem restoration features;
    4. Provide, during construction, any additional funds necessary to make its total contribution for ecosystem restoration equal to 35 percent of total ecosystem restoration costs;

b. Provide 50 percent of total recreation costs as further specified below:

   1. Provide 25 percent of design costs allocated by the Government to recreation in accordance with the terms of a design agreement entered into prior to commencement of design work for the recreation features;
   2. Provide, during the first year of construction, any additional funds necessary to pay the full non-Federal share of design costs allocated by the Government to recreation;
   3. 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 all as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of the recreation features;
   4. Provide, during construction, any additional funds necessary to make its total contribution for recreation equal to 50 percent of total recreation costs;

c. Provide, during construction, 100 percent of the total recreation costs that exceed an amount equal to 10 percent of the federal share of total ecosystem restoration costs;

d. Shall not use funds from other federal programs, including any non-federal contribution required as a matching share therefor, 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 such funds are authorized to be used to carry out the project;

e. 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 ecosystem restoration features, hinder operation and maintenance of the project, or interfere with the project's proper function;

f. Shall not use the ecosystem restoration features or lands, easements, and rights-of-way required for such features as a wetlands bank or mitigation credit for any other project;

g. Keep the recreation features, and access roads, parking areas, and other associated public use facilities, open and available to all on equal terms;

h. 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 CFR 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;

i. For so long as the project remains authorized, operate, maintain, repair, rehabilitate, and replace the project, or functional portions of the project, including any mitigation features, 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;

j. 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;

k. Hold and save the United States free from all damages arising from the 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;

l. 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 systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 Code of Federal Regulations (CFR) Section 33.20;

m. 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, entitled "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 (revising, codifying and enacting without substantial change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a *et seq.*), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 *et seq.*), and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c *et seq.*);

n. 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;

o. 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;

p. 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

q. 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 Water Resources Development Act 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.

Date: 21 MAY 15

José L. Aguilar
Colonel, Corps of Engineers
District Commander

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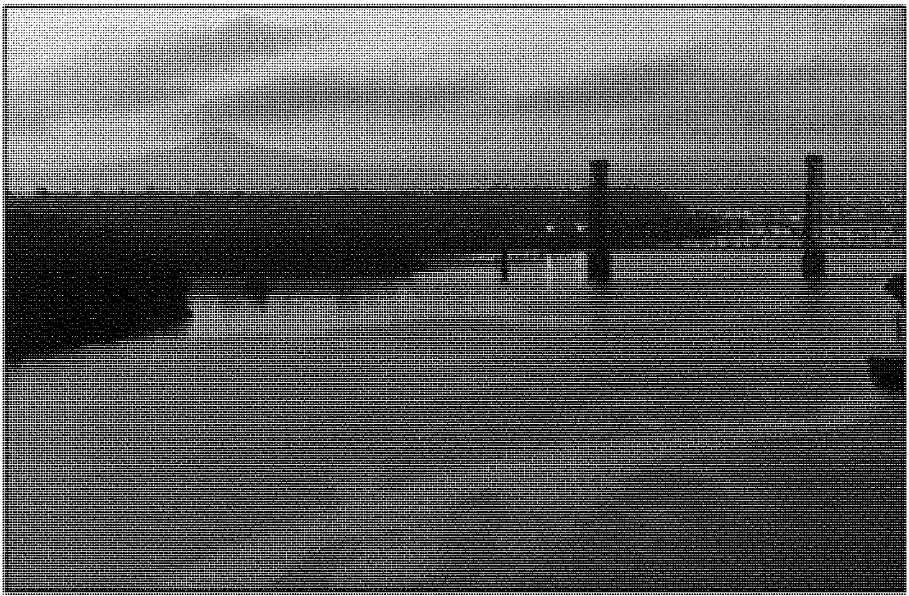
VOLUME 2

LOWER WILLAMETTE RIVER ENVIRONMENTAL DREDGING AND ECOSYSTEM RESTORATION

APPENDICES A-I



US Army Corps of Engineers ®
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APPENDIX A

Geomorphology

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1. INTRODUCTION

The U.S. Army Corps of Engineers, Portland District, and the City of Portland (City) are proposing to implement restoration measures at five sites in the Lower Willamette River and some of its tributaries. Previous analyses and consultation with project stakeholders have identified five potential restoration sites located along the Lower Willamette River, Columbia Slough, and in the Tryon Creek watershed (Figure 1). Conceptual restoration designs to enhance habitat have been developed for each site, which consist of varying combinations of: culvert replacement, side channel excavation, revegetation, installation of large wood (LW), and grading the channel banks.

This appendix details the geomorphic evaluation that was conducted at the restoration sites to identify potential design constraints and risks to the proposed restoration projects. A preliminary review of the geomorphology of the Lower Willamette River is presented followed by site specific evaluations. The proposed restoration sites are located in the North Reach (Columbia River confluence to River Mile 6), Columbia Slough, the South Reach (Ross Island Bridge [River Mile 14] to Sellwood Bridge [River Mile 16.6]), and Tryon Creek Figure 1.1).

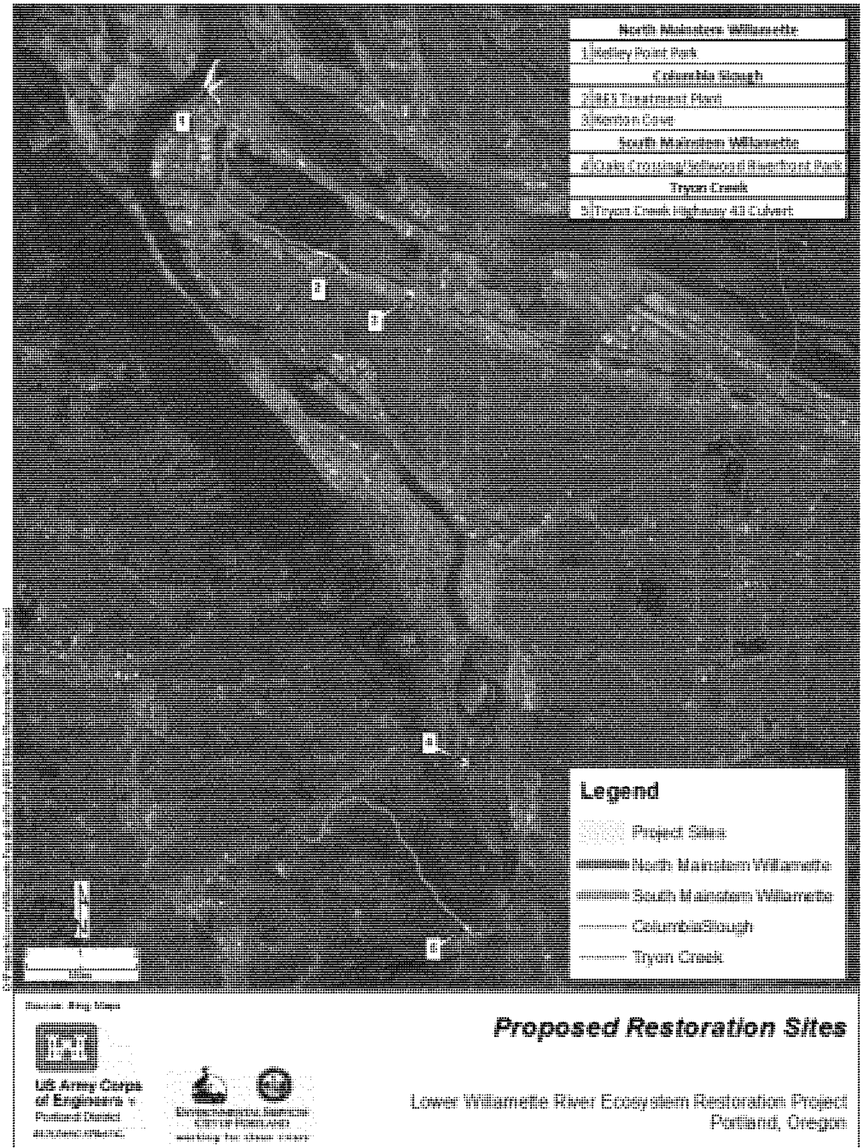

Figure 1.1. Proposed Restoration Sites

2. GEOMORPHOLOGY OF THE LOWER WILLAMETTE RIVER

The Willamette River has formed within a geologic setting created by volcanic outcropping and sediment deposits of the Missoula Floods. The dominant geological formation of the region is Columbia River basalt originating in lava flows from the eastern Columbia Basin. Willamette Falls, a basalt outcrop, provides significant hydraulic control for the river upstream of the Falls. Underlying the basalt is the Scappoose formation of late Oligocene to early Miocene age (approximately 22 million years ago), which is a sandstone and shale deposit that was formed when the region was ancient ocean bottom.

The Missoula Floods occurred approximately 13 to 15 thousand years ago during the last ice age and consisted of a series of massive floods from Glacial Lake Missoula discharging up to 100 million cubic feet per second (cfs) down the Columbia River Gorge that resulted in flooding across much of eastern Washington and the Willamette Valley in western Oregon. The floods were the caused by periodic failure of ice dams formed by the advancing glacial ice repeatedly damming the Clark Fork of the Columbia River. Sediment transported during the floods filled the valley floor. The Willamette River subsequently incised through the flood deposits and combined with the influence of the basaltic outcropping, the main channel planform has remained relatively stable (Hulse et al. 2002).

The Lower Willamette River is now a predominantly single-thread channel through the study area (Hulse et al. 2002). The channel gradient is very flat and flows are tidally influenced by the Columbia River as far upstream as Willamette Falls (River Mile 26)

Historically, streambed diversity was found in the form of floodplain marshes, side channels, braiding and islands. Following urban development, the extensive network of islands and sloughs of the historic delta are mostly gone, although a few islands remain, and there have been significant changes to the channel banks and the hydraulic characteristics of the river, most notably with the increase in average depth and decrease in the amount of shallow water and associated habitat.

Construction of the upstream dams on the Columbia and Willamette Rivers has significantly reduced frequency and magnitude of peak flows of the overbank flows, as well reduced the sediment supply to the Columbia and Willamette Rivers.

2.1 Channel Bed Material

The historical channel bed material characteristics of the Lower Willamette River are not known, but it is likely they were comprised of sand and fine-grained sediments along much of its length. The extensive changes in flow patterns, construction of dams, and extensive changes in channel structure and floodplain connection in both the Columbia and Willamette have almost certainly had an effect on sediment transport and deposition through the lower river, but the data to verify or quantify these potential changes are lacking (Portland Bureau of Environmental Services [PBES] 2006).

Presently, the 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 with the majority of the bedrock located between Willamette Falls and Portland (PBES 2006).

2.2 North Reach

Historically, the North Reach, which was probably the most dynamic reach below the Falls, consisted of a complex channel with in-channel islands and the river was strongly connected to the extensive low-lying wetlands formed by the Columbia Slough and Sauvie Island. The channel banks were described as gently sloping, and the channel geometry was more varied, providing a range of flow depths, including a significant amount of shallow water habitat. The pre-dam hydrology would have favored channel movement and reworking of the large island delta system at the mouth. Large accumulations of wood would have been present in and along the channel, along the banks, and throughout the floodplain, and would have had a large role in influencing channel morphology (PBES 2006).

Compared to historical conditions, the channel area has been reduced by approximately 10 percent due to encroachment of the floodplain and concentration of flows in the channel caused by dredging and bank armoring. The channel is now deeper, the banks have been steepened and there is now a weak connection to a greatly reduced floodplain area. All of these factors have contributed to a loss of approximately 780 acres of shallow water habitat. Historically, water less than 20 feet deep used to comprise 71 percent of the channel area and now comprises 12 percent; water from 40 to 60 feet deep used to be 1 percent of the total channel area in this segment and is now 47 percent of the channel area. Significant accumulations of large wood are absent which has greatly simplifying channel and bank structure (PBES 2006).

Presently, many of the banks consist of riprap, structures, unclassified fill, and sea walls. Twenty-six percent of the banks consist of natural and river beach banks, and 2 percent are biotechnical and bioengineered banks. Bank hardening is most prevalent along the port facilities in the southern portion of this segment. Banks have been diked and steepened with dredge fill over the years, which has further confined the channel and limited connection to the floodplain (PBES 2006).

Two tributaries that join the Willamette River at the North Reach are Miller Creek and Columbia Slough. Columbia Slough is approximately 19 miles long and drains a 32,700-acre watershed. This watershed historically consisted of a series of wetlands, lakes, and channels located between the Columbia and the Willamette Rivers. Although the Columbia Slough has undergone extensive structural alterations including development on its immediate overbank area, historical records indicate that the channel confluence with the Willamette River has remained in approximately the same location (PBES 2006). A review of historical aerial photos of the Columbia Slough indicates that the channel planform has been relatively stable at the proposed sites over the last 30 years

2.3 South Reach

Historically, the South Reach had more shallow water habitat than the North Reach, with 95 percent of the segment composed of water less than 20 feet deep. The segment is tightly constrained on the west bank by the West Hills. There are few streamside lowlands in this portion. The channel and floodplain broadened considerably near Ross Island and Oaks Bottom. The main channel flowed to the west of Ross Island and a smaller secondary channel flowed to the east of the island. An 1850s vegetation survey shows the island split in two by a channel and 1888 surveys show the island as a single large island nearly split in two by a channel (PBES 2006).

The South Reach is the only segment in which total channel area increased over the last 150 years, due to the decrease in the amount of uplands on Ross Island. Similar to the other segments, the channel has been significantly deepened, which has resulted in the shallow water depth being reduced from 95 percent under historic conditions to 44 percent under existing conditions, and 40- to 60-foot depths have gone from less than 1 percent to 21 percent of the segment. Despite these modifications, the South Reach retains the greatest amount of remaining shallow water habitat of the four segments.

Under existing conditions, approximately 60 percent of the bank length is beach habitat. Twenty-three percent of the banks have been converted to artificial bank structures such as riprap and bulkheads, by far the lowest of any of the segments. Bank hardening is most prevalent along the western shore opposite Ross Island.

3. GEOMORPHIC EVALUATION OF THE RESTORATION SITES

A geomorphic evaluation of the restoration sites was conducted to assess the potential risks to the proposed projects. The sites are separated into three areas: the Columbia Slough, Willamette River, and Tryon Creek. In general, the geomorphic conditions and proposed restoration features are similar within each project area.

Site inspections were conducted on January 16 and 17, 2013, and the field observations, together with observations from previous field work, aerial photographs, topographic mapping, and existing hydraulic model output, were used to develop the site evaluations. During the January 2013 field inspection, the Highway 43 site on Tryon Creek was visited, along with both sites on the Willamette River mainstem and both sites on Columbia Slough. In addition, field data collected during previous field trips were used in the site assessments. The site observations were documented using field notes, field mapping and photographs, and the locations of the observations were recorded using a handheld GPS. Some of the key features observed at the sites include the channel planform, channel geometry, hydraulic structures, existing restoration features, indicators of channel aggradation/degradation and lateral channel migration, sediment composition of the channel and overbanks, bank stability, and channel and overbank vegetation.

3.1 Columbia Slough Restoration Sites

The BES Plant and Kenton Cove sites are located along Columbia Slough. The proposed restoration plans for these sites consist of varying combinations of the following measures:

- Installation of LW for turtle habitat.
- Revegetation with native plants.
- Grading of channel banks to increase low-flow refugia.
- Excavation of portions of the overbank to increase high-flow refugia and connections under normal winter flows.
- Removal of fill material, installation of erosion control features.

Restoration plans for the BES Plant site include an excavated channel that links an existing pond to the main part of the slough (Figure 3.1). High-flow refugia will be excavated to correspond to normal winter flows (occurring roughly between November-April) so these sites will be inundated for up to 6 months of each year. Large wood will be keyed into the bank and anchored with large wood posts, so risk of mobilization is low. Elevations at which wood would be installed have not been developed at this stage of design, but at this site the primary purpose of installing wood is to provide cover for small fish and basking areas for turtles, therefore the elevations would be set such that wood would be partially submerged under low flows, and would emerge to allow for turtle basking areas and perching locations for birds. In this case, wood would not be installed to manipulate hydraulic features, and is not expected to do so due to very low velocities in the area. The upland area surrounding the pond and proposed channel is quite flat and stable and sediment input from upland sources is likely to be minimal. However, there is the potential for sediment deposition along the excavated channel between the pond and Columbia Slough, particularly in the vicinity of the confluence. Occasional maintenance may be required at this location to ensure that the channel remains open. The river banks are steep but appear to be stable due to the vegetation reinforcement and the sediment cohesion. The banks will be graded to a flatter slope to increase the amount of shallow water habitat and to widen the riparian zone (Figure 3.2). This, combined with low velocity of currents in Columbia Slough, indicates that risk of bank failure is minimal at this site.

The Kenton Cove site is a small embayment adjacent to Columbia Slough. It has high banks and levees around much of the site, which separates the embayment from the river. There is an open water connection to Columbia Slough at the downstream end of the embayment (Figure 3.3). The water-surface elevations in the embayment are tidally influenced and the velocities during the inflowing and outflowing tides are likely to be very low. The river banks at the site appear to be stable and, combined with the low velocities, the potential risks to the restoration features are considered low. Similar to the BES Plant site, elevations at which wood would be installed have not been developed at this stage of design, but at this site the primary purpose of installing wood is to provide cover for small fish therefore the elevations would be set such that wood would be partially submerged under low flows, and would emerge to allow for turtle basking areas and perching locations for birds. Wood would not be installed to manipulate hydraulic features, and is not expected to do so due to very low velocities in the area.

Figure 3.1. Off-channel swale at BES Plant Site.

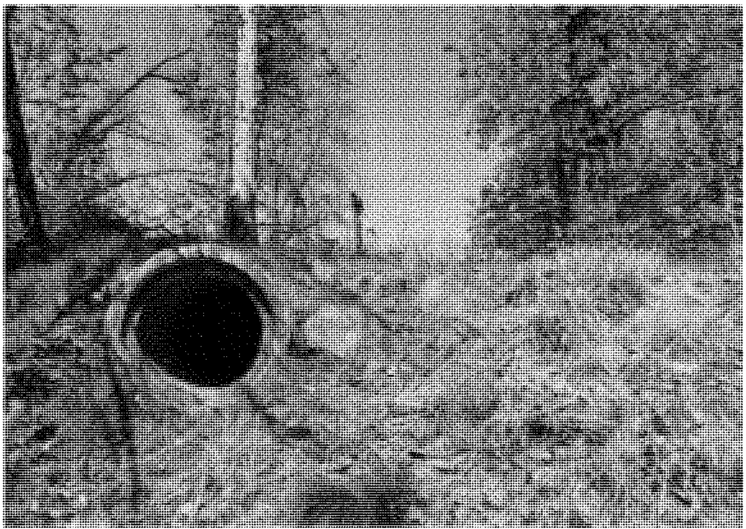

Figure 3.2. Steep banks and inlet to ponded area, BES Plant Site.

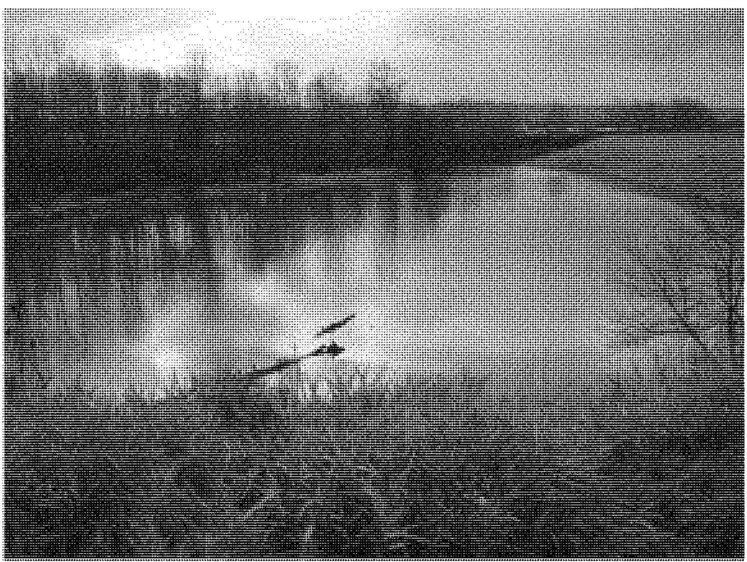

Figure 3.3. Overview of Kenton Cove, facing west. Connection to Columbia Slough is visible in upper right of the photo.

3.2 Willamette River Sites

The banks of the Willamette River sites have a mild slope and comprised of sand-sized material. (Figures 3.4 and 3.5). During flood stage, the flow depths and velocities are sufficiently high to transport LW onto and off of the river banks; therefore, it will be important to ensure the LW proposed in the restoration plan is adequately anchored. Due to the higher velocities that are likely to occur adjacent to the river and associated higher sediment transport rates, revegetation is proposed at the higher river bank elevations.

Proposed restoration measures at the Oaks Crossing/Sellwood Riverfront Park site include swale features constructed on the river bank and an excavated channel linking the swales to the river. Bottom elevations of the swales and the channel have been set at approximately 0.5 ft below the water surface elevation at normal winter flows, which is approximately 9.9 ft NAVD88 at this site. The channel is designed to connect directly to the river, with the swales connecting to the channel. At this preliminary level of design, the channel has been designed to ensure low velocities (< 1.0 f/s) during inundation and draining of the newly connected swales and existing wetlands. Similar to the Columbia Slough sites, there is the potential for sediment deposition along the excavated channel, particularly in the vicinity of the confluence with the Willamette River.

The proposed design of the Kelley Point Park site includes constructed side channels in the overbank to create off-channel habitat. Design features including elevations of the side channels, frequency of inundation, and connection to the river correspond to the methods described for the Oaks Crossing/Sellwood Riverfront Park site, above. The right bank of the river at this location is comprised of sand sized material and significant sand deposits were observed on the low-lying floodplain up to 300 feet away from the river. In addition, significant amounts of LW were observed in the overbank area, indicating the potential for LW to be transported on the floodplain during floods.

Elevations at which wood would be installed at these sites have not been developed at this stage of design, but at these sites the primary purpose of installing wood is to provide cover for small fish, therefore the elevations would be set such that wood would be partially submerged under low flows, and would emerge to allow for perching locations for birds. In this case, wood would not be installed to manipulate hydraulic features, and is not expected to do so due to very low velocities in the area.

Given the significant amount of sand deposits observed at the Kelley Point and Oaks Crossing/Sellwood Riverfront Park sites, including in the vicinity of the proposed inlet and outlet locations of the side channels, and the low gradient of the side channels, careful consideration will be given to the design of the side channels to prevent them from being blocked with sediment.

Figure 3.4. Looking downstream along the right bank of the Willamette River at the Kelley Point Park site at the approximate location of the outlet of the proposed side channel.

Figure 3.5. Looking upstream at banks of the Oaks Crossing/Sellwood Riverfront Park site.

3.3 Tryon Creek Highway 43 Culvert Site

The Tryon Creek watershed is located in southwest Portland and covers approximately 6.25 square miles. Tryon Creek flows from its headwaters near Multnomah Village southeast for about 7 miles to its confluence with the Willamette River in Lake Oswego. The watershed has been developed with mostly single-family residential housing. Approximately 20 percent of the watershed is parks and open space areas, with the Tryon Creek State Natural Area comprising a large portion of this area. In general, the watershed consists of predominately sandy loams and the hill slopes are very steep. The increase in impervious surface area due to development from housing and roads, as well as the steep topography, has resulted in a flashy hydrologic regime. Compared to historical conditions, the flood duration is longer and the magnitude of the peak flows has increased. Previous hydrology studies have shown that urbanization can increases peak flow rates by 2 to 5 times the predevelopment flows (Booth and Reinelt 1993). Although no data is available, it is likely that this altered hydrologic regime has contributed to channel incision and bank and slope instability, which resulted in an increase in sediment load to the system and a loss of riparian habitat.

The restoration plan at the Tryon Creek Highway 43 Culvert site (Figure 3.6) includes the replacement of the existing culvert with a 30-foot arch bottom culvert and revegetation of portions of the overbank upstream and downstream of the culvert.

The channel gradient immediately upstream of the culvert is relatively steep (approximately 4 percent), compared to the overall reach of approximately 2 percent. Upstream of the culvert, both banks are very steep and confine all the flows within the channel. The 2- and 100-year peak flow events are 264 cfs and 544 cfs, respectively (Tetra Tech 2013). The channel and banks are composed of boulder-sized material with the in-channel boulders forming a series of step-pools that provide grade control, energy dissipation and pool resting areas under low-flow conditions.

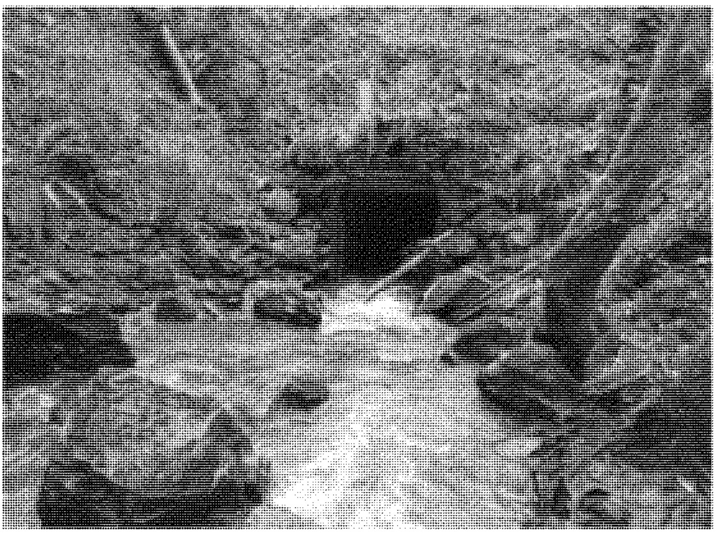

Figure 3.6. Looking downstream at the Tryon Creek Highway 43 Culvert inlet.

Upstream of the culvert, the channel has a pool-riffle planform and the bed is composed of gravel- to cobble-sized material (Figure 3.7 and Figure 3.8) with an approximate median size (D50) of 30-40 mm. Boulder-sized material line the margins of the channel. The channel width typically varies from 10 to 20 feet and the average channel slope is approximately 2 percent. No studies have been conducted to assess the mobility of the bed material or the sediment load along Tryon Creek. Field observations indicate that the bed material is periodically mobilized and erosion of the channel banks and valley walls contributes fine sediment to the creek. Large wood (LW) was observed along the creek and ranged up to 18 inches in diameter (Figure 3.6 and Figure 3.9). If mobilized, the LW could potentially block the existing culvert; however, the replacement culvert has been sized to pass large objects including trees, therefore this risk is considered to be low.

The channel is confined by the ravine walls and there were very few indicators to assess historic incision (Figure 3.8). Point bars have formed on the inside bends at wider sections of the ravine. The channel appears to be relatively stable, mature trees grow down to the margins of the channel and there are no signs of channel or bank instability between the culvert and approximately 600 feet upstream of the culvert. Although there is currently no evidence that large amounts of vegetation or woody debris mobilize during high flows, it is assumed that as ongoing upstream restoration efforts mature, additional wood will be available for recruitment into the stream. Therefore, the culvert has been sized to pass trees and other large debris.

Depending on the final design of the culvert, and in particular the slope of the culvert, a series of step-pools may be installed at the upstream end to provide grade control and fish passage in the steeper channel section and will prevent channel incision upstream of the new culvert. It has been proposed that a series of cross vanes weirs constructed using boulders will be placed within the culvert to provide energy dissipation and low-velocity zones and resting areas for fish passage. The boulders within the culvert will be adequately sized and anchored to remain stable under high flow conditions. Also, due to the large size of the culvert, it is anticipated that culvert will be less susceptible to blockage compared to the existing culvert. Monitoring of the culvert will be recommended as part of the ongoing maintenance plan.

At the downstream end of the existing culvert, there is a large plunge pool which provides energy dissipation and acts as a launching pool for upstream migrating fish (Figure 3.10). Downstream from the pool is a roughened chute (plane-bed section) that was constructed as part of the City of Portland's Lower Tryon Creek Stream Enhancement Project (Herrera Environmental Consultants 2007). The chute is composed of boulder-sized material, large wood, and imported streambed substrate. The upstream end of the chute provides the tailwater control for the pool. In general, the City's restoration appears to be functioning well; however, there are localized areas of bank instability downstream from the chute (Figure 3.11) due to the undersized channel and the alignment of the overbank flow path.

In summary, the channel upstream and downstream of the culvert appears to be stable, and there do not appear to be any significant limitations or adverse effects associated with replacing the culvert. As part of any design, it will be necessary to ensure that a sewer line that follows the creek alignment is protected.

Figure 3.8 Representative bed material size in Tryon Creek upstream from the culvert.

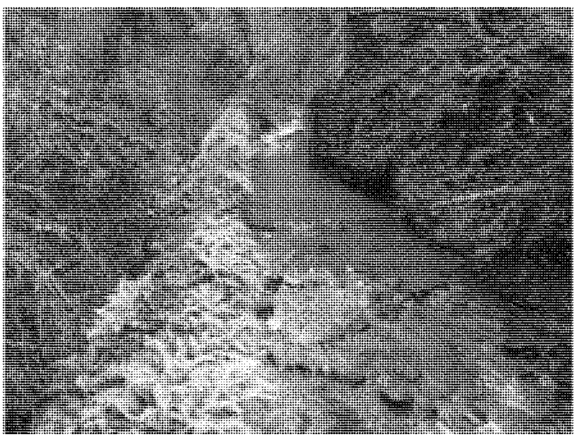

Figure 3.7 View looking upstream along Tryon Creek. Photo taken from approximately 100 feet upstream of the culvert.

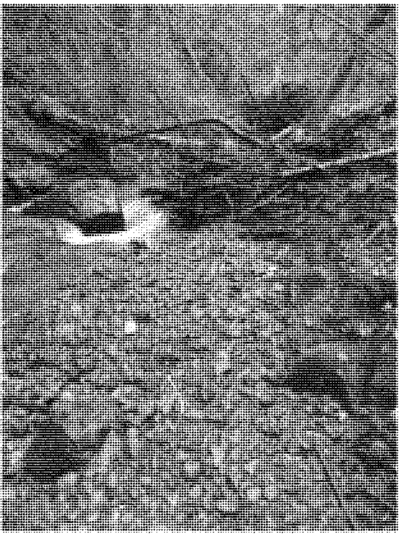

Figure 3.9 Large woody debris in channel upstream of the Highway 43 culvert.

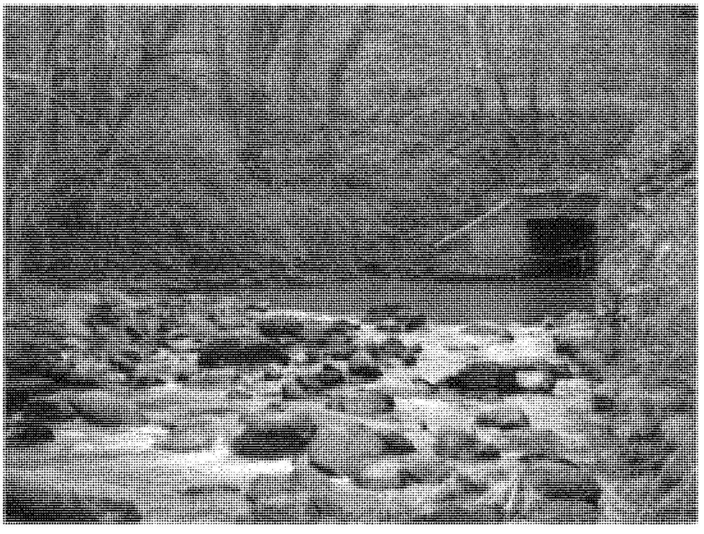

Figure 3.10 Looking upstream at the outlet of the Tryon Creek Highway 43 Culvert.

Figure 3.11 View upstream of Tryon Creek at localized bank failure at a previous restoration site.

4. SUMMARY

The five potential restoration sites were separated into three areas with similar geomorphic characteristics: Willamette River, Columbia Slough, and the Tryon Creek watershed. The Willamette and Columbia Slough sites are tidally influenced and the channel gradients are very low. It is predicted that these projects will have a relatively low risk of failure due to the relatively low velocities. Under flood conditions, it is anticipated that sand-sized material will be transported into the overbanks; therefore, it will be necessary, to the extent practical, to design the overbank side channels to minimize sediment the amount of sediment deposition, particularly at the upstream and downstream confluences.

The Tryon Creek Highway 43 site is located near the confluence of Tryon Creek and the Willamette River. The upper portions of Tryon Creek have steep channels, and due to urban development, the watershed hydrology is flashier with likely higher peak flows compared to predevelopment conditions. As a result, the channels have incised resulting in: (1) higher banks and a disconnection between the main channel and the floodplain, (2) culverts that are impassable to fish, and (3) bank and slope instability, which has resulted in an increase in sediment load to the channel.

Culvert replacement has been proposed at the Tryon Creek Highway 43 site. Step-pool grade control structures have been proposed on the upstream side of the culvert to provide grade control and fish passage during low flow conditions. At all of the sites, it has been proposed to install LW to provide habitat to increase channel stability. The LW will be designed and installed to ensure it remains in place under high flow conditions. There is likely a low risk of project failure and no adverse effects are anticipated at this stage; however, as with any restoration project, the risk of project failure is typically highest immediately after construction before the vegetation has become reestablished and the site stabilized.

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APPENDIX B

Hydrology and Hydraulics

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1. INTRODUCTION

1.1 Project Background

The United States Army Corps of Engineers (USACE), Portland District, in partnership with the City of Portland, Oregon, and the Port of Portland, is proposing to restore numerous sites in the Lower Willamette River as part of the Lower Willamette River Ecosystem Restoration Project. The USACE and its partners have prepared the Lower Willamette River General Investigation Study Conceptual Restoration Plan (Tetra Tech 2008), which formulated, evaluated, and screened potential solutions to improve significant ecosystem degradation in the Lower Willamette River watershed. In that document, conceptual restoration plans were prepared for a total of 31 sites.

The next phase of this project was designed to determine the data necessary to assess the feasibility of the proposed project and to evaluate the availability of this data. The Feasibility Work Plan (Tetra Tech 2009) summarized the background information available for each of the recommended project sites. Since the development of that report, further investigation of existing sites has resulted in a reduced number of sites included in the recommended plan. Sites along the mainstem of the Lower Willamette River, Columbia Slough, Johnson Creek, and Tryon Creek were initially assessed for feasibility of restoration. Sites along Johnson Creek have been removed from this planning process because of land ownership constraints or subsequent completion of restoration projects by other entities, and will not be mentioned further. Additional site screening has since occurred, leaving five sites as part of the recommended plan. This report considers the final five sites that have been selected for a full feasibility study (Figure 1.1).

As part of the work required for the completion of a draft feasibility report of the ecosystem restoration alternatives, a feasibility-level, or 35 percent, design is required including design plans, construction cost estimates, and a hydrologic and hydraulic assessment. The analysis presented in this technical memorandum provides the details of the hydrologic and hydraulic assessment component of the draft feasibility report for the remaining sites. It meets the four objectives outlined in the scope of work:

- Update statistical analyses for the five selected design discharges (median summer, median annual, median winter, 2-year, and 100-year) for evaluation of site feasibility.
- Apply HEC-RAS[1] models to evaluate the site on Tryon Creek.
- Investigate the potential impact of boat propeller scour on the sites.
- Compare existing and proposed hydraulic conditions based on modeled results for Tryon Creek.

Personal communication with USACE staff indicated there is a lack of existing impact studies of boat propeller scour that would be relevant to the draft feasibility analysis of the selected restoration sites. It was determined that no additional effort would be applied toward this objective at this time.

[1] HEC-RAS, or Hydrologic Engineering Center-River Analysis System, is a computer program that models the hydraulics of water flow through natural rivers and other channels.

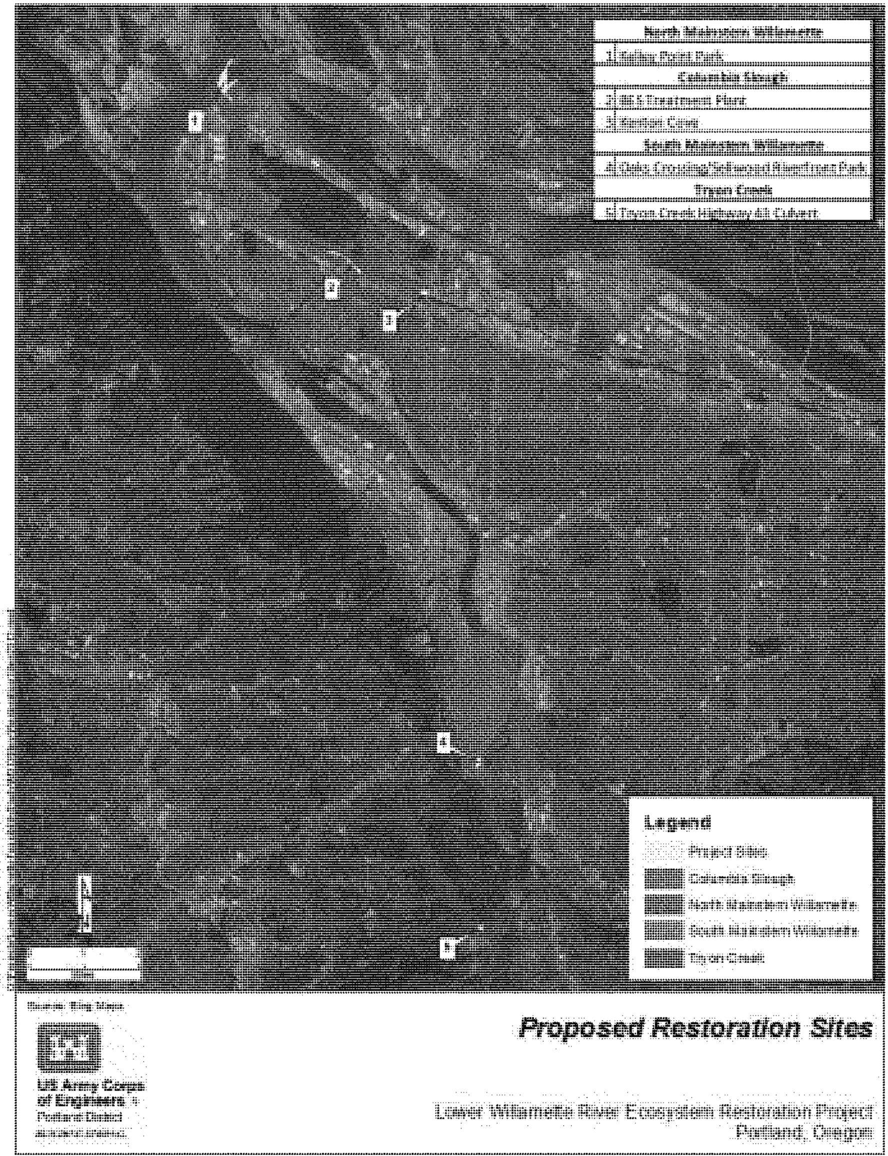

Figure 1.1. Proposed Restoration Site Locations

1.2 Site Locations and Proposed Restoration Measures

Mainstem Willamette River

The restoration project sites adjacent to the banks of the Mainstem of the Willamette River are directly influenced by the hydrology and hydraulics of the river. These sites are located at the confluence of tributaries to the Willamette River, at sloughs, or lakes, and have insignificant water level variation from the water surface elevation of the river. The restoration sites of this study that are within the Mainstem area include:

- Kelley Point Park
- Oaks Crossing/Sellwood Riverfront Park

The restoration measures proposed for these two sites include developing side channels or backwater areas, reducing bank steepness, and revegetating with native species. The hydrologic analyses performed to guide the design elevations for these elements are presented in this report.

Columbia Slough

Columbia Slough is a remnant of the historically extensive wetlands along the Columbia River between the mouths of the Sandy River and the Willamette River. The slough has an extensive levee system, enabling development of the floodplain. Several restoration project sites are adjacent to the banks of the lower portion of the Columbia Slough. The lower portion of Columbia Slough is defined by the City of Portland as the 8.5 mile long reach extending downstream of Northeast 18th Avenue to the confluence with the Willamette River (City of Portland 2007a). The restoration sites characterized as Columbia Slough sites are:

- City of Portland Bureau of Environmental Services (BES) Plant Banks
- Kenton Cove

The restoration measures proposed for both of these sites include reshaping of banks and/or side slough areas, revegetating with native species, and the addition of large woody debris (LWD). The hydrologic analyses performed to guide the design elevations for these elements are presented in this report.

Tryon Creek

Tryon Creek discharges generally southeast for about 7 miles from its headwaters to its confluence with the Willamette River. While the watershed is entirely within an urbanized area, more than 20 percent of the land within the watershed has been preserved in Tryon Creek State Natural Area (TCSNA). With the high percentage of land protected through preservation and conservation, the Tryon Creek watershed has the possibility to provide one of the largest and protected lengths of fish accessible habitat within the Portland metropolitan area.

A box culvert owned by the Oregon Department of Transportation (ODOT) is located approximately 1200 feet above the Tryon Creek confluence with the Willamette River and provides conveyance for Tryon Creek beneath Highway 43 and the Great Western Railroad. It was originally constructed in the 1920's and extended in 1955. The roadway elevation above the culvert is at approximately 85 feet above the North American Vertical Datum of 1988 (NAVD88). The existing culvert is 401 feet long with two segments of varying grade and alignment. The upper 100 foot segment of the culvert is sloped at 5.94% from 39.51 feet NAVD88 the to 33.57 feet NAVD88; and, the lower 301 foot segment is sloped at 2.94% from 33.57 feet NAVD88 to 24.72 feet NAVD88 (Figure 1.2). The culvert alignment resulted in a straightening of the natural Tryon Creek channel and loss of approximately 40 to 50 feet of stream length; and, the culvert alignment both increased (to 5.94%) and decreased (to 2.94%) the slope of the culvert segment from an average natural slope of 3.5% (City of Portland 2005). The design drawing for the culvert (ODOT 1955) indicates that the straightened section placed within the existing culvert was constructed through bedrock.

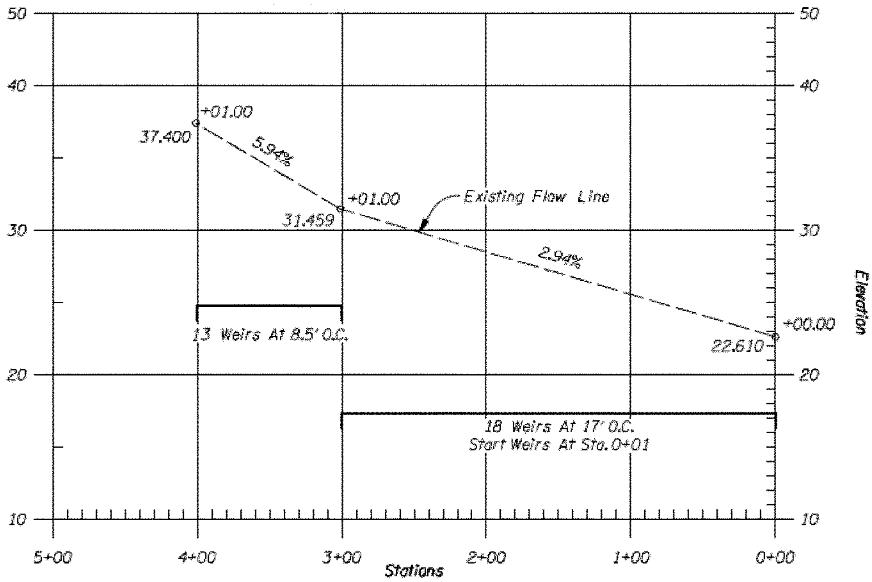

Figure 1.2. Existing Vertical Alignment of Tryon Creek Culvert

The culvert and portion of Tryon Creek below the culvert have been identified as a passage barrier for fish to access the middle and upper reaches of Tryon Creek habitat. This is due to higher water velocities and lower depths than what are needed for fish passage and holding within the culvert, and a perched downstream entrance to the culvert that causes a jump impediment. A plunge, or scour, pool that is approximately 4 to 5 feet deep is located below the downstream exit of the culvert, and energy dissipation was recommended to address the scour problem (City of Portland 2005). In 2005, the ODOT classified the Highway 43 culvert as a high priority for fish passage improvements.

Previous analysis and construction were performed as part of separate projects to improve fish passage below and through the Highway 43 culvert. Analysis of alternative designs for the culvert to provide fish, wildlife, and pedestrian passage was conducted by Henderson Land Services (2007) for the City of Lake Oswego and included an arch span culvert and a bridge. These features were taken to conceptual design but no farther. Downstream of the culvert entrance and as part of a separate study, the City of Portland created a roughened chute, comprised of boulders, streambed cobbles, and sill logs, intended to elevate water surfaces so that fish may swim into the culvert rather than jump to enter the culvert, and also reducing bank steepness (Herrera Environmental Consultants 2007). During the 2013 field reconnaissance surveys for the fluvial geomorphologic evaluation of the proposed restoration sites identified in this report, areas of instability were noted along the restored bank that were evidenced by erosion (Appendix A of the Feasibility Study Report).

Work within the culvert was performed in 2007 by ODOT to create the baffles (Figure 1.3) to provide holding water and suitable velocities for fish passage and a lamprey friendly design (ODFW 2011). The Columbia River Fisheries Program Office of the United States Fish and Wildlife Service (USFWS) has provided monitoring within Tryon Creek for Pacific and western brook lampreys, salmon, steelhead, and coastal cutthroat trout and assessment for distribution, determination of the ability of monitored species for passage through the Highway 43 culvert, and with the goal determining upstream passage efficiency. The USFWS monitoring indicates that following the culvert baffle and lower Tryon Creek work, lamprey and adult fish are not present upstream of the culvert (USFWS 2012).

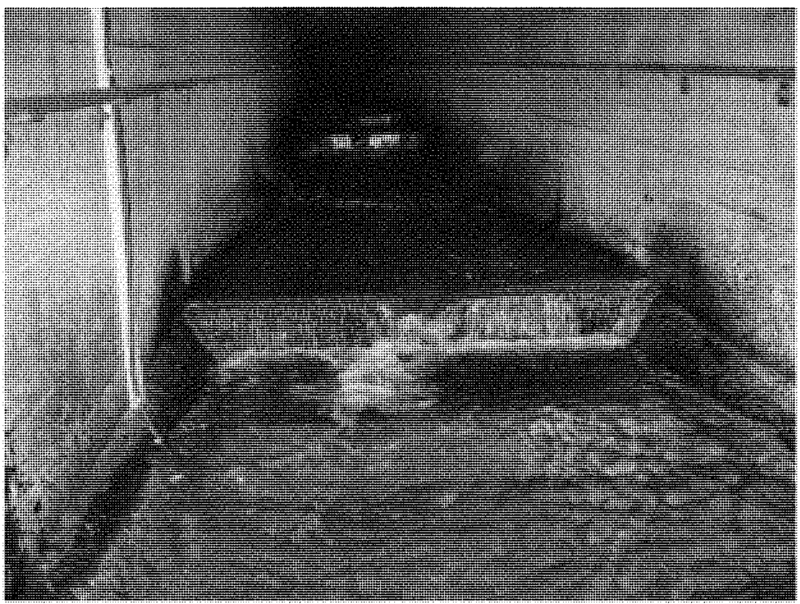

Figure 1.3. Modified baffles within Highway 43 culvert (USFWS 2012)

The restoration site in the Tryon Creek watershed that is the focus the Lower Willamette River Ecosystem Restoration Project is referred to as the Tryon Creek Highway 43 Culvert Replacement.

The restoration measures proposed for replacement of the Highway 43 culvert include removal of the existing 8 foot by 8 foot box culvert and replacement with an open bottom arch span culvert and creation of a natural stream channel within the culvert that provides fish passage meeting the Oregon Department of Fish and Wildlife (ODFW) criteria for the stream simulation option. Providing a fish passable culvert at this location will provide access for adult steelhead trout and cutthroat salmon to upper portion of the watershed. The hydrologic and hydraulic analyses to support the preliminary replacement culvert design meeting the fish passage criteria is presented in this report.

2. HYDROLOGY AND HYDRAULICS

This technical memorandum documents existing and proposed project hydrologic and hydraulic conditions for the project sites. Previously documented data and analyses were augmented and updated, and for some sites new data were obtained and analyzed. Existing and proposed characterizations include water levels and depths, velocities, and shear stresses at a level of detail commensurate with the available data and scope of work developed for each site (Tetra Tech 2008).

2.1 Mainstem Willamette River

This section describes the flood frequency, flow duration and stage duration analyses that were conducted to describe the hydrologic conditions of the Mainstem Willamette River. The basis for the analyses was the flow and stage data collected at U.S. Geological Service (USGS) Gage 14211720 (Willamette River at Portland, OR), which is located at River Mile (RM) 12.8. This gaging station is equipped with a water-stage recorder and an acoustic velocity meter. Flow at this station is affected by upstream reservoirs and is also affected by tidal conditions. According to the USGS surface water records for this station, daily mean discharge values since Water Year (WY) 2007 are produced from "Godin filtered" instantaneous discharges to remove the effects of the daily tidal cycle. The Godin process resamples the series to hourly increments using linear interpolation, and then applies three moving averages.

The objective of the flood frequency analysis was to quantify the 2-year and 100-year Annual Exceedance Probability (AEP) flow rates and water surface elevations at USGS Gage 14211720. The objective of the flow duration and stage duration analyses was to quantify the annual median flow rate and water surface elevation at USGS Gage 14211720, as well as the median summer and median winter flow rates and water surface elevations. Since proposed side channels and alcoves are intended to provide high-flow refugia for juvenile salmonids during the winter-spring time period when fish are present, invert elevations of side channels were intended to allow for a minimum of 0.5 feet water depth under median winter/spring flows, such that the refugia would be accessible at least 50% of the time during average winter-spring flow conditions. Also, since the objective is to provide high-flow refugia, and the side channels would always be inundated at high-flows (meaning above the winter-spring median), this objective would be met. Variability could occur during periods of unusually low winter-spring flows due to operations of the upstream dams or because of drought, but the high-flow refugia objective should still be met at least 50% of the time.

Flood Frequency Analysis

Maximum annual peak streamflow data and maximum annual peak gage height data were obtained for USGS Gage 14211720. Annual peak streamflow data were available for WY 1973 through WY 2013; however, not all of the published annual peak values are true instantaneous values. For many of the water years, the USGS only published annual maximum mean daily flow values instead of instantaneous peak flow values. In these instances, the published annual maximum mean daily flow values were derived from a hydrologic routing analysis. Table 2.1 summarizes the USGS published annual peak streamflow dataset for USGS Gage 14211720. In this table, those values that are true instantaneous peak flow values are differentiated from those that are maximum annual mean daily flow values. The values for WY 1995 through WY 2002 were not available on the USGS website, but instead were obtained directly from the USGS.

Table 2.1. Annual Peak Discharge for Water Years 1973-2012 for the Willamette River USGS Gage 14211720

Water Year	Date of Peak	USGS Published Annual Peak Flows (cfs) [1]	Annual Peak Flow Values used for Flood Frequency Analysis
1973	Dec. 24, 1972	142,000	142,000
1974	Jan. 18, 1974	283,000	283,000
1975	Dec. 22, 1974	123,000	123,000
1976	Dec. 04, 1975	164,000	164,000
1977	Mar. 10, 1977	58,100 [2]	61,600
1978	Dec. 16, 1977	237,000 [2]	251,000
1979	Feb. 13, 1979	120,000 [2]	127,000
1980	Jan. 14, 1980	217,000	217,000
1981	Dec. 28, 1980	198,000	198,000
1982	Feb. 21, 1982	207,000	207,000
1983	Jan. 08, 1983	170,000	170,000
1984	Feb. 15, 1984	138,000	138,000
1985	Nov. 29, 1984	148,000 [2]	157,000
1986	Feb. 24, 1986	213,000 [2]	226,000
1987	Feb. 02, 1987	164,000 [2]	174,000
1988	Jan. 16, 1988	170,000 [2]	180,000
1989	Jan. 12, 1989	112,000 [2]	119,000
1990	Jan. 09, 1990	142,000 [2]	150,000
1991	Jan. 15, 1991	102,000 [2]	108,000
1992	Feb. 22, 1992	105,000 [2]	111,000
1993	Mar. 24, 1993	122,000 [2]	129,000
1994	Feb. 25, 1994	117,000	117,000
1995	Jan. 17, 1995	180,000 [2]	191,000
1996	Feb. 09, 1996	420,000 [2]	445,000
1997	Jan. 02, 1997	293,000 [2]	310,000
1998	Jan. 17, 1998	146,000 [2]	155,000
1999	Dec. 30, 1998	240,000 [2]	254,000
2000	Nov. 28, 1999	160,000 [2]	170,000
2001	Dec. 25, 2000	53,000 [2]	56,200
2002	Dec. 17, 2001	140,000 [2]	148,000
2003	Feb. 01, 2003	160,000 [2]	170,000
2004	Jan. 31, 2004	136,000 [2]	144,000
2005	Dec. 12, 2004	94,300 [2]	99,900
2006	Dec. 31, 2005	191,000	191,000
2007	Dec. 16, 2006	146,000	146,000
2008	Dec. 05, 2007	135,000	135,000
2009	Jan. 02, 2009	188,000	188,000
2010	Jun. 07, 2010	115,000	115,000
2011	Jan. 18, 2011	149,000	149,000
2012	Jan. 21, 2012	211,000	211,000

Notes:
1. The USGS reported annual peak streamflow data includes both instantaneous peak flow values and annual maximum daily flow values
2. Flow value is a maximum annual mean daily flow value

Annual peak gage height data is also available for most, but not all, of the water years between WY 1973 and WY 2013. Due to the tidal influence on the gage, the reported maximum annual peak gage height does not necessarily correspond with the time of occurrence of the maximum annual peak flow value. Additionally, the gage height, even during periods of flood conditions, is influenced not only by the river flow but also the downstream tidal conditions. For this reason, it is not appropriate to conduct a flood frequency analysis on the stage data at this site to quantify the 2-year and 100-year water surface elevations. The Flood Insurance Study for the City of Portland (FEMA 2010) provides a summary of water surface elevations associated with the 10-year, 50-year, 100-year, and 500-year flood events. These values are presented in Table 2.2.

Table 2.2. Flood related water surface elevations for the Willamette River at Morrison Bridge (FEMA 2010)

Annual Percent Chance Exceedance	**AEP (years)**	**Water Surface Elevation (ft NAVD88)**
0.2	500	37.2
1	100	32.3
2	50	30.2
10	10	25.5

Prior to conducting the flood frequency analysis on the maximum annual peak streamflow dataset, those values that were reported as maximum annual mean daily flow values were first converted to an approximate instantaneous value using a ratio of 1.06. This ratio was determined by computing the ratio between instantaneous peak flow and the corresponding mean daily flow for each annual flood event for which both values were available. This computation was made for the seventeen flood events in Table 2.1 that had reported instantaneous peak flow values. The ratios ranged between 1.02 and 1.15, with a median value of 1.05 and an average value of 1.06.

The statistical software package HEC-SSP (USACE 2010) was used to calculate the 2-year and 100-year AEP flow rates. The 2-year AEP flow rate is also referred to as the flow rate that has a 50 percent chance of being exceeded in any given year. Likewise, the 100-year AEP flow rate is also referred to as the flow rate that has a 1 percent chance of being exceeded in any given year. The method used in HEC-SSP is based on the procedures described in *USGS Bulletin 17B Guidelines for Determining Flood Flow Frequency* (IACW 1982). The results of the analysis are summarized in Table 2.3, which shows that the 2-year AEP flow rate is estimated to be 160,000 cubic feet per second (cfs) and the 100-year AEP flow rate is estimated to be 384,000 cfs. These values are the ordinate values from the computed flood frequency curve, which is shown in Figure 2.1.

Table 2.3. Flood Frequency Analysis Results, Willamette River USGS Gage 14211720, WY 1973 to WY 2012

Annual Percent Chance Exceedance	AEP (years)	Computed Flood Frequency Curve Ordinate (cfs)
0.2	500	480,000
0.5	250	424,000
1.0	100	384,000
2.0	50	344,000
5.0	20	293,000
10.0	10	255,000
20.0	5	217,000
50.0	2	160,000

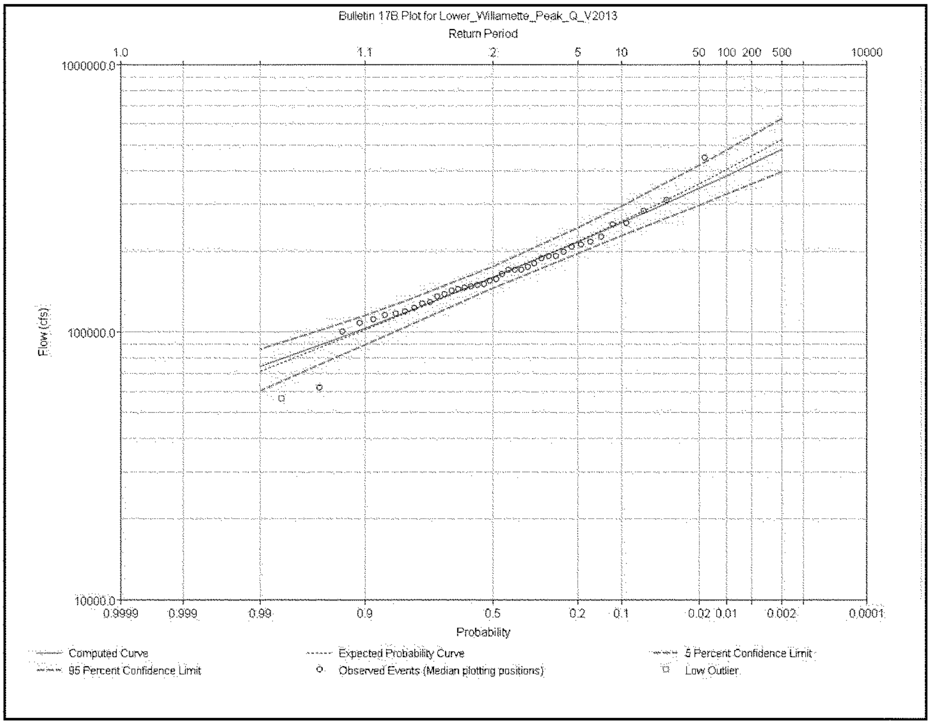

Figure 2.1. Flood Frequency Curve, Willamette River USGS Gage 14211720, WY 1973 to WY 2012

Flow and Stage Duration Analysis

A flow and stage duration analysis was conducted to characterize the hydrologic conditions in the Willamette River at USGS Gage 1421172. Specifically, the hydrologic conditions of interest were the annual, spring/summer seasonal and fall/winter seasonal median (50-percent exceedance) flow rates and water surface elevations. The spring/summer period was defined as May through September, inclusive, and the fall/winter period was defined as October through April, inclusive. Mean daily flow data was available for the time period from October 1, 1972 through March 28, 2013 and mean daily stage data was available for the time period October 11, 1987 through March 28, 2013. Both the flow and stage duration analysis were therefore conducted using these mean daily data sets. Because of the tidally influenced nature of the river at the gage location, it would be more appropriate to use hourly data for the stage duration analysis. However historical hourly stage data are not available at this site.

The median summer, annual and winter period flow rates and water surface elevation, as determined from the daily flow and stage duration analysis are summarized in Table 2.4. The water surface elevations in Table 2.4 are expressed relative to NAVD88. The raw stage data at the USGS gage is reported relative to a gage datum. According to the on-line station information for this gage, 1.55 feet is added to the gage height to convert gage height to an elevation relative to the National Geodetic Vertical Datum of 1929 (NGVD29). Using VERTCON, a computer program created by the National Geodetic Survey, it was determined that the conversion of elevation from NGVD29 to NAVD88 is 3.48 feet. Therefore the equation that was used to convert raw stage data to elevation data relative to the NAVD88 vertical datum was as follows:

NAVD88 (feet) = Gage Height (feet) + 1.55 feet + 3.48 feet

Table 2.4. Median Discharge and Water Surface Elevations for Summer, Annual and Winter Periods, Willamette River USGS Gage 14211720

Period	Discharge (cfs) [1]	Water surface elevation (feet NAVD88) [2]
Summer	11,100	9.6
Annual	21,600	9.8
Winter	34,000	9.9

Notes:
1. Median discharge for period based on published mean daily flows between October 1, 1972 and March 28, 2013
2. Median water surface elevation for period based on published mean daily gage heights between October 11, 1987 and March 28, 2013

Hydraulics

As stated previously, the hydrology of the mainstem Willamette River is affected by oceanic tide fluctuations and inflow from the upstream portions of the watershed, and the flow conditions are also influenced by the backwatering of the Columbia River. The USGS Gage 14211720 is located 12.3 miles upstream of Kelley Point Park and 3.7 miles downstream of Oaks Crossing/Sellwood Riverfront Park. Since the restoration site at Kelley Point Park is located less than 1 mile from the USGS Gage 14211820 on Columbia Slough and the conditions observed at this gage reflect conditions in the nearby mainstem

Willamette River, as discussed in Section 2.2 Columbia Slough (below), the analyses at the Columbia Slough gage were used to design the conditions at Kelley Point Park. The restoration measures for both of the restoration sites on the Mainstem Willamette River are focused on providing inundation at the median winter level side channel/backwater areas and are primarily dependent upon water surface elevations. Therefore the results from the flow and stage duration analysis were utilized in the design of these sites, and no hydraulic modeling was performed for these sites.

2.2 Columbia Slough

This section describes the flood frequency, flow duration and stage duration analyses that were conducted to describe the hydrologic conditions in the vicinity of the two Columbia Slough Sites - the Bureau of Environmental Services (BES) Treatment Plant Site and the Kenton Cove Site. The basis for the analyses was the flow and stage data collected at USGS Gage 14211820 (Columbia Slough at Portland, OR), which is located 0.6 miles upstream of the mouth of the Columbia Slough and 1.25 miles upstream from the Willamette River and Columbia River confluence. This gaging station is equipped with a water-stage recorder and an acoustic velocity meter. Flow at this station is affected by astronomical tidal conditions, which can cause reverse flow during tidal cycle. According to the USGS surface water records for this station, daily mean discharge values since WY 2007 are produced from "Godin filtered" instantaneous discharges to remove the effects of the daily tidal cycle. The Godin process resamples the series to hourly increments, on the hour, using linear interpolation, and then applies three moving averages.

The objective of the flood frequency analysis was to quantify the 2-year and 100-year AEP flow rates. The objective of the flow duration and stage duration analyses was to quantify the annual median flow rate and water surface elevation at USGS Gage 14211820, as well as the median summer and median winter flow rates and water surface elevations.

Flood Frequency Analysis

Maximum annual peak streamflow data and maximum annual peak gage height data were obtained for USGS Gage 14211820. Annual peak streamflow data were available for WY 1990 through WY 2012. All of the published annual peak values are annual maximum mean daily flow values as opposed to instantaneous peak flow values. Table 2.5 summarizes the USGS published annual peak streamflow dataset for USGS Gage 14211820.

The statistical software package HEC-SSP (USACE 2010) was used to calculate the 2-year and 100-year AEP flow rates. The 2-year AEP flow rate is also referred to as the flow rate that has a 50 percent chance of being exceeded in any given year. Likewise, the 100-year AEP flow rate is also referred to as the flow rate that has a 1 percent chance of being exceeded in any given year. The method used in HEC-SSP is based on the procedures described in *USGS Bulletin 17B Guidelines for Determining Flood Flow Frequency* (IACW 1982). The results of the analysis are summarized in Table 6. It is noted that the flood frequency analysis was conducted using the maximum annual mean daily flow dataset. Therefore, the flood frequency analysis ordinates summarized in Table 2.6 are mean daily flow values, not instantaneous peak flow values. Table 2.6 shows that the mean daily flow rate that has a 50 percent chance of being exceeded in any given year (2-year AEP) is 600 cfs. The mean daily flow rate that has a 1 percent chance of being exceeded in any given year is 3,250 cfs.

The reliability of the flood frequency curve gradually decreases for more extreme flood events and the period of record for the sample is the main controlling factor concerning the reliability of the flood frequency curve. A general rule of thumb presented in Cudworth (1989), which is supported by statistical calculations, indicates that frequency curves are reasonably reliable out to AEPs of no more than twice the period of record of the sample. Hence, given the relatively short 23-year period of record for the annual flood series, the flood frequency results summarized in Table 2.6 and in Figure 2.2 are reasonably reliable out to approximately the 50-yr AEP.

Table 2.5. Annual Peak Discharge for Water Years 1990-2012 for the Columbia Slough USGS Gage 14211820

Water Year	Date of Peak	USGS Published Annual Peak Flows (cfs) [1]
1990	Jan. 28 1990	1,570
1991	Jun. 20 1991	424
1992	Feb. 23 1992	366
1993	Dec. 10 1992	340
1994	Feb. 27 1994	327
1995	Oct. 27 1994	560
1996	Dec. 5 1995	2,400
1997	Jan. 5 1995	2,080
1998	Jun. 2 1998	394
1999	Mar. 1 1999	956
2000	Nov. 28 1999	497
2001	Dec. 15 2000	307
2002	Feb. 10 2002	311
2003	Feb. 4 2003	873
2004	Feb. 1 2004	422
2005	Dec. 19 2004	331
2006	Jan. 15 2006	1,190
2007	Nov. 11 2006	502
2008	Jun. 8 2008	507
2009	Jan. 11 2009	421
2010	Jun. 14 2010	854
2011	Apr. 8 2011	875
2012	Apr. 5 2012	1,270
Notes: 1. All flow values are maximum annual mean daily flow rates		

Table 2.6. Flood Frequency Analysis Results, Columbia Slough USGS Gage 14211820, WY 1990 to WY 2012

Annual Percent Chance Exceedance	AEP (yrs)	Computed Flood Frequency Curve Ordinate (cfs) [1]
0.2	500	5,210
0.5	250	4,010
1.0	100	3,250
2.0	50	2,600
5.0	20	1,890
10.0	10	1,440
20.0	5	1,050
50.0	2	600

Notes:
1. Flood frequency analysis was conducted on maximum annual mean daily flow values, so the flood frequency ordinates are mean daily flow values

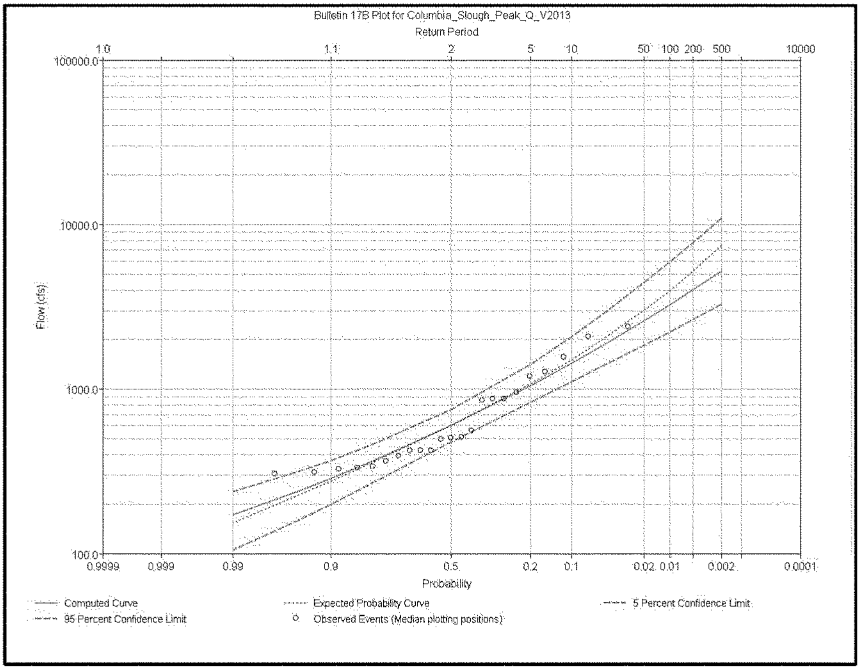

Figure 2.2. Flood Frequency Curve, Columbia Slough USGS Gage 14211720, WY 1990 to WY 2012

Flow and Stage Duration Analysis

A flow and stage duration analysis was conducted to characterize the hydrologic conditions in the Columbia Slough at USGS Gage 14211820. Specifically, the hydrologic conditions of interest were the annual, spring/summer seasonal and fall/winter seasonal median (50-percent exceedance) flow rates and water surface elevations. Mean daily flow data was available for the time period from October 14, 1988 through March 28, 2013 and mean daily stage data was available for the time period October 12, 2002 through March 28, 2013. Both the flow and stage duration analysis were therefore conducted using these mean daily data sets. Because of the tidally influenced nature of the river at the gage location, it would be more appropriate to use hourly data for the stage duration analysis. However historical hourly stage data are not available at this site.

The median summer, annual and winter period flow rates and water surface elevation, as determined from the daily flow and stage duration analysis are summarized in Table 2.7. The water surface elevations in Table 2.7 are expressed relative to NAVD88. The raw stage data at the USGS Gage is reported relative to a gage datum. According to the on-line station information for this gage, 1.53 feet is added to the gage height to convert gage height to an elevation relative to NGVD29. Again, using VERTCON, it was determined that the conversion of elevation from NGVD29 to NAVD88 is 3.39 feet. Therefore the equation that was used to convert raw stage data at this gage to elevation data relative to the NAVD88 vertical datum was as follows:

$$\text{NAVD88 (feet)} = \text{Gage Height (feet)} + 1.53 \text{ feet} + 3.39 \text{ feet}$$

Table 2.7. Median Discharge and Water Surface Elevations for Summer, Annual and Winter Periods, Columbia Slough USGS Gage 14211820

Period	Discharge (cfs) [1]	Water surface elevation (feet NAVD88) [2]
Summer	66	9.3
Annual	92	9.6
Wiuter	114	9.7

Notes:
1. Median discharge for period based on published mean daily flows between October 14, 1988 and March 28, 2013
2. Median water surface elevation for period based on published mean daily gage heights between October 12, 2002 and March 28, 2013

Hydraulics

The water surface elevations of the lower portion of Columbia Slough are primarily affected by the backwatering of the Columbia River and the Willamette River flow conditions, and also from oceanic tidal water surface fluctuations propagated up the Columbia River and Willamette River (City of Portland 2007a). The lower portion of Columbia Slough, having a median annual discharge that is approximately 0.5 percent of the median annual discharge of the Willamette River, does not experience high discharges, or the associated high velocities and shear stresses observed in the Willamette River. Since the restoration measures for the Columbia Slough sites, including the desired median winter inundation level of side slough areas and elevation zones for with native vegetation species planting are primarily dependent upon water surface elevations, the results from the flow and stage duration analysis were utilized in the design of these sites. Therefore, no hydraulic modeling was performed for the Columbia Slough sites.

2.3 Tryon Creek

Flood Frequency Analysis

Flood frequency analysis for Tryon Creek was developed for the final pre-design report for the Boones Ferry Road Culvert Replacement Project (Tetra Tech 2007). The discharges presented in that report are reproduced in Table 2.8.

Table 2.8. Flood Frequency Results for Tryon Creek

Annual Percent Chance Exceedance	AEP (yrs)	Discharge (cfs)
1.0	100	544
2.0	50	445
4.0	25	379
10.0	10	330
20.0	5	294
50.0	2	264

Flow Duration Analysis

Median seasonal discharges were also developed for the Boones Ferry Road Culvert Replacement Project (Tetra Tech 2007). These discharges are provided in Table 2.9.

Table 2.9. Summary of Frequency Analysis for Tryon Creek Watershed Restoration Sites

Site	Median Summer Discharge (cfs)	Median Annual Discharge (cfs)	Median Winter Discharge (cfs)
Highway 43 Culvert	1	5	10

Hydraulics

Hydraulic analysis was performed to support the feasibility level design of a replacement culvert for Tryon Creek at the Highway 43 crossing. The purpose of this analysis was to provide proof of concept for a replacement culvert that meets the State of Oregon's fish passage criteria based on the stream simulation option for an open-bottomed road-stream crossing structure (OAR 2013a) as determined during the conceptual phase of the Lower Willamette River Ecosystem Restoration Project. During the conceptual phase of the project, a cost analysis was completed and conceptual designs were prepared to assess the differences between replacing the existing culvert with an arch span culvert and a bridge. This previous work determined that the arch span culvert was the most cost effective replacement solution and recommended this conceptual design for further analysis in the Feasibility Study.

A HEC-RAS hydraulic model was developed by the City of Portland (2007b) for the Highway 43 culvert on Tryon Creek and a second model for the segment of Tryon Creek downstream of the culvert to the confluence with the Willamette River (City of Portland 2007c). This first model was created and used previously for the design of baffles (*Figure 1.3*) within the Highway 43 culvert to enhance fish passage by providing holding water between the baffles for fish. Each of the baffles was simulated in the HEC-RAS model using the inline structure geometry options. The model was obtained from ODOT. The second model was created and used previously for the Lower Tryon Creek Stream Enhancement Design (Herrera Environmental Consultants 2007), and was obtained from the City of Portland. The Lower Tryon Creek Stream Enhancement Design project resulted in the creation of a roughened chute located downstream of a plunge pool at the exit of the culvert. The roughened chute was designed to maintain a water depth of 1 foot at the exit of the culvert, for a Tryon Creek discharge of 1.4 cfs, to allow fish to swim into the culvert rather than jump into the culvert. Roughness coefficients used in the Herrera model varied between n = 0.03 and n = 0.06. Contraction and Expansion coefficients were left at the default values of 0.1 and 0.3, respectively. The roughened chute was modeled by adjusting the cross sectional geometry to reflect the design of the chute. Bed elevations were increased 1.5-2 ft while the roughness coefficients were increased from n = 0.038 to n = 0.04 within the channel. The cross sections in the roughened chute were spaced 2- 7.75 ft apart, with an average spacing of 4.75 ft. Downstream of the roughened chute, cross sections were spaced 8-25 ft apart with an average spacing of 17.4 ft.

The two previous HEC-RAS models were merged to create a continuous model of Tryon Creek extending from the upstream inlet of the Highway 43 culvert to the confluence with the Willamette River. Elevations within the provided models were referenced to the City of Portland's vertical datum, which is approximately 2.11 feet below NAVD88. The elevations of the merged model were increased by 2.11 feet to convert to NAVD88. Additional cross section and thalweg survey data were collected during 2008 and 2009, and were supplemented with LiDAR data (Watershed Sciences 2009). This information was used to extend the length of Tryon Creek that was modeled upstream of the Highway 43 culvert in order to better estimate the upstream hydraulic conditions. The two modeled cross sections were spaced 500 ft apart, with the downstream cross section spaced 40 ft upstream of the culvert entrance. Roughness coefficients in the two upstream cross sections were set at a constant n = 0.05. The most upstream cross section used the default contraction and expansion coefficients of 0.1 and 0.3, respectively, while the downstream cross section used contraction and expansion coefficients of 0.6 and 0.8, respectively, to account for the transition to the culvert.

The existing hydraulic conditions were modeled using the five discharge conditions, including the 2-year, the 100-year, the median summer, median winter, and median annual. Although the Willamette River provides a backwater effect at the confluence with Tryon Creek, thus reducing water velocities within Tryon Creek, the downstream boundary conditions for the HEC-RAS modeling of Tryon Creek were set to the normal depth condition. Using the normal depth assumption for the downstream boundary condition of Tryon Creek removes the backwater effect of the Willamette River from the analysis and provides a more conservative approach to evaluating fish passage and stream channel stability.

The State of Oregon fish passage criteria used to guide the culvert sizing and hydraulic analysis requires that the culvert be wide enough to accommodate the active channel width which according to OAR (2013a) can be defined as the stream width between the channel bankfull elevations. The existing conditions model was used to estimate upstream hydraulic conditions for the 2-year discharge corresponding to an approximate the bankfull elevation (OAR 2013b) of 47.2 feet NAVD88. Using the estimated bankfull elevation an active channel width of 20.2 feet was determined. Chapter 6 of the ODOT Hydraulics Manual (ODOT 2011) provides a conservative approach (Case 2) for sizing the minimum width of a culvert as a span equal to 125% of the active channel width plus 2 feet, which for the Highway 43 culvert results in a span of 27.25 feet (20.2 feet * 1.25 + 2 feet = 27.25 feet). To increase efficiency during construction and reduce costs, it was assumed during the conceptual phase of the project that the arch culvert designed would be a pre-cast structure. The pre-cast arch culvert size large enough to accommodate this span width is 30 feet wide (Contech 2013) with a rise of 12.3 feet. The State of Oregon's fish passage criteria requires that a minimum of 3 feet of vertical clearance be provided from the active channel width elevation to the inside top of the structure. For the proposed structure, 14.8 feet of vertical clearance will be provided from the active channel width elevation to the inside top of the structure. A maximum interior width of 30 feet will provide capacity to pass large debris, such as wood and boulders, through the culvert. Therefore, a width of 20.2 feet was used to define the low flow channel width and a width of 30 feet used to define the high flow channel width proposed for the interior of the replacement culvert. This cross section is illustrated in Figure 2.3.

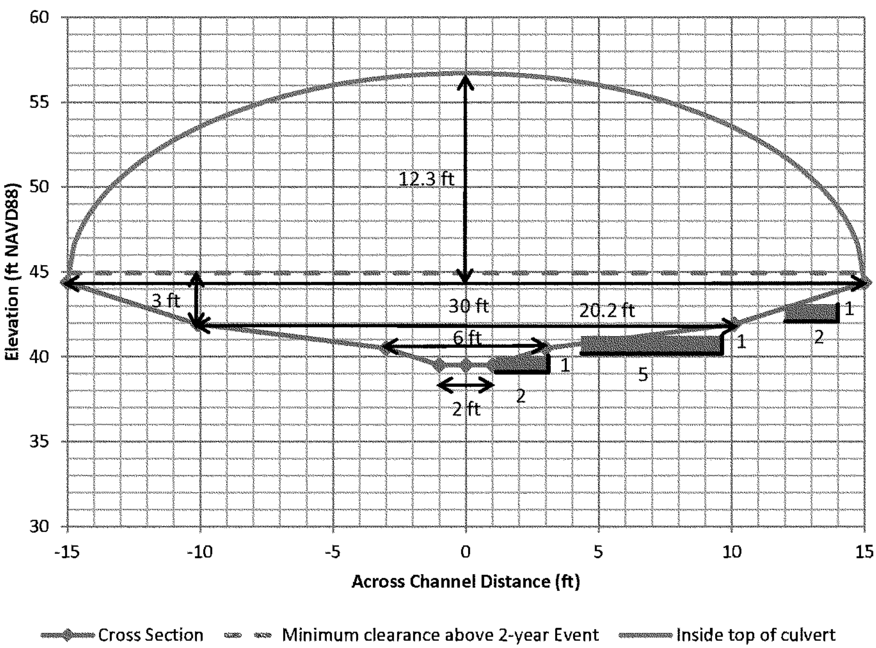

Figure 2.3. Channel cross section geometry inside of replacement culvert at Highway 43

The State of Oregon fish passage criteria specifies that the structure shall have a slope equal to that of the surrounding stream profile and have elevations that are continuous with this profile. Previous analysis indicates that the natural streambed slope is 3.5%, that the existing culvert has a variable slope of 5.94% and 2.94%, and that the plunge pool downstream of the existing culvert is seen as a scour problem. Therefore, the proposed profile will extend from the upstream elevation of the existing culvert of 39.51 feet NAVD88 to the top of the roughened chute downstream of the plunge pool to the existing elevation of 23.4 feet NAVD88, and achieve an average streambed slope of 3.4%. The resulting streambed slope is closer to the overall natural streambed slope of 3.5% (City of Portland 2005) than the existing culvert slopes, is continuous with upstream and downstream existing elevations, and eliminates the plunge pool downstream of the existing culvert by the proposed grading. The filled-in plunge pool was modeled by copying the cross section downstream of the pool and adjusting the elevations to account for the slope. For grade control and to further facilitate fish passage within the culvert, a series of streambed grade controls constructed of approximately 36 inch diameter boulders that are partially embedded and arranged in channel spanning rock weirs inside of the culvert have been added. These features provide a simulated step pool sequence and are simulated in the HEC-RAS model using the inline structure geometry options. The existing and proposed streambed slopes are illustrated in Figure 2.4.

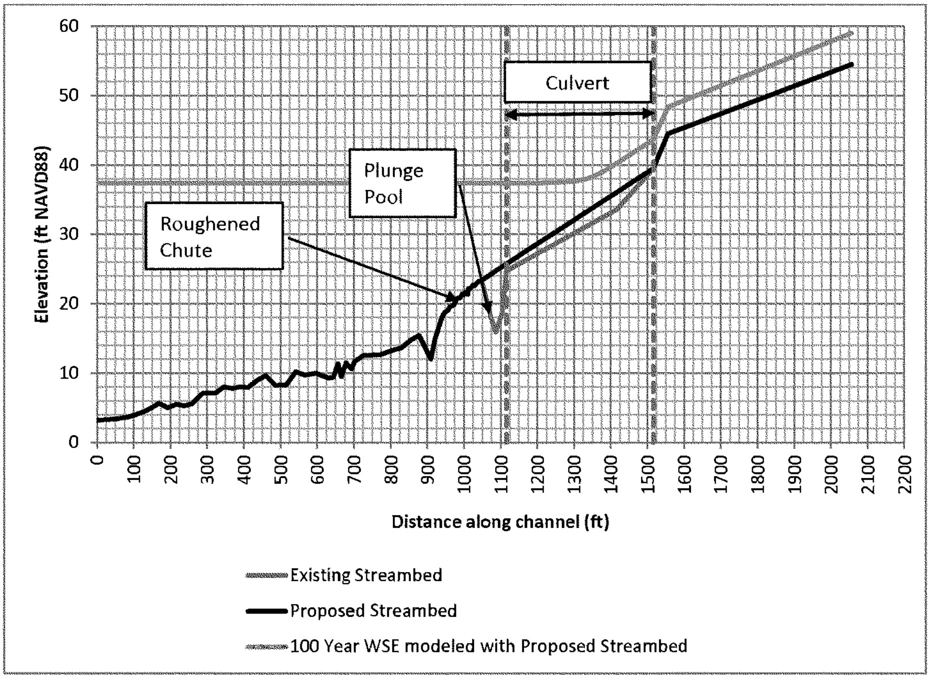

Figure 2.4. Profiles for the existing and proposed streambeds used for hydraulic analysis

The State of Oregon's fish passage criteria requires that the bed material placed within the structure be stable, mechanically placed, composed of similarly sized and graded material as the natural surrounding stream, and for closed-bottom road-stream crossing structures contain partially-buried over-sized rock. Therefore the hydraulic model roughness factors for cross sections representing the natural channel design within the open bottomed culvert were adjusted following USACE guidance (USACE 1994a) for obstructions and set to the Manning's n value of 0.06. Interpolated cross sections were inserted in the model at 10 ft intervals over the 400 ft length of the culvert. The culvert was modeled as an open channel, with contraction and expansion coefficients increased to 0.6 and 0.8, respectively, to account for the transition to varied stream bed.

The proposed and existing conditions HEC-RAS models were evaluated using both the subcritical and mixed flow regimes. The results of the mixed flow evaluation are the same as the subcritical evaluation within the culvert, and differ only downstream of the proposed culvert exit. The hydraulics within the proposed conditions culvert are controlled by the streambed grade control features, which create backwater pools up to the next sequential rock weir and dissipate energy through the culvert. In the proposed conditions, the culvert grade has been reduced from the existing and in order to more closely match the natural/historical condition for Tryon Creek with a slope of 3.4%. Additionally, the plunge pool located downstream of the existing conditions culvert outlet was filled in to achieve the reduced proposed conditions culvert grade.

Comparisons of velocity and depth results for the hydraulic simulations at representative cross sections are presented in Table 2.10 and Table 2.11 for both the subcritical and mixed flow regime analysis. The State of Oregon's fish passage criteria requires that average water depths and velocities of the surrounding stream channel are maintained within the road-stream crossing structure. Fish passage for the proposed design is considered a priority for the median winter conditions, which correspond to the period of migration for adult steelhead trout and cutthroat salmon. For these conditions, the model results indicate that the water depths and velocities predicted inside of the proposed culvert fall within the range of the surrounding stream. For the mixed flow regime analysis, increased velocities and decreased water surface elevations are predicted for the former pool location, and for the next design phase the proposed conditions will be further investigated to methods of dissipating this energy and reducing velocities/shear stresses.The cross section layout for the proposed conditions is shown in Figure 2.5. The five discharge steady state boundary conditions were then simulated for the proposed culvert. Modeled water surface elevations were used to delineate the flood extents of the 100 year discharge upstream of the culvert. The resulting flood extents are shown in Figure 2.6. Downstream of the culvert, the water surface elevation mapped as 37.4 ft, corresponding to the 100 year WSE of the Willamette River. These extents were mapped by filling all areas within the 37.4 ft contour.

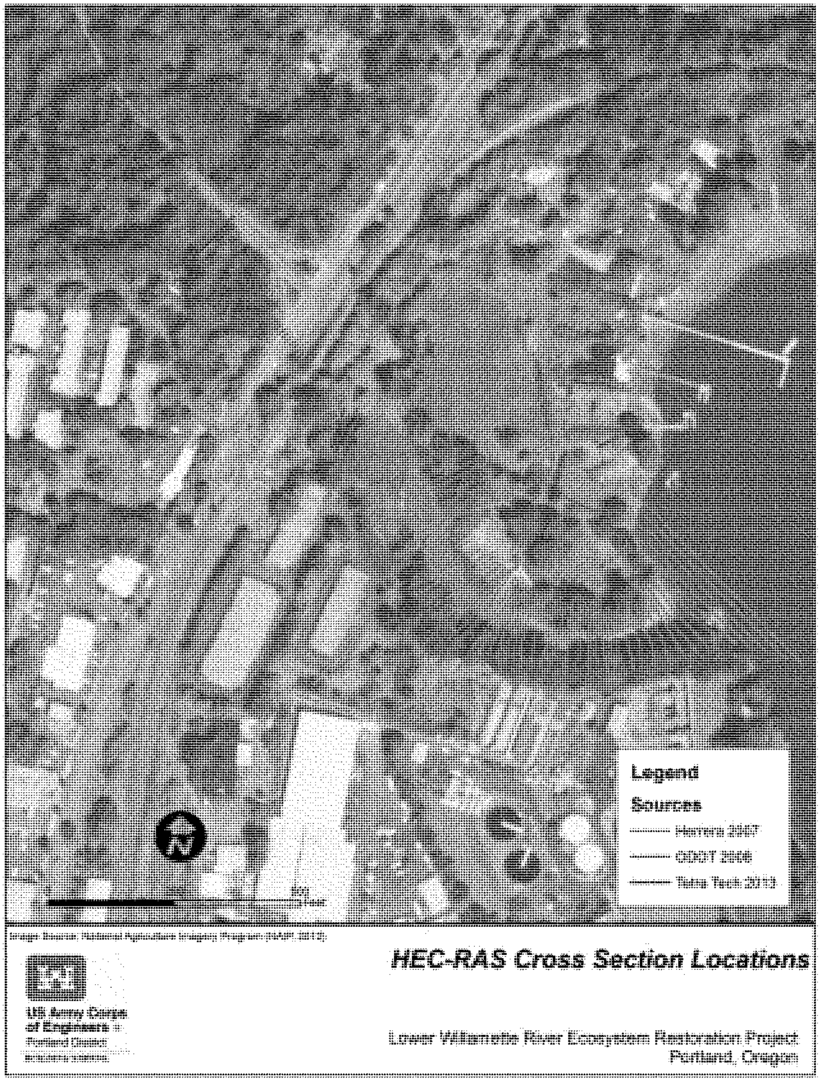

Figure 2.5. Cross sectional layout and sources for the proposed conditions model

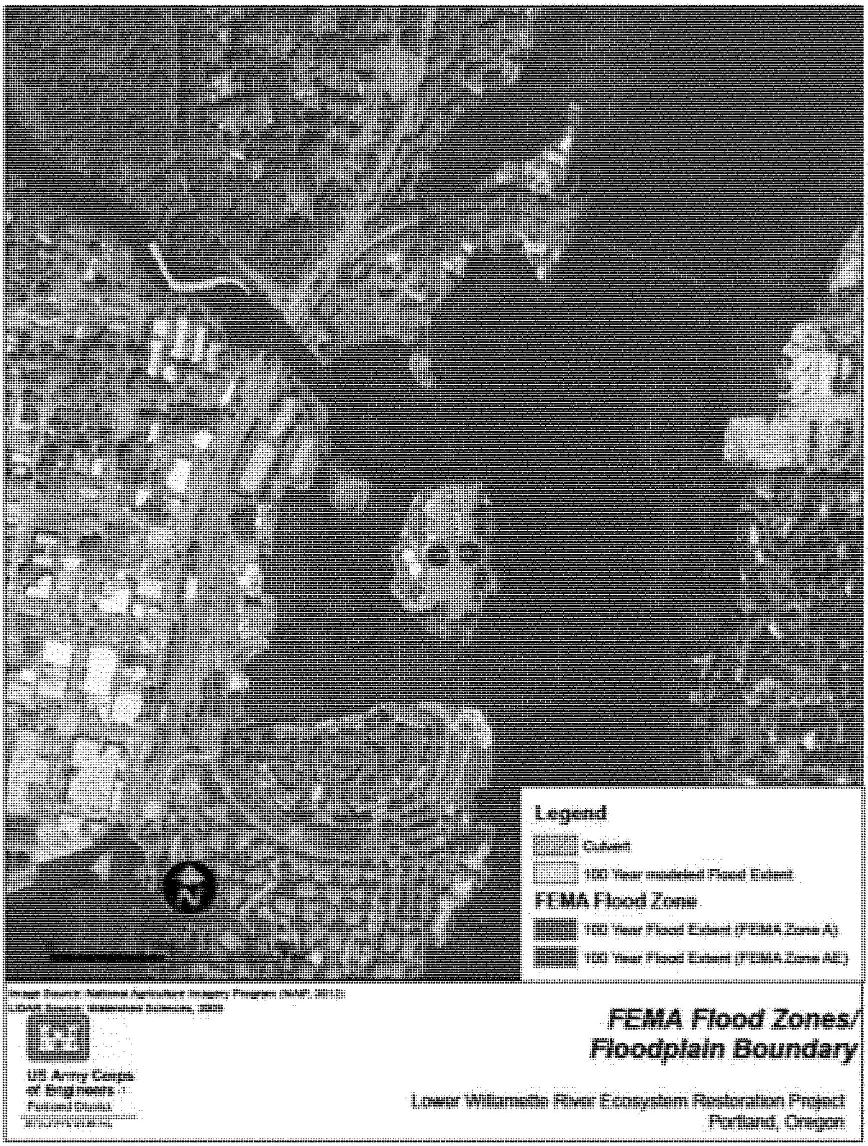

Figure 2.6. Willamette River and Tryon Creek Base Flood Zones

FEMA Boundaries

The 100-year flood water surface elevation of the Willamette River at this site has been delineated at 37.4 feet NAVD88 (FEMA 2010) (Figure 2.5). No fill will be placed at or below this elevation. A floodway has not been designated along Tryon Creek, which is in a FEMA Zone A. The water surface elevation associated with the base flood will not be increased in this area because 21,000 cubic yards of material will be removed and 17,000 cubic yards of material will be backfilled as part of the culvert replacement, resulting in increased conveyance capacity. Furthermore, at 30 feet wide and 12 feet high, the replacement culvert will be substantially larger than the existing culvert, which measures approximately 8'x 8'. A detailed HEC-RAS model has shown that there would be no rise in surface elevations in the culvert under the 100-year flood discharge rate (Table 2.11), and a no-rise analysis for the roughened chute downstream of the culvert has been completed (Herrera 2009). Some rise in water surface elevation changes in the mixed flow regime analysis were identified downstream of the proposed culvert near the location of the filled in plunge pool. Further evaluation in subsequent design phases is warranted for the plunge pool in order to dissipate energy. However, a no-rise analysis may be prepared for the culvert replacement during later stages of planning and design.

Table 2.10. Comparison of existing and proposed condition modeled velocities

		Velocity (ft/s)					
Flow Condition	**Location**	**Existing Subcritical**	**Existing Mixed Flow**	**Proposed Subcritical**	**Proposed Mixed Flow**	**Subcritical Difference (Proposed-Existing)**	**Mixed Flow Difference (Proposed-Existing)**
2-Year	**Upstream of Culvert**	7.49	7.49	7.55	7.55	0.06	0.06
	Middle of Culvert	6.61	6.61	3.8	3.8	-2.81	-2.81
	Near Downstream Entrance to Culvert	5.54	5.54	5.54	5.54	0.00	0.00
100-Year	**Upstream of Culvert**	8.99	8.99	9	9	0.01	0.01
	Middle of Culvert	8.77	8.77	5.31	5.31	-3.46	-3.46
	Near Downstream Entrance to Culvert	7.20	7.20	7.2	9.28	0.00	2.08
Median Summer	**Upstream of Culvert**	2.19	2.19	2.15	2.15	-0.04	-0.04
	Middle of Culvert	0.25	0.25	0.27	0.27	0.02	0.02
	Near Downstream Entrance to Culvert	1.49	1.49	1.49	1.49	0.00	0.00
Median Winter	**Upstream of Culvert**	3.43	3.43	3.45	3.45	0.02	0.02
	Middle of Culvert	1.31	1.31	0.93	0.93	-0.38	-0.38
	Near Downstream Entrance to Culvert	1.94	1.94	1.94	1.94	0.00	0.00
Median Annual	**Upstream of Culvert**	3.00	3.00	2.98	2.98	-0.02	-0.02
	Middle of Culvert	0.84	0.84	0.7	0.7	-0.14	-0.14
	Near Downstream Entrance to Culvert	1.85	1.85	1.85	1.85	0.00	0.00

Table 2.11. Comparison of existing and proposed condition modeled depths

Flow Condition	Location	Depth (ft)					
		Existing Subcritical	Existing Mixed Flow	Proposed Subcritical	Proposed Mixed Flow	Subcritical Difference (Proposed-Existing)	Mixed Flow Difference (Proposed-Existing)
2-Year	Upstream of Culvert	2.73	2.73	2.71	2.71	-0.02	-0.02
	Middle of Culvert	5.06	5.06	4.55	4.55	-0.51	-0.51
	Near Downstream Entrance to Culvert	1.69	1.69	1.69	1.69	0.00	0.00
100-Year	Upstream of Culvert	3.87	3.87	3.87	3.87	0.00	0.00
	Middle of Culvert	7.82	7.82	5.83	5.83	-1.99	-1.99
	Near Downstream Entrance to Culvert	2.50	2.50	2.5	2.01	0.00	-0.49
Median Summer	Upstream of Culvert	0.28	0.28	0.29	0.29	0.01	0.01
	Middle of Culvert	0.57	0.57	0.95	0.95	0.38	0.38
	Near Downstream Entrance to Culvert	0.16	0.16	0.16	0.16	0.00	0.00
Median Winter	Upstream of Culvert	0.71	0.71	0.71	0.71	0.00	0.00
	Middle of Culvert	1.03	1.03	1.71	1.71	0.68	0.68
	Near Downstream Entrance to Culvert	0.37	0.37	0.37	0.37	0.00	0.00
Median Annual	Upstream of Culvert	0.54	0.54	0.54	0.54	0.00	0.00
	Middle of Culvert	0.82	0.82	1.39	1.39	0.57	0.57
	Near Downstream Entrance to Culvert	0.28	0.28	0.28	0.28	0.00	0.00

Incipient Motion and Bed Stability

A reconnaissance level geomorphic survey of the study area was completed in 2013 (see Appendix A of the main feasibility study). The survey found that in the proximity of the culvert, the channel has a pool-riffle planform and the bed is composed of gravel- to cobble-sized material with an approximate median size (D50) of 30-40 mm. Boulder-sized material line the margins of the channel. The channel width typically varies from 10 to 20 feet and the average channel slope is approximately 2 percent. No studies have been conducted to assess the mobility of the bed material or the sediment load along Tryon Creek. Field observations indicate that the bed material is periodically mobilized and erosion of the channel banks and valley walls contributes fine sediment to the creek.

An incipient motion analysis was conducted to support the sizing of the bed material within the sequential step pools of the culvert. Additionally, the average size of particle that will be mobilized along the entire modeled reach of Tryon Creek was also evaluated. For computation of the median grain size within the step pools, the average of the maximum size computed for each pool is presented to ensure pool bed material stability. The analysis was conducted using the HEC-RAS results from the 2-yr and 100-yr AEP design flow conditions for the proposed conditions. The analysis utilized the allowable shear stress method (USACE 1994b) for stream beds comprised of gravel and larger sized materials, and assessed for a range of shields parameter values to evaluate parameter sensitivity. Shields parameters evaluated included the

- typical value of 0.06,
- common value of 0.045, and
- stable bed value of 0.03.

The recommended median grain size (D50) obtained by using the shields parameter value of 0.03, for a stable channel bed (USACE 1994b), will be used in further design phases to specify the stream bed gradation within the culvert step pools.

The inputs utilized the depth of flow, hydraulic slope, assumed dry relative density of sediment computed from the HEC-RAS analysis. The computation of median grain size (D50) was performed using the following equation (USACE 1994b):

$$D_{50} = \frac{d \times S}{F_*(s-1)}$$

Where:

D_{50} = median grain size (feet)

d = depth of flow (feet)

S = energy slope (feet/foot)

F_* = dimensionless Shields parameter

s = dry relative density of sediment (assumed to equal 2.65)

The results are summarized in Tables 2.12 and 2.13.

Table 2.12. Incipient motion results for within the proposed culvert step pools.

Flow Regime	Upstream Inflow	Downstream Boundary Condition	Shields Number		
			0.03	0.045	0.06
			Median Grain Size Predicted to Move for Shields Number (Inches)		
Subcritical	2-Year	Normal Depth	6.8	4.6	3.4
Mixed Flow	2-Year	Normal Depth	6.8	4.6	3.4
Subcritical	100-Year	Normal Depth	10.5	7.0	5.2
Mixed Flow	100-Year	Normal Depth	10.5	7.0	5.2

Table 2.13. Incipient motion results average for the entire proposed conditions model reach.

Flow Regime	Upstream Inflow	Downstream Boundary Condition	Shields Number		
			0.03	0.045	0.06
			Median Grain Size Predicted to Move for Shields Number (Inches)		
Subcritical	2-Year	Normal Depth	7.6	5.1	3.8
Mixed Flow	2-Year	Normal Depth	9.5	6.4	4.8
Subcritical	100-Year	Normal Depth	11.1	7.4	5.6
Mixed Flow	100-Year	Normal Depth	13.4	8.9	6.7

3. RECOMMENDATIONS

The purpose of the work documented in this technical memorandum was to determine hydrologic and hydraulic conditions for the design of the selected restoration sites. The design is discussed in a separate appendix to the feasibility report (Appendix H of the Feasibility Study report). When available from other sources, hydrologic and hydraulic information was obtained and compiled for this task. Additional information needed beyond what was available from existing sources was developed.

Each of these sites includes the design elements of bank grading, floodplain reconnections, and/or side channels. For the feasibility level design of these elements, the median winter water surface elevation has been designated as the design criteria. The evaluation presented in Sections 2.1 and 2.2 of this report determined the proximity of the four restoration sites to the gage used for the hydrologic analysis and the elevation that should provide the most representative median winter water surface elevation at each site. These design elements serve to provide fish habitat and high flow refugia during flow events higher than the median water surface elevation. In order to provide fish habitat based on the State of Oregon's criteria, a minimum of 6 inches of water depth is needed. Therefore, it is recommended that the thalweg or lower bank elevation for these sites be designed to allow inundation of 6 inches at the median winter elevation. The elevations for each site and reference gage are provided in Table 3.1.

Table 3.1. Recommended design elevations to provide fish habitat and refugia for median winter conditions

Site	Median Winter Water Surface Elevation (ft NAVD88)	Thalweg or Lower Bank Elevation (ft NAVD88)	Gage Referenced for Site Design Criteria
Kelley Point Park	9.7	9.2	USGS Gage 14211820 (Columbia Slough at Portland, OR)
BES Plant Banks	9.7	9.2	USGS Gage 14211820 (Columbia Slough at Portland, OR)
Kenton Cove	9.7	9.2	USGS Gage 14211820 (Columbia Slough at Portland, OR)
Oaks Crossing/Sellwood Riverfront Park	9.9	9.4	USGS Gage 14211720 (Willamette River at Portland, OR)

Hydraulic modeling was not performed for the two Mainstem Willamette River sites or the two Columbia Slough sites because no existing conditions hydraulic model was available and not enough information was available within the scope of the performed analysis to develop hydraulic models for these sites. A geomorphologic assessment was performed for the feasibility study (Appendix A of the Feasibility Study report) and indicated that during higher flow conditions sand-sized material is transported in the river and in the overbanks. Future phases of design for these sites should consider the potential deposition of this sand-sized material and the associated loss of fish habitat and refugia function if the aggradation should cause water depths less than 6 inches for the median winter conditions.

The existing culvert for Tryon Creek at Highway 43 and the Portland and Western Railroad was identified as a priority for fish passage improvements in 2005. Two previous projects have been designed and constructed to enhance fish entrance (Herrera Environmental Consultants 2007) and passage (ODOT 2007). The analysis presented as part of the Feasibility Study considers a replacement of the culvert with a 30 ft arch span culvert that meets the State of Oregon's fish passage criteria. Hydraulic analysis using the HEC-RAS model was performed to determine the culvert span required to accommodate the active channel width, and the proposed culvert was modeled to assess passage velocities and depths. Additionally, the model results were to perform an incipient motion analysis to determine the specification of the required oversized rock and for the streambed gradation. Both of these are required to meet the State of Oregon's fish passage criteria for stability of the proposed streambed. A minimum diameter of 18 to 20 inches is recommended for the rock placed for stream grade control cross weirs within the culvert structure. The proposed culvert has a continuous slope of 3.4%, which results in partial reduction of the existing culvert slope and providing an overall segment slope closer to that of the natural stream.

Additional work is recommended for future design phases for the replacement culvert. A scour analysis should be performed to determine the appropriate culvert footing elevation. The extent of bedrock around the existing culvert should be determined through a geotechnical investigation to better understand constraints on constructability and potential revisions to the proposed culvert alignment. Additional upstream survey data should be obtained to better delineate the active channel width and construction quantities. Some survey data that may be utilized for the next phase of this project was recently acquired by BergerABAM on behalf of the City of Portland's Tryon Creek Trunk Sewer Upgrade project, but is not yet available for distribution. Construction issues related to possible need to realign the trunk sewer to accommodate the replacement culvert, and preliminary analysis of traffic control and temporary bypasses for both road and railroad traffic should be considered.

The proposed culvert is designed to pass 100-year flows and large debris, including trees. The risk of blockage is minimal due to the large size of the culvert and because the relatively sparse riparian area does not contribute extensive large trees, therefore a trash rack is not proposed at this location, reducing maintenance. Periodic maintenance inspections to ensure that footings and wingwalls are not being undercut by scour are recommended, although the culvert would be built into bedrock so such an effect is unlikely. The main risk associated with this configuration is that the rock weirs that will be installed for grade control will dislodge during high flows, allowing for increased velocities and reduction in plunge pools that are necessary for fish passage. Although it is assumed that the weirs will be designed to withstand peak flows, occasional inspection of these structures is recommended, particularly after sustained or high flows.

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Appendix A:

Water Surface Elevations for With and Without Project Conditions, 100-year Discharge

Water Surface Elevations under Without Project Conditions

Reach	River Sta	Profile	W.S. Elev (ft.)
OR43 Culvert	941	100-Yr	59.03
OR43 Culvert	441	100-Yr	48.38
OR43 Culvert	401	100-Yr	47.83
OR43 Culvert	400.5	100-Yr	47.83
OR43 Culvert	399.5	100-Yr	47.35
OR43 Culvert	394	100-Yr	47.41
OR43 Culvert	393	100-Yr	46.82
OR43 Culvert	385.5	100-Yr	46.9
OR43 Culvert	384.5	100-Yr	46.32
OR43 Culvert	377	100-Yr	46.39
OR43 Culvert	376	100-Yr	45.81
OR43 Culvert	368.5	100-Yr	45.89
OR43 Culvert	367.5	100-Yr	45.3
OR43 Culvert	360	100-Yr	45.38
OR43 Culvert	359	100-Yr	44.8
OR43 Culvert	351.5	100-Yr	44.88
OR43 Culvert	350.5	100-Yr	44.28
OR43 Culvert	343	100-Yr	44.36
OR43 Culvert	342	100-Yr	43.8
OR43 Culvert	334.5	100-Yr	43.88
OR43 Culvert	333.5	100-Yr	43.31
OR43 Culvert	326	100-Yr	43.39
OR43 Culvert	325	100-Yr	42.85
OR43 Culvert	317.5	100-Yr	42.93
OR43 Culvert	316.5	100-Yr	42.46
OR43 Culvert	309	100-Yr	42.53
OR43 Culvert	308	100-Yr	42.12
OR43 Culvert	301	100-Yr	42.18
OR43 Culvert	299	100-Yr	41.82
OR43 Culvert	290.5	100-Yr	41.84
OR43 Culvert	289.5	100-Yr	41.46
OR43 Culvert	273.5	100-Yr	41.49
OR43 Culvert	272.5	100-Yr	41.15
OR43 Culvert	256.5	100-Yr	41.18
OR43 Culvert	255.5	100-Yr	40.85
OR43 Culvert	239.5	100-Yr	40.88
OR43 Culvert	238.5	100-Yr	40.55
OR43 Culvert	222.5	100-Yr	40.58

Water Surface Elevations under With Project Conditions

Reach	River Sta	Profile	W.S. Elev (ft)
OR43 Culvert	941	100-Yr	59.03
OR43 Culvert	441	100-Yr	48.38
OR43 Culvert	401	100-Yr	43.68
OR43 Culvert	391.*	100-Yr	43.33
OR43 Culvert	381.*	100-Yr	42.99
OR43 Culvert	371.*	100-Yr	42.65
OR43 Culvert	361.*	100-Yr	42.3
OR43 Culvert	351.*	100-Yr	41.96
OR43 Culvert	341.*	100-Yr	41.62
OR43 Culvert	331.*	100-Yr	41.27
OR43 Culvert	321.*	100-Yr	40.93
OR43 Culvert	311.*	100-Yr	40.59
OR43 Culvert	301.*	100-Yr	40.26
OR43 Culvert	291.*	100-Yr	39.92
OR43 Culvert	281.*	100-Yr	39.59
OR43 Culvert	271.*	100-Yr	39.28
OR43 Culvert	261.*	100-Yr	38.97
OR43 Culvert	251.*	100-Yr	38.69
OR43 Culvert	241.*	100-Yr	38.44
OR43 Culvert	231.*	100-Yr	38.22
OR43 Culvert	221.*	100-Yr	38.05
OR43 Culvert	211.*	100-Yr	37.9
OR43 Culvert	201.*	100-Yr	37.79
OR43 Culvert	191.*	100-Yr	37.71
OR43 Culvert	181.*	100-Yr	37.64
OR43 Culvert	171.*	100-Yr	37.59
OR43 Culvert	161.*	100-Yr	37.55
OR43 Culvert	151.*	100-Yr	37.51
OR43 Culvert	141.*	100-Yr	37.49
OR43 Culvert	131.*	100-Yr	37.46
OR43 Culvert	121.*	100-Yr	37.45
OR43 Culvert	111.*	100-Yr	37.43
OR43 Culvert	101.*	100-Yr	37.42
OR43 Culvert	90.9999*	100-Yr	37.41
OR43 Culvert	81.*	100-Yr	37.4
OR43 Culvert	71.0000*	100-Yr	37.39
OR43 Culvert	61.*	100-Yr	37.39

OR43 Culvert	221.5	100-Yr	40.27		OR43 Culvert	51.0000*	100-Yr	37.38
OR43 Culvert	205.5	100-Yr	40.29		OR43 Culvert	41.*	100-Yr	37.38
OR43 Culvert	204.5	100-Yr	39.99		OR43 Culvert	31.0000*	100-Yr	37.37
OR43 Culvert	188.5	100-Yr	40.01		OR43 Culvert	20.9999*	100-Yr	37.37
OR43 Culvert	187.5	100-Yr	39.74		OR43 Culvert	11.*	100-Yr	37.36
OR43 Culvert	171.5	100-Yr	39.76		OR43 Culvert	.999989*	100-Yr	37.36
OR43 Culvert	170.5	100-Yr	39.49		OR43 Culvert	0	100-Yr	37.36
OR43 Culvert	154.5	100-Yr	39.5		OR43 Culvert	-10.6	100-Yr	37.39
OR43 Culvert	153.5	100-Yr	39.24		OR43 Culvert	-28.6	100-Yr	37.39
OR43 Culvert	137.5	100-Yr	39.25		OR43 Culvert	-42.6	100-Yr	37.39
OR43 Culvert	136.5	100-Yr	38.99		OR43 Culvert	-66.6	100-Yr	37.4
OR43 Culvert	120.5	100-Yr	39		OR43 Culvert	-71.6	100-Yr	37.4
OR43 Culvert	119.5	100-Yr	38.75		OR43 Culvert	-76.6	100-Yr	37.4
OR43 Culvert	103.5	100-Yr	38.76		OR43 Culvert	-81.6	100-Yr	37.4
OR43 Culvert	102.5	100-Yr	38.52		OR43 Culvert	-86.6	100-Yr	37.4
OR43 Culvert	86.5	100-Yr	38.54		OR43 Culvert	-90.6	100-Yr	37.4
OR43 Culvert	85.5	100-Yr	38.3		OR43 Culvert	-98.6	100-Yr	37.4
OR43 Culvert	69.5	100-Yr	38.3		OR43 Culvert	-102.6	100-Yr	37.4
OR43 Culvert	68.5	100-Yr	38.08		OR43 Culvert	-104.6	100-Yr	37.4
OR43 Culvert	52.5	100-Yr	38.08		OR43 Culvert	-108.6	100-Yr	37.4
OR43 Culvert	51.5	100-Yr	37.87		OR43 Culvert	-112.6	100-Yr	37.4
OR43 Culvert	35.5	100-Yr	37.88		OR43 Culvert	-116.6	100-Yr	37.4
OR43 Culvert	34.5	100-Yr	37.67		OR43 Culvert	-120.6	100-Yr	37.4
OR43 Culvert	18.5	100-Yr	37.68		OR43 Culvert	-124.6	100-Yr	37.4
OR43 Culvert	17.5	100-Yr	37.48		OR43 Culvert	-129.6	100-Yr	37.4
OR43 Culvert	1.5	100-Yr	37.49		OR43 Culvert	-133.6	100-Yr	37.4
OR43 Culvert	0	100-Yr	37.31		OR43 Culvert	-138.6	100-Yr	37.4
OR43 Culvert	-10.6	100-Yr	37.4		OR43 Culvert	-143.6	100-Yr	37.4
OR43 Culvert	-28.6	100-Yr	37.4		OR43 Culvert	-148.6	100-Yr	37.4
OR43 Culvert	-42.6	100-Yr	37.4		OR43 Culvert	-153.6	100-Yr	37.4
OR43 Culvert	-66.6	100-Yr	37.4		OR43 Culvert	-158.6	100-Yr	37.4
OR43 Culvert	-71.6	100-Yr	37.4		OR43 Culvert	-164.6	100-Yr	37.4
OR43 Culvert	-76.6	100-Yr	37.4		OR43 Culvert	-169.6	100-Yr	37.4
OR43 Culvert	-81.6	100-Yr	37.4		OR43 Culvert	-175.6	100-Yr	37.4
OR43 Culvert	-86.6	100-Yr	37.4		OR43 Culvert	-194.6	100-Yr	37.4
OR43 Culvert	-90.6	100-Yr	37.4		OR43 Culvert	-205.6	100-Yr	37.4
OR43 Culvert	-98.6	100-Yr	37.4		OR43 Culvert	-221.6	100-Yr	37.4
OR43 Culvert	-102.6	100-Yr	37.4		OR43 Culvert	-237.6	100-Yr	37.4
OR43 Culvert	-104.6	100-Yr	37.4		OR43 Culvert	-259.6	100-Yr	37.4
OR43 Culvert	-108.6	100-Yr	37.4		OR43 Culvert	-273.1	100-Yr	37.4

OR43 Culvert	-112.6	100-Yr	37.4	OR43 Culvert	-286.6	100-Yr	37.4
OR43 Culvert	-116.6	100-Yr	37.4	OR43 Culvert	-302.6	100-Yr	37.4
OR43 Culvert	-120.6	100-Yr	37.4	OR43 Culvert	-318.6	100-Yr	37.4
OR43 Culvert	-124.6	100-Yr	37.4	OR43 Culvert	-341.6	100-Yr	37.4
OR43 Culvert	-129.6	100-Yr	37.4	OR43 Culvert	-364.6	100-Yr	37.4
OR43 Culvert	-133.6	100-Yr	37.4	OR43 Culvert	-389.6	100-Yr	37.4
OR43 Culvert	-138.6	100-Yr	37.4	OR43 Culvert	-413.6	100-Yr	37.4
OR43 Culvert	-143.6	100-Yr	37.4	OR43 Culvert	-421.6	100-Yr	37.4
OR43 Culvert	-148.6	100-Yr	37.4	OR43 Culvert	-436.6	100-Yr	37.4
OR43 Culvert	-153.6	100-Yr	37.4	OR43 Culvert	-449.6	100-Yr	37.4
OR43 Culvert	-158.6	100-Yr	37.4	OR43 Culvert	-458.6	100-Yr	37.4
OR43 Culvert	-164.6	100-Yr	37.4	OR43 Culvert	-471.6	100-Yr	37.4
OR43 Culvert	-169.6	100-Yr	37.4	OR43 Culvert	-485.6	100-Yr	37.4
OR43 Culvert	-175.6	100-Yr	37.4	OR43 Culvert	-502.1	100-Yr	37.4
OR43 Culvert	-194.6	100-Yr	37.4	OR43 Culvert	-518.6	100-Yr	37.4
OR43 Culvert	-205.6	100-Yr	37.4	OR43 Culvert	-533.6	100-Yr	37.4
OR43 Culvert	-221.6	100-Yr	37.4	OR43 Culvert	-548.6	100-Yr	37.4
OR43 Culvert	-237.6	100-Yr	37.4	OR43 Culvert	-573.6	100-Yr	37.4
OR43 Culvert	-259.6	100-Yr	37.4	OR43 Culvert	-586.6	100-Yr	37.4
OR43 Culvert	-273.1	100-Yr	37.4	OR43 Culvert	-599.6	100-Yr	37.4
OR43 Culvert	-286.6	100-Yr	37.4	OR43 Culvert	-614.1	100-Yr	37.4
OR43 Culvert	-302.6	100-Yr	37.4	OR43 Culvert	-628.6	100-Yr	37.4
OR43 Culvert	-318.6	100-Yr	37.4	OR43 Culvert	-642.1	100-Yr	37.4
OR43 Culvert	-341.6	100-Yr	37.4	OR43 Culvert	-655.6	100-Yr	37.4
OR43 Culvert	-364.6	100-Yr	37.4	OR43 Culvert	-678.6	100-Yr	37.4
OR43 Culvert	-389.6	100-Yr	37.4	OR43 Culvert	-703.6	100-Yr	37.4
OR43 Culvert	-413.6	100-Yr	37.4	OR43 Culvert	-723.6	100-Yr	37.4
OR43 Culvert	-421.6	100-Yr	37.4	OR43 Culvert	-745.6	100-Yr	37.4
OR43 Culvert	-436.6	100-Yr	37.4	OR43 Culvert	-769.6	100-Yr	37.4
OR43 Culvert	-449.6	100-Yr	37.4	OR43 Culvert	-793.6	100-Yr	37.4
OR43 Culvert	-458.6	100-Yr	37.4	OR43 Culvert	-810.6	100-Yr	37.4
OR43 Culvert	-471.6	100-Yr	37.4	OR43 Culvert	-827.6	100-Yr	37.4
OR43 Culvert	-485.6	100-Yr	37.4	OR43 Culvert	-842.1	100-Yr	37.4
OR43 Culvert	-502.1	100-Yr	37.4	OR43 Culvert	-856.6	100-Yr	37.4
OR43 Culvert	-518.6	100-Yr	37.4	OR43 Culvert	-877.6	100-Yr	37.4
OR43 Culvert	-533.6	100-Yr	37.4	OR43 Culvert	-898.6	100-Yr	37.4
OR43 Culvert	-548.6	100-Yr	37.4	OR43 Culvert	-922.6	100-Yr	37.4
OR43 Culvert	-573.6	100-Yr	37.4	OR43 Culvert	-946.6	100-Yr	37.4
OR43 Culvert	-586.6	100-Yr	37.4	OR43 Culvert	-969.6	100-Yr	37.4
OR43 Culvert	-599.6	100-Yr	37.4	OR43 Culvert	-987.6	100-Yr	37.4

OR43 Culvert	-614.1	100-Yr	37.4		OR43 Culvert	-1007.6	100-Yr	37.4
OR43 Culvert	-628.6	100-Yr	37.4		OR43 Culvert	-1029.6	100-Yr	37.4
OR43 Culvert	-642.1	100-Yr	37.4		OR43 Culvert	-1045.6	100-Yr	37.4
OR43 Culvert	-655.6	100-Yr	37.4		OR43 Culvert	-1061.6	100-Yr	37.4
OR43 Culvert	-678.6	100-Yr	37.4		OR43 Culvert	-1079.6	100-Yr	37.4
OR43 Culvert	-703.6	100-Yr	37.4		OR43 Culvert	-1097.6	100-Yr	37.4
OR43 Culvert	-723.6	100-Yr	37.4		OR43 Culvert	-1115.6	100-Yr	37.4
OR43 Culvert	-745.6	100-Yr	37.4		* Represent Interpolated Cross Sections			
OR43 Culvert	-769.6	100-Yr	37.4					
OR43 Culvert	-793.6	100-Yr	37.4					
OR43 Culvert	-810.6	100-Yr	37.4					
OR43 Culvert	-827.6	100-Yr	37.4					
OR43 Culvert	-842.1	100-Yr	37.4					
OR43 Culvert	-856.6	100-Yr	37.4					
OR43 Culvert	-877.6	100-Yr	37.4					
OR43 Culvert	-898.6	100-Yr	37.4					
OR43 Culvert	-922.6	100-Yr	37.4					
OR43 Culvert	-946.6	100-Yr	37.4					
OR43 Culvert	-969.6	100-Yr	37.4					
OR43 Culvert	-987.6	100-Yr	37.4					
OR43 Culvert	-1007.6	100-Yr	37.4					
OR43 Culvert	-1029.6	100-Yr	37.4					
OR43 Culvert	-1045.6	100-Yr	37.4					
OR43 Culvert	-1061.6	100-Yr	37.4					
OR43 Culvert	-1079.6	100-Yr	37.4					
OR43 Culvert	-1097.6	100-Yr	37.4					
OR43 Culvert	-1115.6	100-Yr	37.4					

APPENDIX C
Biological Assessment

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Acronyms and Abbreviations

µg/L	micrograms per liter
BA	Biological Assessment
BMPs	Best Management Practices
cfs	Cubic feet per second
CWA	Clean Water Act
DPS	Distinct Population Segment
EA	Environmental Assessment
EFH	Essential Fish Habitat
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESU	Evolutionary Significant Unit(s)
FMP	Fishery Management Plan
GIS	Geographic Information System
IC	Impaired condition
LCFRB	Lower Columbia Fish Recovery Board
LVAP	Lower Vertical Adjustment Potential
LW	Large Wood
NEP	Nonessential experimental population
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPF	Not properly functioning
NWPCC	Northwest Power and Conservation Council
ODEQ	Oregon Department of Environmental Quality
ODFW	Oregon Department of Fish and Wildlife
OHW	Ordinary High Water
PAH	Polycyclic Aromatic Hydrocarbons
PBES	Portland Bureau of Environmental Services
PCB	Polychlorinated Biphenyls
PCE	Primary constituent element
PFC	Properly functioning condition
RM	River Mile(s)
RRT	Restoration Review Team
TMDL	Total Maximum Daily Loads
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

1. INTRODUCTION

The U.S. Army Corps of Engineers, Portland District (USACE) in partnership with the City of Portland and the Port of Portland as the non-federal sponsors have conducted a General Investigation Feasibility Study to evaluate ecosystem restoration needs and opportunities within the Lower Willamette River Basin in northwestern Oregon, Multnomah County. The purpose of the Feasibility Study was to evaluate significant ecosystem degradation problems in the basin and to recommend a series of feasible actions and projects that are supported by a local entity willing to provide the necessary items of local cooperation. The sponsors and the USACE initially identified over 50 sites in the Lower Willamette River and tributaries. This list of sites has since been reduced to five, including Kelley Point Park, Kenton Cove, BES Treatment Plant, Oaks Crossing, and Tryon Creek Highway 43 Culvert Replacement, which the City has identified as the critical sites on which to focus the restoration actions. It is these five sites which comprise the Lower Willamette Restoration Project and are referred to as the Project. This Project has been formulated to contribute to the identified restoration objectives of restoring fish and wildlife habitat and natural processes of the watershed.

The actions of the project need to be examined per Section 7(a)(2) of the ESA of 1973 (as amended) in order to "…ensure that any actions authorized, funded, and/or carried out by federal agencies are not likely to jeopardize the continued existence of any federally proposed or listed endangered species or threatened species, or result in the destruction or adverse modification of critical habitat of such species…". This Biological Assessment (BA) has been prepared to comply with this requirement, as well as the requirements for the Essential Fish Habitat (EFH) evaluation under the Magnuson-Stevens Fishery Conservation and Management Act.

This BA is intended to assess potential effects on proposed or listed ESA species under the jurisdiction of the National Marine Fisheries Service that may occur as a result of the project. Table 1-1 lists the species and critical habitat designations in Multnomah County, Oregon, which encompasses the Project action area.

Table 1-1. Species and Critical Habitat Designations Listed in Multnomah County

Species	Federal Status	Critical Habitat	State Status	Likely Present in the Action Area
Lower Columbia River coho salmon (*Oncorhynchus kisutch*)	Threatened June 28, 2005	Proposed January 14, 2013	Endangered	Present
Lower Columbia River Chinook salmon (*Oncorhynchus tshawytscha*)	Threatened June 28, 2005	Designated September 2, 2005	Not listed	Present
Upper Willamette River Chinook salmou (*Oncorhynchus tshawytscha*)	Threatened June 28, 2005	Designated September 2, 2005	Not listed	Present
Lower Columbia River steelhead (*Oncorhynchus mykiss*)	Threatened January 5, 2006	Designated September 2, 2005	Not listed	Present
Upper Willamette River steelhead (*Oncorhynchus mykiss*)	Threatened January 5, 2006	Designated September 2, 2005	Not listed	Present
Southern DPS of North American green sturgeon (*Acipenser medirostris*)	Threatened April 7, 2006	Designated October 9, 2009	Not listed	Unlikely

The purpose of this Project is to restore natural habitat functions at multiple sites along the Lower Willamette River and its tributaries. This Project emphasizes the opportunities to restore aquatic and riparian habitats.

1.1 Federal Action and authority

This BA assesses ecosystem restoration actions in the Lower Willamette River, led by the USACE along with its cost-sharing sponsor, the City of Portland.

This study is 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.

1.2 Consultation History

This BA initiates formal consultation with NMFS.

2. LOCATION AND SITE DESCRIPTION

The Lower Willamette River, which comprises the project area, is generally defined as the area downstream and north of Willamette Falls, and between river miles (RM) 0 and 20.5 (Figure 2-1). Key tributaries included in the Project are Columbia Slough and Tryon Creek.

The action area for the Project encompasses all areas to be affected directly or indirectly by the proposed federal action and not merely the immediate area involved in the action (50 CFR 402-02). The action area encompasses all areas that could be affected by any permanent or temporary impacts caused by project construction or by the presence of the projects themselves.

2.1 Project Area Location

The five project sites are located within three reaches (Figure 2-2) of the larger Lower Willamette River Basin including the mainstem Lower Willamette River, Columbia Slough, and Tryon Creek.

- **Lower Willamette Mainstem**. This reach stretches from RM 0 to Willamette Falls, located at RM 26. The two project sites on the mainstem Willamette River are located at RM 16.2 (Oaks Crossing/Sellwood Riverfront Park) and RM 0 (Kelley Point Park). 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 and contamination issues are less severe in the south end of this reach, where the Oaks Crossing/Sellwood Riverfront Park project site is located. The primary areas of sediment contamination are found in Portland Inner Harbor, located downstream of the Oaks Crossing site.
- **Columbia Slough**. This reach extends along the Columbia Slough from its confluence with the Willamette River to Kenton Cove (RM 0 to RM 9.0). 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. Two project sites are located in this reach: BES (Bureau of Environmental Services) Plant and Kenton Cove, at RMs 5 and 7.
- **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). The Tryon Creek reach offers the most undeveloped area for restoration of any of reach in the project area. The Highway 43 Tryon Creek Culvert project site at RM 0.5 is critical to restoring fish passage to upstream spawning habitat.

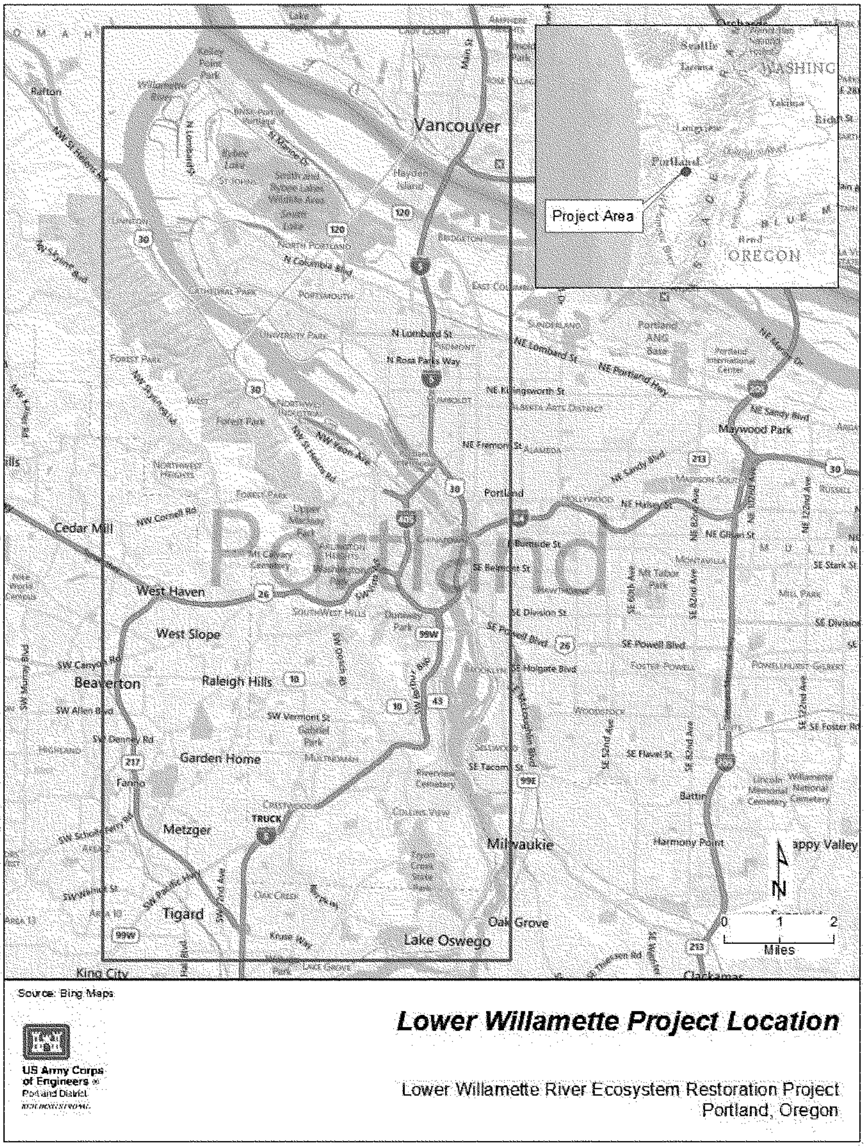

Figure 2-1. Location Map

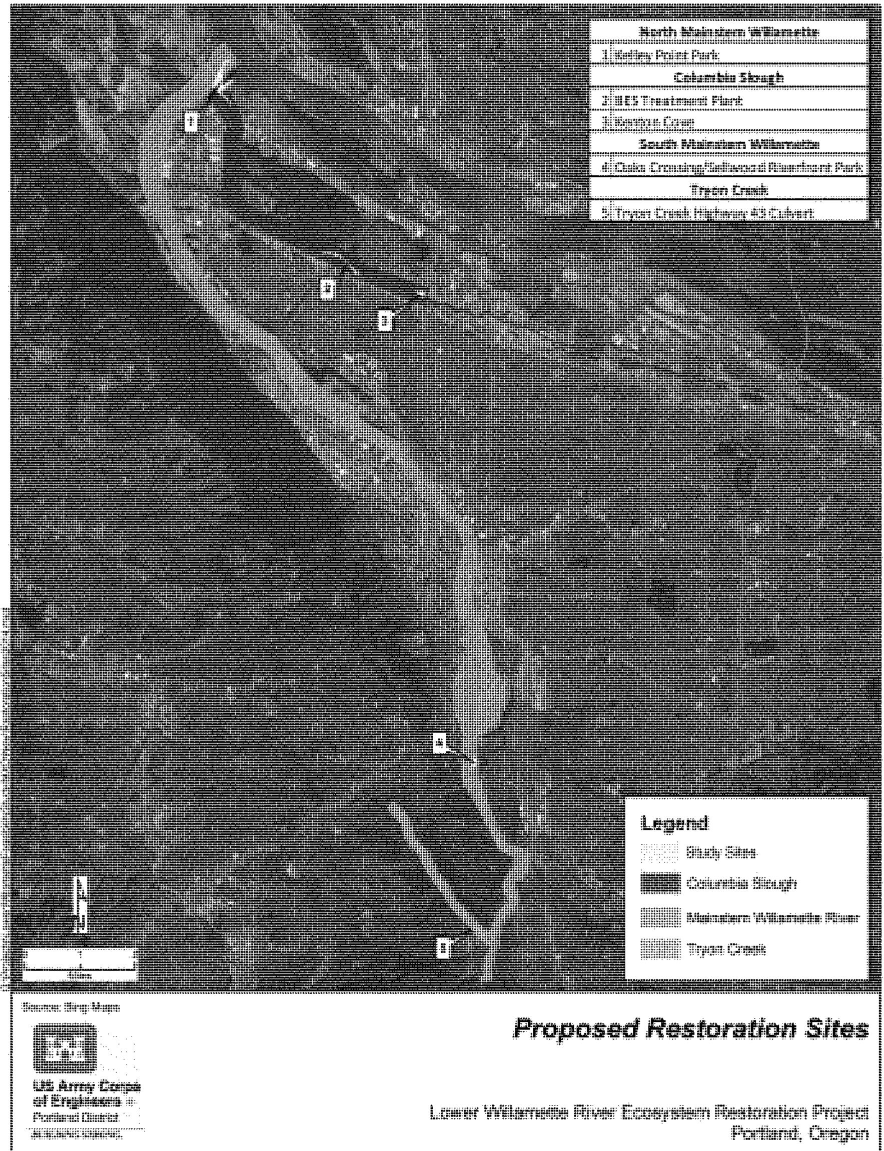

Figure 2-2. Site Specific Action Areas Map

3. DESCRIPTION OF THE ACTION

The project that is the subject of this BA includes five restoration project sites: Kelley Point Park, BES Treatment Plant, Kenton Cove, Oaks Crossing, and Tryon Creek Highway 43 Culvert Replacement. Table 3-1 lists general information on each of the proposed restoration features in the project sites. A summary of the key restoration elements proposed at each site is provided in the discussion following.

Table 3-1. Proposed Restoration Sites and Locations [(1)]

General Location	Project Title General	Proposed Enhancement/Restoration Actions
Willamette Mainstem	Kelley Point Park	Remove invasive plants and plant native species; create off-channel habitat; slope banks to reconnect river and floodplain; add LW.
Columbia Slough	BES Plant	Excavate an alcove for high flow refugia and enhance a connection to off-channel habitat; add in-stream structure though the addition of boulders and LW; remove invasive plants and plant native species.
	Kenton Cove	Add LW and small amounts of fill to create small promontories for bank diversification and increased cover at edge of streambank.
Willamette Mainstem	Oaks Crossing	Excavate off-channel refuge habitat; add LW; remove invasive species and plant native trees and shrubs.
Tryon Creek	Tryon Highway 43 Culvert	Improve fish passage and channel conditions to improve access to upstream spawning habitat in Tryon Creek State Park.

1 Sites are identified and grouped by their general location, which is their associated waterbody.

3.1 Restoration Measures

Different combinations of 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, and seek to minimize use of hard structure except where necessary (primarily to reconstruct or build a fish-passable culvert).

Large Wood and Boulder Placement: 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 restoration technique to enhance stream channel morphology and habitat forming functions such as pool creation, sediment and organic matter retention, and to increase habitat complexity and refugia (PBES 2005). Strategic placement of LW can promote channel scour or bar formation to create micro-habitats in off-channel areas, or can be used to protect restored bank features from the full force of the river's current.

LW would be installed by excavating the streambank to allow trunks or stumps to be keyed into the bank for stability. Generally, one or two pieces of LW will be installed at each location, and vertical posts, boulders, and cables will be used to anchor the wood. After installation, the substrate around the LW will be recontoured to match previous or desired grade, and revegetated as needed. Boulders would be installed by excavating holes or trenches in the streambed with an excavator or backhoe, installing the boulders according to specifications, and backfilling the surrounding area with appropriate substrate.

Invasive Species Removal and Riparian Revegetation: Riparian areas shade streams, moderate stream temperatures, provide overhead cover and habitat for avian species, filter sediments and runoff, control streambank erosion, and provide a terrestrial source of organic matter and insects that support terrestrial and aquatic food webs (PBES 2005). Riparian plantings along river banks and floodplains also restore natural recruitment of LW to the system. Urbanization and development of riparian areas have reduced the natural function of riparian zones throughout the Lower Willamette Basin. Native vegetation will be planted in riparian zones to the edge of project boundary lines to reestablish the maximum riparian function possible.

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 characteristics, and in some instances fundamentally changing soil characteristics and plant communities.

Invasive species removal projects are proposed in combination with riparian planting projects to more 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 is limited. All areas temporarily disturbed during construction will be replanted by hand with native species, and appropriate erosion control including coir mats, straw, or jute netting will be installed to control movement of fine sediment particles into waterways.

In-stream and Channel Modifications: Steepened banks are often a product of bank stabilization and channelization activities, which cause channel incision, increased erosion and floodplain disconnection. Grading banks to gentler slopes is proposed to allow for restored hydrologic connections and to create shallow water habitat, reduce erosion, stabilize banks and to allow riparian and aquatic habitats to form more naturally.

Banks will be graded by use of a land or barge-mounted excavator. Excavated bank angles will vary depending on surrounding land uses and current bank angle. Areas above the ordinary high-water mark will be revegetated with native riparian species, and erosion control features including jute netting or coir mats will be installed. Spoils will be barge or truck hauled to an appropriate disposal facility. Areas below the OHW or below the water surface elevation will generally not be graded as part of this type of measure.

Off-Channel Habitat and Floodplain Reconnection: Connected floodplains attenuate flows, moderate normative flows, and contribute organic matter, substrate, and large wood to the stream system. 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 conducted in the Lower Willamette River (Friesen 2005) found that all sampled off-channel habitats were used by juvenile salmonids for forage and refuge. The creation and reconnection of side channels, alcoves, and backwater habitats is proposed to provide this important habitat to aquatic species, and will serve a dual purpose by supporting floodwater attenuation.

Off-channel habitat creation and reconnection will primarily take the form of side channels and swales excavated in riparian areas. Excavation will involve heavy equipment including excavators, scrapers, backhoes, and dump trucks. Excavated areas will coincide with natural swales or other contours that will minimize the amount of materials to be excavated and fit with the landscape to the highest degree possible. Large trees will be avoided as much as possible, and work will occur in the dry except when removing the final amount of fill to allow inflow from the Willamette River or Columbia Slough, which will occur during the in-water work window. The banks of side channels will be contoured to resist erosion and revegetated above the ordinary high water elevation. LW and boulders will be installed as described above to create habitat diversity.

Fish Barrier Removal: Ill-placed or poorly designed culverts or other fish passage barriers affect the ability of salmonids to return to natal streams for spawning. As a result, culverts and impassable barriers can influence the temporal and spatial distribution of salmonids throughout a sub-basin. In Portland, Johnson Creek and Tryon Creek are the only two waterways that are open year-round to salmonids, although access into spawning areas of Tryon Creek is severely restricted by the culvert located where Tryon Creek passes under Highway 43.

3.2 Approved Actions and Design Criteria

These restoration measures 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 U.S. Fish and Wildlife Service (USFWS) and the NOAA Restoration Center in the States of Oregon, Washington and Idaho. The PROJECTS approved actions that are applicable to the proposed Project are described below, along with the design criteria that are provided for each action.

Fish Passage Restoration: This type of action includes total removal, replacement, or resetting of culverts or bridges; stabilizing headcuts and other channel instabilities; removing, relocating, constructing, repairing, or maintaining fish ladders; and replacing, relocating, or constructing fish screens and irrigation diversions. The following design criteria pertain only to the Tryon Creek Hwy 43 Culvert replacement project:

> **a. Stream simulation culvert and bridge projects.** All road-stream crossing structures shall adhere to the most recent version of NMFS fish passage criteria, which are as follows:

- Bed width will be greater than bankfull channel width, and of sufficient vertical clearance to allow ease of maintenance activities.
- Vertical clearance between the culvert bed and ceiling will be more than 6 feet to allow for debris removal.
- Slope will be equal to the slope of, and at elevations continuous with, the surrounding long-channel streambed profile Culvert will be open-bottomed, so footings will be keyed into the underlying bedrock.
- Culvert will be more than 150 feet, but a bridge is not possible at this location due to cost and transportation disruptions.
- Fill materials will match native substrate.
- Average water depth and velocities will simulate those in the surrounding stream channel.

NMFS engineering review, if required, shall occur at the conceptual, post-modeling, and final design phases, which is approximated by 30%, 60%, and 90% designs. All road-stream crossing structures shall simulate stream channel conditions per industry design standards found in any one of the following:

i. *Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings* (USDA-Forest Service 2008).

ii. *Part XII Fish Passage Design and Implementation, Salmonid Stream Habitat Restoration Manual* (California Department of Fish and Game 2009) or the most recent version.

iii. *Water Crossings Design Guidelines* (Barnard *et al.* 2013) or the most recent version).

b. General road-stream crossing criteria

i. Span

1. Span is determined by the crossing width at the proposed streambed grade.
2. Single span structures will maintain a clear, unobstructed opening above the general scour elevation that is at least as wide as 1.5 times the active channel width.
3. Multi-span structures will maintain clear, unobstructed openings above the general scour elevation (except for piers or interior bents) that are at least as wide as 2.2 times the active channel width.
4. Entrenched streams: If a stream is entrenched (entrenchment ratio of less than 1.4), the crossing width will accommodate the floodprone width. Floodprone width is the channel width measured at twice the maximum bankfull depth (Rosgen 1996).
5. Minimum structure span is 6ft.

ii. Scour Prism

1. Designs shall maintain the general scour prism, as a clear, unobstructed opening (i.e., free of any fill, embankment, scour countermeasure, or structural material to include abutments, footings, and culvert inverts). No scour or stream stability countermeasure may be applied above the general scour elevation.
2. When bridge abutments are set back beyond the applicable criteria span they may be located above the general scour elevation.

iii. Embedment

1. All culvert footings and inverts shall be placed below the thalweg at a depth of 3 feet, or the Lower Vertical Adjustment Potential (LVAP) line, whichever is deeper.
   a. LVAP, as calculated in Stream Simulation: *An ecological approach to providing passage for aquatic organisms at road crossings* (USDA-Forest Service 2008).
2. In addition to embedment depth, embedment of closed bottom culverts shall be between 30% and 50% of the culvert rise.

v. NMFS fish passage review and approval. NMFS will review crossing structure designs if the span width is determined to be less than the criteria established above or if the design is inconsistent with criteria in *Anadromous Salmonid Passage Facility Design* (NMFS 2011a).

Large wood (LW), Boulder, and Gravel Placement: This type of action includes LW and boulder placement, and porous boulder step structures. The following design criteria pertain to all five proposed projects:

a. Large wood and boulder projects

i. Place LW and boulders in areas where they would naturally occur and in a manner that closely mimics natural accumulations for that particular stream type. For example, boulder placement may not be appropriate in low-gradient meadow streams.

ii. Structure types shall simulate disturbance events to the greatest degree possible and include, but are not limited to, log jams, debris flows, wind-throw, and tree breakage.

iii. No limits are to be placed on the size or shape of structures as long as such structures are within the range of natural variability of a given location and do not block fish passage.

iv. Projects can include grade control and streambank stabilization structures, while size and configuration of such structures will be commensurate with scale of project site and hydraulic forces.

v. The partial burial of LW and boulders is permitted and may constitute the dominant means of placement. This applies to all stream systems but more so for larger stream systems where use of adjacent riparian trees or channel features is not feasible or does not provide the full stability desired.

vi. LW includes whole conifer and hardwood trees, logs, and rootwads. LW size (diameter and length) should account for bankfull width and stream discharge rates. When available, trees with rootwads should be a minimum of 1.5 x bankfull channel width, while logs without rootwads should be a minimum of 2.0 x bankfull widths.

vii. Structures may partially or completely span stream channels or be positioned along stream banks.

viii. Stabilizing or key pieces of LW will be intact, hard, with little decay, and if possible have root wads (untrimmed) to provide functional refugia habitat for fish. Consider orienting key pieces such that the hydraulic forces upon the LW increase stability.

ix. Anchoring LW — Anchoring alternatives may be used in preferential order:

1. Use of adequate sized wood sufficient for stability
2. Orient and place wood in such a way that movement is limited
3. Ballast (gravel or rock) to increase the mass of the structure to resist movement
4. Use of large boulders as anchor points for the LW
5. Pin LW with rebar to large rock to increase its weight. For streams that are entrenched (Rosgen F, G, A, and potentially B) or for other streams with very low width to depth ratios (less than 12) an additional 60% ballast weight may be necessary due to greater flow depths and higher velocities.
6. Anchoring LW by cable is not allowed under this opinion.

b. Porous boulder step structures and vanes (Tryon Creek Highway 43 site only)

i. Full channel spanning boulder structures are to be installed only in highly uniform, incised, bedrock-dominated channels to enhance or provide fish habitat in stream reaches where log placements are not practicable due to channel conditions (not feasible to place logs of sufficient length, bedrock dominated channels, deeply incised channels, artificially constrained reaches, etc.), where damage to infrastructure on public or private lands is of concern, or where private landowners will not allow log placements due to concerns about damage to their streambanks or property.

ii. Install boulder structures low in relation to channel dimensions so that they are completely overtopped during channel-forming flow events (approximately a 1.0 to 1.5-year flow event).

iii. Boulder step structures are to be placed diagonally across the channel or in more traditional upstream pointing "V" or "U" configurations with the apex oriented upstream.

iv. Boulder step structures are to be constructed to allow upstream and downstream passage of all native fish species and life stages that occur in the stream. Plunges shall be kept less than 6 inches in height.

v. The use of gabions, cable, or other means to prevent the movement of individual boulders in a boulder step structure is not allowed.

vi. Rock for boulder step structures shall be durable and of suitable quality to assure long-term stability in the climate in which it is to be used. Rock sizing depends on the size of the stream, maximum depth of flow, planform, entrenchment, and ice and debris loading.

vii. The project designer or an inspector experienced in these structures should be present during installation.

viii. Full spanning boulder step structure placement should be coupled with measures to improve habitat complexity and protection of riparian areas to provide long-term inputs of LW.

Off- and Side-Channel Habitat Restoration: These actions will be implemented to reconnect historic side channels with floodplains by removing off-channel fill and plugs. Furthermore, new side-channels and alcoves can be constructed in geomorphic settings that will accommodate such features. The following design criteria pertain to all sites except for the Tryon Creek Highway 43 Culvert site.

a. NMFS fish passage review and approval. When a proposed side channel will contain greater than 20% of the bankfull flow, the action will be reviewed by the restoration review team (RRT) and reviewed and approved by NMFS for consistency with NMFS (2011a) *Anadromous Salmonid Passage Facility Design* criteria.

b. Data requirements. Data requirements and analysis for off- and side-channel habitat restoration include evidence of historical channel location, such as land use surveys, historical photographs, topographic maps, remote sensing information, or personal observation.

c. Allowable excavation. Off- and side-channel improvements can include minor excavation (less than or equal to 10% of volume) of naturally accumulated sediment within historical channels, *i.e.*, based on the OHW level as the elevation datum. The calculation of the 10% excavation volume does not include manually placed fill, such as dikes, berms, or earthen plugs. There is no limit as to the amount of excavation of anthropogenic fill within historical side channels as long as such channels can be clearly identified through field or aerial photographs. Excavation depth will not exceed the maximum thalweg depth in the main channel. Excavated material removed from off- or side-channels shall be hauled to an upland site or spread across the adjacent floodplain in a manner that does not restrict floodplain capacity.

Streambank Restoration: This type of action includes alluvium placement, LW placement, roughened toe, woody plantings, herbaceous cover in areas where the native vegetation does not include trees or shrubs, bank reshaping and slope grading, coir logs, deformable soil reinforcement, ELJs, floodplain flow spreaders, and floodplain roughness. The following design criteria pertain to all five proposed projects.

- NMFS will review LW placement projects that would occupy greater than 25% of the bankfull cross section area.
- Structure shall simulate disturbance events to the greatest degree possible and include, but not be limited to, log jams, debris flows, wind-throw, and tree breakage.
- Structures may partially or completely span stream channels or be positioned along stream banks.

- Where structures partially or completely span the stream channel LW should be comprised of whole conifer and hardwood trees, logs, and rootwads. LW size (diameter and length) should account for bankfull width and stream discharge rates.

- Structures will incorporate a diverse size (diameter and length) distribution of rootwad or non-rootwad, trimmed or untrimmed, whole trees, logs, snags, slash, *etc.*

- For individual logs that are completely exposed, or embedded less than half their length, logs with rootwads should be a minimum of 1.5 times bankfull channel width, while logs without rootwads should be a minimum of 2.0 times bankfull width.

- Consider orienting key pieces such that the hydraulic forces upon the LW increase stability.

- If LW mechanical anchoring is required, a variety of methods may be used. These include large angular rock, buttressing the wood between adjacent trees, or the use of manila, sisal or other biodegradable ropes for lashing connections. If hydraulic conditions warrant use of structural connections, rebar pinning or bolted connections may be used. Use of cable is not covered by this opinion.

- When a hole in the channel bed caused by local scour will be filled with rock to prevent damage to a culvert, road, or bridge foundation, the amount of rock will be limited to the minimum necessary to protect the integrity of the structure.

- When a footing, facing, head wall, or other protection will be constructed with rock to prevent scouring or down-cutting of, or fill slope erosion or failure at, an existing culvert or bridge, the amount of rock used will be limited to the minimum necessary to protect the integrity of the structure. Whenever feasible, include soil and woody vegetation as a covering and throughout the structure.

- Use a diverse assemblage of vegetation species native to the action area or region, including trees, shrubs, and herbaceous species. Vegetation, such as willow, sedge and rush mats, may be gathered from abandoned floodplains, stream channels, *etc.*

- Do not apply surface fertilizer within 50 feet of any stream channel.

- Install fencing as necessary to prevent access to revegetated sites by livestock or unauthorized persons.

- Conduct post-construction monitoring and treatment or removal of invasive plants until native plant species are well established.

Wetland Restoration: This type of action restores degraded wetlands by (a) excavation and removal of fill materials; (b) contouring to reestablish more natural topography; (c) setting back existing dikes, berms, and levees; (d) reconnecting or recreating historical tidal and fluvial channels; (e) planting native wetland species; or (f) a combination of the above methods. The following design criteria pertain only to the Oaks Crossing project:

a. Include applicable General Construction Measures for specific types of actions as applicable (e.g., Off- and Side-Channel Habitat Restoration, above) to ensure that all adverse effects to fish and their designated critical habitats are within the range of effects considered in the PROJECTS BiOp.

3.3 Project Descriptions

This section provides details on specific actions that would occur at each restoration site. In all cases, heavy equipment such as excavators and haul trucks would be used during construction; all in-water work will be confined to the designated work window; and in-water work areas will be isolated with coffer dams so that construction will be performed "in the dry" to reduce turbidity and adverse effects to fish and wildlife. Photos of each site are shown in Section 4, and conceptual plans showing project features are shown in Appendix A.

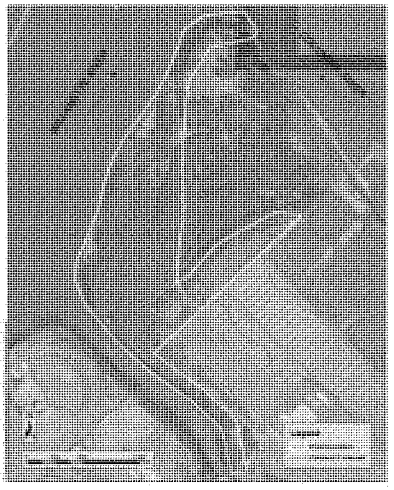

Figure 3-1. Kelly Point Park Project Site

Kelley Point Park (Restoration Action Types: Large wood (LW), Boulder, and Gravel Placement; Off- and Side-Channel Habitat Restoration; Streambank Restoration). The proposed actions at this 48-acre site will be to excavate two off-channel backwater areas totaling approximately 5,000 feet in length and 10 feet wide to an elevation approximately 6 inches below the normal winter flow water surface elevation; remove invasive plants and revegetate with native riparian species over approximately 16.9 acres; regrade steep banks for floodplain enhancement along 5,000 linear feet of the Willamette River and Columbia Slough, and place LW as needed to enhance habitat complexity. Trails throughout the park would be adjusted to allow for restoration as needed, and up to three crossing structures would be installed. 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. An estimated 197,000 cubic yards (cy) of material will be excavated and hauled off-site either by barge or truck.

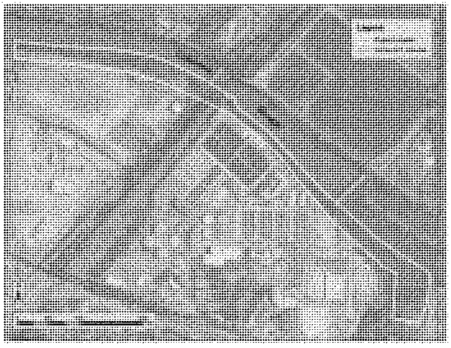

Figure 3-2. BES Plant Project Site

BES Plant (Restoration Action Types: Large wood (LW), Boulder, and Gravel Placement; Off- and Side-Channel Habitat Restoration; Streambank Restoration).

The intent of this project is to excavate a connection to a floodplain backwater/swale area to allow more frequent inundation and enhance the riparian zone along Columbia Slough. Habitat quality is moderate to good, but opportunities to improve and expand riparian wetland and backwater habitats exist in several parts of the project site. Off-channel rearing and high-water refugia would be enhanced 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. Steepened banks would be laid back along approximately 400 linear feet of Columbia Slough by excavating and hauling approximately 13,000 cy of soil; LW would be added along the banks to increase habitat complexity; several large boulders would be placed in the backwater area for reptile and amphibian habitat; and invasive species removal and riparian revegetation would occur on approximately 0.7 acres.

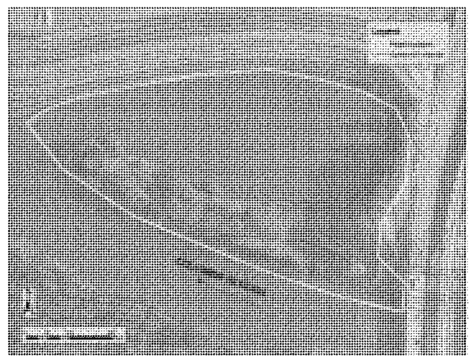

Figure 3-3. Kenton Cove Project Site

Kenton Cove (Restoration Action Types: LW, Boulder, and Gravel Placement; Streambank Restoration). Most of this 3.2 acre 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 project is to enhance this backwater cove 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, it is recommended to create small habitat islands with clean fill and woody debris, with the wood as the centerpiece of the habitat island. An estimated 1600 cy of gravel and topsoil will be imported and hauled by truck for the creation of the habitat islands. LW would be installed as appropriate and invasive species removal and revegetation with native species would occur over approximately 3.2 acres.

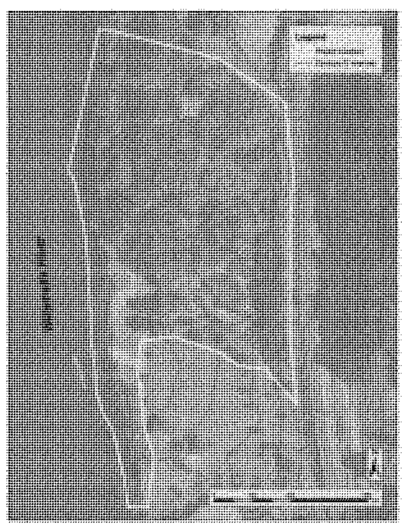

Figure 3-4. Oaks Crossing/Sellwood Riverfront Park Project Site.

Oaks Crossing/Sellwood Riverfront Park (Restoration Action Types: LW, Boulder, and Gravel Placement; Off- and Side-Channel Habitat Restoration: Wetland Restoration). The intent of this project is to restore salmonid habitat in the floodplain of this 9.97 acre site by connecting off-channel habitat to the river, adding LW, removing invasive species, and revegetating with native wetland and riparian species. Habitat at this site consists of gallery forest lined with native and invasive species. Shallow water habitat would be enhanced by addition of LW as needed to enhance habitat. To create approximately 1,200 linear feet of side channels and backwater habitat, an estimated 9,000 cy of material will be excavated and hauled either by barge or truck. The bottom elevations of the side channels would correspond to an elevation approximately 6 inches below the water surface elevation under normal winter flows. Invasive species would be removed and wetland or riparian vegetation would be planted over approximately 7.2 acres.

Highway 43 Tryon Creek Culvert (Restoration Action Type: Fish Passage Restoration). The intent of this project is to replace the culvert under Highway 43 and the Portland and Northern rail line with a fish passable culvert. The new open-bottom arch culvert would simulate the natural stream dimensions, allowing for sediment and debris to pass through and provide fish unhindered passage beneath the roadway and railroad line. Implementation of this project would allow unhindered fish passage into the Tryon Creek State Natural Area, where fish habitat has been restored recently. Replacing this culvert would require excavation of up to 21,000 cy of overburden from above the culvert; demolition and removal of the entire 400 foot culvert; removal of approximately 1,200 cy of bedrock; installation of a 28-foot wide, open bottom arch culvert; installation of headwalls and wingwalls at both ends of the culvert; installation of rock weirs in the streambed for velocity control; backfill with 17,800 cy of overburden; and riparian revegetation over approximately 2.5 acres. Temporary dewatering may be needed during some of the work in the streambed. All work in the streambed and bank areas would occur during the in-water work window.

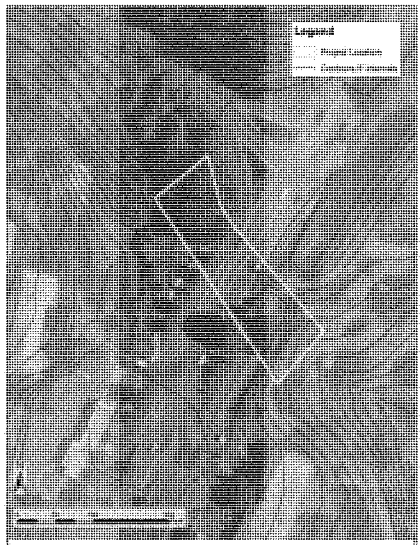

Figure 3-5. Highway 43 Tryon Creek Culvert Project Site.

A drawing of the proposed culvert appears below. This culvert has been designed to be consistent with design criteria from the PROJECTS BiOp (NMFS 2013) and recommendations in *Anadromous Salmonid Passage Facility Design* (NMFS 2008).

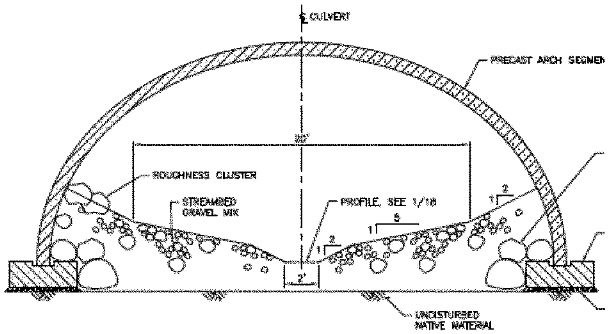

Figure 3-6. Cross Section of Proposed Tryon Creek Highway 43 Culvert

4. DESCRIPTION OF ACTION AREA AND PROJECT SITES

4.1 Existing Conditions

The Lower Willamette River ecosystem has changed markedly during the last 150 years as a result of floodplain fill, installation of revetments, and development of the watershed (Hulse et al. 2002). Changes to the ecosystem have been evident in the dramatic declines in riparian and floodplain areas, wetlands, and fish populations. Fish distribution throughout the Lower Willamette River watershed is shown in Figure 4-1.

4.1.1 Lower Willamette River

The Lower Willamette River is a tidally influenced freshwater estuary that is significantly 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 NGVD29 (National Geodetic Vertical Datum) 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).

Hydrology in the Lower Willamette River is driven by upstream reservoir regulation of both the Willamette and Columbia Rivers, natural stream flows, climatic patterns, and tidal effects. 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 swell from 200,000 to 400,000 cfs (Hulse *et al.* 2002). Very high flows correspond to the spring freshet and large storm events, and generally last between 1 and 2 weeks. Normal winter flows are generally attained in October and last until approximately late April, depending on the timing of early snowmelt. During this time, salmonids are typically in need of rearing and refuge habitat to avoid the high flows before they begin their out migration to the ocean.

Hydrologic processes in the Lower Willamette River have changed in response to construction of upstream dams, irrigation diversions, and navigation dredging below Willamette Falls. Winter flood flows have been reduced and summer low flows have increased (PBES 2005). 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 overland flows and groundwater input, although there is little quantitative information to assess the specific nature of these changes.

There are dozens of federal, state, local, and private 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 for downstream flood reduction and hydroelectric power generation, in addition to various bank protection structures for flood control and hydropower production (Willamette Partnership 2004).

Quality habitat for key life stages of salmonids 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. Changes in the abundance and distribution of gravels and LW have reduced suitable spawning areas and rearing habitat (NPCC 2004). Altered flow regimes and water temperature patterns due to upstream dam releases have reduced the availability and quality of off-channel habitat including backwater sloughs, floodplain ponds, and other slow-moving side-channel habitat.

Across the Lower Willamette River reach, the only mapped wetland is a freshwater forested/shrub wetland at the southern end of Kelly Point Park. Although no other wetland has been identified in the remainder 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 may host fringe riparian wetlands. Reconnaissance-level surveys at the Oaks Crossing/Sellwood Riverfront Park site indicate that freshwater forested/shrub wetland occurs there. A mature black cottonwood riparian forest is found close to the bank of the Willamette River at this site.

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, toxic pollutants carried by stormwater, and other sources, have contributed to highly elevated levels of DDT, PCBs, polycyclic aromatic hydrocarbons (PAHs) and heavy metals in Lower Willamette River sediment.

Fish sampling has been conducted at sites within the Lower Willamette and Lower Columbia Rivers to assess if fish may be at risk for toxic effects of DDT contamination. The results of this study concluded that although some bioaccumulation of DDT was detected, the resulting levels were below the threshold concentration for injury from DDT. Although it is likely that some bioaccumulation is inevitable if individuals remain in areas of known high levels of contamination for prolonged durations, testing of fish tissue to date has shown that levels are below established thresholds. Although this effect may be magnified if fish linger in restored areas for rearing, testing did not indicate that levels of toxins would rise above threshold.

Diverse and extensive habitat types are found throughout the Lower Willamette River as a result of its location at the juncture of two major river systems (PBES 2006). Habitat types present in the lower river segment include bottomland forest, scrub/shrub, and grassland. Important wildlife linkages provided by this segment offer wintering and breeding habitat for waterfowl, shorebirds, and neotropical migrants along the Pacific Flyway (Aldolfson Associates 2000). The presence of waterfowl and shorebirds in this tidally influenced area is unique to the project area. Bottomland forests and wetlands 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.

Riparian forests, also called gallery or bottomland forests, grew abundantly on the floodplains of the Willamette River and its tributaries. These forests included a diverse mosaic of brushy thickets, marshes, and ash openings, maintained through annual inundation by floods. Approximately 20 percent of riparian vegetation present in 1851 remains, much of it now only one to two tree lengths in width. Vegetation of bottomland and wetland forests consisted of black cottonwood *(Populus trichocarpa)*, Oregon ash *(Fraxinus latifolia)*, and willow *(Salix* sp.*)* with associated understory assemblages (Portland Bureau of Planning and Sustainability 2009).

4.1.2 Tryon Creek

Tryon Creek is a 5-mile long, perennial tributary to the Willamette River, with headwaters in the West Hills of Portland (west of Interstate 5).The historic hydrology of Tryon Creek is typical of a low to moderate gradient headwater streams, with steep landscape slopes that have been modified by the effects of development and urbanization. The annual hydrograph for Tryon Creek reflects a climatic precipitation pattern, with higher flows and frequent storm flow events during the wet period from approximately October through May, followed by lower flows during the summer dry period (June through September) (PBES 2005). Although there are no quantified historic data to compare hydrologic changes in the last century in the Tryon Creek watershed, it can be inferred from similar streams in the Pacific Northwest that the climatic precipitation pattern has likely not changed significantly with development, but that daily and monthly stream flow events and runoff volumes have changed due to development.

The average annual daily discharge recorded at USGS Gage No. 14211315 (Tryon Creek near Lake Oswego) for water years 2002 to 2011 is 8.72 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). No contaminated sediments were identified in or near Tryon Creek during a database search. The headwaters of the creek are highly developed, and stormwater may bring pollutants associated with urban runoff. The only stormwater or sewage structure identified as occurring at any of the restoration sites included in this study is a sewage pipeline that runs parallel to the Highway 43 Tryon Creek culvert.

No wetlands have been mapped at the Highway 43 Tryon Creek Culvert site. 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.

Cnlverts on Tryon Creek at Boones Ferry Road, Highway 43, and on Arnold Creek at Arnold Creek Road partially or completely block fish passage into the upper reaches of these streams. Boones Ferry Road comprises the upstream extent of the study area, and the Arnold Creek culvert is found further upstream, outside of the study area.

Relatively extensive wildlife habitat is found between Highway 43 and Boones Ferry Road. Much of this area is undeveloped and part of the Tryon Creek State Natural Area. Above Boones Ferry Road, the watershed is more highly developed and wildlife habitat quality is lower.

4.1.3 Columbia Slough

Hydrology within the Columbia Slough watershed has also changed from historic conditions. Levee construction and reinforcement; 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 2005). The result has been disconnection of the slough from its floodplain and only seasonal connection to the Columbia River. These activities have left Columbia Slough with complex and highly managed hydrologic features that affect flows directly above the confluence of the Lower Willamette River with the Columbia River.

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 cfs was observed on February 9, 1996 (USGS 2012b), which corresponds to record flooding throughout the region.

The travel corridors along Columbia Slough are important for dispersion of mammalian species such as deer, coyote, fox, and beaver, as well as reptiles and amphibians (Adolfson Associates 2000).

Although not a designated wetland, Columbia Slough is composed of two types of riverine systems, both of which have the potential to host additional wetlands. The Columbia Slough sites contain freshwater emergent wetlands and freshwater forested/shrub wetlands; most soils in the area are hydric. A very small part of the BES treatment plant has a forest/shrub wetland at the west tip of the property. Kenton Cove has no mapped wetlands, but likely has narrow fringing freshwater emergent wetland at the toe of the banks.

Several obstructions to fish access in the subbasin also affect native fish. Access to the middle and upper Columbia Slough is prevented by the Multnomah County Drainage District dike and pumping system. It is likely that fish could access the upper slough area during high spring runoff in the Columbia (PBES 2006). Columbia Slough at the location of the project sites is fully accessible to fish moving upstream from the confluence of the slough with the Willamette River.

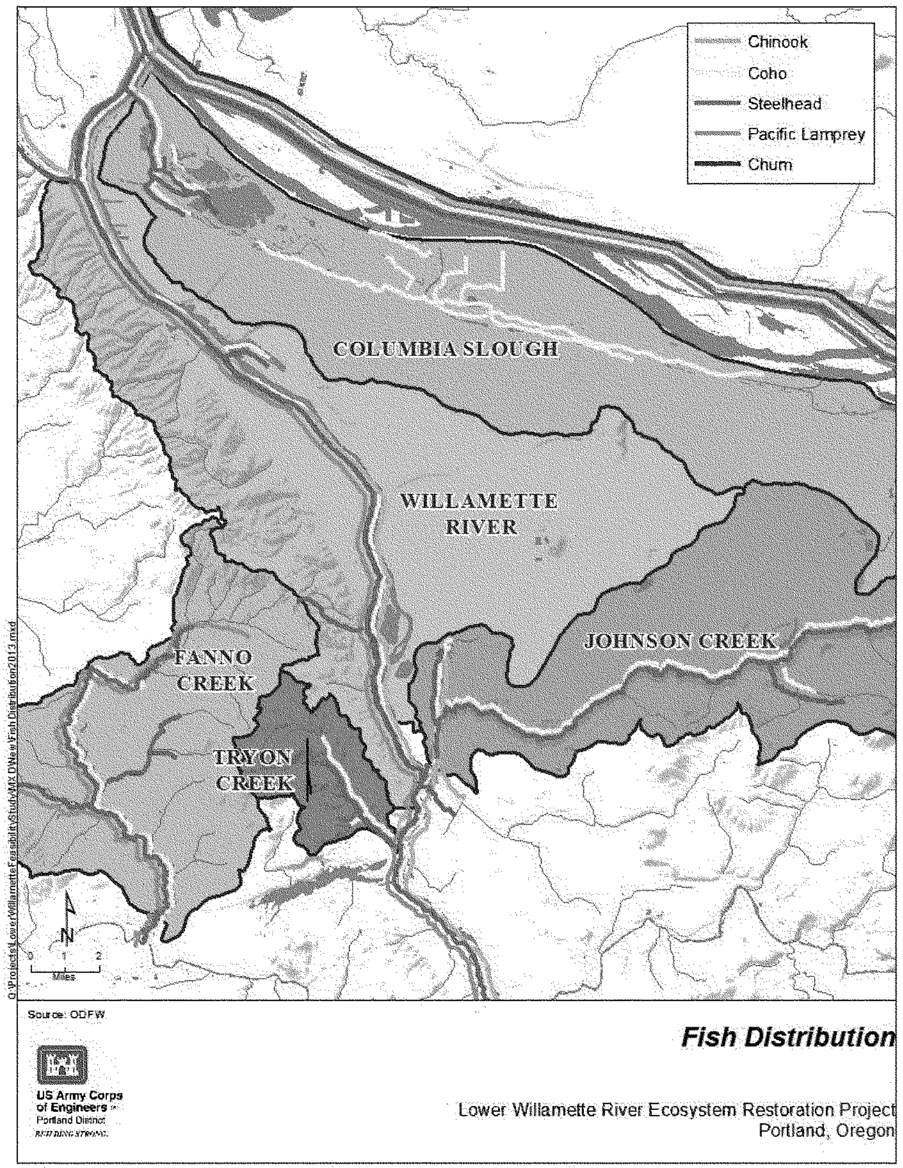

Figure 4-1. Salmonid distribution in study area

4.2 Site Descriptions

The final list of sites included in this study collectively provide spawning, forage, rearing, and escape habitat for some or all of the listed anadromous species mentioned in this BA. Sites were selected to be consistent with the City of Portland's priority habitat areas and watershed restoration objectives. This section contains a general description of baseline conditions at each of the five sites shown in Figure 2-2. Components of the recommended restoration plans for each site are shown in the figures in Appendix A.

4.2.1 Kelley Point Park

Habitat value in Kelley Point Park is currently moderate. The dominant vegetation includes large grassy areas, with an Oregon ash and cottonwood riparian zone that is on average 50 feet wide. Blackberry is dominant in multiple locations. The shoreline along Kelley Point is of good quality, with shallow-water habitat and moderately sloping banks with some LW present (Figure 4-2). Banks are steepest at the confluence of the Willamette and Columbia Rivers, and along the banks of the Columbia Slough. Aquatic habitat includes a sandy shoreline with a steep drop-off and little to no shoreline or aquatic vegetation to provide cover.

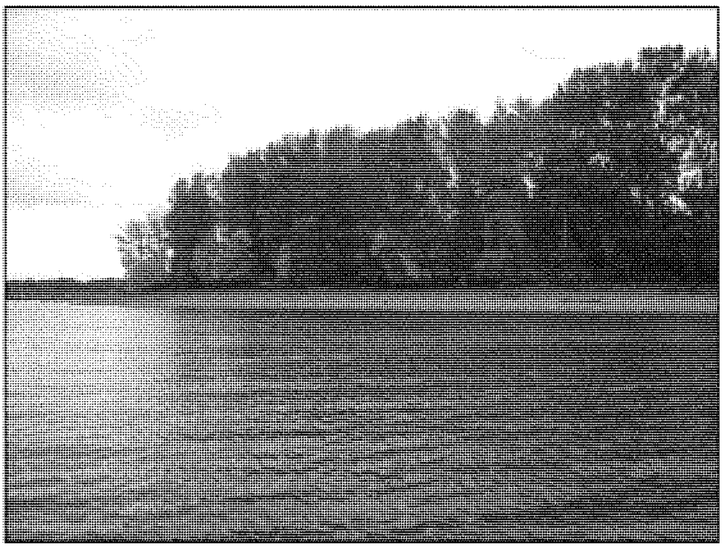

Figure 4-2. Kelley Point Park Banks along the Willamette River

4.2.2 BES Treatment Plant

The BES Treatment Plant site consists of a City-owned bike trail and park, and the left bank of the Columbia Slough. Dominant vegetation includes black cottonwood, ninebark *(Physocarpus capitatus)*, Himalayan blackberry (*Rubus armeniacus*), English ivy (*Hedera helix*), and reed canarygrass *(Phalaris arundinaceae)*. The shoreline appears to be naturally vertical and is about 8 feet high. Aquatic habitat is limited due to the steep banks and little to no cover. A small swale area (<1 ac) at the east end of the site is connected to the slough infrequently through a culvert (Figure 4-3).

Figure 4-3. Backwater swale at BES Treatment Plan

4.2.3 Kenton Cove

Currently, most of the Kenton Cove site is surrounded by a highly maintained levee with a natural riparian floodplain zone along Columbia Slough. Although Kenton Cove has a direct, consistent connection with the Columbia Slough, aquatic habitat is lacking with little to no vegetative cover, offering little benefit to aquatic species. The riparian zone includes dominant species such as black cottonwood, Himalayan blackberry, and reed canarygrass (Figure 4-4).

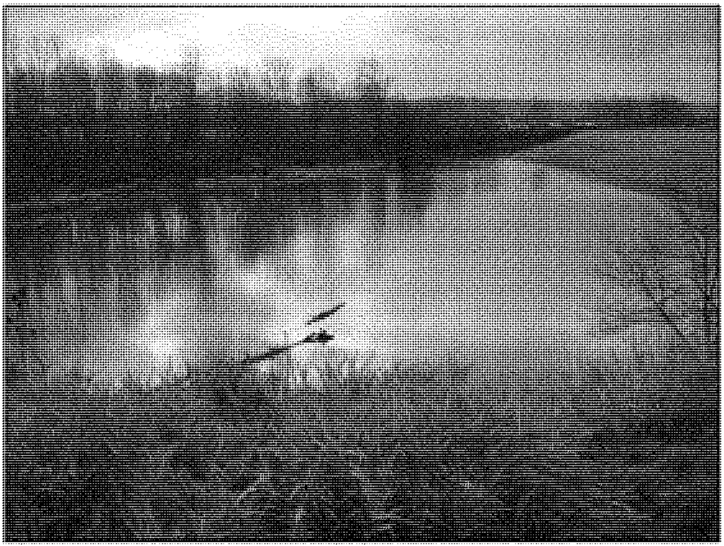

Figure 4-4. Kenton Cove

4.2.4 Oaks Crossing

The Oaks Crossing site consists of a low riparian zone lined with native and invasive species. The site is within a multi-use park setting. Dominant species in the riparian zone include black cottonwood, willows, cedars, Himalayan blackberry, English ivy, and reed canarygrass (Figure 4-5). There is a powerline tower on the site that sits within a small existing wetland. The shoreline consists of gradual sandy slope with little to no vegetative cover.

The site's close proximity to Oaks Bottom Wildlife Refuge increases the value for habitat improvement on this adjacent property for wildlife and aquatic species. Although there is no hydrologic connection between these two sites and they are separated by a road and the SAM TRANS rail line, migration of amphibians and waterfowl is likely to occur between the two areas.

Figure 4-5. Banks of Oaks Crossing along the Willamette River

4.2.5 Tryon Creek - Highway 43 Culvert Replacement

This site includes a culvert complex that acts as a fish passage barrier under most conditions. The length of the existing culvert under Highway 43 and the train line is approximately 400 feet. The culvert is approximately a 6-foot concrete box (Figure 4-6). Weirs downstream of the culvert and baffles within the culvert were installed in an attempt to facilitate immediate fish passage until a long-term solution can be found. Upstream of this culvert is ~2.7 miles of high quality unhindered spawning and rearing habitat up to the Boones Ferry Road crossing. The Boones Ferry Road crossing is a barrier to upstream fish passage for which a passable replacement culvert is under design by the City of Portland. The estimated bankfull width of the stream is 30 feet.

Figure 4-6. Highway 43 Culvert on Tryon Creek (facing upstream)

5. CONSERVATION MEASURES

The Project would comply with relevant conservation construction measures and best management practices listed below.

5.1 General Construction Conservation Measures

- **Site Contamination Assessment:** An HTRW assessment of available records has been conducted for the project sites to ensure that the proposed project will not release contaminants to aquatic habitat. This assessment, which included a search of relevant databases and a field reconnaissance survey, concluded that there are no HTRW sites within ¼ mile of any of the proposed restoration sites.

- **Site Layout and Flagging Sensitive Areas:** Before construction begins flagging of entry and exit points, staging areas, and sensitive resources will occur in order to avoid disturbance during construction.

- **Staging Storage and Stockpile Areas:** Staging area and storage areas will be designated to store materials, fuel, and equipment. Equipment will be staged at least 150 from any natural water body or wetland to avoid contamination or sedimentation of water bodies. However since the project sites may occur in confined areas, this may not be feasible. If the staging area(s) will be located within 150 feet of the river or the wetlands, they will be fenced and fully contained to prevent the runoff of sediment or pollutant laden stormwater into the river or wetlands.

- **Erosion Controls:** Site planning and site erosion control measures will be installed prior to construction to prevent erosion and sediment discharge. Temporary erosion controls measures including fiber wattles, site fences, jute matting, wood fiber mulch, or geotextiles will be installed, as appropriate, before any significant alteration of the site occurs. Additional sediment barriers will be stored on site if needed.

- **Hazardous Material Spill Prevention Control:** An erosion and pollution control plan will be prepared for each individual project site and carried out, commensurate with the scope of the action that includes the following information: (a) the name, phone number, and address of the person responsible for accomplishing the plan; (b) best management practices to confine vegetation and soil disturbance to the minimum area, and minimum length of time, as necessary to complete the action, and otherwise prevent or minimize erosion associated with the action; (c) best management practices to confine, remove, and dispose of construction waste, including debris, discharge water, concrete, cement, grout, washout facility, petroleum product, or other hazardous materials generated, used, or stored on-site; (d) procedures to contain and control a spill of any hazardous material generated, used or stored on-site, including notification of proper authorities; and (e) steps to cease work under high flows, except for efforts to avoid or minimize resource damage.

- **Equipment, Vehicles, and Power Tools:** Equipment will be selected to minimize adverse effects on the environment. Vehicles and equipment will be inspected daily for fluid leaks before leaving the staging area when operating within 50 feet of any stream, waterbody, or wetland and the equipment will be steam cleaned before operation below the ordinary high water or as necessary to remain grease free and prevent invasive species contamination. Biodegradable lubricants and fuels will be used as available.

- **Temporary Access Roads:** Temporary access roads will not be built on steep slopes, where grade, soil, or other features suggest a likelihood of excessive erosion or failure. For the most part, existing access roads are present, and only limited additional grading or placement of gravel/rock for access would be required to facilitate construction.

- **Dust Abatement:** Dust abatement measures will be commensurate with soil type, equipment use, wind conditions, and the effects of other erosion control measures; work will be sequenced to reduce the exposure of bare soil to wind erosion; spill containment supplies will be maintained on site; petroleum-based products will not be used for dust abatement.

- **Temporary Stream Crossings:** No stream crossings will occur at active spawning sites, when holding adult listed fish are present or holding, or when eggs or alevins are in the gravel; temporary crossings will not be placed in areas that may increase the risk of channel re-routing or avulsion, or in potential spawning habitat, *e.g.*, pools and pool tailouts. The number of temporary stream crossings will be minimized, and existing stream crossings will be used whenever reasonable; temporary bridges and culverts will be installed to allow for equipment and vehicle crossing over perennial streams during construction. Whenever possible, vehicles and machinery will cross streams at right angles to the main channel or equipment and vehicles will cross the stream in the wet only where the streambed is bedrock, or where mats or off-site logs are placed in the stream and used as a crossing. All temporary stream crossings will be obliterated as soon as they are no longer needed, and any damage to affected stream banks or channel will be fully restored following project implementation.

- **Surface Water Withdrawal and Construction Discharge Water:** Surface water will only be diverted to meet construction needs if developed sources are unavailable or inadequate. Diversions will not exceed 10% of the available flow and will have a juvenile fish exclusion device that is consistent with NMFS's criteria. Screens will be installed, operated, and maintained to meet NMFS fish screen criteria. All construction discharge water will be treated using the best management practices applicable to site conditions to remove debris, sediment, petroleum products, and any other pollutants likely to be present, (*e.g.*, green concrete, contaminated water, silt, welding slag, sandblasting abrasive, grout cured less than 24 hours, drilling fluids) to ensure that no pollutants are discharged from the construction site.

- **Fish Passage**: Fish passage will be provided for adult or juvenile fish present in the action area during construction, or fish will be salvaged and removed if waters are diverted. All reconnection channels and passageways will meet NMFS fish passage criteria described in Section 4.

- **In-water Work Period:** All work below the ordinary high water line will occur during the designated ODFW in-water work periods for the Lower Willamette River and tributaries, as appropriate (see Table 5-1). These in-water work periods are generally listed in the Oregon Guidelines for Timing of In-water Work to Protect Fish and Wildlife Resources (ODFW 2008, or most recent version), but are then more specifically determined by coordination with ODFW staff. Coordination with ODFW and NMFS will happen accordingly for this project.

Table 5-1. Listed In-water Work Periods for the Lower Willamette and Tributaries

Waterbody	Work Window
Tryon Creek	July 15 to September 30
Mainstem Willamette	July 1 to October 31
Columbia Slough	June 15 to September 15

Source: ODFW 2009

- **Fisheries, Hydrology, Geomorphology, Wildlife, Botany, and Cultural Surveys in Support of Aquatic Restoration:** A monitoring and adaptive management plan to track the success of the restoration features will be developed.

- **Work Area Isolation:** Any work within the wetted channel will be isolated from the Lower Willamette River and its tributaries by installation of coffer dams and other measures, as appropriate. A work area isolation and fish salvage plan will be prepared for each site for approval by ODFW and NMFS and carried out with a scientific collection permit. Fish and wildlife will be salvaged and removed from the work area. Any pumps used outside of isolated areas will be screened per ODFW requirements. Any groundwater present in the excavation area will be pumped and treated via infiltration or other methods (such as Baker tanks or silt bags) prior to discharge back to either the river or wetlands.

- **Fish Capture and Release:** Any fish that may be trapped within the isolated work area will be captured and released using a trap, seine, electrofishing, or other methods as prudent to minimize the risk of injury, then released at a safe release site. A scientific collection permit will be obtained to conduct this work, with approval of the fish salvage plan from NMFS and ODFW. Capture and release will be supervised by a fishery biologist experienced with work area isolation and competent to ensure the safe handling of fish. If electrofishing is used, the NMFS electrofishing guidelines will be followed (NMFS 2000).

- **Invasive and non-native plant control**: Invasive and non-native plant control will use manual, mechanical, or hydro-mechanical methods as a priority. Herbicide use will be used secondarily and will follow all NMFS approved herbicide label instructions and application will occur by or supervised by a licensed applicator

- **Site Restoration**: Any temporary access routes constructed will be removed in their entirety and the locations will be restored via mulching and hydroseeding and then planting of native shrub and tree species. Any fill placed in wetlands for temporary construction purposes will be removed and the area will be fully restored. Any large wood, native vegetation, topsoil and native channel material displaced by construction will be stockpiled for reuse on-site during restoration, as feasible. When construction is complete, all disturbed areas will be restored as necessary to renew ecosystem processes. Fencing will be installed as necessary to prevent damage to newly revegetated sites by unauthorized persons.

- **Planting or Installing Vegetation:** Disturbed areas will be planted and seeded before or at the beginning of the first growing season after construction. A diverse mix of native species adapted to the site conditions will be used for all revegetation efforts. Non-native or invasive species will not be included. Existing non-native or invasive species will be controlled as feasible on the site to promote native vegetation growth and dominance.

6. BIOLOGY AND DISTRIBUTION OF LISTED SPECIES

Of those species listed in Table 6-1, the only known ESA-listed species present in the project area are the fishes. It is assumed, given the best scientific information available, that the necessary habitat requirements for all other species listed in Table 1-1 are not present in the action area and individuals are therefore absent from the project sites. Otherwise, there are no listed plants, amphibians, reptiles, or mammals known to occur or that have the potential to occur in the proposed action areas.

The yellow-billed cuckoo *(Coccyzus americanus)* was proposed for listing as *threatened* under the ESA on 3 October 2013 (FR 78 61622). Although this species is considered a riparian obligate species, the large, extensive riparian forests they prefer are inter-mixed with an urban landscape. It is assumed that very few birds are present in the region, and if any birds are present they would occupy extensive riparian forests outside of the action area; therefore the yellow-billed cuckoo is not expected to be present in the action area. The proposed restoration actions described above will not impact the gallery forests preferred by cuckoos, as most construction work is intended to restore aquatic habitats and the associated floodplain. No large trees or forested areas will be removed or damaged during construction. For these reasons, the Corps has determined the proposed action will have ***no effect*** to yellow-billed cuckoos and this species is not evaluated further in this assessment.

Table 6-1. ESA Status of Key Species Found in the Project Area

Species	Scientific Name	ESU	ESA Listing Status
Coho salmon	*Oncorhynchus kisutch*	Lower Columbia / Southwest Washington	Threatened
Chinook salmon	*Oncorhynchus tshawytscha*	Lower Columbia	Threatened
		Upper Columbia Spring-run	Endangered
		Upper Willamette	Threatened
		Snake Spring/ Summer-run	Threatened
		Snake Fall-run	Threatened
Steelhead	*Oncorhynchus mykiss*	Lower Columbia	Threatened
		Middle Columbia	Threatened
		Upper Columbia	Threatened
		Upper Willamette	Threatened
		Snake	Threatened
Chum salmon	*Oncorhynchus keta*	Columbia	Threatened
North American green sturgeon	*Acipenser medirostris*	Southern DPS	Threatened

Source: NMFS 2014.

The species carried forward for further analysis in this assessment include seven listed fish species that have the potential to be present in the action area and have a federal listing status of threatened. A total of 15 ESUs composed of these seven different species may use or migrate through watercourses in the project area. These species include Lower Columbia River coho salmon ESU (*Oncorhynchus kisutch*), Lower Columbia River Chinook salmon ESU (*O. tshawytscha*), Upper Willamette River Chinook salmon ESU (*O. tshawytscha*), Upper Willamette River steelhead DPS (*O. mykiss*), Lower Columbia River steelhead DPS (*O. mykiss*), and the Southern DPS of North American green sturgeon (*Acipenser medirostris*). Only one species, the Lower Columbia River coho salmon, also has a state listing status of endangered. The Clackamas population of Chum salmon (*O. keta*) was not included in this evaluation as it is likely extirpated from the Willamette River (NMFS 2004).

6.1 Lower Columbia River Coho Salmon ESU, Threatened

The Lower Columbia River coho salmon ESU was listed as threatened on June 28, 2005 (70FR37160); critical habitat has been proposed on January 14, 2013 (78FR2726). 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, as well as the Willamette River to Willamette Falls, Oregon, and 25 artificial propagation programs (NMFS 2005a). Information presented in this discussion came primarily from the Federal Register designating the listing status of the Lower Columbia River coho salmon ESU (NMFS 2005a) and the 5-Year Review of Lower Columbia River Salmon (NMFS 2011).

Coho salmon is a widespread species of Pacific salmon, with production in most major river basins around the Pacific Rim from central California to Korea and northern Hokkaido, Japan (Laufle et al. 1986). The Lower Columbia River 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, and includes the Willamette River to Willamette Falls, Oregon, as well as twenty-five artificial propagation programs (NMFS 2011). The following ESU description was taken from the Lower Columbia Fish Recovery Board's (LCFRB's) technical framework (2004). Coho salmon runs in the Columbia River, and to some extent the Willamette River, show considerable temporal variability in river entry and spawn timing. Coho salmon begin to return to the Columbia River in August and continue through December/January, peaking in September/October. This variability resembles the pattern of river entry in other river systems, such as the Chehalis in southwest Washington, the Skagit in northern Washington, and the Klamath in southern Oregon (Leidy and Leidy 1984; Washington Department of Fisheries 1993).

The timing of coho salmon spawning can also reflect water temperature changes in a particular river system. Lister et al. (1981) found that spawn timing of coho salmon in tributaries of the Cowichan River (British Columbia) was strongly correlated to tributary water temperature; coho salmon spawning in warmer tributaries spawned later than those spawning in colder tributaries. Such factors make determining and comparing when coho salmon will enter a river or spawn difficult because of the temperature variability across and within basins (NMFS 2005a). Other environmental factors influence coho salmon spawning as well. Adult coho salmon returning to spawn need adequate flows and water quality, and unimpeded passage to their natal grounds. They also need deep pools with vegetative cover and in-stream structures such as root wads for resting and shelter from predators.

After emergence, coho salmon fry move to shallow, low velocity rearing areas, primarily along the stream edges and in side channels. They congregate in quiet backwaters, side channels, and small creeks, especially in shady areas with overhanging branches (Gribanov 1948). All coho salmon juveniles remain in their natal river for a full year after leaving the gravel.

Most juvenile coho salmon migrate seaward as smolts in late spring, typically during their second year. Factors that tend to affect the time of migration include: the size of the fish, flow conditions, water temperature, dissolved oxygen levels, day length, and the availability of food (Shapovalov and Taft 1954). The size of coho salmon smolts is fairly consistent over the species' geographic range; a fork length of 3.9 inches (100 mm) appears to be the threshold for smoltification (Gribanov 1948). Generally, the timing of outmigration is earlier in the southern coho salmon populations compared to northern populations.

Coho salmon use estuaries primarily to adjust physiologically to salt water. Most research indicates that, upon entering the ocean, coho salmon remain in nearshore environments over the continental shelf for a couple of months before they disperse on more seaward migrations; this holds true from California to Alaska (Shapovalov and Taft 1954; Milne 1964; Godfrey 1965). This pattern may help coho salmon avoid pelagic predators and reduce feeding competition with immature salmon that are older by a year or more.

Coho salmon typically spend 18 months in the ocean before returning to freshwater. Thus, many returning coho salmon are 3 years old and have spent 18 months in freshwater and 18 months in salt water. Jacks, however, return earlier at age 2. These sexually mature males return to freshwater to spawn after only 5 to 7 months in the ocean.

The latest status review of Lower Columbia coho salmon concludes that the ESU is not meeting recovery criteria and 21 out of 24 historical populations are at very high risk of extinction with the remaining three at high to moderate risk of extinction (NMFS 2011c). The Lower Columbia River ESU is primarily limited by habitat degradation, but past over-harvest and the natural spawning of stray hatchery coho were also identified as contributing to the decline of the ESU.

6.1.1 Utilization of the Action Area

Historically the Lower Willamette River subbasin has provided the third most important spawning grounds for coho salmon throughout the entire Lower Columbia Basin. Coho are believed to be native only to the watershed below Willamette Falls, most notably the Clackamas River, Johnson Creek, Tryon Creek, and tributaries of Multnomah Channel (PBES 2006). The Lower Willamette River and its tributaries up to Willamette Falls include critical spawning and rearing habitat for coho. Coho typically spawn in small, low-gradient areas of the Lower Willamette River tributaries. Juveniles rear up to a year in side channels, backwater pools, and beaver ponds before emigrating seaward. Coho are in low abundance within the Lower Willamette basin. Mostly fish utilize the mainstem as a corridor for adult returns to tributaries such as the Clackamas River and for out-migration of juveniles (NMFS 2011c). Recently, coho have been collected in Tryon Creek between the confluence with the Willamette River and the Highway 43 culvert (PBES 2012). Additionally, juvenile coho have been identified in the Columbia Slough during winter months (ODFW 2009).

Adults may spawn in the tributary streams within the project area from September through December. Eggs are present in the redds until hatching, when the fry emerge. Juveniles will rear in backwater and refuge areas wherever present in the action area.

6.1.2 Critical Habitat

Critical habitat was proposed for the Lower Columbia River coho salmon ESU on January 14, 2013 and includes the mainstem Willamette River, Tryon Creek, and Columbia Slough in the action area.

Within the proposed rule for critical habitat, physical and biological requirements were defined for coho salmon based on their natural history and habitat needs. These requirements are defined in terms of a concept called primary constituent elements (PCEs), which are physical or biological features that have been identified as essential for their conservation. These PCEs include:

PCE 1: Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development;

PCE 2: Freshwater rearing sites with:

> (i) Water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility;
>
> (ii) Water quality and forage supporting juvenile development; and
>
> (iii) Natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.

PCE 3: Freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival;

PCE 4: Estuarine areas free of obstruction and excessive predation with:

> (i) Water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater;
>
> (ii) Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels; and

(iii) Juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.

PCE 5: Nearshore marine areas free of obstruction and excessive predation with:

(i) Water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and

(ii) Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels.

PCE 6: Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.

Status of Critical Habitat in the Action Area Freshwater habitats in the action area contain only a subset of the identified physical or biological features for coho salmon: PCEs 1 to 3 are present in the action area. The environmental baseline of the action area has been assessed by rating each PCE condition as "properly functioning (PFC)," "impaired (IC)," or "not properly functioning (NPF)." A summary of each PCE element follows in Table 6-2, along with a justification for the status of each PCE element in the action area. The effects that the project may have on the environmental baseline of each PCE element are analyzed in the following section (Section 7).

Table 6-2. Environmental Baseline Summary of Relevant Chinook Critical Habitat PCEs in the Action Area

PCE	Function	Description of Existing Conditions	Cause of Degradation from PFC
Chinook salmon			
1. Freshwater spawning sites	IC	The mainstem Willamette River has been largely impacted by upriver dams and dredging has reducing the amount of braiding and side channels that may have supported spawning; Tryon Creek has partial barriers limiting passage into potential spawning sites.	Habitat loss and impaired access to spawning sites from mainstem dams, impassible culverts, land use, and dredging.
2. Freshwater rearing sites	IC	The mainstem Willamette River has been largely impacted by upriver dams and dredging reducing the amount of braiding, side channels and off-channel rearing habitat area.	Habitat loss and degradation from mainstem dams, land use, and dredging. Contaminated sediments from industrial and urban development further degrade overall habitat quality.
3. Freshwater migration corridors	IC	Water temperatures and water quality have been altered due to changes in the hydrograph and effects of urbanization and fish passage barriers partially block access on Tryon Creek.	Mainstem dams, impassible culverts, urbanization, contaminants, stormwater, and land use.

6.2 Lower Columbia River ESU and Upper Willamette River ESU Chinook Salmon, Threatened

Both the Lower Columbia River Chinook salmon ESU and Upper Willamette River Chinook salmon ESU (*Oncorhynchus tshawytscha*) were listed as threatened on March 24, 1999 (64FR14329) with the threatened status reaffirmed on June 28, 2005 (70FR37160); critical habitat for these ESUs was designated on September 2, 2005 (70FR52630). Draft Interim Regional Recovery Plans have been prepared for both ESUs (NMFS 2005b and NMFS 2010a, respectively). 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 (64FR14208) (NMFS 2005a). 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 (64FR14208) (NMFS 2005a). Information presented in this discussion came primarily from the Federal Register designating the listing status of the Lower Columbia River Chinook salmon ESU and Upper Willamette River Chinook salmon ESU (NMFS 2005a), the 5-Year Review of Lower Columbia River Salmon (NMFS 2011c), the 5-Year Review of Upper Willamette River Salmon (NMFS 2012), and the Draft Interim Regional Recovery Plans whenever applicable (NMFS 2005b, 2010a).

Chinook salmon, also known by the common names king, spring, quinault, and tyee salmon, historically ranged from the Ventura River in California to Point Hope, Alaska in North America (Healey 1991). Additionally, Chinook salmon have been reported in the Mackenzie River area of northern Canada (McPhail and Lindsey 1970). Factors implicated in the decline of the species include dams, logging, agriculture, water withdrawal, mining, and urbanization, all of which contribute to habitat loss and degradation. Overfishing and the wide use of hatcheries and other forms of artificial propagation are also factors (Myers et al. 1998; West Coast Salmon Biological Review Team 2003). In addition, sources suggest that the "inadequacy of existing regulatory mechanisms" is a general reason for overall decline in abundance of Chinook salmon (Oregon Natural Resources Council 1995).

Chinook salmon are the largest of the salmon species in body size and exhibit one of the most diverse and complex life history strategies. Two generalized freshwater life-history types were initially described by Gilbert (1912): "stream-type" Chinook salmon reside in freshwater for a year or more following emergence, whereas "ocean-type" Chinook salmon migrate to the ocean within their first year. Healey (1991) has promoted the use of broader definitions for "ocean-type" and "stream-type" to describe two distinct races of Chinook salmon. This racial approach incorporates life history traits, geographic distribution, and genetic differentiation and provides a valuable frame of reference for comparisons of Chinook salmon populations.

Chinook salmon populations can be characterized by their time of freshwater entry as spring, summer, or fall runs (NMFS 2005a, 2005b, 2010). Spring Chinook salmon tend to enter freshwater, migrate far upriver, where they hold and become sexually mature before spawning in the late summer and early autumn (NMFS 2005a, 2005b, 2010). Fall Chinook salmon enter freshwater in a more advanced stage of sexual maturity, move rapidly to their spawning areas on the mainstem or lower tributaries of their natal rivers, and spawn within a few days or weeks of freshwater entry (Fulton 1970; Healey 1991). Summer Chinook salmon are intermediate between spring and fall runs, spawning in large and medium-sized tributaries, and not showing the extensive delay in maturation exhibited by spring Chinook salmon (Fulton 1970). The Lower Columbia River Chinook ESU includes both fall and spring runs while the Upper Willamette River Chinook ESU is a spring run population (NMFS 1999).

Chinook salmon require clean, cool water and clean gravel to spawn. Females deposit their eggs in the gravel bottom in areas of relatively swift water; eggs hatch approximately 6 to 12 weeks later. Chinook prefer to spawn in the mainstem of large tributaries (NMFS 2005a, 2005b, 2010). For maximum survival of eggs and larvae, water temperatures must range between 57°F. Optimum rearing habitat for Chinook consists of pools and wetland areas with woody debris and overhanging vegetation. Chinook salmon typically spend 2 to 4 years maturing in the ocean before returning to their native streams to spawn. All adult Chinook salmon die after spawning (NMFS 2005a, 2005b, 2010).

The latest status reviews of Lower Columbia River and Upper Willamette River Chinook salmon show mixed recovery results (NMFS 2011c and NMFS 2012). The Lower Columbia River populations showed increases in abundance during the early 2000s but declines back to the 2000 level in subsequent years. Nearly all spring Chinook salmon populations are cut off from access to essential spawning habitat by tributary hydroelectric dams. The Sandy spring Chinook salmon population, which is not affected by a tributary dam, is considered at moderate risk. All other spring Chinook salmon populations are considered at very high risk or extirpated or nearly so. Of the 32 historical populations in this ESU, 28 are considered at very high risk and only two populations are considered viable. Additionally, the Upper Willamette River ESU of Chinook salmon is also not meeting recovery criteria and not considered viable. The Clackamas and McKenzie populations were found to be at moderate to low risk of extinction for abundance and productivity; the remaining five are in the very high risk category.

6.2.1 Utilization of the Action Area

Upper Willamette River ESU spring Chinook are an early-run population supported in such tributaries as the Clackamas, Molalla, Calapooia, Santiam, McKenzie, and Middle Fork Willamette Rivers. Lower Columbia River ESU fall Chinook did not historically ascend Willamette Falls, but rather spawned and reared in the reaches of the Lower Willamette River and its tributaries (including the Clackamas River). The Lower Willamette River continues to provide critical spawning and rearing habitat for Willamette Basin Chinook. Recently, Chinook have been collected in Tryon Creek between the confluence with the Willamette River and the Highway 43 culvert (PBES 2012). Additionally, juvenile Chinook have been identified in the Columbia Slough primarily during their outmigration in the spring, but have also been observed in the summer and winter months (ODFW 2009).

6.2.2 Critical Habitat

Critical habitat for Lower Columbia River Chinook is designated in the mainstem Willamette River in the action area, the mouth of Tryon Creek, and Columbia Slough. Critical rearing and migration corridor habitat for Upper Willamette Chinook includes the mainstem Willamette River in the action area.

Within the final rule for critical habitat, physical and biological requirements were defined for Chinook salmon based on their natural history and habitat needs. These requirements are defined in terms of a concept called primary constituent elements (PCEs), which are physical or biological features that have been identified as essential for their conservation. These PCEs include:

PCE 1: Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development;

PCE 2: Freshwater rearing sites with:

(i) Water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility;

(ii) Water quality and forage supporting juvenile development; and

(iii) Natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.

PCE 3: Freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival;

PCE 4: Estuarine areas free of obstruction and excessive predation with:

(i) Water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater;

(ii) Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels; and

(iii) Juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.

PCE 5: Nearshore marine areas free of obstruction and excessive predation with:

(i) Water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and

(ii) Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels.

PCE 6: Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.

Status of Critical Habitat in the Action AreaFreshwater habitats in the action area contain only a subset of the identified physical or biological features for Chinook salmon: PCEs 1 to 3 are present in the action area. The environmental baseline of the action area has been assessed by rating each PCE condition as "properly functioning (PFC)," "impaired (IC)," or "not properly functioning (NPF)." A summary of each PCE element follows in Table 6-3, along with a justification for the status of each PCE element in the action area. The effects that the project may have on the environmental baseline of each PCE element are analyzed in the following section (Section 7).

Table 6-3. Environmental Baseline Summary of Relevant Chinook Critical Habitat PCEs in the Action Area

PCE	Function	Description of Existing Conditions	Cause of Degradation from PFC
Chinook salmon			
1. Freshwater spawning sites	IC	The mainstem Willamette River has been largely impacted by upriver dams and dredging has reducing the amount of braiding and side channels that may have supported spawning; Tryon Creek has partial barriers limiting passage into potential spawning sites.	Habitat loss and impaired access to spawning sites from mainstem dams, impassible culverts, land use, and dredging.
2. Freshwater rearing sites	IC	The mainstem Willamette River has been largely impacted by upriver dams and dredging reducing the amount of braiding, side channels and off-channel rearing habitat area.	Habitat loss and degradation from mainstem dams, land use, and dredging. Contaminated sediments from industrial and urban development further degrade overall habitat quality.
3. Freshwater migration corridors	IC	Water temperatures and water quality have been altered due to changes in the hydrograph and effects of urbanization and fish passage barriers partially block access on Tryon Creek.	Mainstem dams, impassible culverts, urbanization, contaminated sediments, navigation structures, and land use.

6.3 Lower Columbia River DPS and Upper Willamette River DPS Steelhead, Threatened

The Lower Columbia River steelhead and Upper Willamette River steelhead (*Oncorhynchus mykiss*) populations were listed as a threatened species on March 19, 1998 (63FR13347) and the threatened status was reaffirmed on January 5, 2006 (71FR834); critical habitat for these DPSs was designated on September 2, 2005 (70FR52630). Draft Interim Regional Recovery Plans have been prepared for both DPSs (NMFS 2010b and NMFS 2005b, respectively).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 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 (NMFS 2006a). Information presented in this discussion came primarily from the Federal Register designating the listing status of the Lower Columbia River Steelhead DPS and Upper Willamette River

Steelhead DPS (NMFS 2006a), and the 5-Year Review of Lower Columbia River Salmon (NMFS 2011c).

Steelhead in North America are distributed from northwestern Mexico to the Kuskokwim River in Alaska (NMFS 2006a). Steelhead exhibit more complex life history traits than other Pacific salmonid species. Some forms of *O. mykiss* are anadromous while others, called rainbow or redband trout, are resident forms that remain permanently in freshwater. Anadromous steelhead usually reside in freshwater for 2 years but have been reported to stay as long as 7 years before moving to the ocean. Steelhead typically reside in marine waters for 1 or 3 years before returning to their natal stream to spawn at 4 or 5 years of age. Some Oregon and California populations include "half-pounders" that migrate from the ocean to freshwater and return to the ocean without spawning (NMFS 2006a).

Steelhead can be divided into two basic run types based on the level of sexual maturity at the time of river entry and the duration of the spawning migration (Burgner et al. 1992). The stream-maturing type (inland), or summer steelhead, enters freshwater in a sexually immature condition and requires several months in freshwater to mature and spawn. The ocean-maturing type (coastal), or winter steelhead, enters freshwater with well-developed gonads and spawns shortly after river entry (NMFS 2005b, 2006, 2010b). Variations in migration timing exist between populations. Both summer and winter steelhead occur in British Columbia, Washington, and Oregon; Idaho has only summer steelhead, and California is thought to have only winter steelhead (Busby et al. 1996). In the Pacific Northwest, summer steelhead enter freshwater between May and October, and winter steelhead enter freshwater between November and April. The Upper Willamette River steelhead is a winter run population while the Lower Columbia River steelhead has both winter and summer runs.

Steelhead are iteroparous, or capable of spawning more than once before death. Repeat spawning by steelhead probably ranges from 10 to 20 percent of the spawning population annually. Steelhead spawn in cool, clear streams with suitable gravel size, depth, and current velocity. Intermittent streams may also be used for spawning (NMFS 2005b, 2006, 2010b). Steelhead enter streams and arrive at spawning grounds weeks or even months before they spawn, when they are vulnerable to disturbance and predation. Cover in the form of overhanging vegetation, undercut banks, submerged vegetation, submerged objects such as logs and rocks, floating debris, deep water, turbulence, and turbidity is required to reduce disturbance and predation of spawning steelhead. Summer steelhead usually spawn farther upstream than winter steelhead (Behnke 1992). Summer steelhead juveniles typically rear in freshwater from 1 to 4 years before migrating to the ocean. Winter steelhead generally smolt after 2 years in freshwater (Busby et al. 1996).

Based on catch data, juvenile steelhead tend to migrate offshore during their first summer rather than migrating near the coast as do salmon. During fall and winter, juveniles move southward and eastward (Hartt and Dell 1986). Available fin-mark and coded-wire tag data suggest that winter steelhead tend to migrate farther offshore but not as far north into the Gulf of Alaska as summer steelhead (Burgner et al. 1992) and that southern Oregon and California populations are south-migrating rather than north-migrating (Nicholas and Hankin 1988). Ocean distribution data for specific ESUs is limited. Maturing Columbia River steelhead are found off the coast of northern British Columbia and west into the north Pacific Ocean (Myers et al. 1998). At the time adults are entering freshwater, tagging data indicate that immature Columbia River steelhead are out in the mid-north Pacific Ocean.

6.3.1 Utilization of the Action Area

In the Lower Willamette River, populations below Willamette Falls are part of the Lower Columbia River ESU. These anadromous steelhead spawn and rear in both east and west side tributaries, notably, the Clackamas River, Johnson Creek, and Tryon Creek, with restricted rearing in the Columbia slough. Upstream of Willamette Falls, steelhead are part of the Upper Willamette River ESU. These steelhead predominately populate eastside tributaries and the Tualatin River to the west. The Lower Willamette River is an important rearing and migratory corridor for this population. Recently, steelhead have been collected in Tryon Creek between the confluence with the Willamette River and the Highway 43 culvert (PBES 2012).

6.3.2 Critical Habitat

Critical habitat for Lower Columbia River steelhead is located in the mainstem Willamette River in the action area, Johnson Creek, Tryon Creek, Columbia Slough, and Smith and Bybee Lakes. Critical rearing and migration corridor habitat for Upper Willamette steelhead includes the mainstem Willamette River in the action area.

Within the final rule for critical habitat, physical and biological requirements were defined for steelhead based on their natural history and habitat needs. The PCEs for Lower Columbia River steelhead have been identified as essential for their conservation, are listed below:

PCE 1: Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development;

PCE 2: Freshwater rearing sites with:

> (i) Water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility;
>
> (ii) Water quality and forage supporting juvenile development; and
>
> (iii) Natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.

PCE 3: Freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival;

PCE 4: Estuarine areas free of obstruction and excessive predation with:

> (i) Water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater;

(ii) Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels; and

(iii) Juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.

PCE 5: Nearshore marine areas free of obstruction and excessive predation with:

(i) Water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and

(ii) Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels.

PCE 6: Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.

Status of Critical Habitat in the Action Area Freshwater habitats in the action area contain only a subset of the identified physical or biological features for steelhead: PCEs 1 to 3. The environmental baseline of the action area has been assessed by rating each PCE condition as PFC, IC, or NPF. A summary of each PCE element follows in Table 6-4, along with a justification for the status of each PCE element in the action area. The effects that the project may have on the environmental baseline of each PCE element are analyzed in the following section (7).

Table 6-4. Environmental Baseline Summary of Relevant Steelhead Critical Habitat PCEs in the Action Area

PCE	Function	Description of Existing Conditions	Cause of Degradation from PFC
Freshwater spawning sites	IC	The mainstem Willamette River has been largely impacted by upriver dams and dredging has reduced the amount of braiding and side channels that may have supported spawning; Tryon Creek has partial barriers limiting passage into potential spawning sites.	Mainstem dams, land use, and dredging.
Freshwater rearing sites	IC	The mainstem Willamette River has been largely impacted by upriver dams and dredging has reduced the amount of braiding, side channels and off-channel rearing habitat area.	Mainstem dams, land use, and dredging.
Freshwater migration corridors	IC	Water temperatures and water quality have been altered due to changes in the hydrograph and effects of urbanization and fish passage barriers partially block access on Tryon Creek.	Mainstem dams, contaminants, stormwater, urbanization and land use.

6.4 Southern DPS of North American Green Sturgeon, Threatened

The Southern DPS of North American green sturgeon (*Acipenser medirostris*) was listed as threatened on October 9, 2009 (50CFR223); no critical habitat has been designated for this species (50CFR226). No recovery plan has been drafted for the Southern DPS of North American green sturgeon to date. 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 U.S. 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 (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) (NMFS 2006b). Information presented in this discussion came primarily from the Federal Register designating the listing status of the Southern DPS of North American green sturgeon (NMFS 2006b).

Green sturgeon are long-lived, slow-growing fish and the most marine-oriented of the sturgeon species. Mature males range from 4.5 to 6.5 feet (1.4 to 2 m) in fork length and do not mature until they are at least 15 years old, while mature females range from 5 to 7 feet (1.6 to 2.2 m) fork length and do not mature until they are at least 17 years old (VanEenennaam 2002). Maximum ages of adult green sturgeon are likely 60 to 70 years (Moyle 2002). This species is found along the west coast of Mexico, the United States, and Canada (NMFS 2006b).

Green sturgeon are believed to spend the majority of their lives in nearshore oceanic waters, bays, and estuaries. Early life-history stages reside in freshwater, with adults returning to freshwater to spawn when they are more than 15 years old and more than 4 feet (1.3 m) long. Spawning is believed to occur every 2 to 5 years (Moyle 2002). Adults typically migrate into freshwater beginning in late February; spawning occurs from March to July, with peak activity from April to June (Moyle et al. 1995). Females produce 60,000 to 140,000 eggs (Moyle et al. 1992). Juvenile green sturgeon spend 1 to 4 years in fresh and estuarine waters before dispersal to saltwater (Beamesderfer and Webb 2002). They disperse widely in the ocean after their out-migration from freshwater (Moyle et al. 1992).

The only feeding data available on adult green sturgeon has shown them to eat benthic invertebrates including shrimp, mollusks, amphipods, and even small fish (Moyle et al. 1992).

Green sturgeon utilize both freshwater and saltwater habitat (NMFS 2006b). Green sturgeon spawn in deep pools or "holes" in large, turbulent, freshwater river mainstems (Moyle et al. 1992). Specific spawning habitat preferences are unclear, but eggs likely are broadcast over large cobble substrates, with a range of clean sand to bedrock substrates also used (Moyle et al. 1995). It is likely that cold, clean water is important for proper embryonic development. Adults occupy oceanic waters, bays, and estuaries when not spawning. Green sturgeon are known to forage in estuaries and bays ranging from San Francisco Bay to British Columbia (NMFS 2006b).

A principal factor in the decline of the Southern DPS is the reduction of the spawning area to a limited section of the Sacramento River (NMFS 2006b). This remains a threat due to increased risk of extirpation due to catastrophic events. Insufficient freshwater flow rates in spawning areas, contaminants (e.g., pesticides), bycatch of green sturgeon in fisheries, potential poaching (e.g., for caviar), entrainment by water projects, influence of exotic species, small population size, impassable barriers, and elevated water temperatures likely pose a threat to this species (NMFS 2006b). It is not likely that green sturgeon spawn in the action area.

6.4.1 Utilization of the Action Area

Southern DPS green sturgeon occur in Oregon in nearshore marine area, bays, estuaries, and the deep, low elevation, riverine mainstem of coastal rivers. Southern green sturgeon only spawn in the Sacramento River system (NMFS 2013b). There is no evidence that green sturgeon spawning occurs within the Willamette or Columbia Rivers (NMFS 2006b). Green sturgeon mainly use deep waters of the mainstem Columbia, well outside of the shallow water and tributary habitats of the proposed action area. For these reasons, it is highly unlikely that any sturgeon would be present at the project sites or in the action area.

6.4.2 Critical Habitat

Critical habitat for the Southern DPS of North American green sturgeon is not designated in the Lower Willamette River or the Lower Columbia River within the project vicinity. Critical habitat in the Lower Columbia River Estuary extends only up the Columbia River to River Mile 46.

7. EFFECTS OF THE PROPOSED ACTION

7.1 Effects on Species

This project is intended to have long-term beneficial effects on listed species and their critical habitats and help contribute towards the recovery of these species. However, there are also likely to be temporary adverse effects associated with the construction of the project. The effects of the Project have been evaluated on the listed fish species with respect to life stage, as relevant. Beneficial effects are expected for all life stages as a result of each restoration action improving habitat conditions. However, during construction adverse effects to all life stages could occur. These potential adverse effects would be avoided or minimized as restoration actions will not be undertaken at sites occupied by spawning adult fish or where ocupied redds are present and construction will be deferred until the time of year when the fewest fish are present. The in-water work windows for Tryon Creek, the Columbia Slough, and the Mainstem Willamette have been determined by ODFW (2008) and are listed in Table 7-1.

Table 7-1. In-water Work Periods for the Lower Willamette and Tributaries

Waterbody	Work Window
Tryon Creek	July 15 to September 30
Mainstem Willamette	July 1 to October 31
Columbia Slough	June 15 to September 15

Source: ODFW 2008

The types of effects associated with construction of the various habitat features are described generally in the following paragraph, and more specifically for each type of restoration action in the following section.

Construction will have direct physical effects on the environment including vegetation clearing, development of access roads, construction staging areas, and materials storage areas; water diversion and pumping, excavation, fill, and grading; followed by site restoration such as placement of wood, revegetation, placement of topsoil and other substrates and other actions to restore habitats and ecosystem processes. These construction activities can disrupt or reduce the natural vegetative and fluvial processes at a project site, such as the recruitment of large wood, riparian shading, sediment and nutrient deposition, and groundwater recharge (NMFS 2013a). During wet weather, cleared areas can erode and suspend sediments in runoff and also potentially increase the volume and frequency of runoff. This can elevate turbidity in receiving waterbodies and adversely affect spawning gravels and other habitats (i.e. by filling in pools) as well as increasing volumes into streams during runoff events. The erosion of topsoil can reduce the upland fertility. In-water work can also resuspend sediments or generate turbidity that can be transported downstream. Heavy equipment can compact soils and reduce suitability for plant growth and reduce infiltration. The use of heavy equipment also creates a risk of spills of fuels, lubricants and other contaminants. A spill into a waterbody would likely cause short-term lethal toxicity to fish and invertebrates in the vicinity.

However, these effects are likely to be short-term at any one site (few months). Turbidity from in-water excavation and installation of large wood is likely to abate very quickly (few hours). Other effects may persist for longer until riparian and floodplain vegetation is fully reestablished.

7.1.1 Large Wood and Boulder Placement

Installation of LW and boulders would require disruption of the riparian area and excavation of stream beds and banks to allow these materials to be keyed into the substrate, or for installation of anchoring materials including wooden posts and cables.

Beneficial effects from installing LW and boulders would include increased stream habitat complexity, reestablished natural hydraulic processes, increased overhead cover, increased prey and food-web dynamics, and sediment retention. Large wood and boulders in a stream will trap gravel above the structure, creating pools, increasing the connection with the floodplain vegetation. As a result of these benefits, an increase in habitat functions is expected.

Potential adverse effects of this action may include minor damage to riparian soil and vegetation and minor disturbance of streambanks and channel substrate. Potential short term unavoidable construction related effects including harassment or actual mortality through contact with in-water construction equipment or materials may occur. Temporary effects to suitable habitat and water quality are likely to result from in-water work resulting in increased turbidity and suspended sediments and sediment deposition. Effects to species from these actions may include the temporary displacement of individual fish. If the streambed is dewatered during construction, fish passage will be temporarily restricted.

To the degree possible, installation of LW would occur in the dry, and installation of boulders and LW in the active channel would occur during the in-water work window. Additionally, fill placement would occur when creating small habitat islands in Kenton Cove. The island creation would be isolated by silt curtains or coffer dams, and fish would be removed from the area prior to construction. Effects from installing these types of features would be similar to effects from off-channel habitat creation and in-stream channel modifications.

If fish are present in the work area, flowing water will be isolated and fish captured and relocated to an appropriate location in an effort to minimize possible mortality. Juveniles would likely experience increased levels of stress and injury during handling, which could be exacerbated by poor water quality (increased temperatures, low dissolved oxygen saturation), prolonged periods of holding between capture and release, and any debris that may accumulate in the traps. The appropriate conservation measures and handling techniques will be employed to ensure that most of the stress resulting from handling and transport is short-lived and minor.

7.1.2 Invasive Species Removal and Riparian Revegetation

Riparian restoration would consist primarily of mechanical removal of invasive species and revegetating with native species by hand and with light machinery. The intent of this action would be to restore native riparian functions.

Beneficial effects of this action would be the reestablishment of native riparian forests and plant communities, increase overhead cover, and provide a long-term source of instream wood, reduce fine sediment supply, increase shade, nutrient input, and moderate microclimate effects.

This work would occur above the ordinary high water mark and in the dry, so adverse effects to listed anadromous species would be limited to noise from construction equipment, temporary increases in input of fine sediment from soils disturbed during construction, and disturbance from human presence in the revegetation area. These effects are expected to be very limited and temporary, and will not contribute to adversely affecting anadromous fish.

7.1.3 In-Stream and Channel Modifications

The intent of this action is to reduce artificially increased channel height and steepness. Increased streambank heights may result in increased bank erosion, disconnection from the floodplain, and may be responsible for a significant portion of sediment loads in streams.

Beneficial effects include improving aquatic and riparian habitat diversity and complexity, reconnect stream channels to floodplains, reduce bed and bank erosion, increase hyporheic exchange, and moderate flow disturbance. Grading banks to gentler slopes is proposed to allow for restored hydrologic connections and create shallow water habitat, reduce erosion, stabilize banks and to allow riparian and aquatic habitats to form more naturally.

Although most of this work would occur in the dry, potential direct construction effects include harassment or direct mortality through contact with construction equipment during in-water work, stress related to fish displacement, handling, or removal, increased suspended sediment and deposition, blocked migration, disrupted or disturbed behavior, and temporary displacement from bank areas that may be dewatered during construction. Potential adverse effects to suitable habitat and critical habitat include temporary loss of riparian vegetation and temporary loss or imbalance of nutrients and food supply.

In-water work associated with channel modifications will occur during the in-water work window, when fish are least likely to be present. Given the low potential for listed salmonids to access the construction areas at this time, and because fish will have ample room either in the Willamette River or Columbia Slough to avoid the construction areas and any associated turbidity plume, these effects are considered to be unlikely to result in mortality.

During construction, biologists will be on-site to observe if any fish are present. If fish are present in the work area, flowing water will be isolated and fish captured and relocated to an appropriate location in an effort to minimize possible mortality. Juveniles would likely experience increased levels of stress and injury during handling, which could be exacerbated by poor water quality (increased temperatures, low dissolved oxygen saturation), prolonged periods of holding between capture and release, and any debris that may accumulate in the traps. The appropriate conservation measures and handling techniques will be employed to ensure that most of the stress resulting from handling and transport is short-lived and minor.

7.1.4 Off-Channel Habitat and Floodplain Reconnection

The intent of creating off-channel habitat and floodplain reconnections is to increase habitat diversity, provide rearing habitat for juvenile salmonids, and refuge habitat for fish during high flows. Off-channel habitat creation and floodplain reconnection would involve excavation of fill to create side channels and backwater habitat, and installation of woody debris and boulder to enhance habitat.

The main beneficial effects of this action would be to provide high water refuge and winter and summer rearing habitat for fish. Additional benefits include increased habitat complexity, long-term nutrient storage and food web production, and increased sediment storage.

This work would occur in the dry, with the exception of final excavation which would occur to allow the river to access the excavated channels and backwater areas. However the amount of excavation and earthwork required could be substantial. Resulting potential adverse effects of the action include a loss of riparian vegetation and temporary loss or imbalance of nutrients and food supply Potential adverse effects resulting from construction actions include harassment or actual mortality through contact with in-water construction equipment or materials. Temporary effects to suitable habitat and water quality are likely to result from in-water work, resulting in increased turbidity and suspended sediments and sediment deposition. Effects to species from these actions may include the temporary displacement of individual fish.

During the final phase of construction when side channels are connected to the main channel, a fish biologist will be present to identify if fish are present in the work area. If fish are observed, flowing water will be isolated and fish captured and relocated to an appropriate location in an effort to minimize possible mortality. Juveniles would likely experience increased levels of stress and injury during handling, which could be exacerbated by poor water quality (increased temperatures, low dissolved oxygen saturation), prolonged periods of holding between capture and release, and any debris that may accumulate in the traps. The appropriate conservation measures and handling techniques will be employed to ensure that most of the stress resulting from handling and transport is short-lived and minor.

7.1.5 Fish Barrier Removal

Replacing the culvert at the Tryon Creek Highway 43 site will include removal of overburden above the culvert; excavation of the culvert; replacement with a new culvert; replacement of the overburden; recontouring of affected stretches of streambed and bank; and revegetation of affected riparian areas. The intent of this action is to restore and improve juvenile and adult fish passage where it has been partially or completely eliminated by past actions.

The main beneficial effect to listed salmonid species from culvert replacement expected over the long-term is increased access to historic spawning grounds in Tryon Creek, restoring the spatial and temporal connectivity of the creek and permitting fish to access upstream areas essential for spawning and rearing. Enhanced access to almost three miles of tributary habitat will significantly increase the amount of such habitat in the Lower Willamette River watershed. In addition, the natural bedload movements will be restored in the lower portion of Tryon Creek.

Potential adverse effects resulting from construction actions include harassment or actual mortality through contact with in-water construction equipment or materials. Temporary effects to suitable habitat and water quality are likely to result from in-water work, resulting in increased turbidity and suspended sediments and sediment deposition. Effects to species from these actions may include the temporary displacement of individual fish. If the streambed is dewatered during construction, fish passage will be temporarily restricted.

In-stream work associated with culvert replacement will occur in the late summer during the in-water work window, which coincides with low flow and highest water temperatures in Tryon Creek. Given the low potential for listed salmonids to access the construction area at this time, and because the construction area is located in close proximity to the Willamette River, it is considered unlikely that construction would force listed salmonids into unsuitable habitats or cause migration delays.

If fish are present in the work area, flowing water will be isolated and fish captured and relocated to an appropriate location in an effort to minimize possible mortality. Juveniles would likely experience increased levels of stress and injury during handling, which could be exacerbated by poor water quality (increased temperatures, low dissolved oxygen saturation), prolonged periods of holding between capture and release, and any debris that may accumulate in the traps. The appropriate conservation measures and handling techniques will be employed to ensure that most of the stress resulting from handling and transport is short-lived and minor.

7.1.6 Wetland Restoration

Wetland restoration is likely to result in effects similar to those of off- and side-channel reconnection, described above.

7.2 Effects of the Action on PCEs of Relevance in the Action Area

The project is likely to have the following effects on the PCEs of relevance in the action area (Table 7-2).

Table 7-2. Summary of the Proposed Condition of the PCEs in the Action Area

PCE	Function	Proposed Condition Description	Explanation
Lower Columbia River Coho, Lower Columbia River and Upper Willamette River Chinook ESU, and Lower Columbia River and Upper Willamette River Steelhead			
1. Freshwater Spawning Sites	Improve IC	In Tryon Creek, fish passage will be improved providing passage into spawning areas; bar and off-channel habitat gravels recruitment will provide additional spawning habitat.	Tributary spawning areas will be opened up by removing fish passage barriers. Gravel recruitment and sorting are likely to occur with the installation of LW.
2. Freshwater Rearing Sites	Improve IC	Rearing habitats will be substantially increased, both in-channel and in off-channel areas. Water temperatures will improve via restoration of a vegetative canopy, but will still remain elevated. The quantity of wood, log jams, and riparian vegetation will increase.	The dams will still control peak flows and release flows with high temperatures in the mainstem; however, the proposed action will restore and connect off-channel and riparian habitats as well as install large wood in-stream and in floodplain areas to provide habitat structure and cover.
3. Freshwater Migration Corridors	Improve IC	The migration corridors will continue to have high water temperatures and water quality issues. However, juveniles will experience a substantial increase in the quantity of available off-channel rearing habitats during outmigration. In Tryon Creek, a passage barrier will be removed and in-stream habitat will have enhanced vegetative cover and pools.	Dams and urbanization have modified the temperature regime and water quality in the mainstem. Riparian areas will be restored in the tributaries and off-channel habitat areas and quantities of large wood will be added to the system. Off-channel habitats will be connected and restored.

PFC - Properly Functioning Condition
IC – Impaired Condition

7.3 Cumulative Effects

Cumulative effects under ESA are defined as "those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation" (50 CFR 402.02). As discussed above, significant cumulative effects have already occurred in the northern Willamette River Valley, which have caused or contributed to the decline of the above species. No specific additional projects in the restoration areas are anticipated at this time, although continued industrial, commercial, and residential development will likely occur in the action area as the population of the region grows.

The City of Portland, watershed councils, municipalities, counties, the State of Oregon, and other entities are likely to continue to undertake restoration measures to improve habitats for listed species in the Lower Willamette subbasin. These effects will result in improvements to fish population abundance, productivity, and spatial structure and result in some improvement to the condition of critical habitat PCEs. When considered together, these cumulative effects are likely to have a balancing effect on listed species and their critical habitats.

As the population grows, new residential and industrial growth will likely occur in the urban areas. Concurrently, increased growth will increase the pressure to expand the urban growth boundary, which will result in the expansion of development into rural and semi-rural areas of the subbasin. Increased development of tributary watersheds could increase peak flows and increase water quality issues, further degrading habitat. Water quality will be affected by additional point and non-point (stormwater) water quality impact sources. Although TMDLs have already been developed for the subbasin to address the worst water quality problems and it is likely that there will be improvements in water quality as a result, water quality standards may not ultimately be achieved.

The combined expected development and population growth would likely reduce the availability and quality of habitats for listed species and also contribute to adverse effects on the hydrologic regime and water quality. This would result in the continued degradation of the PCEs of critical habitats, indirectly impacting individuals.

The City of Portland's River Plan/North Reach includes a compensatory mitigation program to account for protecting the environmental resources of the North Reach of the Willamette River. Development along this reach of the Lower Willamette River will require the mitigation of impacts to habitat so that natural ecosystem functions are not reduced or lost. Overall, this program will at least balance the needs for economic development with the protection of natural resources.

The remediation and clean-up of the Portland Harbor Superfund site will also improve the condition of sediment and water quality in the Lower Willamette River through the removal of contamination sources. The Record of Decision document and related clean-up activities are expected to begin in 2014 after the EPA agrees upon a Proposed Plan. However, clean-up has already begun at some early-action areas that were deemed to possibly become a threat to people or the environment before the long-term cleanup is completed (EPA 2012).

Overall, the project will incrementally restore habitats that are rare in the project area. Parameters that will be incrementally improved as a result of this project include water temperature, off-channel habitat, in-stream habitat, and riparian habitat. This project will not inhibit or preclude future restoration projects that could restore habitats and natural processes to the basin. This project will incrementally contribute to the improved function of adjacent habitats in order to ultimately achieve properly functioning conditions and recover listed species.

7.4 Inter-related and inter-dependent effects

7.4.1 Willamette River Projects Biological Opinion

This project is not intended to help fulfill the requirements of any existing Biological Opinions. However, on an incidental basis, some of the actions described herein are consistent with recommendations for anadromous species recovery as specified in the Willamette River Projects Biological Opinion (NMFS and USFWS 2008). This document spelled out recommendations for restoration of habitat features, including substrate quality, water temperature regulation, and fish passage and migration. Although the project described in this BA will not likely have a significant effect on the quality of substrate or temperature in the Willamette River, it will be consistent with the Willamette BiOp recommendations by increasing opportunities for fish passage into upstream spawning habitat and supporting upstream and downstream migration by providing for increased foraging habitat and refugia from predation and high flows.

7.4.2 Willamette Floodplain Restoration General Investigation

The project proposed in this BA is consistent with restoration actions that are recommended for implementation as part of the Willamette Floodplain Restoration Study (WFRS). The WFRS project would restore floodplain habitat for various fish species, including the Upper Willamette River Chinook salmon, a species that would benefit from the increased foraging habitat and refugia offered by this project.

7.4.3 Portland Harbor Superfund Site

Although consultation has not been implemented for most remediation projects that would be implemented as part of the Portland Harbor CERCLA project, numerous entities responsible for remediation will also need to restore aquatic and riparian habitat to cover Natural Resource Damage Assessment (NRDA) obligations. These projects will occur in the same reach of the Lower Willamette River as the project described in this BA, leading to an overall lift in the quality of habitat in this reach.

7.5 Effects Determination

7.5.1 Lower Columbia River Coho, Threatened

The project *may affect, is likely to adversely affect* Lower Columbia River coho salmon. The project *may affect, but is not likely to adversely affect* Lower Columbia River coho salmon critical habitat. Immediate and temporary effects may occur during construction of the project, although in-water work is to be conducted only during the designated in-water work window. Benefits to the species as a direct result of the project are expected, including improved fish passage; improved spawning, rearing, and refuge habitats; and improved water quality and riparian habitats.

7.5.2 Lower Columbia River and Upper Willamette River Chinook, Threatened

The project *may affect, is likely to adversely affect* Lower Columbia River and Upper Willamette River Chinook salmon. The project *may affect, but is not likely to adversely affect* Lower Columbia River and Upper Willamette River Chinook salmon critical habitat. Immediate and temporary effects may occur during construction of the project, although in-water work is to be conducted only during the designated in-water work window. Benefits to the species as a direct result of the project are expected, including improved fish passage; improved rearing and refuge habitats; and improved water quality and riparian habitats.

7.5.3 Lower Columbia River and Upper Willamette River Steelhead, Threatened

The Project *may affect, is likely to adversely affect* Lower Columbia River and Upper Willamette River steelhead. The project *may affect, but is not likely to adversely affect* Lower Columbia River and Upper Willamette River steelhead critical habitat. Immediate and temporary effects may occur during construction of the project, although in-water work is to be conducted only during the designated in-water work window. Benefits to the species as a direct result of the project are expected, including improved fish passage; improved spawning, rearing, and refuge habitats; and improved water quality and riparian habitats.

7.5.4 Southern DPS of North American Green Sturgeon, Threatened

The Project will have *no effect* on the Southern DPS of North American green sturgeon. Southern DPS green sturgeon occur in Oregon in nearshore marine area, bays, estuaries, and the deep, low elevation, riverine mainstem of coastal rivers. The Southern DPS of green sturgeon only spawn in the Sacramento River system and there is no evidence that green sturgeon spawning occurs within the Willamette or Columbia Rivers (NMFS 2006b, NMFS 2013b). Therefore, the proposed action will have no effect on green sturgeon spawning. Green sturgeon mainly use deep waters of the mainstem Columbia and are not likely to experience the effects of the proposed action, as the actions will be confined primarily to shallow water habitats that are not frequented by southern green sturgeon. Therefore there are no expected effects (beneficial or adverse) on the Southern DPS of North American green sturgeon.

8. CLIMATE CHANGE CONSIDERATIONS

Ongoing climate change will likely affect listed species in the Pacific Northwest. The Independent Scientific Advisory Board (2007) identified potential effects of climate change in the Columbia River Basin. Changes in precipitation and temperatures are likely throughout the basin, which would affect hydrology and habitats for salmonid rearing and migration. In the Willamette Basin, it is likely that there will be an increasing proportion of rainfall versus snowpack, which could lead to less water available for storage in reservoirs and less water available during the summer and fall months when temperatures are high and flows are naturally diminished. Water temperatures are likely to increase during low flow periods due to lesser proportions of snowmelt runoff and lesser quantities of water. More intense rain storms may also occur, which would cause more intense runoff and associated flooding from development and urbanization. The potential increases in water temperatures could cause issues with pre-spawning mortality, egg incubation, and rearing for salmonids. More intense runoff and flooding events could cause scour of redds/eggs and flush juvenile salmonids downstream.

The project may help reduce some of the potential adverse effects of climate change by restoring riparian and floodplain vegetation to provide more shade and thermal refugia. The project will also conserve and restore off-channel connections that will provide refuge and rearing habitats and increase filtration of pollutants, as well as attenuate flows and help recharge groundwater sources.

9. CONCLUSIONS

Table 9-1 summarizes the effect determinations made for each of the species potentially occurring in the project vicinity.

Table 9-1. Determination of Effects Summary Table

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

10. ESSENTIAL FISH HABITAT

10.1 Background

The Sustainable Fisheries Act of 1996 (Public Law 104-297) amended the Magnuson-Stevens Fishery Conservation and Management Act (now called the Magnuson-Stevens Act) to require federal agencies to consult with NOAA Fisheries on activities that may adversely affect EFH. The EFH guidelines (50 CFR §600.05-600.930) outline the process for federal agencies, NOAA Fisheries, and the Fishery Management Councils to satisfy the EFH consultation requirement under Section 305(b(2)-(4)) of the Magnuson-Stevens Act. As part of the EFH consultation process, the guidelines require federal action agencies to prepare a written EFH Assessment describing the effects of that action on EFH (50 CFR §600.920(e)(1)). This document has been prepared to satisfy that requirement.

EFH is defined as "those waters and substrates necessary to fish for spawning, breeding, feeding, or growth to maturity" (16 U.S.C §1802(10). For the purpose of interpreting this definition of EFH: "*waters* include aquatic areas (marine waters, intertidal habitats, and freshwater streams) and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; *substrate* includes sediment, hard bottom, structures underlying the waters, and associated biological communities; *necessary* means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and *spawning, breeding, feeding, or growth to maturity* covers a species' full life cycle (50 CFR §600.10); *Adverse effect* is defined as any impact that reduces quality and/or quantity of EFH, and may include direct (*e.g.*, contamination or physical disruption), indirect (*e.g.*, loss of prey or reduction in species fecundity), site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions" (50 CFR §600.810). The Magnuson-Stevens Act promotes the protection of these habitats through review, assessment, and mitigation of activities that may adversely affect these habitats.

The EFH mandate applies to all species managed under a Fishery Management Plan (FMP). In Washington, Oregon, and California, there are three FMPs covering groundfish, coastal pelagic species, and Pacific salmon. Federal agencies must consider the impact of a proposed action on all three types of EFH. This project is located in the freshwater Willamette River and its tributaries, therefore only the Pacific salmon EFH is applicable in this assessment.

Pacific salmon EFH for the Pacific Coast Salmon FMP includes all streams, lakes, ponds, wetlands, and other water bodies currently and historically utilized by Pacific salmon within Washington, Oregon, Idaho, and California within the USGS HUC. Excluded from the FMP are some areas upstream of certain impassable man-made barriers (e.g., dams as identified by the Pacific Fishery Management Council in Appendix A of Amendment 14 to the Pacific Coast Salmon Plan), and longstanding, naturally-impassable barriers (e.g., natural waterfalls in existence for several hundred years) (Pacific Fishery Management Council [PFMC] 2000).

Based on the available life history information, freshwater EFH for Pacific salmon consists of four major components: (1) spawning and incubation, (2) juvenile rearing, (3) juvenile migration corridors, and (4) adult migration corridors and adult holding habitat (Roni et al. 1999). Important features of essential habitat for spawning, rearing, and migration include adequate: (1) substrate composition; (2) water quality (dissolved oxygen, nutrients, temperature, etc.); (3) water quantity, depth, and velocity; (4) channel gradient and stability; (5) food availability; (6) cover and habitat complexity (e.g., large woody debris, pools, channel complexity, aquatic vegetation, etc.); (7) space (habitat area); (8) access and passage; and (9) floodplain and habitat complexity. Potential threats to these habitat features and life history components include: (1) direct (hydrologic modifications); (2) indirect (loss of prey or reduction of species diversity); (3) site-specific; or (4) habitat-wide impacts that are chemical, biological, and physical in nature and may result in individual, cumulative, or synergistic consequences (Wilbur and Pentony 1999).

10.2 Identification of EFH in the Project Action Area

The Lower Willamette River is located in the U.S. Geological Survey hydrologic unit (HUC) 17090012 and is designated as EFH for Chinook and coho salmon. Steelhead and the Southern DPS of North American green sturgeon are not managed by the Pacific Fishery Management Council, so EFH is not designated for these species (PFMC 2000). The project area contains essential fish habitat, including potential habitat for spawning, rearing/breeding, feeding, and growth to maturity.

10.3 Potential Adverse Effects of the Project on EFH

The definition of "adverse effect" is "any impact that reduces quality and/or quantity of EFH, including direct (e.g., contamination or physical disruption), indirect (e.g., loss of prey or reduction in species fecundity), site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions" (50 CFR §600.810). The significance of small-scale projects lies in the cumulative and synergistic effects resulting from a large number of these activities occurring in a single watershed or at the same time.

Upon project completion, features of fish habitat will be improved or restored including water quality, habitat access, habitat elements, channel dynamics, and watershed conditions. Based on these factors, this project will improve the quality and quantity of spawning, rearing, migration, and holding EFH in the project area.

The effects of the project action have already been discussed in the ESA effects analysis on Chinook and coho salmon and their critical habitats and collectively these would apply to EFH. Construction activities of the project will have temporary and localized impacts on fish habitat. Turbidity may increase during the in-water portion of the work; however, it is likely to be localized and on a small scale. The conservation measures proposed in this BA will avoid and minimize any temporary adverse effects from project construction on EFH; no long term adverse effects to EFH are expected to result from the action.

The proposed action will restore EFH components for juvenile rearing, adult holding, migration, and adult spawning habitat by reconnecting off-channel habitats, installing LW, and removing fish passage barriers.

11. MATRIX OF PATHWAYS AND INDICATORS

Table 11-1 summarizes the likely effects of the project using the matrix of pathways and indicators (NMFS 1996). This matrix assists with evaluating the effects of the Project on anadromous salmonid habitat, lists six major habitat elements (pathways), measurable indicators associated with habitat function, and a comparison of the functional rating for the environmental baseline with the effects of the action.

Table 11-1. Checklist for Documenting Environmental Baseline and Effects of Proposed Action on Relevant Indicators

		Environmental Baseline			Effects of the Action		
Pathways	**Indicators**	**Properly Functioning**	**At Risk**	**Not Properly Functioning**	**Restore**	**Maintain**	**Degrade**
Water Quality	Temperature			X		X	
	Sediment			X	X		
	Chemical Contamination/ Nutrients			X		X	
Habitat Access	Physical Barriers			X	X		
Habitat Elements	Substrate[3]			X	X		
	Large Woody Debris		X		X		
	Pool Frequency		X		X		
	Pool Quality		X		X		
	Off-channel Habitat			X	X		
	Refugia			X	X		
Channel Condition & Dynamics	Width/Depth Ratio		X			X	
	Streambank Condition		X		X		
	Floodplain Connectivity			X	X		
Flow/ Hydrology:	Peak/Base Flows			X		X	
	Increase in Drainage Network			X		X	
Watershed Conditions	Road Density & Location			X		X	
	Disturbance History			X		X	
	Riparian Reserves			X	X		

12. REFERENCES

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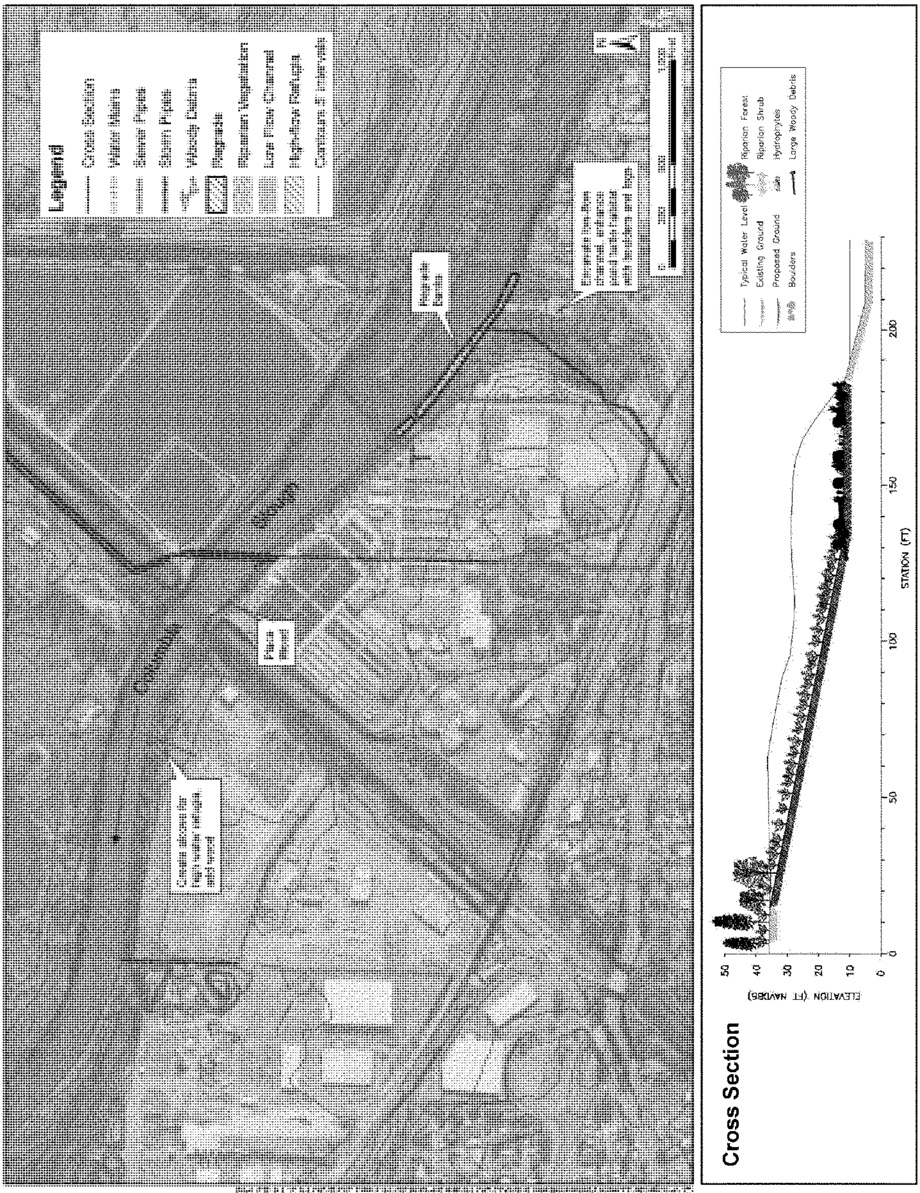
Appendix A – Conceptual Restoration Plans

BES Plant

US Army Corps of Engineers®
Portland District
BUILDING STRONG.

Lower Willamette Ecosystem Restoration Project
Conceptual Restoration Plan



Kelley Point Park

Lower Willamette Ecosystem Restoration Project Conceptual Restoration Plan

US Army Corps of Engineers® Portland District
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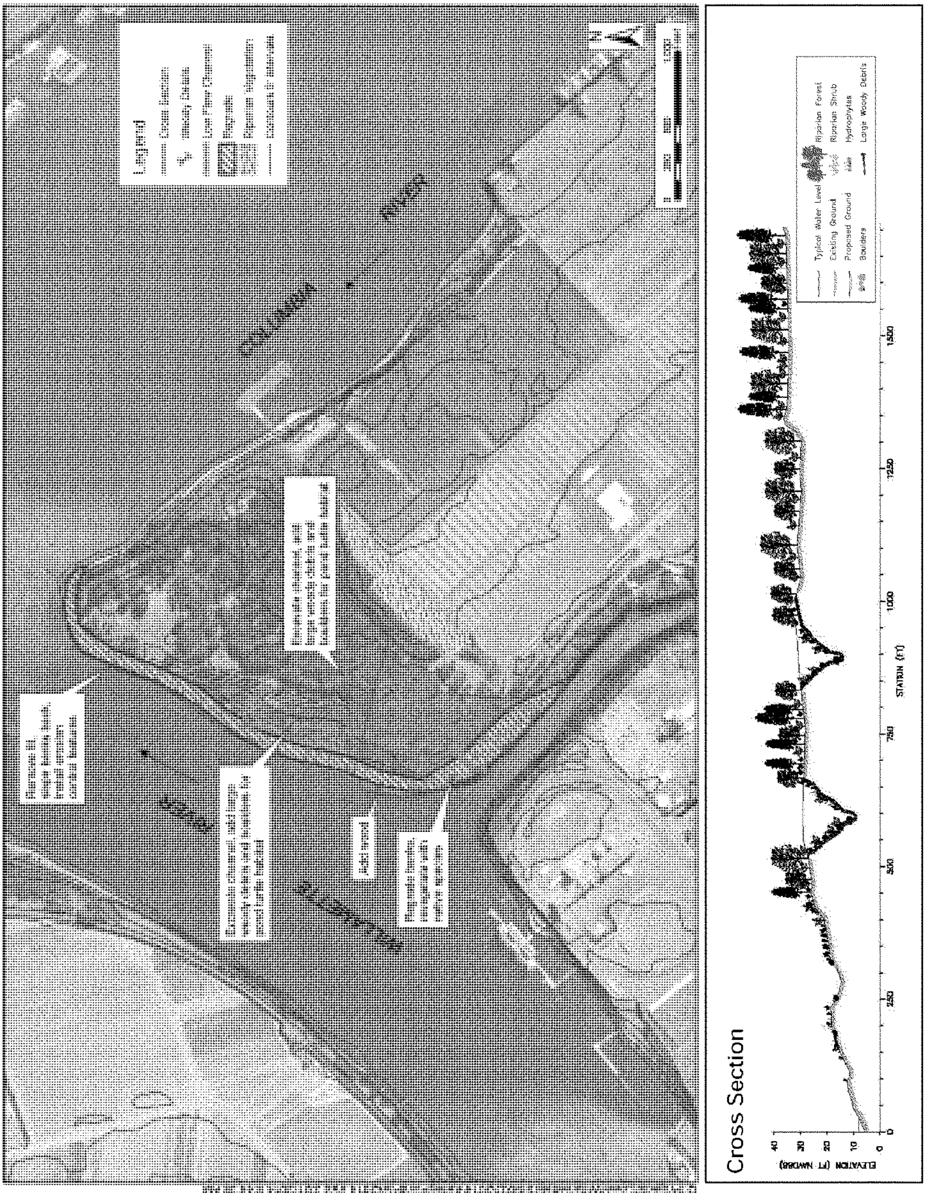

Kenton Cove

US Army Corps of Engineers®
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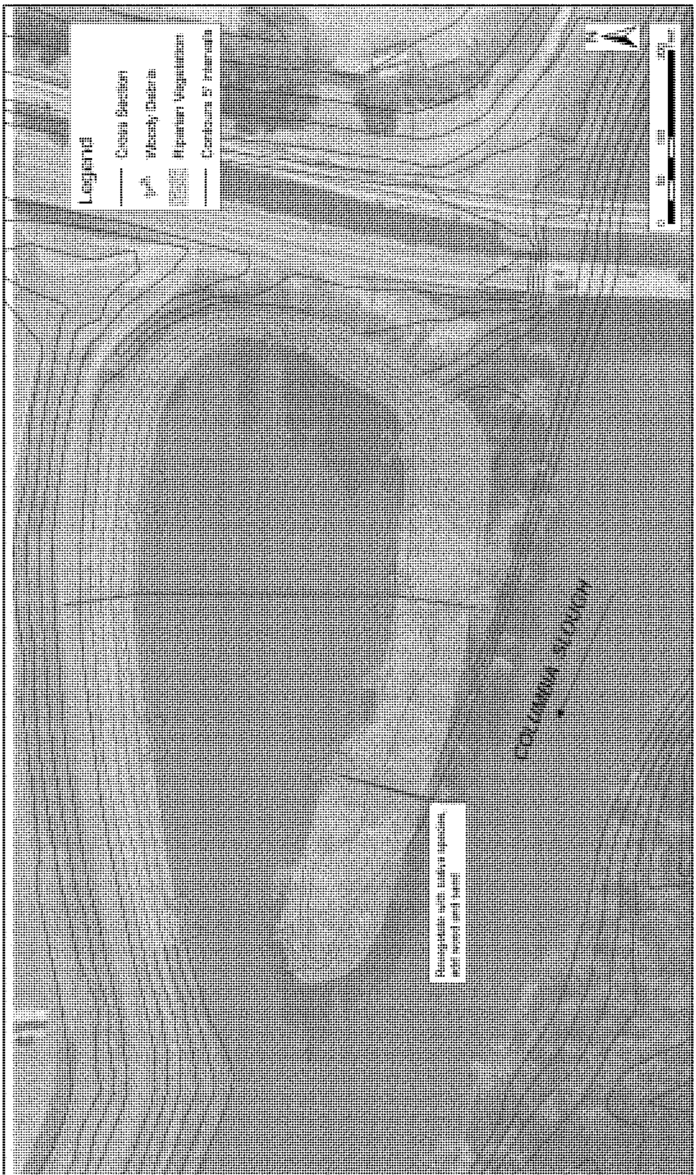
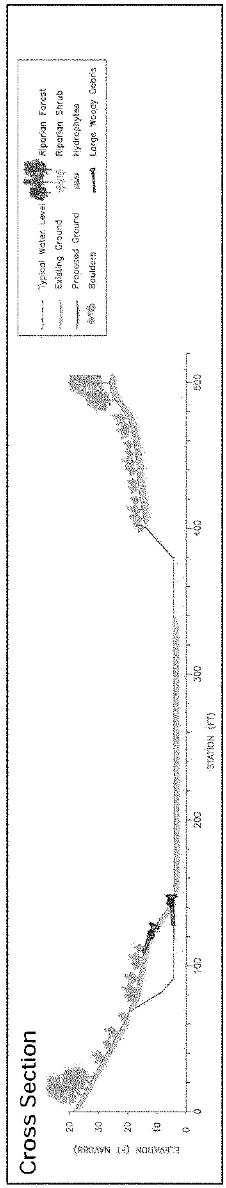
Lower Willamette Ecosystem Restoration Project
Conceptual Restoration Plan

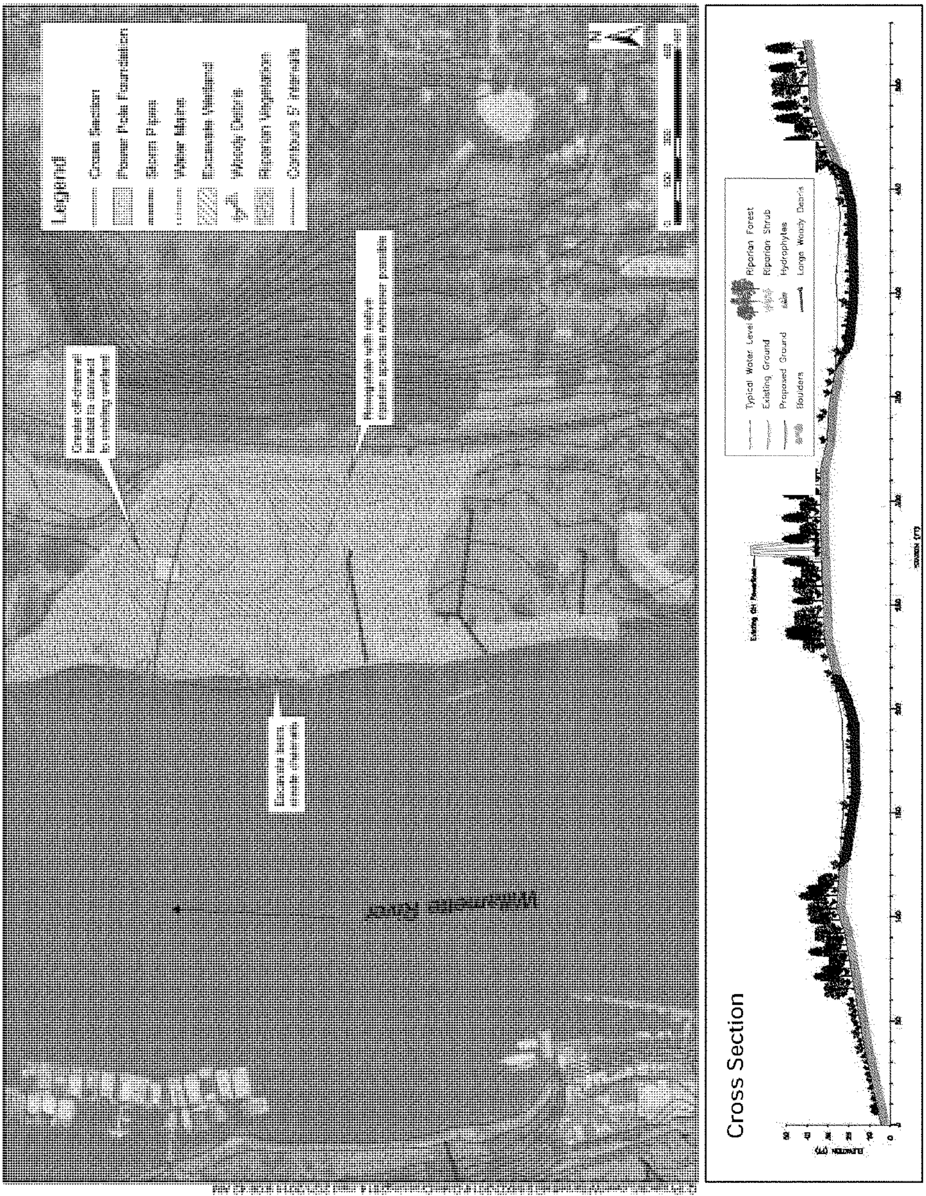




Oaks Crossing/ Sellwood Riverfront Park

US Army Corps of Engineers® Portland District BUILDING STRONG.

Lower Willamette Ecosystem Restoration Project Conceptual Restoration Plan



Tryon Creek Highway 43 Culvert

US Army Corps of Engineers®
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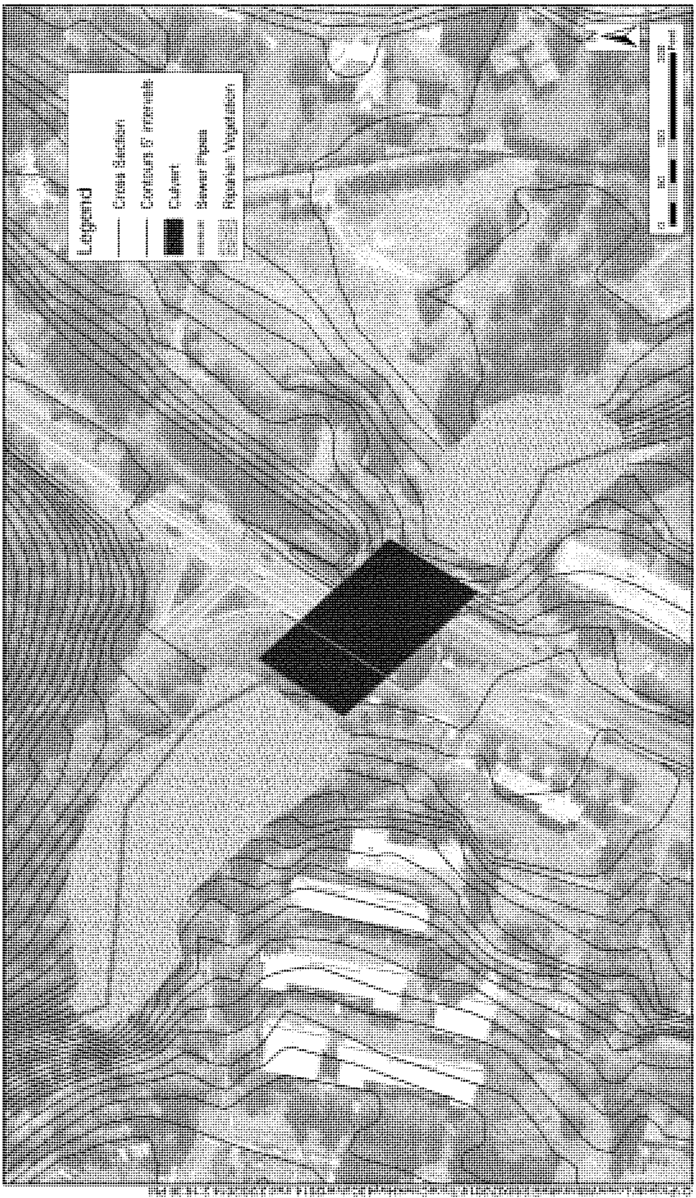
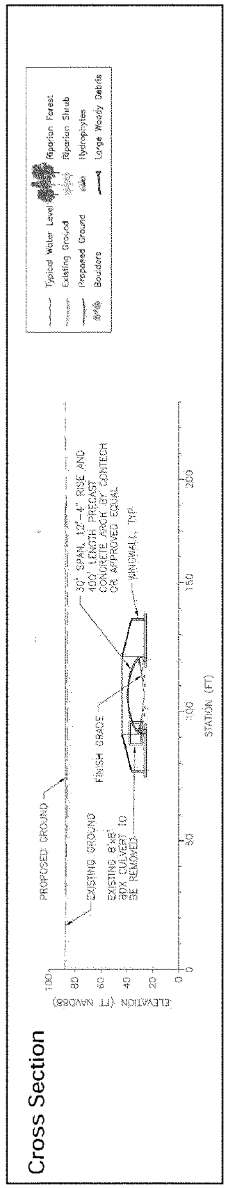
Lower Willamette Ecosystem Restoration Project
Conceptual Restoration Plan





Appendix B – Biological Opinion and Incidental Take Statement

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
1201 NE Lloyd Boulevard, Suite 1100
Portland, OR 97232

Refer to NMFS No:
WCR-2014-633

May 23, 2014

Joyce Casey, Chief
Environmental Resources Branch
Planning, Programs and Project Management Division
U.S. Army Corps of Engineers, Portland District
P.O. Box 2946
Portland, Oregon 97208-2946

Re: Endangered Species Act Biological and Conference Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for the Lower Willamette River Ecosystem Restoration General Investigation on the Willamette River, the Columbia Slough, and Tryon Creek (HUC 17090012), Multnomah and Clackamas Counties, Oregon

Dear Ms. Casey:

The enclosed document contains a biological and conference opinion (opinion) prepared by the National Marine Fisheries Service (NMFS) pursuant to section 7(a)(2) of the Endangered Species Act (ESA) on the effects of a proposal by the Portland District of the U.S. Army Corps of Engineers to authorize actions under the Lower Willamette River Ecosystem Restoration General Investigation 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*. In this opinion, NMFS concludes that the proposed action is not likely to jeopardize the continued existence of Lower Columbia River (LCR) Chinook salmon (*Oncorhynchus tshawytscha*), Upper Willamette River (UWR) Chinook salmon, LCR coho salmon (*O. kisutch*), LCR steelhead (*O. mykiss*), or UWR steelhead or result in the destruction or adverse modification of their designated or proposed (for LCR coho salmon) critical habitats.

As required by section 7 of the ESA, NMFS is providing an incidental take statement with the opinion. The incidental take statement describes reasonable and prudent measures NMFS considers necessary or appropriate to minimize the impact of incidental take associated with this action. The take statement sets forth nondiscretionary terms and conditions, including reporting requirements, that the Federal action agency must comply with to carry out the reasonable and prudent measures. Incidental take from actions that meet these terms and conditions will be exempt from the ESA's prohibition against the take of listed species.

This document also includes the results of our analysis of the action's likely effects on essential fish habitat (EFH) pursuant to section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), and includes two conservation recommendations to avoid, minimize, or otherwise offset potential adverse effects on EFH. One of these conservation recommendations is identical to the ESA take statement's terms and conditions. Section 305(b) (4) (B) of the MSA requires Federal agencies to provide a detailed written response to NMFS within 30 days after receiving these recommendations.

If the response is inconsistent with the EFH conservation recommendations, the Federal action agency must explain why the recommendations will not be followed, including the scientific justification for any disagreements over the effects of the action and the recommendations. In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, we request that in your statutory reply to the EFH portion of this consultation, you clearly identify the number of conservation recommendations accepted.

Please direct questions regarding this opinion to Genevieve Angle in the Willamette Branch of the Oregon/Washington Coastal Area Office, at 503-231-2223.

Sincerely,

Keith Kirkendall

for William W. Stelle, Jr.
Regional Administrator

Endangered Species Act (ESA) Section 7(a)(2) Biological and Conference Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation

Lower Willamette River Ecosystem Restoration General Investigation
on the Willamette River, the Columbia Slough, and Tryon Creek (HUC 17090012),
Multnomah and Clackamas Counties, Oregon

NMFS Consultation Number: WCR-2014-633

Action Agency: U.S. Army Corps of Engineers

Affected Species and Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species or Critical Habitat?	Is Action Likely To Jeopardize the Species?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Lower Columbia River Chinook Salmon (*Oncorhynchus tshawytscha*)	Threatened	Yes	No	No
Upper Willamette River Chinook Salmon (*O. tshawytscha*)	Threatened	Yes	No	No
Lower Columbia River Coho Salmon (*O. kisutch*)	Threatened	Yes	No	No*
Lower Columbia River Steelhead (*O. mykiss*)	Threatened	Yes	No	No
Upper Willamette River Steelhead (*O. mykiss*)	Threatened	Yes	No	No

*Critical habitat is proposed for LCR coho salmon.

Fishery Management Plan That Describes EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast Salmon	Yes	Yes

Consultation Conducted By: National Marine Fisheries Service, Northwest Region

Issued By:

Keith Kirkendall
for William W. Stelle, Jr.
Regional Administrator

Date: May 23, 2014

TABLE OF CONTENTS

LIST OF ACRONYMS

BA	Biological Assessment
BMP	Best Management Practice
CFR	Code of Federal Regulations
CHART	Critical Habitat Analytical Review Team
DPS	Distinct Population Segment
EFH	Essential Fish Habitat
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FR	Federal Register
HUC	Hydraulic Unit Code
LCR	Lower Columbia River
LW	Large Wood
MSA	Magnuson Stevens Act
NMFS	National Marine Fisheries Service
OHW	Ordinary High Water
PCE	Primary constituent element
RM	River Mile
RPM	Reasonable and prudent measure
TRT	Technical Review Team
U.S.C.	United States Code
UWR	Upper Willamette River
VSP	Viable Salmonid Population
WLC	Willamette-Lower Columbia

1. INTRODUCTION

This Introduction Section provides information relevant to the other sections of this document and is incorporated by reference into sections 2 and 3 below.

1.1 Background

The National Marine Fisheries Service (NMFS) prepared the biological opinion (opinion) and incidental take statement portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531, *et seq.*), and implementing regulations at 50 CFR 402.

We also completed an essential fish habitat (EFH) consultation on the proposed action, in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801, *et seq.*) and implementing regulations at 50 CFR 600.

The opinion, incidental take statement, and EFH conservation recommendations are each in compliance with the Data Quality Act (44 U.S.C. 3504(d)(1) *et seq.*) and they underwent pre-dissemination review.

1.2 Consultation History

The NMFS received a letter from the U.S. Army Corps of Engineers (Corps) on April 1, 2014, requesting formal consultation on the effects of authorizing actions under the Lower Willamette River Ecosystem Restoration General Investigation 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 restoration actions would take place on the east bank of the Lower Willamette River at river mile (RM) 0 and 16.2, in the Columbia Slough at RM 7.5 and 9, and in Tryon Creek at RM 0.5, in Multnomah County and Clackamas County, Oregon. Along with the letter requesting formal consultation, we received a biological assessment for the proposed action, as well as project drawings, maps, and photographs. The City of Portland and the Port of Portland are the local sponsors for the actions covered under this General Investigation, and for the purposes of this opinion, we refer to them as the "applicant." Consultation was initiated on April 1, 2014. This opinion is based on the information provided in the documents described above.

The Corps determined that the proposed action is likely to adversely affect Lower Columbia River (LCR) Chinook salmon (*Oncorhynchus tshawytscha*), Upper Willamette River (UWR) Chinook salmon, LCR coho salmon (*O. kisutch*), LCR steelhead (*O. mykiss*), and UWR steelhead. The Corps also determined that designated or proposed critical habitat for the species listed above and EFH for Chinook and coho salmon may be adversely affected by the proposed action.

A complete record of this consultation is on file in Portland, Oregon.

1.3 Proposed Action

"Action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies. Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration. No interrelated or interdependent actions were identified for the proposed action.

The Corps proposes to authorize five restoration projects. These projects are located at Kelley Point Park (Willamette RM 0), the Bureau of Environmental Services (BES) Treatment Plant (Columbia Slough RM 7.5), Kenton Cove (Columbia Slough RM 9), Oaks Crossing (Willamette RM 16.2), and the Tryon Creek Highway 43 Culvert (Tryon Creek RM 0.5). A summary of the key restoration elements proposed at each site is provided below.
Different combinations of restoration features are proposed at each site, depending on the problems to be addressed and the opportunities each site offers.

Large Wood and Boulder Placement: Large wood (LW) will be installed by excavating the streambank to allow trunks or stumps to be keyed into the bank for stability. Generally, one or two pieces of LW will be installed at each location. After installation, the substrate around the LW will be recontoured to match previous or desired grade, and revegetated as needed. Boulders will be installed by excavating holes or trenches in the streambed with an excavator or backhoe, installing the boulders according to specifications, and backfilling the surrounding area with appropriate substrate.

Invasive Species Removal and Riparian Revegetation: Native vegetation will be planted in riparian zones to the edge of project boundaries. Invasive species removal is proposed in combination with riparian planting. This will 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 will be done by mechanical means (plowing, disking, and mowing), hand removal (cutting), and/or spot applications of herbicides where the risk of contamination is limited. All areas temporarily disturbed during construction will be replanted by hand with native species, and appropriate erosion control including coir mats, straw, or jute netting will be installed to control movement of fine sediment particles into waterways.

In-stream and Channel Modifications: Grading banks to gentler slopes is proposed to allow for restored hydrologic connections and to create shallow water habitat, reduce erosion, stabilize banks and to allow riparian and aquatic habitats to form more naturally. Banks will be graded by use of a land or barge-mounted excavator. Excavated bank angles will vary depending on surrounding land uses and current bank angle. Areas above the ordinary high-water mark will be revegetated with native riparian species, and erosion control features including jute netting or coir mats will be installed. Spoils will be hauled by barge or truck to an appropriate disposal facility. Areas below ordinary high water or below the water surface elevation will generally not be graded as part of this type of measure.

Off-Channel Habitat and Floodplain Reconnection: Off-channel habitat creation and floodplain reconnection will primarily take the form of side channels and swales excavated in riparian areas. Excavation will involve heavy equipment including excavators, scrapers, backhoes, and dump trucks. Excavated areas will coincide with natural swales or other contours that will minimize the amount of materials to be excavated and fit with the landscape to the highest degree possible. Large trees will be avoided as much as possible, and work will occur in the dry except when removing the final amount of fill to allow inflow from the Willamette River or Columbia Slough, which will occur during the in-water work window. The banks of side channels will be contoured to resist erosion and revegetated above the ordinary high water elevation. LW and boulders will be installed as described above to create habitat diversity.

Fish Barrier Removal: Access into spawning areas of Tryon Creek is severely restricted by the culvert located where Tryon Creek passes under Highway 43. This culvert is proposed for replacement. The new culvert will allow access to spawning areas upstream of the culvert.

These restoration measures align with the 18 project categories of aquatic restoration actions covered under the Programmatic Restoration Opinion for Joint Ecosystem Conservation by the Services (PROJECTS) (NMFS No.: NWR-2013-10221). The PROJECTS Biological Opinion 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 Act on the effects of implementing aquatic restoration actions proposed to be funded or carried out by the U.S. Fish and Wildlife Service (USFWS) and the NOAA Restoration Center in the States of Oregon, Washington and Idaho. The PROJECTS approved actions that are applicable to the proposed projects are described below, along with the design criteria that are provided for each action. The Corps proposes to adhere to these design criteria for the proposed restoration actions discussed above. This allows us to conduct an expedited review of these actions because we have already carried out a detailed analysis of these types of actions with the proposed design criteria.

1) Fish Passage Restoration: This type of action includes total removal, replacement, or resetting of culverts or bridges; stabilizing headcuts and other channel instabilities; removing, relocating, constructing, repairing, or maintaining fish ladders; and replacing, relocating, or constructing fish screens and irrigation diversions. The following design criteria pertain only to the Tryon Creek Highway 43 culvert replacement project:

a. Stream simulation culvert and bridge projects. All road-stream crossing structures shall adhere to the most recent version of NMFS fish passage criteria, which are as follows:

- Bed width will be greater than bankfull channel width, and of sufficient vertical clearance to allow ease of maintenance activities.
- Vertical clearance between the culvert bed and ceiling will be more than 6 feet to allow for debris removal.
- Slope will be equal to the slope of, and at elevations continuous with, the surrounding long-channel streambed profile. Culvert will be open-bottomed so footings will be keyed into the underlying bedrock.
- Culvert will be more than 150 feet, but a bridge is not possible at this location due to cost and transportation disruptions.
- Fill materials will match native substrate.

- Average water depth and velocities will simulate those in the surrounding stream channel.

The proposed road-stream crossing structures shall simulate stream channel conditions per industry design standards found in any one of the following:

i. *Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings* (USDA-Forest Service 2008).
ii. *Part XII Fish Passage Design and Implementation, Salmonid Stream Habitat Restoration Manual* (California Department of Fish and Game 2009) or the most recent version.
iii. *Water Crossings Design Guidelines* (Barnard *et al.* 2013) or the most recent version.

b. General road-stream crossing criteria

i. Span
1. Span is determined by the crossing width at the proposed streambed grade.
2. Single span structures will maintain a clear, unobstructed opening above the general scour elevation that is at least as wide as 1.5 times the active channel width.
3. Multi-span structures will maintain clear, unobstructed openings above the general scour elevation (except for piers or interior bents) that are at least as wide as 2.2 times the active channel width.
4. Entrenched streams: If a stream is entrenched (entrenchment ratio of less than 1.4), the crossing width will accommodate the floodprone width. Floodprone width is the channel width measured at twice the maximum bankfull depth (Rosgen 1996).
5. Minimum structure span is 6ft.

ii. Scour Prism
1. Designs shall maintain the general scour prism as a clear, unobstructed opening (i.e., free of any fill, embankment, scour countermeasure, or structural material to include abutments, footings, and culvert inverts). No scour or stream stability countermeasure may be applied above the general scour elevation.

iii. Embedment
1. All culvert footings and inverts shall be placed below the thalweg at a depth of 3 feet, or the Lower Vertical Adjustment Potential (LVAP) line, whichever is deeper.
   a. LVAP, as calculated in Stream Simulation: An ecological approach to providing passage for aquatic organisms at road crossings (USDA-Forest Service 2008).
2. In addition to embedment depth, embedment of closed bottom culverts shall be between 30% and 50% of the culvert rise.

iv. NMFS fish passage review and approval. NMFS will review crossing structure designs if the span width is determined to be less than the criteria established above or if the design is inconsistent with criteria in *Anadromous Salmonid Passage Facility Design* (NMFS 2011c).

2) Large wood (LW), Boulder, and Gravel Placement: This type of action includes LW and boulder placement, and porous boulder step structures. The following design criteria pertain to all five proposed projects:

a. Large wood and boulder projects

i. Place LW and boulders in areas where they would naturally occur and in a manner that closely mimics natural accumulations for that particular stream type. For example, boulder placement may not be appropriate in low-gradient meadow streams.

ii. Structure types shall simulate disturbance events to the greatest degree possible and include, but are not limited to, log jams, debris flows, wind-throw, and tree breakage.

iii. No limits are to be placed on the size or shape of structures as long as such structures are within the range of natural variability of a given location and do not block fish passage.

iv. Projects can include grade control and streambank stabilization structures, while size and configuration of such structures will be commensurate with scale of project site and hydraulic forces.

v. The partial burial of LW and boulders is permitted and may constitute the dominant means of placement. This applies to all stream systems but more so for larger stream systems where use of adjacent riparian trees or channel features is not feasible or does not provide the full stability desired.

vi. LW includes whole conifer and hardwood trees, logs, and rootwads. LW size (diameter and length) should account for bankfull width and stream discharge rates. When available, trees with rootwads should be a minimum of 1.5 x bankfull channel width, while logs without rootwads should be a minimum of 2.0 x bankfull widths.

vii. Structures may partially or completely span stream channels or be positioned along stream banks.

viii. Stabilizing or key pieces of LW will be intact, hard, with little decay, and if possible have root wads (untrimmed) to provide functional refugia habitat for fish. Consider orienting key pieces such that the hydraulic forces upon the LW increase stability.

ix. Anchoring LW — Anchoring alternatives may be used in preferential order:

1. Use of adequate sized wood sufficient for stability
2. Orient and place wood in such a way that movement is limited
3. Ballast (gravel or rock) to increase the mass of the structure to resist movement
4. Use of large boulders as anchor points for the LW
5. Pin LW with rebar to large rock to increase its weight. For streams that are entrenched (Rosgen F, G, A, and potentially B) or for other streams with very low width to depth ratios (less than 12) an additional 60% ballast weight may be necessary due to greater flow depths and higher velocities.
6. Anchoring LW by cable is not allowed under this opinion.

b. Porous boulder step structures and vanes (Tryon Creek Highway 43 site only)

i. Full channel spanning boulder structures are to be installed only in highly uniform, incised, bedrock-dominated channels to enhance or provide fish habitat in stream reaches where log placements are not practicable due to channel conditions (not feasible to place logs of sufficient length, bedrock dominated channels, deeply incised channels, artificially constrained reaches, etc.), where damage to infrastructure on public or private lands is of concern, or where private landowners will not allow log placements due to concerns about damage to their streambanks or property.

ii. Install boulder structures low in relation to channel dimensions so that they are completely overtopped during channel-forming flow events (approximately a 1.0 to 1.5-year flow event).

iii. Boulder step structures are to be placed diagonally across the channel or in more traditional upstream pointing "V" or "U" configurations with the apex oriented upstream.

iv. Boulder step structures are to be constructed to allow upstream and downstream passage of all native fish species and life stages that occur in the stream. Plunges shall be kept less than 6 inches in height.

v. The use of gabions, cable, or other means to prevent the movement of individual boulders in a boulder step structure is not allowed.

vi. Rock for boulder step structures shall be durable and of suitable quality to assure long-term stability in the climate in which it is to be used. Rock sizing depends on the size of the stream, maximum depth of flow, planform, entrenchment, and ice and debris loading.

vii. The project designer or an inspector experienced in these structures should be present during installation.

viii. Full spanning boulder step structure placement should be coupled with measures to improve habitat complexity and protection of riparian areas to provide long-term inputs of LW.

3) Off- and Side-Channel Habitat Restoration: These actions will be implemented to reconnect historic side channels with floodplains by removing off-channel fill and plugs. Furthermore, new side-channels and alcoves can be constructed in geomorphic settings that will accommodate such features. The following design criteria pertain to all sites except for the Tryon Creek Highway 43 Culvert site.

a. **Data requirements.** Data requirements and analysis for off- and side-channel habitat restoration include evidence of historical channel location, such as land use surveys, historical photographs, topographic maps, remote sensing information, or personal observation.

b. **Allowable excavation.** Off- and side-channel improvements can include minor excavation (less than or equal to 10% of volume) of naturally accumulated sediment within historical channels, *i.e.*, based on the OHW level as the elevation datum. The calculation of the 10% excavation volume does not include manually placed fill, such as dikes, berms, or earthen plugs. There is no limit as to the amount of excavation of anthropogenic fill within historical side channels as long as such channels can be clearly identified through field or aerial photographs. Excavation depth will not exceed the maximum thalweg depth in the main channel. Excavated material removed from off- or side-channels shall be hauled to an upland site or spread across the adjacent floodplain in a manner that does not restrict floodplain capacity.

4) Streambank Restoration: This type of action includes alluvium placement, LW placement, roughened toe, woody plantings, herbaceous cover in areas where the native vegetation does not include trees or shrubs, bank reshaping and slope grading, coir logs, deformable soil reinforcement, engineered log jams (ELJs), floodplain flow spreaders, and floodplain roughness. The following design criteria pertain to all five proposed projects.

- Structure shall simulate disturbance events to the greatest degree possible and include, but not be limited to, log jams, debris flows, wind-throw, and tree breakage.
- Structures may partially or completely span stream channels or be positioned along stream banks.
- Where structures partially or completely span the stream channel LW should be comprised of whole conifer and hardwood trees, logs, and rootwads. LW size (diameter and length) should account for bankfull width and stream discharge rates.
- Structures will incorporate a diverse size (diameter and length) distribution of rootwad or non-rootwad, trimmed or untrimmed, whole trees, logs, snags, slash, *etc.*
- For individual logs that are completely exposed, or embedded less than half their length, logs with rootwads should be a minimum of 1.5 times bankfull channel width, while logs without rootwads should be a minimum of 2.0 times bankfull width.
- Consider orienting key pieces such that the hydraulic forces upon the LW increase stability.
- If LW mechanical anchoring is required, a variety of methods may be used. These include large angular rock, buttressing the wood between adjacent trees, or the use of manila, sisal or other biodegradable ropes for lashing connections. If hydraulic conditions warrant use of structural connections, rebar pinning or bolted connections may be used. Use of cable is not covered by this opinion.
- When a hole in the channel bed caused by local scour will be filled with rock to prevent damage to a culvert, road, or bridge foundation, the amount of rock will be limited to the minimum necessary to protect the integrity of the structure.
- When a footing, facing, head wall, or other protection will be constructed with rock to prevent scouring or down-cutting of, or fill slope erosion or failure at, an existing culvert or bridge, the amount of rock used will be limited to the minimum necessary to protect the integrity of the structure. Whenever feasible, include soil and woody vegetation as a covering and throughout the structure.
- Use a diverse assemblage of vegetation species native to the action area or region, including trees, shrubs, and herbaceous species. Vegetation, such as willow, sedge and rush mats, may be gathered from abandoned floodplains, stream channels, *etc.*
- Do not apply surface fertilizer within 50 feet of any stream channel.
- Install fencing as necessary to prevent access to revegetated sites by livestock or unauthorized persons.
- Conduct post-construction monitoring and treatment or removal of invasive plants until native plant species are well established.

5) **Wetland Restoration**: This type of action restores degraded wetlands by (a) excavation and removal of fill materials; (b) contouring to reestablish more natural topography; (c) setting back existing dikes, berms, and levees; (d) reconnecting or recreating historical tidal and fluvial channels; (e) planting native wetland species; or (f) a combination of the above methods. The following design criteria pertain only to the Oaks Crossing project:

a. **Include applicable General Construction Measures** for specific types of actions as applicable (e.g., Off- and Side-Channel Habitat Restoration, above) to ensure that all adverse effects to fish and their designated critical habitats are within the range of effects considered in the PROJECTS BiOp.

The section below provides details on specific actions that would occur at each restoration site. In all cases, heavy equipment such as excavators and haul trucks would be used during construction; all in-water work will be confined to the designated work window; and in-water work areas will be isolated with coffer dams so that construction will be performed "in the dry" to reduce turbidity and adverse effects to fish and wildlife.

Kelley Point Park (Restoration Action Types: Large wood (LW), Boulder, and Gravel Placement; Off- and Side-Channel Habitat Restoration; Streambank Restoration). The proposed actions at this 16-acre site will be to excavate two off-channel backwater areas totaling approximately 5,000 feet in length and 10 feet wide to an elevation approximately 6 inches below the normal winter flow water surface elevation; remove invasive plants and revegetate with native riparian species over approximately 11 acres; regrade steep banks for floodplain enhancement along 5,000 linear feet of the Willamette River and Columbia Slough, and place LW as needed to enhance habitat complexity. Trails throughout the park will be adjusted to allow for restoration as needed, and up to three crossing structures will be installed. To reduce the amount of fill to be removed, rather than excavating large areas of floodplain, meandering channels will be cut along existing swales to allow for off-channel refugia. An estimated 197,000 cubic yards (cy) of material will be excavated and hauled off-site either by barge or truck.

BES Plant (Restoration Action Types: Large wood (LW), Boulder, and Gravel Placement; Off- and Side-Channel Habitat Restoration; Streambank Restoration). The intent of this project is to excavate a connection to a floodplain backwater/swale area to allow more frequent inundation and enhance the riparian zone along Columbia Slough. Habitat quality is moderate to good, but opportunities to improve and expand riparian wetland and backwater habitats exist in several parts of the project site. Off-channel rearing and high-water refugia will be enhanced 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. Steepened banks will be laid back along approximately 400 linear feet of the Columbia Slough by excavating and hauling approximately 13,000 cy of soil; LW will be added along the banks to increase habitat complexity; several large boulders will be placed in the backwater area for reptile and amphibian habitat; and invasive species removal and riparian revegetation will occur on approximately 0.7 acres.

Kenton Cove (Restoration Action Types: LW, Boulder, and Gravel Placement; Streambank Restoration). Most of this 3.2 acre site is surrounded by a highly maintained levee, with a natural riparian floodplain zone along the Columbia Slough. The dominant species include black cottonwood, Himalayan blackberry, and reed canarygrass. The intent of this project is to enhance this backwater cove 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 with clean fill and woody debris will be created, with the wood as the centerpiece of the habitat island. An estimated 1600 cy of gravel and topsoil will be imported and hauled by truck for the creation of the habitat islands. LW will be installed as appropriate and invasive species removal and revegetation with native species will occur over approximately 3.2 acres.

Oaks Crossing/Sellwood Riverfront Park (Restoration Action Types: LW, Boulder, and Gravel Placement; Off- and Side-Channel Habitat Restoration; Wetland Restoration). The intent of this project is to restore salmonid habitat in the floodplain of this 7.2 acre site by connecting off-channel habitat to the river, adding LW, removing invasive species, and revegetating with native wetland and riparian species. Habitat at this site consists of gallery forest lined with native and invasive species. Shallow water habitat will be enhanced by addition of LW as needed. To create approximately 1,200 linear feet of side channels and backwater habitat, an estimated 9,000 cy of material will be excavated and hauled either by barge or truck. The bottom elevations of the side channels will correspond to an elevation approximately 6 inches below the water surface elevation under normal winter flows. Invasive species will be removed and wetland or riparian vegetation will be planted over approximately 7.2 acres.

Highway 43 Tryon Creek Culvert (Restoration Action Type: Fish Passage Restoration). The intent of this project is to replace the culvert under Highway 43 and the Portland and Northern rail line with a fish passable culvert. The new open-bottom arch culvert will simulate the natural stream dimensions, allowing for sediment and debris to pass through and provide fish unhindered passage beneath the roadway and railroad line. Implementation of this project will allow unhindered fish passage into the Tryon Creek State Natural Area, where fish habitat has been restored recently. Replacing this culvert will require excavation of up to 21,000 cy of overburden from above the culvert; demolition and removal of the entire 400 foot culvert; removal of approximately 1,200 cy of bedrock; installation of a 28-foot wide, open bottom arch culvert; installation of headwalls and wingwalls at both ends of the culvert; installation of rock weirs in the streambed for velocity control; backfill with 17,800 cy of overburden; and riparian revegetation over approximately 2.5 acres. Temporary dewatering may be needed during some of the work in the streambed. All work in the streambed and bank areas will occur during the in-water work window.

This culvert has been designed to be consistent with design criteria from the PROJECTS BiOp (NMFS 2013a) and recommendations in *Anadromous Salmonid Passage Facility Design* (NMFS 2008).

The applicant has proposed the following conservation measures to minimize the effects of the proposed action:

- <u>**Site Contamination Assessment:**</u> An assessment of available records has been conducted for the project sites to ensure that the proposed project will not release contaminants to aquatic habitat. This assessment, which included a search of relevant databases and a field reconnaissance survey, concluded that there are no hazardous, toxic or radioactive waste sites within ¼ mile of any of the proposed restoration sites.
- <u>**Site Layout and Flagging Sensitive Areas:**</u> Before construction begins, flagging of entry and exit points, staging areas, and sensitive resources will occur in order to avoid disturbance during construction.

- **<u>Staging, Storage and Stockpile Areas:</u>** Staging areas and storage areas will be designated to store materials, fuel, and equipment. Equipment will be staged at least 150 feet from any natural water body or wetland when possible to avoid contamination or sedimentation of water bodies. However since the project sites may occur in confined areas, this may not be feasible. If the staging area(s) will be located within 150 feet of the river or the wetlands, they will be fenced and fully contained to prevent the runoff of sediment or pollutant laden stormwater into the river or wetlands.
- **<u>Erosion Controls:</u>** Site planning and site erosion control measures will be installed prior to construction to prevent erosion and sediment discharge. Temporary erosion control measures including fiber wattles, site fences, jute matting, wood fiber mulch, or geotextiles will be installed, as appropriate, before any significant alteration of the site occurs. Additional sediment barriers will be stored on site if needed.
- **<u>Hazardous Material Spill Prevention Control:</u>** An erosion and pollution control plan will be prepared for each individual project site and carried out, commensurate with the scope of the action that includes the following information: (a) the name, phone number, and address of the person responsible for accomplishing the plan; (b) best management practices to confine vegetation and soil disturbance to the minimum area, and minimum length of time, as necessary to complete the action, and otherwise prevent or minimize erosion associated with the action; (c) best management practices to confine, remove, and dispose of construction waste, including debris, discharge water, concrete, cement, grout, washout facility, petroleum product, or other hazardous materials generated, used, or stored on-site; (d) procedures to contain and control a spill of any hazardous material generated, used or stored on-site, including notification of proper authorities; and (e) steps to cease work under high flows, except for efforts to avoid or minimize resource damage.
- **<u>Equipment, Vehicles, and Power Tools</u>:** Equipment will be selected to minimize adverse effects on the environment. Vehicles and equipment will be inspected daily for fluid leaks before leaving the staging area when operating within 50 feet of any stream, waterbody, or wetland and the equipment will be steam cleaned before operation below the ordinary high water or as necessary to remain grease free and prevent invasive species contamination. Biodegradable lubricants and fuels will be used as available.
- **<u>Temporary Access Roads</u>:** Temporary access roads will not be built on steep slopes, where grade, soil, or other features suggest a likelihood of excessive erosion or failure. For the most part, existing access roads are present, and only limited additional grading or placement of gravel/rock for access will be required to facilitate construction.
- **<u>Dust Abatement:</u>** Dust abatement measures will be commensurate with soil type, equipment use, wind conditions, and the effects of other erosion control measures; work will be sequenced to reduce the exposure of bare soil to wind erosion; spill containment supplies will be maintained on site; petroleum-based products will not be used for dust abatement.
- **<u>Temporary Stream Crossings</u>:** No stream crossings will occur at active spawning sites, when adult listed fish are present or holding, or when eggs or alevins are in the gravel; temporary crossings will not be placed in areas that may increase the risk of channel re-routing or avulsion, or in potential spawning habitat, *e.g.*, pools and pool tailouts. The number of temporary stream crossings will be minimized, and existing stream crossings will be used whenever reasonable; temporary bridges and culverts will be installed to

allow for equipment and vehicle crossing over perennial streams during construction. Whenever possible, vehicles and machinery will cross streams at right angles to the main channel or equipment and vehicles will cross the stream in the wet only where the streambed is bedrock, or where mats or off-site logs are placed in the stream and used as a crossing. All temporary stream crossings will be obliterated as soon as they are no longer needed, and any damage to affected stream banks or channel will be fully restored following project implementation.

- **Surface Water Withdrawal and Construction Discharge Water:** Surface water will only be diverted to meet construction needs if developed sources are unavailable or inadequate. Diversions will not exceed 10% of the available flow and will have a juvenile fish exclusion device that is consistent with NMFS's criteria. Screens will be installed, operated, and maintained to meet NMFS fish screen criteria. All construction discharge water will be treated using the best management practices applicable to site conditions to remove debris, sediment, petroleum products, and any other pollutants likely to be present, (*e.g.*, green concrete, contaminated water, silt, welding slag, sandblasting abrasive, grout cured less than 24 hours, drilling fluids) to ensure that no pollutants are discharged from the construction site.

- **Fish Passage**: Fish passage will be provided for adult or juvenile fish present in the action area during construction, or fish will be salvaged and removed if waters are diverted. All reconnection channels and passageways will meet NMFS fish passage criteria.
- **In-water Work Period:** All work below the ordinary high water line will occur during the designated ODFW in-water work periods for the Lower Willamette River and tributaries, as appropriate (Tryon Creek- July 15 to September 30, Mainstem Willamette- July 1 to October 31, Columbia Slough- June 15 to September 15).
- **Fisheries, Hydrology, Geomorphology, Wildlife, Botany, and Cultural Surveys in Support of Aquatic Restoration:** A monitoring and adaptive management plan to track the success of the restoration features will be developed.
- **Work Area Isolation:** Any work within the wetted channel will be isolated from the Lower Willamette River and its tributaries by installation of coffer dams and other measures, as appropriate. A work area isolation and fish salvage plan will be prepared for each site for approval by ODFW and NMFS and carried out with a scientific collection permit. Fish and wildlife will be salvaged and removed from the work area. Any pumps used outside of isolated areas will be screened per ODFW requirements. Any groundwater present in the excavation area will be pumped and treated via infiltration or other methods (such as Baker tanks or silt bags) prior to discharge back to either the river or wetlands.
- **Fish Capture and Release:** Any fish that may be trapped within the isolated work area will be captured using a trap, seine, electrofishing, or other methods as prudent to minimize the risk of injury, then released at a safe release site. A scientific collection permit will be obtained to conduct this work, with approval of the fish salvage plan from NMFS and ODFW. Capture and release will be supervised by a fishery biologist experienced with work area isolation and competent to ensure the safe handling of fish. If

electrofishing is used, the NMFS electrofishing guidelines will be followed (NMFS 2000).

- **Invasive and non-native plant control**: Invasive and non-native plant control will use manual, mechanical, or hydro-mechanical methods as a priority. Herbicide use will be used secondarily and will follow all NMFS approved herbicide label instructions and application will occur or be supervised by a licensed applicator.
- **Site Restoration**: Any temporary access routes constructed will be removed in their entirety and the locations will be restored via mulching and hydroseeding and then planting of native shrub and tree species. Any fill placed in wetlands for temporary construction purposes will be removed and the area will be fully restored. Any large wood, native vegetation, topsoil and native channel material displaced by construction will be stockpiled for reuse on-site during restoration, as feasible. When construction is complete, all disturbed areas will be restored as necessary to renew ecosystem processes. Fencing will be installed as necessary to prevent damage to newly revegetated sites by unauthorized persons.
- **Planting or Installing Vegetation:** Disturbed areas will be planted and seeded before or at the beginning of the first growing season after construction. A diverse mix of native species adapted to the site conditions will be used for all revegetation efforts. Non-native or invasive species will not be included. Existing non-native or invasive species will be controlled as feasible on the site to promote native vegetation growth and dominance.

NMFS relied on the foregoing description of the proposed action, including all features identified to reduce adverse effects, to complete this consultation. To ensure that this opinion remains valid, NMFS requests that the action agency or applicant keep NMFS informed of any changes to the proposed action.

1.4 Action Area

"Action area" means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). For this consultation, the action area is the east bank of the Willamette River at RM 0 and 16.2, the Columbia Slough at RM 7.5 and 9, and Tryon Creek at RM 0.5 (Figure 1). The action area also includes the area 500 feet upstream and downstream of these locations where the impacts from construction of the restoration projects (such as suspended sediment and turbidity) could affect ESA-listed salmonids.

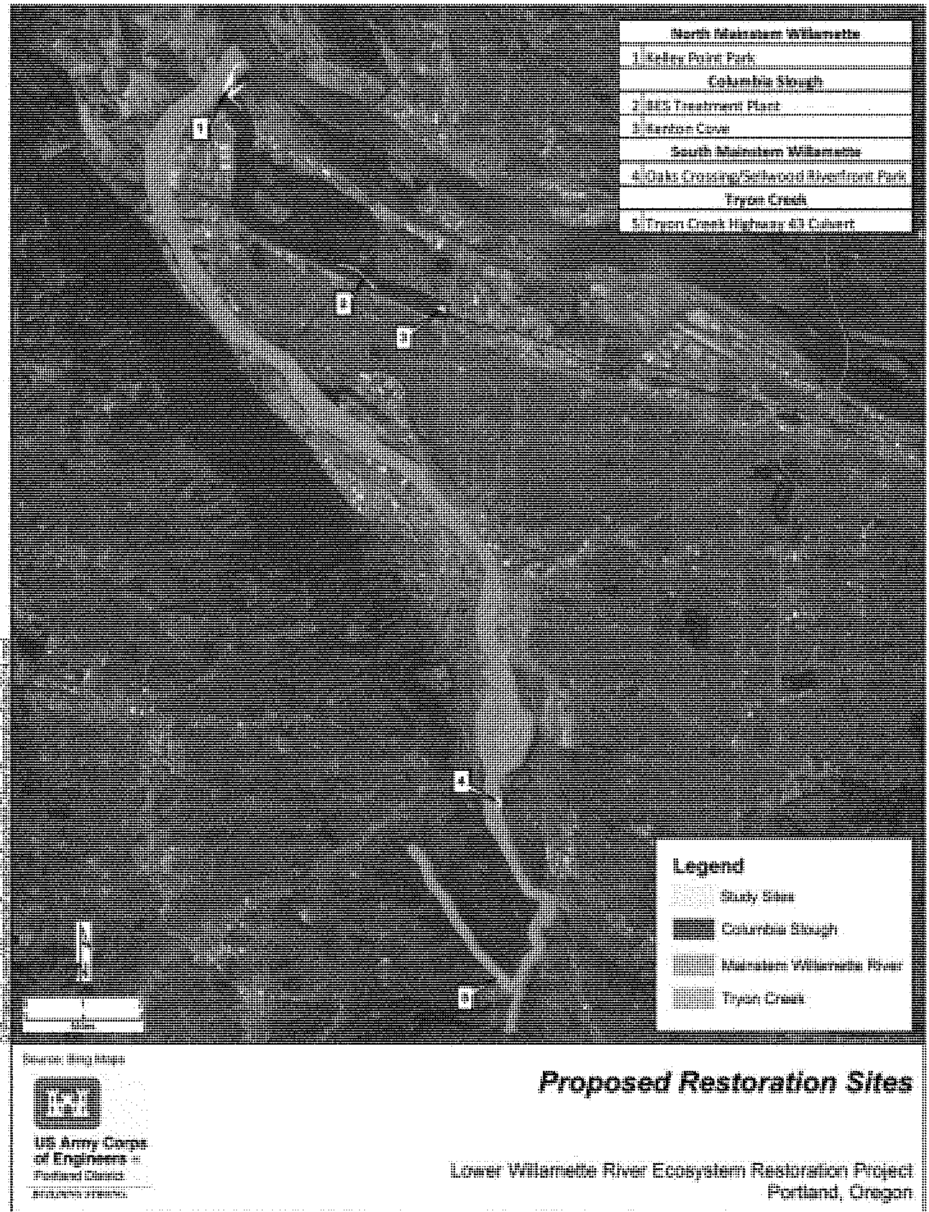


Figure 1. The five project areas.

Five ESA-listed species use the action area for adult migration and spawning, and juvenile rearing and migration. Critical habitat has been designated for all species except LCR coho salmon, for which critical habitat has been proposed but not yet designated. The action area is designated EFH for Chinook salmon and coho salmon (PFMC 1999), and is an area where environmental effects of the proposed action may adversely affect EFH of those species. The effects to EFH are analyzed in the MSA portion of the document.

2. ENDANGERED SPECIES ACT: BIOLOGICAL AND CONFERENCE OPINION AND INCIDENTAL TAKE STATEMENT

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. Section 7(a)(2) of the ESA requires Federal agencies to consult with the United States Fish and Wildlife Service, NMFS, or both, to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or adversely modify or destroy their designated critical habitat. Section 7(b)(3) requires that at the conclusion of consultation, the Service provide an opinion stating how the agencies' actions will affect listed species and their critical habitat. If incidental take is expected, section 7(b)(4) requires the consulting agency to provide an incidental take statement (ITS) that specifies the impact of any incidental taking and includes reasonable and prudent measures to minimize such impacts.

2.1 Approach to the Analysis

Section 7(a)(2) of the ESA requires Federal agencies, in consultation with NMFS, to insure that their actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. The jeopardy analysis considers both survival and recovery of the species. The adverse modification analysis considers the impacts on the conservation value of designated critical habitat.

"To jeopardize the continued existence of a listed species" means to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR 402.02).

This opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, we have relied upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat.[1]

We will use the following approach to determine whether the proposed action is likely to jeopardize listed species or destroy or adversely modify critical habitat:

[1] Memorandum from William T. Hogarth to Regional Administrators, Office of Protected Resources, NMFS (Application of the "Destruction or Adverse Modification" Standard Under Section 7(a)(2) of the Endangered Species Act) (November 7, 2005).

- *Identify the rangewide status of the species and critical habitat likely to be adversely affected by the proposed action.* This section (2.2) describes the current status of each listed species and its critical habitat relative to the conditions needed for recovery. For listed salmon and steelhead, NMFS has developed specific guidance for analyzing the status of the listed species' component populations in a "viable salmonid populations" paper (VSP; McElhany et al. 2000). The VSP approach considers the abundance, productivity, spatial structure, and diversity of each population as part of the overall review of a species' status. For listed salmon and steelhead, the VSP criteria therefore encompass the species' "reproduction, numbers, or distribution" (50 CFR 402.02). In describing the rangewide status of listed species, we rely on viability assessments and criteria in technical recovery team documents and recovery plans, where available, that describe how VSP criteria are applied to specific populations, major population groups, and species. We determine the rangewide status of critical habitat by examining the condition of its physical or biological features (also called "primary constituent elements" or PCEs in some designations) which were identified when the critical habitat was designated.
- *Describe the environmental baseline in the action area.* The environmental baseline (Section 2.3) includes the past and present impacts of Federal, state, or private actions and other human activities *in the action area.* It includes the anticipated impacts of proposed Federal projects that have already undergone formal or early section 7 consultation and the impacts of state or private actions that are contemporaneous with the consultation in process.
- *Analyze the effects of the proposed action on both species and their habitat.* In this step (Section 2.4), we consider how the proposed action would affect the species' reproduction, numbers, and distribution or, in the case of salmon and steelhead, their VSP parameters. We also evaluate the proposed action's effects on critical habitat features.
- *Describe any cumulative effects in the action area.* Cumulative effects (Section 2.5), as defined in our implementing regulations (50 CFR 402.02), are the effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area. Future Federal actions that are unrelated to the proposed action are not considered because they require separate section 7 consultation.
- *Integrate and synthesize the above factors to assess the risk that the proposed action poses to species and critical habitat.* In this step (Section 2.6), we add the effects of the action (Section 2.4) to the environmental baseline (Section 2.3) and the cumulative effects (Section 2.5) to assess whether the action could reasonably be expected to: (1) reduce appreciably the likelihood of both survival and recovery of the species in the wild by reducing its numbers, reproduction, or distribution; or (2) reduce the conservation value of designated or proposed critical habitat. These assessments are made in full consideration of the status of the species and critical habitat (Section 2.2).
- *Reach jeopardy and adverse modification conclusions.* In this step (Section 2.7) we state our conclusions regarding jeopardy and the destruction or adverse modification of critical habitat. These conclusions flow from the logic and rationale presented in Section 2.6 (Integration and Synthesis).
- *If necessary, define a reasonable and prudent alternative to the proposed action.* If, in completing the last step in the analysis, we determine that the action under consultation is likely to jeopardize the continued existence of listed species or destroy or adversely

modify designated critical habitat, we must identify a reasonable and prudent alternative (RPA) to the action in Section 2.8. The RPA must not be likely to jeopardize the continued existence of listed species nor adversely modify their designated critical habitat and it must meet other regulatory requirements.

2.2 Rangewide Status of the Species and Critical Habitat

This opinion examines the status of each species that would be affected by the proposed action. The status is the level of risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. The species status section helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in 50 CFR 402.02. The opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the current function of the essential physical and biological features that help to form that conservation value.

One factor affecting the status of ESA-listed species considered in this opinion, and aquatic habitat at large is, climate change.

2.2.1 Status of the Species

For Pacific salmon, steelhead, and other relevant species NMFS commonly uses four parameters to assess the viability of the populations that, together, constitute the species: spatial structure, diversity, abundance, and productivity (McElhany *et al.* 2000). These "viable salmonid population" (VSP) criteria therefore encompass the species' "reproduction, numbers, or distribution" as described in 50 CFR 402.02. When these parameters are collectively at appropriate levels, they maintain a population's capacity to adapt to various environmental conditions and allow it to sustain itself in the natural environment. These attributes are influenced by survival, behavior, and experiences throughout a species' entire life cycle, and these characteristics, in turn, are influenced by habitat and other environmental conditions.

"Spatial structure" refers both to the spatial distributions of individuals in the population and the processes that generate that distribution. A population's spatial structure depends fundamentally on habitat quality and spatial configuration and the dynamics and dispersal characteristics of individuals in the population.
"Diversity" refers to the distribution of traits within and among populations. These range in scale from DNA sequence variation at single genes to complex life history traits (McElhany *et al.* 2000).

"Abundance" generally refers to the number of naturally-produced adults (*i.e.*, the progeny of naturally-spawning parents) in the natural environment (*e.g.*, on spawning grounds).

"Productivity," as applied to viability factors, refers to the entire life cycle; *i.e.*, the number of naturally-spawning adults produced per parent. When progeny replace or exceed the number of parents, a population is stable or increasing. When progeny fail to replace the number of parents, the population is declining. McElhany *et al.* (2000) use the terms "population growth rate" and "productivity" interchangeably when referring to production over the entire life cycle. They also refer to "trend in abundance," which is the manifestation of long-term population growth rate.

For species with multiple populations, once the biological status of a species' populations has been determined, NMFS assesses the status of the entire species using criteria for groups of populations, as described in recovery plans and guidance documents from technical recovery teams. Considerations for species viability include having multiple populations that are viable, ensuring that populations with unique life histories and phenotypes are viable, and that some viable populations are both widespread to avoid concurrent extinctions from mass catastrophes and spatially close to allow functioning as metapopulations (McElhany *et al.* 2000).

The summaries that follow describe the status of the 5 ESA-listed species, and their designated critical habitats, that occur within the geographic area of this proposed action and are considered in this opinion. More detailed information on the status and trends of these listed resources, and their biology and ecology, are in the listing regulations and critical habitat designations published in the Federal Register (Table 1).

Table 1. Listing status, status of critical habitat designations and protective regulations, and relevant Federal Register (FR) decision notices for ESA-listed species considered in this opinion. Listing status: 'T' means listed as threatened under the ESA; 'P' means proposed for listing or designation.

Species	Listing Status	Critical Habitat	Protective Regulations
Chinook salmon *(Oncorhynchus tshawytscha)*			
Lower Columbia River	T 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Upper Willamette River	T 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Coho salmon *(O. kisutch)*			
Lower Columbia River	T 6/28/05; 70 FR 37160	P 1/14/13; 78 FR 2726	6/28/05; 70 FR 37160
Steelhead *(O. mykiss)*			
Lower Columbia River	T 1/5/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Upper Willamette River	T 1/5/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160

Climate change is likely to play an increasingly important role in determining the abundance of ESA-listed species, and the conservation value of designated critical habitats, in the Pacific Northwest. These changes will not be spatially homogeneous across the Pacific Northwest. Areas with elevations high enough to maintain temperatures well below freezing for most of the winter and early-spring will be less affected. Low-elevation areas are likely to be more affected. During the last century, average regional air temperatures increased by 1.5°F, and increased up to 4°F in some areas. Warming is likely to continue during the next century as average temperatures increase another 3 to 10°F. Overall, about one-third of the current cold-water fish habitat in the Pacific Northwest is likely to exceed key water temperature thresholds by the end of this century (USGCRP 2009).

Precipitation trends during the next century are less certain than for temperature but more precipitation is likely to occur during October through March and less during summer months, and more of the winter precipitation is likely to fall as rain rather than snow (ISAB 2007; USGCRP 2009). Where snow occurs, a warmer climate will cause earlier runoff so stream flows in late spring, summer, and fall will be lower and water temperatures will be warmer (ISAB 2007; USGCRP 2009).

Higher winter stream flows increase the risk that winter floods in sensitive watersheds will damage spawning redds and wash away incubating eggs. Earlier peak stream flows will also flush some young salmon and steelhead from rivers to estuaries before they are physically mature, increasing stress and the risk of predation. Lower stream flows and warmer water temperatures during summer will degrade summer rearing conditions, in part by increasing the prevalence and virulence of fish diseases and parasites (USGCRP 2009). Other adverse effects are likely to include altered migration patterns, accelerated embryo development, premature emergence of fry, variation in quality and quantity of tributary rearing habitat, and increased competition and predation risk from warm-water, non-native species (ISAB 2007).

The earth's oceans are also warming, with considerable interannual and inter-decadal variability superimposed on the longer-term trend (Bindoff *et al.* 2007). Historically, warm periods in the coastal Pacific Ocean have coincided with relatively low abundances of salmon and steelhead, while cooler ocean periods have coincided with relatively high abundances (Scheuerell and Williams 2005; Zabel *et al.* 2006; USGCRP 2009). Ocean conditions adverse to salmon and steelhead may be more likely under a warming climate (Zabel *et al.* 2006).

The status of species and critical habitat sections below are organized under one recovery domain (Table 2) to better integrate recovery planning information that NMFS is developing on the conservation status of the species and critical habitats considered in this consultation. Recovery domains are the geographically-based areas that NMFS is using to prepare multi-species recovery plans.

Table 2. Relevant recovery planning domain identified by NMFS and its ESA-listed salmon and steelhead species.

Recovery Domain	Species
Willamette-Lower Columbia (WLC)	LCR Chinook salmon UWR Chinook salmon CR chum salmon LCR coho salmon LCR steelhead UWR steelhead

For each recovery domain, a technical review team (TRT) appointed by NMFS has developed, or is developing, criteria necessary to identify independent populations within each species, recommended viability criteria for those species, and descriptions of factors that limit species survival. Viability criteria are prescriptions of the biological conditions for populations, biogeographic strata, and evolutionarily significant units (ESU) that, if met, would indicate that an ESU will have a negligible risk of extinction over a 100-year time frame.[2]

Although the TRTs operated from the common set of biological principals described in McElhany *et al.* (2000), they worked semi-independently from each other and developed criteria suitable to the species and conditions found in their specific recovery domains. All of the criteria have qualitative as well as quantitative aspects. The diversity of salmonid species and populations makes it impossible to set narrow quantitative guidelines that will fit all populations in all situations. For this and other reasons, viability criteria vary among species, mainly in the number and type of metrics and the scales at which the metrics apply (*i.e.*, population, major population group (MPG), or ESU) (Busch *et al.* 2008).

The abundance and productivity (A&P) score considers the TRT's estimate of a populations' minimum threshold population, natural spawning abundance and the productivity of the population. Productivity over the entire life cycle and factors that affect population growth rate provide information on how well a population is "performing" in the habitats it occupies during the life cycle. Estimates of population growth rate that indicate a population is consistently failing to replace itself are an indicator of increased extinction risk. The four metrics (abundance, productivity, spatial structure, and diversity) are not independent of one another and their relationship to sustainability depends on a variety of interdependent ecological processes (Wainwright *et al.* 2008).

Integrated spatial structure and diversity (SS/D) risk combines risk for likely, future environmental conditions, and diversity (McElhany *et al.* 2000; McElhany *et al.* 2007; Ford 2011). Diversity factors include:

- Life history traits: Distribution of major life history strategies within a population, variability of traits, mean value of traits, and loss of traits.
- Effective population size: One of the indirect measures of diversity is effective population size. A population at chronic low abundance or experiencing even a single episode of low abundance is at a higher extinction risk because of loss of genetic variability, inbreeding and the expression of inbreeding depression, or the effects of mutation accumulation.
- Impact of hatchery fish: Interbreeding of wild populations and hatchery origin fish are a significant risk factor to the diversity of wild populations if the proportion of hatchery fish in the spawning population is high and their genetic similarity to the wild population is low.
- Anthropogenic mortality: The susceptibility to mortality from harvest or habitat alterations will differ depending on size, age, run timing, disease resistance or other traits.

[2] For Pacific salmon, NMFS uses its 1991 ESU policy, which states that a population or group of populations will be considered a distinct population segment if it is an evolutionarily significant unit. An evolutionarily significant unit represents a distinct population segment of Pacific salmon under the Endangered Species Act that 1) is substantially reproductively isolated from conspecific populations and 2) represents an important component of the evolutionary legacy of the species. The species *O. mykiss* is under the joint jurisdiction of NMFS and the Fish and Wildlife Service, so in making its January, 2006 ESA listing determinations, NMFS elected to use the 1996 joint FWS-NMFS DPS policy for this species.

- Habitat diversity: Habitat characteristics have clear selective effects on populations, and changes in habitat characteristics are likely to eventually lead to genetic changes through selection for locally adapted traits. In assessing risk associated with altered habitat diversity, historical diversity is used as a reference point.

Overall viability risk scores (high to low) and population persistence scores are based on combined ratings for the A&P and SS/D [3] metrics (Table 3) (McElhany *et al.* 2006). Persistence probabilities, which are provided here for Lower Columbia River salmon and steelhead, are the complement of a population's extinction risk (*i.e.*, persistence probability = 1 – extinction risk) (NMFS 2013b). The IC-TRT has provided viability criteria that are based on McElhany (2000) and McElhany (2006), as well as the results of previous applications in other TRTs and a review of specific information available relative to listed IC ESU populations (IC-TRT 2007; Ford 2011).

Table 3. Population persistence categories from McElhany *et al.* (2006). A low or negligible risk of extinction is considered "viable" (Ford 2011). Population persistence categories correspond to: 4 = very low (VL), 3 = low (L), 2 = moderate (M), 1 = high (H), and 0 = very high (VH) in Oregon populations, which corresponds to "extirpated or nearly so" (E) in Washington populations (Ford 2011).

Population Persistence Category	Probability of population persistence in 100 years	Probability of population extinction in 100 years	Description
0	0-40%	60-100%	Either extinct or "high" risk of extinction
1	40-75%	25-60%	Relatively "high" risk of extinction in 100 years
2	75-95%	5-25%	"Moderate" risk of extinction in 100 years
3	95-99%	1-5%	"Low" (negligible) risk of extinction in 100 years
4	>99%	<1%	"Very low" risk of extinction in 100 years

The boundaries of each population were defined using a combination of genetic information, geography, life-history traits, morphological traits, and population dynamics that indicate the extent of reproductive isolation among spawning groups. The overall viability of a species is a function of the VSP attributes of its constituent populations. Until a viability analysis of a species is completed, the VSP guidelines recommend that all populations should be managed to retain the potential to achieve viable status to ensure a rapid start along the road to recovery, and that no significant parts of the species are lost before a full recovery plan is implemented (McElhany *et al.* 2000).

The size and distribution of the populations considered in this opinion generally have declined over the last few decades due to natural phenomena and human activity, including climate change (as described in Section 2.2), the operation of hydropower systems, over-harvest, effects

[3] The WLC-TRT provided ratings for diversity and spatial structure risks. The IC-TRT provided spatial structure and diversity ratings combined as an integrated SS/D risk.

of hatcheries, and habitat degradation. Enlarged populations of terns, seals, California sea lions, and other aquatic predators in the Pacific Northwest may be limiting the productivity of some Pacific salmon and steelhead populations (Ford 2011). Viability status or probability or population persistence is described below for each of the populations considered in this opinion.

Willamette-Lower Columbia Recovery Domain. Species in the Willamette-Lower Columbia (WLC) recovery domain include LCR Chinook salmon, UWR Chinook salmon, CR chum salmon, LCR coho salmon, LCR steelhead, UWR steelhead, southern DPS green sturgeon, and eulachon. CR chum salmon, southern DPS green sturgeon, and eulachon are not included in this opinion due to the location of the action area. The WLC-TRT has identified 107 demographically independent populations of Pacific salmon and steelhead (Table 4). These populations were further aggregated into strata, groupings above the population level that are connected by some degree of migration, based on ecological subregions. All 107 populations use parts of the mainstem of the Columbia River and the Columbia River estuary for migration, rearing, and smoltification.

Table 4. Populations of ESA-listed salmon and steelhead in the WLC recovery domain.

Species	Populations
LCR Chinook salmon	32
UWR Chinook salmon	7
CR chum salmon	17
LCR coho salmon	24
LCR steelhead	23
UWR steelhead	4

Status of LCR Chinook Salmon

Spatial Structure and Diversity. This species includes all naturally-spawned populations of Chinook salmon in 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; the Willamette River to Willamette Falls, Oregon, exclusive of spring-run Chinook salmon in the Clackamas River; and progeny of seventeen artificial propagation programs.[4] LCR Chinook populations exhibit three different life history types base on return timing and other features: fall-run (a.k.a. "tules"), late-fall-run (a.k.a. "brights"), and spring-run. The WLC-TRT identified 32 historical populations of LCR Chinook salmon— seven in the coastal subregion, six in the Columbia Gorge, and 19 in the Cascade Range (Table 5). Spatial structure has been substantially reduced in several populations. Low abundance, past broodstock transfers and other legacy hatchery effects, and ongoing hatchery straying may have reduced genetic diversity within and among LCR Chinook salmon populations. Hatchery-origin fish spawning naturally may also have reduced population productivity (Lower Columbia Fish Recovery Board 2010; ODFW 2010; NMFS 2013b). Out of the 32 populations that make up this ESU, only the two late-fall runs, the North Fork Lewis and Sandy, are considered viable. Most

[4] In 2009, the Elochoman tule fall Chinook salmon program was discontinued and four new fall Chinook salmon programs have been initiated. In 2011, NMFS recommended removing the Elochoman program from the ESU and adding the new programs to the ESU (NMFS 2011a).

populations (23 out of 32) have a very low probability of persistence over the next 100 years (and some are extirpated or nearly so) (Lower Columbia Fish Recovery Board 2010; ODFW 2010; Ford 2011; NMFS 2013b). Five of the six strata fall significantly short of the WLC-TRT criteria for viability; one stratum, Cascade late-fall, meets the WLC TRT criteria (NMFS 2013b)

Table 5. LCR Chinook salmon strata, ecological subregions, run timing, populations, and scores for the key elements (A&P, spatial structure, and diversity) used to determine overall net persistence probability of the population (NMFS 2013b). Persistence probability ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH).

Stratum		**Spawning Population (Watershed)**	**A&P**	**Spatial Structure**	**Diversity**	**Overall Persistence Probability**
Ecological Subregion	**Run Timing**					
Cascade Range	Spring	Upper Cowlitz River (WA)	VL	L	M	VL
		Cispus River (WA)	VL	L	M	VL
		Tilton River (WA)	VL	VL	VL	VL
		Toutle River (WA)	VL	H	L	VL
		Kalama River (WA)	VL	H	L	VL
		North Fork Lewis (WA)	VL	L	M	VL
		Sandy River (OR)	M	M	M	M
	Fall	Lower Cowlitz River (WA)	VL	H	M	VL
		Upper Cowlitz River (WA)	VL	VL	M	VL
		Toutle River (WA)	VL	H	M	VL
		Coweeman River (WA)	L	H	H	L
		Kalama River (WA)	VL	H	M	VL
		Lewis River (WA)	VL	H	H	VL
		Salmon Creek (WA)	VL	H	M	VL
		Clackamas River (OR)	VL	VH	L	VL
		Sandy River (OR)	VL	M	L	VL
		Washougal River (WA)	VL	H	M	VL
	Late Fall	North Fork Lewis (WA)	VH	H	H	VH
		Sandy River (OR)	VH	M	M	VH
Columbia Gorge	Spring	White Salmon River (WA)	VL	VL	VL	VL
		Hood River (OR)	VL	VH	VL	VL
	Fall	Lower Gorge (WA & OR)	VL	M	L	VL
		Upper Gorge (WA & OR)	VL	M	L	VL
		White Salmon River (WA)	VL	L	L	VL
		Hood River (OR)	VL	VH	L	VL
Coast Range	Fall	Young Bay (OR)	L	VH	L	L
		Grays/Chinook rivers (WA)	VL	H	VL	VL
		Big Creek (OR)	VL	H	L	VL
		Elochoman/Skamokawa creeks (WA)	VL	H	L	VL
		Clatskanie River (OR)	VL	VH	L	VL
		Mill, Germany, and Abernathy creeks (WA)	VL	H	L	VL
		Scappoose River (OR)	L	H	L	L

<u>Abundance and Productivity</u>. A&P ratings for LCR Chinook salmon populations are currently "low" to "very low" for most populations, except for spring Chinook salmon in the

Sandy River, which are "moderate" and late-fall Chinook salmon in North Fork Lewis River and Sandy River, which are "very high" (NMFS 2013b). Low abundance of natural-origin spawners (100 fish or fewer) has increased genetic and demographic risks. Other LCR Chinook salmon populations have higher total abundance, but several of these also have high proportions of hatchery-origin spawners. Particularly for tule fall Chinook salmon populations, poor data quality prevents precise quantification of population abundance and productivity; data quality has been poor because of inadequate spawning surveys and the presence of unmarked hatchery-origin spawners (Ford 2011). A recovery plan was finalized for this species in June 2013.

Limiting Factors include (NOAA Fisheries 2011; NMFS 2013b):

- Degraded estuarine and near-shore marine habitat resulting from cumulative impacts of land use and flow management by the Columbia River hydropower system
- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas, stream substrate, stream flow, and water quality have been degraded as a result of cumulative impacts of agriculture, forestry, and development.
- Reduced access to spawning and rearing habitat mainly as a result of tributary hydropower projects
- Hatchery-related effects
- Harvest-related effects on fall Chinook salmon
- An altered flow regime and Columbia River plume has altered the temperature regime and estuarine food web, and has reduced ocean productivity
- Reduced access to off-channel rearing habitat in the lower Columbia River
- Reduced productivity resulting from sediment and nutrient-related changes in the estuary
- Juvenile fish strandings that result from ship wakes
- Contaminants affecting fish health and reproduction

Status of UWR Chinook Salmon

Spatial Structure and Diversity. This species includes all naturally spawned populations of spring-run Chinook salmon in the Clackamas River; in the Willamette River and its tributaries above Willamette Falls, Oregon; and progeny of seven artificial propagation programs. All seven historical populations of UWR Chinook salmon identified by the WLC-TRT occur within the action area and are contained within a single ecological subregion, the western Cascade Range (Table 6). The McKenzie River population currently characterized as at a "low" risk of extinction and the Clackamas population has a "moderate" risk. (Ford 2011). Consideration of data collected since the last status review in 2005 has confirmed the high fraction of hatchery origin fish in all of the populations of this species (even the Clackamas and McKenzie rivers have hatchery fractions above WLC-TRT viability thresholds). All of the UWR Chinook salmon populations have "moderate" or "high" risk ratings for diversity. Clackamas River Chinook salmon have a "low" risk rating for spatial structure (Ford 2011).

Table 6. Scores for the key elements (A&P, diversity, and spatial structure) used to determine current overall viability risk for UWR Chinook salmon (ODFW and NMFS 2011). All populations are in the Western Cascade Range ecological subregion. Risk ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH).

Population (Watershed)	A&P	Diversity	Spatial Structure	Overall Extinction Risk
Clackamas River	M	M	L	M
Molalla River	VH	H	H	VH
North Santiam River	VH	H	H	VH
South Santiam River	VH	M	M	VH
Calapooia River	VH	H	VH	VH
McKenzie River	VL	M	M	L
Middle Fork Willamette River	VH	H	H	VH

Abundance and Productivity. The Clackamas and McKenzie river populations currently have the best risk ratings for A&P, spatial structure, and diversity. Data collected since the status update in 2005 (Good et al. 2005) highlighted the substantial risks associated with pre-spawning mortality. Although recovery plans are targeting key limiting factors for future actions, there have been no significant on-the-ground-actions since the last status review to resolve the lack of access to historical habitat above dams nor have there been substantial actions removing hatchery fish from the spawning grounds. Overall, the new information does not indicate a change in the biological risk category since the last status review (Ford 2011). A recovery plan was finalized for this species on August 5, 2011.

Limiting Factors include (NOAA Fisheries 2011; ODFW and NMFS 2011):

- Significantly reduced access to spawning and rearing habitat because of tributary dams
- Degraded freshwater habitat, especially floodplain connectivity and function, channel structure and complexity, and riparian areas and large wood recruitment as a result of cumulative impacts of agriculture, forestry, and development
- Degraded water quality and altered temperature as a result of both tributary dams and the cumulative impacts of agriculture, forestry, and urban development
- Hatchery-related effects
- Anthropogenic introductions of non-native species and out-of-ESU races of salmon or steelhead have increased predation on, and competition with, native UWR Chinook salmon
- Ocean harvest rates of approximately 30%

Status of LCR Coho Salmon

Spatial Structure and Diversity. This species 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; in the Willamette River to Willamette Falls, Oregon; and progeny of 25 artificial propagation programs.[5] Spatial diversity is rated "moderate" to "very high" for all the populations, except the North Fork Lewis River, which has a "low" rating for spatial structure.

Three status evaluations of LCR coho salmon status, all based on WLC-TRT criteria, have been conducted since the last NMFS status review in 2005 (McElhany *et al.* 2007; NMFS 2013b). Out of the 24 populations that make up this ESU (Table 7), 21 are considered to have a very low probability of persisting for the next 100 years, and none is considered viable (Lower Columbia Fish Recovery Board 2010; ODFW 2010; Ford 2011; NMFS 2013b).

Table 7. LCR coho salmon strata, ecological subregions, run timing, populations, and scores for the key elements (A&P, spatial structure, and diversity) used to determine current overall net persistence probability of the population (NMFS 2013b). Persistence probability ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH).

Ecological Subregions	Population (Watershed)	A&P	Spatial Structure	Diversity	Overall Persistence Probability
Coast Range	Young's Bay (OR)	VL	VH	VL	VL
	Grays/Chinook rivers (WA)	VL	H	VL	VL
	Big Creek (OR)	VL	H	L	VL
	Elochoman/Skamokawa creeks (WA)	VL	H	VL	VL
	Clatskanie River (OR)	L	VH	M	L
	Mill, Germany, and Abernathy creeks (WA)	VL	H	L	VL
	Scappoose River (OR)	M	H	M	M
Cascade Range	Lower Cowlitz River (WA)	VL	M	M	VL
	Upper Cowlitz River (WA)	VL	M	L	VL
	Cispus River (WA)	VL	M	L	VL
	Tilton River (WA)	VL	M	L	VL
	South Fork Toutle River (WA)	VL	H	M	VL
	North Fork Toutle River (WA)	VL	M	L	VL
	Coweeman River (WA)	VL	H	M	VL
	Kalama River (WA)	VL	H	L	VL
	North Fork Lewis River (WA)	VL	L	L	VL
	East Fork Lewis River (WA)	VL	H	M	VL
	Salmon Creek (WA)	VL	M	VL	VL
	Clackamas River (OR)	M	VH	H	M
	Sandy River (OR)	VL	H	M	VL
	Washougal River (WA)	VL	H	L	VL
Columbia Gorge	Lower Gorge Tributaries (WA & OR)	VL	M	VL	VL
	Upper Gorge/White Salmon (WA)	VL	M	VL	VL
	Upper Gorge Tributaries/Hood (OR)	VL	VH	L	VL

Abundance and Productivity. In Oregon, the Clatskanie Creek and Clackamas River populations have "low" and "moderate" persistence probability ratings for A&P, while the rest are rated "very low." All of the Washington populations have "very low" A&P ratings. The

[5] The Elochoman Hatchery Type-S and Type-N coho salmon programs were eliminated in 2008. The last adults from these two programs returned to the Elochoman in 2010. NMFS has recommended that these two programs be removed from the ESU (NMFS 2011a).

persistence probability for diversity is "high" in the Clackamas population, "moderate" in the Clatskanie, Scappoose, Lower Cowlitz, South Fork Toutle, Coweeman, East Fork Lewis, and Sandy populations, and "low" to "very low" in the rest (NMFS 2013b). Uncertainty is high because of a lack of adult spawner surveys. Smolt traps indicate some natural production in Washington populations, though given the high fraction of hatchery origin spawners suspected to occur in these populations it is not clear that any are self-sustaining. Overall, the new information considered does not indicate a change in the biological risk category since the last status review (Ford 2011; NMFS 2011a; NMFS 2013b). A recovery plan was finalized for this species in June 2013.

Limiting Factors include (NOAA Fisheries 2011; NMFS 2013b):

- Degraded estuarine and near-shore marine habitat resulting from cumulative impacts of land use and flow management by the Columbia River hydropower system
- Fish passage barriers that limit access to spawning and rearing habitats
- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas and large wood supply, stream substrate, stream flow, and water quality have been degraded as a result of cumulative impacts of agriculture, forestry, and development
- Hatchery-related effects
- Harvest-related effects
- An altered flow regime and Columbia River plume has altered the temperature regime and estuarine food web, and has reduced ocean productivity
- Reduced access to off-channel rearing habitat in the lower Columbia River
- Reduced productivity resulting from sediment and nutrient-related changes in the estuary
- Juvenile fish strandings that result from ship wakes
- Contaminants affecting fish health and reproduction

Status of LCR Steelhead

Spatial Structure and Diversity. Four strata and 23 historical populations of LCR steelhead occur within the DPS: 17 winter-run populations and six summer-run populations, within the Cascade and Gorge ecological subregions (Table 8).[6] The DPS also includes the progeny of ten artificial propagation programs.[7] Summer steelhead return to freshwater long before spawning. Winter steelhead, in contrast, return from the ocean much closer to maturity and spawn within a few weeks. Summer steelhead spawning areas in the Lower Columbia River are found above waterfalls and other features that create seasonal barriers to migration. Where no temporal barriers exist, the winter-run life history dominates.

[6] The White Salmon and Little White Salmon steelhead populations are part of the Middle Columbia steelhead DPS and are addressed in a separate species-level recovery plan, the Middle Columbia River Steelhead Distinct Population Segment ESA Recovery Plan (NMFS 2009).

[7] In 2007, the release of Cowlitz Hatchery winter steelhead into the Tilton River was discontinued; in 2009, the Hood River winter steelhead program was discontinued; and in 2010, the release of hatchery winter steelhead into the Upper Cowlitz and Cispus rivers was discontinued. In 2011, NMFS recommended removing these programs from the DPS. A Lewis River winter steelhead program was initiated in 2009, and in 2011, NMFS proposed that it be included in the DPS (NMFS 2011a).

Table 8. LCR steelhead strata, ecological subregions, run timing, populations, and scores for the key elements (A&P, spatial structure, and diversity) used to determine current overall net persistence probability of the population (NMFS 2013b). Persistence probability ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH).

Stratum: Ecological Subregion	Stratum: Run Timing	Population (Watershed)	A&P	Spatial Structure	Diversity	Overall Persistence Probability
Cascade Range	Summer	Kalama River (WA)	H	VH	M	M
		North Fork Lewis River (WA)	VL	VL	VL	VL
		East Fork Lewis River (WA)	VL	VH	M	VL
		Washougal River (WA)	M	VH	M	M
	Winter	Lower Cowlitz River (WA)	L	M	M	L
		Upper Cowlitz River (WA)	VL	M	M	VL
		Cispus River (WA)	VL	M	M	VL
		Tilton river (WA)	VL	M	M	VL
		South Fork Toutle River (WA)	M	VH	H	M
		North Fork Toutle River (WA)	VL	H	H	VL
		Coweeman River (WA)	L	VH	VH	L
		Kalama River (WA)	L	VH	H	L
		North Fork Lewis River (WA)	VL	M	M	VL
		East Fork Lewis River (WA)	M	VH	M	M
		Salmon Creek (WA)	VL	H	M	VL
		Clackamas River (OR)	M	VH	M	M
		Sandy River (OR)	L	M	M	L
		Washougal River (WA)	L	VH	M	L
Columbia Gorge	Summer	Wind River (WA)	VH	VH	H	H
		Hood River (OR)	VL	VH	L	VL
	Winter	Lower Gorge (WA & OR)	L	VH	M	L
		Upper Gorge (OR & WA)	L	M	M	L
		Hood River (OR)	M	VH	M	M

It is likely that genetic and life history diversity has been reduced as a result of pervasive hatchery effects and population bottlenecks. Spatial structure remains relatively high for most populations Out of the 23 populations, 16 are considered to have a "low" or "very low" probability of persisting over the next 100 years, and six populations have a "moderate" probability of persistence (Lower Columbia Fish Recovery Board 2010; ODFW 2010; Ford 2011; NMFS 2013b). All four strata in the DPS fall short of the WLC-TRT criteria for viability (NMFS 2013b).

Baseline persistence probabilities were estimated to be "low" or "very low" for three out of the six summer steelhead populations that are part of the LCR DPS, moderate for two, and high for one, the Wind, which is considered viable. Thirteen of the 17 LCR winter steelhead populations have "low" or "very low" baseline probabilities of persistence, and the remaining four are at "moderate" probability of persistence (Table 8) (Lower Columbia Fish Recovery Board 2010; ODFW 2010; NMFS 2013b).

Abundance and Productivity. The "low" to "very low" baseline persistence probabilities of most Lower Columbia River steelhead populations reflects low abundance and productivity (NMFS 2013b). All of the populations increased in abundance during the early 2000s, generally peaking in 2004. Most populations have since declined back to levels within one standard deviation of the long term mean. Exceptions are the Washougal summer-run and North Fork Toutle winter-run, which are still higher than the long term average, and the Sandy, which is lower. In general, the populations do not show any sustained dramatic changes in abundance or fraction of hatchery origin spawners since the 2005 status review (Ford 2011). Although current LCR steelhead populations are depressed compared to historical levels and long-term trends show declines, many populations are substantially healthier than their salmon counterparts, typically because of better habitat conditions in core steelhead production areas (Lower Columbia Fish Recovery Board 2010; NMFS 2013b). A recovery plan was finalized for this species in June 2013.

Limiting Factors include (NOAA Fisheries 2011; NMFS 2013b):

- Degraded estuarine and nearshore marine habitat resulting from cumulative impacts of land use and flow management by the Columbia River hydropower system
- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas and recruitment of large wood, stream substrate, stream flow, and water quality have been degraded as a result of cumulative impacts of agriculture, forestry, and development
- Reduced access to spawning and rearing habitat mainly as a result of tributary hydropower projects and lowland development
- Avian and marine mammal predation in the lower mainstem Columbia River and estuary
- Hatchery-related effects
- An altered flow regime and Columbia River plume has altered the temperature regime and estuarine food web, and has reduced ocean productivity
- Reduced access to off-channel rearing habitat in the lower Columbia River
- Reduced productivity resulting from sediment and nutrient-related changes in the estuary
- Juvenile fish strandings that result from ship wakes
- Contaminants affecting fish health and reproduction

Status of UWR Steelhead

Spatial Structure and Diversity. This species includes all naturally-spawned steelhead populations below natural and manmade impassable barriers in the Willamette River, Oregon, and its tributaries upstream from Willamette Falls to the Calapooia River. One stratum and four extant populations of UWR steelhead occur within the DPS (Table 9). Historical observations, hatchery records, and genetics suggest that the presence of UWR steelhead in many tributaries on the west side of the upper basin is the result of recent introductions. Nevertheless, the WLC-TRT recognized that although west side UWR steelhead does not represent a historical population, those tributaries may provide juvenile rearing habitat or may be temporarily (for one or more generations) colonized during periods of high abundance. Hatchery summer-run steelhead that are released in the subbasins are from an out-of-basin stock, not part of the DPS. Additionally, stocked summer steelhead that have become established in the McKenzie River were not considered in the identification of historical populations (ODFW and NMFS 2011).

Table 9. Scores for the key elements (A&P, diversity, and spatial structure) used to determine current overall viability risk for UWR steelhead (ODFW and NMFS 2011). All populations are in the Western Cascade Range ecological subregion. Risk ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH).

Population (Watershed)	A&P	Diversity	Spatial Structure	Overall Extinction Risk
Molalla River	VL	M	M	L
North Santiam River	VL	M	H	L
South Santiam River	VL	M	M	L
Calapooia River	M	M	VH	M

Abundance and Productivity. Since the last status review in 2005, UWR steelhead initially increased in abundance but subsequently declines and current abundance is at the levels observed in the mid-1990s when the DPS was first listed. The DPS appears to be at lower risk than the UWR Chinook salmon ESU, but continues to demonstrate the overall low abundance pattern that was of concern during the last status review. The elimination of winter-run hatchery release in the basin reduces hatchery threats, but non-native summer steelhead hatchery releases are still a concern for species diversity. Overall, the new information considered does not indicate a change in the biological risk category since the last status review (Ford 2011). A recovery plan was finalized for this species on August 5, 2011.

Limiting Factors include (NOAA Fisheries 2011; ODFW and NMFS 2011):

- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas and large wood recruitment, and stream flow have been degraded as a result of cumulative impacts of agriculture, forestry, and development
- Degraded water quality and altered temperature as a result of both tributary dams and the cumulative impacts of agriculture, forestry, and urban development
- Reduced access to spawning and rearing habitats mainly as a result of artificial barriers in spawning tributaries
- Hatchery-related effects: impacts from the non-native summer steelhead hatchery program
- Anthropogenic introductions of non-native species and out-of-ESU races of salmon or steelhead have increased predation and competition on native UWR steelhead.

2.2.2 Status of the Critical Habitats

This section examines the status of designated critical habitat affected by the proposed action by examining the condition and trends of essential physical and biological features throughout the designated areas. These features are essential to the conservation of the listed species because they support one or more of the species' life stages (*e.g.*, sites with conditions that support rearing, migration and foraging).

Salmon and Steelhead. For salmon and steelhead, NMFS ranked watersheds within designated critical habitat at the scale of the fifth-field hydrologic unit code (HUC_5) in terms of the conservation value they provide to each listed species they support.[8] The conservation rankings are high, medium, or low. To determine the conservation value of each watershed to species viability, NMFS' critical habitat analytical review teams (CHARTs) evaluated the quantity and quality of habitat features (for example, spawning gravels, wood and water condition, side channels), the relationship of the area compared to other areas within the species' range, and the significance to the species of the population occupying that area (NOAA Fisheries 2005). Thus, even a location that has poor quality of habitat could be ranked with a high conservation value if it were essential due to factors such as limited availability (*e.g.*, one of a very few spawning areas), a unique contribution of the population it served (*e.g.*, a population at the extreme end of geographic distribution), or the fact that it serves another important role (*e.g.*, obligate area for migration to upstream spawning areas).

The physical or biological features of freshwater migration corridors associated with spawning and incubation sites include water flow, quality and temperature conditions supporting larval and adult mobility, abundant prey items supporting larval feeding after yolk sac depletion, and free passage (no obstructions) for adults and juveniles (Table 10). These features are essential to conservation because they allow adult fish to swim upstream to reach spawning areas and they allow larval fish to proceed downstream and reach the ocean.

Table 10. PCEs of critical habitats designated for ESA-listed salmon and steelhead species considered in the opinion and corresponding species life history events.

Primary Constituent Elements		**Species Life History Event**
Site Type	**Site Attribute**	
Freshwater rearing	Floodplain connectivity Forage Natural cover Water quality Water quantity	Fry emergence from gravel Fry/parr/smolt growth and development
Freshwater migration	Free of artificial obstruction Natural cover Water quality Water quantity	Adult sexual maturation Adult upstream migration and holding Kelt (steelhead) seaward migration Fry/parr/smolt growth, development, and seaward migration

CHART Salmon and Steelhead Critical Habitat Assessments

The CHART for each recovery domain assessed biological information pertaining to areas under consideration for designation as critical habitat to identify the areas occupied by listed salmon and steelhead, determine whether those areas contained PCEs essential for the conservation of those species and whether unoccupied areas existed within the historical range of the listed salmon and steelhead that are also essential for conservation. The CHARTs assigned a 0 to 3 point score for the PCEs in each HUC5 watershed for:

[8] The conservation value of a site depends upon "(1) the importance of the populations associated with a site to the ESU [or DPS] conservation, and (2) the contribution of that site to the conservation of the population through demonstrated or potential productivity of the area" (NOAA Fisheries 2005).

Factor 1. Quantity,
Factor 2. Quality – Current Condition,
Factor 3. Quality – Potential Condition,
Factor 4. Support of Rarity Importance,
Factor 5. Support of Abundant Populations, and
Factor 6. Support of Spawning/Rearing.

Thus, the quality of habitat in a given watershed was characterized by the scores for Factor 2 (quality – current condition), which considers the existing condition of the quality of PCEs in the HUC_5 watershed; and Factor 3 (quality – potential condition), which considers the likelihood of achieving PCE potential in the HUC_5 watershed, either naturally or through active conservation/restoration, given known limiting factors, likely biophysical responses, and feasibility.

Willamette-Lower Columbia Recovery Domain. Critical habitat was designated in the WLC recovery domain for UWR Chinook salmon, LCR Chinook salmon, LCR steelhead, UWR steelhead, CR chum salmon, southern green sturgeon, and eulachon, and proposed for LCR coho salmon. Critical habitat for CR chum salmon, southern DPS green sturgeon and eulachon is not considered in this opinion due to the location of the action area outside of critical habitat for these species. In addition to the Willamette and Columbia River mainstems, important tributaries on the Oregon side of the WLC include Youngs Bay, Big Creek, Clatskanie River, and Scappoose River in the Oregon Coast subbasin; Hood River in the Gorge; and the Sandy, Clackamas, Molalla, North and South Santiam, Calapooia, McKenzie, and Middle Fork Willamette rivers in the West Cascades subbasin.

Land management activities have severely degraded stream habitat conditions in the Willamette River mainstem above Willamette Falls and associated subbasins. In the Willamette River mainstem and lower sub-basin mainstem reaches, high density urban development and widespread agricultural effects have reduced aquatic and riparian habitat quality and complexity, and altered sediment and water quality and quantity, and watershed processes. The Willamette River, once a highly braided river system, has been dramatically simplified through channelization, dredging, and other activities that have reduced rearing habitat by as much as 75%. In addition, the construction of 37 dams in the basin blocked access to more than 435 miles of stream and river spawning habitat. The dams alter the temperature regime of the Willamette River and its tributaries, affecting the timing and development of naturally-spawned eggs and fry. Logging in the Cascade and Coast Ranges, and agriculture, urbanization, and gravel mining on valley floors have contributed to increased erosion and sediment loads throughout the WLC domain.

The mainstem Willamette River has been channelized and stripped of large wood. Development began to encroach on the riparian forest beginning in the 1870s (Sedell and Froggatt 1984). Gregory (2002a) calculated that the total mainstem Willamette River channel area decreased from 41,000 to 23,000 acres between 1895 and 1995. They noted that the lower reach, from the mouth of the river to Newberg (RM 50), is confined within a basaltic trench, and that due to this geomorphic constraint, less channel area has been lost than in upstream areas. The middle reach from Newberg to Albany (RM 50 to 120) incurred losses of 12% primary channel area, 16% side channels, 33% alcoves, and 9% islands. Even greater changes occurred in the upper reach, from Albany to Eugene (RM 187). There, approximately 40% of both channel length and channel area were lost, along with 21% of the primary channel, 41% of side channels, 74% of alcoves, and 80% of island areas.

The banks of the Willamette River have more than 96 miles of revetments; approximately half were constructed by the ACOE. Generally, the revetments were placed in the vicinity of roads or on the outside bank of river bends, so that while only 26% of the total length is revetted, 65% of the meander bends are revetted (Gregory *et al.* 2002b). The majority of dynamic sections have been armored, reducing adjustments in channel bed and sediment storage by the river, and thereby diminishing both the complexity and productivity of aquatic habitats (Gregory *et al.* 2002b).

Riparian forests have diminished considerably in the lower reaches of the Willamette River (Gregory *et al.* 2002c). Sedell and Froggatt (1984) noted that agriculture and cutting of streamside trees were major agents of change for riparian vegetation, along with snagging of large wood in the channel. The reduced shoreline, fewer and smaller snags, and reduced riparian forest comprise large functional losses to the river, reducing structural features, organic inputs from litter fall, entrained allochthonous materials, and flood flow filtering capacity. Extensive changes began before the major dams were built, with navigational and agricultural demands dominating the early use of the river. The once expansive forests of the Willamette River floodplain provided valuable nutrients and organic matter during flood pulses, food sources for macroinvertebrates, and slow-water refugia for fish during flood events. These forests also cooled river temperatures as the river flowed through its many channels.

Gregory *et al.* (2002c) described the changes in riparian vegetation in river reaches from the mouth to Newberg, from Newberg to Albany, and from Albany to Eugene. They noted that the riparian forests were formerly a mosaic of brush, marsh, and ash tree openings maintained by annual flood inundation. Below the City of Newberg, the most noticeable change was that conifers were almost eliminated. Above Newberg, the formerly hardwood-dominated riparian forests along with mixed forest made up less than half of the riparian vegetation by 1990, while agriculture dominated. This conversion has reduced river shading and the potential for recruitment of wood to the river, reducing channel complexity and the quality of rearing, migration and spawning habitats.

Hyporheic flow in the Willamette River has been examined through discharge measurements and is significant in some areas, particularly those with gravel deposits (Wentz *et al.* 1998; Fernald *et al.* 2001). The loss of channel complexity and meandering that fosters creations of gravel deposits decreases the potential for hyporheic flows, as does gravel mining. Hyporheic flow processes water and affects its quality on reemerging into the main channel, stabilizing variations in physical and chemical water characteristics. Hyporheic flow is important for ecological functions, some aspects of water quality (such as temperature and dissolved oxygen), and some benthic invertebrate life stages. Alcove habitat, which has been limited by channelization, combines low hydraulic stress and high food availability with the potential for hyporheic flows across the steep hydraulic gradients in the gravel separating them from the main channel (Fernald *et al.* 2001).

On the mainstem of the Columbia River, hydropower projects, including the Federal Columbia River Hydropower System (FCRPS), have significantly degraded salmon and steelhead habitats (Bottom *et al.* 2005; Fresh *et al.* 2005; NMFS 2011b; NMFS 2013b). The series of dams and reservoirs that make up the FCRPS block an estimated 12 million cubic yards of debris and sediment that would otherwise naturally flow down the Columbia River and replenish shorelines along the Washington and Oregon coasts.

Industrial harbor and port development are also significant influences on the Lower Willamette and Lower Columbia rivers (Bottom *et al.* 2005; Fresh *et al.* 2005; NMFS 2011b; NMFS 2013b). Since 1878, 100 miles of river channel within the mainstem Columbia River, its estuary, and Oregon's Willamette River have been dredged as a navigation channel by the ACOE. Originally dredged to a 20-foot minimum depth, the Federal navigation channel of the Lower Columbia River is now maintained at a depth of 43 feet and a width of 600 feet. The Lower Columbia River supports five ports on the Washington State side: Kalama, Longview, Skamania County, Woodland, and Vancouver. In addition to loss of riparian habitat, and disruption of benthic habitat due to dredging, high levels of several sediment chemicals, such as arsenic and polycyclic aromatic hydrocarbons (PAHs), have been identified in Lower Columbia River watersheds in the vicinity of the ports and associated industrial facilities.

The most extensive urban development in the Lower Columbia River subbasin has occurred in the Portland/Vancouver area. Outside of this major urban area, the majority of residences and businesses rely on septic systems. Common water quality issues with urban development and residential septic systems include higher water temperatures, lowered dissolved oxygen, increased fecal coliform bacteria, and increased chemicals associated with pesticides and urban runoff.

The Columbia River estuary has lost a significant amount of the tidal marsh and tidal swamp habitats that are critical to juvenile salmon and steelhead, particularly small or ocean-type species (Bottom *et al.* 2005; Fresh *et al.* 2005; NMFS 2011b; NMFS 2013b). Edges of marsh areas provide sheltered habitats for juvenile salmon and steelhead where food, in the form of amphipods or other small invertebrates which feed on marsh detritus, is plentiful, and larger predatory fish can be avoided. Historically, floodwaters of the Columbia River inundated the margins and floodplains along the estuary, allowing juvenile salmon and steelhead access to a wide expanse of low-velocity marshland and tidal channel habitats. In general, the riverbanks were gently sloping, with riparian and wetland vegetation at the higher elevations of the river floodplain becoming habitat for salmon and steelhead during flooding river discharges or flood tides. Sherwood *et al.* (1990) estimated that the Columbia River estuary lost 20,000 acres of tidal swamps, 10,000 acres of tidal marshes, and 3,000 acres of tidal flats between 1870 and 1970. This study further estimated an 80% reduction in emergent vegetation production and a 15% decline in benthic algal production.

Habitat and food-web changes within the estuary, and other factors affecting salmon population structure and life histories, have altered the estuary's capacity to support juvenile salmon (Bottom *et al.* 2005; Fresh *et al.* 2005; NMFS 2011b; NMFS 2013b). Diking and filling activities have reduced the tidal prism and eliminate emergent and forested wetlands and floodplain habitats. These changes have likely reduced the estuary's salmon-rearing capacity. Moreover, water and sediment in the Lower Columbia River and its tributaries have toxic contaminants that are harmful to aquatic resources (Lower Columbia River Estuary Partnership 2007). Contaminants of concern include dioxins and furans, heavy metals, polychlorinated biphenyls (PCBs) and organochlorine pesticides such as DDT. Simplification of the population structure and life-history diversity of salmon possibly is yet another important factor affecting juvenile salmon viability. Restoration of estuarine habitats, particularly diked emergent and forested wetlands, reduction of avian predation by terns, and flow manipulations to restore historical flow patterns have likely begun to enhance the estuary's productive capacity for salmon, although historical changes in population structure and salmon life histories may prevent salmon from making full use of the productive capacity of estuarine habitats.

The WLC recovery domain CHART determined that most HUC_5 watersheds with PCEs for salmon or steelhead are in fair-to-poor or fair-to-good condition. However, most of these watersheds have some or a high potential for improvement. Only watersheds in the upper McKenzie River and its tributaries are in good to excellent condition with no potential for improvement (Table 11).

Table 11. **Willamette-Lower Columbia Recovery Domain:** Current and potential quality of HUC_5 watersheds identified as supporting historically independent populations of ESA-listed Chinook salmon (CK), chum salmon (CM), and steelhead (ST) (NOAA Fisheries 2005).[9] Watersheds are ranked primarily by "current quality" and secondly by their "potential for restoration."

Current PCE Condition	Potential PCE Condition
3 = good to excellent	3 = highly functioning, at historical potential
2 = fair to good	2 = high potential for improvement
1 = fair to poor	1 = some potential for improvement
0 = poor	0 = little or no potential for improvement

Watershed Name(s) and HUC_5 Code(s)	Listed Species	Current Quality	Restoration Potential
Columbia Gorge #1707010xxx			
Wind River (511)	CK/ST	2/2	2/2
East Fork Hood (506), & Upper (404) & Lower Cispus (405) rivers	CK/ST	2/2	2/2
Plympton Creek (306)	CK	2	2
Little White Salmon River (510)	CK	2	0
Grays Creek (512) & Eagle Creek (513)	CK/CM/ST	2/1/2	1/1/2
White Salmon River (509)	CK/CM	2/1	1/2
West Fork Hood River (507)	CK/ST	1/2	2/2
Hood River (508)	CK/ST	1/1	2/2
Unoccupied habitat: Wind River (511)	Chum conservation value "Possibly High"		
Cascade and Coast Range #1708000xxx			
Lower Gorge Tributaries (107)	CK/CM/ST	2/2/2	2/3/2
Lower Lewis (206) & North Fork Toutle (504) rivers	CK/CM/ST	1/3/1	2/1/2
Salmon (101), Zigzag (102), & Upper Sandy (103) rivers	CK/ST	2/2	2/2

[9] On January 14, 2013, NMFS published a proposed rule for the designation of critical habitat for LCR coho salmon and Puget Sound steelhead (USDC 2013). A draft biological report, which includes a CHART assessment for PS steelhead, was also completed (NMFS 2012). Habitat quality assessments for LCR coho salmon are out for review; therefore, they are not inclnded on this table.

Current PCE Condition	**Potential PCE Condition**
3 = good to excellent	3 = highly functioning, at historical potential
2 = fair to good	2 = high potential for improvement
1 = fair to poor	1 = some potential for improvement
0 = poor	0 = little or no potential for improvement

Watershed Name(s) and HUC$_5$ Code(s)	**Listed Species**	**Current Quality**	**Restoration Potential**
Big Creek (602)	CK/CM	2/2	2/2
Coweeman River (508)	CK/CM/ST	2/2/1	2/1/2
Kalama River (301)	CK/CM/ST	1/2/2	2/1/2
Cowlitz Headwaters (401)	CK/ST	2/2	1/1
Skamokawa/Elochoman (305)	CK/CM	2/1	2
Salmon Creek (109)	CK/CM/ST	1/2/1	2/3/2
Green (505) & South Fork Toutle (506) rivers	CK/CM/ST	1/1/2	2/1/2
Jackson Prairie (503) & East Willapa (507)	CK/CM/ST	1/2/1	1/1/2
Grays Bay (603)	CK/CM	1/2	2/3
Upper Middle Fork Willamette River (101)	CK	2	1
Germany/Abernathy creeks (304)	CK/CM	1/2	2
Mid-Sandy (104), Bull Run (105), & Lower Sandy (108) rivers	CK/ST	1/1	2/2
Washougal (106) & East Fork Lewis (205) rivers	CK/CM/ST	1/1/1	2/1/2
Upper Cowlitz (402) & Tilton rivers (501) & Cowlitz Valley Frontal (403)	CK/ST	1/1	2/1
Clatskanie (303) & Young rivers (601)	CK	1	2
Rifle Reservoir (502)	CK/ST	1	1
Beaver Creek (302)	CK	0	1
Unoccupied Habitat: Upper Lewis (201) & Muddy (202) rivers; Swift (203) & Yale (204) reservoirs	CK & ST Conservation Value "Possibly High"		
Willamette River #1709000xxx			
Upper (401) & South Fork (403) McKenzie rivers; Horse Creek (402); & McKenzie River/Quartz Creek (405)	CK	3	3
Lower McKenzie River (407)	CK	2	3
South Santiam River (606)	CK/ST	2/2	1/3
South Santiam River/Foster Reservoir (607)	CK/ST	2/2	1/2
North Fork of Middle Fork Willamette (106) & Blue (404) rivers	CK	2	1
Upper South Yamhill River (801)	ST	2	1
Little North Santiam River (505)	CK/ST	1/2	3/3
Upper Molalla River (905)	CK/ST	1/2	1/1
Abernethy Creek (704)	CK/ST	1/1	1/2
Luckiamute River (306) & Yamhill (807) Lower Molalla (906) rivers; Middle (504) & Lower (506) North Santiam rivers; Hamilton Creek/South Santiam River (601); Wiley Creek (608); Mill Creek/Willamette River (701); & Willamette River/Chehalem Creek (703); Lower South (804) & North (806) Yamhill rivers; & Salt Creek/South Yamhill River (805)	CK/ST	1	1
Hills (102) & Salmon (104) creeks; Salt Creek/Willamette River (103), Hills Creek Reservoir (105), Middle Fork Willamette/Lookont Point (107); Little Fall (108) & Fall (109) creeks; Lower Middle Fork of Willamette (110), Long Tom (301), Marys (305) & Mohawk (406) rivers	CK	1	1
Willamina Creek (802) & Mill Creek/South Yamhill River (803)	ST	1	1
Calapooia River (303); Oak (304) Crabtree (602), Thomas (603) & Rickreall (702) creeks; Abiqua (901), Butte (902) & Rock (903)	CK/ST	1/1	0/1

Current PCE Condition	Potential PCE Condition
3 = good to excellent	3 = highly functioning, at historical potential
2 = fair to good	2 = high potential for improvement
1 = fair to poor	1 = some potential for improvement
0 = poor	0 = little or no potential for improvement

Watershed Name(s) and HUC$_5$ Code(s)	Listed Species	Current Quality	Restoration Potential
creeks/Pudding River; & Senecal Creek/Mill Creek (904)			
Row River (201), Mosby (202) & Muddy (302) creeks, Upper (203) & Lower (205) Coast Fork Willamette River	CK	1	0
Unoccupied habitat in North Santiam (501) & North Fork Breitenbush (502) rivers; Quartzville Creek (604) and Middle Santiam River (605)	CK & ST Conservation Value "Possibly High"		
Unoccupied habitat in Detroit Reservoir/Blowout Divide Creek (503)	Conservation Value: CK "Possibly Medium"; ST Possibly High"		
Lower Willamette #1709001xxx			
Collawash (101), Upper Clackamas (102), & Oak Grove Fork (103) Clackamas rivers	CK/ST	2/2	3/2
Middle Clackamas River (104)	CK/ST	2/1	3/2
Eagle Creek (105)	CK/ST	2/2	1/2
Gales Creek (002)	ST	2	1
Lower Clackamas River (106) & Scappoose Creek (202)	CK/ST	1	2
Dairy (001) & Scoggins (003) creeks; Rock Creek/Tualatin River (004); & Tualatin River (005)	ST	1	1
Johnson Creek (201)	CK/ST	0/1	2/2
Lower Willamette/Columbia Slough (203)	CK/ST	0	2

2.3 Environmental Baseline

The "environmental baseline" includes the past and present impacts of all Federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR 402.02).

The climate change effects on the environmental baseline are described in Section 2.2 above.

Over the past several years, NMFS has engaged in various Section 7 consultations on Federal projects impacting these populations and their habitats, and those impacts have been taken into account in this opinion. These consultations include consultations on dredging and pier maintenance and repair in and around the action area, recently including Advanced American Construction's Facility Maintenance (NWR-2013-9954), the Vigor Industrial Maintenance Dredging (NWR-2013-10001), the Port of Portland Terminal-Wide Maintenance Dredging (NWR-2012-3169), the Shore Terminals LLC Piling Removal and Replacement (NWR-2012-03085), and the Kinder Morgan Bulk Terminals Off Loader Construction (NWR-2011-03868). These projects had a temporary negative effect on local baseline conditions, but no significant long-term effects.

Lower Willamette River

Habitat conditions within the Lower Willamette River are highly degraded. The streambanks have been channelized, off-channel areas removed, tributaries put into pipes, and the river disconnected from its floodplain as the lower valley was urbanized. Silt loading to the lower Willamette River has increased over historical levels due to logging, agriculture, road building, and urban and suburban development within the watershed. Limited opportunity exists for large wood recruitment to the lower Willamette River due to the paucity of mature trees along the shoreline, and the lack of relief along the shoreline to catch and hold the material. The lower Willamette River has been deepened and narrowed through channelization, diking and filling, and much of the shallow-water habitat (important for rearing juvenile salmonids) has been converted to deep water habitat; 79% of the shallow water through the lower river has been lost through historic channel deepening (Northwest Power and Conservation Council 2004). Most recently, the Federal Navigation Channel at Post Office Bar was dredged in October 2011. In addition, much of the historical off-channel habitat (also important habitat for juvenile salmonids) has been lost due to diking and filling of connected channels and wetlands. Gravel continues to be extracted from the river and floodplain and much of the sediment trying to move downstream in the Willamette River is blocked by dams. All of these river changes contribute to the factors limiting recovery of ESA-listed salmonids using the action area.

The Lower Willamette River through the City of Portland is highly developed for industrial, commercial and residential purposes. Much of the river is fringed by seawalls or riprapped embankments. Water quality in the action area reach of the Willamette River reflects its urban location and disturbance history. The Lower Willamette River is currently listed on the Oregon Department of Environmental Quality (DEQ) Clean Water Act 303(d) List of Water Quality Limited Water Bodies. DEQ listed water quality problems identified in the action area include toxics, biological criteria (fish skeletal deformities), bacteria (fecal coliform) and temperature. Cleanup of contaminated sediments in Portland Harbor is presently being addressed under the Federal Superfund process.

Juvenile and adult Chinook salmon, coho salmon, and steelhead use this area as a migratory corridor and as rearing habitat for juveniles (Friesen 2005). The results of the Friesen study demonstrate that juvenile salmon and steelhead are present in the Lower Willamette River nearly year-round. Of the more than 5,000 juvenile salmonids collected during the study, over 87% were Chinook salmon, 9% were coho salmon, and 3% were steelhead. Friesen concluded that the Chinook salmon juveniles were largely spring-run stocks that rear in fresh water for a year or more before migrating to the ocean. Chinook salmon juveniles caught exhibited a bimodal distribution in length, indicating the presence of both subyearlings and yearlings. Although at lower abundance, coho salmon juveniles also exhibited this bimodal distribution of yearlings and subyearlings. The abundance of all juvenile salmon and steelhead increased beginning in November, peaked in April, and declined to near zero by July. Some of the larger juveniles may spend extended periods of time in off-channel habitat. Mean migration rates of juvenile salmon and steelhead ranged from 1.68 miles/day for steelhead to 5.34 miles/day for sub-yearling Chinook salmon. Residence time in the Lower Willamette River ranged from 4.9 days for Chinook to 15.8 days for steelhead. Catch rates of juvenile salmon were significantly higher at sites composed of natural habitat (*e.g.*, beaches and alcoves).

Steelhead are not known to spawn in the mainstem of the Willamette River in the vicinity of the action area. Chinook salmon may spawn upstream from the action area in the lower end of the Clackamas River or in the Willamette River just below Willamette Falls, where suitable gravel-type substrate for spawning may occur, and in Johnson Creek. Recent observations of coho salmon juveniles in Miller Creek (tributary at RM 3 on the Willamette River) and in Johnson Creek by City of Portland biologists suggest that coho spawning may occur in small tributaries in the Lower Willamette River.

Adult Chinook salmon and steelhead have been documented holding in the lower Willamette River for a period of time before moving upriver. Adults migrate upstream to spawn during early spring (spring Chinook salmon), early fall (coho salmon), and late fall through winter (steelhead), and spawn in early to mid-fall (Chinook and coho salmon) and spring (steelhead). Adult steelhead have been documented entering the mouth of the Clackamas River with a darkened coloration, indicating that they have been in freshwater for some time.

The 2005 Friesen study's key finding is that the Lower Willamette River is no longer appropriately considered simply a migration corridor. The presence of naturally-spawned Chinook salmon from November through July, as well as significant evidence of fish growth, contradicts a longstanding assumption that spring Chinook salmon primarily reared in their natal streams over the winter and migrated out of the Willamette River during the spring. In this study, juvenile Chinook salmon were present in the Lower Willamette River in every month sampled from May, 2000 through July, 2003. Juvenile salmon were captured more frequently during winter and spring than during other seasons. Coho salmon and steelhead were generally present only during winter and spring. Therefore, juvenile Chinook salmon will be present in the river during the proposed action, and there will likely be a few LCR coho salmon and steelhead juveniles present as well. The degraded habitat conditions in the action area likely reduce survival for salmonids rearing and migrating through this reach of the Willamette River.

Tryon Creek

Tryon Creek is a 5-mile long, perennial tributary to the Willamette River, with headwaters in the West Hills of Portland (west of Interstate 5).The historic hydrology of Tryon Creek is typical of a low to moderate gradient headwater streams, with steep landscape slopes that have been modified by the effects of development and urbanization.

No contaminated sediments were identified in or near Tryon Creek during a database search. The headwaters of the creek are highly developed, and stormwater may bring pollutants associated with urban runoff. Culverts on Tryon Creek at Boones Ferry Road, Highway 43, and on Arnold Creek at Arnold Creek Road partially or completely block fish passage into the upper reaches of these streams. Relatively extensive wildlife habitat is found between Highway 43 and Boones Ferry Road. Much of this area is undeveloped and part of the Tryon Creek State Natural Area. Above Boones Ferry Road, the watershed is more highly developed and wildlife habitat quality is lower.

Columbia Slough

Hydrology within the Columbia Slough watershed has also changed from historic conditions. Levee construction and reinforcement; 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 2005). The result has been disconnection of the slough from its floodplain and only seasonal connection to the Columbia River. These activities have left Columbia Slough with complex and highly managed hydrologic features that affect flows directly above the confluence of the Lower Willamette River with the Columbia River.

Several obstructions to fish access in the subbasin also affect native fish. Access to the middle and upper Columbia Slough is prevented by the Multnomah County Drainage District dike and pumping system. Columbia Slough at the location of the project sites is fully accessible to fish moving upstream from the confluence of the slough with the Willamette River.

In summary, habitat within the action area has been degraded by a number of factors. This degradation generally reduces survival of juvenile and adult salmonids migrating through the action area. The reduction in survival negatively impacts population abundance and productivity. However, critical habitat in the action area, although degraded, provides a critical migration corridor and important rearing habitat. Therefore, this habitat has high conservation value.

2.4 Effects of the Action on Species and Designated Critical Habitat

"Effects of the action" means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur.

The proposed action will affect the salmonid species considered in this opinion by causing physical, chemical, and biological changes to the environment, and through direct effects to individual fish. These effects include a temporary reduction in water quality from increased suspended sediment during construction, a temporary loss of riparian vegetation, and harassment/displacement from fish salvage or disturbance caused by other construction activities. There is also a small chance of an accidental contaminant release from construction equipment or activities, however any release would likely be small and quickly contained due to the implementation of a pollution control plan. Beneficial effects will be long term and include all effects associated with habitat restoration.

The projects considered in this opinion are intended to have long-term beneficial effects on listed species and their critical habitats and help contribute towards recovery. However, there are also likely to be temporary adverse effects associated with the construction of the projects. These adverse effects will be minimized because the projects will be deferred until the time of year when the fewest fish are present.

The types of effects associated with construction of the various habitat features are described generally in the following paragraph, and more specifically for each type of restoration action in the following section.

Construction will have direct physical effects on the environment including vegetation clearing, development of access roads, construction staging areas, and materials storage areas; water diversion and pumping, excavation, fill, and grading; followed by site restoration such as placement of wood, revegetation, placement of topsoil and other substrates, and other actions to restore habitats and ecosystem processes. These construction activities can disrupt or reduce the natural vegetative and fluvial processes at a project site, such as the recruitment of large wood, riparian shading, sediment and nutrient deposition, and groundwater recharge (NMFS 2013a). During wet weather, cleared areas can erode and suspend sediments in runoff and also potentially increase the volume and frequency of runoff. This can elevate turbidity in receiving waterbodies and adversely affect habitat as well as increasing volumes into streams during runoff events. In-water work can also resuspend sediments or generate turbidity that can be transported downstream. Heavy equipment can compact soils, reduce suitability for plant growth and reduce infiltration. The use of heavy equipment also creates a risk of spills of fuels, lubricants and other contaminants.

However, these effects are likely to be short-term at any one site (few months). Turbidity from in-water excavation and installation of large wood is likely to abate very quickly (few hours). Other effects may persist for longer until riparian and floodplain vegetation is fully reestablished.

Large Wood and Boulder Placement

Installation of LW and boulders will require disruption of the riparian area and excavation of stream beds and banks to allow these materials to be keyed into the substrate, or for installation of anchoring materials.

Beneficial effects from installing LW and boulders will include increased stream habitat complexity, reestablished natural hydraulic processes, increased overhead cover, increased prey and food-web dynamics, and sediment retention. Large wood and boulders in a stream will trap gravel above the structure, creating pools, increasing the connection with the floodplain vegetation. As a result of these benefits, an increase in habitat functions is expected. Adverse effects of this action may include minor damage to riparian soil and vegetation and minor disturbance of streambanks and channel substrate. Harassment or mortality of listed species through contact with in-water construction equipment or materials may occur. Temporary effects to suitable habitat and water quality are likely to occur from in-water work, resulting in increased turbidity and suspended sediments and sediment deposition. Effects to species from these actions may include the temporary displacement of individual fish.

To the degree possible, installation of LW will occur in the dry, and installation of boulders and LW in the active channel will occur during the in-water work window. Additionally, fill placement will occur when creating small habitat islands in Kenton Cove. The island creation would be isolated by silt curtains or coffer dams, and fish will be removed from the area prior to construction.

If fish are present in the work area, flowing water will be isolated and fish captured and relocated to an appropriate location in an effort to minimize possible mortality. Juveniles will likely experience increased levels of stress and injury during handling, which could be exacerbated by poor water quality (increased temperatures, low dissolved oxygen saturation), prolonged periods of holding between capture and release, and any debris that may accumulate in the traps. The appropriate conservation measures and handling techniques will be employed to ensure that the stress resulting from handling and transport is short-lived and minor.

Invasive Species Removal and Riparian Revegetation

Riparian restoration would consist primarily of mechanical removal of invasive species and revegetating with native species by hand and with light machinery. The intent of this action is to restore native riparian functions.

Beneficial effects of this action would be the reestablishment of native riparian forests and plant communities which will increase overhead cover, and provide a long-term source of instream wood, reduce fine sediment supply, increase shade, nutrient input, and moderate microclimate effects.

This work will occur above the ordinary high water mark and in the dry, so adverse effects to listed anadromous species would be limited to temporary increases in input of fine sediment from soils disturbed during removal and planting. Tiny amounts of herbicides will be applied in upland areas well above ordinary high water by spraying individual plants. No herbicides or herbicide residues are expected to reach the water. All effects associated with invasive species removal and riparian revegetation are expected to be very limited and temporary.

In-Stream and Channel Modifications

The intent of this action is to reduce artificially increased channel height and steepness. Increased streambank heights may result in increased bank erosion, disconnection from the floodplain, and may be responsible for a significant portion of sediment loads in streams. Beneficial effects include improving aquatic and riparian habitat diversity and complexity, reconnecting stream channels to floodplains, reducing bed and bank erosion, increasing hyporheic exchange, and moderating flow disturbance. Grading banks to gentler slopes is proposed to allow for restored hydrologic connections and create shallow water habitat, reduce erosion, stabilize banks and to allow riparian and aquatic habitats to form more naturally.

Although most of this work would occur in the dry, potential direct construction effects include harassment or direct mortality through contact with construction equipment during in-water work, stress related to fish displacement, handling, or removal, increased suspended sediment and deposition, blocked migration, disrupted or disturbed behavior, and temporary displacement from bank areas that may be dewatered during construction. Potential adverse effects also include temporary loss of riparian vegetation and temporary loss or imbalance of nutrients and food supply.

In-water work associated with channel modifications will occur during the in-water work window, when fish are least likely to be present. Given the low potential for listed salmonids to access the construction areas at this time, and because fish will have ample room to avoid the construction areas and any associated turbidity plume, these effects are considered minor.

During construction, biologists will be on-site to observe if any fish are present. If fish are present in the work area, flowing water will be isolated and fish captured and relocated to an appropriate location in an effort to minimize possible mortality. Juveniles would likely experience increased levels of stress and injury during handling, which could be exacerbated by poor water quality (increased temperatures, low dissolved oxygen saturation), prolonged periods of holding between capture and release, and any debris that may accumulate in the traps. The appropriate conservation measures and handling techniques will be employed to ensure that the stress resulting from handling and transport is short-lived and minor.

Off-Channel Habitat and Floodplain Reconnection

Creating off-channel habitat and floodplain reconnections will increase habitat diversity, provide rearing habitat for juvenile salmonids, and refuge habitat for fish during high flows. Off-channel habitat creation and floodplain reconnection will involve excavation of fill to create side channels and backwater habitat, and installation of woody debris and boulders to enhance habitat.

The main beneficial effects of this action will be to provide high water refuge and winter and summer rearing habitat for fish. Additional benefits include increased habitat complexity, long-term nutrient storage and food web production, and increased sediment storage.

This work will occur in the dry, with the exception of final excavation which will occur to allow the river to access the excavated channels and backwater areas. However, the amount of excavation and earthwork required could be substantial. Adverse effects of the action include a loss of riparian vegetation and temporary loss or imbalance of nutrients and food supply, and harassment or mortality through contact with in-water construction equipment or materials. Temporary effects to suitable habitat and water quality are likely to result from in-water work, resulting in increased turbidity and suspended sediments and sediment deposition. Effects to species from these actions may include the temporary displacement of individual fish.

During the final phase of construction when side channels are connected to the main channel, a fish biologist will be present to identify if fish are present in the work area. If fish are observed, flowing water will be isolated and fish captured and relocated to an appropriate location in an effort to minimize possible mortality. Juveniles will likely experience increased levels of stress and injury during handling, which could be exacerbated by poor water quality (increased temperatures, low dissolved oxygen saturation), prolonged periods of holding between capture and release, and any debris that may accumulate in the traps. The appropriate conservation measures and handling techniques will be employed to ensure that the stress resulting from handling and transport is short-lived and minor.

Fish Barrier Removal

Replacing the culvert at the Tryon Creek Highway 43 site will include removal of overburden above the culvert; excavation of the culvert; replacement with a new culvert; replacement of the overburden; recontouring of affected stretches of streambed and bank; and revegetation of affected riparian areas. The intent of this action is to restore and improve juvenile and adult fish passage where it has been partially or completely eliminated by past actions.

The main beneficial effect to listed salmonid species from culvert replacement expected over the long-term is increased access to historic spawning grounds in Tryon Creek, restoring the spatial and temporal connectivity of the creek, and permitting fish to access upstream areas essential for spawning and rearing. Enhanced access to almost three miles of tributary habitat will significantly increase the amount of such habitat in the Lower Willamette River watershed. In addition, the natural bedload movements will be restored in the lower portion of Tryon Creek. Potential adverse effects resulting from construction actions include harassment or mortality through contact with in-water construction equipment or materials. Temporary effects to water quality are likely to result from in-water work, resulting in increased turbidity and suspended sediments and sediment deposition. Effects to species from these actions may include the temporary displacement of individual fish. If the streambed is dewatered during construction, fish passage will be temporarily restricted.

In-stream work associated with culvert replacement will occur in the late summer during the in-water work window, which coincides with low flow and highest water temperatures in Tryon Creek. Given the low potential for listed salmonids to access the construction area at this time, and because the construction area is located in close proximity to the Willamette River, it is considered unlikely that construction would force listed salmonids into unsuitable habitats or cause migration delays.

If fish are present in the work area, flowing water will be isolated and fish captured and relocated to an appropriate location in an effort to minimize possible mortality. Juveniles would likely experience increased levels of stress and injury during handling, which could be exacerbated by poor water quality (increased temperatures, low dissolved oxygen saturation), prolonged periods of holding between capture and release, and any debris that may accumulate in the traps. The appropriate conservation measures and handling techniques will be employed to ensure that the stress resulting from handling and transport is short-lived and minor.

Below is a more in-depth discussion of the primary adverse effects on listed species expected to occur during construction of the proposed projects:

Most direct, lethal effects of authorizing and carrying out the proposed projects are likely to be caused by the isolation of in-water work areas, even though lethal and sublethal effects would be greater without isolation. Any individual fish present in the work isolation area will be captured and released. While adults are unlikely to be present, most salmon in the vicinity are of a size that allows them to easily escape during isolation of the proposed project areas. Capturing and handling fish causes them stress, though they typically recover fairly rapidly from the process and therefore the overall effects of the procedure are generally short-lived (NMFS 2002). Fish that are transferred to holding tanks can experience trauma if care is not taken in the transfer process, and fish can experience stress and injury from overcrowding in traps, if the traps are not emptied on a regular basis. Stress and death from handling occur because of differences in water temperature and dissolved oxygen between the river and transfer buckets, as well as physical trauma and the amount of time that fish are held out of the water. Stress on salmon increases rapidly from handling if the water temperature exceeds 64°F, or if dissolved oxygen is below saturation. Debris buildup and predation within minnow traps can also kill or injure listed fish if they are not monitored and cleared on a regular basis. Best management practices related to the capture and release of fish during work area isolation will avoid most of these consequences, and ensure that most of the resulting stress is short-lived (NMFS 2002).

Except for fish that are captured during work area isolation, individual fish whose condition or behavior is impaired by the effects of a project authorized or completed under this opinion are likely to suffer primarily from ephemeral or short-term sublethal effects during construction, including diminished rearing and migration as described below.

Any construction impacts to stream margins are likely to be most important to fish because those areas often provide shallow, low-flow conditions, may have a slow mixing rate with mainstem waters, and may also be the site at which subsurface runoff is introduced. Juvenile salmon and steelhead, particularly recently emerged fry, often use low-flow areas along stream margins. Chinook salmon rear near stream margins until they reach about 60 mm in length (Bottom *et al.* 2005; Fresh *et al.* 2005). As juveniles grow, they migrate away from stream margins and occupy habitats with progressively higher flow velocities. Nonetheless, stream margins continue to be used by larger salmon and steelhead for a variety of reasons, including nocturnal resting, summer and winter thermal refuge, predator avoidance, and flow refuge.

Salmon are generally able to avoid adverse conditions if those conditions are limited to areas that are small or local compared to the total habitat area, and if the aquatic system can recover before the next disturbance. This means juvenile and adult salmon will, to the maximum extent possible, readily move out of a construction area to obtain a more favorable position within their range of tolerance along a complex gradient of temperature, turbidity, flow, noise, contaminants, and other environmental features. The degree and effectiveness of the avoidance response varies with life stage, season and the frequency and duration of exposure to the unfavorable condition, and the ability of the individual to balance other behavioral needs for feeding, growth, migration, and territory.

Excavation of channels at the project sites will cause elevated turbidity in the action area. Exposure duration is a critical determinant of the occurrence and magnitude of turbidity-caused physical or behavioral effects (Newcombe and Jensen 1996). Salmonids have evolved in systems that periodically experience short-term pulses (days to weeks) of high suspended sediment loads, often associated with flood events, and are adapted to such high pulse exposures. Behavioral avoidance of turbid waters may be one of the most important effects of suspended sediments; salmonids have been observed moving laterally and downstream to avoid turbid plumes (Sigler 1988, Lloyd 1987, Servizi and Martens 1991). At moderate levels, turbidity has the potential to adversely affect primary and secondary productivity, and at high levels, has the potential to injure and kill adult and juvenile fish (Newcombe and Jensen 1996). Turbidity might also interfere with feeding (Spence *et al.* 1996). Other behavioral effects on fish, such as gill flaring and feeding changes, have been observed in response to pulses of suspended sediment (Berg and Northcote 1985). Localized increases of turbidity during in-water work will likely displace fish in the project area and disrupt normal behavior. There is a low probability of direct mortality from turbidity associated with proposed activities because the turbidity should be infrequent, localized, and take place when adult fish are least likely to be present. The most likely effects from turbidity will be behavioral, as juveniles move away from the suspended sediments, potentially leading to greater exposure to predators.

Invasive and non-native plant control actions, including manual, mechanical, and herbicidal treatment, are commonly employed as part of streambank restoration projects. Manual and mechanical treatments are likely to produce at least minor damage to riparian soil and vegetation over a defined area. In some cases, this will decrease stream shade, increase suspended sediment and temperature in the water column, reduce organic inputs (*e.g.*, insects, leaves, woody material), and alter streambanks and the composition of stream substrates. However, these changes are only likely to occur with invasive plant treatments of monocultures on small stream channels. The effects would vary depending on site aspect, elevation, and amount of topographic shading, but are likely to decrease over time as shade from native vegetation is reestablished. For these proposed projects, only very limited spot applications of herbicides will occur well away from stream channels, so contamination of aquatic areas is not likely to occur.

The effects on the environment of reconnecting stream channels with historical river floodplain swales, abandoned side channels, and floodplain channels are likely to include relatively intense construction effects, as discussed above. Off- and side-channel habitat restoration to reconnect stream channels with historical river floodplain swales, abandoned side channels, and floodplain channels, and setting back existing berms, dikes and levees, are likely to have similar but significantly greater positive indirect effects on habitat diversity and complexity by affecting a larger habitat area (Cramer 2012). These effects include greater channel complexity and/or increased shoreline length; increased floodplain functionality; reduction of chronic bank erosion and channel instability due to sediment deposition; and increased width of riparian corridors. Increased riparian functions are likely to include increased shade and hence moderated water temperatures and microclimate; increased abundance and retention of wood; increased organic material supply; water quality improvement; filtering of sediment and nutrient inputs; more efficient nutrient cycling; and restoration of flood-flow refuge for ESA-listed fish (Cramer 2012).

The effects of stream bank restoration are likely to include the construction effects discussed above, and reestablishment of native riparian forests or other appropriate native riparian plant communities, which will provide increased cover (large wood, boulders, vegetation, and bank protection structures) and a long-term source of all sizes of instream wood, reduce fine sediment supply, increase shade, moderate microclimate effects, and provide more normative channel migration over time.

Summary of Effects on Listed Species. The applicant proposes to complete all in-water work during the relevant in-water work window. The overall number of listed salmonids in the project areas is lowest during these times. Therefore, the potential for direct interaction between construction equipment/impacts and salmon and steelhead will be significantly lower during the in-water work windows than during the rest of the year because salmon presence is low.

However, NMFS does expect some fish to be present during construction. Most of the fish present will incur short-term stress due to salvage and reduced water quality during construction. Any non-lethal stress experienced by individual fish is likely to be brief (minutes to days). A few fish may be injured or killed by salvage or by the culmination of joint causes, such as a previous wound inflicted by the environmental baseline and genetic weakness.

Considering the low abundance and short residence time of juvenile ESA-listed salmonids in the action area during the in-water work window, any effects to the growth, survival, and distribution of ESA-listed salmonids in the action area will be small and isolated. These effects are unlikely to be significant at either the local or population scale. The proposed action will improve the long-term abundance trends of the populations addressed by this opinion.

Critical Habitat within the Action Area. Designated critical habitat within the action area for ESA-listed salmon and steelhead considered in this opinion consists of freshwater rearing sites and freshwater migration corridors and their essential physical and biological features (PCEs) as listed below. The effects of the proposed action on these features are summarized as a subset of the habitat-related effects of the action that were discussed more fully above. The adverse water quality, forage, cover and passage effects described will be short-term (*i.e.*, months) during and immediately following project construction. All beneficial effects will be long-term.

Freshwater rearing

Floodplain connectivity – This will improve due to construction of several of the projects proposed, especially those involving off- and side-channel habitat restoration.

Forage – Decreased quantity and quality of forage due to disturbance during construction. Forage will improve over the long-term due to improved habitat diversity and complexity, and improved riparian function and floodplain connectivity.

Natural cover – Natural cover will have short-term decrease due to riparian and channel disturbance, and a long-term increase due to improved habitat diversity and complexity, improved riparian function and floodplain connectivity, and off- and side channel habitat restoration.

Water quality – Increased suspended sediment during and for a short period following project construction. Water quality will increase over the long-term due to better floodplain and riparian function.

Water quantity – No effect.

Freshwater migration

Free of artificial obstruction – Possible delayed juvenile migration during construction due to work area isolation and suspended sediment. The replacement of the culvert in Tryon Creek will remove an artificial obstruction and allow passage to upstream areas. Passage will also be improved over the long-term due to improved water quality, habitat diversity and complexity, forage, and natural cover

Natural cover – Natural cover will have short-term decrease due to riparian and channel disturbance, and a long-term increase due to improved habitat diversity and complexity, improved riparian function and floodplain connectivity, and off- and side channel habitat restoration.

Water quality – Increased suspended sediment during and for a short period following project construction. Water quality will increase over the long-term due to better floodplain and riparian function.

Water quantity – No effect.

The proposed action is likely to cause minor, localized and temporary degradation of critical habitat PCEs for water quality, natural cover, forage, and free passage. None of the effects are likely to reduce the quality and function of the PCEs within the action area over the long term. Instead, the quality and function of PCEs within the action area will be significantly improved over the long term due to construction of the proposed restoration projects. The critical habitat in the action area will retain its ability to provide rearing sites and freshwater migration corridors for the species considered in this opinion.

2.5 Cumulative Effects

"Cumulative effects" are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

For this action, state or private activities in the vicinity of the project locations are expected to cause cumulative effects in the action area. Additionally, future state and private activities in upstream areas are expected to cause habitat and water quality changes that are expressed as cumulative effects in the action area. Our analysis considers: (1) How future activities in the Willamette basin are likely to influence habitat conditions in the action area, and (2) cumulative effects caused by specific future activities in the vicinity of the project locations.

The action area has a high population density since it is located in the Portland metropolitan area. The past effect of that population is expressed as changes to physical habitat and loadings of pollutants contributed to the Willamette River. These changes were caused by residential, commercial, industrial, agricultural, and other land uses for economic development, and are described in the Environmental Baseline (Section 2.3). The collective effects of these activities tend to be expressed most strongly in lower river systems where the impacts of numerous upstream land management actions aggregate to influence natural habitat processes and water quality.

Resource-based industries (*e.g.*, agriculture, hydropower facilities, timber harvest, fishing, and metals and gravel mining) caused many long-lasting environmental changes that harmed ESA-listed species and their critical habitats, such as basin-wide loss or degradation of stream channel morphology, spawning substrates, instream roughness and cover, estuarine rearing habitats, wetlands, floodplains, riparian areas, water quality (*e.g.*, temperature, sediment, dissolved oxygen, contaminants), fish passage, and habitat refugia. Those changes reduced the ability of populations of ESA-listed species to sustain themselves in the natural environment by altering or interfering with their behavior in ways that reduce their survival throughout their life cycle. The environmental changes also reduced the quality and function of critical habitat PCEs that are necessary for successful spawning, production of offspring, and migratory access necessary for adult fish to swim upstream to reach spawning areas and for juvenile fish to proceed downstream and reach the ocean. Without those features, the species cannot successfully spawn and produce offspring.

Many of the activities described in Section 2.3 are ongoing and will continue into the future. Over time, the level of extraction of some natural resources and the associated habitat degradation in Oregon has declined and industry standards and regulatory requirements have improved. For instance, large-scale placer mining for gold (NRC 1995, Lichatowich 1999) has been replaced by smaller recreational mining operations. Timber harvest in Oregon has decreased from roughly 8.5 billion board feet in the 1980s to about 4 billion board feet in 2004 (Oregon Department of Forestry 2005). Timber harvest for Oregon from 2005 to 2010 ranged from 4.4 billion board feet to 2.7 billion board feet.[10] In 1971, Oregon passed the first comprehensive forest practices act in the nation. The law became effective on July 1, 1972, and implementation began immediately following adoption of the first set of forest practice rules (Everest and Reeves 2007). Although the Oregon Forest Practices Act and associated forest practice rules generally have become more protective of riparian and aquatic habitats over time, significant concerns remain over their ability to adequately protect water quality and salmon habitat (Everest and Reeves 2007, IMST 1999).

While widespread degradation of aquatic habitat associated with intense natural resource extraction is no longer common, ongoing and future land management actions are likely to continue to have a depressive effect on aquatic habitat quality in the Willamette basin. As a result, recovery of aquatic habitat is likely to be slow in most areas and cumulative effects at the basin-wide scale are likely to have a neutral to negative impact on population abundance trends and the quality of critical habitat PCEs.

The human population in the Portland area is likely to continue to grow in the foreseeable future (Portland State University 2012). No specific projection of future pollutant loadings in the Willamette River as a result of that population increase is available, but a larger population is likely to have a commensurate level of demand for residential, commercial, industrial, and other land uses that produce contaminants that enter rivers. Thus, it is likely that trends in habitat and water quality in the area of the proposed project will continue, but with changes as described below.

To counteract past trends in pollution of the lower Willamette River, State, tribal, local or private parties, including groups such as the Portland Harbor responsible parties, together with non-Federal members of the Portland Harbor Natural Resource Trustee Council acting in their own capacity, are reasonably certain to continue taking aggressive actions to reduce toxic pollution and runoff to the Willamette River from all sources (U.S. EPA 2011). Those actions include public education, increased toxic reduction and clean-up actions, monitoring to better identify and control sources, research into ecosystem effects of toxic pollutants, and development of a regional data management system. Upland remediation activities are often unlikely to have a Federal nexus and thus will not be the subject of a section 7 consultation. These future actions

[10] Data available at: http://www.oregon.gov/ODF/Pages/state_forests/frp/Charts.aspx (accessed Sept. 2013)

will likely lead to a significant reduction in the volume of some pollutants delivered to the lower Willamette River, although data are still insufficient to identify a trend in the concentration of most of those contaminants in the water itself (Johnson *et al.* 2005; U.S. EPA 2009; U.S. EPA 2011). We did not find any other specific information about non-Federal actions reasonably certain to occur in the vicinity of the projects.

2.6 Integration and Synthesis

The Integration and Synthesis Section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we will add the effects of the action (Section 2.4) to the environmental baseline (Section 2.3) and the cumulative effects (Section 2.5) to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) Reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) reduce the value of designated or proposed critical habitat for the conservation of the species. These assessments are made in full consideration of the status of the species and critical habitat (Section 2.2).

All adult UWR Chinook salmon and UWR steelhead must migrate through the action area to the Upper Willamette River basin and all juvenile UWR Chinook salmon and UWR steelhead must migrate from the Upper Willamette River basin to the ocean through the action area. Therefore, individuals from all populations of these two species could potentially be affected by the proposed projects. The LCR Chinook salmon, LCR steelhead and LCR coho salmon individuals in the action area are likely to be from the Clackamas River populations and must also pass through the action area as juveniles and adults. Over the past several years, NMFS has engaged in various Section 7 consultations on Federal projects impacting these populations and their habitats, and those impacts have been taken into account in this opinion.

The current extinction risk for UWR Chinook salmon is very high and the recovery goal for the extinction risk is very low. The current extinction risk for UWR steelhead is low and the recovery goal for the extinction risk is very low. The current extinction risk for the Clackamas River population of LCR Chinook salmon is very high and the recovery goal for the extinction risk is medium. The current extinction risk for the Clackamas River population of LCR coho salmon is medium and the recovery goal for the extinction risk is very low. The current extinction risk for the Clackamas River population of LCR steelhead is medium and the recovery goal for the extinction risk is low. The Clackamas River population is identified as a "core" population. In order to meet the ESU-viability criteria, representative populations, such as the Clackamas River population, need to achieve viability criteria or be maintained (ODFW 2010).

The environmental baseline is such that individual ESA-listed salmonids in the action area are exposed to reduced water quality, lack of suitable riparian and aquatic habitat and restricted movement due to developed urban areas and land use practices. These stressors, as well as those from climate change, already exist and are in addition to any adverse effects produced by the proposed action. Major factors limiting recovery of the ESA-listed salmonids considered in this opinion include degraded estuarine and nearshore habitat; degraded floodplain connectivity and function; channel structure and complexity; riparian areas and large wood recruitment; stream substrate, streamflow; fish passage; water quality; harvest and hatchery impacts; predation/competition; and disease.

The effects of the proposed action on the factors limiting recovery for the ESA-listed salmonids considered in this opinion include a temporary reduction in water quality and riparian vegetation in the action area from suspended sediment and the removal of vegetation during construction. Fish passage may also be temporarily reduced due to work area isolation. The reduction in water quality and passage will be short term (a few months) during project construction, while newly planted riparian vegetation may take several years to reach full function. Because these effects are relatively brief and small in scale, survival and recovery of ESA-listed salmonids will not be affected. This is primarily because the number of fish within the action area during construction activities will be extremely small when compared to the total abundance of individuals within the populations affected by this action. In addition, the proposed projects will have positive effects on the factors limiting recovery by restoring floodplain connectivity and function, channel structure and complexity, riparian areas and large wood recruitment, fish passage, and water quality. The cumulative effects described above should have a neutral to slightly negative effect on ESA-listed populations.

The few adults and juveniles that are likely to be injured or killed due to the action are too few to cause a measurable effect on the long-term abundance or productivity of any affected population or to appreciably reduce the likelihood of survival and recovery of any listed species.
The proposed action will have no adverse effect on population diversity or spatial structure. Therefore, the proposed action will not reduce the productivity or survival of the affected populations of LCR Chinook salmon, UWR Chinook salmon, LCR steelhead, UWR steelhead or LCR coho salmon, even when combined with a degraded environmental baseline and additional pressure from cumulative effects and climate change.

The value of critical habitat for these species in the Lower Willamette River is limited by poor water quality, altered hydrology, lack of floodplain connectivity and shallow-water habitat, and lack of complex habitat to provide forage and cover. The action area is in an urban area where the habitat has been degraded due to past land use practices including stormwater runoff and industrial and urban development. Despite this, the critical habitat in the action area has a high conservation value for LCR Chinook salmon, LCR steelhead, LCR coho salmon (proposed), UWR Chinook salmon, and UWR steelhead due to its critical role as a migration corridor.

The same effects of the proposed action that will have an effect on ESA-listed salmon and steelhead will also have an effect on critical habitat PCEs for salmon and steelhead critical habitat. The proposed action is likely to result in the short-term (months) reduction in the quality and function of critical habitat PCEs in the action area during construction due to suspended sediment, loss of riparian vegetation, reduction in forage and passage effects. A long-term increase in the quality and function of critical habitat PCEs will occur due to habitat restoration that will increase floodplain connectivity, fish passage, water quality, natural cover, and forage.

The effects of this action will not lower the quality and function of the necessary habitat attributes in the action area over the long term. Instead, it will increase the quality and function of the habitat attributes in the area over the long term. At the watershed scale, the proposed action will not increase the extent of degraded habitat within the basin, add to the degradation of water quality, or further decrease limited rearing areas or limit access to rearing habitat. Even when cumulative effects and climate change are included, the proposed action will not negatively influence the function or conservation role of critical habitat at the watershed scale. Critical habitat for LCR Chinook salmon, LCR steelhead, UWR Chinook salmon, and UWR steelhead, and proposed critical habitat for LCR coho salmon will remain functional, or retain the current ability for the PCEs to become functionally established, to serve the intended conservation role for the species (in this case, to provide freshwater rearing sites and migration corridors).

For all the reasons described in the preceding paragraphs of this section, the proposed action will not appreciably reduce the likelihood of both survival and recovery of the species in the wild by reducing its numbers, reproduction or distribution nor will the proposed action reduce the value of designated critical habitat for the conservation of the species.

2.7 Conclusion

After reviewing the current status of the listed species, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent actions, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of LCR Chinook salmon, UWR Chinook salmon, LCR coho salmon, LCR steelhead, or UWR steelhead or to destroy or adversely modify critical habitat designated or proposed for these species.

You may ask NMFS to adopt the conference opinion as a biological opinion when critical habitat for LCR coho salmon is designated. The request must be in writing. If we review the proposed action and find there have been no significant changes to the action that would alter the contents of the opinion and no significant new information has been developed (including during the rulemaking process), we may adopt the conference opinion as the biological opinion on the proposed action and no further consultation will be necessary.

2.8 Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by regulation to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. For this consultation, we interpret "harass" to mean an intentional or negligent action that has the potential to injure an animal or disrupt its normal behaviors to a point where such behaviors are abandoned or significantly altered.[11] Section 7(b)(4) and section 7(o)(2)

[11] NMFS has not adopted a regulatory definition of harassment under the ESA. The World English Dictionary defines harass as "to trouble, torment, or confuse by continual persistent attacks, questions, etc." The U.S. Fish and Wildlife Service defines "harass" in its regulations as "an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns

provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this incidental take statement.

2.8.1 Amount or Extent of Take

The proposed construction of the five projects considered in this opinion will take place within and along the active channel of the Willamette River, Columbia Slough and Tryon Creek when individual Chinook salmon, coho salmon, and steelhead considered in this opinion are reasonably certain to be present. Adverse effects of the proposed action will include harm and harassment from work area isolation and fish salvage, an increase in suspended sediment, turbidity, and pollutants during the months when project construction is occurring, and a temporary reduction in riparian vegetation and associated forage. These effects are reasonably certain to result in harassment of adults and juveniles and injury or death of a few individuals.

The amount of take for this action is 500 ESA-listed fish captured during fish salvage for all five projects.

The distribution and abundance of fish that occur within an action area are affected by habitat quality, competition, predation, and the interaction of processes that influence genetic, population, and environmental characteristics. These biotic and environmental processes interact in ways that may be random or directional, and may operate across far broader temporal and spatial scales than are affected by the proposed action. Thus, the distribution and abundance of fish within the action area cannot be attributed entirely to habitat conditions, nor can NMFS precisely predict the number of fish that are reasonably certain to be injured or killed if their habitat is modified or degraded by the proposed action. In such circumstances, NMFS cannot provide an amount of take that would be caused by the proposed action.

The best available indicator for the extent of take is the extent of suspended sediment plumes. This feature best integrates the likely take pathways associated with this action, is proportional to the anticipated amount of take, and is the most practical and feasible indicator to measure. Thus, the extent of take indicator that will be used as a reinitiation trigger for this consultation is: increased suspended sediment from construction activities with suspended sediment plumes 100 feet from the boundary of construction activities at 10% over the background level.

The increase in suspended sediment and the number of fish captured are thresholds for reinitiating consultation. Exceeding either for the amount or extent of take will trigger the reinitiation provisions of this opinion.

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which include, but are not limited to, breeding, feeding, or sheltering (50 CFR 17.3). The interpretation we adopt in this consultation is consistent with our understanding of the dictionary definition of harass and is consistent with the Service's interpretation of the term.

2.8.2 Effect of the Take

In Section 2.7, NMFS determined that the level of anticipated take, coupled with other effects of the proposed action, is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

2.8.3 Reasonable and Prudent Measures

"Reasonable and prudent measures" are nondiscretionary measures to minimize the amount or extent of incidental take (50 CFR 402.02). The following measures are necessary and appropriate to minimize the impact of incidental take of listed species from the proposed action:

The Corps shall:

1. Minimize incidental take from project-related activities by applying conditions to the proposed action that avoid or minimize adverse effects to fish from work area isolation and salvage, water quality, and loss of riparian vegetation.
2. Ensure NMFS has opportunities for formal involvement in the pre-construction, engineering, and design (PED) phases of the project to allow for NMFS review and input into final project design.
3. Ensure completion of a monitoring and reporting program to confirm that the take exemption for the proposed action is not exceeded, and that the terms and conditions in this incidental take statement are effective in minimizing incidental take.

2.8.4 Terms and Conditions

The terms and conditions described below are non-discretionary, and the Corps or any applicant must comply with them in order to implement the reasonable and prudent measures (50 CFR 402.14). The Corps or any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this incidental take statement (50 CFR 402.14). If the following terms and conditions are not complied with, the protective coverage of section 7(o)(2) will likely lapse.

1. To implement reasonable and prudent measure #1, the Corps shall ensure that:

    a. Work Window. To minimize effects to juvenile salmonids, construction shall be limited to the appropriate in-water work window (Tryon Creek- July 15 to September 30, Mainstem Willamette- July 1 to October 31, Columbia Slough- June 15 to September 15).
    b. Notice to Contractors. Before beginning work, all contractors working on site shall be provided with a complete list of Corps permit special conditions, reasonable and prudent measures, and terms and conditions intended to minimize the amount and extent of take resulting from in-water work.

c. Minimize Impact Area. The applicant will confine construction impacts to the minimum area necessary to complete the project, including minimizing effects to native riparian vegetation.

d. Fish Capture and Release. If practicable, allow listed fish species to migrate out of the work area or remove fish before isolating the area; otherwise remove fish from an exclusion area with methods such as hand or dip-nets, seining, or trapping with minnow traps (or gee-minnow traps).

i. Fish capture will be supervised by a qualified fisheries biologist, with experience in work area isolation and competent to ensure the safe handling of fish.

ii. Conduct fish capture activities during periods of the day with the coolest air and water temperatures possible, normally early in the morning to minimize stress and injury of species present.

iii. Monitor the nets frequently enough to ensure they stay secured to the banks and free of organic accumulation.

iv. Electrofishing will be used during the coolest time of day, and only after other means of fish capture are determined to be not feasible or ineffective.

1. Follow the most recent version of NMFS (2000) electrofishing guidelines.
2. Do not electrofish when the water appears turbid, *e.g.*, when objects are not visible at depth of 12 inches.
3. Do not intentionally contact fish with the anode.
4. Use direct current (DC) or pulsed direct current within the following ranges:
   - If conductivity is less than 100 μs, use 900 to 1100 volts.
   - If conductivity is between 100 and 300 μs, use 500 to 800 volts.
   - If conductivity greater than 300 μs, use less than 400 volts.
5. Begin electrofishing with a minimum pulse width and recommended voltage, then gradually increase to the point where fish are immobilized.
6. Immediately discontinue electrofishing if fish are killed or injured, *i.e.*, dark bands visible on the body, spinal deformations, significant de-scaling, torpid or inability to maintain upright attitude after sufficient recovery time. Recheck machine settings, water temperature and conductivity, and adjust or postpone procedures as necessary to reduce injuries.

v. If buckets are used to transport fish:

1. Minimize the time fish are in a transport bucket.
2. Keep buckets in shaded areas or, if no shade is available, covered by a canopy.
3. Limit the number of fish within a bucket; fish will be of relatively comparable size to minimize predation.
4. Use aerators or replace the water in the buckets at least every 15 minutes with cold clear water.

5. Release fish in an area upstream with adequate cover and flow refuge; downstream is acceptable provided the release site is below the influence of construction.
6. Be careful to avoid mortality counting errors.

vi. Monitor and record fish presence, handling, and injury during all phases of fish capture and submit a fish salvage report to NMFS within 60 days of capture that documents date, time of day, fish handling procedures, air and water temperatures, and total numbers of each salmon and steelhead handled, and numbers of ESA-listed fish injured or killed.

e. Turbidity. Monitoring shall be conducted and recorded as described below. Monitoring shall occur each day during daylight hours when in-water work is being conducted.

i. Representative background point. An observation must be taken every 2 hours at a relatively undisturbed area at least 600 feet upcurrent from in-water disturbance to establish background turbidity levels for each monitoring cycle. Background turbidity, location, time, and tidal stage must be recorded prior to monitoring downcurrent.

ii. Compliance point. Monitoring shall occur every 2 hours approximately 100 feet downcurrent from the point of disturbance and be compared against the background observation. The turbidity, location, time, and tidal stage must be recorded for each sample.

iii. Compliance. Results from the compliance points should be compared to the background levels taken during that monitoring interval. Turbidity may not exceed an increase of **10%** above background at the compliance point during construction.

iv. Exceedence. If an exceedence occurs, the applicant must modify the activity and continue to monitor every 2 hours. If an exceedence over the background level continues after the second monitoring interval, then work must be stopped and NMFS notified so that revisions to the BMPs can be evaluated.

v. If the weather conditions are unsuitable for monitoring (heavy fog, ice/snow, excessive winds, rough water, *etc.*), then operations must cease until conditions are suitable for monitoring.

vi. Copies of daily logs for turbidity monitoring shall be available to NMFS upon request.

f. Pollution Control Plan. The applicant will implement a pollution control plan (PCP) to prevent pollution caused by construction activities from entering the river. The PCP must have the following components:

i. The name and address of the party responsible for accomplishment of the PCP.

ii. Practices to prevent contaminant releases associated with equipment and material storage sites and fueling staging areas.

iii. A description of any regulated or hazardous products or materials that will be used for the project, including procedures for inventory, storage, handling, and monitoring.

- iv. A spill containment and control plan with notification procedures, specific cleanup and disposal instructions for different products, quick response containment and cleanup measures that will be available on the site, proposed methods for disposal of spilled materials, and employee training for spill containment.
- v. Practices to prevent debris from dropping into any stream or waterbody, and to remove any material that does drop with a minimum disturbance to the streambed and water quality.
- vi. During construction activities, monitoring will be done as often as necessary to ensure the controls discussed above are working properly. If monitoring or inspection shows that the controls are ineffective, work crews will be mobilized immediately to make repairs, install replacements, or install additional controls as necessary.

g. The applicant will maintain an absorptive boom during all in-water activities to capture contaminants that may be floating on the water surface as a consequence of construction activities.

h. The applicant will follow proposed actions #1 through #5 and their associated design criteria as listed in the proposed action section of this biological opinion (from NMFS's PROJECTS biological opinion (NMFS 2013a)).

2. To implement reasonable and prudent measure #2 (NMFS involvement in the pre-construction, engineering, and design phase), the Corps shall:

a. Notify NMFS within 90 days of execution of the pre-construction, engineering, and design phase (PED) agreement and invite NMFS staff to participate in design development.

b. As part of design development, the Corps and NMFS will mutually agree on:
- i. Frequency and timing of involvement in development of project designs.
- ii. Timing of delivery and review of draft project designs related to NMFS fish passage criteria (NMFS 2011c).

c. For all projects undertaken pursuant to the proposed action, the Corps will provide (at least 60 days before construction) site plans and other pertinent information to NMFS for review to ensure the consistency of the action with this opinion.

3. To implement reasonable and prudent measure #3, the Corps shall ensure that:

a. Reporting. The Corps reports all monitoring items, including a fish salvage report, turbidity observations, dates of initiation and completion of in-water work, and compliance with all relevant project design criteria from the PROJECTS biological opinion (NMFS 2013a) to NMFS within 60 days of the close of any work window that had in-water work within it. Any exceedence of take covered by this opinion must be reported to NMFS immediately. The report will include a discussion of implementation of the terms and conditions in #1, above.

b. The applicant will submit monitoring reports to:
National Marine Fisheries Service
Oregon Washington Coastal Area Office
Attn: WCR-2014-633
1201 NE Lloyd Boulevard, Suite 1100
Portland, OR 97232-2778

2.9 Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR 402.02). The following conservation recommendation is a discretionary measure that NMFS believes is consistent with this obligation and therefore should be carried out by the Corps or applicants should be encouraged to conduct this activity:

- The effectiveness of some types of stream restoration actions are not well documented, partly because decisions about which restoration actions deserve support do not always address the underlying processes that led to habitat loss. NMFS recommends that the Corps encourage cost-share partners to use species' recovery plans to help ensure that their actions will address those underlying processes that limit fish recovery.

Please notify NMFS if the Corps carries out this recommendation so that we will be kept informed of actions that are intended to improve the conservation of listed species or their designated critical habitats.

2.10 Reinitiation of Consultation

As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) The amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action.

3. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT CONSULTATION

The consultation requirement of section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. The MSA (section

3) defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Adverse effects occur when EFH quality or quantity is reduced by a direct or indirect physical, chemical, or biological alteration of the waters or substrate, or by the loss of (or injury to) benthic organisms, prey species and their habitat, or other ecosystem components. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH.

This analysis is based, in part, on the EFH assessment provided by the Corps and descriptions of EFH for Pacific coast salmon (PFMC 1999) contained in the fishery management plans developed by the Pacific Fishery Management Council (PFMC) and approved by the Secretary of Commerce.

3.1 Essential Fish Habitat Affected by the Project

The proposed action and action area for this consultation are described in the Introduction to this document. The action area includes areas designated as EFH for various life-history stages of Chinook and coho salmon as identified in the Fishery Management Plan for Pacific coast salmon (PFMC 1999).

3.2 Adverse Effects on Essential Fish Habitat

Based on information provided by the action agency and the analysis of effects presented in the ESA portion of this document, NMFS concludes that the proposed action will have adverse effects on EFH designated for Chinook and coho salmon. These effects include a temporary reduction in riparian vegetation, a temporary reduction in water quality from sediment disturbance, and harassment/displacement from disturbance caused by construction. There will also be many long- term beneficial effects from habitat restoration due to the proposed action.

3.3 Essential Fish Habitat Conservation Recommendations

1. Implement all terms and conditions (except those relating to fish salvage) as presented in the ESA portion of this document.
2. The effectiveness of stream restoration actions is not well documented, partly because decisions about which restoration actions deserve support do not always address the underlying processes that led to habitat loss. NMFS recommends that the Corps encourage applicants to use species' recovery plans to help ensure that their actions will address those underlying processes that limit fish recovery.

NMFS expects that fully implementing these EFH conservation recommendations would protect, by avoiding or minimizing the adverse effects described in Section 3.2 above, approximately 30 acres of designated EFH for Pacific coast salmon.

3.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, the Corps must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation. Such a response must be provided at least 10 days prior to final approval of the action if the response is inconsistent with any of NMFS' EFH Conservation Recommendations unless NMFS and the Federal agency have agreed to use alternative time frames for the Federal agency response. The response must include a description of measures proposed by the agency for avoiding, mitigating, or offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with the Conservation Recommendations, the Federal agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, mitigate, or offset such effects (50 CFR 600.920(k)(1)).

In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, we ask that in your statutory reply to the EFH portion of this consultation, you clearly identify the number of conservation recommendations accepted.

3.5 Supplemental Consultation

The Corps must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH conservation recommendations (50 CFR 600.920(l)).

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

The DQA specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the opinion addresses these DQA components, documents compliance with the DQA, and certifies that this opinion has undergone pre-dissemination review.

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended user of this opinion is the U.S. Army Corps of Engineers. Other interested users could include the City of Portland, citizens living near the action area, or others interested in the conservation of the affected ESUs/DPS. Individual copies of this opinion were provided to the Corps. This opinion will be posted on the NMFS West Coast Region web site (http://www.westcoast.fisheries.noaa.gov/). The format and naming adheres to conventional standards for style.

4.2 Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

4.3 Objectivity

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA regulations, 50 CFR 402.01, et seq., and the MSA implementing regulations regarding EFH, 50 CFR 600.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References Section. The analyses in this opinion/EFH consultation contain more background on information sources and quality.

Referencing: All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NMFS staff with training in ESA and MSA implementation, and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

5. REFERENCES

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Appendix C – USFWS Proposed Conditions and Other Recommendations

United States Department of the Interior

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SEP 22 2014

Lieutenant Colonel Glenn O. Pratt
Portland District, Corps of Engineer
ATTN: CENWP-PME, Chief, Environmental Resources Branch (Ms. Joyce E. Casey)
P.O. Box 2946
Portland, Oregon 97208-2946

Subject: Final Review of the Lower Willamette River Ecosystem Restoration Study Draft Integrated Feasibility Report / Environmental Assessment, Lower Willamette River, Rivermile 0 to Rivermile 26, Multnomah County, Oregon (USFWS reference # 01EOFW00-2014-CPA-0023).

Dear Lieutenant Colonel Pratt:

On May 16, 2014, the U.S. Fish and Wildlife Service's (Service) Oregon Fish and Wildlife Office received a letter from the Portland District Corps of Engineers (Corps) requesting review and recommendations on the Lower Willamette River Ecosystem Restoration Study Draft Integrated Feasibility/Environmental Assessment Report (Report) under the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq) (FWCA). The Service submitted draft comments to the Corps on June 17, 2014, and we received comments from the Corps on our draft letter on August 18, 2014. This letter represents our final comments.

The Corps met with the Service in August 2013 to solicit input and feedback on the identification and evaluation of specific project locations, restoration alternatives, and the development of site-specific design elements. More recently, the Corps and the Service met on January 13th and 14th to discuss several on-going feasibility studies for general investigations, including the Lower Willamette Restoration project. At this time, both agencies reviewed project history and the current scope, specific study areas, and the various design elements of the project. Summary meeting notes were prepared and shared among meeting participants and both agencies agreed the notes may function as a roadmap for developing formal conservation recommendations for the Lower Willamette River Ecosystem Restoration Study Draft.

The Service is supportive of the goals of the Lower Willamette River Ecosystem Restoration Study and recognizes the Corps' need to include formal FWCA recommendations as part of its draft Feasibility Report. The Service is able to offer a number of proposed conditions and other recommendations in-lieu of a Coordination Act Report (CAR). These in-lieu recommendations, once incorporated into the Feasibility Study Report, will satisfy the Service's FWCA goals for the Report (Corps 2014) and the Corps' compliance with the FWCA.

The Service looks forward to continuing to coordinate with the Corps throughout the Pre-construction, Engineering, and Design (PED) Phase for the Study. On August 27, 2014, a final work plan (Attachment 1) for the PED Phase was developed by the Service and modified to reflect comments and suggestions from several Corps' project managers. The work plan identifies a pathway for future involvement from the Service to review and comment on engineering designs, participation in the development of monitoring plans, provide up to date information on newly listed and delisted species, evaluate estimated levels of take, and provide updated conservation measures. Through this involvement, the Corps and the Service will further address their respective mission standards and goals under both FWCA and the Endangered Species Act.

Consistent with the above, the Service has reviewed the Report prepared in March of 2014 and provides the following comments and recommendations.

Objective of the Recommended Restoration Plan

The Lower Willamette River Ecosystem Restoration Project is currently in Phase 3 and is part of a larger, overarching study to conduct ecosystem restoration actions in the Lower Willamette River. The project was initiated in 2002 and has been led by the Corps along with cost-sharing sponsors, the City of Portland and the Port of Portland. This proposed study is a final response to the 2002 study authorization. Since 2002, the City of Portland has identified over 50 individual sites with the potential to restore aquatic and riparian habitat. The current proposed project has selected five projects sites for this restoration plan and these projects will be moved forward for feasibility level designs.

The overall goal of this project is to improve site specific habitat benefits through improved aquatic habitat structure and function. The main objectives include: 1) reestablish communities of native plants in the floodplain and riparian areas; 2) improve aquatic and riparian habitat conditions to support the quality and diversity of biological communities; and 3) restore floodplain function by reestablishing key components of bank configuration and floodplain connectivity while continuing to support river dependent activities (Table 1).

Description of the Project and Site Specific Project Recommendations

The study area encompasses the Lower Willamette River and its tributaries Tryon Creek and the Columbia Slough, from its confluence with the Columbia River at River Mile (RM) 0 to Willamette Falls, located at RM 26.

Table 1. Site restoration objectives for the Lower Willamette River Ecosystem Restoration Project.

	Objective 1	Objective 2			Objective 3
Measures	Revegetation	LW	Off Channel Habitat	Fish Barrier Removal	Floodplain Reconnection
SITES					
Kelly Point Park	X	X	X		X
BES Plant	X	X	X		X
Kenton Cove	X	X			

Oaks Crossing	X	X	X		X
Tryon Creek	X			X	

These project sites include Kelly Point Park, Bureau of Environmental Services (BES) Treatment and Kenton Cove (both in the Columbia Slough), Oaks Crossing, and Tryon Creek. A description of the proposed action is incorporated by reference and is located in the draft biological assessment (Appendix C) of the Report.

Site 1 - Kelly Point Park

Project Categories (as defined by the 2013 NMFS PROJECTS BiOp):

- 2 – Large Wood (LW), Boulder, and Gravel Placement
- 5 – Off- and Side-Channel Habitat Restoration
- 6 – Streambank Restoration

A. NMFS Project Design Criteria for LW, Boulder, and Gravel Placement include:
   a. **Large wood and boulder projects**
      i. Place LW and boulders in areas where they would naturally occur and in a manner that closely mimics natural accumulations for that particular stream type. For example, boulder placement may not be appropriate in low-gradient meadow streams.
      ii. Structure types shall simulate disturbance events to the greatest degree possible and include, but are not limited to, log jams, debris flows, wind-throw, and tree breakage.
      iii. No limits are to be placed on the size or shape of structures as long as such structures are within the range of natural variability of a given location and do not block fish passage.
      iv. Projects can include grade control and streambank stabilization structures, while size and configuration of such structures will be commensurate with scale of project site and hydraulic forces.
      v. The partial burial of LW and boulders is permitted and may constitute the dominant means of placement. This applies to all stream systems but more so for larger stream systems where use of adjacent riparian trees or channel features is not feasible or does not provide the full stability desired.
      vi. LW includes whole conifer and hardwood trees, logs, and rootwads. LW size (diameter and length) should account for bankfull width and stream discharge rates. When available, trees with rootwads should be a minimum of 1.5x bankfull channel width, while logs without rootwads should be a minimum of 2.0 x bankfull widths.
      vii. Structures may partially or completely span stream channels or be positioned along stream banks.
      viii. Stabilizing or key pieces of LW will be intact, hard, with little decay, and if possible have root wads (untrimmed) to provide functional refugia habitat for fish. Consider orienting key pieces such that the hydraulic forces upon the LW increase stability.
      ix. Anchoring LW – Anchoring alternatives may be used in preferential order:

2. Orient and place wood in such a way that movement is limited
3. Ballast (gravel or rock) to increase the mass of the structure to resist movement
4. Use of large boulders as anchor points for the LW
5. Pin LW with rebar to large rock to increase its weight. For streams that are entrenched (Rosgen F, G, A, and potentially B) or for other streams with very low width to depth ratios (less than 12) an additional 60% ballast weight may be necessary due to greater flow depths and higher velocities.
6. Anchoring LW by cable is not allowed under this opinion.

b. **Gravel augmentation**

i. Gravel can be placed directly into the stream channel, at tributary junctions, or other areas in a manner that mimics natural debris flows and erosion.

ii. Augmentation will only occur in areas where the natural supply has been eliminated, significantly reduced through anthropogenic disruptions, or used to initiate gravel accumulations in conjunction with other projects, such as simulated log jams and debris flows.

iii. Gravel to be placed in streams shall be a properly sized gradation for that stream, clean alluvium with similar angularity as the natural bed material. When possible use gravel of the same lithology as found in the watershed. Reference *Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings* (USDA-Forest Service 2008) to determine gravel sizes appropriate for the stream.

iv. Gravel can be mined from the floodplain at elevations above bankfull, but not in a manner that will cause stranding during future flood events.

v. Crushed rock is not permitted.

vi. After gravel placement in areas accessible to higher stream flow, allow the stream to naturally sort and distribute the material.

vii. Do not place gravel directly on bars and riffles that are known spawning areas, which may cause fish to spawn on the unsorted and unstable gravel, thus potentially resulting in redd destruction.

viii. Imported gravel will be free of invasive species and non-native seeds. If necessary, wash gravel prior to placement.

B. NMFS Project Design Criteria for Off- and Side- Channel Restoration include:

a. **Off- and Side-Channel Habitat Restoration** projects will be implemented to reconnect historical side-channels with floodplains by removing off-channel fill and plugs. Furthermore, new side-channels and alcoves can be constructed in geomorphic settings that will accommodate such features. This activity category typically applies to areas where side channels, alcoves, and other backwater habitats have been filled or blocked from the main channel, disconnecting them from most if not all flow events.

b. **NMFS fish passage review and approval.** When a proposed side channel will contain greater than 20% of the bankfull flow,[1] the action will be reviewed by the

[1] Large side channels projects are essentially channel construction projects if they contain more than 20% of flow.

RRT and reviewed and approved by NMFS for consistency with NMFS (2011a) *Anadromous Salmonid Passage Facility Design* criteria.

c. **Data requirements.** Data requirements and analysis for off- and side-channel habitat restoration include evidence of historical channel location, such as land use surveys, historical photographs, topographic maps, remote sensing information, or personal observation.
d. **Allowable excavation.** Off- and side-channel improvements can include minor excavation (less than or equal to 10% of volume) of naturally accumulated sediment within historical channels, *i.e.*, based on the OHW level as the elevation datum. The calculation of the 10% excavation volume does not include manually placed fill, such as dikes, berms, or earthen plugs (see PDC 39). There is no limit as to the amount of excavation of anthropogenic fill within historical side channels as long as such channels can be clearly identified through field or aerial photographs. Excavation depth will not exceed the maximum thalweg depth in the main channel. Excavated material removed from off- or side-channels shall be hauled to an upland site or spread across the adjacent floodplain in a manner that does not restrict floodplain capacity.

C. NMFS Project Design Criteria for Streambank Restoration include:

Streambank Restoration

a. The following streambank stabilization methods may be used individually or in combination:
   i. Alluvium placement
   ii. LW placement
   iii. Roughened toe
   iv. Woody plantings
   v. Herbaceous cover, in areas where the native vegetation does not include trees or shrubs
   vi. Bank reshaping and slope grading
   vii. Coir logs
   viii. Deformable soil reinforcement
   ix. Engineered log jams (ELJ)
   x. Floodplain flow spreaders
   xi. Floodplain roughness
b. For more information on the above methods see Federal Emergency Management Agency (2009)[2] or Cramer *et al.* (2003).[3] Other than those methods relying solely upon woody and herbaceous plantings, streambank stabilization projects should be designed by a qualified engineer that is appropriately registered in the state where the work is performed.
c. Rock will not be used for streambank restoration, except as ballast to stabilize LW. Stream barbs and full-spanning weirs are not allowed for stream bank stabilization under this opinion.
d. **Alluvium Placement** can be used as a method for providing bank stabilization using imported gravel/cobble/boulder-sized material of the same composition and size as that in the channel bed and banks to halt or attenuate streambank erosion, stabilize

[2] http://www.fema.gov/pdf/about/regions/regionx/Engineering_With_Nature_Web.pdf

[3] http://wdfw.wa.gov/publications/00046/wdfw00046.pdf

riffles, and provide critical spawning substrate for native fish. This method is predominantly for use in small to moderately sized channels and is not appropriate for application in mainstem systems. These structures are designed to provide roughness, redirect flow, and provide stability to adjacent streambed and banks or downstream reaches, while providing valuable fish and wildlife habitat.

i. **NMFS fish passage review and approval.** NMFS will review alluvium placement projects that occupy more than 25% of the channel bed or more than 25% of the bankfull cross sectional area.
ii. This design method is only approved in those areas where the natural sediment supply has been eliminated, significantly reduced through anthropogenic disruptions, or used to initiate or simulate sediment accumulations in conjunction with other structures, such as LW placements and ELJs.
iii. Material used to construct the toe should be placed in a manner that mimics attached longitudinal bars or point bars.
iv. Size distribution of toe material will be diverse and predominately comprised of D_{84} to D_{max} size class material.
v. Spawning gravels will constitute at least one-third of the total alluvial material used in the design.
vi. Spawning gravels are to be placed at or below an elevation consistent with the water surface elevation of a bankfull event.
vii. Spawning size gravel can be used to fill the voids within toe and bank material and placed directly onto stream banks in a manner that mimics natural debris flows and erosion.
viii. All material will be clean alluvium with similar angularity as the natural bed material. When possible use material of the same lithology as found in the watershed. Reference *Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings* (USDA-Forest Service 2008) to determine gravel sizes appropriate for the stream.
ix. Material can be mined from the floodplain at elevations above bankfull, but not in a manner that will cause stranding during future flood events.
x. Crushed rock is not permitted.
xi. After placement in areas accessible to higher stream flow, allow the stream to naturally sort and distribute the material.
xii. Do not place material directly on bars and riffles that are known spawning areas, which may cause fish to spawn on the unsorted and unstable gravel, thus potentially resulting in redd destruction.
xiii. Imported material will be free of invasive species and non-native seeds. If necessary, wash prior to placement.

e. **Large Wood Placements** are defined as structures composed of LW that do not use mechanical methods as the means of providing structure stability (*i.e.*, large rock, rebar, rope, cable, *etc*.). The use of native soil, run of alluvium, wood, or buttressing with adjacent trees as methods for providing structure stability are authorized. This method is predominantly for use in small to moderately sized channels and is not appropriate for application in mainstem systems. These structures are designed to provide roughness, redirect flow, and provide stability to adjacent streambed and banks or downstream reaches, while providing valuable fish and wildlife habitat.

i. **NMFS Review and Approval.** NMFS will review LW placement projects that would occupy greater than 25% of the bankfull cross section area.
ii. Structure shall simulate disturbance events to the greatest degree possible and include, but not be limited to, log jams, debris flows, wind-throw, and tree breakage.
iii. Structures may partially or completely span stream channels or be positioned along stream banks.
iv. Where structures partially or completely span the stream channel LW should be comprised of whole conifer and hardwood trees, logs, and rootwads. LW size (diameter and length) should account for bankfull width and stream discharge rates.
v. Structures will incorporate a diverse size (diameter and length) distribution of rootwad or non-rootwad, trimmed or untrimmed, whole trees, logs, snags, slash, *etc*.
vi. For individual logs that are completely exposed, or embedded less than half their length, logs with rootwads should be a minimum of 1.5 times bankfull channel width, while logs without rootwads should be a minimum of 2.0 times bankfull width.
vii. Consider orienting key pieces such that the hydraulic forces upon the LW increase stability.

f. **Roughened toe**
   i. Minimum amount of wood incorporated into the treated area, for mitigation of riprap, is equal to the number of whole trees whose cumulative summation of rootwad diameters is equal to 80% of linear-feet of treated streambank.

g. **Engineered log jams**
   i. See PDC 34b.

h. If LW mechanical anchoring is required, a variety of methods may be used. These include large angular rock, buttressing the wood between adjacent trees, or the use of manila, sisal or other biodegradable ropes for lashing connections. If hydraulic conditions warrant use of structural connections, rebar pinning or bolted connections may be used. Use of cable is not covered by this opinion.

i. When a hole in the channel bed caused by local scour will be filled with rock to prevent damage to a culvert, road, or bridge foundation, the amount of rock will be limited to the minimum necessary to protect the integrity of the structure.

j. When a footing, facing, head wall, or other protection will be constructed with rock to prevent scouring or down-cutting of, or fill slope erosion or failure at, an existing culvert or bridge, the amount of rock used will be limited to the minimum necessary to protect the integrity of the structure. Whenever feasible, include soil and woody vegetation as a covering and throughout the structure.

k. Use a diverse assemblage of vegetation species native to the action area or region, including trees, shrubs, and herbaceous species. Vegetation, such as willow, sedge and rush mats, may be gathered from abandoned floodplains, stream channels, *etc.*

l. Do not apply surface fertilizer within 50 feet of any stream channel.

m. Install fencing as necessary to prevent access to revegetated sites by livestock or unauthorized persons.

n. Conduct post-construction monitoring and treatment or removal of invasive plants until native plant species are well established.

Current Project Description:

The proposed actions at this 47 acre site will excavate two off-channel backwater areas, remove invasive plants, revegetate with native species, re-grade steep banks for floodplain enhancement, and place 50 pieces of LW to enhance 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. An estimated 197,000 cubic yards (cy) of material will be excavated and hauled either by barge or truck, as appropriate.

Habitat value in Kelly Point Park is moderate, but implementation of the project would result in the creation of approximately 5,000 linear feet of high-flow channel 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 re-contouring banks, removing invasive species, and re-vegetating 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.

Service Recommendations for Kelly Point:

- Follow the relevant NMFS PROJECTS design criteria for project categories 2, 5, and 6 (Appendix 1).
- Follow General Conservations Measures listed below.
- Slope banks in the dry and at low flow. Place toe of slope above low flow elevation.
- Maximize the opportunity to create distributary and high flow channels as well as wetlands.
- Add snags and large wood on the floodplain and throughout the site.
- Minimize recreational access to high value habitat by placing trails where they will have the lowest impact, minimize trail crossings in aquatic habitat, and if needed, use bridges or boardwalks to maintain hydrologic connections, reduce soil compaction and maintain native vegetation and water quality.
- Create painted turtle habitat using woody material and limit the use of boulders. Also, provide open areas for nesting habitat.
- Use vertical posts for LW stability and structural habitat for perching birds.
- Remove the word "debris" from all reference to large wood.
- Use anchoring system for LW in preferential order per the PROJECTS programmatic biological opinion.
- Use live willow "play pens" around LW.
- Do not develop water control structures.

Site 2 – BES Treatment

Project Categories (as defined by the 2013 NMFS PROJECTS BiOp):

- 2 – Large Wood (LW), Boulder, and Gravel Placement
- 5 – Off- and Side-Channel Habitat Restoration
- 6 – Streambank Restoration

Current Project Description:

The intent of this six acre project is to excavate a connection to a floodplain backwater/swale area to allow more frequent inundation and enhance the riparian zone along Columbia Slough. Steepened bank angles would be reduced and 35 pieces of LW would be 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 enhanced 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 re-vegetating with native trees and shrubs. Painted turtle habitat would be enhanced by addition of LW near the mouth of the channel between the slough and the low swale. An estimated 13,000 cy of material will be excavated and hauled either by barge or truck, as appropriate.

Service Recommendations for BES:

- Follow relevant NMFS PROJECTS design criteria for project categories 2, 5, and 6 (Appendix 1).
- Follow General Conservations Measures listed below.
- Slope banks in the dry and at low flow. Place toe of slope above low flow elevation.
- Create painted turtle habitat using woody material and limit the use of boulders. Also, provide open areas for nesting habitat.
- Use vertical posts for LW stability instead of boulders.
- Use live willow "play pens" around LW.
- Use anchoring system for LW in preferential order per the PROJECTS programmatic biological opinion.

Site 3 – Kenton Cove

Project Categories (as defined by the 2013 NMFS PROJECTS BiOp):

- 2 – Large Wood (LW), Boulder, and Gravel Placement, Engineered Logjams (ELJ)
- 6 – Streambank Restoration

D. NMFS Project Design Criteria for Engineered Log Jams:
   c. **Engineered Logjams (ELJs)** are structures designed to redirect flow and change scour and deposition patterns.[4] While providing valuable fish and wildlife habitat, they are also designed to redirect flow and can provide stability to a streambank or downstream gravel bar. To the extent practical, ELJs are designed to simulate stable natural log jams and can be either naturally stable due to LW size and/or stream width or anchored in place using rebar, rock, or piles (driven into a dewatered area or the streambank, but not in water). They are also designed to create a hydraulic

[4] ELJs are defined as structures composed of LW with at least three key members incorporating the use of an anchoring system as defined in PDC 33.a.ix.

shadow, a low-velocity zone downstream that allows sediment to settle out and scour holes adjacent to the structure.

i. **NMFS fish passage review and approval.** For ELJs that occupy greater than 25% of the bankfull area, NMFS will review the action for consistency with criteria in *Anadromous Salmonid Passage Facility Design* (NMFS 2011a).

ii. ELJs will be patterned, to the greatest degree possible, after stable natural log jams.

iii. Grade control ELJs are designed to arrest channel down-cutting or incision by providing a grade control that retains sediment, lowers stream energy, and increases water elevations to reconnect floodplain habitat and diffuse downstream flood peaks.

iv. Stabilizing or key pieces of LW that will be relied on to provide streambank stability or redirect flows will be intact and solid (little decay). If possible, acquire LW with untrimmed rootwads to provide functional refugia habitat for fish.

v. When available, trees with rootwads attached should be a minimum length of 1.5 times the bankfull channel width, while logs without rootwads should be a minimum of 2.0 times the bankfull width.

vi. The partial burial of LW and boulders may constitute the dominant means of placement, and key boulders (footings) or LW can be buried into the streambank or channel.

vii. Angle and offset – The LW portions of ELJ structures should be oriented such that the force of water upon the LW increases stability. If a rootwad is left exposed to the flow, the bole placed into the streambank should be oriented downstream parallel to the flow direction so the pressure on the rootwad pushes the bole into the streambank and bed.
Wood members that are oriented parallel to flow are more stable than members oriented at 45 or 90 degrees to the flow.

viii. If LW anchoring is required, a variety of methods may be used. These include buttressing the wood between riparian trees, or the use of manila, sisal, or other biodegradable ropes for lashing connections. If hydraulic conditions warrant use of structural connections, rebar pinning or bolted connections may be used. Rock may be used for ballast but is limited to that needed to anchor the LW.

Current Project Description:

This four acre site is surrounded by a highly maintained levee, with a natural riparian floodplain zone along Columbia Slough and is devoid of riparian habitat. The dominant species include Himalayan blackberry and reed canary grass. The intent of this project is to enhance this backwater cove with 16 pieces of 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, 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. An estimated 1600 cy of clean fill material will be imported and hauled by truck for the creation of the habitat islands.

Service Recommendations for Kenton Cove:

- Follow NMFS PROJECTS design criteria for project categories 2 and 6 (Appendix 1).
- Follow General Conservation Measures listed below.
- Slope banks in the dry and at low flow. Place toe of slope above low flow elevation.
- Use vertical posts for LW stability.
- Use live willow "play pens" around LW.
- Use LW anchoring system in preferential order per the PROJECTS programmatic biological opinion.
- Do not use materials that are inappropriate for the habitat type – i.e. large boulders in a fine sediment-dominated area.
- Create small islands with LW, gravel and/or sand.

Site 4 – Oaks Crossing

Project Categories (as defined by the 2013 NMFS PROJECTS BiOp):

- 2 – Large Wood (LW), Boulder, and Gravel Placement
- 5 – Off- and Side-Channel Habitat Restoration
- 17 – Wetland Restoration

E. NMFS Project Design Criteria for Wetland Restoration:
  Wetland Restoration restores degraded wetlands by (a) excavation and removal of fill materials; (b) contouring to reestablish more natural topography; (c) setting back existing dikes, berms and levees; (d) reconnecting or recreating historical tidal and fluvial channels; (e) planting native wetland species; or (f) a combination of the above methods. This action does not include installation of water control structures or fish passage structures.
  a. Include applicable General Construction Measures (PDC 13-32) and PDC for specific types of actions as applicable (*e.g.*, Off- and Side-Channel Habitat Restoration (PDC 37); Set-Back or Removal of Existing Berms, Dikes, and Levees for Wetland and Estuary Restoration (PDC 39); and Dam and Legacy Structure Removal (PDC 35)) to ensure that all adverse effects to fish and their designated critical habitats are within the range of effects considered in this opinion.

Current Project Description:

The intent of this 20 acre project is to enhance salmonid habitat in the floodplain by connecting off-channel habitat to the river, removing invasive species, and re-vegetating with native floodplain and riparian species. Habitat at this site consists of a gallery forest composed of both native and invasive species. Dominant species in the riparian zone include black cottonwood, willows, cedars, Himalayan blackberry, English ivy, and reed canary grass. Sandy beach habitat would be enhanced by addition of 8 pieces of LW. An estimated 9,000 cy of material will be excavated and hauled either by barge or truck, as appropriate.

Service Recommendations for Oaks Crossing:

- Follow the relevant NMFS PROJECTS design criteria for project categories 2, 5, and 17 (Appendix 1).
- Follow General Conservation Measures listed below.
- Add snags and large wood on the floodplain.
- Minimize access to high value habitat by siting trails where they will have the lowest impact; minimize trail crossings in aquatic habitat, and if needed use bridges or boardwalks to maintain hydrologic connections, reduce soil compaction and maintain native vegetation and water quality.
- Use vertical posts for LW stability.
- Use live willow "play pens" around LW.
- Use anchoring system for LW in preferential order per the PROJECTS programmatic biological opinion.

<u>Site 5 – Tryon Creek Highway 43 Culvert</u>

Project Categories (as defined by the 2013 NMFS PROJECTS BiOp):

- 1 – Fish Passage Restoration (Stream Simulation Culvert and Bridge Projects

F. NMFS Project Design Criteria for Fish Passage Restoration:
 Fish Passage
 a. Provide fish passage for any adult or juvenile ESA-listed fish likely to be present in the action area during construction, unless passage did not exist before construction, stream isolation and dewatering is required during project implementation, or the stream is naturally impassable at the time of construction.
 b. After construction, provide fish passage that meets NMFS' fish passage criteria for any adult or juvenile ESA-listed fish (NMFS 2011a), for the life of the action.

Current Project Description:

The intent of this project is to replace the culvert under Highway 43 and the railroad. The new culvert would simulate the natural stream dimensions, allowing for sediment and debris to pass through and give fish and wildlife unhindered passage beneath the roadway and railroad line. The existing culvert is a fish and wildlife barrier under most flow conditions. Implementation of this project would allow unhindered fish and wildlife passage for 3 miles up into the Tyron Creek Watershed. The Tryon Creek State Natural Area has had numerous restoration projects completed upstream of the Highway 43 culvert for improved fish and wildlife habitat. If constructed in combination with installation of a fish-passable culvert at Boones Ferry Road, fish would have access up Tryon Creek to the upstream end of Marshall Park. Without this project, the benefits of stream and riparian restoration in Tryon Creek State Natural Area and in Marshall Park would be significantly diminished.

Service Recommendations for Tryon Creek Hwy 43 Culvert:

- Follow the relevant NMFS PROJECTS design criteria for project category 1 (Appendix 1).

- Follow General Conservation Measures listed below.
- Take out "excavate flow channel" on any maps that contain this language.
- Only use large boulders if they are part of the native habitat; LW is a better material.
- We appreciate your efforts to design a solution to the fish passage issues at the Tryon Creek culvert. As we mentioned at the workshop, a separate planning effort coordinated by the Tryon Creek Watershed Council has been underway that has involved many of the major stakeholders with an interest and role to play in the restoration outcome for that site. We recommend that you coordinate with members of that group, consider the alternatives and design features that have been and are being evaluated (e.g., replacing the culvert with a bridge), and factor their interests and long-term vision into your decisions. Their current work advances former efforts by stakeholders to address the culvert, as described in the 2007 Tryon Creek @ HWY 43 Culvert Alternates Analysis (http://www.fws.gov/oregonfwo/ToolsForLandowners/UrbanConservation/Greenspaces/Documents/Projects/2003/6505.0309%20Mouth%20of%20Tryon%20Creek/Tryon%20Creek%20Hwy%2043AltAnal.pdf).
- Make sure stakeholders, via Carl Axelsen (Tryon Creek Watershed Council Coordinator), are informed and updated about this effort.

Fish and Wildlife Resource Concerns

The Lower Willamette River supports a network of fish and wildlife species including plants, benthic invertebrates, fish, reptiles, amphibians, birds, and mammals. Included in this network are migratory birds and anadromous and resident fish. Wildlife of importance to the Service includes migratory and resident piscivorous birds such as bald eagle (*Haliaeetus leucocephalus*) and osprey (*Pandion haliaetus*). Anadromous fish spawn throughout the upper river basin, upstream of the proposed study area. The lower Willamette River is a migratory corridor for juvenile and adult anadromous fish and provides rearing habitat for several juvenile anadromous fish species. Important representatives of fish species include Chinook (*Oncorhynchus tshawytscha*), chum (*O. keta*), and coho (*O. Kisutch*) salmon; steelhead (*O. myskiss*) and coastal cutthroat (*O. clarki clarki*) trout; and Pacific lamprey (*Entosphenus tridentata*).

A number of fish and wildlife have reduced or limited number of individuals and are the focus of conservation concerns. Factors contributing to these declines include habitat loss, introduced species, and direct human disturbance. For example, predation by introduced species may be at least partly responsible for observed declines in populations of the red-legged frogs (*Rana aurora*) and the Western pond turtle (*Clemmys marmorata*). These species may have relied heavily on the backwater habitats along the Willamette River and other wetland that have been substantially reduced in the past 150 years. Although this restoration plan is intended to enhance habitat features for these sensitive species, we are concerned construction activities, may have short-term adverse impacts to fish and wildlife, and if not properly implemented, may inadvertently cause exotic species such as bull frogs (*Rana catesbeiana*) and warm water game fish to be introduced or proliferate.

General Conservation Recommendations

The restoration plan proposes to restore natural floodplain functions and fish and wildlife habitats along the Lower Willamette River and its tributaries Tryon Creek and the Columbia Slough. The types of individual restoration measures proposed in this restoration plan proposes to be conducted using appropriate conservation measures and best management practices (BMPs) to avoid and minimize any adverse effects during construction, including the NMFS PROJECTS Programmatic Restoration Biological Opinion (NMFS 2013). The long-term effects of this proposed plan are intended to be beneficial and specifically benefit sensitive fish and wildlife species and contribute to the restoration of natural riverine and floodplain processes. Due to the large scale of the feasibility study, site specific information regarding current fish and wildlife habitat conditions is not available for each of the individual sites. The Service therefore is unable to specifically evaluate the potential short-term adverse effects of the constructions activities to fish and wildlife resources. At this time, the Service requests the Corps incorporate the following conservation measures or BMPs into this restoration plan in addition to those measures already considered, to provide protection to listed and sensitive species, and further minimize any short-term negative impacts to their habitats during construction activities. These conservation recommendations provided below should reduce the overall project impacts and improve habitat conditions for aquatic and riparian dependent species.

<u>General Aquatic Conservation Measures</u>

The activities considered by this restoration plan are intended to protect and restore fish and wildlife habitat with long-term benefits to ESA listed species and species of concern. However, project construction may have short-term adverse effects. To minimize these short-term adverse effects and make them predictable for purposes of programmatic analysis, the following general conservation measures are recommended to be followed for all projects.

Documentation

1) Name(s), phone number(s), and address(es) of the person(s) responsible for oversight will be posted at the work site;
2) A description of hazardous materials that will be used, including inventory, storage, and handling procedures will be available on-site;
3) Procedures to contain and control a spill of any hazardous material generated, used or stored on-site, including notification of proper authorities, will be readily available on-site;
4) A standing order to cease work in the event of high flows (above those addressed in the design and implementation plans), or exceedance of incidental take or water quality limits, will be posted on-site.

Project Design and Site Preparation

1) <u>Climate change</u>. Best available science regarding the future effects within the project area of climate change, such as changes in stream flows and water temperatures, will be considered during project design.

2) <u>State and Federal Permits</u>. All applicable regulatory permits and official project authorizations will be obtained before project implementation. These permits and authorizations include, but are not limited to, National Environmental Policy Act, National Historic Preservation Act, and the appropriate state agency removal and fill permit, and Clean Water Act (CWA) section 401 water quality certifications.

3) Timing of in-water work. Appropriate state Oregon Department of Fish and Wildlife (ODFW) guidelines for timing of in-water work windows (IWW) will be followed.
   a) Proposed restoration activities will not adversely modify designated and/or proposed critical habitats for Chinook salmon, chum, or steelhead.
   b) Lamprey – the project sponsor and/or their contractors will avoid working in stream or river channels that contain Pacific Lamprey from March 1 to July 1. If this timeframe is incompatible with other objectives, the area will be surveyed for nests and lamprey presence, and avoided if possible. If lampreys are known to exist, the project sponsor will utilize dewatering and salvage procedures outlined in US Fish and Wildlife Service (2010)[5].
   c) Proposed restoration activities will follow the Oregon guidelines for the timing of IWW (2008)[2] for each affected stream reach, unless ODFW approves an extension based on current year site specific conditions. Work will not proceed outside of the IWW until the exception is approved by e-mails from NMFS and the Service.

4) Contaminants. The project sponsor will complete a site assessment with the following elements to identify the type, quantity, and extent of any potential contamination for any action that involves excavation of more than 20 cubic yards of material:
   a) A review of available records, such as former site use, building plans, and records of any prior contamination events;
   b) A site visit to inspect the areas used for various industrial processes and the condition of the property;
   c) Interviews with knowledgeable people, such as site owners, operators, and occupants, neighbors, or local government officials; and
   d) A summary, stored with the project file that includes an assessment of the likelihood that contaminants are present at the site, based on items 3(a) through 3(c).

5) Site layout and flagging. Prior to construction, the action area will be clearly flagged to identify the following:
   a) Sensitive resource areas, such as areas below ordinary high water, spawning areas, springs, Western pond turtle nesting sites, and wetlands;
   b) Equipment entry and exit points;
   c) Road and stream crossing alignments;
   d) Staging, storage, and stockpile areas; and
   e) No-spray areas and buffers.

6) Temporary access roads and paths.
   a) Existing access roads and paths will be preferentially used whenever reasonable, and the number and length of temporary access roads and paths through riparian areas and floodplains will be minimized to lessen soil disturbance and compaction, and impacts to vegetation.

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[5] U.S. Fish and Wildlife Service. 2010. Best management practices to minimize adverse effects to Pacific lamprey. Available online at: http://www.fws.gov/pacific/Fisheries/sphabcon/lamprey/pdf/Best%20Management%20Practices%20for%20Pacific%20Lamprey%20April%202010%20Version.pdf.

[2] Oregon Department of Fish and Wildlife. 2008. Oregon guidelines for timing of in-water work to protect fish and wildlife resources. Available online at: http://www.dfw.state.or.us/lands/inwater/Oregon_Guidelines_for_Timing_of_%20InWater_Work2008.pdf.

b) Temporary access roads and paths will not be built on slopes where grade, soil, or other features suggest a likelihood of excessive erosion or failure. If slopes are steeper than 30%, then the road will be designed by a civil engineer with experience in steep road design.
c) The removal of riparian vegetation during construction of temporary access roads will be minimized. When temporary vegetation removal is required, vegetation will be cut at ground level (not grubbed).
d) At project completion, all temporary access roads and paths will be obliterated, and the soil will be stabilized and revegetated. Road and path obliteration refers to the most comprehensive degree of decommissioning and involves decompacting the surface and ditch, pulling the fill material onto the running surface, and reshaping to match the original contour.
e) Temporary roads and paths in wet areas or areas prone to flooding will be obliterated by the end of the in-water work window.

7) Temporary stream crossings.
   a) Existing stream crossings will be preferentially used whenever reasonable, and the number of temporary stream crossings will be minimized.
   b) Temporary bridges and culverts will be installed to allow for equipment and vehicle crossing over perennial streams during construction.
   c) Equipment and vehicles will cross the stream in the wet only where:
      i) The streambed is bedrock; or
      ii) Mats or off-site logs are placed in the stream and used as a crossing.
   d) Vehicles and machinery will cross streams at right angles to the main channel wherever possible.
   e) The location of the temporary crossing will avoid areas that may increase the risk of channel re-routing or avulsion.
   f) Potential spawning habitat (i.e., pool tailouts) and pools will be avoided to the maximum extent possible.
   g) No stream crossings will occur at active spawning sites, when holding adult listed fish are present, or when eggs or alevins are in the gravel. The appropriate state fish and wildlife agency will be contacted for specific timing information.
   h) After project completion, temporary stream crossings will be obliterated and the stream channel and banks restored.

8) Staging, storage, and stockpile areas.
   a) Staging areas (used for construction equipment storage, vehicle storage, fueling, servicing, and hazardous material storage) will be 150 feet or more from any natural water body or wetland, or on an adjacent, established road area in a location and manner that will preclude erosion into or contamination of the stream or floodplain.
   b) Natural materials used for implementation of aquatic restoration, such as large wood, gravel, and boulders, may be staged within the 100-year floodplain.
   c) Any large wood, topsoil, and native channel material displaced by construction will be stockpiled for use during site restoration at a specifically identified and flagged area.
   d) Any material not used in restoration, and not native to the floodplain, will be removed to a location outside of the 100-year floodplain for disposal.

9) Equipment. Mechanized equipment and vehicles will be selected, operated, and maintained in a manner that minimizes adverse effects on the environment (e.g., minimally-sized, low

pressure tires; minimal hard-turn paths for tracked vehicles; temporary mats or plates within wet areas or on sensitive soils). All vehicles and other mechanized equipment will be:

a) Stored, fueled, and maintained in a vehicle staging area placed 150 feet or more from any natural water body or wetland or on an adjacent, established road area;
b) Refueled in a vehicle staging area placed 150 feet or more from a natural waterbody or wetland, or in an isolated hard zone, such as a paved parking lot or adjacent, established road (this measure applies only to gas-powered equipment with tanks larger than 5 gallons);
c) Biodegradable lubricants and fluids should be used, if possible, on equipment operating in and adjacent to the stream channel and live water.
d) Inspected daily for fluid leaks before leaving the vehicle staging area for operation within 150 feet of any natural water body or wetland; and
e) Thoroughly cleaned before operation below ordinary high water, and as often as necessary during operation, to remain grease free.

10) <u>Erosion control.</u> Erosion control measures will be prepared and carried out, commensurate in scope with the action, that may include the following:
  a) Temporary erosion controls.
    i) Temporary erosion controls will be in place before any significant alteration of the action site and appropriately installed downslope of project activity within the riparian buffer area until site rehabilitation is complete.
    ii) If there is a potential for eroded sediment to enter the stream, sediment barriers will be installed and maintained for the duration of project implementation.
    iii) Temporary erosion control measures may include fiber wattles, silt fences, jute matting, wood fiber mulch and soil binder, or geotextiles and geosynthetic fabric.
    iv) Soil stabilization utilizing wood fiber mulch and tackifier (hydro-applied) may be used to reduce erosion of bare soil if the materials are noxious weed free and nontoxic to aquatic and terrestrial animals, soil microorganisms, and vegetation.
    v) Sediment will be removed from erosion controls once it has reached 1/3 of the exposed height of the control.
    vi) Once the site is stabilized after construction, temporary erosion control measures will be removed.
  b) Emergency erosion controls. The following materials for emergency erosion control will be available at the work site:
    i) A supply of sediment control materials; and
    ii) An oil-absorbing floating boom whenever surface water is present.

11) <u>Dust abatement</u>. The project sponsor will determine the appropriate dust control measures (if necessary) by considering soil type, equipment usage, prevailing wind direction, and the effects caused by other erosion and sediment control measures. In addition, the following criteria will be followed:
  a) Work will be sequenced and scheduled to reduce exposed bare soil subject to wind erosion.
  b) Dust-abatement additives and stabilization chemicals (typically magnesium chloride, calcium chloride salts, or ligninsulfonate) will not be applied within 25 feet of water or a stream channel and will be applied so as to minimize the likelihood that they will enter streams. Applications of ligninsulfonate will be limited to a maximum rate of 0.5 gallons per square yard of road surface, assuming a 50:50 (ligninsulfonate to water) solution.
  c) Application of dust abatement chemicals will be avoided during or just before wet weather, and at stream crossings or other areas that could result in unfiltered delivery of the dust

abatement materials to a waterbody (typically these would be areas within 25 feet of a waterbody or stream channel; distances may be greater where vegetation is sparse or slopes are steep).

d) Spill containment equipment will be available during application of dust abatement chemicals.
e) Petroleum-based products will not be used for dust abatement.

12) Spill prevention, control, and countermeasures. The use of mechanized machinery increases the risk for accidental spills of fuel, lubricants, hydraulic fluid, or other contaminants into the riparian zone or directly into the water. Additionally, uncured concrete and form materials adjacent to the active stream channel may result in accidental discharge into the water. These contaminants can degrade habitat, and injure or kill aquatic food organisms and ESA listed species. The project sponsor will adhere to the following measures:
  a) A description of hazardous materials that will be used, including inventory, storage, and handling procedures will be available on-site.
  b) Written procedures for notifying environmental response agencies will be posted at the work site.
  c) Spill containment kits (including instructions for cleanup and disposal) adequate for the types and quantity of hazardous materials used at the site will be available at the work site.
  d) Workers will be trained in spill containment procedures and will be informed of the location of spill containment kits.
  e) Any waste liquids generated at the staging areas will be temporarily stored under an impervious cover, such as a tarpaulin, until they can be properly transported to and disposed of at a facility that is approved for receipt of hazardous materials.

13) Invasive species control. The following measures will be followed to avoid introduction of invasive plants and noxious weeds into project areas:
  a) Prior to entering the site, all vehicles and equipment will be power washed, allowed to fully dry, and inspected to make sure no plants, soil, or other organic material adheres to the surface.
  b) Watercraft, waders, boots, and any other gear to be used in or near water will be inspected for aquatic invasive species.
  c) During project design, actions will be identified and implemented, in conjunction with ODFW, to prevent, if feasible, future introductions of bull frogs, warm water game fish, and other aquatic invasive species.

Construction Conservation Measures

1) Work Area Isolation & Fish Salvage.
  a) Any work area within the wetted channel will be isolated from the active stream whenever ESA listed fish are reasonably certain to be present, or if the work area is less than 300-feet upstream from known spawning habitats.
  b) When work area isolation is required, engineering design plans will include all isolation elements, fish release areas, and, when a pump is used to dewater the isolation area and fish

are present, a fish screen that meets NMFS's fish screen criteria (NMFS 2011[6], or most current).

c) Work area isolation and fish capture activities will occur during periods of the coolest air and water temperatures possible, normally early in the morning versus late in the day, and during conditions appropriate to minimize stress and death of species present.

d) Salvage operations will follow the ordering, methodologies, and conservation measures specified below in Steps 1 through 6. Steps 1 and 2 will be implemented for all projects where work area isolation is necessary according to condition 1(a) above. Electrofishing (Step 3) can be implemented to ensure all fish have been removed following Steps 1 and 2, or when other means of fish capture may not be feasible or effective. Dewatering and rewatering (Steps 4 and 5) will be implemented unless wetted in-stream work is deemed to be minimally harmful to fish, and is beneficial to other aquatic species. Dewatering will not be conducted in areas occupied by lamprey, unless lampreys are salvaged using guidance set forth in US Fish and Wildlife Service (2010)[7].

  i) **Step 1: Isolate**
    (1) Block nets will be installed at up and downstream locations and maintained in a secured position to exclude fish from entering the project area.
    (2) Nets will be secured to the stream channel bed and banks until fish capture and transport activities are complete. Nets may be left in place for the duration of the project to exclude fish.
    (3) If block nets or traps remain in place more than one day, the nets and traps will be monitored at least daily to ensure they are secured to the banks and free of organic accumulation, and to minimize fish predation in the trap.
    (4) Nets and traps will be monitored hourly anytime there is instream disturbance.

  ii) **Step 2: Salvage** – As described below, fish trapped within the isolated work area will be captured to minimize the risk of injury, then released at a safe site:
    (1) Remove as many fish as possible prior to dewatering.
    (2) During dewatering, any remaining fish will be collected by hand or dip nets.
    (3) Seines with a mesh size to ensure entrapment of the residing ESA-listed fish will be used.
    (4) Minnow traps will be left in place overnight and used in conjunction with seining.
    (5) If buckets are used to transport fish:
      (a) The time fish are in a transport bucket will be limited, and will be released as quickly as possible;
      (b) The number of fish within a bucket will be limited based on size, and fish will be of relatively comparable size to minimize predation;
      (c) Aerators for buckets will be used or the bucket water will be frequently changed with cold clear water at 15 minute or more frequent intervals.
      (d) Buckets will be kept in shaded areas or will be covered by a canopy in exposed areas.
      (e) Dead fish will not be stored in transport buckets, but will be left on the stream bank to avoid mortality counting errors.

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[6] National Marine Fisheries Service. 2011. Anadromous salmonid passage facility design. Northwest Region. Available online at: http://www.nwr.noaa.gov/Salmon-Hydropower/FERC/upload/Fish-Passage-Design.pdf

[7] U.S. Fish and Wildlife Service. 2010. Best management practices to minimize adverse effects to Pacific lamprey. Available online at: http://www.fws.gov/pacific/Fisheries/sphabcon/lamprey/pdf/Best%20Management%20Practices%20for%20Pacific%20Lamprey%20April%202010%20Version.pdf

(6) As rapidly as possible (especially for temperature-sensitive bull trout), fish will be released in an area that provides adequate cover and flow refuge. Upstream release is generally preferred, but fish released downstream will be sufficiently outside of the influence of construction.
(7) Salvage will be supervised by a qualified fisheries biologist experienced with work area isolation and competent to ensure the safe handling of all fish.

iii) **Step 3: Electrofishing** – Electrofishing will be used only after other salvage methods have been employed or when other means of fish capture may not be feasible or effective.
(1) If electrofishing will be used to capture fish for salvage, the salvage operation will be led by an experienced fisheries biologist and the following guidelines will be followed:
(a) The NMFS's electrofishing guidelines (NMFS 2000)[8].
(b) Only direct current (DC) or pulsed direct current (PDC) will be used.
(i) If conductivity is less than 100 μs, voltage ranges from 900 to 1100 will be used;
(ii) For conductivity ranges between 100 to 300 μs, voltage ranges will be 500 to 800;
(iii) For conductivity greater than 300 μs, voltage will be less than 400.
(c) Electrofishing will begin with a minimum pulse width and recommended voltage and then gradually increase to the point where fish are immobilized.
(d) The anode will not intentionally contact fish.
(e) Electrofishing shall not be conducted when the water conditions are turbid and visibility is poor. This condition may be experienced when the sampler cannot see the stream bottom in 1-foot of water.
(f) If mortality or obvious injury (defined as dark bands on the body, spinal deformations, de-scaling of 25% or more of body, and torpidity or inability to maintain upright attitude after sufficient recovery time) occurs during electrofishing, operations will be immediately discontinued, machine settings, water temperature and conductivity checked, and procedures adjusted or postponed to reduce mortality.

iv) **Step 4: Dewater** – Dewatering, when necessary, will be conducted over a sufficient period of time to allow species to naturally migrate out of the work area and will be limited to the shortest linear extent practicable.
(1) Diversion around the construction site may be accomplished with a coffer dam and a by-pass culvert or pipe, or a lined, non-erodible diversion ditch. Where gravity feed is not possible, a pump may be used, but must be operated in such a way as to avoid repetitive dewatering and rewatering of the site. Impoundment behind the cofferdam must occur slowly through the transition, while constant flow is delivered to the downstream reaches.
(2) All pumps will have fish screens to avoid juvenile fish entrainment, and will be operated in accordance with NMFS's current fish screen criteria (NMFS 2011[9], or

[8] National Marine Fisheries Service. 2000. Guidelines for electrofishing waters containing salmonids listed under the Endangered Species Act. Portland, Oregon and Santa Rosa, California. Available online at http://www.nwr.noaa.gov/ESA-Salmon-Regulations-Permits/4d-Rules/upload/electro2000.pdf

[9] National Marine Fisheries Service. 2011. Anadromous salmonid passage facility design. Northwest Region. Available online at: http://www.nwr.noaa.gov/Salmon-Hydropower/FERC/upload/Fish-Passage-Design.pdf

most recent version). If the pumping rate exceeds 3 cfs, a NMFS Hydro fish passage review will be necessary.

(3) Dissipation of flow energy at the bypass outflow will be provided to prevent damage to riparian vegetation or stream channel.

(4) Safe reentry of fish into the stream channel will be provided, preferably into pool habitat with cover, if the diversion allows for downstream fish passage.

(5) Seepage water will be pumped to a temporary storage and treatment site or into upland areas to allow water to percolate through soil or to filter through vegetation prior to reentering the stream channel.

v) **Step 5: Re-watering** – Upon project completion, the construction site will be slowly re-watered to prevent loss of surface flow downstream and to prevent a sudden increase in stream turbidity. During re-watering, the site will be monitored to prevent stranding of aquatic organisms below the construction site.

vi) **Step 6: Salvage Notice** – Monitoring and recording of fish presence, handling, and mortality must occur during the duration of the isolation, salvage, electrofishing, dewatering, and rewatering operations. Once operations are completed, a salvage report will document procedures used, any fish injuries or deaths (including numbers of fish affected), and causes of any deaths.

2) Fish passage. Fish passage will be provided for any adult or juvenile fish likely to be present in the action area during construction, unless passage did not exist before construction or the stream is naturally impassable at the time of construction. If the provision of temporary fish passage during construction will increase negative effects on aquatic species of interest or their habitat, a variance can be requested from the NMFS Branch Chief and the FWS Field Office Supervisor. Pertinent information, such as the species affected, length of stream reach affected, proposed time for the passage barrier, and alternatives considered, will be included in the variance request. After construction, adult and juvenile passage that meets NMFS' fish passage criteria (NMFS 2011) will be provided for the life of the action.

3) Construction and discharge water.
   a) Surface water may be diverted to meet construction needs, but only if developed sources are unavailable or inadequate.
   b) Diversions will not exceed 10% of the available flow.
   c) All construction discharge water will be collected and treated using the best available technology applicable to site conditions.
   d) Treatments to remove debris, nutrients, sediment, petroleum hydrocarbons, metals and other pollutants likely to be present will be provided.

4) Minimize time and extent of disturbance. Earthwork (including drilling, excavation, dredging, filling and compacting) in which mechanized equipment is in stream channels, riparian areas, and wetlands will be completed as quickly as possible. Mechanized equipment will be used in streams only when project specialists believe that such actions are the only reasonable alternative for implementation, or would result in less sediment in the stream channel or damage (short- or long-term) to the overall aquatic and riparian ecosystem relative to other alternatives. To the extent feasible, mechanized equipment will work from the top of the bank, unless work from another location would result in less habitat disturbance.

5) Cessation of work. Project operations will cease under the following conditions:

a) High flow conditions that may result in inundation of the project area, except for efforts to avoid or minimize resource damage;
b) When allowable water quality impacts, as defined by the state CWA section 401 water quality certification, have been exceeded; or
c) When take limitations have been reached or exceeded.

Post-construction Conservation Measures

1) Site restoration. When construction is complete:
   a) All streambanks, soils, and vegetation will be cleaned up and restored as necessary using stockpiled large wood, topsoil, and native channel material.
   b) All project related waste will be removed.
   c) All temporary access roads, crossings, and staging areas will be obliterated. When necessary for revegetation and infiltration of water, compacted areas of soil will be loosened.
   d) All disturbed areas will be rehabilitated in a manner that results in similar or improved conditions relative to pre-project conditions. This will be achieved through redistribution of stockpiled materials, seeding, and/or planting with local native seed mixes or plants.

2) Revegetation. Long-term soil stabilization of disturbed sites will be accomplished with reestablishment of native vegetation using the following criteria:
   a) Planting and seeding will occur prior to or at the beginning of the first growing season after construction.
   b) An appropriate mix of species that will achieve establishment, shade, and erosion control objectives, preferably forb, grass, shrub, or tree species native to the project area or region and appropriate to the site will be used.
   c) Vegetation, such as willow, sedge and rush mats, will be salvaged from disturbed or abandoned floodplains, stream channels, or wetlands.
   d) Only native species will be used.
   e) Short-term stabilization measures may include the use of non-native sterile seed mix (when native seeds are not available), weed-free certified straw, jute matting, and other similar techniques.
   f) Surface fertilizer will not be applied within 50 feet of any stream channel, waterbody, or wetland.
   g) Fencing will be installed as necessary to prevent access to revegetated sites by livestock or unauthorized persons.
   h) Re-establishment of vegetation in disturbed areas will achieve at least 70% of pre-project conditions within 3 years.
   i) Invasive plants will be removed or controlled until native plant species are well-established (typically 3-years post-construction).

3) Site access. The project sponsor will retain the right of reasonable access to the site in order to monitor the success of the project over its life.

Inspections and Monitoring

1) Implementation monitoring. Project sponsor staff or their designated representative will provide implementation monitoring to ensure compliance with the applicable biological opinion, including:
   a) General conservation measures are adequately followed; and
   b) Effects to listed species are not greater than predicted and incidental take limitations are not exceeded.

2) CWA section 401 water quality certification. The project sponsor or designated representative will complete and record water quality observations to ensure that in-water work is not degrading water quality. During construction, CWA section 401 water quality certification provisions provided by the Oregon Department of Environmental Quality will be followed.

Reptiles and Amphibians

Work with the local ODFW biologist to obtain a salvage permit, if needed, and jointly develop a plan to avoid and minimize disturbance and/or mortality to native turtles and amphibians.

ESA Listed Plants

Field surveys for listed plants and suitable habitat known or suspected to occur in the action area will occur prior to federal activities during the growing season, before aquatic restoration activities would occur. Any listed plant or plant suitable habitat discovered during the survey that is within 0.25 miles of the proposed aquatic restoration project will cause project planners to design the restoration activities to not "likely to adversely affect" listed plants. Understanding plant distribution and avoiding the plants during restoration activities has proven to be the best way to facilitate conservation for these species and to meet the goals of the agencies. In some cases restoration activities are consistent with listed plant recovery actions and can benefit listed species.

Migratory Birds

Migratory birds are protected under the Migratory Bird Treaty Act of 1918, as amended (16 USC 703-712). Under the Act, taking, killing or possessing migratory birds is unlawful. The best way to avoid disturbing nesting birds is to schedule activities outside the nesting season. The nesting season is not the same for all species, and not all sites will have nesting birds present during the entire nesting season. Here are some general guidelines to help you plan project activities:

1) The time between August 1 – January 31 is the best time to plan for tree removal, invasive plant species management, and grubbing and clearing.
2) Avoid disturbance activities between February 1 – April 15. This is considered the early nesting season. Disturbance to vegetation, especially trees, should be avoided during this time.
3) Avoid disturbance activities between April 15 – July 31. This is considered the primary nesting season. Disturbance to vegetation should be avoided during this time. If birds are not present during nesting season, vegetation removal and other disturbance activities may proceed.
4) If work must occur in the recommended avoidance time frames, the project area and specific vegetation impacted should be surveyed for nesting birds. We recommend you follow the City of Portland bird nesting guidelines at: http://www.portlandoregon.gov/bes/article/322164.
5) Field surveys for the western yellow-billed cuckoo (Coccyzus americanus), proposed as threatened under the ESA, and suitable habitat should be conducted if known or suspected to

occur in the action area prior to federal activities early in the nesting season. Consult with the Service prior to any construction activity if detected.

Bald Eagles

The bald eagle was formally delisted from the federal Endangered Species Act in 2008 but remains protected under the Migratory Bird Treaty Act of 1918, as amended (16 USC 703-712), and the Bald and Golden Eagle Protection Act of 1940, as amended (16 USC 668-668d). The nesting season for the bald eagle occurs between January 1 and August 31. If bald eagles are likely to be in the project area and Corps activities may disturb bald eagles during the nesting season, we recommend the Corps refer to the Service's guidance and restrictions at our website: http://www.fws.gov/pacific/eagle/disturb.html .

Thank you for the opportunity to provide these comments. Please contact Kathy Roberts or Rollie White at (503-231-6179) if you have any questions or concerns regarding this letter.

Sincerely yours,

Paul Henson, Ph.D
State Supervisor

cc: Kris Lightner, Corps Project Manager

Literature Cited

Corps (U.S. Army Corps of Engineers). 2014. Lower Willamette River Ecosystem Restoration Study Draft Integrated Feasibility Report/Programmatic Environmental Assessment.

NMFS (U.S. National Marine Fisheries Service). 2013. Programmatic Restoration Opinion for Joint Ecosystem Conservation by the Services (PROJECTS) by the U.S. Fish and Wildlife Service Using the Partners for Fish and Wildlife, Fisheries, Coastal, and Recovery Programs and NOAA Restoration Center Using the Damage Assessment, Remediation and Restoration Program (DARRP), and Community-Based Restoration Program (CRP) in the States of Oregon, Washington, and Idaho. 222 pp.

APPENDIX D

Cultural Resources

EXECUTIVE SUMMARY

This report documents a study which identified the known archaeological history of 26 proposed habitat restoration projects located in the City of Portland, Oregon and the results of visits made by a Tetra Tech archaeologist to each site to visually inspect each restoration site for archaeological resources and the likelihood for buried archaeological deposits. Sites likely to hold archaeological materials were tested per SHPO survey regulations, those sites deemed not likely were subjected to a less intense testing regiment to identify site conditions as well as the likelihood for the presence of cultural resources. This study supports the Lower Willamette River Ecosystem Restoration General Investigation Study. The purpose of that study is to assist the US Army Corps of Engineers, the Port of Portland, and the City of Portland to formulate, evaluate, and screen potential solutions to significant ecosystem degradation problems in the lower Willamette River watershed identified in the feasibility study that was performed during the first phase of that project.

An archaeologist from Tetra Tech completed cultural resource investigations of each proposed habitat restoration project (Figure 1) during the week of 9/28-10/2 2009 and on 3/25 2010. Pedestrian survey was used to evaluate each restoration site. This study was not intended to identify all cultural resources present at each project site but rather a step to determine if any archaeological resources could be impacted by implementation of the proposed restoration activities. The remains of piers are the only significant artifacts and features remaining at several of the restoration sites, most sites did not appear to hold any cultural materials due to setting or disturbances.

<u>Subject Property</u>: The subject property is made up of 26 individual sites where a specific action or set of actions will take place in an effort to restore native habitats and ecosystem balance. The sites are identified in Figures 2 through 6.

<u>Subject Property Locations:</u>

Sections: 23, 33, 35, 36	Township: <u>2 North</u>	Range: <u>1 West</u>
Sections: 12, 13, 5, 22	Township: <u>1 North</u>	Range: <u>1 West</u>
Sections: 5	Township: <u>1 North</u>	Range: <u>1 East</u>
Sections: 22, 28, 33	Township: <u>1 South</u>	Range: <u>1 East</u>
Sections: 19, 21, 29	Township: <u>1 South</u>	Range: <u>2 East</u>
Sections: 2	Township: <u>2 South</u>	Range: <u>1 East</u>

USGS Quad maps:

Sauvie Island (7.5')
Linnton (7.5')
Portland (7.5')
Lake Oswego (7.5')
Gladstone (7.5')

Elevation: 19-300 Feet above Mean Sea Level
Nearest water bodies: Willamette River, Columbia Slough, Tryon Creek, Johnson Creek
Owner(s): Various public and private entities

Archaeological sites within or adjacent to the project area:

35MU15	35MU20	35MU21	35MU22	35MU44
35MU46	35MU47	35MU48	35MU49	35MU50
35MU51	35MU52	35MU60	35MU110	35MU111
35MU114	35MU117			

National Register of Historic Places (NRHP) Properties within or adjacent to the project area:

No properties eligible for or listed in the National Register of Historic Places fall within any of the restoration sites. No new historic properties were identified as a result of this investigation. Project work is proposed on several known archaeological sites, which are listed in Section 5.1.

Historic Properties will be affected by this project.
No new historic properties were identified as a result of this investigation. Project work is proposed on several known archaeological sites, which are listed in Section5.1.

We recommend that the proposed restoration project proceed as proposed.
The project manager and the on-site inspectors for the project should be familiar with the attached unanticipated discoveries protocol and should have a copy on site for the responsible construction superintendent to carry. This plan should be reviewed ahead of time so the project managers may address questions regarding the identification of cultural material or the process to follow should any questionable material be encountered during construction. The unanticipated discoveries protocol should be provided to contractors during the bid process so they are aware of this process when they develop their estimates.

If an accidental discovery is made during ground-disturbing activity, work shall be stopped immediately, and a qualified archaeologist shall assess the find and decide upon the nature and extent of future investigation and recovery. If human remains are discovered, the Multnomah or Clackamas County Coroner's Office shall be contacted immediately.

Table of Contents

Figures

SECTION 1.0 INTRODUCTION

In support of the Lower Willamette River Ecosystem Restoration General Investigation Study, a Tetra Tech archaeologist completed a file review and on the ground site survey of 26 proposed restoration sites. The file review took place on 9/30/2009 and 3/25/2010. The site surveys took place on 9/28-10/2 2009 and on 3/25 2010. Sites likely to hold archaeological materials were tested per SHPO survey regulations, those sites deemed not likely were subjected to a less intense testing regiment to identify site conditions as well as the likelihood for the presence of cultural resources.

The purpose of this study is to assist the US Army Corps of Engineers, the Port of Portland, and the City of Portland to formulate, evaluate, and screen potential solutions to significant ecosystem degradation problems in the lower Willamette River watershed. As part of that study the impact to cultural resources is addressed by this report.

The National Historic Preservation Act (NHPA) of 1966 and the National Environmental Policy Act (NEPA; 42 USC 4321-4370c) requires that historic properties be considered in federal undertakings. Cultural resources are defined as:

• Historic properties protected under the NHPA, as amended (16 USC 470-470);

• Cultural items protected under the Native American Graves Protection and Repatriation Act (NAGPRA) of 1990 (25 USC 3001-3013);

• Archaeological resources protected under the Archaeological Resources Protection Act (ARPA) of 1979 (16 USC 470aa-47011);

• Sacred sites, to which access is provided under the American Indian Religious Freedom Act (AIRFA), in Executive Order (EO) 13007; and

• Collections and associated records in 36 CFR 79, Curation of Federally-Owned and Administered Collections.

The federal regulations regarding historic properties are specified in 36 CFR Part 800, Protection of Historic Properties. Requirements set forth in NEPA, NHPA, ARPA, NAGPRA, AIRFA, 36 CFR 79, EO 13007, and their implementing regulations define the Army's compliance responsibilities for management of historic properties and other cultural resources. Regulations applicable to the Army's management of cultural resources include those promulgated by the Advisory Council on Historic Preservation and the National Park Service (NPS). Army Regulation 200-4, Cultural Resources Management, specifies Army policy for cultural resources management.

SECTION 2.0 LOCATION AND ENVIRONMENTAL SETTING

Each proposed restoration project is found within the city limits of Portland, Oregon in Multnomah and Clackamas Counties. The study area consists of the lower Willamette River mainstem from its confluence with the Columbia River upstream to its confluence with Johnson Creek at River Mile (RM) 18.5, as well as key tributaries including Tryon Creek, Johnson Creek downstream of Powell Butte, and Columbia Slough.

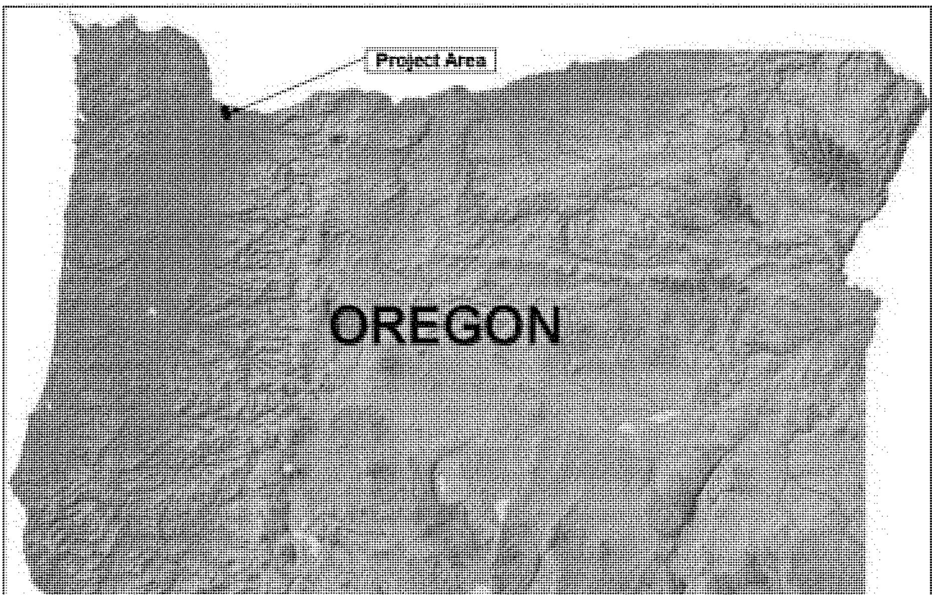

Figure 1. Project Location

The following maps identify the specific location of each restoration site. The maps were generated by grouping restoration sites according to the water body on which they are found.

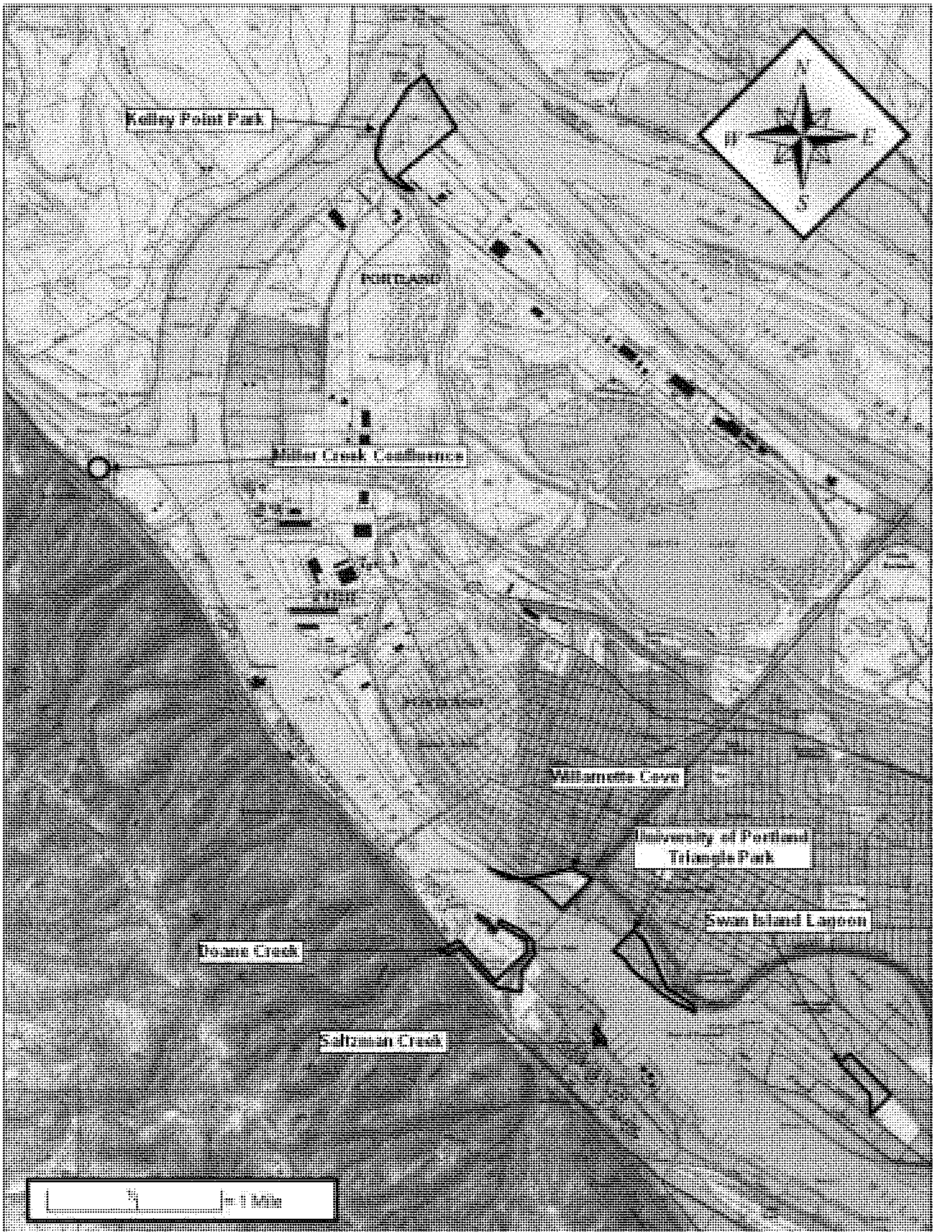

Figure 2. North Mainstem of the Willamette River. This reach stretches from RM 10.0 to RM 0.0 (Balch Creek Confluence to Columbia River).

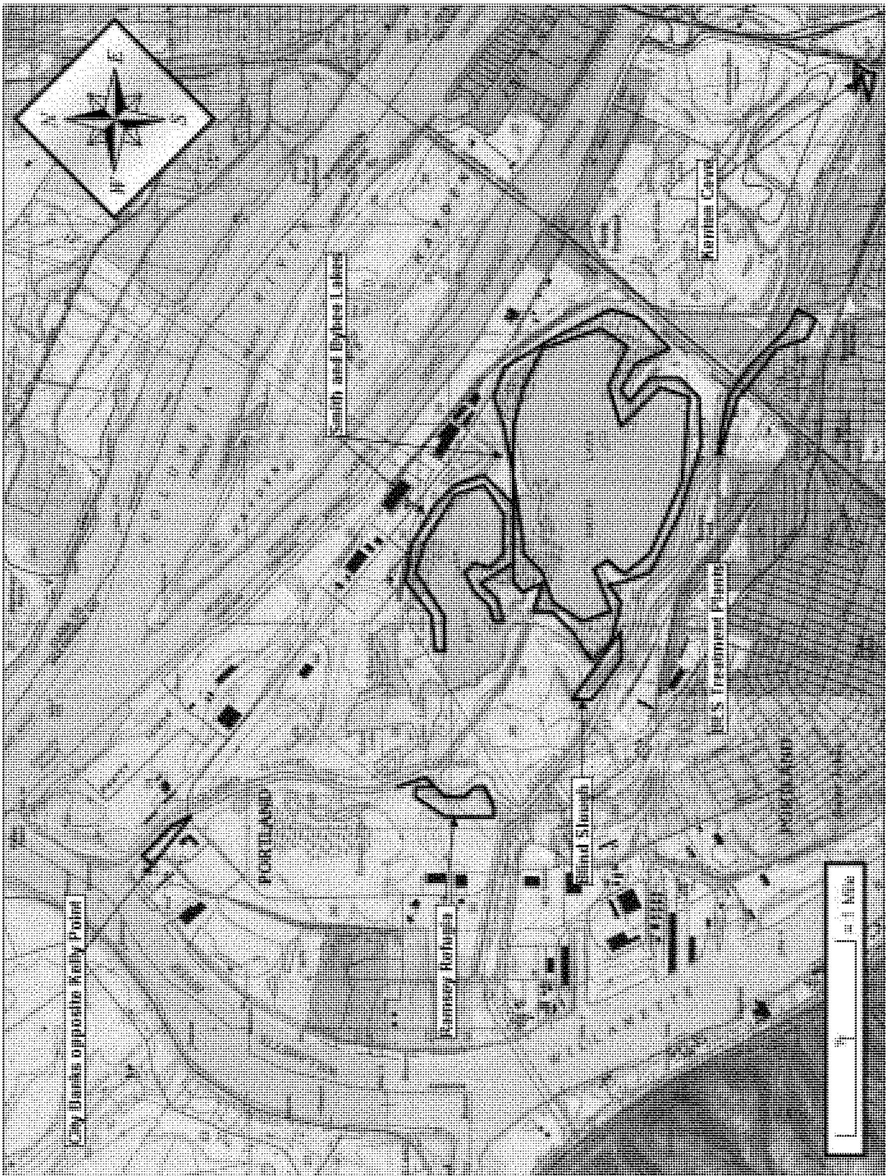

Figure 3. Columbia Slough. Kenton Cove to Willamette River (RM 0.5).

Figure 4. South Mainstem of the Willamette River. This reach stretches from River Mile (RM) 17.0 to 14.0 (Sellwood Bridge to Ross Island Bridge).

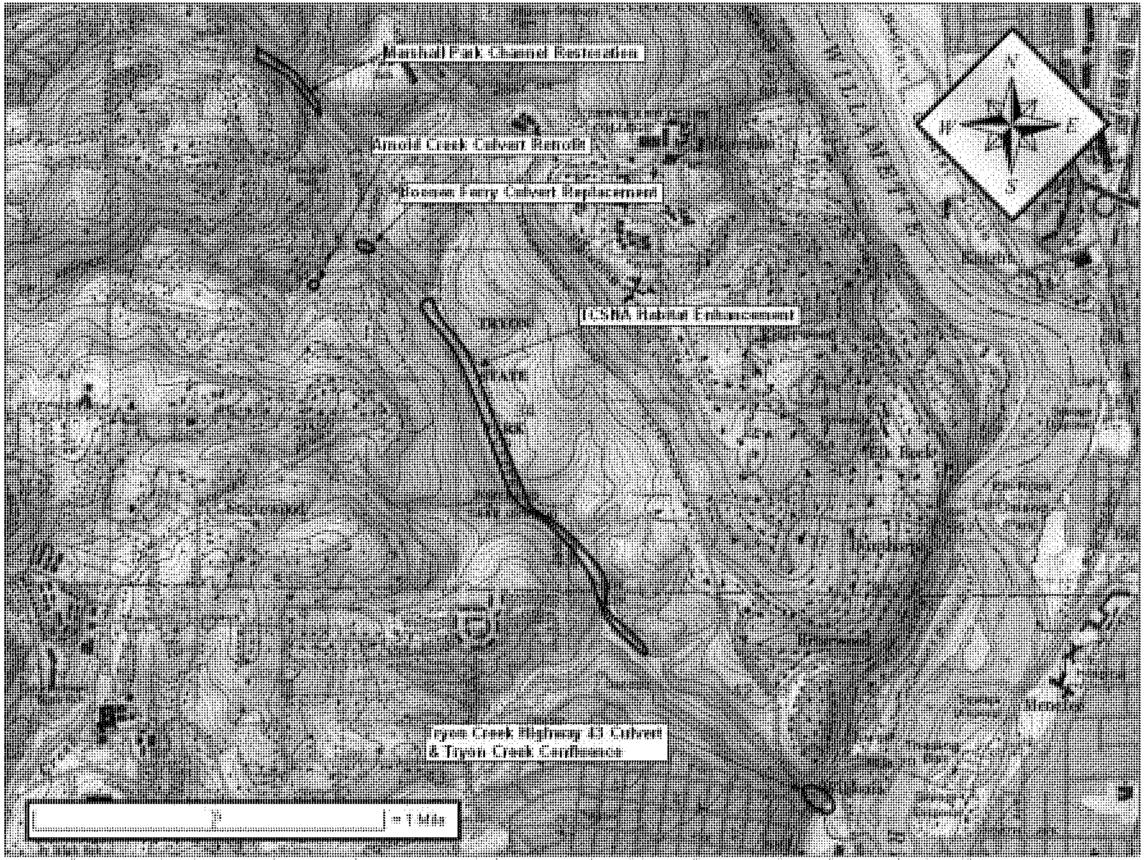

Figure 5. Tryon Creek. Marshall Park to Willamette River (RM 20.5). This reach consists of Tryon Creek near its confluence with the Willamette River to the upstream extent of Marshall Park.

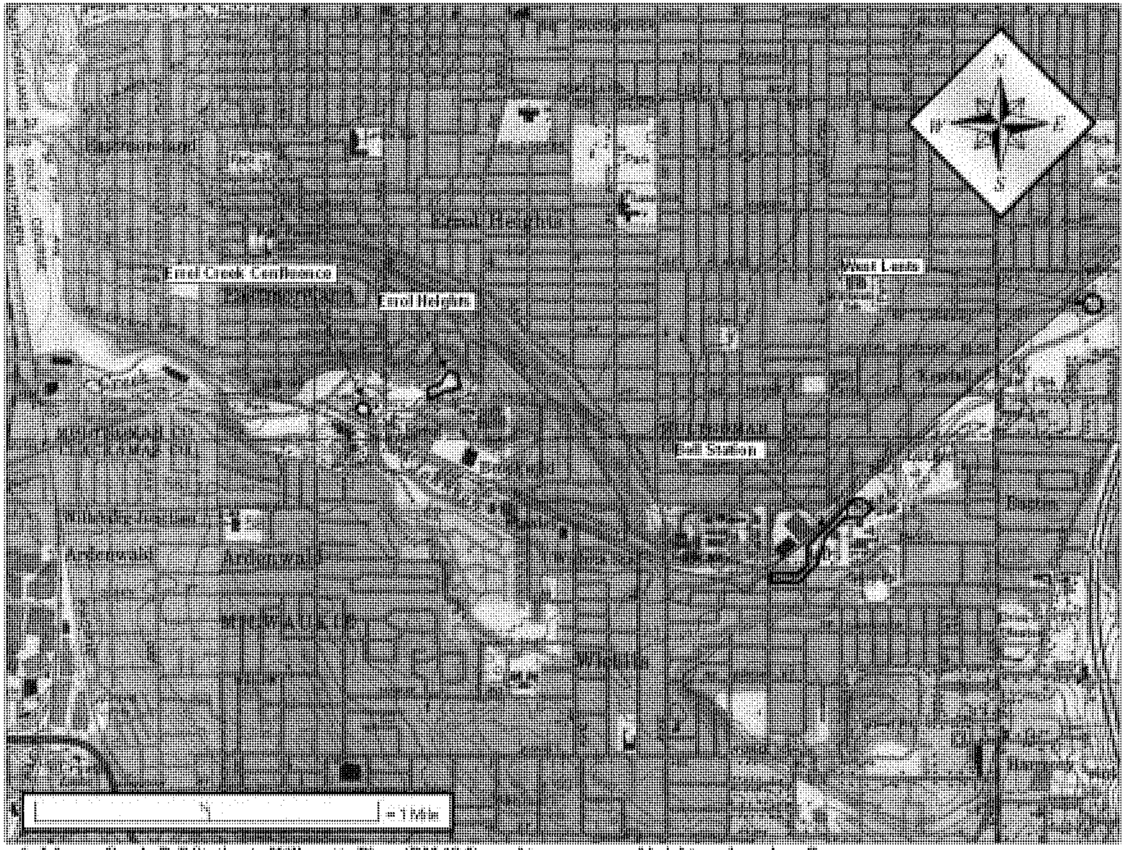

Figure 6. Johnson Creek, Bell Station to Willamette River (RM 18.5), need to remove errol heights and errol confluence

2.2 GEOLOGY AND STRATIGRAPHY

The project area lies within the Willamette Valley Province as described by Franklin and Dyrness (1988). The province stretches from the Columbia River to approximately Cottage Grove, Oregon where the Cascade and Coastal Mountain ranges converge. The project areas are all found near the northern terminus of this province, near it's confluence with the Columbia River. This portion of the Willamette Valley is characterized by broad alluvial flats separated by groups of low basalt hills such as the Portland and Chehalem Hills. The valley floor found within the study area displays the greatest elevation change within the entire Willamette valley.

2.3 CLIMATE

Portland experiences oceanic or marine west coast temperate climate, with mild, damp winters and relatively dry, warm summers. Summers in Portland are warm, sunny and relatively dry, with July reaching an average high of 81 °F and a low of 58 °F late in the month. Due to Portland's inland location and when there is an absence of a sea breeze, heat waves occur (in particular during the months of July and August) with air temperatures rising to over 100 °F. Winters can be mild to cold, and very moist, with January averaging a high of 46 °F and a low of 37 °F, cold snaps are short-lived. Spring can bring rather unpredictable weather, resulting from warm spells, to thunderstorms rolling off the Cascade Range. The rainfall averages 37.5 inches per year in downtown Portland. Portland averages 155 days with measurable precipitation per year. Snowfall occurs no more than a few times per year, although the city has been known to see major snow and ice storms thanks to cold air outflow from the Columbia River Gorge. The city's winter snowfall totals have ranged from just a trace on many occasions, to 60.9 inches in 1892-93. The lowest temperature ever recorded in Portland was −3 °F, set on February 2, 1950. The highest temperature ever recorded was 107 °F, set on July 30, 1965 as well as August 8, 1981, and August 10, 1981. Temperatures of 100 °F have been recorded in each of the months from May through September.

2.4 FLORA

Portland is home to a number of native and exotic floras that contribute to its urban setting. All of the restoration sites are located near water resources and are home to native, exotic and invasive species. Specific flora varieties observed at each of the restoration sites are summarized in Section 2.6.

2.5 FAUNA

Fauna found within the restoration sites is typical of a forested urban setting. Small mammals and birds occupy the majority of the fauna population with occasional deer and raptor species.

2.6 PRESENT LAND USE AND LAND DISTURBANCE

The existing conditions of each restoration project site vary in its present use and disturbances. Due to these fluctuations in land use each restoration project area will be described individually below.

Kelley Point Park: This site is a public park located at the confluence of the Willamette and Columbia Rivers that has a documented use as a dump area for Columbia River dredging operations (Houck 2000). The dominant vegetation includes large grassy areas, with an Oregon ash and cottonwood riparian zone. The shoreline along Kelley Point is good quality sand beaches with a moderate amount of wood. Blackberry is dominant in multiple locations. The public park itself has created disturbances through open field maintenance, path and trail construction and a parking lot. The specific project elements proposed for this site fall within portions of the park that are used by the public for walking trails and beach access.

Miller Creek Confluence: This site lies adjacent to a marina on the Multnomah Channel near its confluence with the Willamette River. Vegetation near the water is extremely dense with blackberry and nettle growth. Extensive dredge spoil deposition has occurred in the interior portion of this site, but does not directly affect Miller Creek itself. Aerial photography also shows that the NE quarter of this area has been cleared sometime between 1995 and 2000.

Doane Creek/Railroad Corridor: Most of this site lies between a railroad track and a commercial facility, both of which have significantly altered the landscape. The western culvert portion of the project area is covered by Highway 30 and a commercial building complex. The northern beach portion of the project area is a maintained park environment used by the nearby industrial complex. A strip of forest lies downslope from the railroad tracks and is covered with deciduous forest. Several homeless camps were observed in these woods. The remainder of the site skirts the bottom of the railroad grade and has been severely impacted by railroad construction.

Saltzman Creek: This site is characterized by a highly incised streambed surrounded by high mounds of what appear to be dredge spoils. The surrounding area is highly industrialized. The riparian zone is dominated by non-native locust, with some Oregon ash and red alder. The understory is predominantly Himalayan blackberry with some Pacific willow. The northern half of this project area is heavily vegetated and the surface could not be observed. The remaining portion of the project area lies along an open beach where no signs of cultural materials or features were identified.

Willamette Cove: The site is covered with invasive weeds and small concentrations of Douglas fir. Numerous hard packed roads are found at the site which appear to be used for pedestrian trails. This site is extremely disturbed based on ground level undulations likely caused by the presence of the former McCormick and Baxter treatment plant located directly east of the Willamette Cove site. Railroad tracks border the site to the east and north, homeless camps were observed on the site.

Ramsey Refugia: This site is covered with young deciduous tree growth and typical understory vegetation. A dirt road has been constructed through the site and starts at N. Lombard St. and travels north through the site, household trash was observed in various locations. Additional dirt roads were identified across the site and wetlands appear to have been constructed or enhanced for wildlife.

Blind Slough: Black cottonwood, cedar and fir dominate the overstory and the understory is comprised of Himalayan blackberry, snowberry, trailing blackberry and reed canary grass. The site is bordered to the north and west by a City of Portland garbage dump.

Smith and Bybee Lakes: This site surrounds Smith Lake and a large portion of Bybee Lake. Proposed project activities are limited to the wetland environments immediately surrounding these two lakes. A mix of grasses, shrubs, and small trees is found around the edges of the lakes in most places, but much of the vegetation consists of invasive species such as reed canary grass. The two lakes were once part of a landfill and are now being restored by the City of Portland.

BES Treatment Plant: This site consists of a bike trail and park and the left bank of Columbia Slough. The dominant vegetation includes black cottonwood, ninebark, Himalayan blackberry, English ivy, and reed canary grass. The shoreline appears to be naturally vertical and about 8 feet high. The site appears to have been recontoured at some point, perhaps to accommodate spoils from construction of the adjacent treatment plant.

Kenton Cove: This site consists of a large, shallow backwater area bordered by a levee on one side. The terrestrial portion is covered with young black cottonwood, Himalayan blackberry, and reed canary grass. No significant disturbances were observed outside of the levee area.

Ross Island: The entire north portion of the island is covered with invasive species and deciduous tree growth. The south portion of the island has undergone significant alteration from gravel mining. Because this location is accessible only by boat, it gets relatively few visitors. Access to the upland portion is restricted due to the presence of a great blue heron rockery.

Oaks Amusement Park: This site is located along the Willamette River and is frequented by public park users. Pier pilings are found along the beach. Heavy blackberry growth exists along the entire site and deciduous trees provide a tree canopy.

Oaks Crossing/ Sellwood Riverfront Park: This site is frequented by public park users. Pier pilings are found in place along the beach. Heavy blackberry growth exists along the river portion of the site. Deciduous and coniferous trees provide a tree canopy. Trails travel throughout the forest portion of the site. No significant impacts were observed and the maintained portion of the park is outside of the proposed project work within the site.

Errol Creek Confluence: The site is covered by invasive species and young deciduous trees. The culvert portion of the project to the north is found in a residential yard that has been maintained as an open space. This site has had stone work in Johnson Creek installed as a Works Progress Administration project in the 1930's and two road culverts. Also, the creek was channelized to accommodate local roads and residential development. No other significant disturbances were observed.

Errol Heights Headwaters: This site is used as a park which includes walking paths throughout. The vegetation is dominated by Pacific willow, Oregon ash, big leaf maple, Himalayan blackberry, English hawthorn, reed canary grass, and ivy. The headwaters area includes several springs that feed into a large wetland complex. Some excavation of channels and ponds has occurred. No other significant disturbances were observed.

Bell Station: Johnson Creek is highly channelized through this reach with a narrow strip of riparian zone dominated by young red alder, Oregon ash, and a few sparse cottonwoods. The understory is predominantly Himalayan blackberry and reed canary grass with some willows, red elderberry and hazelnut. No significant disturbances were observed within the site but the surrounding area has undergone significant alterations by the construction of residential neighborhoods and the previously mentioned commercial complex.

West Lents: This site is a mixed coniferous/deciduous forest which includes a maintained open grass area near its northern border. Invasive species have taken over the interior making access difficult. The creek is fairly channelized in a narrow corridor with banks dominated by blackberry. A portion of the floodplain has had blackberries removed and some plantings have occurred. There is a narrow strip of trees along the creek including Oregon ash, Pacific willow, big leaf maple, and Douglas firs, with Himalayan blackberry and swordfern understory. The site is surrounded by residential and commercial construction. Walking paths give limited access to the interior of the site.

Marshall Park Channel Restoration: The majority of the park is vegetated with second growth (mostly 12-18 inch dbh) alder and some Douglas fir and Western red cedar. The shrub layer is primarily native including salmonberry, Indian plum, sword fern, and trailing blackberry, but English ivy is also present.

Arnold Creek Culvert Retrofit: This site is surrounded by deciduous forest and has a paved road running through. The riparian zone is dominated by Himalayan blackberry and ivy, with a few red alder, Western red cedar and willows present. The site has been significantly impacted by the installation of the existing culvert which is scheduled to be replaced by the Lower Willamette.

Boones Ferry Culvert Retrofit: This site is surrounded by deciduous forest and has a paved road running through. The site has been significantly impacted by the installation of the existing culvert which is scheduled to be replaced by the Lower Willamette Restoration project.

<u>Middle TCSNA Habitat Enhancement:</u> This site lies at the bottom of a steep draw in which Tryon Creek runs. The majority of the site is vegetated with a second growth Douglas fir and Western red cedar forest. The riparian zone is dominated by red alder, salmonberry, sword fern, young cedar, and red elderberry. The site is surrounded by a mature deciduous forest. No significant impacts were observed.

<u>Tryon Highway 43 Culvert:</u> The site is dominated by Highway 43 and includes areas of heavy blackberry and young red alder growth.

<u>Tryon Creek Confluence:</u> The south bank of the creek has an above-ground sewer pipeline that runs along its length to the wastewater treatment plant on a high terrace above the creek. The south side has recently undergone noxious weed removal and replanting, while the north side of the creek once included a residence which was bought out and demolished by the City of Portland. The dominant vegetative species are cottonwood, red alder, and Pacific willow, with an understory of Himalayan blackberry, ivy, bamboo, Japanese knotweed, reed canary grass, and buttercup.

<u>University of Portland Triangle Park:</u> The site is mostly open and is driven over frequently created a hard packed surface (west half), steep river bank (east half) constitute the remainder of the site.

SECTION 3.0 CULTURAL SETTING

3.1 PREHISTORIC CULTURAL CHRONOLOGY

The Paleo-Indian stage is recognized throughout North America and represents the earliest known human settlement in North America. Paleo-Indian populations are thought have been composed of small, very mobile groups who focused on the hunting of large, now-extinct mammals such as mastodon, mammoth, giant ground sloth, giant bison, camel, and horse. Although artifacts associated with the Paleo-Indian Stage have been found in the Willamette Valley, no evidence of Paleo-Indian presence in the Portland Basin has been found to date (Aikens 1993, Ames 1994).

In North America, the Paleo-Indian stage was followed by the Archaic Stage, which extended from about 10,500 years ago to about 6,400 years ago. The Archaic is generally characterized by small, mobile, hunting/gathering groups that relied on a variety of plant and animal resources (the megafauna that characterized the Paleo-Indian stage were largely extinct by the beginning of the Archaic stage). Expressions of the Archaic stage varied in different regions, and over time regional and local groups became increasingly focused on locally abundant resources. This regional specialization in the later Archaic is reflected in the development of relatively large settlements and extensive trade networks in some regions of North America (Ames 1994).

Archaic settlement in the Portland Basin is highly probable but to date there has been little conclusive archaeological evidence for such occupations. Two sites in the general Portland area are considered likely candidates as Archaic sites. One of these is located in the Clackamas River drainage near the town of Sandy. The second of these sites is 35CL96 in Lake Oswego, located near the southern portion of the research area. The archaeological deposits have not been firmly dated but the artifact assemblage at 35CL96 is very similar to assemblages at other sites dating to between about 9,000 and 7,000 years ago (Ames 1994, Minor 1994).

In the past, the Archaic stage was often considered to continue until the appearance of agriculture, which was considered a prerequisite for the development of sedentary settlements and more complex societies. These latter features generally defined the Formative stage. In the Pacific Northwest, this model is not applicable since complex societies developed based on fishing, hunting, and gathering rather than farming. This exception was recognized by Willey and Phillips (1958), the authors of the concept of the Archaic and Formative stages, but was largely ignored or forgotten. Minor et al. (1994) have pursued the Archaic-Formative exception in the Portland Basin and argue that the Formative stage developed in western Oregon about 2,000 years ago, as evidenced by the appearance of sedentary villages. Although there is archaeological evidence of settlements with circular house pits in the Portland area before 2,000 years, Minor et al. argue that it is the construction of rectangular houses that is an index of truly permanent settlements. The earliest, archaeologically known rectangular houses in the Portland Basin date to about 2,000 years ago.

Ames (1994) builds of this formative idea and suggests that the Archaic was followed by the "Pacific period" on the Northwest Coast (including the lower Columbia River). The "Pacific period" designation was developed by Ames and Maschner to recognize the evolution of the Native peoples into complex hunter-gatherers, including the appearance and refinement of many of the distinctive cultural features of the Northwest Coast region. These features include occupation of permanent villages, the presence of social hierarchies and status differences, the importance of ritual, and participation of communities in interaction spheres that created extensive networks of kinship and exchange. Not all of these features are in evidence at archaeological sites in the Portland Basin, nor are they all apparent in the ethnohistoric literature. But it appears that the prehistoric and historic-period Native peoples of the Portland Basin were influenced by these regional developments. The Pacific period "model" is therefore applicable to the Portland Basin in helping to define how Native peoples in the lower Columbia River area shared in regional cultural patterns, had developed variations on those regional patterns, and had cultural attributes specific to the lower Columbia area. The Pacific period extends from about 4400 BC to AD 1775 (Ames 1994).

All of the known archaeological sites in the Portland Basin that have been dated with some accuracy are from Pacific period and most of these are from the Formative stage as defined by Minor et al (1994). The three oldest radiocarbon-dated Portland Basin sites are all located on the Columbia River floodplain not far from the mouth of the Willamette River: 45CL31 near Vancouver Lake (radiocarbon dates of 3510±100 BP ["before present", defined arbitrarily as AD 1950] and 3360±70 BP); 35MU117 on Bybee Lake (2970±80 BP, 2850±30 BP, and 2800±110 BP); and 35MU9 on Sauvie Island (2880±155 BP and 2850±95 BP) (Ellis 2000; Wessen 1983). In addition to these sites, limited excavations have been conducted at four sites along lower Columbia Slough that are from 1.1 to 1.8 km (3,500 to 6,000 ft) east of the Willamette River. Two of these sites (35MU105 and 35MU112) appear to have been seasonal camps; 35MU112 was occupied between about AD 700 and 1250; 35MU105, directly across the slough from 35MU112, was occupied between AD 1450 and 1800 (Ellis 1996, 1998). A third site (35MU47) may also have been a seasonal camp, dating to about AD 1335-1435. The fourth of these sites is 35MU46, at which excavations in 1990 indicated that the site was a possible winter village occupied between about AD 1425 and 1800 (Woodward 1990). Excavations at 35MU46 in 2002-2003 have provided substantially more evidence that it is a village site.

Summary data on radiocarbon-dated archaeological sites in the Portland Basin (Ames 1994; Minor et al. 1994) demonstrate that known archaeological sites provide an extensive record of the past 2,000 years in the Portland Basin. The past 1,500 years are especially well represented. Although some gaps in the sequence have been suggested, these gaps have tended to disappear as further archaeological studies have been conducted. This archaeological record demonstrates the presence of villages located on the banks of the Columbia and Clackamas rivers and along some of the larger drainages across the Columbia River floodplain (e.g., Columbia Slough).

Seasonal camps (some of which may have included houses) were more widely distributed across the floodplain, along sloughs and adjacent to ponds, lakes, and marshes. There are also some limited data indicating the presence of seasonal use locations (either camps or resource harvesting and processing areas) along streams in more upland settings (e.g., Johnson Creek). There are also a few archaeological sites that do not appear to be associated with any drainages or wetlands.

In a settlement model developed for the Columbia South Shore area (i.e., the Columbia River floodplain between NE 82nd Avenue and NE 185th Avenue), Minor et al. (1994) proposed that (1) low-lying sloughs and ponds were the locations for task-specific activities and short-term, dry-season camps; (2) marsh and wet meadow settings are found at slightly higher elevations than the slough/pond zone and were the locations of task-specific activities and more long-term seasonal occupations; and (3) the higher-elevation grasslands and woodlands were where seasonal camps and permanent villages were located, especially where they offered ready access to resource-rich wetlands.

3.2 RECORDED ETHNOGRAPHIC HISTORY

Prior to the arrival of Euro-Americans to the region Chinookan people occupied the region in which the project is located. These people collectively spoke various dialects of the Upper Chinookan language branch which is a part of the Penutian phylum Silverstein 1990, French and French 1998). The Chinookan people in general relied heavily on water resources but also included hunting and gathering in their subsistence economy (Silverstein 1990).

The Chinook group as a whole first encountered Euro-American explorers in 1792 when Robert Gray and John Boit of the *Columbia* were exploring the Willamette River. Following brief encounters by other explorers the Chinook people engaged in trade with fur traders and by the early 19th century missionaries were reporting on the Chinook populations. During the 19th century disease spread throughout all of the Pacific NW populations and in particular the Clackamas are said to have suffered extensively (Silverstein 1990).

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 Upland South borderlands of Missouri, Iowa, and the Ohio Valley.[39] Many of these emigrants followed the Oregon Trail, a 2,170-mile (3,490 km) trek across western North America that began at Independence, Missouri and finally ended at various locations near the mouth of the Willamette River. Although people had been traveling to Oregon since 1836, large-scale migration did not begin until 1843, when nearly one thousand pioneers headed westwards. Over the next 25 years, some 500,000 settlers traveled the Oregon Trail, braving the rapids of the Snake and Columbia Rivers in order to reach the Willamette Valley (Oregon Trail 2010).

Starting in the 1820's Oregon City grew up around Willamette Falls. Incorporated in 1844, it was the first city west of the Rocky Mountains to have that distinction (Oregon – California Trails Association 2010). John McLoughlin, a Hudson's Bay Company official, was one of the major contributors to the founding of the town in 1829 (Lewis 2008). McLoughlin attempted to persuade the British government (which still held sway over the area) to allow American settlers to live on the land, and provided significant help to American colonization of the area, all against the HBC's orders. Oregon City prospered because of the paper mills that were run by the water power of the Willamette Falls, which, unfortunately to the economic development of the area, formed an impassable barrier to river navigation. Linn City (originally Robins Nest) was established across the Willamette from Oregon City (Lewis 2008).

By the mid-19th century, settlers were increasingly encroaching on Native American lands in the Willamette Valley. Skirmishes between natives and settlers in the Umpqua and Rogue valleys to the southwest of the Willamette River resulted in the Oregon state government removing the natives by military force (Jette 2010). They were first led off their traditional lands to the Willamette Valley, but soon were marched to the Siletz Reservation on the coast west of the valley. Joel Palmer, a pioneer and legislator of the Oregon government, who had been involved with driving out the Umpqua and Rogue peoples, later forced tribes of the Willamette Valley to sign a treaty that transferred 7,500,000 acres (30,400 km2) of their land to the United States government for $200,000 (Palmer 2002). The natives of the Willamette Valley were similarly moved into the Siletz Reservation, which since has shrunk to a fraction of its former size (Columbia River History 2006). Palmer, later criticized for bringing unnecessary risk to white settlers (by angering the Native Americans) and often unlawful treatment of the natives, was removed from the legislature in 1856 (Palmer 2002). However, by that year, further conflicts with Native Americans saw the last of the tribes being removed from the valley (Beckham 1990).

After Portland was incorporated in 1851, quickly growing into Oregon's largest city, Oregon City began to slowly lose its importance as the economic and politic center of the Willamette Valley. Beginning in the 1850s, steamboats began to ply the Willamette, but Willamette Falls formed an almost impassable boundary (Lewis 2008). As a result, navigation on the Willamette River was divided into two stretches: the 27-mile (43 km) lower stretch from Portland to Oregon City, which allowed connection with the rest of the Columbia River system, and the upper reach, which encompassed most of the Willamette's length. In 1873, the construction of the Willamette Falls Locks bypassed the falls and allowed easy navigation between the upper and lower river. Each lock chamber measured 210 feet (64 m) long and 40 feet (12 m) wide, and the canal was originally manually operated (today it is electrically powered). Today, however, the lock system is little used (Lewis 2008).

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 (Portland 2010).

Swan Island was once a real island and 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 (Portland 2010).

SECTION 4.0 METHODS

4.1 CULTURAL RESOURCES RECORDS CHECK

The Oregon Parks and Recreation Department, State Historic Preservation Office; Geographic Information System (GIS) database of cultural resources sites and surveys was reviewed. Such a check was done to determine whether the subject parcel and/or its immediate environs had been previously surveyed for cultural resources and whether any archaeological sites have been identified and mapped.

4.2 TRIBAL NOTIFICATIONS

The Army Corp. of Engineers will be heading the Tribal Notification responsibilities for this project. This report does not contain any information regarding tribal notifications or associated documentation.

4.3 FIELD SURVEY

An archaeologist from Tetra Tech DIV, Bothell completed cultural resources investigations at all of the propose habitat restoration sites during the week of 9/28-10/2 2009 and on 3/25 2010. The Principal Investigator for the project was Mr. Frank Stipe, (Tetra Tech, Bothell, WA). Mr. Stipe meets and exceeds The Secretary of the Interior's Standards and Guidelines, and is, therefore, qualified to conduct and supervise archaeological investigations on federal, state, and private lands.

Field investigations were conducted at each site. Sites where conditions indicated a potential likelihood for subsurface archaeological materials were tested at 20 meter intervals on a grid set to cardinal directions. Sites where conditions indicated that archaeological materials were not likely underwent a less intense testing regiment to identify site conditions, identify disturbances and to identify any indications that archaeological materials may be present on the site.

SECTION 5.0 RESULTS

5.1 CULTURAL RESOURCES RECORDS CHECK

The Oregon Parks and Recreation Department, State Historic Preservation Office; GIS database of cultural resources sites and surveys was used to identify any known archaeological resources at the individual restoration sites as well as the level of archaeological survey completed at each restoration site.

The database identified numerous cultural resources located on several of the restoration sites as well as completed archaeological surveys which encompassed several of the restoration sites. The results of that research are outlined below.

Kelly Point Park: The northern tip of the project area has been covered with river dredging, stated under an unidentified report polygon within the GIS database (OR SHPO GIS dtabase). These dredgings would have presumably been placed towards the center of the "point" away from either the Columbia or Willamette rivers. The project related disturbances will occur near the shore were the banks will be sloped back and erosion control features installed. Along the southern border of the site, along the Columbia slough, four archaeological sites are known to exist. These sites are:
35MU47: Two 5-10 cm. bands of charcoal and thermally altered rock interspersed with a 10-15 cm. thick layer of silt in the bank of the Columbia Slough.
35MU48: Seasonal Campsite
35MU49: Seasonal Campsite
35MU50: Seasonal Campsite

All four of these sites were identified in 1979, in a subsequent cultural survey completed in 1983 (Survey#5246) 35MU48 and 35MU49 could not be found while the size of sites 35MU50 and 35MU47 appear to grow considerably. All four of these sites are located along a 1000 foot stretch of the Columbia slough's north bank.

Miller Creek confluence: No artifacts, sites or cultural features have been identified in or around the proposed restoration area. An archaeological survey passes through the restoration site but does not completely cover the proposed restoration area. The survey is described by report #17115 (Cultural Resources Reconnaissance Survey and Inventory of the Portland Segment of Level 3's Proposed Fiber Optic Line from Portland).

Doane Creek/Railroad Corridor: No artifacts, sites or cultural features have been identified in or around the proposed restoration area. An archaeological survey passes through the restoration site but does not completely cover the proposed restoration area. The survey is described by report #17115 (Cultural Resources Reconnaissance Survey and Inventory of the Portland Segment of Level 3's Proposed Fiber Optic Line from Portland).

Saltzman Creek: No artifacts, sites or cultural features have been identified in or around the proposed restoration area. No archaeological surveys have been completed which include any part of the restoration site.

Willamette Cove: One archaeological site has been identified within the project boundaries. This site (35MU114) is mainly a brick scatter related to the Western Cooperage Mill built in 1915. The site was discovered while a survey of the McCormick & Baxter Superfund (CERCLA) Property (#18347) was completed. One other archaeological survey has been completed in the restoration area. This survey (#1303) was completed for the St Johns Riverfront Development and had no physical survey completed.

Ramsey Refugia: No artifacts, sites or cultural features have been identified in or around the proposed restoration area. One survey has been completed which includes a part of the proposed restoration site. This survey (#8262) "The Ramsay Lake Project Area" identified numerous archaeological resources along its eastern project border but none along its western border where the proposed restoration site is located.

Blind Slough: No artifacts, sites or cultural features have been identified in or around the proposed restoration area. No archaeological surveys have been completed which include any part of the restoration site.

Smith and Bybee Lakes: Numerous archaeological surveys have been completed in and around the proposed restoration area and numerous archaeological sites are known to exist within the project area as well. All surveys completed in and around the Smith and Bybee Lakes project are described below.

Survey # 623: Identifies a lithic scatter in a letter report. Located between Smith and Bybee Lakes.
Survey # 8262: Identified fire hearths, FCR and lithic scatters NE of the proposed project area.
Survey # 15861: Did not identify any cultural resources.
Survey # 16729: Identified 3 hearth features that did not include any other artifacts forms. Two of these sites are located away from the restoration area while one of the sites falls along the north shore of Smith Lake within the restoration area.
Survey # 19765: Did not identify any cultural resources.
Survey # 21059: Did not identify any cultural resources.

Twelve archaeological sites where identified within the proposed restoration area during the records review. These sites are described below.

35MU15: Area of fire cracked rock located below the average water level.
35MU20: Area of fire cracked rock extending from 10 feet contour into lake
35MU21: Area of fire cracked rock at 10 ft. contour
35MU22: Area of fire cracked rock extending into the lake at normal lake level
35MU44: Possible Village Site
35MU46: Possible Village Site
35MU51: Seasonal campsite
35MU52: Area of fire cracked rock
35MU60: FCR and lithic artifacts
35MU110: Prehistoric short term campsite
35MU111: remains of a hearth
35MU117: Warm season base camp

BES Treatment Plant: No artifacts, sites or cultural features have been identified in or around the proposed restoration area. An archaeological survey passes through the restoration site but does not completely cover the proposed restoration area. The survey is described by report #17215 (Fiber Optic Line between Portland & Seattle Cultural Resource Assessment Clark, Cowlitz, Lewis, Thurston, Pierce & King Counties).

Kenton Cove: No artifacts, sites or cultural features have been identified in or around the proposed restoration area. An archaeological survey passes through the restoration site but does not completely cover the proposed restoration area. The survey is described by report #14770 (Preliminary Cultural Resource Assessment of Inverness Force Main Route Alternatives).

Ross Island: No artifacts, sites or cultural features have been identified in or around the proposed restoration area. An archaeological survey has been completed which covers the entire restoration area. The survey is described by report #622 (Report on Archaeological Reconnaissance of Ross Island).

Oaks Amusement Park: No artifacts, sites or cultural features have been identified in or around the proposed restoration area. An archaeological survey has been completed which covers the entire restoration area. The survey is described by report #312 (An assessment of the Cultural resources to be Affected by the Proposed Southeast Relieving Interceptor Project). There was no physical survey of the proposed restoration area.

Oaks Crossing/ Sellwood Riverfront Park: No artifacts, sites or cultural features have been identified in or around the proposed restoration area. No archaeological surveys have been completed which include any part of the restoration site.

Errol Creek Confluence: No artifacts, sites or cultural features have been identified in or around the proposed restoration area. No archaeological surveys have been completed which include any part of the restoration site.

Errol Heights Headwaters: No artifacts, sites or cultural features have been identified in or around the proposed restoration area. No archaeological surveys have been completed which include any part of the restoration site.

Bell Station: No artifacts, sites or cultural features have been identified in or around the proposed restoration area. No archaeological surveys have been completed which include any part of the restoration site.

West Lents: No artifacts, sites or cultural features have been identified in or around the proposed restoration area. No archaeological surveys have been completed which include any part of the restoration site.

Marshall Park Channel Restoration: No artifacts, sites or cultural features have been identified in or around the proposed restoration area. No archaeological surveys have been completed which include any part of the restoration site.

Arnold Creek Culvert Retrofit: No artifacts, sites or cultural features have been identified in or around the proposed restoration area. An archaeological survey passes through the restoration site but does not completely cover the proposed restoration area. The survey is described by report #15865 (HRA Letter Report 96-45: Cultural Resource Survey of Four Portland Area Watersheds).

Boones Ferry Culvert Retrofit: No artifacts, sites or cultural features have been identified in or around the proposed restoration area. An archaeological survey passes through the restoration site but does not completely cover the proposed restoration area. The survey is described by report #15865 (HRA Letter Report 96-45: Cultural Resource Survey of Four Portland Area Watersheds).

Middle TCSNA Habitat Enhancement: Four archaeological sites have previously been identified within the proposed restoration area. These sites have not been given Smithsonian trinomials. The sites are described below and are separated by bullets:

- Concrete foundations remains with associated bricks
- Earthen Depression
- Glass, ceramic, metal cable
- Bottles and cans

One archaeological survey has been completed within the proposed restoration area. This survey (#21479) did not identify any cultural materials or features other than those listed above.

Tryon Highway 43 Culvert: No artifacts, sites or cultural features have been identified in or around the proposed restoration area. No archaeological surveys have been completed which include any part of the restoration site.

Tryon Creek Confluence: No artifacts, sites or cultural features have been identified in or around the proposed restoration area. No archaeological surveys have been completed which include any part of the restoration site.

University of Portland Triangle Park: No artifacts, sites or cultural features have been identified in or around the proposed restoration area, site 35MU114 is located north of this site in the Willamette Cove site, the former McCormick & Baxter wood treatment plant is lcated between these two sites.

5.2 FIELD SURVEY

Each of the 26 restoration project sites was visited by a Tetra Tech archaeologist to inspect the area for cultural resources and to determine whether the area has the potential to hold intact subsurface cultural materials that would add to the archaeological record of the region. The site visit consisted of the archaeologist performing a pedestrian survey over all areas to be impacted by project activities, including potential lay down areas, and looking for evidence of those archaeological sites identified under section 5.1. Additionally; Sites where conditions indicated a potential likelihood for subsurface archaeological materials were tested at 20 meter intervals on a grid set to cardinal directions. Sites where conditions indicated that archaeological materials were not likely underwent a less intense testing regiment to identify site conditions, identify disturbances and to identify any indications that archaeological materials may be present on the site.

SECTION 6.0 DISCUSSION

"Historic properties," as defined by the ACHP, the body charged with implementing the National NHPA of 1966 [as amended], include any "...prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the NRHP maintained by the Secretary of the Interior" (36 CFR 800). The NPS has developed four criteria for determining eligibility for inclusion in the NRHP (36 CFR 60.4):

The quality of significance in American history, architecture, archeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity, design, setting, materials, workmanship, feeling, and association and

A. That are associated with events that have made a significant contributions to the broad patterns of our history; or

B. That are associated with the lives of persons significant in our past; or

C. That embodies the distinctive of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

D. That has yielded, or may be likely to yield, information important in prehistory or history.

6.1 Expectations

As discussed by Minor (1994) and summarized in Section 3.1 of this report; prehistoric cultural remains that are likely to be found in the project areas littoral environments are likely to be represented by procurement and specific task related archaeological sites. Evidence of these site types are not likely to be found on the surface, and given the known vegetation and subsurface disturbances experienced by all of these project areas from 20th century residential, commercial and industrial development these smaller site types are not expected to be identified within the selected project areas.

Euro-American occupation of the Lower Willamette and its tributaries, as summarized in Section 3.1, shows ongoing development and alteration of the landscape to suit individual occupation requirements. These developments and alterations have left a record of constant landscape alterations and renewal that is a patchwork across the landscape. Remains of various Euro-American occupations are expected and due to the project areas littoral context are expected to be related to commercial shipping and riverside industrial activities.

6.2 Archaeological Assessment of the Restoration Sites

Assessments are made based on known archaeological sites in the area and the level of perceptible disturbance that the project area has received which would have disrupted intact cultural materials and features that might be present. When possible the methodology of previous archaeological surveys will be used as a guide to determine the level of effort put forward towards identifying cultural resources at a particular restoration site. If a survey completed shovel testing across the entire project area with no results then the probability is low while if a windshield survey was completed then that survey will not be counted on as a marker for the level of possible archaeological materials present at the restoration site.

Kelly Point Park: The city of Portland acquired the Kelly Point Park site in 1984 from the Port of Portland, which had covered much of the peninsula with dredged material from the Columbia River to create places to build terminals like terminal 6 just SE of the park (Houck 2000).

The majority of project work will occur along the beach of the park where dredging would not have presumably been placed due to the proximity of either river. Inland from the beach the project will create a channel through the park and place woody debris and boulders for pond turtle habitat. These inland activities have the potential to dig through the dredging layer and into intact soil horizons that may hold cultural materials similar to those found in the surrounding area as described in section 5.1. In particular are sites 35MU50 and 35MU47 which as last visit had grown considerably in size. Evidence of these two sites was not observed but vegetation has grown back over the site locations and likely hides any cultural materials from view, a great asset in a public park.

Six shovel test pits were completed along the proposed channel which will travel through the public park. A dark loamy A soil horizon was underlain by a dark sandy horizon (presumably river dredging material), this sandy soil extended to between 40 cm. and 80 cm. from the ground surface. Below this sandy horizon was a dark slightly clayey sand that is likely the transition from dredging material to former top soil, due to depth and water seepage the shovel test probes were not completed, i.e. 20 cm. past a sterile C horizon.

The Kelly Point Park project has a high probability to disturb archaeological materials and/or features due to the close proximity of known archaeological resources and the lack of cultural resource survey completed on the specific project activity areas.

Miller Creek Confluence: Vegetation in the project area prevented any visual observations of the ground surface. The majority of project activities will occur on a flat rise where the area will be vegetated with native upland species. This area of the project appears deflated and aerial photographs show the trees cleared out of a portion of the project area after 1995 and before 2000.

The remaining project area skirts the river and dock area and will create wetland areas along Miller Creek which will be redirected to place the mouth of the Creek near the NE corner of the project area.

No archaeological resources are known to exist on the project area although a significant village site is known to exist just 1.5 miles upstream on the opposite side of the Multnomah Channel. This site is significant due to the excellent artifact preservation that has occurred due to the village's position below the average water line.

Four shovel test probes were dug on the flat rise where tree saplings will be planted. Soils on this flat consisted of a shallow A horizon (less than 5 cm.) underlain by yellowish brown loamy clay. Tree removal likely contributed to top soil erosion. Those areas to be used for wetland development near the water line could not be excavated due to water seepage and loose soils.

The Miller Creek Confluence project has a moderate probability to disturb archaeological materials and/or features. Site 35MU0004 is found approximately 1.5 miles upstream of the restoration site along the Multnomah Channel. Site 35MU0004 is a submerged archaeological site that dates to a time period when water level was lower than they are at present and has produced delicate archaeological materials preserved in their submerged state. As the proposed restoration project intends to disturb soils near the water line and because of known archaeological sites found along the same water course the proposed restoration efforts may disturb similar archaeological materials as those found at 35MU0004.

Doane Creek/Railroad Corridor: All portions of the restoration area have been heavily disturbed by railroad and highway construction. Project activities will involve installation of a fish passable culvert, create marsh habitat, install erosion control features and to slope back the banks along the Willamette river.

The Doane Creek/ Railroad Corridor project has a low probability to disturb any archaeological resources due to surface and sub-surface disturbances completed over the project area by railroad, railroad bridge, and road construction. Trees currently cover extremely low portions of the site and at the time of survey standing water was found.

Due to previous disturbances no shovel test probes were completed at this site.

Saltzman Creek: No artifacts, sites or cultural features have been identified in or around the proposed restoration area. An archaeological survey has been completed near the project area (report #17115) this survey did not identify any cultural materials or features near the restoration area. An industrial park is located directly west of the site. Ground visibility was good at the site, most of the site is located on the Willamette River beach.

The Saltzman Creek project has a low probability to disturb archaeological materials since the previous survey did not identify any archaeological materials and no known archaeological materials exist near the restoration site.

Willamette Cove: One archaeological site has been identified within the project boundaries. This site (35MU114) is mainly a brick scatter related to the Western Cooperage Mill built in 1915. The site was discovered while a survey of the McCormick

& Baxter Superfund (CERCLA) Property (#18347) was completed. One other archaeological survey has been completed in the restoration area. This survey (#1303) was completed for the St Johns Riverfront Development and had no physical survey completed.

The brick scatter is located near the Willamette River and the north side of the railroad bridge, glass was observed mixed with the bricks. No shovel test probes were completed within the known site boundaries of 35MU114. Ten shovel test probes were dug in relatively undisturbed portions of the site where archaeological materials would be most likely identified. Soils indicated that a shallow hard packed light brown A horizon is underlain by a brown gravelly Ab horizon. Due to rocks and hard packed soils the soil test probes could not be completed to depth.

No artifacts were identified but due to the presence of the cooperage mill, other Euro-American related archaeological deposits may be present; therefore this project has a high probability for disturbing archaeological materials.

City Banks opposite Kelly Point: The restoration activities at this site have the potential to disturb intact soil horizons that may hold cultural materials similar to those found in the surrounding area as described in section 5.1. In particular are sites 35MU50 and 35MU47 which as last visit had grown considerably in size. Evidence of these two sites was not observed but vegetation has grown back over the site locations and likely hides any cultural materials from view, a great asset in a public park.

Six shovel test pits were completed along the proposed channel which will travel through the public park. A dark loamy A soil horizon was underlain by a dark sandy horizon (presumably river dredging material), this sandy soil extended to between 40 cm. and 80 cm. from the ground surface. Below this sandy horizon was a dark slightly clayey sand that is likely the transition from dredging material to former top soil, due to depth and water seepage the shovel test probes were not completed, i.e. 20 cm. past a sterile C horizon.

The City Banks opposite Kelly Point project has a high probability to disturb intact subsurface archaeological resources such as those found in 35MU47 and 35MU50.

Ramsey Refugia: No artifacts, sites or cultural features have been identified in or around the proposed restoration area. One survey has been completed which includes a part of the proposed restoration site. This survey (#8262) "The Ramsay Lake Project Area" identified numerous archaeological resources along its eastern project border but none along its western border where the proposed restoration site is located. The proposed project work includes creating a channel, re-vegetation, replace culverts, slope back banks and to enhance permanent wetland conditions.

The Ramsey Refugia project has a low probability to disturb archaeological resources due existing disturbances related to wetland creation and culvert installation. Shovel test probes were completed in those areas where re-vegetation and bank enhancement activities would take place on the west border of the refuge (an industrial complex is located directly west of the site to mark its western border). These areas included heavy undergrowth of blackberry and relative understory varieties, the ground surface was not easily visible. Two shovel test probes were completed which showed a shallow dark brown loam A horizon underlain by a brown silty loam which transitioned to a dark brown slightly silty clay with grey mottles. Both shovel test probes were dug to 50 cm. and no artifacts were identified.

Blind Slough: No artifacts, sites or cultural features have been identified within the proposed restoration area. One archaeological survey has been completed within the proposed restoration area. This survey (OR SHPO # 16729) identified several hearth features that did not include any other artifacts forms. The nearest archaeological site identified by this survey to the restoration site is 35MU116 which is a site found to hold intact soil horizons of charcoal that may indicate a hearth. This site is located just under one half mile from the restoration site along the Columbia Slough.

Six shovel test probes were completed along this site which appears undisturbed and features mature alder growth with a blackberry understory. Shovel test probes showed an approximate 10-12 cm. silty loam dark brown A horizon transitioning to a brown silty clay with grey mottles. These shovel test probes were dug to 50 cm. below ground surface, no artifacts were identified.

The Blind Slough restoration project has a moderate possibility to disturb archaeological materials based on its setting, which is similar to other nearby locations that hold archaeological materials (35MU116) in the immediate vicinity, and the lack of perceptible disturbances which may have alter the landscape in such a way as to destroy and remove archaeological materials.

Smith and Bybee Lakes: Twelve archaeological sites have been identified in the immediate area of the planned restoration site. Disturbances from the former city garbage dump are expected but due to the marsh setting of the lakes and the known archaeological sites in the area the Smith and Bybee Lakes restoration project has a high potential to disturb intact cultural materials.

Due to the number of known archaeological sites within the Smith and Bybee Lakes site no shovel test probes were completed as potential areas for testing are known archaeological sites.

BES Treatment Plant: No artifacts, sites or cultural features have been identified in or around the proposed restoration area. An archaeological survey passes through the restoration site but does not completely cover the proposed restoration area. The presence of the homeless camps makes the possibility of any significant archaeological surface materials low but due to the mature forest, lack of perceptible disturbances the restoration project has a moderate chance of disturbing intact cultural materials. Two shovel test probes were completed on this site, both approximately 100 feet southwest of the Columbia Slough in areas not disturbed by soil moving activities and homeless camps. Both shovel test probes showed a brown silty clay A horizon underlain by a light brown B horizon starting at 14 cm. below the ground surface. The shovel test probes were dug down to 50 cm. and no artifacts were identified.

Kenton Cove: No artifacts, sites or cultural features have been identified in or around the proposed restoration area. An archaeological survey passes through the restoration site but does not completely cover the proposed restoration area. No disturbances were noted during the survey and considering the low level of disturbances expected from restoration activities the probability is low that any archaeological materials will be disturbed by this project.

Ross Island: A cultural resource survey (#622) has been conducted which covers the entire island. This survey did not identify any archaeological materials and no research has suggested that any would be expected.

The Ross Island project has a low potential to disturb unknown archaeological resources.

Oaks Amusement Park: No artifacts, sites or cultural features have been identified in or around the proposed restoration area. An archaeological survey report has been completed which covers the entire restoration area but no physical survey of the proposed restoration area was completed. Due to the existing pier pilings found in place along the beach the restoration site likely contains some archaeological materials but since the area is frequented by beach walkers from Sellwood Riverfront Park surface materials would not be expected.

The project has a moderate possibility to disturb archeological materials mostly likely during the excavation of the proposed channel due to the known Euro-American presence indicated by the pier pilings. Three shovel test probes were dug between the vegetated portion of the park and the piers located in the water on the park beach. The shovel test probes were dug in grassy areas where sand could be seen on the surface. The shovel test probes showed a loamy sand on the surface underlain by a brown sandy silt. No artifacts were identified in any of the probes.

Oaks crossing/ Sellwood Riverfront Park: No artifacts, sites or cultural features have been identified in or around the proposed restoration area. No archaeological surveys have been completed which include any part of the restoration site. Due to the existing pier pilings found in place along the beach the restoration site likely contains some archaeological materials but since the area is frequented by beach walkers from Sellwood Riverfront Park surface materials would not be expected. Project activities within the forest area of the site may uncover archaeological materials related to the pier pilings.

The project has a moderate possibility to disturb archeological materials due to the known Euro-American presence indicated by the pier pilings. Four shovel test probes were dug in the park away from the piers located in the water on the park beach. The shovel test probes were dug in grassy areas where sand could be seen on the surface. The shovel test probes showed a loamy sand on the surface underlain by a brown sandy silt. No artifacts were identified in any of the probes.

Errol Creek Confluence: No artifacts, sites or cultural features have been identified in or around the proposed restoration area. No archaeological surveys have been completed which include any part of the restoration site. A stone work was identified in Johnson Creek within the restoration site that is attributed to a Works Progress Administration project dating to the 1930's. This stone work was presumably limited to Johnson Creek but the surrounding area may hold archaeological materials related to the construction of that project and data that would add to the archaeological record of depression era Portland. Due to the existing stone work the project has a high likelihood of disturbing archaeological materials.

Errol Heights Headwaters: No artifacts, sites or cultural features have been identified in or around the proposed restoration area. No archaeological surveys have been completed which include any part of the restoration site. The project has a low chance of disturbing archaeological materials due to its location within a developed portion of Portland

Bell Station: No artifacts, sites or cultural features have been identified in or around the proposed restoration area. No archaeological surveys have been completed which include any part of the restoration site. The project has a low chance of disturbing archaeological materials due to the close proximity of residential housing and the commercial complex.

West Lents: No artifacts, sites or cultural features have been identified in or around the proposed restoration area. No archaeological surveys have been completed which include any part of the restoration site. The project has a low chance of disturbing archaeological materials due to the close proximity of residential housing and the commercial complex.

Marshall Park Channel Restoration: No artifacts, sites or cultural features have been identified in or around the proposed restoration area. The project is found in an area of steep slopes and second growth forest. The project has a low potential to disturb archaeological materials.

Arnold Creek Culvert Retrofit: No artifacts, sites or cultural features have been identified in or around the proposed restoration area. An archaeological survey passes through the restoration site but does not completely cover the proposed restoration area. The project has a low potential to disturb archaeological materials since the main objective is to replace an existing culvert which would have already disturbed and uncovered any archaeological materials that could be present when it was installed.

Boones Ferry Culvert Retrofit: No artifacts, sites or cultural features have been identified in or around the proposed restoration area. An archaeological survey passes through the restoration site but does not completely cover the proposed restoration area.

The project has a low potential to disturb archaeological materials since the main objective is to replace an existing culvert which would have already disturbed and uncovered any archaeological materials that could be present when it was installed.

Middle TCSNA Habitat Enhancement: Four archaeological sites have been identified near the proposed restoration area. These sites are composed of Euro-American refuse remains and a building foundation. The project has a low potential to disturb archaeological materials since project activities are limited to the lower creek area and not higher up outside of the creek draw where the previously mentioned sites were found. The specific project area has already been surveyed by an archaeologist who did not identify any cultural materials near the creek itself.

Tryon Creek Culvert: No artifacts, sites or cultural features have been identified in or around the proposed restoration area. No archaeological surveys have been completed which include any part of the restoration site. The project has a low probability of disturbing archaeological materials since the original culvert installation disturbed and uncovered any archaeological materials which might have been present. No shovel test probes were completed due to the small project size and the total disturbance of the project area.

Tryon Creek Confluence: No artifacts, sites or cultural features have been identified in or around the proposed restoration area. No archaeological surveys have been completed which include any part of the restoration site. The project has a low probability of disturbing archaeological materials due to the adjacent disturbances caused by residential and commercial construction.

University of Portland Triangle Park: One archaeological site has been identified within the project boundaries. This site (35MU114) is mainly a brick scatter related to the Western Cooperage Mill built in 1915. The site was discovered while as survey of the McCormick & Baxter Superfund (CERCLA) Property (#18347) was completed. This survey did not identify any other cultural materials. Due to the presence of the cooperage mill, other Euro-American related archaeological deposits may be present; therefore this project has a high probability for disturbing archaeological materials.

7.0 CONCLUSIONS

The Oregon SHPO GIS database indicated that there are historic properties within the APE although none are eligible for inclusion in the NHRP. A pedestrian archaeological field survey and limited subsurface testing using shovel test probes failed to detect any historic properties. This is to say that no "significant" prehistoric or historic-era sites, features, buildings, or artifacts were recorded.

In summary, no properties eligible for or listed in the National Register of Historic Places were observed in the Lower Willamette APE. The proposed project actions are not expected to have an adverse effect on historic properties.

SECTION 8.0 RECOMMENDATIONS

Section 106 of the NHPA requires that federal agencies take into account the effects of their undertakings on historic properties and seek ways to avoid, minimize, or mitigate any adverse effects on such properties (36 CFR 800.1(a)). No historic properties were identified within any of the project areas. Insofar as no significant prehistoric or historic era artifacts, features, sites, or districts were identified, it follows that no federal historic properties have been identified. Given these observations and deductions, Tetra Tech, Inc., presents the following recommendations regarding the proposed undertaking:

• No historic properties (as defined by the ACHP with regard to the NHPA have been observed or recorded within any of the Lower Willamette Restoration sites APE. Thus, no historic properties will be affected by the proposed undertaking as currently proposed;

• If ground-disturbing activities (such as dozing, grading, or backhoe excavation) expose any prehistoric or historic-era artifacts (older than 50 years), features, or sites, all work in the immediate area is to be stopped. The appropriate cultural resources manager is to be notified of the find immediately;

• If human remains are discovered in the course of ground disturbance all work in that area should be halted or diverted until the appropriate County Coroner's Office is notified and that office offers an opinion/disposition. Notification of the appropriate County Coroner shall occur within 24 hours of discovery.

SECTION 9.0 CERTIFICATION

I hereby certify that the statements furnished above and in the attached exhibits regarding the Lower Willamette Cultural Resource Review Project present the data and information required for this archaeological report, and that the facts, statements and information presented are true and correct to the best of my knowledge and belief. I also certify that I am a qualified California archaeologist who meets and exceeds The Secretary of the Interior's Standards and Guidelines.

Signed: Date: November 5, 2010

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APPENDIX E

Hazardous, Toxic, and Radioactive Waste

1. Introduction

As part of the Lower Willamette River Ecosystem Restoration General Investigation, Tetra Tech conducted a preliminary Hazardous and Toxic Waste and Materials (HTRW) investigation of each recommended site to determine if there is any current and/or historical contamination that could adversely influence the implementation of any future planned restoration measures. The preliminary assessment was based on a review of relevant environmental databases maintained by Federal and state regulatory agencies, and limited site reconnaissance, both conducted in September 2009.

1.1 Database Search

As a primary basis for the preliminary assessment, Tetra Tech requested a search of available environmental databases for each restoration site, which was performed by Environmental Data Resources, Inc. (EDR 2009). The EDR database search included lists compiled by the U.S. Environmental Protection Agency (EPA) and the State of Oregon for sites within or in proximity to each restoration site that have had recent or historical unauthorized releases of hazardous materials or hazardous waste, where hazardous materials may have been used or stored, or which may be generators and/or transporters of hazardous wastes.

The following government databases were included in the EDR search in accordance with American Society for Testing and Materials (ASTM) Standard E 1527-05 search distances:

- Brownfields Investigations and Cleanup (Brownfields). The EPA maintains and monitors all properties subject to brownfield investigation and cleanup under cooperative agreements that may involve Federal and state agencies and responsible parties.
- Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS). CERCLIS is a nationwide database of sites identified by EPA as abandoned, inactive, or uncontrolled hazardous waste sites that may require cleanup.
- Emergency Response Notification System. This database is maintained by EPA that covers reported unauthorized releases of oil and hazardous substances.
- Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) / Toxic Substance Control Act (TSCA) Tracking System (FTTS). These are recent cases tracked by EPA that involve pesticide enforcement actions and compliance activities related to FIFRA, the TSCA, and the Federal Emergency Planning and Community Right-to-Know Act.
- National Priorities List (NPL). This is a database maintained by EPA under the Comprehensive Environmental Response Compensation and Liability Act of 1980. Those CERCLIS sites that contain the greatest potential risk to human health and the environment become part of the NPL.
- Resource Conservation and Recovery Information System. In this database, EPA maintains information on those sites across the country that may generate, transport, store, treat, and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act.

- Toxic Chemical Release Inventory System (TRIS). The EPA maintains a list and monitors facilities that release reportable quantities of toxic chemicals to the air, water, or land.
- Aerometric Information Retrieval System. This is a database maintained by Oregon Department of Environmental Quality (ODEQ) regarding all Title V permitted facilities in Oregon that release regulated contaminants to the air.
- Environmental Cleanup Site Information (ECSI). Used by the ODEQ to track sites with known, suspected, or cleaned up hazardous substance contamination.
- Leaking Underground Storage Tanks. Information is maintained at ODEQ on reported leaking underground storage tank incidents.
- National Pollutant Discharge Elimination System (NPDES). This is a list of waste discharge systems (including stormwater) maintained and monitored by ODEQ.
- Oregon Confirmed Release List and Inventory. This list of sites, maintained and monitored by ODEQ, contains those sites in Oregon that have confirmed releases of contamination. This is the state's version of CERCLIS.
- Oregon Voluntary Cleanup Program (VCP). These are sites listed by ODEQ that have confirmed or unconfirmed releases where a project proponent has requested the state to oversee investigation and/or cleanup activities at the proponent's expense.
- Oregon Spills (SPILLS). This is a database tracking system used by the ODEQ to inventory and track oil and hazardous materials spills in the state that have been reported through the Environmental Response Program.
- Solid Waste Facility / Landfill (SWF/LF). The ODEQ maintains a list of, and information on SWF/LF in the state. Data maintained include location, type and age of landfill, if it is a permitted facility, and the status of its permit.
- Underground Injection Control (UIC) Program. This database is maintained by ODEQ which has been delegated by EPA to regulate all underground injection programs to remediate hazardous materials migration to protect groundwater resources.

2. Initial Findings Identified from the EDR Database Search Report

An overview of the database search report was conducted to assess any initial findings reported within the databases listed above. Findings that may indicate a need for further study of the information provided in the EDR report are discussed for each site in the section below. The additional investigation and/or monitoring suggested for these sites of interest might include field investigation, agency file and document research, and discussions with agency personnel and others who are knowledgeable about these sites. 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.

2.1 Kelley Point Park

The overview of data generated for the Kelley Point Park site yielded 12 initial findings, as summarized in Table 2.1.

Table 2.1: Summary of HTRW Initial Findings in the Kelley Point Study Area Identified from EDR Database Report

Database	Initial Findings
ECSI	1
FTTS	1
NPDES	2
SPILLS	5
VCP	1
TRIS	1
UIC	1
TOTAL	12

Source: EDR Database Search Report (EDR 2009).

A closer review of the information provided in the EDR database report was performed for each of the above initial findings. Based on the review of information, three sites of interest in proximity to the Kelley Point Park study area were identified. Of these sites, one is located at least 0.25 miles away from the study site and is on the opposite side of Columbia Slough, and another is located approximately 1 mile away from the study site. No additional investigation is recommended for these sites.

The third site of interest is the temporary new auto storage lot at the Port of Portland, which is located adjacent to the study site. This site was listed in the NPDES database, therefore a review of conditions under the Port of Portland's NPDES permit is recommended.

Table 2.2: HTRW Sites of Interest in the Kelley Point Park Study Area

Site of Interest	Database(s)	Address / Location	EDR Map Id

1. Land O' Lakes Inc.	ECSI, VCP, NPDES, SPILLS	15840 N. Simons Road, Portland, OR 97203	D
2. Portland General Electric – Kelley Point	UIC	8201 N. Marine Drive, Portland, OR, 97203	A
3. Auto Warehousing Co.	NPDES	8235 N. Marine Drive, Portland, 97203	A

Source: EDR Database Search Report (EDR 2009).

2.2 BES Plant

The database search report overview for BES Treatment Plant yielded 43 initial findings reported in the above-listed databases, as summarized in Table 2.3.

Table 2.3: Summary of HTRW Initial Findings in the Study Area Identified from EDR Database Report

Database	Initial Findings
Brownfields	1
ECSI	3
FTTS	3
LUST	14
NPDES	6
OR CRL	1
SPILLS	7
SWF/LF	2
UIC	5
VCP	1
TOTAL	43

Source: EDR Database Search Report (EDR 2009).

A closer review of the information provided in the EDR database report was performed for each of the 43 initial findings. Based on the review of information provided in the EDR report for these sites it was concluded that there are three sites of interest in proximity to the study area. Of these, one is located on the opposite side of Columbia Slough and at least 0.5 miles away from the study site, and a second is located at least 0.25 miles away from the study site. A third site, described below, is located at the BES Treatment Plant and warrants limited additional investigation.

Table 2.4: HTRW Sites of Interest in the BES Treatment Plant Study Area

Site of Interest	Database(s)	Address / Location	EDR Map ID

1. Columbia Boulevard Wastewater Treatment Plant	NPDES, ECSI, FTTS, SPILLS, SWF/LF, LUST	5001 N. Columbia Boulevard, Portland, OR 97203	F

Source: EDR Database Search Report.

2.3 Kenton Cove

The database search report overview for Kenton Cove yielded 14 initial findings reported in the above-listed databases, as summarized in Table 2.5.

Table 2.5: Summary of HTRW Initial Findings in the Study Area Identified from EDR Database Report

Database	Initial Findings
AIRS	1
ECSI	1
LUST	1
NPDES, ICIS	1
OR CRL	1
RCRA - LQG	1
SPILLS	6
TRIS	1
VCP	1
TOTAL	14

Sonrce: EDR Database Search Report (EDR 2009).

A closer review of the information provided in the EDR database report was performed for each of the 14 initial findings. Based on the review of information provided in the EDR report for the Kenton Cove study area, one site of interest was identified in proximity to the study area. However, this site is located approximately 0.25 miles away from the Kenton Cover study area, and is also on the other side of Columbia Slough. Therefore, no additional investigation is recommended at this site.

2.4 Oaks Crossing

An overview of the data generated for the Oaks Crossing study area yielded 25 initial findings, as summarized in Table 2.6.

Table 2.6: Summary of HTRW Initial Findings in the Study Area Identified from EDR Database Report

Database	Initial Findings
Brownfields	1
ECSI	2
LUST	14
NPDES, ICIS	1

OR CRL	1
SPILLS	5
VCP	1
TOTAL	25

Source: EDR Database Search Report (EDR 2009).

A closer review of the information provided in the EDR database report identified two sites of interest in proximity to the study area. However, both of these sites are on the opposite side of the Willamette River from the Oaks Crossing study area, therefore no additional investigation is recommended.

2.5 Tryon Creek Highway 43 Culvert

An overview of the data generated for the Tryon Creek Highway 43 Culvert study area yielded 17 initial findings reported in the above-listed databases, as summarized in Table 2.7.

Table 2.7: Summary of HTRW Initial Findings in the Study Area Identified from EDR Database Report

Database	Initial Findings
ECSI	1
FTTS	2
LUST	8
NPDES	1
SPILLS	5
TOTAL	17

Source: EDR Database Search Report (EDR 2009).

A closer review of the information provided in the EDR database report identified one site of interest in proximity to the study area. However, this site is located approximately 0.5 miles from the edge of the study area, therefore no additional investigation is recommended.

3. Further Investigation

Figure 1 displays the HTRW sites identified as occurring in the vicinity of the project sites. Projects that may need additional investigation are Kelley Point Park and BES Plant. Each of these sites will undergo a site specific evaluation to determine the effects of the potential for HTRW contamination. However, based on this preliminary evaluation, the potential for significant HTRW presence appears to be low.

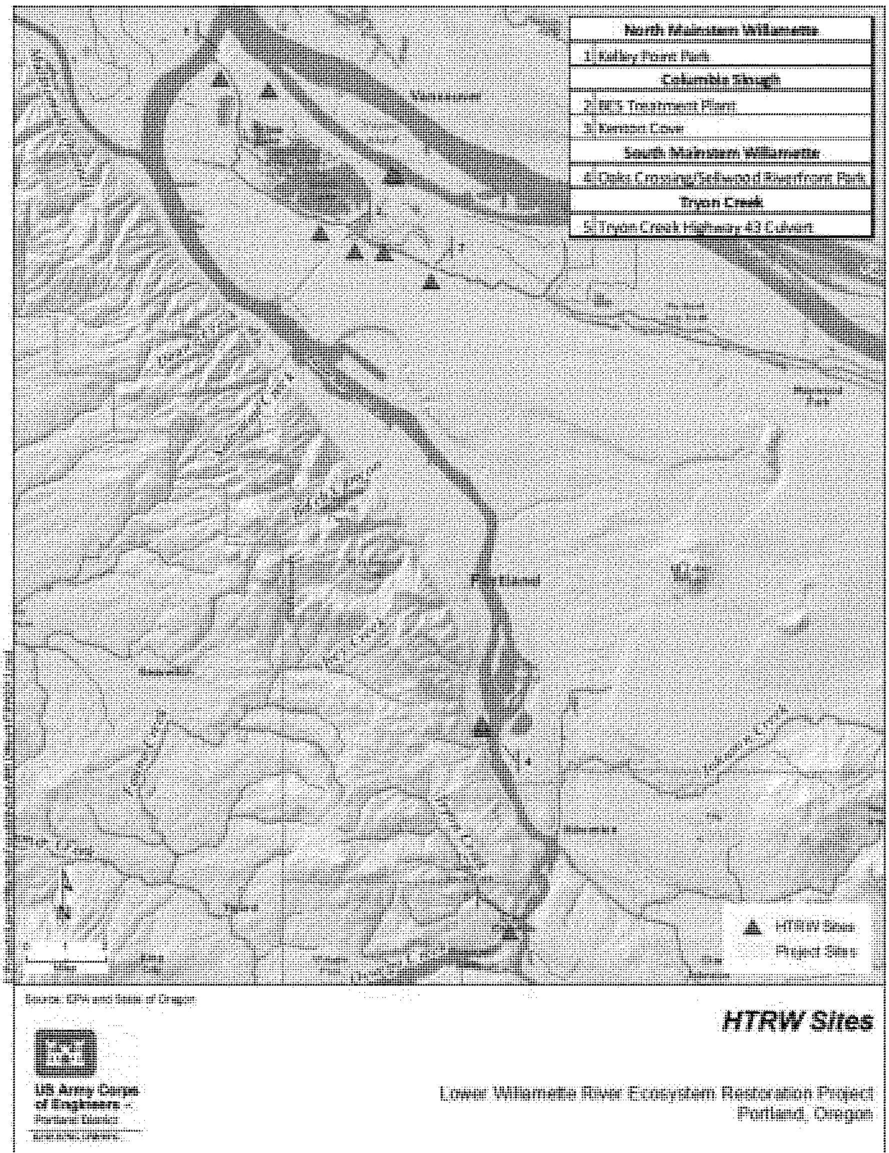

Figure 1. HTRW Sites

4. Future Without Project Conditions

If potential future restoration measures for each site being considered in this general investigation are not implemented, the baseline conditions regarding the use of hazardous wastes and materials and the generation, storage, and disposal of hazardous wastes and materials in the study area will likely continue as at present into the foreseeable future. In addition, at identified sites of interest, there is the potential for current and historical contamination at these sites to adversely affect human activities in the study area, with or without the implementation of the proposed action.

APPENDIX F
Habitat Evaluation Procedure Model

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Appendix A – Model Certification Letters

LOWER WILLAMETTE RIVER ECOSYSTEM RESTORATION PROJECT HABITAT EVALUATION MODEL

1. PURPOSE

The purpose of the Lower Willamette River Ecosystem Restoration Project habitat evaluation model is to evaluate the increase in ecological function and habitat benefits as a result of restoring aquatic, riparian, and floodplain habitats along the Lower Willamette River in Portland, Oregon. Specifically, the model and its components will address the extent to which habitat restoration will benefit multiple key fish and wildlife species. The model is comprised of multiple species Habitat Suitability Indices (HSIs) within the Habitat Evaluation Procedures (HEP) framework developed by the U.S. Fish and Wildlife Service (USFWS 1980a).

The habitat evaluation model is proposed for one-time use for the Lower Willamette River Ecosystem Restoration Study being conducted by the U.S. Army Corps of Engineers, Portland District and its cost-share partner, the City of Portland. HSIs for native salmonids (tributary model), native amphibians, and western pond turtles as described in this model have been approved for one-time use on this project. The Mainstem Salmonid HIS is a new model and is under review for certification. HSIs for beaver and wood duck used existing models but not all parameters were used. The HSI for the yellow warbler may be reviewed as an additional parameter was added to broaden its applicability to include additional neotropical migrants. Documentation of approval is provided in Appendix A.

2. BACKGROUND

This document summarizes the model used for estimating ecological function of the proposed alternatives of the Lower Willamette River Ecosystem Restoration Study (Study). This model was used to assess the existing and the with- and without-project future condition of riverine, riparian, and floodplain habitats and their relationships to fish and wildlife species production and survival. The intent of the model was to provide a set of quantitative tools for evaluating and comparing a broad set of potential ecological outputs associated with various alternatives.

In order to evaluate and compare restoration alternatives, it was necessary to assign a numeric value to the habitat benefits for each alternative. These habitat benefits, known as Habitat Unit (HU) outputs are derived through the use of the Habitat Evaluation Procedure (HEP). HEP provides a means for designing a mathematical model based on the habitat suitability of the proposed restored habitats for one or more species that represent those habitats. The output of the model provides a quantitative value (HUs) to be used for further evaluation and comparison of the proposed alternatives. This quantitative or numeric scoring method further facilitates comparisons of potential habitat impacts and benefits between alternatives through the use of the HUs in conducting an incremental cost and cost effectiveness analysis. Section 3 provides a description of the development and use of the HEP model.

2.1 Proposed Project

The study area includes the Lower Willamette River watershed between its confluence with the Columbia River at river mile (RM) 0 and Willamette Falls, located at RM 26.6. Several tributaries are found within the study area, two of which are included in this study. Those tributaries include Columbia Slough, which enters the Willamette River at RM 0.5, and Tryon Creek, which enters the river at RM 20.1.

The Lower Willamette River is a large, low-gradient river with average annualized daily discharge of 33,160 cfs. Habitat types present in the floodplain include bottomland riparian forest, scrub/shrub, ponded wetlands, and grassland. Columbia Slough is tied to the Willamette River hydrologically, but supports habitat types more typically associated with backwaters than with a high-discharge stream. Tryon Creek is a typical mid-gradient stream approximately 7 miles long, with an average annualized discharge of approximately 5 cfs. Tryon Creek supports the only potential spawning habitat in the study area.

Quality habitat for salmonids and other native fish species is limited in the Lower Willamette River and its tributaries. 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. 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.

- **<u>Loss of Habitat Complexity</u>** 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.

- **<u>Loss or Degradation of Off-channel Habitats</u>** 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.

- **<u>Reduction in Nutrients and Woody Material</u>** 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.

- **<u>Degraded Water Quality</u>** 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.

- **<u>Contaminated Sediments</u>** 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.

Several physical, hydraulic, and chemical parameters are considered necessary to establishing baseline habitat quality in the study area. These parameters include the following:

Tidal Influence: Tidal range in the Willamette mainstem and Columbia Slough typically is between 0-3 feet. Because the influence of tidal fluctuation varies depending on discharge from the Willamette River, the influence of tidal inundation on velocity and water surface elevation is difficult to predict in the absence of extensive hydraulic modeling. However, stage data developed by use of USGS gauges on the Willamette River indicate that the average water surface elevation under normal winter flows is between 9.7 and 9.9 ft NAVD for sites on the mainstem and Columbia Slough. There is no tidal influence on Tryon Creek upstream of the mouth of the creek.

Salinity: The confluence of the Willamette River and the Columbia River is located at Columbia RM 101, well upstream of the Columbia River estuarine mixing zone, the upstream extent of which occurs at about RM 30. Therefore, there are no saline or brackish waters found at any of the proposed restoration sites.

Velocity: Due to the lack of hydraulic modeling data in the lower mainstem, it is not possible to completely predict water velocity at edges or in side channels. The mainstem river in the study area, particularly in proximity to its confluence with the Columbia River, is low gradient and water velocities tend to be relatively low. In order to restore conditions found in historic side channels of the lower river, side channels in Kelley Point Park have been designed to have velocities of less than 1 foot/sec. Similar or lower velocities are expected in backwater sloughs and wetlands, such as those proposed for the BES Plant and Oaks Bottom/Sellwood Riverfront Park sites.

Dissolved Oxygen (DO): Aroner (2001) found DO levels between 6.0 and 14.3 mg/L in the mainstem Willamette River. Data regarding DO levels in Tryon Creek were not found, but it is assumed that DO levels in that water body are equal to or higher than those in the mainstem, as water is generally cooler and the streambed and instream structures offer more opportunities for oxygen to be mixed with flowing water than in the mainstem. Low DO (<4 mg/L) has occurred on past occasions in Columbia Slough, usually as a result of high input of de-icing materials from nearby Portland International Airport. Measures to contain de-icing materials have been put into place, and such events no longer occur. However, overall DO levels in Columbia Slough appear to be low, although current specific monitoring data for DO is not available.

Temperature: Water temperature is a concern in the project area and total maximum daily loads (TMDLs) are in place for temperature in the Willamette River mainstem, Columbia Slough, and Tryon Creek (ODEQ 2006). Numeric temperature criteria have been designated in Oregon that are specific to salmonids life stages. The mainstem Willamette is considered a migration corridor and has a 64.4°F seven-day moving average standard of daily maximum temperature for rearing and migration (ODEQ 2006). Water temperature in the mainstem Willamette River can reach upward of 73°F during the summer/fall low flow period (July-Sept.). However during the winter and spring, including the spring runoff when juvenile salmonids are out-migrating, temperatures rarely exceed 58°F (USGS 2014). On the other hand, temperatures in the tributaries are of concern year-round, and have a designated numeric temperature criteria for spawning and juvenile rearing of 55.4°F. Therefore summer/fall low temperatures can be limiting as high temperatures have been recorded in the Columbia Slough up to 73°F and 68°F in Tryon Creek.

3. HABITAT EVALUATION MODEL

The Habitat Evaluation Procedure (HEP) is a procedure developed by the U.S. Fish and Wildlife Service (1980a and 1980b) to facilitate the identification of effects of various types of actions on fish and wildlife habitat. The basic premise of HEP is that habitat quantity and quality can be numerically described. HEP can provide a comparison of habitat quality between different sites or between different times at one site (for example, pre-construction versus post-construction). A key assumption in HEP is that an individual species "prefers" (or survives/reproduces better) in habitats with certain physical characteristics that can be measured. For example, if yellow warblers typically nest in deciduous shrubs, then sites with greater deciduous shrub cover are more suitable for yellow warblers than sites which have little or no deciduous shrub cover.

A Habitat Suitability Index (HSI) is the typical format used in HEP which is a mathematical relationship between a physical, chemical, or biological habitat attribute and its suitability for a single species or assemblage of species. The Suitability Index (SI) is a unit less number between 0 and 1 that describes the requirements of a species for certain attributes such as cover, distance to foraging, water temperature, etc. A set of one or more Suitability Indices that represent key habitat requisites for the species during one or more life history stages are combined into an overall Habitat Suitability Index (HSI) by adding or multiplying the individual indices. The attributes are measured in the field and/or via GIS analysis and their corresponding index values are inserted into the model to produce a score that describes existing habitat suitability. The overall HSI value is also an index score between 0 and 1. This index value can be multiplied by the area of the site to yield HUs, or it can be used as an index score for a habitat quality comparison only.

A number of HSIs have been published for either individual species or guilds or other attributes, including those that may occur in Oregon (both native and non-native). Existing HSI models encourage model users to devise other models or make model alterations based on their knowledge of the species ecology. Alterations to the models should be fully documented (Raleigh et al 1986). HSIs can be created or modified using literature and other data. For example, local or draft models have been developed for native amphibians (WDFW 1997), and Western pond turtle (Tetra Tech 2012), and are based on the literature for the species.

The selection of species to include in this HEP model was based on several criteria. First and foremost, the species' geographic range must include the project vicinity. The species must also utilize the habitat type or types that are currently present, or are proposed for restoration. Species with existing HSI models are preferred. Utilizing previously developed and verified models provides a greater level of scoring certainty. Suitable HSI models must include habitat variables for which data collection is possible, given the availability of time and resources. Finally, variables must also show a change in score between the existing and proposed condition. If the project does not affect the SI score for a species, it will not be possible to quantify an effect. Habitat variables that do not meet the above requirements were omitted.

The existing models offer the user a maximum number of habitat variables for a species that can be used in assessing a variety of project impacts. Therefore, focusing on variables that respond to the action would provide a greater measure of the project effects and provide more meaningful scores. Any alterations to the existing models were made to ensure that the SIs utilized were identified as variables that would show a measurable response to project features. These variables were selected for each species based upon available, site-specific data and knowledge and understanding of habitat issues of the Lower Willamette ecosystem.

The individual SIs for various habitat parameters for each species are combined arithmetically to yield an overall index score for the species. In cases where existing species SIs were modified by eliminating parameters, the scores for the remaining variables were averaged to provide equal weight to each, yielding an overall average index score. Scores for each species can be used individually or combined to yield an overall index score for multiple species or species assemblages. In this case, the individual scores for each species or assemblage are averaged together to provide an overall HSI score. Averaging allows for equal weighting of the species or assemblages and ensures that no species is of greater importance, providing a multi-species approach to restoration. The overall HSI score is multiplied by the area of habitat that may be affected by a project. This final score yields HUs. HUs can be calculated separately for each species or for a combined score for multiple species. The future with- and without-project HUs are compared to determine the net difference (either positive or negative) between alternatives.

4. DESCRIPTION OF MODEL

As identified previously, the proposed habitat evaluation model is a combination of multiple individual species HSIs. The resultant indices were averaged or geometrically combined, and during the use of the model.

4.1 Description of Input Data

Input data for the model was collected specifically at the project alternative sites and by the use of aerial photographs or a GIS database for the project area. The input data required varies substantially from one HSI to another. Typical variables that were measured include percent canopy cover, diameter of trees, water depth, water velocity, number of pieces of downed wood, vegetation composition, etc. These measured variables were then assigned an SI value (unitless number from 0 to 1) based on the suitability curve or discreet suitability values or thresholds developed in the model.

Typically, input variables were measured at multiple locations on the project site and then averaged to yield an overall percent canopy cover or similar value. If the project site was comprised of several distinctly different vegetation communities, then variables were measured specifically for each community to yield multiple scores for the overall site.

Acreages for the model were developed by mapping the area at each site where restoration actions were both implementable and would have an effect on habitat quality. The acreage for with- and without-project conditions is the same to ensure an objective comparison of habitat values before and after implementation of restoration measures.

4.2 Description of Output Data

The output data from an HSI, one or several individual suitability indices, were entered into the HSI model equation to yield an overall habitat suitability index for the species. For example, yellow warbler model includes four variables: 1) V1, percent deciduous shrub crown cover; 2) V2, percent overall canopy cover; 3) V3, average height of deciduous shrub cover; and 4) V4, percent shrub canopy comprised of hydrophytic vegetation. The equation for combining these variables is an average as shown below, because none of the variables are limiting factors (such that a score of zero should render the habitat completely unsuitable for yellow warbler), and it appears that the variables are compensatory (such that while a low suitability score for one variable will reduce the overall habitat suitability, the other variables can somewhat compensate and still provide suitable habitat).

$$HSI = (V_1 + V_2 + V_3 + V_4) / 4$$

4.3 Capabilities and Limitations of the Model

A major assumption of HEP is that there is a linear relationship between the HSI and either carrying capacity for a species or an observed preference/requirement for a specific habitat feature. When developing specific HSI models, it is necessary to define varying qualities of habitat (i.e. optimum, good, fair, poor) based on observed relationships in the literature. For example, if the majority of observations of yellow warbler nests were in deciduous shrubs ranging from 1.5 to 4 meters, then deciduous shrubs of that height are assumed to provide optimal nesting habitat, and thus yield a high index score (in the range of 0.8 to 1.0). Shrubs of lesser height are assumed to be less suitable and yield lower index scores.

Specific limitations have been observed in the use of HEP and HSIs and include: 1) many of the developed models have not been tested sufficiently to match observed "preferred" habitats by the various species or to match species experts' knowledge of optimal habitat; 2) high values generated from the HSIs do not necessarily match observed higher species diversity or abundance than sites with lower values; 3) difficulty in collecting sufficient data to use the models (particularly when models have numerous variables); 4) use of one species model to represent suitability for wider guilds or assemblages may not accurately represent those other species; and 5) lack of variables that describe landscape scale effects on species diversity and abundance. (Barry, *et al.* 2006; O'Neil, *et al.* 1988; Wakeley 1988)

These limitations have been recognized in the development of this integrated model. Because it may be inaccurate to represent habitat suitability for large guilds or assemblages of species, multiple species were selected for the HEP portion of this model (and are described later) to encompass the habitat requirements for relatively small guilds or individual species of interest.

Another limitation in the use of ecological models is that other factors beyond the specific parameters evaluated in the models could have greater effects on species populations. Examples could be infectious diseases that could wipe out a localized population, climate change effects on temperatures and hydrology, and invasive species. These are important considerations for the success of any habitat restoration project and while not amenable to analysis in this proposed model, they should be considered by the project team during design development and implementation. Specifically:

- **Climate change** Although Earth's climate is clearly changing; insufficient data exists to accurately predict the effects this process will have on parameters that directly affect some of the species whose life stages were used to prepare this model. Increasing temperatures may cause warmer water temperatures, higher base flows in the winter and spring and lower base flows in the summer and fall, and less predictable tidal fluctuation, Although this same lack of data means that the effects of climate change cannot be measured in this HEP model, long-term monitoring and adaptive management strategies can be developed to measure these effects and respond to them effectively.

- **Invasive species:** One of the objectives of this study is to restore a viable native riparian and wetland plant community. This is to be accomplished by removing invasive species, revegetating with native species, and creating conditions under which native species are competitive with invasive species. Specific measures have been developed as part of this study to reduce the effects of invasive species, and although these effects may not be measurable in this model, effective control of invasive species will lead to more habitat complexity in riparian and wetland areas, thus increasing the value of these habitats for foraging and cover by juvenile salmonids and other species. Monitoring and adaptive management strategies for reestablishing native plant communities are outlined in Section 10 of the Feasibility Study.

This project is not intended to restore or manage habitat for a single species, nor is it intended to specifically increase the population of a single species. This project is intended to restore functioning habitat in the Lower Willamette River basin to support ecosystem function over time, rather than creating a specific static habitat type. The models have been modified or created to reflect local or regional data, as well as to simplify the models so that only the variables (and habitat types) likely to change as a result of the restoration project are included.

4.4 Model Development Process

All HSIs proposed for use in this model have been documented and reviewed. The amphibian model was developed by a multi-agency team based on regional literature and expert opinions. The Western pond turtle model was developed based on regional literature and reviewed and modified based on expert reviews. Testing and validation of the models is more limited. A recommendation for future use of these models is that the monitoring plan developed for this project should incorporate many of the parameters included in the HSI models to test and validate assumptions on habitat suitability. This monitoring data could inform future refinements or changes to the models and improve their predictive capability.

4.5 Identification of Formulas and Proof Computations are Done Correctly

All equations used in the HEP model are specifically stated and described below, as well as the Suitability Curves. Calculations are done in standard spreadsheet software (i.e. Microsoft Excel). The models are completely transparent and all assumptions can be verified.

4.6 Availability of Input Data

Input data used for this model was collected from on-site field surveys and from the use of aerial photography and GIS data.

4.7 Proposed HSI Models

Published HSIs for the following species or guilds were reviewed for potential inclusion in the HEP including: beaver *(Castor canadensis)*, yellow warbler *(Dendroica petechia)*, great blue heron *(Ardea herodias)*, downy woodpecker *(Picoides pubescens)*, red-winged blackbird *(Agelaius phoeniceus)*, wood duck *(Aix sponsa)*, osprey *(Pandion haliaetus)*, bald eagle *(Haliaeetus leucocephalus)*, black-capped chickadee *(Poecile atricapilla)*, native amphibians.

It is recommended that HSIs for several species be utilized to capture the range of benefits that could be provided by habitat restoration projects. The recommended HEP model includes the following species or guild: (1) Western pond turtle *(Clemmys marmorata)*; (2) beaver; (3) wood duck; (4) yellow warbler; (5) native amphibians (Northwestern salamander (*Ambystoma gracile*), long-toed salamander (*Ambystoma macrodactylum*), roughskin newt (*Taricha granulosa*), red-legged frog (*Rana aurora*), Oregon spotted frog (*Rana pretiosa*) and the Pacific treefrog (*Hyla regilla*) and (6) salmonids. As the life stage requirements for habitat differ between the mainstem Willamette River and the tributaries for salmonids, different models were selected for the tributaries and mainstem sites. For the tributaries, the salmonid model was based on both the spawning and rearing habitats of coho (*Oncorhynchus kisutch*) and Chinook. For the mainstem, the salmonid model was based on the habitat requirements of juvenile Chinook (*Oncorhynchus tshawytscha)*.

The Western pond turtle is a species of concern in the study area and utilizes backwaters and ponds. The beaver is a mammal species dependent on native riparian species for food (cottonwood, willow, and alder). The wood duck is a cavity nesting waterfowl species that utilizes riparian areas for nesting. While the yellow warbler represents migratory neotropical birds that utilize riparian habitat for nesting, their foraging characteristics are sufficiently different that they are evaluated separately. The red-legged frog, Pacific treefrog, and rough-skinned newt are native amphibians that primarily represent aquatic amphibians utilizing riparian and wetland habitats. Chinook and coho are native salmonids that are listed as threatened under the federal Endangered Species Act and are currently present in the Lower Willamette basin.

Table 4.1 provides a list of the species or guilds recommended for the model along with the variables or attributes measured for the model associated with their preferred habitat.

Table 4.1. Recommended species for HEP model

Species/Guild Selected	Habitat Type Associated With	Variables/Attributes
Western pond turtle	Off-channel ponds, sloughs, and backwaters	Water depth, water temperature, percent cover, availability of nesting sites
Beaver	Riparian and floodplain vegetation communities (particularly cottonwood and willow)	Tree canopy closure, tree size class, shrub crown cover, height of shrub canopy, species composition
Wood duck	Riparian and floodplain vegetation communities and near shore aquatic habitats	Cover
Yellow warbler	Riparian and floodplain vegetation communities (particularly cottonwood and willow)	Deciduous shrub crown cover, canopy cover, height of shrub canopy, hydrophytic shrubs, velocity
Native amphibians (Northwestern salamander, long-toed salamander, red-legged frog, Pacific treefrog, Oregon spotted frog, roughskin newt)	Slow velocity stream reaches/alcoves, off-channel ponds, sloughs, and backwaters and other wetlands	Permanent water, water velocity, emergent and submergent vegetation, ground cover along water's edge, riparian zone width, water temperature, land use
Native salmonids (tributaries) (Chinook and coho)	Tributary spawning and rearing (pools, riffles, instream structure)	Maximum water temperature, percent pools, substrate, % pools and backwaters
Native salmonids (mainstem) (Chiuook)	Mainstem out-migration and rearing (shallow water margins, floodplain side channels and backwaters)	Substrate, depth, and percent cover bank vegetation

Several of the existing HSI models do not appear appropriate to use in their current condition and the reasons for not selecting the species and models are briefly described in Table 4.2.

Table 4.2 Species not selected for HEP model

Species	Description of Variables	Reason for Not Selecting
Bald eagle	Size of waterbody for foraging; morphoedaphic index; distance from nest to foraging area	Model designed for breeding season at lacustrine habitats and based on volume of forage base. Not relevant to project area or proposed alternatives. Could have created new model for wintering habitat, bnt primarily based on availability of perching habitat and proximity to waterbodies, which will not change significantly as a result of proposed restoration measures.

Species	Description of Variables	Reason for Not Selecting
Black-capped chickadee	% Tree canopy closure, average height of trees, # of snags	Restoration of floodplain and riparian habitats will benefit these attributes and habitat requirements, but are not directly predictable from proposed changes.
Downy woodpecker	Basal area per hectare, # snags/ha	Will likely benefit from floodplain/riparian restoration, but attributes are not directly relevant.
Great blue heron	Distance between foraging areas and heronry sites, shallow clear water, distance from human activities	Attributes not likely to show a significant change from future without-project to future with-project condition.
Osprey	Obstructions over water, transparency, human activities	Attributes will not show a significant change.
Red-winged blackbird	Dominant emergent vegetation type, water present/absent, carp present/absent, larvae of odonates, patchiness of vegetation, layers of wetland vegetation	Will benefit from floodplain wetland restoration, but attributes not directly relevant.

4.7.1 Western Pond Turtle Life History and Habitat Requirements

The Western pond turtle (*Clemmys marmorata*) is found in the Pacific Northwest generally west of the Cascade Range from Puget Sound south to Baja California Norte. There are two subspecies: the northern subspecies occurs north of the American River in California (C. *marmorata marmorata*) and the southern subspecies occurs south of the American River (C. *marmorata pallida*). In Oregon, the species occurs in the western Cascades, the Willamette Valley, Coast Range, and Klamath Mountains and possibly east of the Cascades in the Deschutes and John Day drainages (likely from introductions, Holland, 1994).

Western pond turtles are in the family of Emydidae that includes many species of semi-aquatic pond and marsh turtles including slider turtles. Life history requirements of the turtles in this family have many similarities (Rosenberg et al. 2009). The model described herein was based on the slider turtle model developed by the U.S. Fish and Wildlife Service (Morreale and Gibbons 1986) with the addition of key parameters identified by regional Western pond turtle experts. Based on the co-occurrence of Western pond turtles and red eared sliders in most habitats in the Willamette Valley and similar life history uses of habitats, the parameters included in the model appear appropriate for Western pond turtle.

Western pond turtles are very wary and sensitive to human disturbance, particularly movements of pedestrians even as far as 100 meters away (Holland 1994). They forage in water and eat a wide variety of aquatic invertebrates, and terrestrial insects. Pond turtles likely eat small fish, crayfish and frogs as well, but much less frequently, and possibly only via scavenging. Scavenging of carrion may also be an important food source, particularly seasonally (early spring). Pond turtles typically overwinter in the northern part of the range from one to six months, but may frequently emerge on sunny days to bask. Overwintering can occur in mud on the bottom of ponds, under overhanging banks, or in forested areas under a thick layer of leaf litter. Pond turtles may also use terrestrial habitats if their aquatic habitat seasonally dries up (Rosenberg et al 2009). During the rest of the year, turtles generally occur in aquatic habitats, with a slow to moderate current. A significant amount of time is used for basking on rocks, logs or emergent vegetation.

Nesting can occur from late April through July. Nesting habitat is a key terrestrial component of Western pond turtle life history. Females excavate nests in sparsely vegetated areas with grass and/or forbs. It is typically on south-facing gentle slopes or other areas with good sun exposure and typically fairly compact dry soil with silt or clay, although sandy loam and gravel/cobble mixed with soil have also been used

(Rosenberg et al. 2009). Nesting habitat within approximately 200 meters to aquatic habitats may be preferred. The various studies cited in Rosenberg et al. (2009) generally found that solar exposure and warmer temperature soils were the most consistent trait. It appears that hatchlings remain in the nest over the winter and emerge the following spring.

Predation on eggs and hatchlings is typically very high by raccoons, fox, coyote, and skunks, as well as, domestic dogs. Small turtles may also fall prey to largemouth bass, bullfrogs, trout, other resident fish and waterfowl. Larger turtles typically do not have many predators, but may occasionally be taken by the mammals listed above, and also by bear, river otter, and humans. Minimizing habitat for bullfrogs and other non-native predators will benefit western pond turtles, although unfortunately the turtles typically prefer warm waters that bullfrogs also prefer. Some significant limiting factors to western pond turtle survival in the Willamette Valley appear to be: 1) predation of nests; 2) hatchling predation by bullfrogs; and 3) lack of nesting habitat (B. Castillo, ODFW, pers. comm.). Loss of aquatic habitat and road mortality are also major threats to this species (Rosenberg et al. 2009).

Table 4.3 shows the parameters used in the western pond turtle HSI, and describes the rationale behind their inclusion in this study.

Table 4.3 Western Pond Turtle Variables

Species	V	Variable	Used	Not Used	Rationale
Western Pond Turtle					This model was created specifically for this species native to the west coast states. The model was developed based on current literature and researchers inclnding Rosenburg et al 2009, Morreale and Gibbons 1986, Holland 1994, aud personal commnnication with former ODFW turtle expert, Bill Castillo. It is the same as the model approved for use on the Willamette Floodplain Restoration Project.
	V_1	Percent area with water depth preferred by adults	X		Identified as a limiting factor that could be measurably improved.
	V_2	Percent cover along water's edge	X		Identified as a limiting factor that could be measurably improved.
	V_3	Water temperature during low flows	X		Identified as a limiting factor that could be measurably improved.
	V_4	Percent area with water depth < 0.3 meters	X		Identified as a limiting factor that could be measurably improved.
	V_5	Availability of suitable nesting sites	X		Identified as a limiting factor that could be measurably improved.
$HSI_{W\ Pond\ Turtle} = (V_1 + V_2 + V_3 + V_4 + V_5) / 5$					

4.7.2 Beaver Life History and Habitat Requirements

Beaver are herbivorous aquatic mammals found throughout North America wherever suitable riparian and wetland habitats occur. Beaver were once so numerous (50-100 million) that most aquatic habitats in North America were shaped by beaver activity. The HSI model for beaver is described in Allen (1982) and habitat requirements for the winter food life stage, which is targeted for this project, are summarized below. The winter food life requisite was targeted for riverine and wetland cover types. The water life requisite was omitted due to lack of influence of change the project would have on these factors which, include percent stream gradient, aver water fluetuation on an annual basis. Beaver are generalized herbivores, but have strong preferences for specific plant species and size classes. Aspen, willow, cottonwood, and alder are the preferred species. Woody stems less than 10 centimeters in diameter near water are preferred and herbaceous vegetation and leaves are consumed during the summer. Aquatic vegetation is also utilized.

Table 4.4 shows the variables used in the beaver HSI, and describes the rationale behind their inclusion in this study.

Table 4.4 Beaver Variables

Species	V	Variable	Used	Not Used	Rationale
Beaver					**Same as Willamette Floodplain model**
	V_1	Percent tree canopy closure	X		Variable identified in the published HSI as a limiting factor for winter food life requisite for riverine and wetland cover types.
	V_2	Percent trees 1-6 inches dbh	X		Variable identified in the published HSI as a limiting factor for winter food life requisite for riverine and wetland cover types.
	V_3	Percent shrub crown cover <5m	X		Variable identified in the published HSI as a limiting factor for winter food life requisite for riverine and wetland cover types.
	V_4	Average height of shrub canopy	X		Variable identified in the published HSI as a limiting factor for winter food life requisite for riverine and wetland cover types.
	V_5	Species composition of woody vegetation (trees and/or shrubs)	X		Variable identified in the published HSI as a limiting factor for winter food life requisite for riverine and wetland cover types.
	V_6	Percent of lacustrine surface dominated by yellow and/or white water lily		X	Only relevant for lacustrine habitat, not riverine or wetland
	V_7	Percent stream gradient		X	Not relevant for winter food life requisite
	V_8	Average water fluctuation on annual basis		X	Not relevant for winter food life requisite
	V_9	Shoreline development factor		X	Only relevant for lacustrine habitat, not riverine or wetland
$HSI_{Beaver} = (V_1 + V_2 + V_3 + V_4 + V_5) / 5$					

4.7.3 Wood Duck Life History and Habitat Requirements

Wood duck range and life history are summarized in Sousa and Farmer (1983). Wood ducks inhabit creeks, rivers, floodplain lakes, swamps, and beaver ponds. A Pacific population breeds from British Columbia south to California and east to Montana of which, a majority winters in the Sacramento Valley. Wood ducks have been referred to as primarily herbivorous, although invertebrates also make up a part of their annual diet. Suitable cover for wood ducks may be provided by trees or shrubs overhanging water, flooded woody vegetation, or a combination of these two types. For nesting, wood ducks utilize bottomland hardwood forests with trees of sufficient size to contain usable cavities that are near water.

The habitat in the project area is suitable for winter habitat only and therefore that is the life requisite focused on for this project.

Table 4.5 shows the variables used in the wood duck HSI, and describes the rationale behind their inclusion in this study.

Table 4.5 Wood Duck Variables

Species	V	Variable	Used	Not Used	Rationale
Wood Duck – Winter Habitat Only					Same as Willamette Floodplain model
	V_1	Number of potentially suitable tree cavities / 0.4 ha (1.0 acre)		X	Not relevant for winter habitat
	V_2	Number of nest boxes / 0.4 ha (1.0 acre)		X	Not relevant for winter habitat
	V_3	Density of potential nest sites / 0.4 ha (1.0 acre) = $(0.18^* V_1 + 0.95^* V_2)$		X	Not relevant for winter habitat
	V_4	Percent of water surface covered by potential brood cover		X	Not relevant for winter habitat
	V_5	Percent of the water surface covered by potential winter cover	X		Appropriate for use since the model is prepared for winter habitat
$HSI_{Wood\ Duck} = V_1$					

4.7.4 Yellow Warbler Life History and Habitat Requirements

The yellow warbler was selected to represent neotropical migratory birds that may use the riparian habitat of the Willamette River. Yellow warblers are a breeding bird throughout the U.S. The existing model and habitat requirements are described in Schroeder (1982). The yellow warbler prefers riparian habitats composed of abundant, moderately tall, deciduous shrubs ranging in height from 1.5 to 4 meters. Shrub densities between 60 and 80% are considered optimal and coniferous areas are avoided. Greater than 90% of prey are insects and foraging takes place primarily on small limbs in deciduous foliage. Nests are generally located 0.9 to 2.4 meters above the ground in willows, alders, and other hydrophytic shrubs and trees, including box elders and cottonwoods. Male yellow warblers have greater mating success in shrubs less than 3 meters tall. The SIs used in the yellow warbler HSI include the three variables in the published model (Schroeder 1982) plus one additional variable utilized in the Willamette Floodplain model, to be consistent with that model as accepted by Eco-PCX.

Table 4.6 shows the variables used in the yellow warbler HSI, and describes the rationale behind their inclusion in this study.

Table 4.6 Yellow Warbler Variables

Species	V	Variable	Used	Not Used	Rationale
Yellow Warbler					**Same as Willamette Floodplain model**
	V_1	Percent deciduous shrub crown cover	X		Identified as a limiting factor that could be measurably improved.
	V_2	Percent overall canopy cover	X		Identified as a limiting factor that could be measurably improved.
	V_3	Average height of deciduous shrub canopy	X		Identified as a limiting factor that could be measurably improved.
	V_4	Percent of shrub canopy comprised of hydrophytic shrubs – Yellow Warbler	X		Identified as a limiting factor that could be measurably improved.
$HSI_{\text{Yellow Warbler}} = (V_1 + V_2 + V_3 + V_4) / 4$					

4.7.5 Native Amphibians Life History and Habitat Requirements

This HSI is a combination of the habitat requirements of both aquatic and terrestrial amphibians that commonly occur in Western Washington and Oregon including; Northwestern salamander (*Ambystoma gracile*), long-toed salamander (*Ambystoma macrodactylum*), roughskin newt (*Taricha granulosa*), red-legged frog (*Rana aurora*), Oregon spotted frog (*Rana pretiosa*) and the Pacific treefrog (*Hyla regilla*). The habitat requirements of these species in the HSI for native amphibians are summarized below (WDFW 1997). While these amphibian species included in the model are considered aquatic, they also use adjacent riparian areas extensively for wintering and feeding. Due to the multiple species included, additional parameters such as water depth requirements for breeding are not applicable across all species and have not been included.

Northwestern salamanders occur in western Oregon, Washington and British Columbia, and are considered to be aquatic salamanders that breed in ponds and stream backwaters. They live in moist forest or woodlands as juveniles and adults. They lay their eggs in moderately deep water (0.5-2 m) attached to small sticks or rigid stems. Larvae live in surface sediments or under debris or logs in their natal waterbodies.

Long-toed salamanders occur throughout much of Oregon, Washington and British Columbia, are also considered to be aquatic salamanders that breed in seasonal ponds, lake shores and slow-moving streams through wet meadows. They live in a variety of terrestrial habitats (grasslands, woodlands, disturbed areas) as juveniles and adults. They lay their eggs in shallow water (<0.5 m) attached to stems, leaves, or pebbles. Larvae live in surface sediments or under debris in shallow water.

Roughskin newts occur in most of Oregon, and are also considered to be aquatic salamanders, which utilize ponds and slow-moving streams for most of the year or year-round. They prefer forested or partially wooded habitats adjacent to ponds, lakes or sloughs, often where there is extensive aquatic vegetation. They lay their eggs in moderately deep water (0.5-2 m) in mid to late spring, attaching the eggs to stems or floating vegetation. Juveniles and adults live in and under rotting logs and forage in the ponds or moist forest floors.

Red-legged frogs occur on the west side of the Cascade crest in Oregon, Washington and British Columbia. They prefer moist coniferous or deciduous forest and forested wetland habitats. They breed in cool slow-moving waters such as shaded ponds and sloughs in winter to early spring. They lay their eggs in moderately deep water (0.5 - 2 m) and attach the eggs to submerged branches or aquatic vegetation. Juveniles and adults will live in emergent wetlands, logs, or brush adjacent to pond edges. During the rainy season, they move into forest habitats and live under logs and debris, foraging on the forest floor. A major limiting factor for native amphibian survival is lack of adjacent moist forest habitat (B. Castillo, ODFW, pers. comm.).

Oregon spotted frogs occur in British Columbia, western Washington and the Cascade Mountains of Washington and Oregon. Historically they were found in the Willamette Valley, but they appear to have been eliminated from this habitat (Leonard et al. 1993). Oregon spotted frogs are aquatic and require water for breeding, foraging and wintering habitats. They use seasonal waterbodies such as ponds or flooded sloughs/overflows that dry up by summer. However, connections to permanent water must be present to allow tadpoles to metamorphose. Juveniles and adults inhabit marshes, and marshy edges of ponds, streams and lakes with abundant vegetation.

Pacific treefrogs are the most common frog in the northwest and can live in a variety of habitats including marshes, wet meadows, forests and brushy disturbed areas. They breed in shallow water (<0.5 m) attaching their eggs to grasses or twigs. Adults live in wet meadows and riparian areas.

All native frogs have been reduced in part due to the presence of the non-native bullfrog. Bullfrogs often eat smaller frogs, and even small bullfrogs, turtles and fish. This habitat suitability index also incorporates a negative index for some habitat characteristics that are preferred by bullfrogs, such as water temperature, percent silt in the substrate, and permanently ponded deep water.

Table 4.7 shows the variables used in the native amphibian HSI, and describes the rationale behind their inclusion in this study.

Table 4.7 Native Amphibian Variables

Species	V	Variable	Used	Not Used	Rationale
Native Amphibians - New					This is the same model approved for use in the Willamette Floodplain study, except that this model does not use the 7th variable used in that model.
	V_1	Percent area with permanent water	X		Identified as a limiting factor that could be measurably improved.
	V_2	Percent area with emergent or submergent wetland/aquatic vegetation	X		Identified as a limiting factor that could be measurably improved.
	V_3	Percent ground cover along water's edge	X		Identified as a limiting factor that could be measurably improved.
	V_4	Width of riparian zone	X		Identified as a limiting factor that could be measurably improved.
	V_5	Maximum temperature during low flows	X		Identified as a limiting factor that could be measurably improved.
	V_6	Land use within 200 meters of wetland edge	X		Identified as a limiting factor that could be measurably improved.

Species	V	Variable	Used	Not Used	Rationale
	V_7	Water current in breeding areas during spring		X	Current was not identified as a limiting factor because the primary breeding habitat for amphibians would occur in backwater, off-channel areas where there is no current. Furthermore, measures recommended in this plan would not affect current at the scale of measurement recommended in the model.
$HSI_{Native\ Amphibians} = (V_1 + V_2 + V_3 + V_4 + V_5 + V_6) / 6$					

4.7.6 Native Salmonid Life History and Habitat Requirements

The purposes for creating two separate models for native salmonids are to account for differences in how habitats will be utilized by salmonids species at different life stages occurring in the project area and to estimate the effect that implementing specific restoration measures will have on the quality of habitat variables that most directly affect these life stages. The tributary model was formulated by modifying existing HSIs to primarily assess changes in habitat quality and quantity for spawning adults and juvenile salmonids utilizing their natal habitat. The mainstem model was developed to target out-migrating juvenile salmonids as they begin their egress into the estuary and eventually the ocean. The mainstem model utilized both existing HSIs and site specific data collected in the Lower Willamette River.

The following sections describe the development of each of the two models based on the specific life stage requirements for native salmonids that each model targets. Therefore, an overview of salmonids life history is presented along with the habitat features required to support them. The details of the proposed project are then described to link the restoration features with these habitat requirements. Finally, a discussion of each model's development and the rationale of parameters selected to best measure habitat response to the restoration measures is presented.

The restoration measures prescribed to each of the two stream types were selected to correspond to the life stages that utilize them. Measures targeted towards restoring aquatic and riparian habitat are as follows:

- Remove invasive species and minimize disturbance of native habitats.
- Revegetate riparian zones and wetlands with an appropriate mix of native species
- Restore hydrologic aspects of each site to encourage survival of appropriate plant communities
- 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
- 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, and
- Reconnect side channels and backwater wetlands to streams and rivers where possible.

4.7.6.1 Native Salmonids Tributary Model

HSI models have been published for native salmonids that correspond to the life stages that utilize the habitat found in the tributaries of the project area. These include HSIs developed for Chinook salmon (Allen and Hassler 1986, Beauchamp et al. 1983, Raleigh et al. 1986) and coho (McMahon 1983). The HSI curves for these two species were combined to assess tributary habitat conditions.

Chinook Salmon Life Stage Requirements and Utilization of the Tributaries in the Project Area
Spring and fall Chinook occur in the Willamette River, although the fall run is considered to be entirely derived from plantings of hatchery fish from 1964-1994 and Friesen et al. (2007) found that the majority of Chinook collected in the Lower Willamette are spring run. Spring Chinook enter the Willamette River from approximately April through early July and then migrate upstream to spawning grounds, spawning later in the year from August to October. Fall Chinook enter the Willamette River from August to October, spawning immediately from early September through early October. Fry emerge from the spawning grounds from January through April.

Spring Chinook are frequently stream-type, in that juveniles may rear in freshwater streams for up to a year or more before migrating to the ocean. Some spring Chinook and most fall Chinook are typically ocean-type, and only rear for 2-6 months in freshwater before migrating to the ocean. Some ocean-type Chinook migrate as fry to estuarine areas and rear for extended periods there.

In the tributaries of the project area, Chinook salmon use tributary stream habitat for spawning, egg incubation, and freshwater rearing. It is these habitat requirements that are targeted in the tributary model. Chinook salmon require clean, cool water and clean gravel to spawn. Females deposit their eggs in the gravel bottom in areas of relatively swift water. For maximum survival of eggs and larvae, water temperatures must range 43 and 57°F (Raleigh et al. 1986). Optimum rearing habitat for Chinook consists of pools and wetland areas with woody debris, boulders and/or overhanging vegetation for cover. Additionally, hard/rocky substrate is required for the production of algae and macroinvertebrates to provide food for rearing salmonids.

Coho Salmon Life Stage Requirements and Utilization of Tributaries in the Project Area
Adult coho enter the Willamette River from late August through early December, migrating into tributaries along the length of the River. Adult coho will often hold for extended periods in deep pools, where they are less vulnerable to predation, and periodically come out to capture prey in riffle areas. Spawning occurs typically from September through December. Fry emerge from the spawning grounds from late February through April. Coho fry and juveniles rear in their natal streams for one or two years typically, although even longer freshwater residence can occur. Fry typically congregate after emerging from the gravel and within a few days begin swimming along the bank margins, especially near overhanging vegetation. Coho will also typically settle on the bottom during darkness. Areas with a high percentage of margin habitat (narrow streams) and with woody debris and pools are the most productive for coho. Coho move into side channels and under debris for wintering. Most juvenile coho salmon outmigrate seaward as smolts in late spring (March through June), typically during their second year.

Similarly to Chinook, coho utilize tributary habitat found in the project area to complete their adult spawning, egg incubation and juvenile rearing phases. Also similarly to Chinook, coho require similar habitat features for these life stages. Adult coho salmon returning to spawn need adequate flows and water quality, and unimpeded passage to their natal grounds. They also need deep pools with vegetative cover and in-stream structures such as root wads for resting and shelter from predators. The timing of coho salmon spawning can also reflect water temperature changes in a particular river system.

Native Salmonids Tributary Habitat Suitability Model
In order to evaluate the extent to which habitat restoration measures will benefit native salmonids in tributaries to the Lower Willamette River, an HSI model was developed to specifically target the life histories of salmonids that utilize this habitat. The tributary model is comprised of modifications to the existing HSIs for Chinook (Raleigh et al. 1986) and coho salmon (McMahon 1983). Of the existing HSIs for Chinook, Raleigh et al. 1986 was selected for use in the tributary model as the juvenile rearing habitat represented is that of natal tributary streams found in the Project Area. The modifications of the HSIs were based upon localized response variables identified in available data and publications, as well as site specific observations. This modified model was previously approved by ECO-PCX for use by the Willamette Floodplain Ecosystem Restoration Project. It was subsequently assessed and determined that it is applicable to the Lower Willamette River Ecosystem Restoration Project.

The HSIs for both Chinook and coho salmon were modified in order to create the tributary model that includes a list of variables that show a response to the restoration action and that address factors or processes that are limited to the salmonids life histories that utilize this habitat type. As the life stages that are targeted in tributaries are present year round the model applies to year-round conditions.

Table 4.8 includes a list of the variables included in the original Chinook and coho salmon HSIs and the rationale for use or exclusion. Variables were omitted if they did not pertain to a limiting factor in the project area.

Table 4.8 Native Salmonids Tributary Variables

Species	V	Variable	Used	Not Used	Rationale
Native Salmonids					The salmonids tributary model uses an identical set of variables as those used in the Willamette Floodplain Restoration Project model. 3 variables from the existing Chinook model (Raleigh et al 1984) and one variable from the existing Coho model were used to prepare this model (McMahon 1983).
Chinook - Modified					
	V_1	Annual maximal or minimal pH		X	Not identified as a limiting factor that could be measurably affected by the proposed project.
	V_2	Maximum temperature	X		Identified as a limiting factor that could be measurably improved.
	V_3	Minimal dissolved oxygen		X	Not identified as a limiting factor that could be measurably affected by the proposed project.
	V_4	Percent pools during the low water period	X		Identified as a limiting factor that could be measurably improved.
	V_5	Pool class rating		X	Not identified as a limiting factor that could be measurably affected by the proposed project.
	V_6	Maximum temperature (embryo)		X	Not identified as a limiting factor that could be measurably affected by the proposed project.
	V_7	Maximum or minimum temperature (embryo)		X	Not identified as a limiting factor that could be measurably affected by the proposed project.

Species	V	Variable	Used	Not Used	Rationale
	V_8	Average substrate size (embryo)		X	Not identified as a limiting factor that could be measurably affected by the proposed project.
	V_9	Average velocity (embryo)		X	Not identified as a limiting factor that could be measurably affected by the proposed project.
	V_{10}	% fines (embryo)		X	Not identified as a limiting factor that could be measurably affected by the proposed project.
	V_{11}	Average base flow		X	Not identified as a limiting factor that could be measurably affected by the proposed project.
	V_{12}	Average peak flow		X	Not identified as a limiting factor that could be measurably affected by the proposed project.
	V_{13}	Substrate composition in riffle/run areas	X		Identified as a limiting factor that could be measurably improved.
	V_{14}	% riffle-run fines		X	Not identified as a limiting factor that could be measurably affected by the proposed project.
	V_{15}	Nitrate-N concentration		X	Not identified as a limiting factor that could be measurably affected by the proposed project.
	V_{16}	% cover		X	Not identified as a limiting factor that could be measurably affected by the proposed project.
	V_{17}	Substrate cover		X	Not identified as a limiting factor that could be measurably affected by the proposed project.
Coho - Modified					
	V_1	Maximum temperature – upstream migration		X	Not identified as a limiting factor that could be measurably affected by the proposed project.
	V_2	Minimum DO concentration – upstream migration		X	Not identified as a limiting factor that could be measurably affected by the proposed project.
	V_3	Maximum temperature – spawning to emergence of fry		X	Not identified as a limiting factor that could be measurably affected by the proposed project.
	V_4	Minimum DO concentration – spawning to emergence of fry		X	Not identified as a limiting factor that could be measurably affected by the proposed project.
	V_5	Substrate composition in riffle/run areas		X	Not identified as a limiting factor that could be measurably affected by the proposed project.
	V_6	Maximum temperature during rearing		X	Not identified as a limiting factor that could be measurably affected by the proposed project.
	V_7	Minimum DO concentration – rearing		X	Not identified as a limiting factor that could be measurably affected by the proposed project.

Species	V	Variable	Used	Not Used	Rationale
	V_8	% vegetative canopy cover		X	Not identified as a limiting factor that could be measurably affected by the proposed project.
	V_9	Vegetation index of riparian zone		X	Not identified as a limiting factor that could be measurably affected by the proposed project.
	V_{10}	% pools		X	Not identified as a limiting factor that could be measurably affected by the proposed project.
	V_{11}	% pools with canopy		X	Not identified as a limiting factor that could be measurably affected by the proposed project.
	V_{12}	% instream and bank cover		X	Not identified as a limiting factor that could be measurably affected by the proposed project.
	V_{13}	% total area of quiet backwaters and deep pools	X		Identified as a limiting factor that could be measurably improved.
	V_{14}	Maximum temperature during rearing and out-migration of smolts		X	Not identified as a limiting factor, therefore no restoration measures were developed to address this variable.
	V_{15}	Minimum DO concentration during outmigration		X	Not identified as a limiting factor, therefore no restoration measures were developed to address this variable.
$HSI_{\text{Salmonids Tributary}} = (V_1 + V_2 + V_3 + V_4) / 4$					

4.7.6.2 Native Salmonids Mainstem Model

Existing HSIs for out-migrating juvenile Chinook were utilized in the development of a model to represent this life stage of native salmonids. These data along with site specific data were combined to create a model specific for use in evaluating the effects of this proposed Project on native juvenile salmonids migrating and rearing through the tidal estuarine habitat during their egress to the ocean.

Juvenile Chinook Salmon Life Stage Requirements and Utilization of the Mainstem Willamette

When juvenile Chinook salmon enter the mainstem Willamette River they begin their migration out to the ocean through the lower river's tidally influenced estuary. Outmigration typically occurs during the winter and spring, peaking between February and May (Friesen et al. 2007). The habitat conditions required for this life stage are unique and the process by which out-migrating juvenile salmonids take up residence in large, tidally influenced estuarine systems is more recently becoming understood. Recent studies such as Friesen et al. (2007) and Teel et al. (2009) provide a conceptual model of what are important habitat variables unique to this habitat type.

Juvenile salmonids have been found along channel margins during outmigration through the large rivers, where velocities are lower and cover is more abundant (Murphy et al. 1989 and Beechie et al. 2005). Additionally, outmigration studies have shown that juvenile Chinook are found off-channel floodplain habitats, particularly sloughs and channel edges, and off-channel terrace tributaries and tributary mouths (Murphy et al. 1989; Sommer et al. 2001, 2005; Brown 2002). However, Chinook were virtually absent from beaver ponds or off-channel sloughs. In these studies, velocities along banks in large rivers have been found to have mostly low velocities (<0.5 ft/s) (Beechie et al. 2005) and all backwater habitats had mean water velocity of <0.5 ft/s (Murphy et al. 1989 and Beechie et al. 2005). Therefore, juvenile Chinook are attracted to habitats that are by definition low in velocity. Additionally, numerous studies conclude that younger age classes of juvenile salmonids are highly associated with shallow, nearshore beach habitats with sandy substrate (e.g., Lister and Genoe 1970, Johnsen and Sims 1973, Dauble et al. 1989). Bank cover is also an important variable in out-migrating habitats and juvenile Chinook were found by Beechie et al. (2005) to be associated will all potential cover types present.

The simplification of freshwater and estuarine waterways in the Lower Columbia River Estuary (LCRE) has reduced the amount of estuarine habitat for out migrating juvenile salmonids (Bottom et al. 2005). Therefore, tidally influenced habitats, like those found in the Lower Willamette River, are in need of restoring in order to increase the amount of available rearing and holding habitat for out-migrating juvenile salmonids (Teel et al. 2009 and Roegner 2010). Roegener et al. (2010) studied numerous parameters on restored habitats in the LCRE, including fish use, sediment accretion, and vegetation elevation. It is recommended that similar parameters be built into monitoring the effectiveness of the restoration measures recommended in this plan, although the scope of this study does not allow those same parameters to be incorporated into this model for comparison between baseline and projected conditions.

In the project area, historically, many juvenile salmonids resided in the Willamette River for a period of months or up to a year or more. In the 1940s it was reported that large numbers of fry were present in the Willamette River from February through early April (NPCC 2004). Studies in the 1960s confirm the pattern of rearing in the mainstem of large rivers. Scale analyses of returning adults indicated that only 10 percent had entered the ocean as subyearlings, suggesting that a large proportion of the juveniles observed migrating downstream had overwintered in the mainstem Willamette or Columbia Rivers (NWPCC 2004). Some subyearlings have been observed in off-channel areas of the Willamette and the lower reaches of valley floor tributaries, and their movements may be timed to co-occur with (or may be triggered by) fall and early winter freshets, which flood habitat that would be unsuitable during summer because of high temperatures and low flow (NWPCC 2004). The channelization of the Willamette River has drastically reduced off-channel and other low velocity rearing habitats for juvenile Chinook (Kostow 1995).

Teel et al. (2009) recently identified that Willamette River spring-run Chinook salmon use the seasonal floodplains near the convergence of the Willamette and Columbia rivers. They also identified that that both spring and fall subyearling Chinook salmon from outside the Willamette River use these wetlands, and that some portion of Chinook salmon occupying lower Willamette River wetland habitats make extensive migrations down the Columbia River before entering the Willamette River.

A collaborative effort between the Oregon Department of Fish and Wildlife and City of Portland Bureau of Environmental Services monitored the biology, behavior, and habitat resources of juvenile salmonids in the lower Willamette River from May 2000 – July 2003 (Friesen 2005 and Friesen et al. 2007). The results of this study show that the lower Willamette is more than a simple migration corridor, and that juvenile Chinook salmon not only feed but apparently grow during their outmigrations.

During the three year study, density values of both hatchery and unmarked juvenile Chinook salmon generally increased beginning in November and declined to near zero by June. Habitat associations varied with collection methods. Radio-tagged Chinook salmon are not highly associated with nearshore areas; they were distributed evenly across the river channel regardless of year, time of day, origin, or area. Electrofishing found that catch per unit effort (CPUE) varied significantly among habitat types mainly due to low catches of fish at seawall habitats. In addition, electrofishing CPUE for juvenile salmonids in off-channel areas was not significantly greater than in main-channel areas. However, all off-channel types were clearly utilized.

Habitat use by juvenile Chinook as observed in the mainstem Willamette is described below. Habitats in the study area were categorized into six categories: beaches, alcove, riprap, seawall, rock outcrop and mixed. The majority of the riverbank habitat was classified as undeveloped ('natural') and beaches with sandy substrate were the most prevalent habitat type. Natural beaches appeared to be an important habitat for younger age classes of Chinook salmon. These habitat types are typical under natural conditions in the larger rivers of the Lower Columbia Estuary. In addition, beaches were not a preferred habitat of large predator fishes and therefore enhancements directed at creating beaches were recommended. Unaltered nearshore habitats (beaches) appear to be important to smaller fish as juvenile salmonids are generally associated with the upper portion of the water column. All off-channel habitats were utilized by juvenile salmonids as they are likely important for forage and refuge. Seawalls and riprapped sites on the other hand appeared to be under-utilized by juvenile Chinook. However, densities of large predators were constantly highest at sampling sited dominated by rocky habitats in the summer and autumn.

These studies indicate that juvenile Chinook primarily utilize nearshore shallow water beach habitat with sandy substrate and off-channel refuge habitats during their out-migration in through the estuarine mainstem Willamette River. It is therefore these habitats that are target for restoration in this portion of the project area. However, Friesen et al (2004) state that of the habitat parameters studied some relationships were confused and recommended a more rigorous statistical approach for future work and greater understanding of how juvenile out-migrating salmonids utilize habitat in the Lower Willamette River.

Chinook juveniles appear to prefer areas with slow to moderate velocities, < 30 cm/s (Healey 1991). Although velocities in side channels and off-channel areas that would be created as part of this project were not modeled, these areas were designed to have low velocities. Because they are located in tidal areas, velocities would be associated with filling and draining due to tidal cycles as well as increased or decreased water surface elevations due to fluctuating upstream discharge rates. Since velocities were assumed to be low in restored side channels and off-channel areas across all mainstem sites, velocity was not considered necessary in developing the mainstem model.

Native Salmonids Mainstem Habitat Suitability Model Development

The mainstem model is a new HSI developed for Chinook salmon to account for the unique habitat that exists in the mainstem of the tidally influenced Lower Willamette River and to evaluate the extent to which habitat restoration measures will benefit out-migrating juvenile salmonids. The mainstem model is developed from modifications of existing HSIs for Chinook salmon (Alan and Hassler 1986) and the site specific data collected in the study discussed above (Friesen et al. 2007). The modifications of the existing HSIs were based upon localized response variables identified in available data and publications, as well as site specific observations. The HSIs for Chinook in Alan and Hassler (1986) were selected for use in the mainstem model as the juvenile rearing habitat represented is that of tidal estuaries similar to those found in the project area.

The SIs for Chinook that were selected to include in the mainstem model include variables that may show a response to the restoration action and that address factors or processes that are limited to or preferred by juvenile salmonids utilizing this habitat type. The SIs target the habitat conditions that out-migrating juvenile Chinook would encounter in the study area, as indicative of a large tributary of the Lower Columbia River estuary.

In the Friesen et al. (2007) study, habitat parameters were measured to identify those contributing to habitat selection of juvenile Chinook salmon. In the spring, only bank vegetation showed a relationship with Chinook density. In the winter, sand substrate, shallow water, and moderate amounts of bank vegetation were associated with higher catches. Therefore, bank vegetation, substrate, and depth were the parameters selected to be the indicators of habitat quality for out-migrating juvenile salmonids in the estuarine mainstem of the Willamette River.

As peak out-migration for juvenile Chinook occurs between February and May, the features of the proposed projects were designed to be connected during this season. Additionally, the mainstem model addresses variables that are applicable during this season. For example, temperature and dissolved oxygen may be limiting in some locations in the project area during summer/fall low flow months but since they are within the optimum ranges during the out-migration period, they are not factors included in the model.

Table 4.9 includes a list of the variables included in the original Chinook salmon HSIs and the rationale for use or exclusion. Variables were omitted if they did not pertain to a limiting factor in the project area. Due to the number of variables associated with tidal habitats on large rivers such as the Willamette, more rigorous analysis of Willamette habitat relationships and hydraulic conditions is warranted.

Table 4.9 Native Salmonids Mainstem Variables

Species	V	Variable	Used	Not Used	Rationale
Native Salmonids					This model was created based on recent literature of Chinook use of mainstem Willamette River shallow water habitats -- based off of existing HSIs from Allen and Hassler 1986 and site specific data collected by Friesen et al 2004 and 2007.
Juvenile Chinook - Modified					
	V_1	Temperature (°C)		X	The optimal water temperature for outmigrating salmonids is 12-13°C (53-55°F) (Allen and Hasler 1986). Average temperature in the mainstem Willamette is 58.8°F during the outmigration period, which is within their tolerance range, therefore temperature was not identified as a limiting factor during the season of peak out-migration (February – May), for which the project is designed, and no restoration measures were developed to address this variable. Additionally, scale of the proposed project is too small to make a difference in temperature in the waterbodies in which the restoration sites occur.
	V_2	Salinity (ppt)		X	Lethal salinity level for juvenile salmonids is between 15-30 ppt (Allen and Hasler 1986). Study area is upstream of Columbia River estuarine mixing zone and saline conditions do not exist, therefore salinity was not included as an evaluation parameter.
	V_3	Dissolved Oxygen (mg/L)		X	The tolerance level for DO for juvenile salmonids is >4.5 mg/l (Allen and Hasler 1986). DO in mainstem is between 6.0-14.8 mg/l, therefore not identified as a limiting factor during the season of peak out-migration (February – May), for which the

					project is designed, and no restoration measures were developed to address this variable. Additionally, scale of the proposed project is too small to make a difference in DO in the waterbodies in which the restoration sites occur.
	V_4	Substrate	X		Identified as a limiting factor and showed a relationship with fish presence in Friesen et al. (2007) study.
	V_5	Depth	X		Identified as a limiting factor and showed a relationship with fish presence in Friesen et al. (2007) study.
	V_6	Water Velocity (ft/s)		X	Optimal water velocities for juvenile salmonids are between 0.06-0.24 m/sec. Side channels and backwaters by definition are low velocity habitats and have been designed for this project to have the geometry and other criteria specifically to ensure low velocities (< 30 cm/s). Developing velocity estimates at this stage of the study would require extensive hydraulic modeling of the lower Willamette River, beyond the scope of this study. Proposed side channels and backwaters do not currently exist, therefore there is no baseline to compare benefits.
Juvenile Chinook - New					
	V_1	Depth (<20m from shore)	X		Identified as a limiting factor and showed a relationship with fish presence in Friesen et al. (2007) study.
	V_2	Substrate	X		Identified as a limiting factor and showed a relationship with fish presence in Friesen et al. (2007) study.
	V_3	Percent cover bank vegetation	X		Identified as a limiting factor and showed a relationship with fish presence in Friesen et al. (2007) study.
$HSI_{Salmonids\ Mainstem} = (V_1 + V_2 + V_3) / 3$					

Highlights of the selected model with the attributes measured for each species or species assemblage

HEP Model	
Western Pond Turtle	V_1 = Percent area with water depth preferred by adults V_2 = Percent cover along water's edge V_3 = Water temperature during low flows V_4 = Percent area with water depth less than 0.3 meters V_5 = Availability of suitable nesting sites $HSI_{W\ Pond\ Turtle} = (V_1 + V_2 + V_3 + V_4 + V_5) / 5$
Beaver	V_1 = Percent tree canopy closure V_2 = Percent of trees in 2.5 to 15.2 cm dbh size class V_3 = Percent shrub crown cover V_4 = Average height of shrub canopy V_5 = Species composition of woody vegetation $HSI_{Beaver} = (V_1 + V_2 + V_3 + V_4 + V_5) /5$
Wood Duck	V_1 = Percent of the water surface covered by potential brood cover $HSI_{Wood\ Duck} = V_1$
Yellow Warbler	V_1 = Percent deciduous shrub crown cover V_2 = Percent overall canopy cover V_3 = Average height of deciduous shrub canopy V_4 = Percent of shrub canopy comprised of hydrophytic shrubs $HSI_{Yellow\ Warbler} = (V_1 + V_2 + V_3 + V_4) / 4$
Native Amphibians	V_1 = Percent area with permanent water V_2 = Percent area with emergent or submergent wetland/aquatic vegetation V_3 = Percent ground cover along the water's edge V_4 = Width of riparian zone V_5 = Maximum temperature during low flows V_6 = Land use within 200 meters of the wetland edge $HSI_{Native\ Amphibians} = (V_1 + V_2 + V_3 + V_4 + V_5 + V_6) / 6$
Native Salmonids (Tributaries)	V_1 = Maximum water temperature during low flows V_2 = Percent pools during low water period V_3 = Instream cover (LWD) present V_4 = Predominant substrate size in riffle and run areas $HSI_{Salmonids\ Tributaries} = (V_1 + V_2 + V_3 + V_4) / 4$
Native Salmonids (Mainstem)	V_1 = Depth (<20m from shore) V_2 = Substrate V_3 = Percent cover bank vegetation $HSI_{Salmonids\ Mainstem} = (V_1 + V_2 + V_3) / 3$

4.8 Model Parameters

4.8.1 Western Pond Turtle

The HSI for western pond turtle is described in the following equation:

$HSI_{WPondTurtle} = (V_1 + V_2 + V_3 + V_4 + V_5) /5$

V_1 = % Area with water depth preferred by adults (1-2 m) ***(Morreale and Gibbons 1986)***

% Area	**SI**
0	0
20	0.5
50	1.0
75	1.0
100	0.2

V_2 = % Cover along water's edge (Includes canopy, LWD, emergent wetland vegetation, etc. that either overhangs or is adjacent to the water within ordinary high water (OHW) marks) ***(Morreale and Gibbons 1986)***

% Cover	**SI**
0	0
25	0.2
50	0.5
75	1.0
100	1.0

V_3 = Water temperature during low flows (July-September) ***(Morreale and Gibbons 1986; Holland 1994)***

Temperature (C)	**SI**
5	0
10	0.2
15	0.6
20	1.0
25	1.0
30	0.6

V_4 = % Area with water depth less than 0.3 meters ***(Bill Castillo ODFW)***

% Area	**SI**
0	0.1
25	1.0
50	1.0
75	0.3
100	0

V_5 = Availability of suitable nesting sites (qualitative) ***(Bill Castillo ODFW)***

Availability	SI
None	0
Very few (1-2 in project area)	0.2
Sparse (3-4 in project area)	0.5
Moderate (5-7 in project area)	0.8
Abundant (>7 in project area)	1.0

4.8.2 Beaver

The HSI for beaver is described in the following equation:

$\mathbf{HSI_{Beaver} = (V_1 + V_2 + V_3 + V_4 + V_5) / 5}$

V_1 = Percent tree canopy closure (the percent of the ground surface shaded by a vertical projection of the canopies of woody vegetation ≥5.0 m (16.5 ft) in height) ***(Allen 1982)***

Percent canopy closure	SI
0	0
25	0.5
50	1.0
75	0.8
100	0.6

V_2 = Percent of trees in 2.5 to 15.2 cm (1 to 6 inches) dbh size class ***(Allen 1982)***

Percent of trees	SI
0	0.2
25	0.4
50	0.6
75	0.8
100	1.0

V_3 = Percent shrub crown cover (the percent of the ground surface shaded by a vertical projection of the canopies of woody vegetation < 5 m (16.5 ft) in height) ***(Allen 1982)***

Percent cover	SI
0	0
25	0.6
50	1.0
75	0.9
100	0.8

V_4 = Average height of shrub canopy ***(Allen 1982)***

Average height (meters)	**SI**
0	0
1	0.3
2	1.0
3	1.0
4	1.0

V_5 = Species composition of woody vegetation (trees and/or shrubs) ***(Allen 1982)***

Vegetation Class	**Description**	**SI**
A	Woody vegetation dominated (>50%) by one or more of the following species: aspen, willow, cottonwood, alder	1.0
B	Woody vegetation dominated by other deciduous species	0.6
C	Woody vegetation dominated by coniferous species	0.2

4.8.3 Wood Duck

The HSI Index for wood duck is described in the following equation:

$\mathbf{HSI_{Wood\ Duck} = V_1}$

V_1 = Percent of the water surface covered by potential brood cover (shrub cover, overhanging tree crowns within 1 m (3.3 ft) of the water surface, woody downfall, and herbaceous) ***(Sousa and Farmer 1983)***

Percent surface covered	**SI**
0	0
25	0.4
40	0.8
50-75	1.0
85	0.6
100	0

4.8.4 Yellow Warbler

The HSI for neotropical birds is described in the following equation:

$\mathbf{HSI_{Yellow\ Warbler} = (V_1 + V_2 + V_3 + V_4) / 4}$

V_1 = % deciduous shrub cover *(Schroeder 1982)*

% Cover	SI
0	0
25	0.4
50	0.75
60	1.0
80	1.0
90	0.8
100	0.6

V_2 = % overall canopy cover *(Schroeder 1982)*

% Canopy Cover	SI
0-20	0
20-40	0.1
40-60	0.2
60-70	0.8
70-80	1.0
80-100	0.1

V_3 = Average height of deciduous shrub canopy height *(Schroeder 1982)*

Canopy Height (m)	SI
0	0
1	0.5
2+	1.0

V_4 = % canopy comprised of hydrophytic shrubs (Yellow Warbler) *(Schroeder 1982)*

% Hydrophytic Shrubs	SI
0	0.1
25	0.3
50	0.55
75	0.8
100	1.0

4.8.5 Native Amphibians

The HSI for native amphibians is described in the following equation:
$\mathbf{HSI_{Native\ Amphibians} = (V_1 + V_2 + V_3 + V_4 + V_5 + V_6) / 6}$

V_1 = % Area with permanent water *(modified from WDFW 1997)*

% Area of Permanent Water	SI
0	0

10	0.6
25-40	1.0
>50	0.2

V_2 = % Area with emergent or submergent wetland/aquatic vegetation ***(WDFW 1997).***

% Area Wetland Vegetation*	SI
0	0
25	0.5
>50	1.0

**Areas dominated by reed canary grass and/or purple loosestrife cause HSI = 0.2.*

V_3 = % Ground cover along the water's edge, including debris, overhanging vegetation, undercut banks, etc. (width of area where overhanging vegetation is rooted) ***(WDFW 1997)***

% Cover	SI
0	0
25	0.3
50	0.6
75	0.9
100	1.0

V_4 = Width of riparian zone ***(WDFW 1997)***

Width (m)	SI
0	0
10	0.2
30	0.6
>60	1.0

V_5 = Maximum water temperature during low flows (late summer/early fall) ***(modified from Graves and Anderson 1987)***

Temperature (°C)	SI
0	0.1
5	0.5
10	1.0
15	0.3
20	0

V_6 = Land use within 200 meters of the wetland edge ***(WDFW 1997)***

Land Use	SI
Developed	0

Row Crops	0.1
Managed Pasture	0.5
Fallow Grass/herbs	0.7
Shrubs/trees	1.0

4.8.6 Salmonids Tributaries

The HSI for tributary salmonids is described in the following equation:

$\mathbf{SI_{Salmonids\ Tributaries} = (V_1 + V_2 + V_3 + V_4) /4}$

V_1 = Maximum water temperature during low flow (late summer/early fall) *(Raleigh et al. 1986)*

Temperature (°C)	**SI**[1,2]
0	A = 0, B = 0**
5	A = 0.5, B = 0.3
10	A = 1.0, B = 0.9
15	A = 0.9, B = 1.0
20	A = 0.5, B = 0.9
25	A = 0, B = 0

[1]**A** = prespawning adults, **B** = juveniles
[2]Average the adult and juvenile values for V_1

V_2 = Percent pools during low water period *(Raleigh, et al. 1986)*

Percent Pools	**SI**
0	0.2
25	0.6
50	1.0
75	0.9
100	0.2

V_3 = Instream cover (LWD) present *(modified from McMahon 1983)*

Instream cover (% of surface area)	**SI**
0	0.1
10	0.2
20	0.4
30	0.8
40	1.0

V_4 = Predominant substrate size in riffle or run areas *(Raleigh, et al. 1986)*

Class	**Description**	**SI**
A	Rubble or small boulders predominant; limited amounts of	1.0

	gravel, large boulders, or bedrock	
B	Rubble, gravel, boulders, and fines occur in approximately equal amounts or gravel is predominant	0.6
C	Fines, bedrock, or large boulders are predominant. Rubble and gravel are < 25%	0.3

4.8.7 Native Salmonids Mainstem

The HSI for mainstem salmonids is described in the following equation:

$\mathbf{HSI_{Salmonids\ Mainstem} = (V_1 + V_2 + V_3) / 3}$

V_1 = % Cover Bank Vegetation (Friesen *et al* 2004)

% Cover	SI
0-10	0
11-20	0.3
21-30	1
31-40	0.6
41-80	0.2
81-100	0.1

V_2 = Depth (<20 m from the shore) (Friesen *et al.* 2004; Allen and Hassler 1986)

Depth (m)	SI
0.0 – 0.5	0.5
0.6 – 3.0	1.0
3.1 – 10	0.6
>10	0

V_3 = Substrate (Friesen *et al.* 2004; Allen and Hassler 1986)

Substrate Type	SI
Bedrock	0.25
Riprap	0.35
Sand	1.0
Fines	0.45

4.9 HEP Results

The HSIs for each species or guild were calculated for each proposed project both for existing and future conditions. HSIs were calculated for future-without conditions at five years, ten years, and 25 years and future-with project conditions at five years, ten years, and 25 years. These HSI scores were then combined to produce a combined HSI score utilizing the following equations, one for tributary project sites and the other for mainstem project sites suitable for use in a cost effectiveness and incremental cost analysis (CE/ICA).

HSI Equation Tributaries	$HSI_{All} = (HSI_{WPondTurtle} + HSI_{Beaver} + HSI_{Wood\ Duck} + HSI_{Yellow\ Warbler} + HSI_{Native\ Amphibians} + HSI_{Salmonids\ Tributaries}) / 6$
HSI Equation Mainstem	$HSI_{All} = (HSI_{WPondTurtle} + HSI_{Beaver} + HSI_{Wood\ Duck} + HSI_{Yellow\ Warbler} + HSI_{Native\ Amphibians} + HSI_{Salmonids\ Mainstem}) / 6$

When scoring each variable for without and with project conditions the following assumptions were made:

Without Project Condition Assumptions
The assumptions used to score the baseline future conditions of the restoration sites at 5, 10 years and 25 years through 50 years 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 significantly over the projected time period without a significant 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 disturbance and regeneration 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 and climate change effects. Other water quality parameters including 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 Woody Debris* LWD 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 LWD 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 water's edge is not expected to have increased significantly.

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

- *Fish Passage Barrier Removal* Fish passage would remain partially blocked at some locations.

With Project Condition Assumptions
The assumptions used to establish the future conditions of the restoration sites after implementation of restoration measures are as follows:

- *Revegetation* Five years after the project, 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. Twenty-five years after the project, deciduous trees would be mature and the deciduous tree canopy would be closed to the extent that it was going to close at that level of succession. Shrub canopy cover would decrease somewhat in response to the lower amount of sunlight coming through the upper canopy and shrub heights would decrease. 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 on the mainstem Willamette River as a result of this project, due to its limited size in comparison to the size of the waterbodies on which it occurs. 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 Woody Debris* Within one year following implementation of the project, complexity and instream cover is expected to increase substantially with the placement of LWD. 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. After 25 years with the project, 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 LWD 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 significantly in some areas immediately upon completion of the project due to placement of LWD and revegetation, and is expected to further increase as restored vegetation matures and fills in available spaces.

- *Side Channels and Alcoves* Immediately following implementation of the project, 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 following implementation of the project, fish access would be restored to habitat upstream for both rearing and spawning. This 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 the Tryon Creek/Highway 43 Culvert project is specifically a fish passage project, the only HSI 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 lifecycle of the project.

For each group of species, a habitat suitability index (HSI) was derived (between 0 and 1). For this project, the index scores for each site were averaged. The overall resulting index score was multiplied by the acreage of potential alternative restoration plans to yield habitat units. HSIs were calculated for existing conditions, conditions at 5 years without the project, 10 years without the project, and at 25+ years without the project, at 5 years after restoration, 10 years after restoration, and at 25+ years after restoration. It was assumed that conditions found at these control points would reflect milestone changes in the habitat conditions as the site matures after the project is implemented. After 25 years, it was assumed that the characteristics of the site would reflect conditions expected in a maturing ecosystem that is beginning to realize the full benefits of vegetation plantings and temperature reduction. Fast-growing trees such as alders and willows are starting to mature by then, and conifers such as western red cedars and Douglas-firs are well established.

Existing Habitat at Project Sites

Kelley Point Park is a greenspace at the convergence of the Willamette and Columbia Rivers. Existing habitat features include riparian vegetation, a forested wetland, and the shorelines of the two rivers. 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. Existing and future with project conditions will provide the habitat for all species identified in the HEP model.

The BES Plant site is along the south bank of the Columbia Slough. Existing habitat features at the project site consist of narrow and mostly immature riparian zone on both banks, a depressional wetland swale, and the shoreline of the Columbia Slough. Existing and future with project conditions will provide the habitat for all species identified in the HEP model.

Kenton Cove lies on the north shore of the Columbia Slough. Existing habitat features include gently to moderately sloping banks covered with grasses or riparian forest that lead down to the backwater cove. Existing and future with project conditions will provide the habitat for all species identified in the HEP model.

The Oaks Crossing/Sellwood Riverfront Park site is on the north shore of the Willamette River. The project footprint is comprised mostly of forest cover with small patches of bare ground or grass/lawn. Existing and future with project conditions will provide the habitat for all species identified in the HEP model.

Existing habitat at the Tryon Creek Highway 43 Culvert project site is defined primarily by tributary stream habitat surrounded by a narrow mature riparian zone and a narrow floodplain with steep upland areas consisting of mature trees. Existing habitat conditions of newly accessible stream miles provide the with-project habitat conditions value for tributary fish species only. Therefore only the tributary model was used to score this project. Although there may be incidental benefits to other wildlife utilizing the improved passage at the culvert, these are not measurable with this model. As the habitat conditions of Tryon Creek vary along the length of the newly accessible area, the exiting habitat conditions were scored for three distinct reaches and summed together to provide total habitat units. Furthermore, as fish passage is blocked at this structure the habitat value upstream of the culvert is assumed to be zero for anadromous fish under current conditions.

Table 4.10 summarizes the scores under existing conditions and after restoration occurs. 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 4.10 HSI Scores Under Existing Conditions and After Restoration and Acres at Each Site

Project Site	Existing HSI	HSI After Restoration (25-50 years)	Acres
Mainstem Willamette River			
Kelley Point Park	0.48	0.86	45.10
Cathedral Park	0.40	0.61	3.50
Saltzman Creek	0.37	0.69	2.00
Oaks Crossing/Sellwood Riverfront Park	0.44	0.73	10.44
Columbia Slough			
St. Johns Landfill Boat Ramp	0.29	0.54	3.10
BES Treatment Plant South	0.41	0.70	6.60
Kenton Cove	0.40	0.60	5.90
Tryon Creek			
Tryon Highway 43 Culvert			
Reach 1	0	0.93	13.00
Reach 2	0	0.65	24.10
Reach 3	0	0.63	11.90

Habitat units were determined by multiplying the combined HSI scores by the area of habitat that may be affected by each project. The area of habitat was determined by the project boundaries and area of influence around the project boundaries (i.e., area that would be shaded by riparian vegetation, area opened up by construction of tidal channels, or area around newly installed cover features where juvenile fish may venture to) or in the case where fish passage barriers were replaced, the area was determined by the amount of available habitat opened upstream from the barrier. Table 4.11 shows the results of the HU calculations at set control points selected for years 0, 5, 10, and 25 under both with and without project conditions. To calculate average annual habitat units (AAHUs), the HUs for both with and without-project conditions at each of the control points were entered into the USACE IWR Planning Suite Annualizer. The Annualizer then interpolated HU values for all 50 years of the project life based upon area under the curve calculations. These scores were then totaled and divided by 50 (for the total number of years) to achieve the AAHU score. The AAHU score was calculated for both with and without-project conditions from which a net AAHU score is determined to assess the net gain of the project. AAHU scores under with and without project conditions, as well as net gain, are shown in Table 4.12.

Table 4.11. HU calculations for each project site.

Project Site	Habitat Units						
	Existing	Future Without Project			Future With Project		
	Year 0	Year 5	Year 10	Year 25	Year 5	Year 10	Year 25
Kelley Point Park	21.65	23.00	22.55	22.55	36.08	37.88	38.79
Cathedral Park	1.40	1.37	1.37	1.37	2.07	2.21	2.14
Saltzman Creek	0.74	0.74	0.72	0.72	1.22	1.28	1.38
Oaks Crossing/Sellwood Riverfront	4.59	4.80	4.80	4.91	7.62	8.04	7.62
St. Johns Landfill Boat Ramp	0.90	0.90	0.93	0.93	1.46	1.71	1.67
BES Plant South	2.74	2.81	2.81	2.75	4.20	4.57	4.60
Kenton Cove	2.34	2.39	2.39	2.37	2.86	3.33	3.55
Tryon Highway 43 Culvert	0.00	0.00	0.00	0.00	39.65	39.65	39.65

Table 4.12 Average Annual Habitat Units (AAHUs) for each project site.

Project Site	AAHUs		
	Future W/o Project	Future With Project	Net Gain
Kenton Cove	2.37	3.37	1.00
Oaks Crossing/Sellwood Riverfront Park	4.86	7.55	2.69
BES Plant South	2.76	4.46	1.69
Kelley Point Park	22.55	37.48	14.93
Tryon Highway 43 Culvert	0.00	39.65	39.65
Saltzman Creek	0.72	1.31	0.589
Cathedral Park	1.3715	2.11	0.74
St. Johns Landfill Boat Ramp	0.9255	1.6185	0.693

Conclusions

Table 4.11 shows the increase in habitat value that would occur due to implementation of the proposed projects, and the data sheets in Appendix B show the increased habitat value on a per/species basis and at each site. These tables show that significant lift to the habitat of the indicator species would occur, indicating that the health of the watershed would be significantly improved if the project were implemented. Use of these scores to populate the cost effectiveness/incremental cost analysis model show that these projects are "best buy" plans, meaning that they are good plans that are worth implementing.

5. REFERENCES

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Appendix A - Model Certification Letters

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS
441 G STREET, NW
WASHINGTON, DC 20314-1000

REPLY TO
ATTENTION OF

CECW-P

AUG 15 2013

MEMORANDUM FOR Director, National Ecosystem Restoration Planning Center of Expertise (ECO-PCX)

SUBJECT: April 12, 2013 ECO-PCX Recommendation for Approval for Single Use of the Oregon Chub, Native Salmon, American Kestrel, Native Amphibians, and Western Pond Turtle Habitat Suitability Index (HSI) Models in the Willamette Floodplain Restoration Study

1. These five HSI models originally were recommended for single use approval on one planning study but during the HQ model review period another team began developing another project study which sought to utilize the same set of HSI models to that study area being coincident with the original study request. These five models are usable and applicable to both of these studies.

2. July 2, 2013 HQUSACE approved these five HSI Models for single use approval on both the Willamette River Floodplain Restoration study and the Lower Willamette River Restoration Study. In application, these reports shall define parameters such as "narrow width", "significant presence", and "low flow period" to document assumptions used and ensure consistent application.

HARRY E. KITCH, P.E.
Deputy Chief, Planning and Policy Division
Directorate of Civil Works

Encl

application.

HARRY E. KITCH, P.E.
Deputy Chief, Planning and Policy Division
Directorate of Civil Works

Encl

REPLY TO ATTENTION OF:

DEPARTMENT OF THE ARMY MISSISSIPPI VALLEY DIVISION, CORPS OF ENGINEERS P.O. BOX 80 VICKSBURG, MISSISSIPPI 39181-0080

CEMVD-PD-N 14 April 2014

MEMORANDUM FOR CECW-NWD (Kopecky)

SUBJECT: Summary of Model Review Results and Recommendation for Approval for Single Use of the Out-Migrating Juvenile Chinook Salmon HSI Model in the Lower Willamette River Ecosystem Restoration Project

1. References:
   a. Engineering Circular 1105-2-412: Assuring Quality of Planning Models, dated 31 March 2011.

   b. US Army Corps of Engineers. Assuring Quality of Planning Models - Model Certification/Approval Process: Standard Operating Procedures. February 2012

   c. Model Approval Plan, Juvenile Chinook Salmon HSI Model, dated 16 October 2013 (Encl 1)

   d. Final Model Documentation (Encl 2)

   e. Model Review Documentation (Encl 3)

2. The Ecosystem Restoration Planning Center of Expertise (ECO-PCX) evaluated the Out-Migrating Juvenile Chinook Salmon HSI Model in accordance with references 1.a, 1.b and the Model Approval Plan (Encl 1). The ECO-PCX recommends single-use approval of the model in the Lower Willamette River Ecosystem Restoration Project. Please log in this recommendation with the Office of Water Project Review for consideration by the Model Certification Team.

3. There is a large amount of life history diversity within the Chinook salmon species. In the Willamette and Columbia River basins substantial variation exists based on time of freshwater entry, time of spawning, age and time of smolt migration, and length of freshwater residence. The Juvenile Chinook model was developed by the Portland District to evaluate the specific habitat requirements associated with active out-migrating juvenile salmon smolts within the lower Willamette's tidally influenced estuary.

The Columbia River/Lower Willamette estuary is critical habitat for all types (stream- and ocean-type) and populations of Chinook salmon because at some point all juveniles take up residence in the estuary (timing is dependent on population type and out-migration status). This out-migration habitat is critical to salmon life history for feeding, rearing, refuge, and salt-water acclimation. Generally, juvenile Chinook salmon utilize nearshore shallow water beach habitat within the mainstem Willamette and Columbia Rivers. The subject model included habitat parameters which contributed to habitat selection of juvenile Chinook salmon migrating and rearing through the tidally influenced habitats in the Lower Willamette River. Based on recent studies, bank vegetation, substrate, and depth were associated with higher densities of juvenile Chinook salmon among nearshore and backwaters habitat types. Therefore, these variables were the parameters selected to be indicators of habitat quality for out-migrating juvenile Chinook salmon in the estuarine mainstem of the lower Willamette River. The model follows the HEP methodology to document the quality (suitability

index score between 0.0 and 1.0) and quantity (area of restoration site) of available habitat for the selected species.

4. Review of the Juvenile Chinook Model was conducted by Fred Goetz (NWS). Fred is a SME in Pacific salmon ecology and familiar with the structure and function of estuarine habitat in the Lower Willamette River. The ECO-PCX managed the review to assess the technical quality, system quality, and usability of the models. The review results are in Enclosure 3.

There were 24 final comments (5 of high significance, 9 of medium significance, and 10 of low significance). The comments of high significance were related to the selection of variables used in the model, the objective of the model, and the spatial resolution/objective of the model. Medium significance comments generally focused on improvements to variable definitions, salmon life history refinements, application considerations, overall documentation structure, and a recommendation for future validation of the model. Finally, comments of low significance addressed the flow of the documentation and refinements to references cited. In response to the comments, the following modifications were made to the model:

- The documentation was revised to explicitly state the objective of the model. Due to the variation within salmon life-history components and the unique habitat requirements for each component, the intended use of the model was revised to more accurately reflect the system being represented. This included better definition of estuarine habitat, out-migration habitat requirements, life-history requirements, and temporal resolution of the model.
- Dissolved oxygen and velocity parameters were added to define the boundary conditions and applicability of the model.
- Spatial resolution was improved through improved definition of the objective of the model and the system being represented by the model.
- Definitions and descriptions were improved throughout the document to better understand the technical aspects of the model's functionality, and justify the selection of model parameters and index scores.

All comments were addressed and incorporated to the satisfaction of the ECO-PCX and reviewer.

5. The Juvenile Chinook Model meets technical quality standards. The theoretical premise behind the model relates to a species' relationship to environmental factors/variables considered important and the range of conditions within which the species selects occupancy. The model provides reliable information on the known habitat requirements of juvenile Chinook salmon, provides an objective method of estimating how well specific habitat variables meet the habitat requirements, and provides a measurable basis for documenting project influences. The model is based on the current state of knowledge regarding the basic environmental conditions and resources required by juvenile Chinook salmon to survive and contribute to the population. The model is applicable to sites with water
velocities <30 cm/s and DO >4.5 mg/L, and during active out-migration time periods. The ATR team should be charged with evaluating the applicability of the model based on limitations and assumptions described in the model documentation. The model is in compliance with Corps policies and accepted procedures.

6. The model has sufficient system quality. The software platform (MS Excel 2007) is appropriate and available to all users. The component of the spreadsheet containing the Juvenile Chinook Model was reviewed and tested for computational correctness by the ECO-PCX. HSI values were calculated

2

CEMVD-PD-N
SUBJECT: Summary of Model Review Results and Recommendation for Approval for Single Use of the Out-Migrating Juvenile Chinook Salmon HSI Model in the Lower Willamette River Ecosystem Restoration Project

correctly. The PDT is proposing the use of additional models within the overall habitat evaluation procedure which requires some level of aggregation to obtain HUs. These methods and the method to produce AAHUs should be reviewed during ATR. As always when aggregating multiple species or community models, the PDT should conduct sensitivity analyses to better understand how individual variables, species or communities are affected by the alternatives.

7. The model has acceptable usability in that the scoring of variables, development of an overall score, and output interpretation is straightforward. The data required for input is readily available through a combination of information ascertained through field/site visits and/or elicitation of expert assistance from ecologists and biologists. The model is transparent and would allow for verification of calculations and outputs.

8. The ECO-PCX has reviewed the comments, District responses, and revisions to the model documentation and determined there are no unresolved or unaddressed issues which would prevent a recommendation for approval for single use.

9. In summary, the ECO-PCX finds the Out-Migrating Juvenile Chinook Salmon HSI model has sufficient technical quality, system quality, meets usability criteria, and complies with USACE policy. It is the recommendation of the ECO-PCX that the model be approved for single use in the Lower Willamette River Ecosystem Restoration Project. Please notify the ECO-PCX of the findings of the Model Certification Panel.

Enclosures (3)

Jodi Creswell
Operating Director, Ecosystem Restoration
Planning Center of Expertise

CF (with enclosures):
CECW-PC (Coleman, Matusiak, Trulick, Ware,
Bee) CECW-CP (Kitch, Hughes)
CECW-PB (Carlson)
CECW-NWD (Durham-Aguilera, McLean,
Kramer) CENWD-PDD (Combs, Fischer, Hudson,
Weiss)
CENWP-PM-E (Lightner,
Cisneros) CENWP-PM-F (Hicks,
Saldana)
CENWS-EN-ER (Gleason, Goetz,
Jackels) CENWS-PM-PL (Ringold)
CEMVD-PD-N (Wilbanks, Lachney,
Creswell) CEMVP-PD-P (Richards,
Stefanik)
CESAW-TSD-PL (Barnes)
CEERD-EE-W (Swannack, Reif)

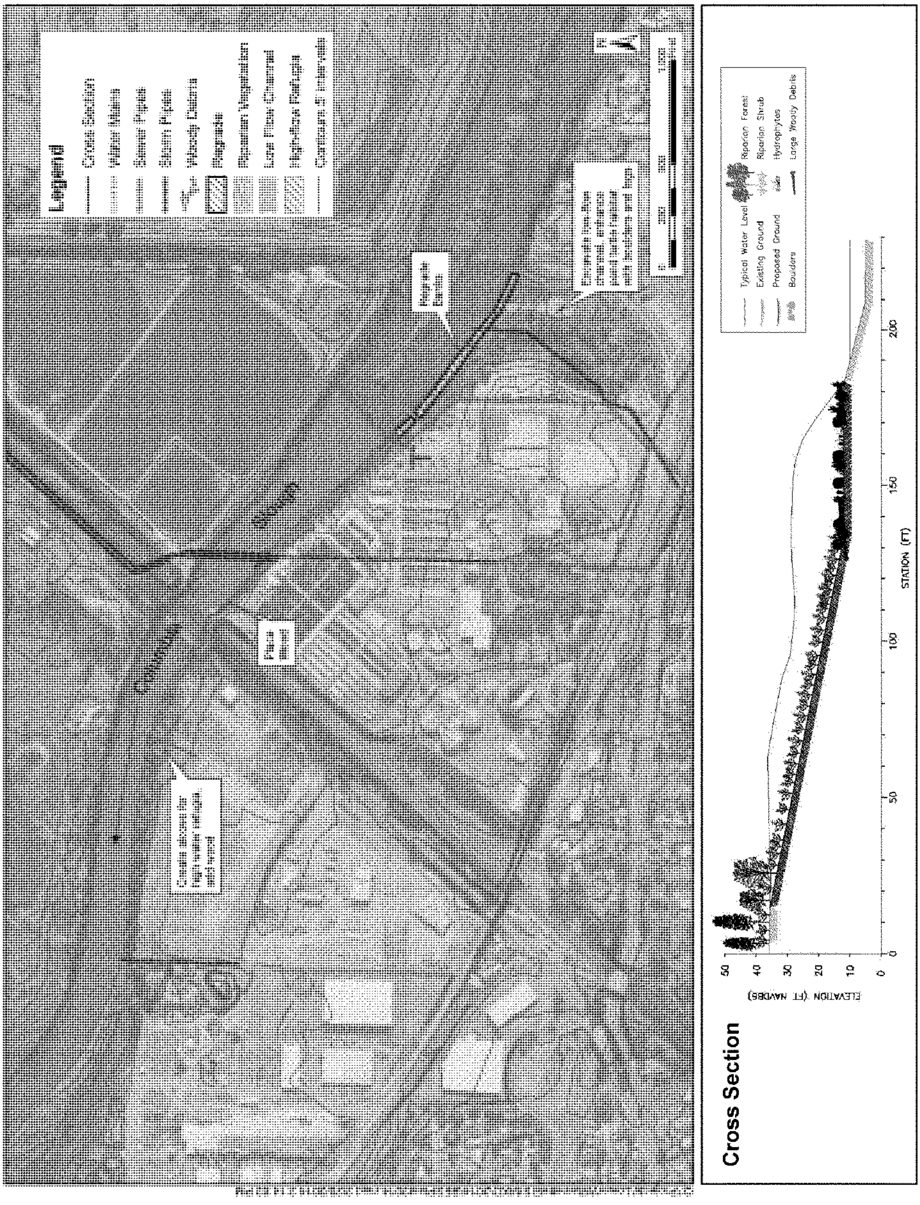
APPENDIX G

Conceptual Ecosystem Restoration Plans

BES Plant

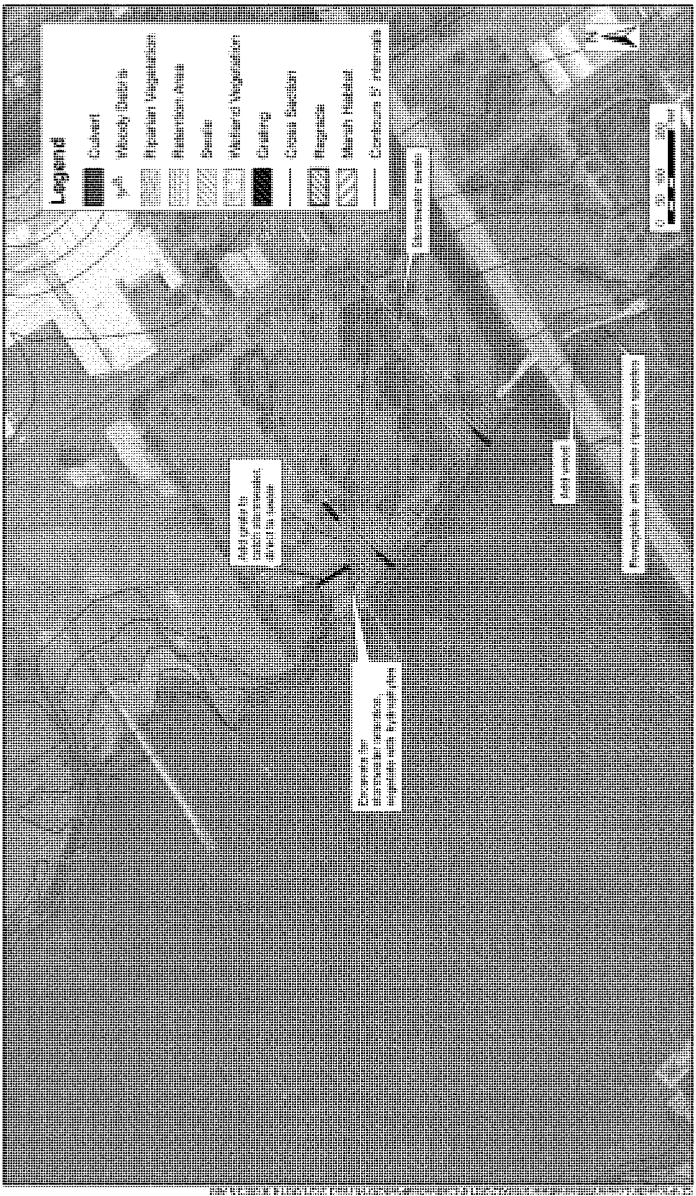
US Army Corps of Engineers
Portland District

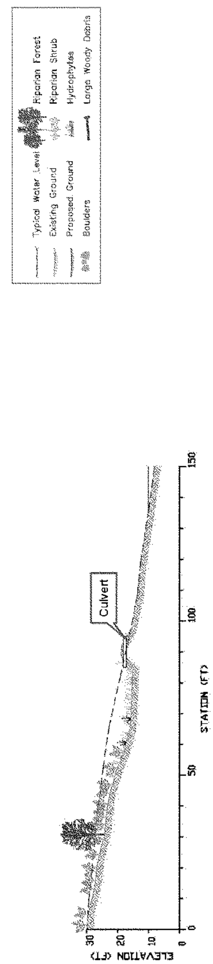
Lower Willamette Ecosystem Restoration Project
Conceptual Restoration Plan



Cathedral Park

Lower Willamette Ecosystem Restoration Project
Conceptual Restoration Plan



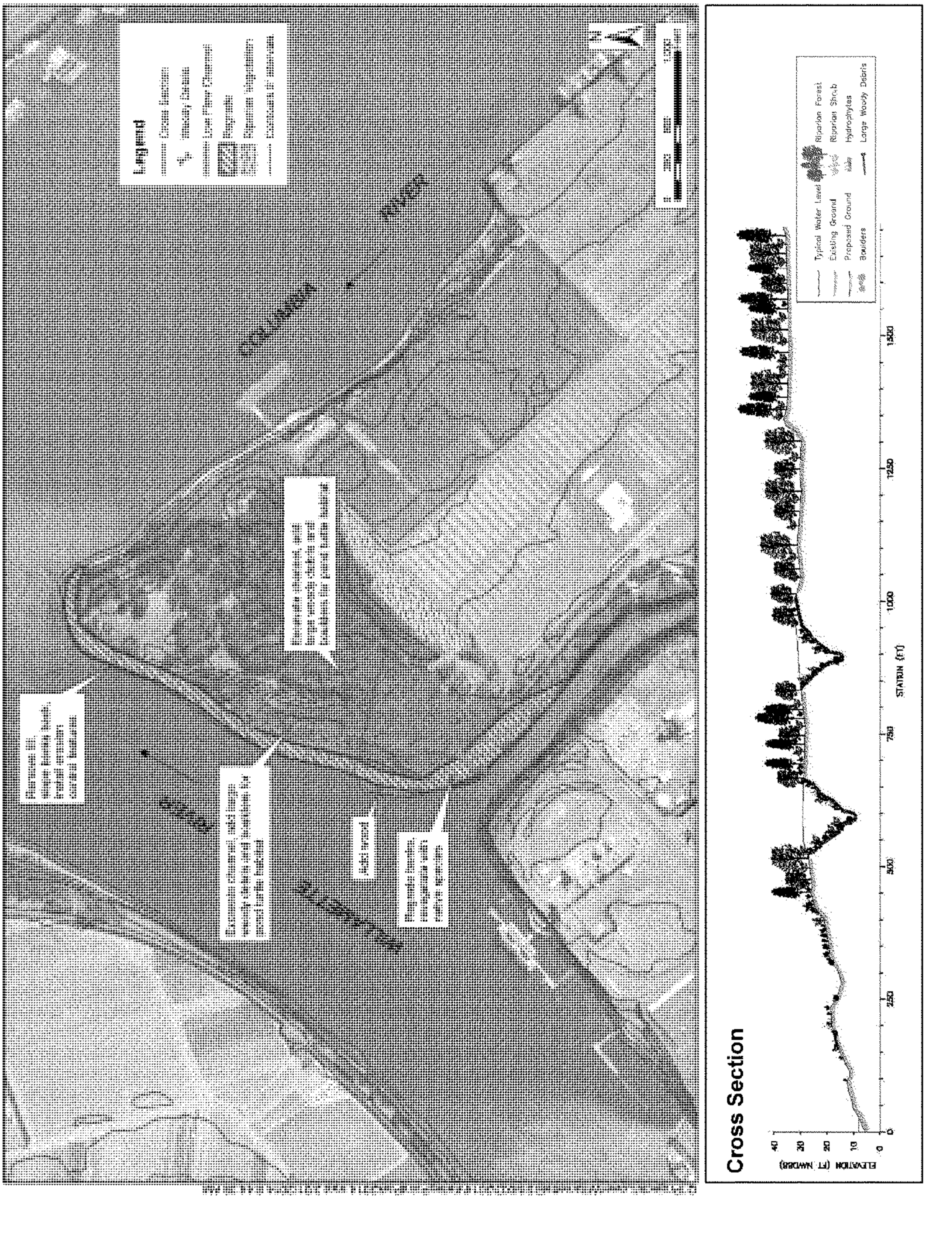


Cross Section

Kelley Point Park

US Army Corps of Engineers®
Portland District
BUILDING STRONG.

Lower Willamette Ecosystem Restoration Project
Conceptual Restoration Plan



Kenton Cove

US Army Corps of Engineers®
Portland District
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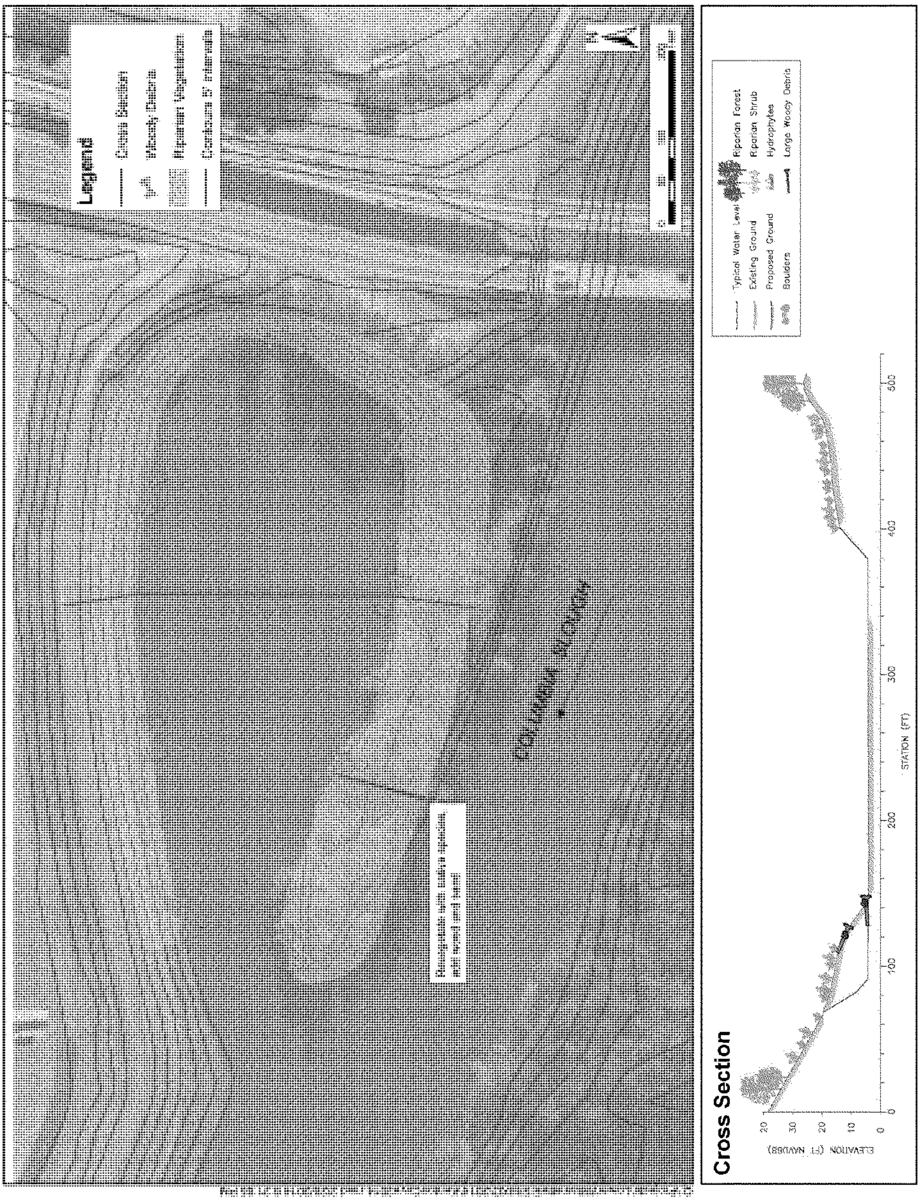
Lower Willamette Ecosystem Restoration Project
Conceptual Restoration Plan



Oaks Crossing/ Sellwood Riverfront Park

US Army Corps of Engineers®
Portland District
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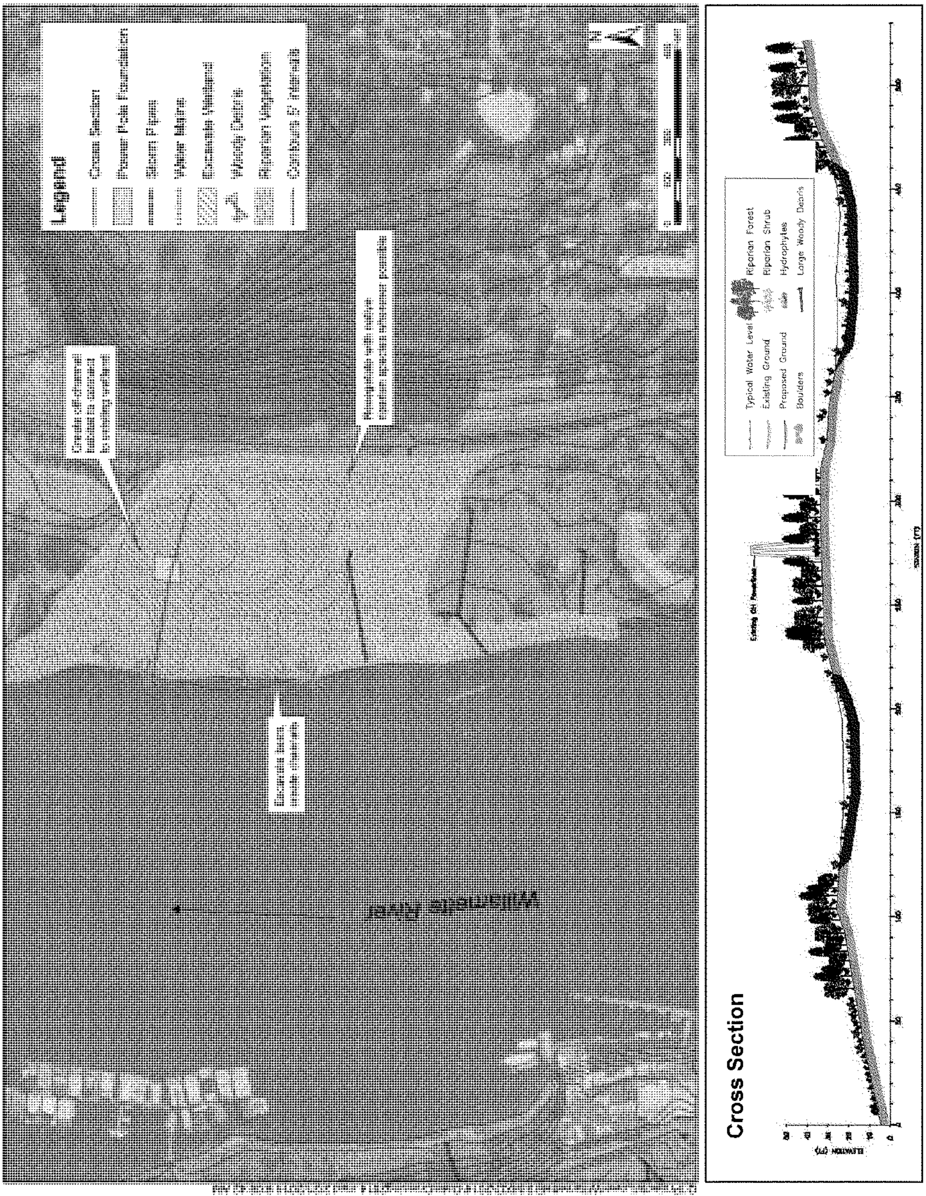
Lower Willamette Ecosystem Restoration Project Conceptual Restoration Plan



Saltzman Creek

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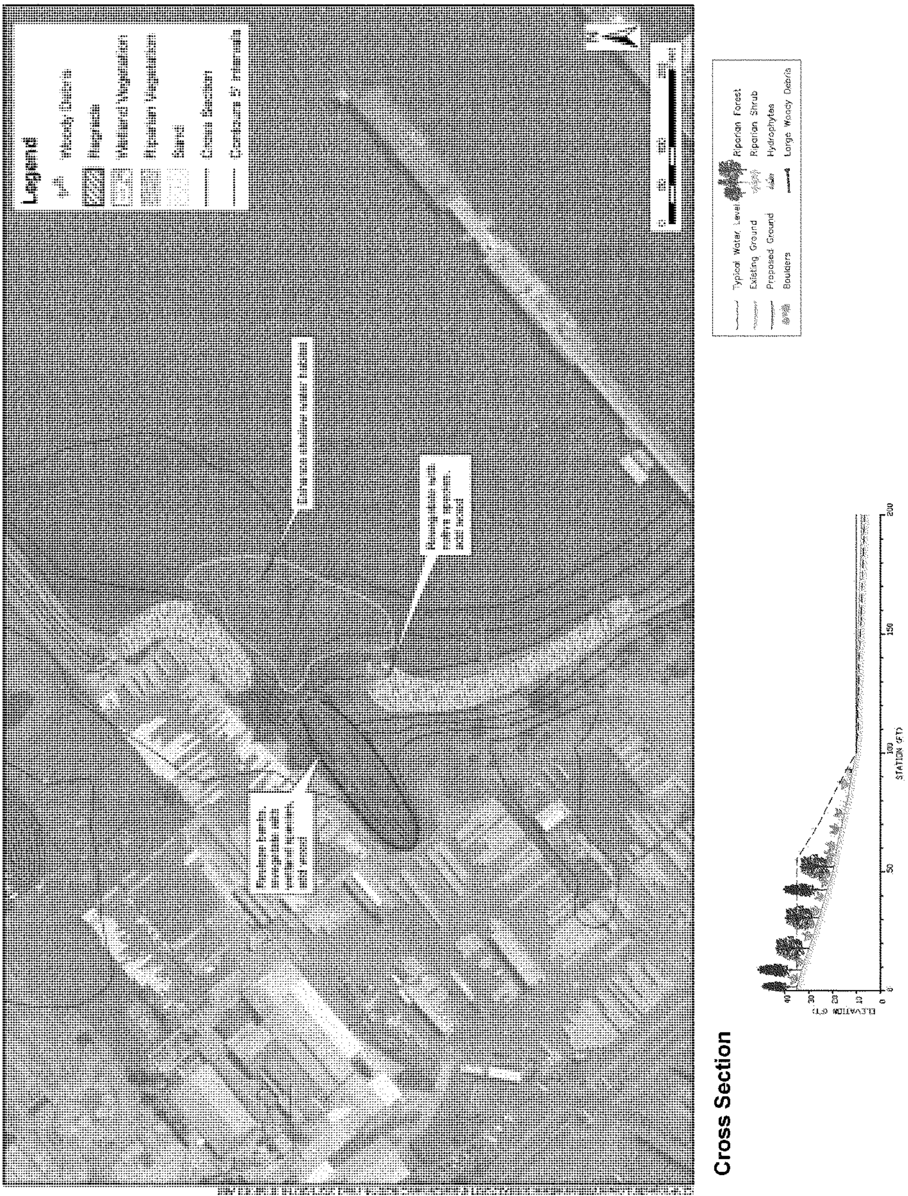
Lower Willamette Ecosystem Restoration Project
Conceptual Restoration Plan



St. Johns Landfill Boat Launch

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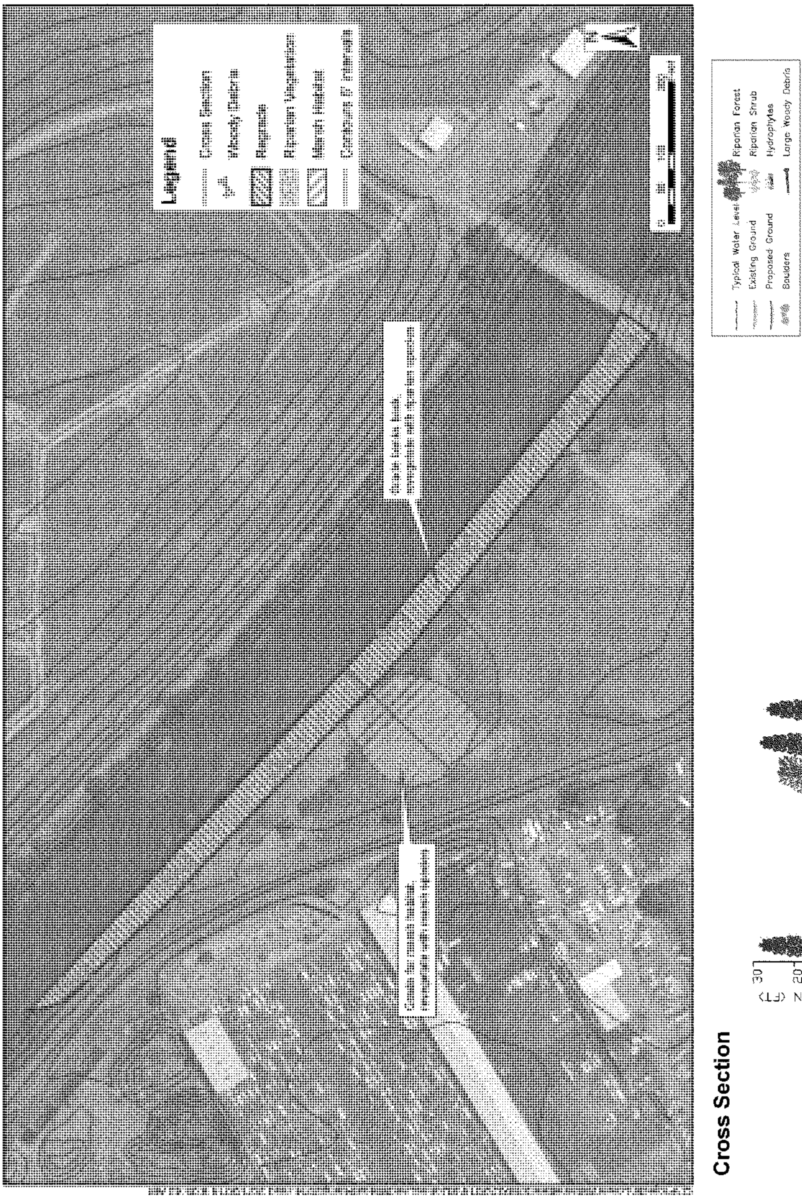
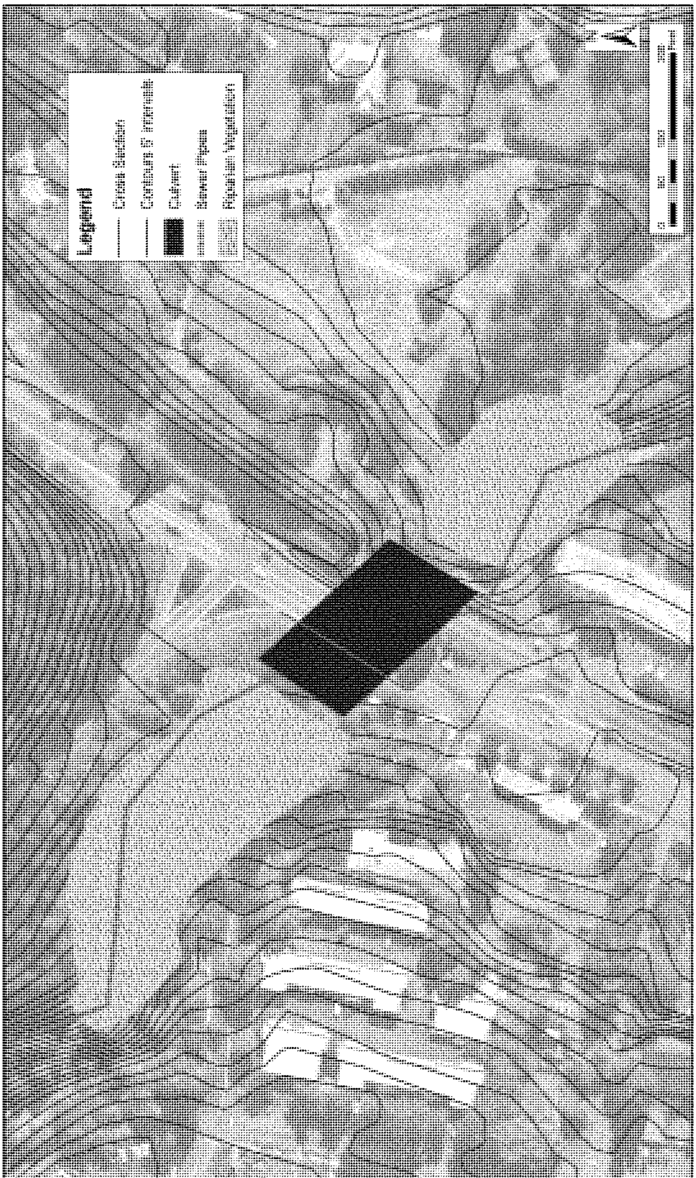
Lower Willamette Ecosystem Restoration Project
Conceptual Restoration Plan

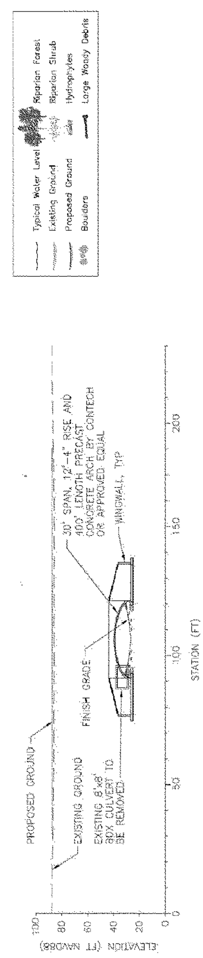


Tryon Creek Highway 43 Culvert

Lower Willamette Ecosystem Restoration Project
Conceptual Restoration Plan

US Army Corps of Engineers®
Portland District





Cross Section

APPENDIX H

Design Report and Cost Estimate

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1. Introduction

1.1 Project Background

The U.S. Army Corps of Engineers (USACE), Portland District, in partnership with the City of Portland and the Port of Portland, is proposing to restore numerous sites in the Lower Willamette River as part of the Lower Willamette River Ecosystem Restoration Project. The USACE and its partners prepared the *Lower Willamette River Ecosystem Restoration General Investigation Study - Conceptual Restoration Plan* (Tetra Tech 2008), which formulated, evaluated, and screened potential solutions to significant ecosystem degradation in the Lower Willamette watershed. In that document, conceptual restoration plans were prepared for a total of 31 sites. After screening and preparation of a cost effectiveness/incremental cost analysis, this group of 31 sites was narrowed down to 23 distinct sites.

The next phase of this project was designed to determine the data that would be needed to assess the feasibility of the proposed project and to evaluate the availability of this data. The *Lower Willamette River Ecosystem Restoration General Investigation Study: Feasibility Work Plan* (Tetra Tech 2009) summarized the background information available for each of the recommended project sites. Since the development of that report, collaboration with the Port of Portland and further investigation of existing sites has reduced the number of sites to five. The remaining sites are located along the mainstem Willamette River, Columbia Slough, and Tryon Creek. This report documents the methods used to develop feasibility (35%) level design (Appendix A), draft planting list (Appendix B), and cost estimates (Appendix C) for the five proposed ecosystem restoration sites on the Lower Willamette River, Columbia Slough, and Tryon Creek. Appendix D contains the MCACES cost estimates for the recommended plan.

1.2 Objectives

Preparation of a feasibility study report for ecosystem restoration alternatives in the Lower Willamette River basin requires, based on Engineering Regulation 1110-2-1150 (USACE 1999), the development of feasibility level (35%) design for the recommended restoration plan and construction cost estimates. The documentation contained within this report meets the requirements of Section 13.2.3, Establishment of the Preliminary Design, covered within Engineering Regulation 1110-2-1150 (USACE 1999). The plan set associated with this report will provide the foundation for the intermediate and final designs and specifications for this project.

This report describes each of the restoration sites, surveying and mapping data used to develop the designs, criteria for function of design elements, and the recommended design of elements for the sites. Additionally, this report describes information required by Engineering Regulation 1110-2-1150 (USACE 1999) including Hazardous Toxic and Radiological Wastes (HTRW) evaluation; geotechnical engineering; structural, electrical, and mechanical engineering; construction procedures; operations and maintenance requirements; and cost estimates for the restoration sites. The design makes use of hydraulic and hydrologic analyses detailed in a separate appendix to the Feasibility Study (Appendix C of the Feasibility Study) and the geomorphic analyses detailed in Appendix B of the Feasibility Study. The location for each of the proposed project sites is shown in Figure 1.1. Appendix A includes the 35% design and cost estimates for each restoration site are included in Appendix C.

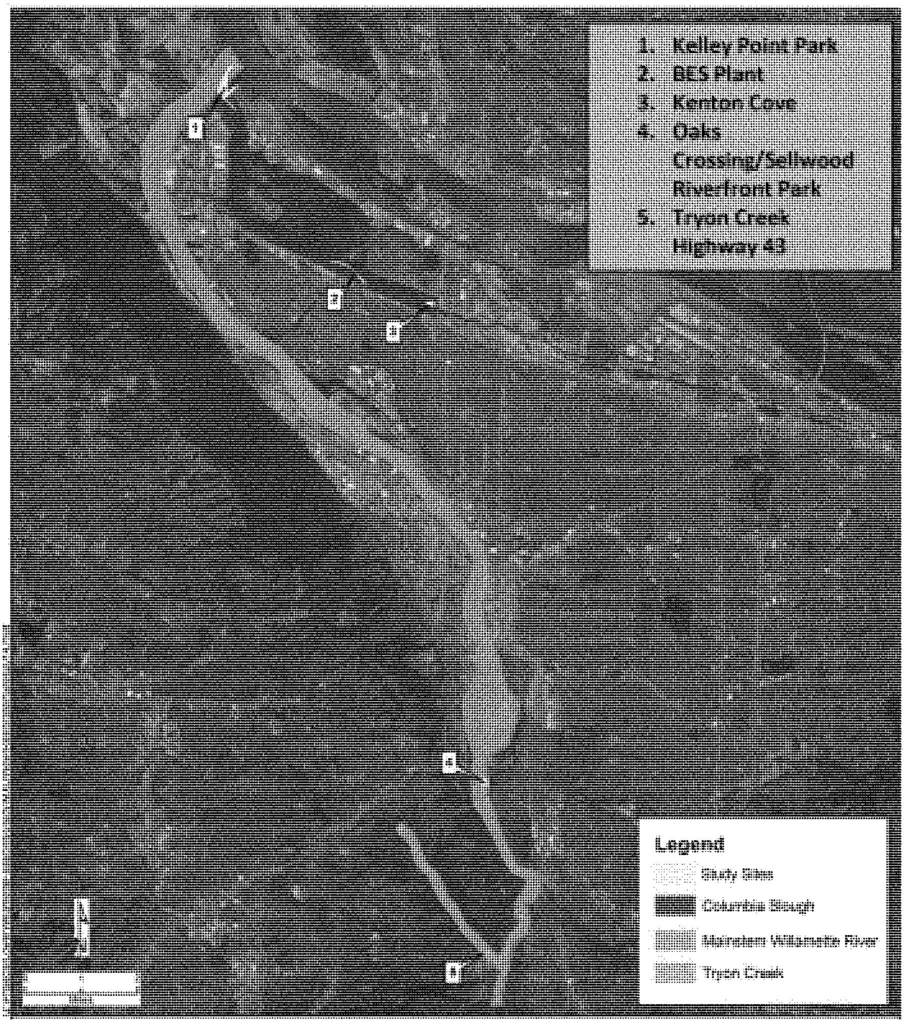

Figure 1.1. Proposed restoration site project locations

2. Restoration Sites

2.1 Mainstem Willamette River

Two of the restoration project sites are predominately influenced by the hydrology and hydraulics of the Willamette River. The restoration sites characterized as within the Mainstem Willamette River area are:

- Kelley Point Park
- Oaks Crossing/Sellwood Riverfront Park

Restoration measures at these sites include developing side channels or backwater areas, reducing bank steepness, and revegetating with native species.

2.2 Columbia Slough

The Columbia Slough is a remnant channel of the Columbia River, and historically was dominated by an extensive wetland system between the mouths of the Sandy River and the Willamette River. Development of the surrounding land and construction of an extensive levee system has eliminated much of the wetlands and enabled development of the floodplain. Two proposed restoration project sites are adjacent to the banks of the lower end of the Columbia Slough. The slough typically is tidally influenced, but does not experience the high flows, velocities, and shear stresses observed in the Willamette River. The restoration sites in Columbia Slough are:

- City of Portland Bureau of Environmental Services (BES) Treatment Plant Banks
- Kenton Cove

Restoration measures at these sites involve reshaping and restoring banks and/or side slough areas, adding large woody debris (LWD), and revegetating with native species.

2.3 Tryon Creek

Tryon Creek flows generally southeast for about 7 miles from its headwaters near Multnomah Village to its confluence with the Willamette River in Lake Oswego. While the watershed is entirely within an urbanized area, more than 20% of the land within the watershed has been preserved in Tryon Creek State Natural Area (TCSNA). The restoration site in the Tryon Creek watershed is:

- Tryon Creek Highway 43 Culvert Replacement

The existing culvert is an 8 foot by 8 foot box culvert that was constructed in the 1920's and extended in 1955. The culvert has a total length of 401 feet, of which the upper 100 feet are sloped at 5.94% and the lower 301 feet are sloped at 2.94%. The design drawing for the culvert (ODOT 1955) indicates that the culvert alignment does not follow the natural Tryon Creek channel alignment, but rather is straightened, resulting in a loss of approximately 40-50 ft of stream length (City of Portland 2005). The straightened portion of the alignment was constructed through bedrock (ODOT 1955).

In 2005, the Oregon Department of Transportation identified the Highway 43 culvert as a high priority for fish passage improvement. Subsequently two projects were designed and constructed in 2008 to address initial concerns. One of these projects repaired and modified the baffles inside of the culvert to provide holding water within the culvert for fish passage; the other project created a roughened chute downstream of the culvert that was designed to increase the water surface elevation during low flow conditions such that fish could swim into the culvert entrance rather than requiring fish to jump.

The restoration measures proposed for the Highway 43 culvert by this Feasibility Study include removal of the existing 8 foot by 8 foot box culvert and replacement with an open bottom arch culvert with a span of 30 feet, and creation of a natural stream channel within the culvert that provides fish passage meeting the Oregon Department of Fish and Wildlife criteria for the stream simulation option (OAR 2013a). Providing a fish passable culvert at this location will provide access for adult steelhead trout and coho salmon to the upper portion of the watershed.

3. Surveying and Mapping

The ground surface data used in development of the 35% design were based on bare earth Light Detection and Ranging (LiDAR) data sets collected from the Oregon Department of Geology and Mineral Industries (DOGAMI), including the 2004 Portland Pilot LiDAR coverage, the 2005 Columbia River/Portland Hills LiDAR coverage, and the 2007 Portland/Mt. Hood LiDAR coverage (DOGAMI 2007). The LiDAR data set has a 3-meter resolution and is projected to the North American Datum of 1983 (NAD83), State Plane Oregon North in units of International Feet and using the North American Vertical Datum of 1988 (NAVD88).

Existing ground cross sections and profiles were measured at selected locations. Cross sections were measured with a survey grade Differential Global Positioning System (DGPS) and the coordinates corrected using the Oregon Real-time GPS Network (ORGN).

4. Design Criteria

4.1 Fish Passage

Fish passage criteria in the State of Oregon are detailed in Oregon Administrative Rule 635-412 (OAR 2013a). This rule describes the criteria for fish passage at road-stream crossing structures and is relevant for culvert replacement at the Highway 43 on Tryon Creek included for analysis in the Feasibility Study. This rule provides two different methods, discussed below, for meeting the requirements:

- the stream simulation option, and
- the alternative option.

In general, the stream simulation option calls for crossing structures with natural substrate and stream widths that exceed that of the active channel. In stream simulation, the culvert bottom must be sloped to match the adjacent upstream and downstream channel profile, have a minimum vertical clearance of 3 feet from the active channel width elevation to the top of the structure, maintain depths and velocities similar to the adjacent channel, and have mechanically-placed natural and stable bed material.

The alternative option allows for analysis of a crossing solution relative to local hydraulic conditions and consideration of adult fish performance for the design species, which include steelhead trout and coho salmon. This analysis typically includes advanced hydraulic modeling and consultation with state fish biologists to determine the most applicable fish performance data set for the local condition.

The design elements for each site included in the Feasibility Study are assessed for their ability to provide fish passage for species of concern, including steelhead trout and coho salmon. The minimum criteria applicable to the open-bottomed culvert replacement design for the Highway 43 culvert on Tryon Creek based on the stream simulation option are:

- **Velocities and depths:** Maintain average water depth and velocities that simulate those in the surrounding stream channel
- **Width**: Equal to or greater than the active channel width, as determined by the OAR (2013a and 2013b), and conservative guidance (ODOT 2011)
- **Minimum vertical clearance**: 3 vertical feet from the active channel width elevation to the inside top of the structure
- **Maximum jump height**: 6 inches
- **Minimum jump pool depth**: Greater of 2 feet or 1.5 times the jump height
- **Slope**: Equal to the slope of, and at elevations continuous with, the surrounding long-channel streambed profile
- **Streambed Material:** Composed of material that is maintained through time, is either similar in size of composition as the surrounding stream or supplemented to address site specific needs that may include bed retention and hydraulic shadow, contain partially-buried over-sized rock since the road-stream crossing structure is greater than 40 feet in length, is mechanically placed during structure installation,

- **Debris Passage**: Active channel shall not be obstructed by trash racks or other debris accumulation structure so as to allow passage of wood and other large debris

4.2 Fish, Turtle, and Native Vegetation Habitat

Some of the restoration elements designed for the Lower Willamette restoration sites are specifically intended to enhance existing fish habitat. These restoration elements include placement of LWD and boulders for in-stream cover, restoration of native riparian and wetland vegetation that will grow to provide overhanging cover, floodplain reconnection, and the grading of artificially steepened banks to provide additional shallow water habitat at higher flows, and creation or restoration of side channels for off-channel rearing and foraging habitat.

The target species/lifestage for development of all restoration features except culvert replacement is juvenile (post-emergent juveniles to pre-smolt) Chinook and chum salmon. These species utilize side channel habitats for crucial life history behaviors, such as resting, rearing, feeding, and predator avoidance (Healey 1991). The target species for culvert fish passage is specified in OAR 635-412 (OAR 2013a) and addressed in the 35% design and future designs of the fish passage structures.

Design criteria for these restoration habitat features include the following:

- Floodplain reconnection, bank grading, and side channel connections: Set side channel minimum elevation to provide a minimum 6 inches of depth during median winter flow.
- Placement of LWD for fish habitat: Provide, at a minimum, in-stream cover during the median winter flow. For Willamette River side channels, LWD should be placed with the center of the root ball at an elevation of 1 foot or less above the water surface elevation of the median winter flow, except as otherwise noted.
- Placement of boulders and LWD for turtle habitat: Provide a minimum of 1 foot of exposed surface during the median summer flow for basking habitat.
- Native riparian vegetation shall be planted to an elevation of 3.5 feet above the median winter water surface elevation.

5. Recommended Restoration Plan and Design Elements

5.1 Alternative Development

Individual alternatives were not developed for each of the sites in this general investigation. The intent is for the sites to be "bundled" together to develop a range of alternatives for restoration in the Lower Willamette River.

5.2 Invasive Removal and Revegetation

Non-native, invasive species have become problematic in the Lower Willamette watershed (City of Portland 2006). Invasive species have the ability to out compete native species and affect the form and function of the habitat. Non-native, invasive plants will be removed from the restoration site project areas through mechanical methods where possible. Chemical applications to some invasive species, such as Japanese knotweed, may be necessary. Methodology for removal will follow protocols based on the best available science.

Revegetation of the restoration site project areas will utilize native plants specific to the habitat type. Wetland plant species will be used at Kelley Point Park, BES Treatment Plant Banks, Kenton Cove, and Oaks Crossing/Sellwood Riverfront Park at elevations starting just below the median winter water surface elevation. Riparian plant species will be used at elevations extending 3.5 feet above the median winter water surface elevation at all sites, including areas outside of the replacement Highway 43 culvert on Tryon Creek. A diversity of native plants will be used to ensure that the form and function of that habitat type has been restored. A draft plant list is presented in Appendix B. Revegetation areas are presented for each site in Table 1.

Table 1. Revegetation areas by habitat type for each restoration site

Site	Wetland Revegetation Area (acres)	Riparian Revegetation Area (acres)
BES Treatment Plant Banks	0	0.67
Kelley Point Park	0	10.89
Kenton Cove	0	3.22
Oaks Crossing/Sellwood Pk.	2.7	4.5
Highway 43 Culvert	0	1.24

The elevation range for riparian plantings at each of the Mainstem Willamette River and Columbia Slough sites are provided in Table 2.

Table 2. Elevation range for riparian plantings at Mainstem Willamette River and Columbia Slough restoration sites

Site	Minimum Elevation (ft NAVD88)	Maximum Elevation (ft NAVD88)
BES Treatment Plant Banks	9.7	13.2
Kelley Point Park	9.7	13.2

Site	Minimum Elevation (ft. NAVD88)	Maximum Elevation (ft. NAVD88)
Kenton Cove	9.7	13.2
Oaks Crossing/Sellwood Pk.	9.9	13.4

Elevation ranges for channel riparian revegetation at the Tryon Creek Highway 43 Culvert site vary for the channel banks upstream and downstream of the culvert and will be specified at a later design phase.

5.3 Bank Grading, Floodplain Reconnection, and Side Channels

Over time, the bank elevations along the mainstem Willamette River within the City of Portland have been raised by the placement of dredge spoils and earth fill, and also stabilized by the placement of rock riprap (City of Portland 2001). These past bank modifications have eliminated or limited fish access to side channels, off-channel areas, and floodplains that provide important rearing habitat, areas for predator avoidance, and velocity refugia during high flows. For this reason, the recommended restoration plan includes bank grading, and the creation of side channels and egress to off-channel habitat.

For the mainstem Willamette River and Columbia Slough restoration sites, the target bank grading slope is 5H:1V. This target slope will foster the establishment of riparian vegetation and will limit erosion. The slope is steepened in areas when structures, property lines, and topography make a 5H:1V slope untenable or not cost-effective.

The minimum elevation for bank grading, floodplain reconnection and side channel thalwegs is determined by the median winter water surface elevation and a minimum desired 6 inches of depth for this condition. Details of a typical channel cross section are shown in Appendix A. Table 3 presents the minimum elevations for each of the sites with this habitat restoration feature. The extent of the grading is shown on the site plan for each site, and typical cross sections are shown in the profile sheet for each site.

Table 3. Minimum elevation for restoration sites with Bank Grading, Floodplain Reconnection, and Low Flow Side Channel Habitat Features

Site Name	Minimum Elevation (ft NAVD88)
Kelley Point Park	9.2
BES Treatment Plant Banks	9.2
Oaks Crossing/Sellwood Pk.	9.4

5.4 Large Woody Debris and Boulders

Boulders and LWD provide key habitat for fish and reptiles in rivers and lakes. Fish utilize wood and large rocks for velocity refugia, holding and feeding areas, and protection from predators. The sites selected for boulder placement as habitat elements are side channel or backwater areas that do not experience high velocities. Reptiles such as the Western pond turtle, a species native to the Lower Willamette River basin, utilize rocks and wood for haul-outs and basking in lakes and ponds. The design and placement of LWD and boulders identified as haul-out and basking habitat should be placed so that the top of the element is at least one foot above the median summer water surface elevation specified for each site and to provide fish habitat the center of the topmost log in each LWD element is specified for a maximum of one foot below the median winter water surface elevation (Table 4).

Table 4. Site specific design elevations for LWD and boulder elements

Site Name	Maximum Elevation of Center of Rootwad for topmost log in LWD element (ft NAVD88)	Minimum Elevation of Top of LWD and Boulder Elements (ft NAVD88)
Kelley Point Park	8.7	10.3
BES Treatment Plant Banks	8.7	10.3
Kenton Cove	8.7	10.3
Oaks Crossing/Sellwood Pk.	8.9	10.6

Placement of these habitat elements is intended to withstand shear forces resulting from high flows. Construction methods for root wads include burying 75-80% of the root wad stem into the bank. To accomplish this, the bank would be excavated no less than 2 feet. Large rocks will be placed with the root wad stems to protect the root wad burial from scour during high flows. After placement of the LWD, the banks will be backfilled to the design grade. Typical LWD construction details are shown on the construction plan set. Table 5 presents the sites that include this habitat restoration feature. The locations of proposed LWD and boulders are shown on the plan sheets for each site.

Table 5. Sites that Include Large Woody Debris and Boulder Habitat Features

Site Name	No. Pieces of Large Wood	No. of Boulders
Kelley Point Park	50	14
BES Treatment Plant Banks	35	14
Kenton Cove	16	0
Oaks Crossing/Sellwood Pk.	8	0

5.5 Culvert Replacement for Fish Passage

Analyses presented in the Hydrology and Hydraulics Technical Memorandum (Appendix C of the Feasibility Study) evaluated the proposed design for the replacement Tryon Creek Highway 43 culvert. The replacement project is intended to improve fish passage by meeting the State of Oregon's fish passage design criteria for stream simulation (OAR 2013a). The fish passage criteria require the culvert to span the active channel width, which was determined from the bankfull elevations (OAR 2013b) determined by HEC-RAS modeling of the 2-year recurrence discharge for the existing channel geometry upstream of the culvert. The active channel width was determined as 20.2 feet. Chapter 6 of the ODOT Hydraulics Manual (2011) further specifies culvert spans to be larger than the active channel width to provide an engineering factor of safety to pass lower frequency high discharge events. The method described by Case 2 (ODOT 2011) determines the conservative culvert span as 125% of the active channel width plus 2 feet, which results in a minimum design span of 27.25 feet. In order to provide a more cost conscious and construction efficient preliminary design for the Feasibility Study, a pre-cast arch culvert is recommended for evaluation in the subsequent design phases for this project. The pre-cast arch culvert size presented here was selected as readily available size large enough to accommodate the conservative width of 27.25 feet, and has a width of 30 feet with a rise of 12.3 feet (CONTECH 2013).

The selected pre-cast arch culvert was evaluated by modifying the HEC-RAS model with a cross section representative of the proposed streambed within the culvert. This streambed will be composed of oversized rock and have a substrate that will be maintained through time to meet the State of Oregon's design requirements. Streambed grade control features will be constructed of oversized rock to ensure stability. Debris passage is unobstructed for the proposed culvert design, and no trash racks or other debris accumulation structures are specified for the culvert.

The proposed cross section was tested for its ability to provide a minimum vertical clearance of 3 feet between the active channel width elevation and the inside top of the structure, and it was determined to exceed this requirement. The design specifies the culvert inlet and outlet invert elevations to match those of the existing channel to provide continuous slope between the surrounding stream and the culvert entrance and exit. The culvert slope is specified as a constant 3.4% to reduce the steeper 5.94% of the upper portion of existing culvert and more closely match the previous and overall natural channel slope of 3.5%.

An incipient motion analysis was conducted utilizing the HEC-RAS results for the proposed culvert that are presented in the Hydrology and Hydraulics Technical Memorandum (Appendix C of the Feasibility Study). This analysis determined that the minimum rock sizes that will resist movement within the channel were 11 inches for the 100-year and 8 inches for the 2-year discharge conditions. Providing a factor of safety to the maximum determined size of 11 inches resulted in a specification of 18-20 inch rock to be placed for stream grade control within the culvert structure. This rock size meets the State of Oregon's fish passage design criteria for oversized rock placement within the streambed.

Additional work is recommended for future design phases for the replacement culvert. A scour analysis should be performed to determine the appropriate culvert footing elevation. The extent of bedrock around the existing culvert should be determined through a geotechnical investigation to better understand constraints on constructability. Additional upstream survey data should be obtained to better delineate the active channel width and construction quantities. This data was recently acquired by BergerABAM on behalf of the City of Portland's Tryon Creek Trunk Sewer Upgrade project, but is not yet available for distribution. Construction issues related to possible need to realign the trunk sewer to accommodate the replacement culvert, and preliminary analysis of traffic control and temporary bypasses for both road and railroad traffic should be considered.

The design plans (Appendix A) provide plan, profile, and cross section drawings for the proposed culvert, and also includes details for the streambed grade control and boulder clusters.

6. Hazardous, Toxic, and Radiological Wastes Evaluation

Hazardous, Toxic, and Radiological Waste (HTRW) data have been collected by performing database searches and field site visits. None of the sites are known to have significant problems concerning hazardous, toxic, or radiological waste. The complete details of the HTRW evaluation are presented in Appendix E of the Feasibility Study.

7. Geotechnical Engineering

Geotechnical borings and soil profiles were not performed for the 35% design at the study sites. While soil profiles are recommended for all sites in future stages of design, geotechnical data are not needed at the sites where only bank grading, floodplain reconnection, or low flow channel excavation would be performed. For the future phases of design, geotechnical data should be collected at the Tryon Creek Highway 43 Culvert site to better understand design constraints and constructability of the proposed culvert alignment, including shoring and stability measures, and possible utility realignment.

Tetra Tech obtained a geotechnical study that was performed in support of seismic upgrades to an elevated pipeline section at the City of Lake Oswego's Tryon Creek Sewage Treatment Plant (Shannon & Wilson 2009), and also obtained the ODOT design drawing for the existing Highway 43 Culvert (ODOT 1955) and a summary of conditions by the City of Portland (2005). According to borings conducted by Shannon & Wilson, the site is underlain by bedrock with 1 to 4 feet of clayey silt alluvium and 2 to 12 feet of variable fill above. The ODOT plans (1955) and summary by the City of Portland (2005) indicate that the existing culvert alignment was constructed through bedrock. The elevation and alignment of Highway 43 and the railroad have been modified since the date of original construction, and the existing roadway is at an approximate elevation of 85 feet NAVD88 and indicating that about 45 feet of fill is placed above the existing culvert alignment (City of Portland 2005).

8. Structural, Electrical, and Mechanical Engineering

The Tryon Creek Highway 43 Culvert site includes elements that require structural engineering design guidance, including culverts, footings, and headwalls. Electrical and mechanical engineering is not indicated for the current design measures.

9. Construction Procedures

For constructability and cost estimating purposes, material sources for rock, gravel, wood, and fill material are assumed to originate within a 10-mile radius of the project sites. Disposal sites for clean soils and demolished concrete, asphalt, and other structural materials are also assumed to be within a 10-mile radius of the project site. The disposal site for contaminated soils is assumed to be the Waste Management Hillsboro Landfill in Hillsboro, Oregon. The procedure for culvert construction assumes culvert fabrication and delivery; installation; construction of footings, headwalls and wingwalls; placement of bed materials; and restoration of the adjacent streambed and banks. Vegetative restoration assumes invasive plant removal by spraying and mowing, and planting materials from locally sourced nurseries.

Other construction procedures, including direction on rock placement, dewatering and erosion control, site earthwork and grading, and environmental protection are presented in the 35% design plan set (Appendix A). The following construction sequence details the steps for construction completion at each of the sites:

1. Award Construction Contract
2. Notice to Proceed
3. Contractor Submit Bonds
4. Contractor Provide Pre-Construction Submittals
5. Conduct Pre-construction Kick-off Meeting
6. Contractor Mobilize to Site
7. Contractor Install Erosion Control Best Management Practices (BMPs) and Create Staging Work Area
8. Improve Access, Only as Necessary
9. Begin Clearing and Grubbing
10. Remove Invasives (can go on while other actions are occurring)
11. Isolate In-Water Work Areas and Remove Fish
12. Conduct Onsite Grading
13. Remove Debris/Concrete/Riprap
14. Excavate Connector Channels Outside of In-Water Work Areas, including Side Channel and Backwater Areas
15. Install Temporary Bridge or Access Route for Wood and Boulder Placement
16. Isolate In-Water Wood and Boulder Work Areas and Remove Fish
17. Construct Wood and Boulder Structures
18. Remove In-Water Isolation Measures When Work is Complete (Grading or Wood/Boulders)
19. Remove Temporary Bridge or Access Route for Wood and Boulders
20. Isolate In-Water Work Area for River Channel Connections and Remove Fish

21. Excavate Final In-Water Channel Connections, including Side Channel, Backwater Areas, and Confluence/Mouth Areas
22. Remove Final Water Isolation Measures
23. Grade Site for Plantings
24. Remove Staging Area and Access Routes as Appropriate
25. Install Erosion Control Seeding/Mulch at each Grading Completed Location
26. Install Plants
27. Remove Erosion Control Features after Seeding has Grown to Minimum 1-inch

Additional construction procedures are necessary for the culvert replacement at Highway 43 on Tryon Creek to address:

- Temporary highway and railroad traffic control and re-route as needed for the duration of project,
- Temporary water management for bypass of flow around work area,
- Placement arch span culvert, streambed material, and streambed grade control features,
- Abandon existing 8 foot by 8 foot box culvert in place or dispose offsite,
- Potential relocation of sewer trunk line and other utilities,
- Placement of fill, and
- Resurfacing of highway and railroad as needed.

10. Operations and Maintenance Requirements

The intent of the proposed site restoration designs is to create favorable conditions for natural habitat feature development; therefore, it is expected that some of the installed or constructed elements will self-adjust in response to actual conditions, or will require adjustment to attain best performance. It is expected that the most significant maintenance actions will occur during the first 5 years. Primary maintenance actions will include control of invasive species during and following construction and ensuring the survival of the planted species. Additionally, monitoring and maintenance should be performed to remove obstructions and aggradation at side channel inlets and outlets, so that the connection points for these sites remain open. The replacement culvert at Highway 43 on Tryon Creek should occasionally be monitored to ensure it is working properly, the streambed material is stable, and to remove debris.

The preliminary cost estimate for each site generally considers general markup costs that include annual operations and maintenance (O&M) costs at 10% of the overall cost for planning, engineering, and construction. At future levels of design, a more specific estimate of O&M costs will be developed individually for each restoration site, using Micro-Computer Aided Cost Estimating System (MCACES) software.

11. Preliminary Cost Estimate

Following design of the restoration elements, each site was evaluated for general construction costs. The cost estimates account only for construction costs, and include site preparation and general markups. These costs are specified in Appendix C.

12. References

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APPENDIX A

DRAFT 35% DESIGN DRAWINGS

US Army Corps of Engineers
Portland District

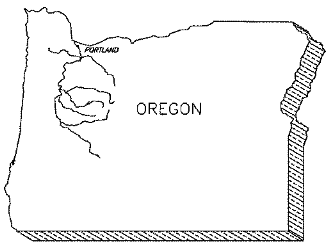
LOWER WILLAMETTE RIVER

ECOSYSTEM RESTORATION PROJECT

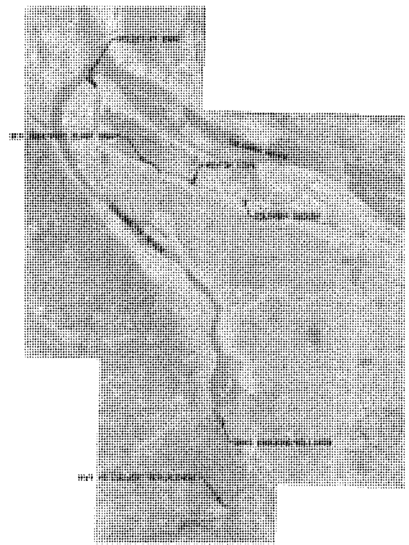
(35% SUBMITTAL)

PORTLAND, OREGON

PROJECT LOCATION IN OREGON



LOCATION MAP



INDEX TO DRAWINGS

U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON

Tetra Tech, Inc
1220 SW Taylor Street
Suite 530
Portland, OR 97205

LOWER WILLAMETTE RIVER
ECOSYSTEM RESTORATION PROJECT

TITLE SHEET & LOCATION MAP

Multnomah County, Oregon

SHEET IDENTIFICATION
01
SHEET 01 OF 19

ABBREVIATIONS

AC	ASPHALT
AC-FT	ACRE FEET
AGG	AGGREGATE
ALIGN	ALIGNMENT
APPROX	APPROXIMATE
AVG	AVERAGE
B.M.	BENCH MARK
BES	BUREAU OF ENVIRONMENTAL SERVICES CITY OF PORTLAND
BOT	BOTTOM
BW	BOTTOM WIDTH
C-C	CENTER-TO-CENTER
CL	CENTERLINE, CONTROL LINE
CFS	CUBIC FEET PER SECOND
CHNL	CHANNEL
CJ	CONSTRUCTION JOINT
CLR	CLEAR
CONC	CONCRETE
COR	CONTRACTING OFFICER REPRESENTATIVE
CP	CONTROL POINT
CULV	CULVERT
D	DEGREE, DEGREE OF CURVATURE
DBH	DIAMETER BREAST HEIGHT
DD°MM'SS"	DEGREES, MINUTES, SECONDS
DEPT	DEPARTMENT
DIA, Ø	DIAMETER
DS	DOWNSTREAM
E	EAST
EA	EACH
EG	EXISTING GRADE
EL,ELEV	ELEVATION
EOP	EDGE OF PAVEMENT
ETC	ET CETERA (AND THE LIKE)
EX	EXISTING
FG	FINISHED GRADE
FTF	OOT OR FEET
GB	GRADE BREAK
HMA	HOT MIX ASPHALT
HORZ	HORIZONTAL
HVF	HIGH VISIBILITY FENCE
HVY	HEAVY
HWY	HIGHWAY
IN	INCH OR INCHES
INV	INVERT
L	LENGTH OF CURVE
LB,LBS	POUND OR POUNDS
LT	LEFT
LWD	LARGE WOODY DEBRIS
MAX	MAXIMUM
MI	MILE
MIN	MINIMUM
MISC	MISCELLANEOUS
MUTCD	MANUAL UNIFORM TRAFFIC CONTROL DEVICES
N	NORTH
NAD	NORTH AMERICAN DATUM
NAVD	NORTH AMERICAN VERTICAL DATUM
NTS	NOT TO SCALE
NO	NUMBER
NOAA	NATIONAL OCEANIC ATMOSPHERIC ADMINISTRATION
OC	ON CENTER
OHWM	ORDINARY HIGH WATER MARK
PC	POINT OF CURVATURE
PERF	PERFORATED
PI	POINT OF INTERSECTION
PIP	PROTECT IN PLACE
POB	POINT OF BEGINNING
POE	POINT OF ENDING
PL	PLATE
PROP	PROPOSED
PT	POINT OF TANGENCY
PSF	POUNDS PER SQUARE FOOT
PSI	POUNDS PER SQUARE INCH
PVC	POLYVINYL CHLORIDE
R	RANGE
RAD	RADIUS
RDWY	ROADWAY
REF	REFERENCE
REQ'D	REQUIRED
RT	RIGHT
ROW	RIGHT OF WAY
S	SOUTH; SLOPE
SCH	SCHEDULE
SHLDR	SHOULDER
SHT	SHEET
SP	STANDARD PLAN
SPEC	SPECIFICATION
SS	SIDESLOPE
STA	STATION
STD	STANDARD
STL	STEEL
SQ	SQUARE
T	TANGENT OF CURVE
TBD	TO BE DEVELOPED
TESC	TEMPORARY EROSION AND SEDIMENT CONTROL
TEMP	TEMPORARY
TH	THICK
TOB	TOP OF BANK
TYP	TYPICAL
UON	UNLESS OTHERWISE NOTED
US	UPSTREAM, UNITED STATES
VAR	VARIES; VARIABLE
W	WEST
W/	WITH
WSE	WATER SURFACE ELEVATION
W/O	WITHOUT
°	DEGREE
@	AT
#	NUMBER
?	DELTA ANGLE

EXISTING LEGEND

- MONUMENT FOUND AS NOTED
- POWER POLE
- MAJOR CONTOURS
- MINOR CONTOURS
- GROUNDLINE
- FENCE
- SANITARY SEWER
- STORM LINE
- WATER LINE
- OVERHEAD UTILITY LINE
- ELECTRICAL NEUTRAL LINE
- GAS LINE
- POWER LINE
- PROPERTY LINE

DESIGN LEGEND

- 100 MAJOR CONTOUR
- MINOR CONTOUR
- WORK LIMITS
- STRUCTURE
- STREAMLINE/CENTERLINE
- HIGH FLOW CHANNEL
- LOW FLOW CHANNEL
- CROSS SECTION LINE
- FOOT BRIDGE
- BRIDGE
- PROP CULVERT
- TEMPORARY CONSTRUCTION ACCESS BRIDGE
- WETLAND PLANTING
- RIPARIAN VEGETATION
- GRAVELLY SAND
- WETLAND & RIPARIAN VEGETATION
- BOULDERS
- TYPE 1 LWD
- TYPE 2 LWD
- TYPE 3 LWD
- TEMPORARY CONSTRUCTION STAGING
- TEMPORARY CONSTRUCTION ACCESS

CONSTRUCTION NOTES

GENERAL NOTES

1. THE CONTRACTOR SHALL COMPLY WITH ALL APPLICABLE FEDERAL, STATE, AND LOCAL LAWS AND REGULATIONS, INCLUDING REQUIREMENTS SET FORTH IN THE PERMITS OBTAINED FOR THIS PROJECT. THE CONTRACTOR SHALL MAINTAIN A COPY OF ALL PERMITS ONSITE DURING CONSTRUCTION.
2. ALL CONSTRUCTION WORK AFFECTING AREAS BELOW THE OHWM MUST BE CONDUCTED DURING THE APPROVED FISH WINDOW, GENERALLY JUNE 1 TO OCTOBER 31; UNLESS AN EXTENSION IS RECEIVED FROM THE OREGON DEPARTMENT OF FISH AND WILDLIFE AND NOAA – FISHERIES.
3. THE CONTRACTOR IS RESPONSIBLE FOR JOB SITE CONDITIONS AND THE SAFETY OF HUMAN LIFE DURING THE COURSE OF CONSTRUCTION. THIS REQUIREMENT SHALL APPLY CONTINUOUSLY DURING THE PERIOD OF CONSTRUCTION AND NOT LIMITED TO NORMAL WORKING HOURS.
4. THE CONTRACTOR SHALL KEEP JOB SITE AREA CLEAN, HAZARD-FREE, AND PROPERLY DISPOSE OF ALL DEBRIS, RUBBISH, AND CONSTRUCTION WASTE. ALL DISTURBED AREAS ARE TO BE REHABILITATED TO PRE-CONSTRUCTION CONDITIONS OR PER PLANTING PLAN, TO BE PROVIDED SEPARATELY.
5. THE CONTRACTOR SHALL VISIT THE JOB SITE AND CONFIRM THAT THE WORK MAY BE ACCOMPLISHED AS SHOWN PRIOR TO PROCEEDING WITH CONSTRUCTION.
6. THE CONTRACTOR SHALL INSTALL ALL EQUIPMENT AND MATERIALS IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS UNLESS SPECIFICALLY INDICATED OTHERWISE.

SURVEY CONTROL AND CONSTRUCTION LIMITS

1. 5'-CONTOUR TOPOGRAPHIC SURVEY BY METRO. DIGITAL ORTHOPHOTO BY METRO 2006. BATHYMETRIC DATA BY CORPS OF ENGINEERS, MARCH AND DECEMBER, 2006.
2. 2009 PARCEL DATA FROM METRO.
3. ALL MAPPING IS PROJECTED TO NAD 83 HARN, STATE PLANE OREGON NORTH. UNITS ARE U.S. INTERNATIONAL FEET. REPRESENTATIONS OF TRUE NORTH SHALL NOT BE USED TO IDENTIFY OR ESTABLISH THE BEARING OF TRUE NORTH AT THE JOB SITE.
4. ALL ELEVATIONS ARE RELATIVE TO NAVD 88 IN UNITS OF FEET.
5. ALL STATIONING REFERS TO CENTERLINE OF CONSTRUCTION AND IS THE MEASURED HORIZONTAL DISTANCE.
6. CONSTRUCTION LIMITS, CENTERLINE AND OFFSET STAKING TO BE PERFORMED BY OTHERS.
7. ALL CONSTRUCTION ACTIVITY, INCLUDING HAUL ROUTES, STAGING AND STOCKPILING, SHALL BE CONFINED TO THE PARCEL AS SHOWN IN THESE PLANS. CONTRACTOR SHALL ADHERE TO CONSTRUCTION LIMITS. CONTRACTOR IS RESPONSIBLE FOR ESTABLISHING AND MAINTAINING REQUIRED DATUM, BENCHMARKS, CONTROL LINES AND LEVELS. DO NOT DISTURB, EXCAVATE OR WORK BEYOND PROJECT LIMITS WITHOUT PERMISSION FROM COR. UTILITY LOCATIONS SHOWN ARE APPROXIMATE AND IN SOME CASES HAVE NOT BEEN SURVEYED. CONTRACTOR SHALL BE RESPONSIBLE FOR CONTACTING OREGON UTILITY NOTIFICATION CENTER AT 800.332.2344 PRIOR TO COMMENCEMENT OF CONSTRUCTION WORK. CONTRACTOR IS RESPONSIBLE FOR DAMAGE TO ABOVE-GROUND AND BELOW-GROUND UTILITIES.

ROCK

1. ALL STREAMBED MATERIAL (GRAVELS AND COBBLES) WITH A MEAN DIAMETER OF LESS THAN 6" TO BE PLACED AS CULVERT SUBSTRATE SHALL BE RIVER RUN, NOT ANGULAR.
2. ALL STREAMBED MATERIAL WITH A MEAN DIAMETER EXCEEDING 6" AND RIPRAP SHALL BE PROVIDED BY A SOURCE THAT IS APPROVED BY THE COR. ROCK MATERIAL WITH A MEAN DIAMETER EXCEEDING 6" SHALL BE ANGULAR IN NATURE AND BE OF SUFFICIENT HARDNESS TO RESIST WEATHERING AND SHALL BE FREE OF CRACKS AND OTHER BLEMISHES. POROUS OR SOFT ROCK SHALL NOT BE ALLOWED FOR USE AS STABILIZATION ROCK.
3. GEOTEXTILE SHALL BE PLACED OVER THE PREPARED SUBGRADE AND BENEATH ROCK MATERIAL AS SHOWN IN THESE PLANS. SUBGRADE SURFACES SHALL BE PREPARED TO BE REASONABLY SMOOTH, FREE OF MOUNDS, DIPS, CUTS OR OVERHANGING SECTIONS AND FREE OF DEBRIS.

CONSTRUCTION NOTES, CONT

ENVIRONMENTAL PROTECTION

1. THE CONTRACTOR SHALL MINIMIZE ENVIRONMENTAL POLLUTION AND DAMAGE THAT MAY OCCUR AS THE RESULT OF CONSTRUCTION OPERATIONS.
2. THE CONTRACTOR IS RESPONSIBLE FOR IMPLEMENTING AND UTILIZING BEST MANAGEMENT PRACTICES (BMPS) TO PREVENT STORMWATER RUNOFF AND WATER POLLUTION DURING CONSTRUCTION ACTIVITIES. CONTRACTOR SHALL SUBMIT SWPPP FOR APPROVAL BY CONTRACTING OFFICER'S REPRESENTATIVE.
3. IF POTENTIAL HAZARDOUS MATERIALS ARE ENCOUNTERED, THE MANAGER SHOULD BE CONTACTED IMMEDIATELY. ALL CONSTRUCTION SPOILS AND WASTE SHALL BE DISPOSED OF AT AN APPROVED LANDFILL FACILITY.
4. EXISTING ON-SITE MATERIALS SHALL BE CAREFULLY REMOVED AND STORED, OR DISPOSED OF. COMPLETELY REMOVE STUMPS, ROOTS, WILLOWS, SHRUBS, WEEDS, AND OTHER DEBRIS PROTRUDING FROM THE GROUND WHERE DIRECTED BY COR. WOODY DEBRIS AND PLANT MATERIAL SHALL BE SALVAGED FOR REUSE AS DIRECTED.
5. TREES TO BE CLEARED WILL BE FLAGGED BY THE CONTRACTOR. TREES DESIGNATED FOR CLEARING SHALL BE REUSED IN STREAM CHANNEL AS SHOWN AND AS APPROVED BY COR. TREES AND LAND AREAS OUTSIDE CONSTRUCTION AND PLANTING LIMITS SHALL BE MARKED FOR PROTECTION IN THE FIELD. EXERCISE CARE IN AREAS NOT SO MARKED TO AVOID UNNECESSARY DAMAGE TO NATURAL VEGETATION.
6. IF WET WEATHER IS FORECAST OR CONSTRUCTION ACTIVITIES ARE NOT ANTICIPATED FOR A 72-HOUR PERIOD, CONTRACTOR SHALL MULCH ALL EXPOSED GROUND, WITH EXCEPTIONS INCLUDING BOTTOMS OF CHANNELS, AND AREAS OF HIGH CONSTRUCTION TRAFFIC. CONTRACTOR SHALL HAVE STRAW BALES ON SITE AT ALL TIMES FOR MULCHING. MULCH SHALL BE FREE FROM WEEDS, MOLD, AND OTHER DELETERIOUS MATERIALS. STRAW OR WOOD CELLULOSE FIBER IS SUITABLE FOR MULCH. STRAW SHALL BE STALKS FROM OATS, WHEAT, RYE, BARLEY, OR RICE.
7. ALL AREAS DISTURBED BY CONSTRUCTION OPERATIONS, INCLUDING STAGING AREA, SHALL BE SEEDED UPON COMPLETION OF THE PROJECT. SEEDING SHOULD ONLY BE PERFORMED AT OPPORTUNE TIMES. SEEDING SHOULD NOT OCCUR DURING EXCESSIVE PRECIPITATION EVENTS OR IN LOCATIONS WHERE RIVER FLOWS WILL ERODE SEED PLACEMENT. SEED MIXTURE SHALL BE IN ACCORDANCE WITH PLANTING PLAN (BY OTHERS). SEEDING WILL INCLUDE MULCH. MULCH SHALL BE STABILIZED THROUGH THE USE OF TACKIFIERS.

DEWATERING AND EROSION CONTROL

1. THE CONTRACTOR SHALL SUBMIT A WATER DIVERSION PLAN TO THE COR. DIVERSION PLAN IS SUBJECT TO APPROVAL BY COR. NOTICE SHALL BE GIVEN TO THE COR A MINIMUM OF THREE DAYS PRIOR TO DIVERSION. CARE SHALL BE TAKEN WHEN INSTALLING SILT CURTAINS TO EXCLUDE FISH FROM CURTAINED AREA.
2. SEDIMENT FENCES SHALL BE INSTALLED WITH FIELD-DIRECTION BY THE COR. SEDIMENT FENCING MATERIALS SHALL BE PROVIDED BY THE CONTRACTOR.
3. STRAW BALES SHALL BE PLACED DOWNSTREAM OF THE WATER RETURN TO TRAP SILT. BALES SHALL BE SECURED WITH WOOD OR METAL STAKES DRIVEN 2 FEET INTO GROUND. 3" MINUS GRAVEL SHALL BE PLACED AT A DEPTH OF 4" ON THE UP-GRADIENT TOE OF THE BALES.

SITE EARTHWORK AND GRADING

1. THE CONTRACTOR IS RESPONSIBLE FOR ALL SITE EARTHWORK AND GRADING ACTIVITIES. MODIFICATIONS MAY BE REQUIRED TO SUIT JOB SITE CONDITIONS PER DIRECTION OF THE COR. SIGNIFICANT DEVIATIONS FROM THESE PLANS SHALL BE COORDINATED WITH THE ENGINEER OF RECORD AND SHALL BE DOCUMENTED FOR INCLUSION IN AS-BUILT DRAWINGS TO BE PREPARED AT COMPLETION OF PROJECT.
2. ALL FILL MATERIAL, WHETHER IMPORTED FILL OR BORROW MATERIAL FROM ON-SITE SHALL BE SUBJECT TO VISUAL INSPECTION BY THE COR AND SHALL BE FREE FROM ORGANIC MATTER, SILTS, CLAYBALLS AND OTHER DELETERIOUS MATERIALS AND SHALL NOT CONTAIN STONES LARGER THAN 3 INCHES IN DIAMETER.
3. EXCAVATED NATIVE SPOILS SHALL BE DISPOSED OF AT THE ONSITE DISPOSAL AREA.

TEMPORARY CONSTRUCTION FACILITIES

1. ALL TEMPORARY UTILITIES AND FACILITIES WILL BE THE RESPONSIBILITY OF THE CONTRACTOR. A CONSTRUCTION TRAILER IS NOT REQUIRED. ANY USE OF POTABLE WATER OR ELECTRICITY FROM EXISTING CONNECTIONS ON SITE MUST BE COORDINATED WITH LANDOWNER THROUGH WRITTEN AGREEMENT PRIOR TO USE. A CHEMICAL TOILET OF SUITABLE TYPE SHALL BE PROVIDED AND MAINTAINED BY THE CONTRACTOR AT ALL TIMES.

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MARK	DESCRIPTION	DATE	APPR.	MARK	DESCRIPTION	DATE	APPR.

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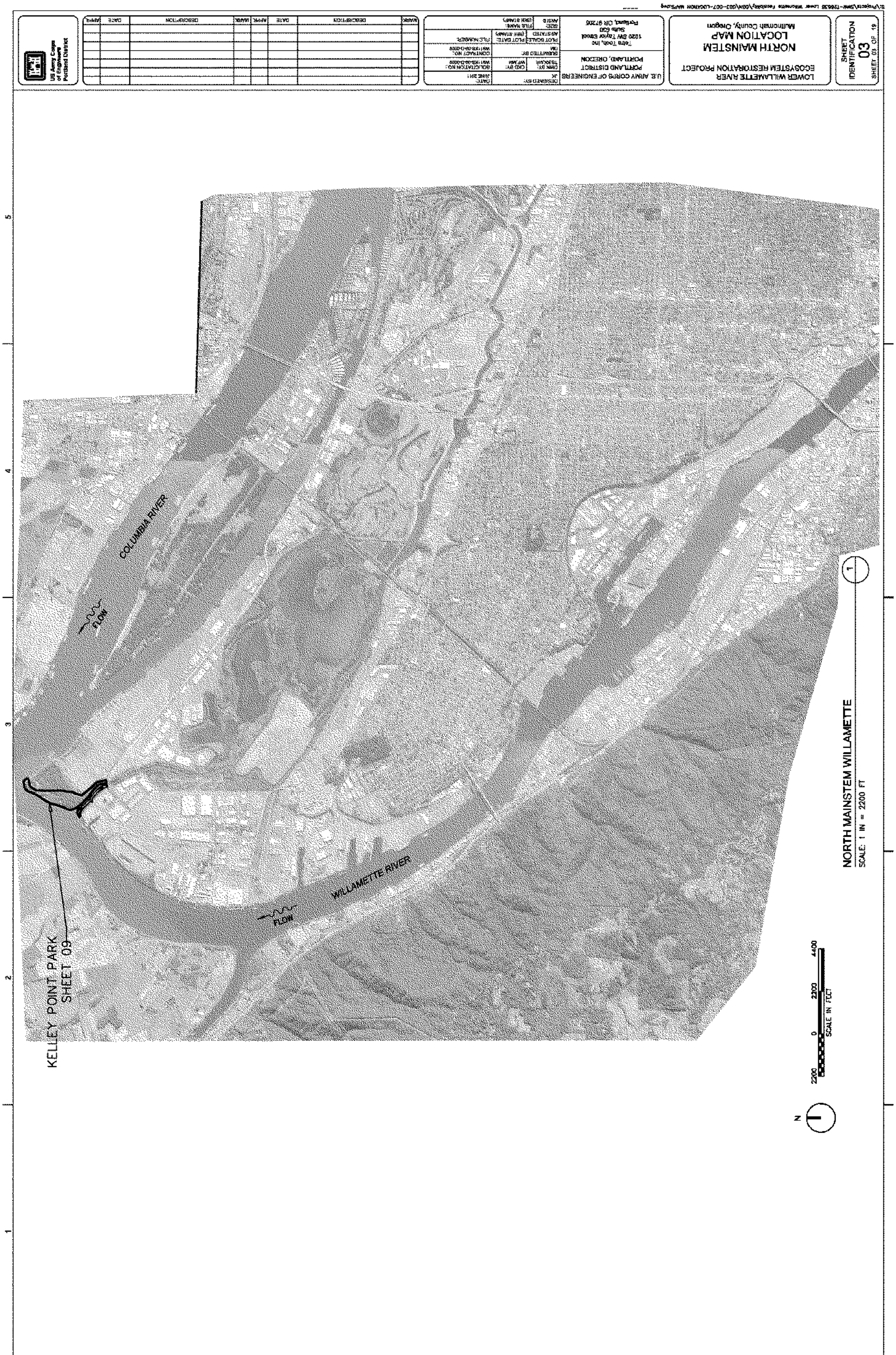
Suite 530
Portland, OR 97205

DESIGNED BY: | DATE: MARCH 2014
DWN BY: | CKD BY: | SOLICITATION NO.:
SUBMITTED BY: | CONTRACT NO.:
PLOT SCALE: AS STATED | PLOT DATE: (SEE STAMP) | FILE NUMBER:
SIZE: ANSI D | FILE NAME: (SEE STAMP)

LOWER WILLAMETTE RIVER
ECOSYSTEM RESTORATION PROJECT
ABBREVIATIONS, NOTES, AND LEGEND
Multnomah County, Oregon

SHEET IDENTIFICATION
02
SHEET 02 OF 19


LOWER WILLAMETTE RIVER
ECOSYSTEM RESTORATION PROJECT
NORTH MAINSTEM
LOCATION MAP
Multnomah County, Oregon
U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON
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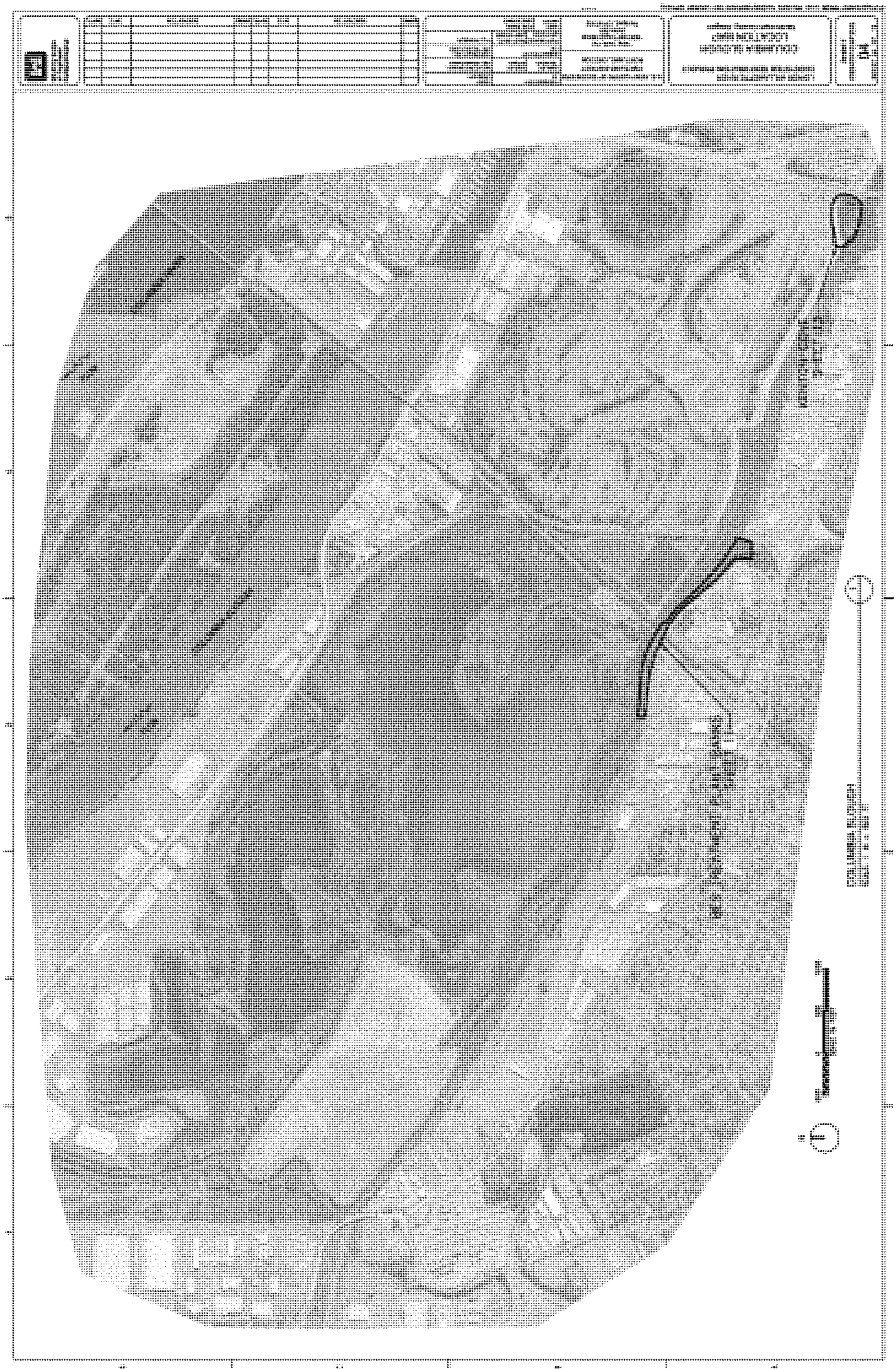
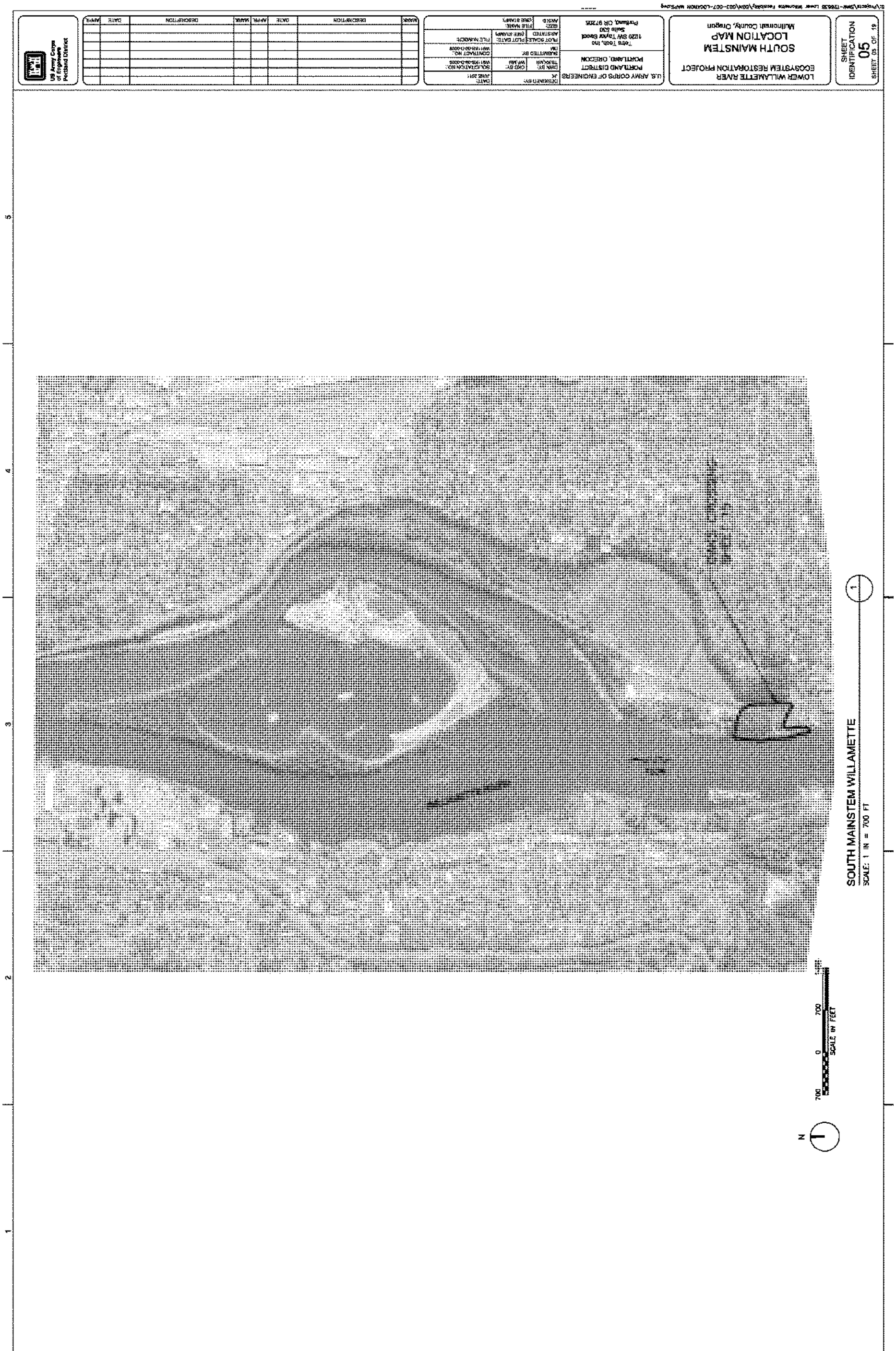
SHEET IDENTIFICATION
03
US Army Corps of Engineers
Portland District
COLUMBIA RIVER
FLOW
WILLAMETTE RIVER
FLOW
KELLEY POINT PARK
SHEET 09
NORTH MAINSTEM WILLAMETTE
SCALE: 1 IN = 2200 FT
SCALE IN FEET

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LOWER WILLAMETTE RIVER
ECOSYSTEM RESTORATION PROJECT
SOUTH MAINSTEM
LOCATION MAP
Multnomah County, Oregon
SHEET IDENTIFICATION
05
SHEET 05 OF 19
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Tetra Tech, Inc
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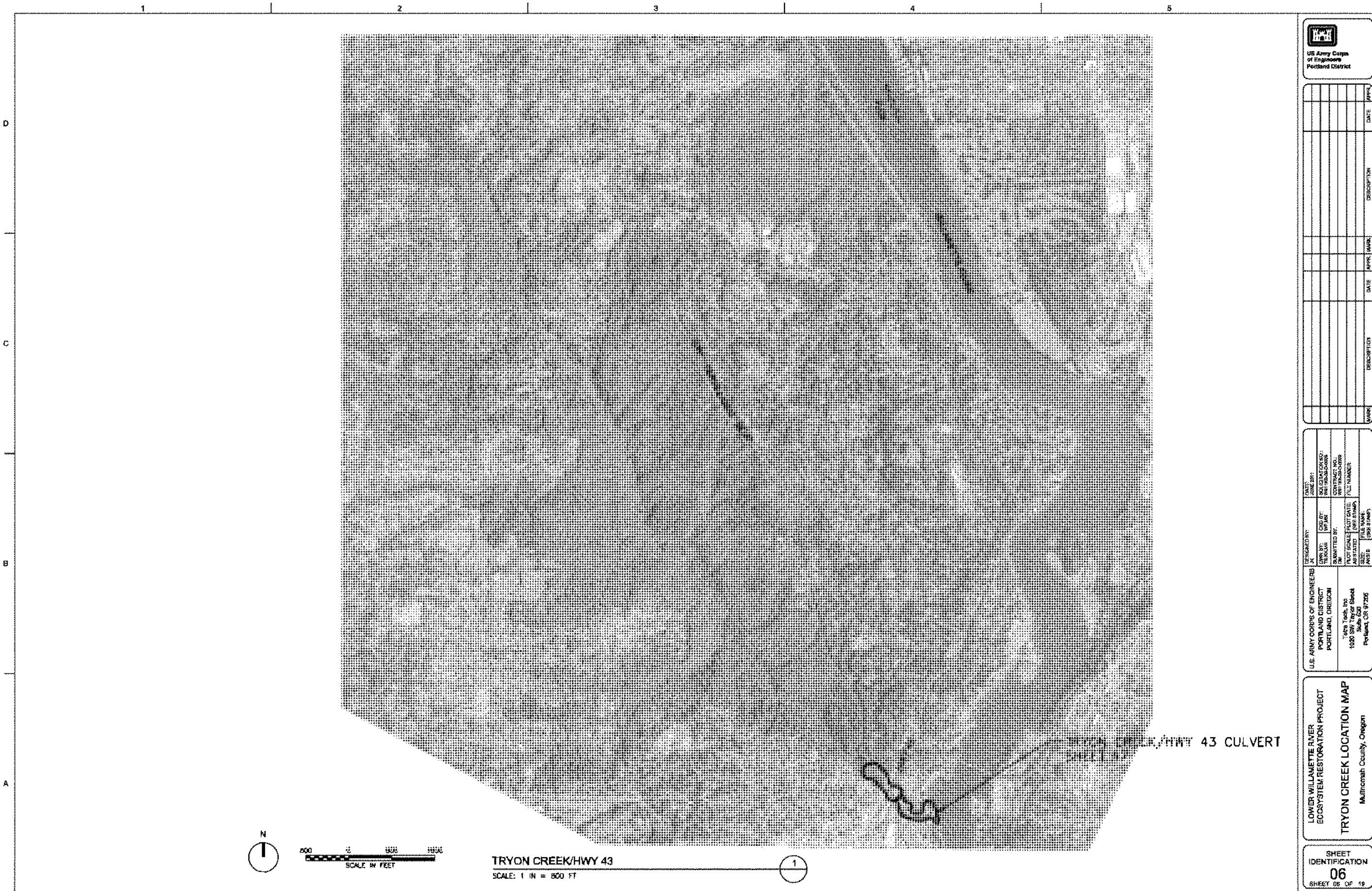
Suite 530
Portland, OR 97205
DESIGNED BY:
DATE:
SUBMITTED BY:
CONTRACT NO.:
FILE NAME:
MARK
DESCRIPTION
DATE
APPR.
SOUTH MAINSTEM WILLAMETTE
SCALE: 1 IN = 700 FT
SCALE IN FEET
700
0
700
N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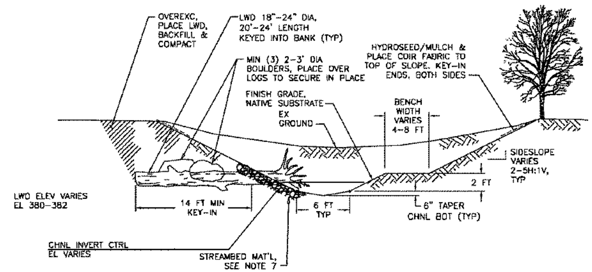
LOWER WILLAMETTE RIVER
ECOSYSTEM RESTORATION PROJECT
TRYON CREEK LOCATION MAP
Multnomah County, Oregon
SHEET IDENTIFICATION
06
SHEET 05 OF 19
43 CULVERT
TRYON CREEK/HWY 43
SCALE: 1 IN = 800 FT
SCALE IN FEET
N



TYPICAL SECTION
W/ NATIVE SUBSTRATE
HORZ. 1 IN = 5 FT/ VERT 1 IN = 5 FT

NOTES

1. STREAMBED MATERIAL SHALL INCLUDE 15% BY WEIGHT SANDY, ORGANIC MIX, AND 85% BY WEIGHT STREAMBED ROCK AS SPECIFIED. PLACEMENT OF STREAMBED MATERIAL SHALL BE AS SPECIFIED.

STREAMBED ROCK GRADATION	
ROCK DIAMETER / SIZE (IN)	PERCENT SMALLER (%)
20	100
16	75-85
12	40-60
4	20-30
1	7-15
1/2	0-10

2. LWD SHALL BE SELECTED FROM LOGS SALVAGED DURING CLEARING, OR IMPORTED PER SPECIFICATIONS.
3. AFTER CONTRACTOR STAKES TOP OF BANK WITH 2.5:1 OR STEEPER SLOPES, NOTIFY COR. COR APPROVAL REQUIRED BEFORE GRADING.
4. VARY CHANNEL SLOPES TO CREATE A NATURAL LOOKING CHANNEL. MAX SLOPE 2:1, MIN SLOPE 5:1.
5. CONSTRUCT 4 FT STREAMBED MATL POCKETS (OR TOEDOWNS) SIMILAR TO DETAIL 1 AT U/S AND D/S ENDS OF BRIDGE PROTECTION.
6. HYDROSEED, PLACE MULCH AND COIR FABRIC ALONG UPPER SLOPE OF ENTIRE CHANNEL.
7. BACKFILL WITH STREAMBED MAT'L AT FINISH GRADE SURFACE ADJACENT TO ALL LWD. SEE DETAILS ON SHT 08.

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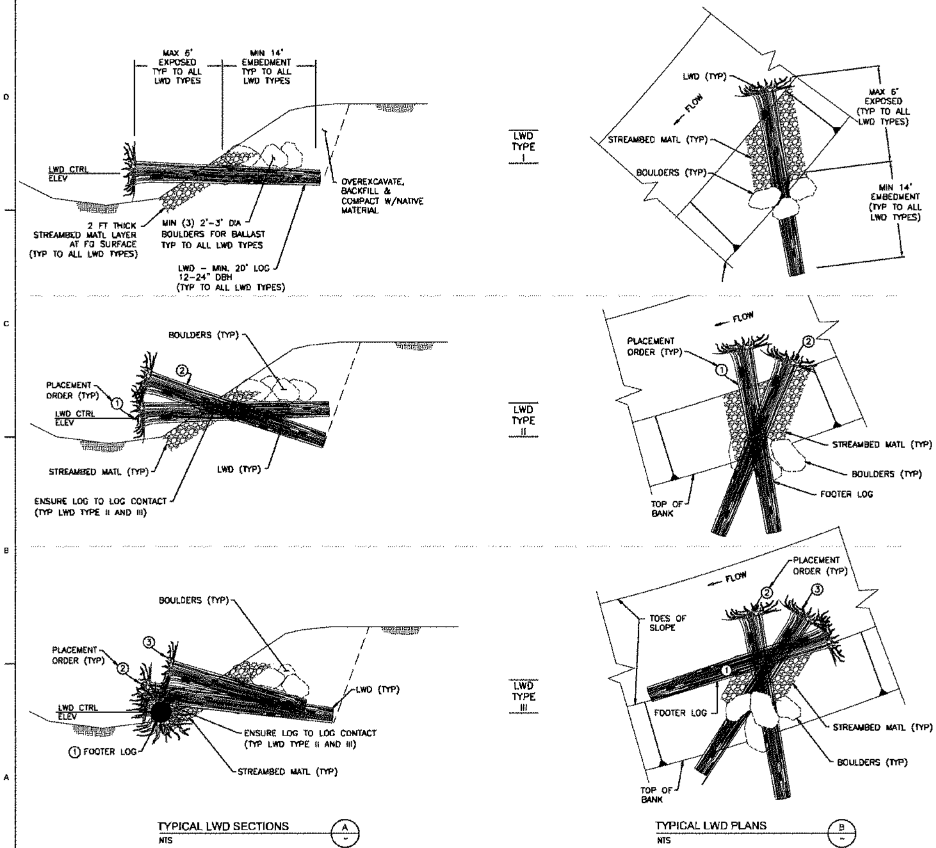
LOWER WILLAMETTE RIVER
ECOSYSTEM RESTORATION PROJECT

CHANNEL TYPICAL
CROSS SECTION
Multnomah County, Oregon

SHEET IDENTIFICATION
07
SHEET 07 OF 19



NOTES:

1. LWD SELECTED FROM LOGS SALVAGED DURING CLEARING ACTIVITIES SHALL HAVE ROOTWADS INTACT. ACCEPTANCE OF LOGS SHALL BE PER ENGINEER.
2. CONTRACTOR TO VARY PLAN VIEW ORIENTATION OF LOGS WITHIN LIMITS SHOWN AND PER SPECS AND FIELD DIRECTION FROM COR AND/OR ENGINEER. GENERALLY ORIENT LWD WITH ROOTWAD FACING U/S.
3. BOULDERS SALVAGED DURING CHANNEL EXCAVATION AND DEMO ACTIVITIES MAY BE USED FOR LWD BALLAST IF THEY MEET SIZE REQUIREMENTS SHOWN.
4. COBBLE AND BOULDERS (>6 IN DIA) FROM CHANNEL EXCAVATION MAY BE SUBSTITUTED FOR STREAMBED MATERIAL PLACED AT LWD. MATERIAL TO BE VISUALLY INSPECTED BY COR BEFORE CONSTRUCTION OF LWD.

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LOWER WILLAMETTE RIVER
ECOSYSTEM RESTORATION PROJECT

LWD DETAILS

Multnomah County, Oregon

SHEET IDENTIFICATION
08
SHEET 08 OF 19

PEDESTRIAN BRIDGES				
BRIDGE	ALIGN	STATION	LENGTH (FT)	WIDTH (FT)
1	2	14+00	190	10
2	2	31+50	120	10
3	1	23+00	180	10

NOTES:

1. LWD ARE DOUBLED IN SIZE FOR CLARITY.
2. ONLY 5' PROPOSED CONTOURS ARE SHOWN
3. ALL PEDESTRIAN BRIDGES ARE PREFABRICATED

SITE PLAN - KELLEY POINT PARK

SCALE: 1 IN = 200 FT

N

200 0 200 400

SCALE IN FEET

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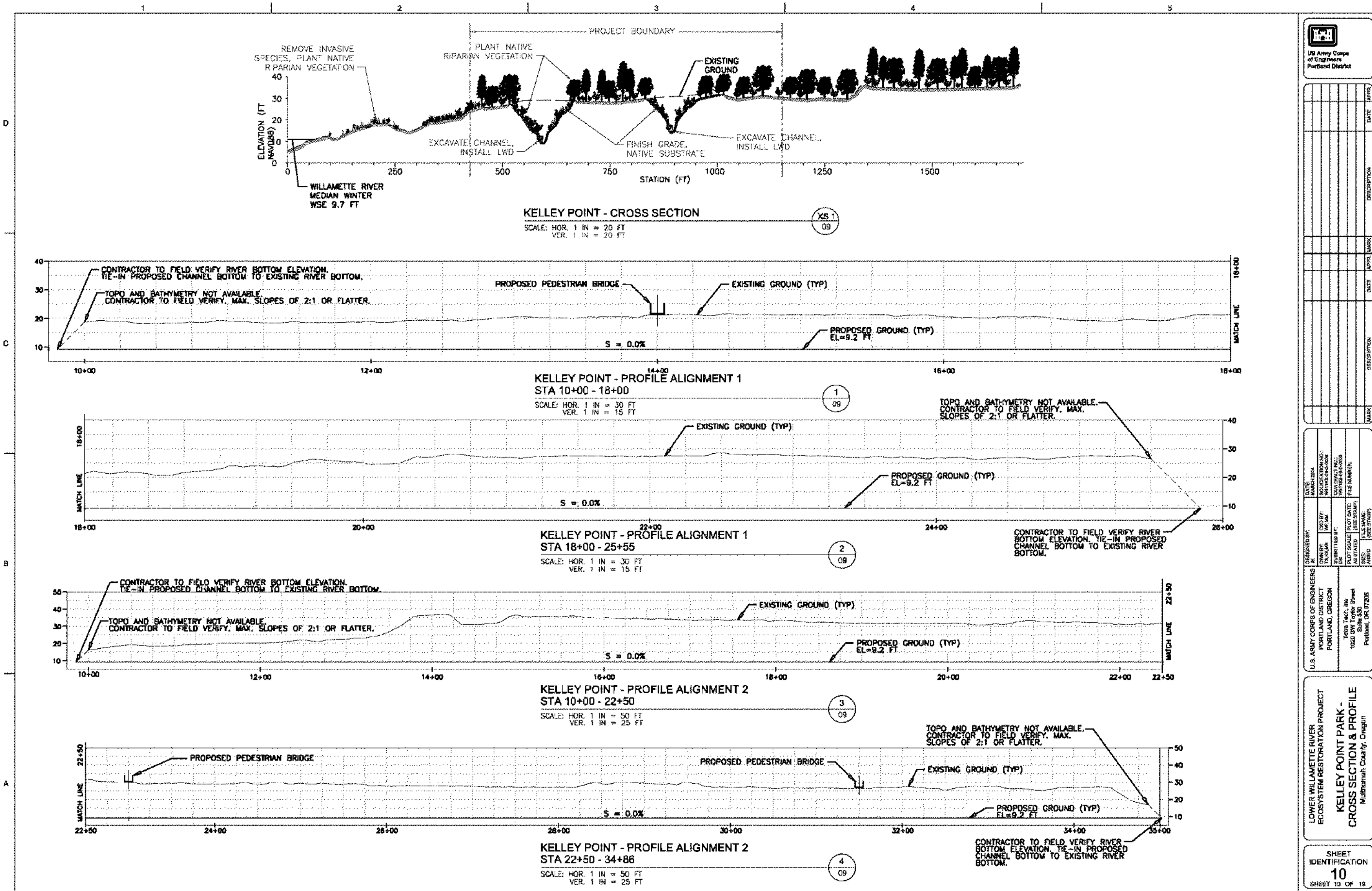
LOWER WILLAMETTE RIVER
ECOSYSTEM RESTORATION PROJECT

KELLEY POINT PARK -
SITE PLAN

Multnomah County, Oregon

SHEET IDENTIFICATION
09
SHEET 09 OF 19


PROJECT BOUNDARY
REMOVE INVASIVE SPECIES, PLANT NATIVE RIPARIAN VEGETATION
PLANT NATIVE RIPARIAN VEGETATION
EXISTING GROUND
EXCAVATE CHANNEL, INSTALL LWD
FINISH GRADE, NATIVE SUBSTRATE
ELEVATION (FT NAVD88)
STATION (FT)
WILLAMETTE RIVER MEDIAN WINTER WSE 9.7 FT
KELLEY POINT - CROSS SECTION
SCALE: HOR. 1 IN = 20 FT
VER. 1 IN = 20 FT
XS 1
09
CONTRACTOR TO FIELD VERIFY RIVER BOTTOM ELEVATION. TIE-IN PROPOSED CHANNEL BOTTOM TO EXISTING RIVER BOTTOM.
TOPO AND BATHYMETRY NOT AVAILABLE. CONTRACTOR TO FIELD VERIFY. MAX. SLOPES OF 2:1 OR FLATTER.
PROPOSED PEDESTRIAN BRIDGE
EXISTING GROUND (TYP)
PROPOSED GROUND (TYP) EL=9.2 FT
S = 0.0%
MATCH LINE
KELLEY POINT - PROFILE ALIGNMENT 1
STA 10+00 - 18+00
SCALE: HOR. 1 IN = 30 FT
VER. 1 IN = 15 FT
1
09
KELLEY POINT - PROFILE ALIGNMENT 1
STA 18+00 - 25+55
SCALE: HOR. 1 IN = 30 FT
VER. 1 IN = 15 FT
2
09
KELLEY POINT - PROFILE ALIGNMENT 2
STA 10+00 - 22+50
SCALE: HOR. 1 IN = 50 FT
VER. 1 IN = 25 FT
3
09
KELLEY POINT - PROFILE ALIGNMENT 2
STA 22+50 - 34+86
SCALE: HOR. 1 IN = 50 FT
VER. 1 IN = 25 FT
4
09
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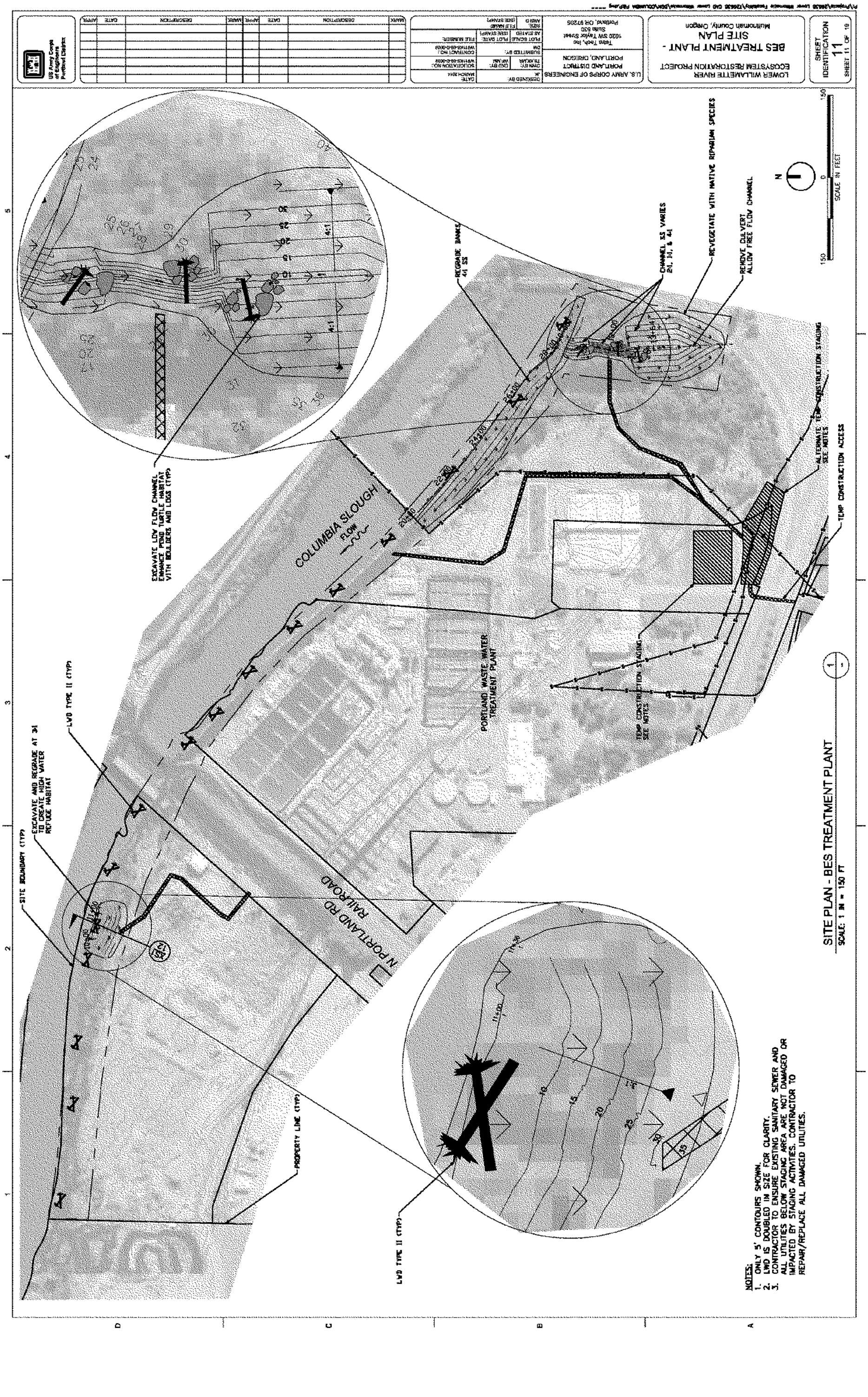
LOWER WILLAMETTE RIVER
ECOSYSTEM RESTORATION PROJECT
KELLEY POINT PARK - CROSS SECTION & PROFILE
Multnomah County, Oregon
SHEET IDENTIFICATION
10
SHEET 10 OF 19


LOWER WILLAMETTE RIVER
ECOSYSTEM RESTORATION PROJECT
BES TREATMENT PLANT -
SITE PLAN
Multnomah County, Oregon
U.S. ARMY CORPS OF ENGINEERS
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SHEET IDENTIFICATION
11
SHEET 11 OF 19
US Army Corps of Engineers
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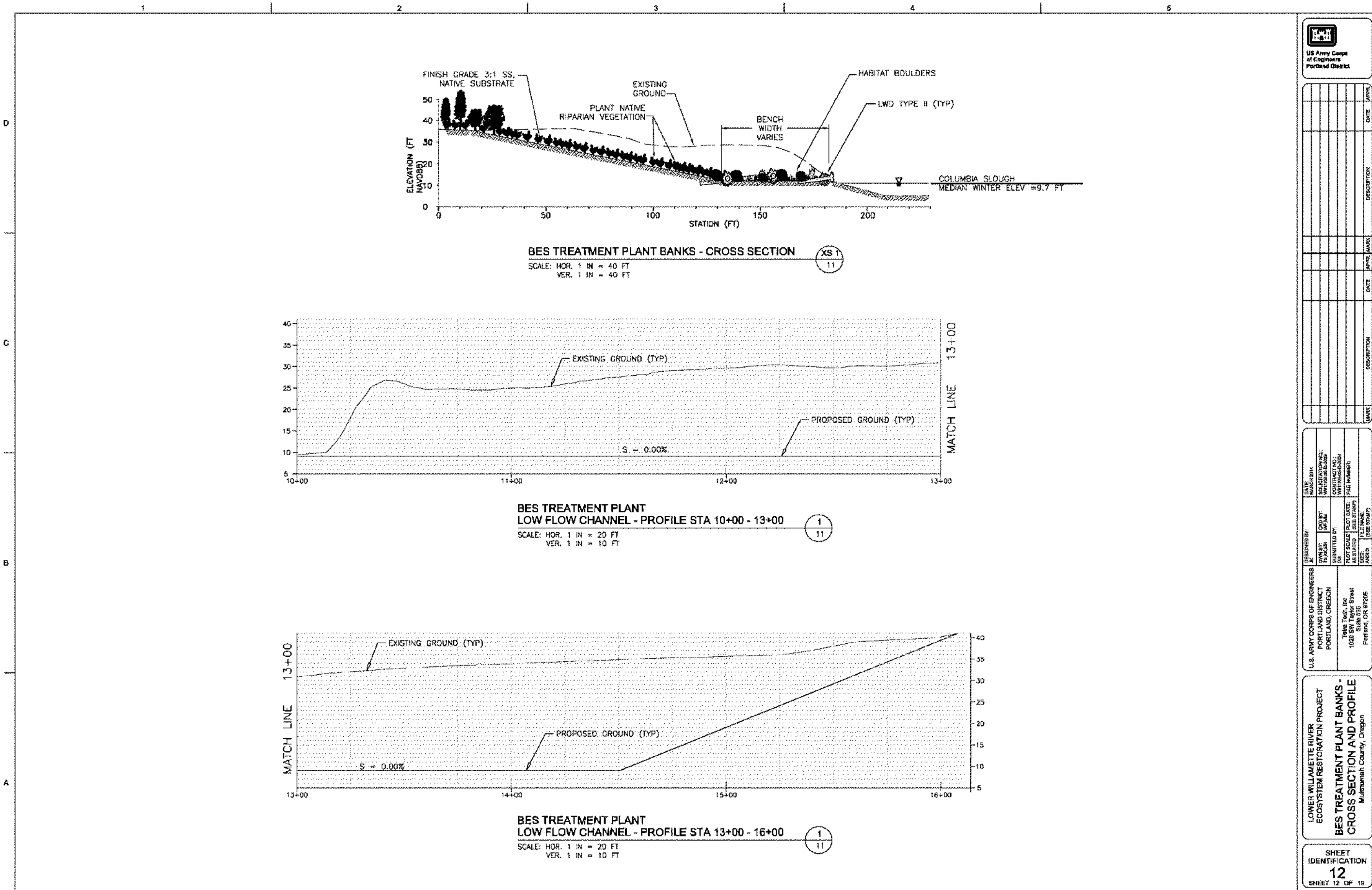
SITE PLAN - BES TREATMENT PLANT
SCALE: 1 IN = 150 FT
SCALE IN FEET
COLUMBIA SLOUGH
FLOW
N PORTLAND RD
RAILROAD
PORTLAND WASTE WATER TREATMENT PLANT
EXCAVATE LOW FLOW CHANNEL
ENHANCE POND TURTLE HABITAT
WITH BOULDERS AND LOGS (TYP)
REGRADE BANKS
4:1 SS
CHANNEL SS VARIES
2:1, 3:1, & 4:1
REVEGETATE WITH NATIVE RIPARIAN SPECIES
REMOVE CULVERT
ALLOW FREE FLOW CHANNEL
ALTERNATE TEMP CONSTRUCTION STAGING
SEE NOTES
TEMP CONSTRUCTION ACCESS
TEMP CONSTRUCTION STAGING
SEE NOTES
LWD TYPE II (TYP)
SITE BOUNDARY (TYP)
EXCAVATE AND REGRADE AT 3:1
TO CREATE HIGH WATER
REFUGE HABITAT
PROPERTY LINE (TYP)
NOTES:
1. ONLY 5' CONTOURS SHOWN.
2. LWD IS DOUBLED IN SIZE FOR CLARITY.
3. CONTRACTOR TO ENSURE EXISTING SANITARY SEWER AND ALL UTILITIES BELOW STAGING AREA ARE NOT DAMAGED OR IMPACTED BY STAGING ACTIVITIES. CONTRACTOR TO REPAIR/REPLACE ALL DAMAGED UTILITIES.


FINISH GRADE 3:1 SS, NATIVE SUBSTRATE
EXISTING GROUND
PLANT NATIVE RIPARIAN VEGETATION
BENCH WIDTH VARIES
HABITAT BOULDERS
LWD TYPE II (TYP)
COLUMBIA SLOUGH
MEDIAN WINTER ELEV =9.7 FT
ELEVATION (FT NAVD88)
STATION (FT)
BES TREATMENT PLANT BANKS - CROSS SECTION
SCALE: HOR. 1 IN = 40 FT
VER. 1 IN = 40 FT
XS 1
11
EXISTING GROUND (TYP)
PROPOSED GROUND (TYP)
S = 0.00%
MATCH LINE 13+00
BES TREATMENT PLANT
LOW FLOW CHANNEL - PROFILE STA 10+00 - 13+00
SCALE: HOR. 1 IN = 20 FT
VER. 1 IN = 10 FT
1
11
EXISTING GROUND (TYP)
PROPOSED GROUND (TYP)
S = 0.00%
MATCH LINE 13+00
BES TREATMENT PLANT
LOW FLOW CHANNEL - PROFILE STA 13+00 - 16+00
SCALE: HOR. 1 IN = 20 FT
VER. 1 IN = 10 FT
1
11
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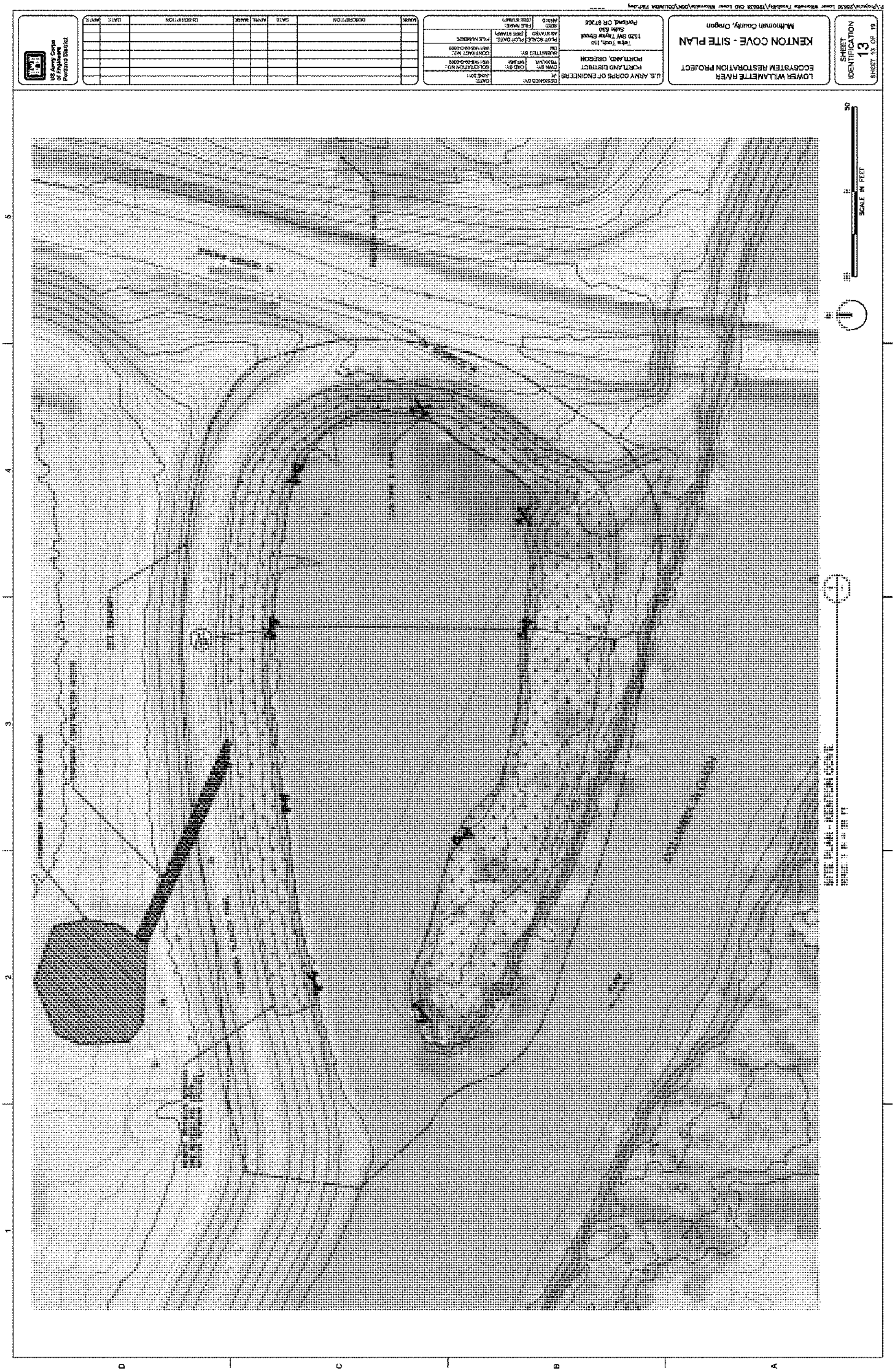
LOWER WILLAMETTE RIVER
ECOSYSTEM RESTORATION PROJECT
BES TREATMENT PLANT BANKS - CROSS SECTION AND PROFILE
Multnomah County, Oregon
SHEET IDENTIFICATION
12
SHEET 12 OF 19


LOWER WILLAMETTE RIVER
ECOSYSTEM RESTORATION PROJECT
KENTON COVE - SITE PLAN
Multnomah County, Oregon
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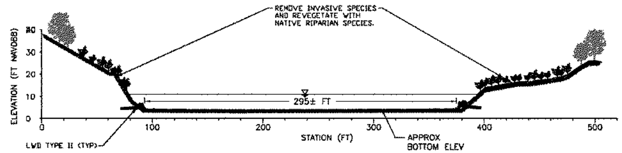
SHEET IDENTIFICATION
13
SHEET 13 OF 19
US Army Corps of Engineers
Portland District
SCALE IN FEET



KENTON COVE - CROSS SECTION
SCALE: HOR. 1 IN = 80 FT
VER. 1 IN = 20 FT

XS 1
13

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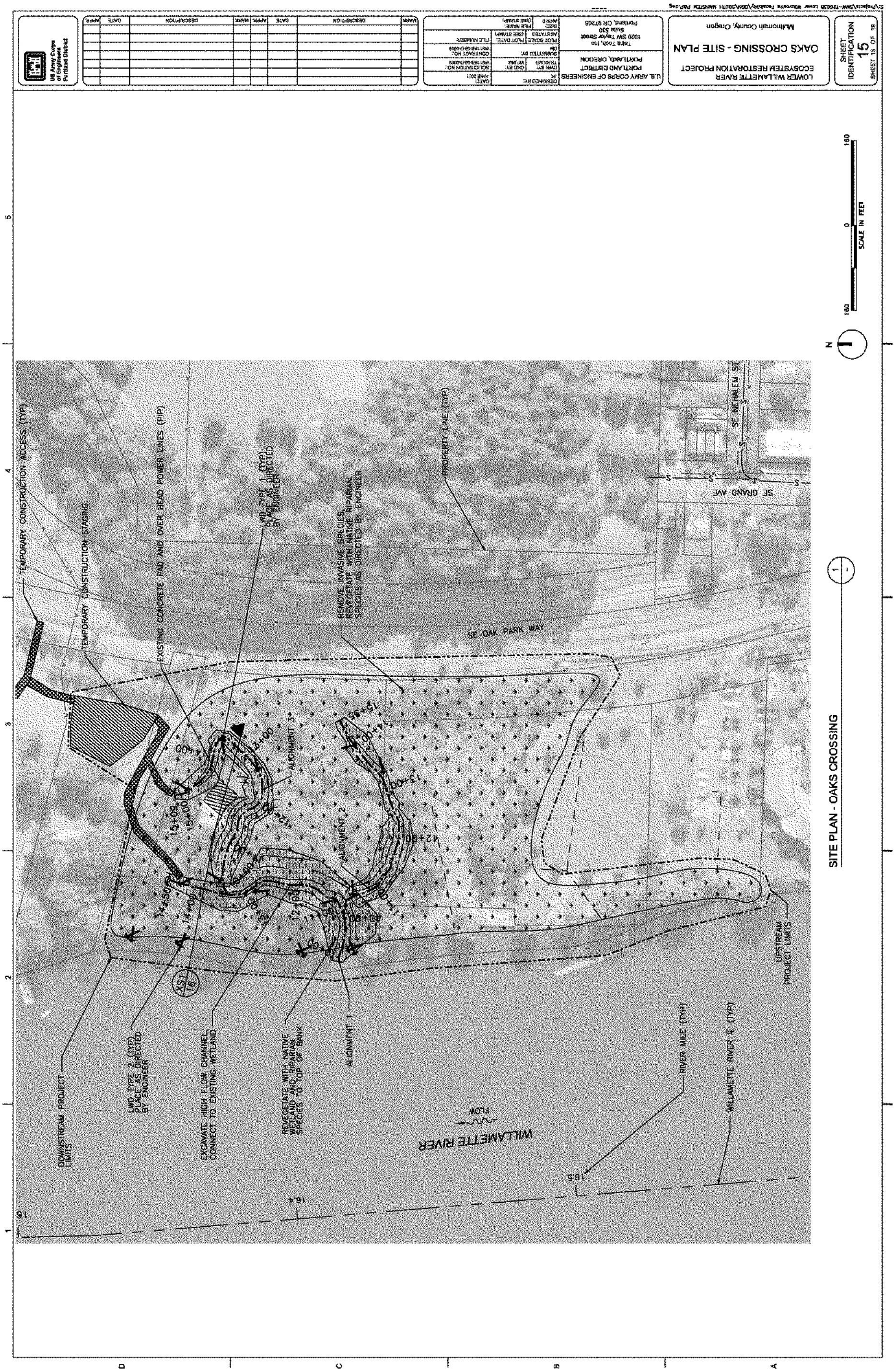
LOWER WILLAMETTE RIVER
ECOSYSTEM RESTORATION PROJECT

KENTON COVE -
CROSS SECTION
Multnomah County, Oregon

SHEET IDENTIFICATION
14
SHEET 14 OF 19


LOWER WILLAMETTE RIVER
ECOSYSTEM RESTORATION PROJECT
OAKS CROSSING - SITE PLAN
Multnomah County, Oregon
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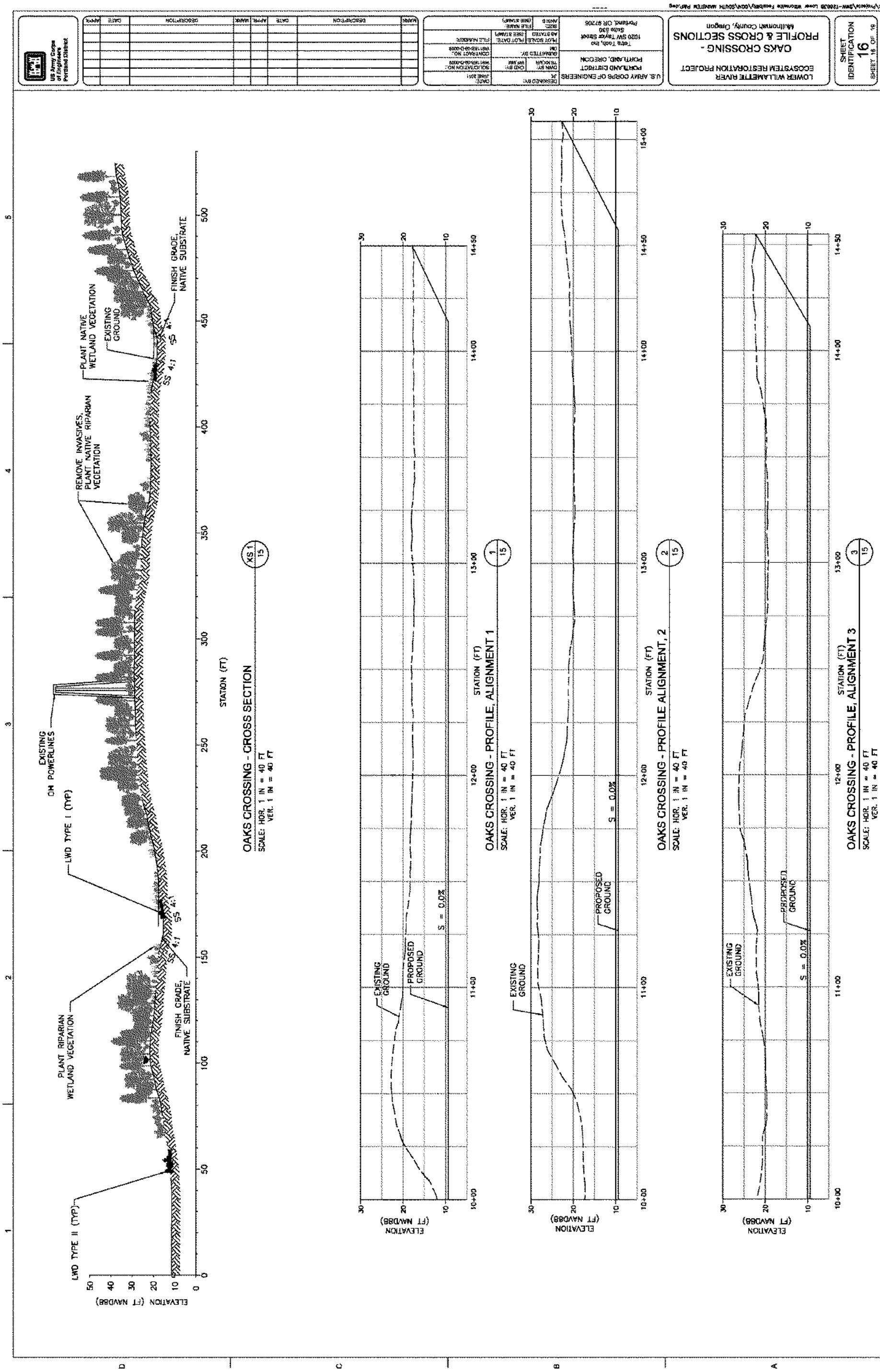
SHEET IDENTIFICATION
15
SHEET 15 OF 19
SITE PLAN - OAKS CROSSING
SCALE IN FEET
TEMPORARY CONSTRUCTION ACCESS (TYP)
TEMPORARY CONSTRUCTION STAGING
EXISTING CONCRETE PAD AND OVER HEAD POWER LINES (PIP)
LWD TYPE 1 (TYP) PLACE AS DIRECTED BY ENGINEER
PROPERTY LINE (TYP)
REMOVE INVASIVE SPECIES, REVEGETATE WITH NATIVE RIPARIAN SPECIES AS DIRECTED BY ENGINEER
SE OAK PARK WAY
SE GRAND AVE
SE NEHALEM ST
ALIGNMENT 3
ALIGNMENT 2
ALIGNMENT 1
DOWNSTREAM PROJECT LIMITS
LWD TYPE 2 (TYP) PLACE AS DIRECTED BY ENGINEER
EXCAVATE HIGH FLOW CHANNEL, CONNECT TO EXISTING WETLAND
REVEGETATE WITH NATIVE WETLAND AND RIPARIAN SPECIES TO TOP OF BANK
UPSTREAM PROJECT LIMITS
RIVER MILE (TYP)
WILLAMETTE RIVER ℄ (TYP)
WILLAMETTE RIVER
FLOW
16.5
16.4
16


LWD TYPE II (TYP)
PLANT RIPARIAN WETLAND VEGETATION
LWD TYPE I (TYP)
EXISTING OH POWERLINES
REMOVE INVASIVES, PLANT NATIVE RIPARIAN VEGETATION
PLANT NATIVE WETLAND VEGETATION
EXISTING GROUND
FINISH GRADE, NATIVE SUBSTRATE
SS 4:1
ELEVATION (FT NAVD88)
STATION (FT)
OAKS CROSSING - CROSS SECTION
SCALE: HOR. 1 IN = 40 FT
VER. 1 IN = 40 FT
XS 1
15
EXISTING GROUND
PROPOSED GROUND
S = 0.0%
OAKS CROSSING - PROFILE, ALIGNMENT 1
OAKS CROSSING - PROFILE ALIGNMENT, 2
OAKS CROSSING - PROFILE, ALIGNMENT 3
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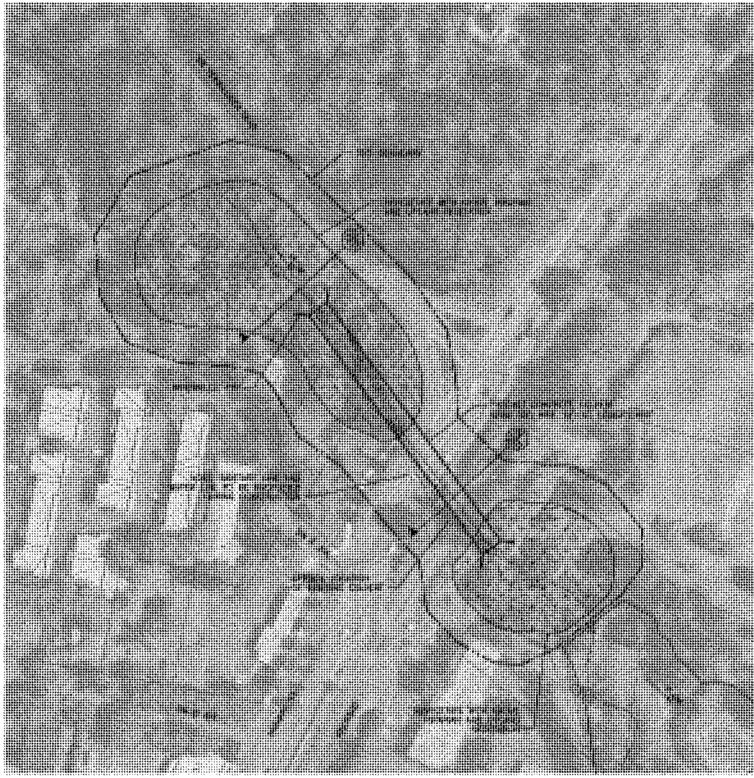
ECOSYSTEM RESTORATION PROJECT
OAKS CROSSING - PROFILE & CROSS SECTIONS
Multnomah County, Oregon
SHEET IDENTIFICATION
16
SHEET 16 OF 19



SITE PLAN - TRYON CREEK HIGHWAY 43 CULVERT

SCALE: 1 IN = 60 FT

NOTE:

LOCATIONS OF CONSTRUCTION STAGING WILL BE DETERMINED AT A LATER DATE UPON COORDINATION WITH CITY OF PORTLAND, CITY OF LAKE OSWEGO, OREGON DEPARTMENT OF TRANSPORTATION, AND UNION PACIFIC RAILROAD.

N

80 0 80 120

SCALE IN FEET

US Army Corps of Engineers
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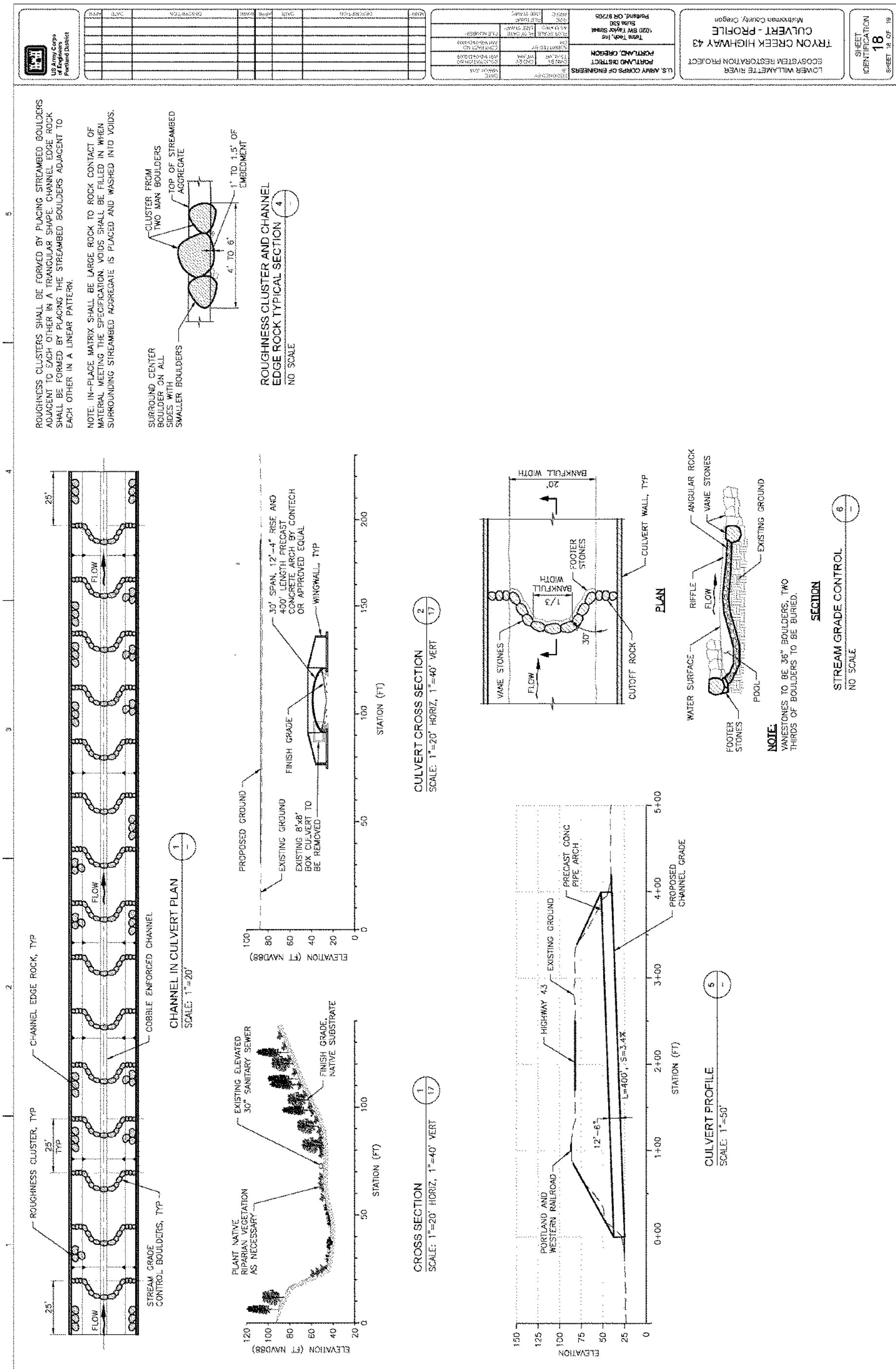
LOWER WILLAMETTE RIVER
ECOSYSTEM RESTORATION PROJECT

TRYON CREEK HIGHWAY 43
CULVERT - SITE PLAN
Multnomah County, Oregon

SHEET IDENTIFICATION
17
SHEET 17 OF 19



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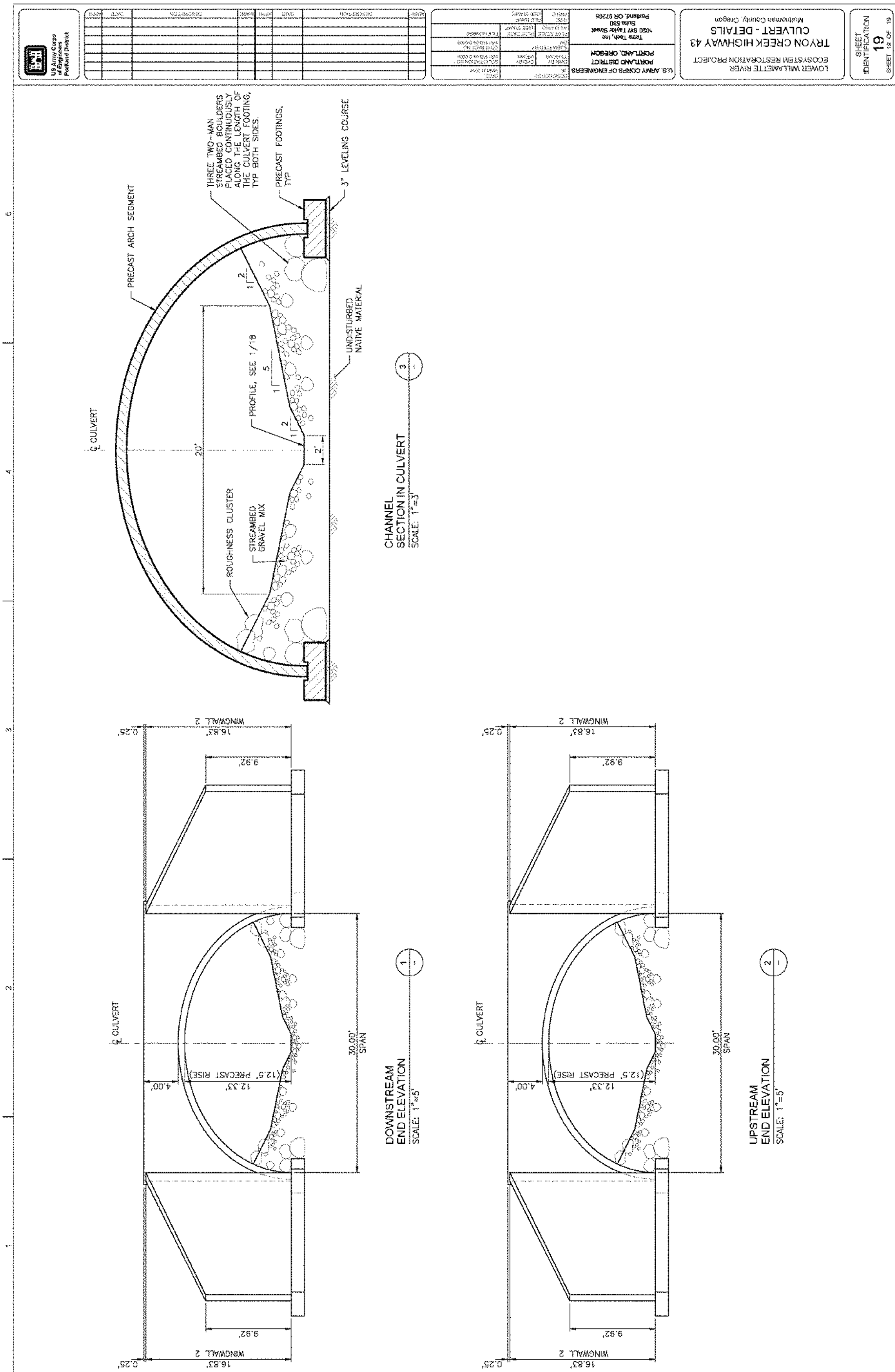
LOWER WILLAMETTE RIVER
ECOSYSTEM RESTORATION PROJECT
TRYON CREEK HIGHWAY 43
CULVERT - PROFILE
Multnomah County, Oregon
SHEET IDENTIFICATION
18
SHEET 18 OF 19
ROUGHNESS CLUSTERS SHALL BE FORMED BY PLACING STREAMBED BOULDERS ADJACENT TO EACH OTHER IN A TRIANGULAR SHAPE. CHANNEL EDGE ROCK SHALL BE FORMED BY PLACING THE STREAMBED BOULDERS ADJACENT TO EACH OTHER IN A LINEAR PATTERN.
NOTE: IN-PLACE MATRIX SHALL BE LARGE ROCK TO ROCK CONTACT OF MATERIAL MEETING THE SPECIFICATION. VOIDS SHALL BE FILLED IN WHEN SURROUNDING STREAMBED AGGREGATE IS PLACED AND WASHED INTO VOIDS.
SURROUND CENTER BOULDER ON ALL SIDES WITH SMALLER BOULDERS
CLUSTER FROM TWO MAN BOULDERS
TOP OF STREAMBED AGGREGATE
1' TO 1.5' OF EMBEDMENT
4' TO 6'
ROUGHNESS CLUSTER AND CHANNEL EDGE ROCK TYPICAL SECTION
NO SCALE
ROUGHNESS CLUSTER, TYP
CHANNEL EDGE ROCK, TYP
25'
25' TYP
FLOW
STREAM GRADE CONTROL BOULDERS, TYP
COBBLE ENFORCED CHANNEL
CHANNEL IN CULVERT PLAN
SCALE: 1"=20'
PROPOSED GROUND
EXISTING GROUND
EXISTING 8'x8' BOX CULVERT TO BE REMOVED
FINISH GRADE
30' SPAN, 12'-4" RISE AND 400' LENGTH PRECAST CONCRETE ARCH BY CONTECH OR APPROVED EQUAL
WINGWALL, TYP
ELEVATION (FT NAVD88)
STATION (FT)
CULVERT CROSS SECTION
SCALE: 1"=20' HORIZ, 1"=40' VERT
VANE STONES
FOOTER STONES
BANKFULL WIDTH
1/3
20'
30°
CUTOFF ROCK
CULVERT WALL, TYP
PLAN
WATER SURFACE
RIFFLE
ANGULAR ROCK
VANE STONES
POOL
EXISTING GROUND
NOTE:
VANESTONES TO BE 36" BOULDERS, TWO THIRDS OF BOULDERS TO BE BURIED.
SECTION
STREAM GRADE CONTROL
NO SCALE
PLANT NATIVE RIPARIAN VEGETATION AS NECESSARY
EXISTING ELEVATED 30" SANITARY SEWER
FINISH GRADE, NATIVE SUBSTRATE
CROSS SECTION
SCALE: 1"=20' HORIZ, 1"=40' VERT
PORTLAND AND WESTERN RAILROAD
HIGHWAY 43
EXISTING GROUND
PRECAST CONC PIPE ARCH
PROPOSED CHANNEL GRADE
12'-6"
L=400', S=3.4%
CULVERT PROFILE
SCALE: 1"=50'


US Army Corps of Engineers Portland District
U.S. ARMY CORPS OF ENGINEERS
PORTLAND DISTRICT
PORTLAND, OREGON
Tetra Tech, Inc
1020 SW Taylor Street
Suite 530
Portland, OR 97205
LOWER WILLAMETTE RIVER
ECOSYSTEM RESTORATION PROJECT
TRYON CREEK HIGHWAY 43
CULVERT - DETAILS
Multnomah County, Oregon
SHEET IDENTIFICATION
19
SHEET 19 OF 19
PRECAST ARCH SEGMENT
THREE TWO-MAN STREAMBED BOULDERS PLACED CONTINUOUSLY ALONG THE LENGTH OF THE CULVERT FOOTING, TYP BOTH SIDES.
PRECAST FOOTINGS, TYP
3" LEVELING COURSE
UNDISTURBED NATIVE MATERIAL
PROFILE, SEE 1/18
℄ CULVERT
20'
2'
ROUGHNESS CLUSTER
STREAMBED GRAVEL MIX
CHANNEL SECTION IN CULVERT
SCALE: 1"=3'
3
WINGWALL 2
16.83'
0.25'
9.92'
4.00'
12.33'
(12.5' PRECAST RISE)
30.00' SPAN
DOWNSTREAM END ELEVATION
SCALE: 1"=5'
1
UPSTREAM END ELEVATION
SCALE: 1"=5'
2

APPENDIX B

DRAFT PLANTING LIST

Lower Willamette Planting Tables

Emergent Wetland Seed Mix		
Native Grasses	**Common Name**	**Lbs/Acre**
Alopecuris geniculatus	Water Foxtail	3
Agrostis exarata	Spike Bent Grass	3
Beckmania syzigachne	American Slough Grass	2
Deschampsia elongata	Slender hair Grass	3
Hordeum brachyantherum	Meadow Barley	5
Carex obnupta	Slough Sedge	2
	Total Lbs/Acre	18

Riparian Herbaceous Seed Mix

Agrostis exarata	Spike Bent Grass	3
Deschampsia elongata	Slender hair Grass	4
Elymus glaucus	Blue wildrye	5
Hordeum brachyantherum	Meadow Barley	5
	Total Lbs/Acre	17

Pacific Willow Temporarily Flooded Woodland Plant list

Species	Common Name	Plant Density	Propagule
Salix lucida var. lasiandra	Pacific Willow	4000/acre	Tublings/cuttings
Salix fluviatilis	Columbia River Willow		Tublings/cuttings
Salix sitchensis	Sitka Willow		Tublings/cuttings
Salix hookeriana	Piper's Willow		Tublings/cuttings
Spirea douglasii	Spirea		Tublings/cuttings
Lonicera involucrata	Twin Berry		Tublings/cuttings
Cornus sericea	Red Osier Dogwood		Tublings/cuttings

Riparian Forested Plant List

Species	Common Name	Plant Density	Propagule
Fraxinus latifolia	Oregon Ash	100/ac	1 gal
Thuja plicata	Western red cedar	50/ac	1 gal/bareroot
Salix lucida var. lasiandra	Pacific Willow	200/ac	Tublings/cuttings
Salix sitchensis	Sitka Willow	100/ac	Tublings/cuttings
Populus balsamifera	Black cottonwood	100/ac	Poles
Lonicera involucrata	Twin Berry	200/ac	Tublings/cuttings
Cornus sericea	Red Osier Dogwood	200/ac	Tublings/cuttings

Upland Plant List

Species	Common Name	Plant Density	Propagule
Acer macrophyllum	Big leaf maple	100/ac	1 gal
Pseudotsuga menziesii	Douglas fir	100/ac	5 gal
Sambucus caerula	Blue elderberry	50/ac	1 gal
Ribes sanguineum	Red-flowering currant	200/ac	1 gal
Mahonia aquifolium	Tall Oregon grape	200/ac	1 gal
Holodiscus discolor	Oceanspray	200/ac	1 gal

APPENDIX C

PRELIMINARY COST ESTIMATE

Lower Willamette ERGI Phase II

Unit Costs and Standard Markups for Restoration Projects

Cat.	Line Item	Unit	Source	Notes
Site Preparation Markups	Mob/Demob	Site prep markups are shown as percantage of construction subtotal, NOT INCLUDING THESE SITE PREP MARKUPS	PDOT Bid Tab #1 (8% mobilization)	Includes mob/demob of construction equipment and preparation of site access and staging areas.
	Permitting		Engineer's estimate - average for restoration sites	Includes contractor's construction permits only. NEPA and other pre-construction permit documents included in design phase costs.
	Dewatering/Diversion		Engineer's estimate - average for restoration sites	Includes dewatering, water control, and stream diversion as necessary.
	Erosion/Control and BMP's		PDOT Bid Tab #22,30 (1.5% Erosion+1% Pollution)	Includes silt fences, straw bales, inlet protection, biofilter bags, and other BMP's.
	Traffic Control		PDOT Bid Tab #2 (4% temp prot/div of traffic)	Site access/routing constr. vehicle traffic, not incl. long-term detours, rerouting traffic, or improvements to detour routes (sep. line items).
	Utilities		Engineer's estimate - average for restoration sites	Utility coord/notif, accomodations for minor utility impacts only, not incl. major service interruptions/relocations (covered in sep. line items).
	Demolition		PDOT Bid Tab #31 (3% rem of struc. & obstr.)	Demo and disposal of debris/obstructions, not including demolition of major infrastructure. Major work included in separate line items.
	Sum of Site Preparation Markups		Subtotal	Site prep markups are to construction subtotal, non-inclusive of markups.
Construction Line Items	Structural Concrete	per cubic yard	Engineer's estimate	Average cost for precast (delivered) or cast-in-place (incl. forms) structural concrete, including reinforcing steel
	Demo/Dispose Rock/Concrete	per ton	Engineer's estimate	Demo of grouted rock or unreinforced concrete
	Concrete Box Culvert	per lineal foot	PDOT Bid Tab #128 ($1220/ft concrete arch culvert)	8'-12' span culvert, incl. fabrication, delivery, installation/forming, footings, wingwalls, headwalls, streambed (double PDOT est for extras)
	Concrete Arch Culvert	per lineal foot	Engineer's estimatem (compare Boones Ferry)	~30'-40'-span culvert, incl. fabrication, delivery, installation/forming, footings, wingwalls, headwalls, streambed (double cost of shorter span)
	Pipe Culvert	per lineal foot	Engineer's estimate	Assume HDPE or PVC pipe, ~18" dia
	Pipe Culvert	per lineal foot	Engineer's estimate	Assume concrete pipe or aluminum arch, ~60"-72" dia
	Pipe Culvert with Slide Gate	per lineal foot	Engineer's estimate	Culvert fabrication, delivery, installation, based on 12" dia CMP with hand-operated slide gate
	Concrete Bridge	per square foot	Average from 2006 ODOT bridge cost data	Price based on deck area, including abutments and superstructure
	Railroad Bridge	per square foot	Engineer's estimate	Price based on deck area, including abutments and superstructure
	Footbridge	per square foot	Continental Bridge	Price based on deck area, including abutments and superstructure
	Metal Grating	per square foot	Engineer's estimate	Install metal grating for drainage, accommodate HS-20 load
	Barge Excavation	per cubic yard	Engineer's estimate	Excavate and haul offsite based on barge-mounted dredge with access from Willamette River
	Excavate and Haul Offsite	per cubic yard	PDOT Bid Tab #46	Standard excavation, assume 10-mile round-trip haul with no soil treatment
	Excavate and Regrade Onsite	per cubic yard	Engineer's estimate	Excavation and regrading within 50 feet with no net haul
	Import, Place, and Compact Fill	per cubic yard	PDOT Bid Tab #114 ($38.30 per SY)	Average cost for imported topsoil, structural backfill (PDOT Bid Tab #224), including delivery, rough grading, compaction, and smoothing
	Erosion Control Fabric	per square yard	PDOT Bid Tab #55 ($1 per SY)	Place on steep slopes or areas exposed to flow
	Plant Wetland Vegetation	per acre	Beaver Lake Nursery, Valley Growers, Scholl's	Remove invasives @$3,000 per acre, plant emergent wetland planting plugs at 2' O.C. $0.50 each material, $1.25 each installed
	Plant Shrub/Riparian Vegetation	per acre	Beaver Lake Nursery, Valley Growers, Scholl's	Remove invasives @$3,000 per acre, plant riparian species @$3 ea gal mat'l, $6 ea installed at 8' O.C.+ seeding @$2,500/acre + willow cuttings/alder stakes
	Plant Upland Vegetation	per acre	Beaver Lake Nursery, Valley Growers, Scholl's	Remove invasives @$3,000 per acre, plant riparian species @$3 ea gal mat'l, $6 ea installed at 8' O.C.+seeding @$2,500/acre
	Place Large Woody Debris	each	Engineer's estimate - average for restoration sites	Place buried, non-anchored logs with attached rootballs
	Place Anchored Large Woody Debris	each	Engineer's estimate - average for restoration sites	Place buried logs with attached rootballs, anchored with ecology blocks
	Remove Boulders	per ton	Engineer's estimate	Assume salvage value for rip rap
	Place Boulders	per ton	PDOT Bid Tab #61 ($80/CY)	Place boulders as habitat features among large woody debris clusters or grade control, including geotextile as necessary
General Markups	Contingency	General markups are shown as % of construction subtotal, including site prep markups, but NOT INCLUDING EACH PRECEDING INDIVIDUAL GENERAL MARKUP	Previous Corps 206 projects	Relatively high contingency to account for unknown topography, subsurface conditions, and site conditions
	Design Phase		Previous Corps 206 projects (PDOT Standard 25%)	Includes geotech, permitting, precon survey, staking, and as-builts
	Real Estate		Engineer's estimate (PDOT ROW Contingency 20%)	Investigations, notification & coordination with site landowners and adjacent landowners. No acquisition costs included at this level.
	Construction Management		Engineer's estimate (PDOT Standard 15%)	Includes construction oversight, inspections, administration, and engineering during construction
	Present Value of O&M Costs		Engineer's estimate	Present value for 50 years of inspections, maintenance, revegetation, replacement, operation, etc.
	Monitoring		Engineer's estimate	Includes development of site specific monitoring plans, annual monitoring and reporting.
	Sum of General Markups		Subtotal	Markup to construction subtotal, including site preparation markups, but not including individual general markups

Additional Assumptions:

1. Unit costs include equipment, labor, materials, contractor overhead and profit.
2. Real estate costs were developed on a preliminary basis based on assessors parcel values multiplied by the percent of the parcel(s) need for any given proejct.
3. Mitigation costs are not included as projects are generally assumed to be self-mitigating. Some additional costs may need to be added to individual projects.
4. Where applicable, unit prices are based on prior USACE or BES projects and City of Portland Transportation Engineering and Development bid tabs.
5. Costs do not account for phased construction (multiple mobilizations).
6. Markups in PDOT bid tabs are based on percentage of contract, inclusive of markups (see conversion tab).
7. Costs are in 2008 dollars. Escalation costs for anticipated period of construction are not included and would need to be added dependent on the time of construction.
8. Revegetation costs include topsoil as needed.
9. All haul-away costs for barge-based disposal assume open-water disposal without the need for additional handling by land-based equipment.
10. Earthwork costs assume no contaminated material. If contaminated materials are encountered, additional costs would be incurred for treatment.
11. Operation and maintenance costs assume a 50-year project life, with annual costs shown as an equivalent present value.

BES Treatment Plant Cost Estimate			
Line Item	Units	Cost	Notes/Assumptions
Site Preparation	LS	$ 68,741	Standard markups (see cost appendix)
Barge Excavation	CY	$ 129,222	Lay back existing 2:1 riverbank to 5:1
Excavate and Haul	CY	$ 62,785	Excavate and haul for high-water refugia and low-flow channel
Plant Riparian Vegetation	AC	$ 8,010	Remove invasives and plant native species, including soil treatment
Place Large Woody Debris	EA	$ 28,000	Place buried, non-anchored logs with attached rootballs
Place Boulders	TN	$ 1,120	Place boulders as habitat features among large woody debris clusters
General Markups	LS	$ 217,451	Standard markups (see cost appendix)
Real Estate	LS	$ 66,770	Assessor's value for parcels multiplied by percent of parcels needed for project
Total Cost		$ 582,099	Total cost of design, construction and maintenance

Kelley Point Park Cost Estimate			
Line Item	Units	Cost	Notes/Assumptions
Site Preparation	LS	$ 1,048,957	Standard markups (see cost appendix)
Construct Footbridge	SF	$ 160,000	Fabricate, deliver, and install 2 footbridges, 100' length, 8' width, including abutments and superstructure
Barge Excavation	CY	$ 2,108,800	Lay back existing 2:1 riverbank to 5:1
Excavate and Haul	CY	$ 531,109	Create channels
Erosion control fabric	SF	$ 474,480	Place erosion control fabric on exposed bank
Plant Riparian Vegetation	AC	$ 130,711	Remove invasives and plant native species, including soil treatment
Plant Upland Vegetation	AC	$ 50,302	Remove invasives and plant native species, including soil treatment
Place Boulders	TN	$ 1,120	Place boulders as habitat features among large woody debris clusters
Place Large Woody Debris	EA	$ 40,000	Place buried, non-anchored logs with attached rootballs
General Markups	LS	$ 3,318,200	Standard markups (see cost appendix)
Real Estate	LS	$ 100,000	Estimated cost for construction easement.
Total Cost		$ 7,963,679	Total cost of design, construction and maintenance

Kenton Cove Cost Estimate			
Line Item	Units	Cost	Notes/Assumptions
Site Preparation	LS	$ 3,840	Standard markups (see cost appendix)
Import Soil for Fill	CY	$ 51,105	Import and place clean sand fill for shallow water habitat
Plant Riparian Vegetation	AC	$ 38,655	Remove invasives and plant native species, including soil treatment
Place Large Woody Debris	EA	$ 12,800	Place buried, non-anchored logs with attached rootballs
General Markups	LS	$ 77,672	Standard markups (see cost appendix)
Estimated Real Estate Cost	LS	$ 47,250	Assessor's value for parcels multiplied by percent of parcels needed for project
Total Cost		$ 231,322	Total cost of design, construction and maintenance

Oaks Crossing/Sellwood Riverfront Park

Line Item	Units	Cost	Notes/Assumptions
Site Preparation	LS	$ 30,398	Standard markups (see cost appendix)
Excavate and Haul	CY	$ 219,213	Create off-channel habitat area
Plant Wetland Vegetation	AC	$ 40,763	Remove invasives and plant native species, including soil treatment
Plant Riparian Vegetation	AC	$ 54,165	Remove invasives and plant native species, including soil treatment
Place Large Woody Debris	EA	$ 6,400	Place buried, non-anchored logs with attached rootballs
General Markups	LS	$ 256,186	Standard markups (see cost appendix)
Estimated Real Estate Costs	LS	$ 44,090	Assessor's value for parcels multiplied by percent of parcels needed for project
Total Cost		$ 651,215	Total cost of design, construction and maintenance

Tryon Highway 43 Cost Estimate			
Line Item	**Units**	**Cost**	**Notes/Assumptions**
Site Preparation	LS	$ 1,526,311	Standard markups (see cost appendix)
Traffic Control	LS	$ 500,000	Supplemental traffic control (beyond accomodations for construction vehicles) - full closure and detour, 90 days
Temporary Shoo-Fly	LS	$ 1,000,000	Temporary railroad bridge during construction (or phased construction)
Utilities	LS	$ 180,000	Supplemental utility work beyond standard markups, assume OH electric, gas, water, sewer, telecom
Demolition	LS	$ 40,000	Demo and haul existing culvert
Shoring	SF	$ 1,650,000	Soldier pile full length and depth for culvert
Excavation for culvert	CY	$ 273,000	38' excavation width used
Bedrock removal	CY	$ 297,600	Lower portion expected to encounter bedrock, especially under the railroad
Obstruction removal	LS	$ 100,000	Buried trestle piles and other remnants from 1929 construction
Culvert backfill	CY	$ 320,400	
Sewer trunk relocation	LS	$ 720,000	Both open cut along SW E Ave and bore/jack under HWY 43/RR for 30" trunk sewer feeding nearby treatment plant
Culvert material and installation	LS	$ 1,400,000	30' span BEBO arch system, CIP footings
Headwalls, wingwalls	LS	$ 100,000	
Road surface restoration	LS	$ 200,000	HMA over CSBC
Plant Riparian Vegetation	AC	$ 14,904	Remove invasives and plant native species, including soil treatment
Plant Upland Vegetation	AC	$ 11,799	Remove invasives and plant native species, including soil treatment
General Markups	LS	$ 6,083,829	Standard markups (see cost appendix)
Estimated Real Estate Costs	LS	$ 63,455	Assessor's value for parcels multiplied by percent of parcels needed for project
Total Cost		$ 14,481,297	Total cost of design, construction and maintenance

APPENDIX D

MCACES Cost Estimate

**** TOTAL PROJECT COST SUMMARY ****

Printed:4/28/2015
Page 1 of 6

PROJECT: Lower Willamette Ecosystem Restoration Project
PROJECT NO: T26638
LOCATION: Willamette River, OR

DISTRICT: Portland District

PREPARED: 3/9/2015-Updated w/Real Estate cost-4/17/2015
POC: CHIEF, COST ENGINEERING, Eileen Horiuchi

This Estimate reflects the scope and schedule in report; Lower Willamette Ecosys. Rest. Proj. Draft Tech. Memo.

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)						TOTAL PROJECT COST (FULLY FUNDED)			
						Program Year (Budget EC): 2016; Effective Price Level Date: 1 OCT 15									
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014 ($K)	TOTAL FIRST COST ($K)	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B	C	D	E	F	G	H	I	J		K	L	M	N	O
02	RELOCATIONS	$337	$152	45.02%	$489	1.9%	$343	$155	$498	$0	$498	3.5%	$355	$160	$515
06	FISH & WILDLIFE FACILITIES	$11,066	$3,857	34.85%	$14,923	1.9%	$11,273	$3,929	$15,202	$0	$15,202	2.2%	$11,519	$4,023	$15,542
08	ROADS, RAILROADS & BRIDGES	$1,400	$715	51.05%	$2,115	1.9%	$1,426	$728	$2,154	$0	$2,154	3.5%	$1,476	$754	$2,230
14	RECREATION FACILITIES	$1,103	$271	24.53%	$1,373	1.9%	$1,123	$276	$1,399	$0	$1,399	1.4%	$1,140	$280	$1,419
	CONSTRUCTION ESTIMATE TOTALS:	$13,906	$4,994	35.91%	$18,900	1.9%	$14,166	$5,087	$19,253	$0	$19,253	2.4%	$14,490	$5,216	$19,706
01	LANDS AND DAMAGES	$5,383	$1,077	20.00%	$6,460	1.9%	$5,484	$1,097	$6,580	$0	$6,580	0.2%	$5,493	$1,099	$6,592
30	PLANNING, ENGINEERING & DESIGN	$1,743	$316	18.15%	$2,059	3.4%	$1,803	$327	$2,130	$0	$2,130	2.6%	$1,849	$336	$2,185
31	CONSTRUCTION MANAGEMENT	$1,390	$361	25.96%	$1,751	3.4%	$1,438	$373	$1,811	$0	$1,811	4.6%	$1,503	$390	$1,893
	PROJECT COST TOTALS:	$22,422	$6,747	30.09%	$29,169		$22,890	$6,884	$29,774	$0	$29,774	2.0%	$23,336	$7,040	$30,376

_______________ CHIEF, COST ENGINEERING, Eileen Horiuchi

_______________ PROJECT MANAGER, Gail Saldana

_______________ CHIEF, REAL ESTATE, Amanda Dethman

_______________ CHIEF, PLANNING, Laura Hicks

_______________ CHIEF, ENGINEERING, Lance Helwig

_______________ CHIEF, OPERATIONS, Dwane Watsek

_______________ CHIEF, CONSTRUCTION, Karen Garmire

_______________ CHIEF, CONTRACTING, Ralph Banse-Fay

_______________ CHIEF, PM-PB, Don Erickson

_______________ CHIEF, DPM, Kevin Brice

ESTIMATED FEDERAL COST:	65%	$18,822
ESTIMATED NON-FEDERAL COST:	35%	$10,135
ESTIMATED TOTAL PROJECT COST:		**$28,957**

RECREATIONAL FACILITIES

ESTIMATED FEDERAL COST:	50%	$710
ESTIMATED NON-FEDERAL COST:	50%	$710
ESTIMATED TOTAL PROJECT COST:		**$1,419**

TOTAL PROJECT COST WITH RECREATIONAL FACILITIES **$30,376**

Filename: MCASES ~~TCPS 28_Apr_2015_approved by MCX.xlsx~~
TPCS

**** TOTAL PROJECT COST SUMMARY ****

BES TREATMENT PLANT

**** CONTRACT COST SUMMARY ****

PROJECT: Lower Willamette Ecosystem Restoration Project
LOCATION: Willamette River, OR
This Estimate reflects the scope and schedule in report; Lower Willamette Ecosys. Rest. Proj. Draft Tech. Memo.

DISTRICT: Portland District
POC: CHIEF, COST ENGINEERING, Eileen Horiuchi

PREPARED: lated w/Real Estate cc

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepered: 2/5/2015 Effective Price Level: 1-Oct-14				Program Year (Budget EC): 2016 Effective Price Level Date: 1 OCT 15								
WBS NUMBER		Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	RISK BASED CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A		B	C	D	E	F	G	H	I	J	P	L	M	N	O
		BES TREATMENT PLANT													
02		RELOCATIONS	$0	$0	10.00%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
06		FISH & WILDLIFE FACILITIES	$581	$183	31.48%	$763	1.9%	$591	$186	$778	2016Q3	1.0%	$597	$188	$785
08		ROADS, RAILROADS & BRIDGES		$0	0.00%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
14		RECREATION FACILITIES		$0	0.00%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
		CONSTRUCTION ESTIMATE TOTALS:	$581	$183	31.48%	**$763**		$591	$186	$778			$597	$188	$785
01		LANDS AND DAMAGES	$2,300	$460	20.00%	$2,760	1.9%	$2,343	$469	$2,812	2016Q1	0.0%	$2,343	$469	$2,812
30		PLANNING, ENGINEERING & DESIGN													
	1.5%	Project Management	$9	$2	18.15%	$11	3.4%	$9	$2	$11	2016Q1	0.0%	$9	$2	$11
	1.5%	Planning & Environmental Compliance	$9	$2	18.15%	$11	3.4%	$9	$2	$11	2016Q1	0.0%	$9	$2	$11
	4.0%	Engineering & Design	$23	$4	18.15%	$27	3.4%	$24	$4	$28	2016Q1	0.0%	$24	$4	$28
	0.5%	Reviews, ATRs, IEPRs, VE	$3	$1	18.15%	$4	3.4%	$3	$1	$4	2016Q1	0.0%	$3	$1	$4
	0.5%	Life Cycle Updates (cost, schedule, risks)	$3	$1	18.15%	$4	3.4%	$3	$1	$4	2016Q1	0.0%	$3	$1	$4
	1.0%	Contracting & Reprographics	$6	$1	18.15%	$7	3.4%	$6	$1	$7	2016Q1	0.0%	$6	$1	$7
	1.5%	Engineering During Construction	$9	$2	18.15%	$11	3.4%	$9	$2	$11	2016Q3	1.9%	$9	$2	$11
	1.0%	Planning During Construction	$6	$1	18.15%	$7	3.4%	$6	$1	$7	2016Q3	1.9%	$6	$1	$7
	1.0%	Project Operations	$6	$1	18.15%	$7	3.4%	$6	$1	$7	2016Q1	0.0%	$6	$1	$7
31		CONSTRUCTION MANAGEMENT													
	6.0%	Construction Management	$35	$9	25.96%	$44	3.4%	$36	$9	$46	2016Q3	1.9%	$37	$10	$46
	2.0%	Project Operation:	$12	$3	25.96%	$15	3.4%	$12	$3	$16	2016Q3	1.9%	$13	$3	$16
	2.0%	Project Management	$12	$3	25.96%	$15	3.4%	$12	$3	$16	2016Q3	1.9%	$13	$3	$16
		CONTRACT COST TOTALS:	$3,014	$671		$3,685		$3,072	$684	$3,756			$3,079	$687	$3,766

Filename: MCASES TCPS 28_Apr_2015_approved by MCX.xlsx
TPCS

****** TOTAL PROJECT COST SUMMARY ******

KENTON COVE

****** CONTRACT COST SUMMARY ******

PROJECT: **Lower Willamette Ecosystem Restoration Project**
LOCATION: Willamette River, OR
This Estimate reflects the scope and schedule in report; Lower Willamette Ecosys. Rest. Proj. Draft Tech. Memo.

DISTRICT: Portland District
POC: CHIEF, COST ENGINEERING, Eileen Horiuchi

PREPARED: lated w/Real Estate c(

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared: / Effective Price Level:			3/15/2014 / 1-Oct-14	Program Year (Budget EC): / Effective Price Level Date:			2016 / 1 OCT 15					
WBS NUMBER A		Civil Works Feature & Sub-Feature Description B	COST ($K) C	CNTG ($K) D	CNTG (%) E	TOTAL ($K) F	ESC (%) G	COST ($K) H	CNTG ($K) I	TOTAL ($K) J	Mid-Point Date P	INFLATED (%) L	COST ($K) M	CNTG ($K) N	FULL ($K) O
		KENTON COVE													
02		RELOCATIONS		$0	0.00%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
06		FISH & WILDLIFE FACILITIES	$366	$87	23.65%	$453	1.9%	$373	$88	$461	2016Q3	1.0%	$377	$89	$466
08		ROADS, RAILROADS & BRIDGES		$0	0.00%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
14		RECREATION FACILITIES		$0	0.00%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
								$0							
		CONSTRUCTION ESTIMATE TOTALS:	$366	$87	23.65%	**$453**		$373	$88	$461			$377	$89	$466
01		LANDS AND DAMAGES	$131	$26	20.00%	$157	1.9%	$133	$27	$160	2016Q1	0.0%	$133	$27	$160
30		PLANNING, ENGINEERING & DESIGN													
	1.5%	Project Management	$5	$1	18.15%	$6	3.4%	$5	$1	$6	2016Q1	0.0%	$5	$1	$6
	1.5%	Planning & Environmental Compliance	$5	$1	18.15%	$6	3.4%	$5	$1	$6	2016Q1	0.0%	$5	$1	$6
	4.0%	Engineering & Design	$15	$3	18.15%	$18	3.4%	$16	$3	$18	2016Q1	0.0%	$16	$3	$18
	0.5%	Reviews, ATRs, IEPRs, VE	$2	$0	18.15%	$2	3.4%	$2	$0	$2	2016Q1	0.0%	$2	$0	$2
	0.5%	Life Cycle Updates (cost, schedule, risks)	$2	$0	18.15%	$2	3.4%	$2	$0	$2	2016Q1	0.0%	$2	$0	$2
	1.0%	Contracting & Reprographics	$4	$1	18.15%	$5	3.4%	$4	$1	$5	2016Q1	0.0%	$4	$1	$5
	1.5%	Engineering During Construction	$5	$1	18.15%	$6	3.4%	$5	$1	$6	2016Q3	1.9%	$5	$1	$6
	1.0%	Planning During Construction	$4	$1	18.15%	$5	3.4%	$4	$1	$5	2016Q3	1.9%	$4	$1	$5
	1.0%	Project Operations	$4	$1	18.15%	$5	3.4%	$4	$1	$5	2016Q1	0.0%	$4	$1	$5
31		CONSTRUCTION MANAGEMENT													
	6.0%	Construction Management	$22	$6	25.96%	$28	3.4%	$23	$6	$29	2016Q3	1.9%	$23	$6	$29
	2.0%	Project Operation:	$7	$2	25.96%	$9	3.4%	$7	$2	$9	2016Q3	1.9%	$7	$2	$9
	2.0%	Project Management	$7	$2	25.96%	$9	3.4%	$7	$2	$9	2016Q3	1.9%	$7	$2	$9
		CONTRACT COST TOTALS:	$579	$131		$710		$591	$133	$725			$596	$134	$730

****** TOTAL PROJECT COST SUMMARY ******

KELLEY POINT PARK

****** CONTRACT COST SUMMARY ******

PROJECT: Lower Willamette Ecosystem Restoration Project
LOCATION: Willamette River, OR
This Estimate reflects the scope and schedule in report; Lower Willamette Ecosys. Rest. Proj. Draft Tech. Memo.

DISTRICT: Portland District
POC: CHIEF, COST ENGINEERING, Eileen Horiuchi
PREPARED: lated w/Real Estate cc

Civil Works Work Breakdown Structure			ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
			Estimate Prepared: Effective Price Level:		3/15/2014 1-Oct-14		Program Year (Budget EC): Effective Price Level Date:		2016 1 OCT 15						
WBS NUMBER A		Civil Works Feature & Sub-Feature Description B	COST ($K) C	CNTG ($K) D	CNTG (%) E	TOTAL ($K) F	ESC (%) G	COST ($K) H	CNTG ($K) I	TOTAL ($K) J	Mid-Point Date P	INFLATED (%) L	COST ($K) M	CNTG ($K) N	FULL ($K) O
		KELLEY POINT PARK													
02		RELOCATIONS		$0	0.00%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
06		FISH & WILDLIFE FACILITIES	$5,428	$1,632	30.06%	$7,060	1.9%	$5,530	$1,662	$7,192	2016Q4	1.4%	$5,609	$1,686	$7,295
08		ROADS, RAILROADS & BRIDGES		$0	0.00%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
14		RECREATION FACILITIES	$1,103	$271	24.53%	$1,373	1.9%	$1,123	$276	$1,399	2016Q4	1.4%	$1,140	$280	$1,419
								$0							
		CONSTRUCTION ESTIMATE TOTALS:	$6,531	$1,902	29.13%	**$8,434**		$6,653	$1,938	$8,591			$6,749	$1,966	$8,714
01		LANDS AND DAMAGES	$2,118	$424	20.00%	$2,542	1.9%	$2,158	$432	$2,589	2016Q1	0.0%	$2,158	$432	$2,589
30		PLANNING, ENGINEERING & DESIGN													
	1.5%	Project Management	$98	$18	18.15%	$116	3.4%	$101	$18	$120	2016Q1	0.0%	$101	$18	$120
	1.5%	Planning & Environmental Compliance	$98	$18	18.15%	$116	3.4%	$101	$18	$120	2016Q1	0.0%	$101	$18	$120
	4.0%	Engineering & Design	$261	$47	18.15%	$308	3.4%	$270	$49	$319	2016Q1	0.0%	$270	$49	$319
	0.5%	Reviews, ATRs, IEPRs, VE	$33	$6	18.15%	$39	3.4%	$34	$6	$40	2016Q1	0.0%	$34	$6	$40
	0.5%	Life Cycle Updates (cost, schedule, risks)	$33	$6	18.15%	$39	3.4%	$34	$6	$40	2016Q1	0.0%	$34	$6	$40
	1.0%	Contracting & Reprographics	$65	$12	18.15%	$77	3.4%	$67	$12	$79	2016Q1	0.0%	$67	$12	$79
	1.5%	Engineering During Construction	$98	$18	18.15%	$116	3.4%	$101	$18	$120	2016Q4	2.9%	$104	$19	$123
	1.0%	Planning During Construction	$65	$12	18.15%	$77	3.4%	$67	$12	$79	2016Q4	2.9%	$69	$13	$82
	1.0%	Project Operations	$65	$12	18.15%	$77	3.4%	$67	$12	$79	2016Q1	0.0%	$67	$12	$79
31		CONSTRUCTION MANAGEMENT													
	6.0%	Construction Management	$392	$102	25.96%	$494	3.4%	$405	$105	$511	2016Q4	2.9%	$417	$108	$526
	2.0%	Project Operation:	$131	$34	25.96%	$165	3.4%	$135	$35	$171	2016Q4	2.9%	$139	$36	$176
	2.0%	Project Management	$131	$34	25.96%	$165	3.4%	$135	$35	$171	2016Q4	2.9%	$139	$36	$176
		CONTRACT COST TOTALS:	$10,119	$2,644		**$12,763**		$10,331	$2,698	$13,030			$10,451	$2,732	**$13,183**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

OAKS CROSSING/SELLWOOD RIVERFRONT PARK

PROJECT: Lower Willamette Ecosystem Restoration Project
LOCATION: Willamette River, OR
This Estimate reflects the scope and schedule in report; Lower Willamette Ecosys. Rest. Proj. Draft Tech. Memo.

DISTRICT: Portland District
POC: CHIEF, COST ENGINEERING, Eileen Horiuchi
PREPARED: lated w/Real Estate cc

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared:			3/15/2014	Program Year (Budget EC):			2016	FULLY FUNDED PROJECT ESTIMATE				
		Effective Price Level:			1-Oct-14	Effective Price Level Date:			1 OCT 15					
WBS NUMBER A	Civil Works Feature & Sub-Feature Description B	COST ($K) C	CNTG ($K) D	CNTG (%) E	TOTAL ($K) F	ESC (%) G	COST ($K) H	CNTG ($K) I	TOTAL ($K) J	Mid-Point Date P	INFLATED (%) L	COST ($K) M	CNTG ($K) N	FULL ($K) O
	OAKS CROSSING/SELLWOOD RIVERFRONT PARK													
02	RELOCATIONS		$0	0.00%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	$455	$108	23.65%	$563	1.9%	$464	$110	$574	2016Q4	1.4%	$471	$111	$582
08	ROADS, RAILROADS & BRIDGES		$0	0.00%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
14	RECREATION FACILITIES		$0	0.00%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
							$0							
	CONSTRUCTION ESTIMATE TOTALS:	$455	$108	23.65%	$563		$464	$110	$574			$471	$111	$582
01	LANDS AND DAMAGES	$458	$92	20.00%	$550	1.9%	$467	$93	$560	2016Q1	0.0%	$467	$93	$560
30	PLANNING, ENGINEERING & DESIGN													
	1.5% Project Management	$7	$1	18.15%	$8	3.4%	$7	$1	$9	2016Q1	0.0%	$7	$1	$9
	1.5% Planning & Environmental Compliance	$7	$1	18.15%	$8	3.4%	$7	$1	$9	2016Q1	0.0%	$7	$1	$9
	4.0% Engineering & Design	$18	$3	18.15%	$21	3.4%	$19	$3	$22	2016Q1	0.0%	$19	$3	$22
	0.5% Reviews, ATRs, IEPRs, VE	$2	$0	18.15%	$2	3.4%	$2	$0	$2	2016Q1	0.0%	$2	$0	$2
	0.5% Life Cycle Updates (cost, schedule, risks)	$2	$0	18.15%	$2	3.4%	$2	$0	$2	2016Q1	0.0%	$2	$0	$2
	1.0% Contracting & Reprographics	$5	$1	18.15%	$6	3.4%	$5	$1	$6	2016Q1	0.0%	$5	$1	$6
	1.5% Engineering During Construction	$7	$1	18.15%	$8	3.4%	$7	$1	$9	2016Q4	2.9%	$7	$1	$9
	1.0% Planning During Construction	$5	$1	18.15%	$6	3.4%	$5	$1	$6	2016Q4	2.9%	$5	$1	$6
	1.0% Project Operations	$5	$1	18.15%	$6	3.4%	$5	$1	$6	2016Q1	0.0%	$5	$1	$6
31	CONSTRUCTION MANAGEMENT													
	6.0% Construction Management	$27	$7	25.96%	$34	3.4%	$28	$7	$35	2016Q4	2.9%	$29	$7	$36
	2.0% Project Operation:	$9	$2	25.96%	$11	3.4%	$9	$2	$12	2016Q4	2.9%	$10	$2	$12
	2.0% Project Management	$9	$2	25.96%	$11	3.4%	$9	$2	$12	2016Q4	2.9%	$10	$2	$12
	CONTRACT COST TOTALS:	$1,016	$222		$1,238		$1,037	$226	$1,263			$1,045	$228	$1,273

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**** TOTAL PROJECT COST SUMMARY ****

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TRYON HIGHWAY 43 CULVERT

**** CONTRACT COST SUMMARY ****

PROJECT: Lower Willamette Ecosystem Restoration Project
LOCATION: Willamette River, OR
This Estimate reflects the scope and schedule in report; Lower Willamette Ecosys. Rest. Proj. Draft Tech. Memo.

DISTRICT: Portland District
POC: CHIEF, COST ENGINEERING, Eileen Horiuchi

PREPARED: lated w/Real Estate cc

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: 3/15/2014 Effective Price Level: 1-Oct-14				Program Year (Budget EC): 2016 Effective Price Level Date: 1 OCT 15				FULLY FUNDED PROJECT ESTIMATE				
WBS NUMBER *A*	Civil Works Feature & Sub-Feature Description *B*	COST ($K) *C*	CNTG ($K) *D*	CNTG (%) *E*	TOTAL ($K) *F*	ESC (%) *G*	COST ($K) *H*	CNTG ($K) *I*	TOTAL ($K) *J*	Mid-Point Date *P*	INFLATED (%) *L*	COST ($K) *M*	CNTG ($K) *N*	FULL ($K) *O*
	TRYON HIGHWAY 43 CULVERT													
02	RELOCATIONS	$337	$152	45.02%	$489	1.9%	$343	$155	$498	2017Q4	3.5%	$355	$160	$515
06	FISH & WILDLIFE FACILITIES	$4,235	$1,848	43.63%	$6,083	1.9%	$4,315	$1,882	$6,197	2017Q4	3.5%	$4,466	$1,918	$6,414
08	ROADS, RAILROADS & BRIDGES	$1,400	$715	51.05%	$2,115	1.9%	$1,426	$728	$2,154	2017Q4	3.5%	$1,476	$754	$2,230
14	RECREATION FACILITIES		$0	0.00%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
							$0							
	CONSTRUCTION ESTIMATE TOTALS:	$5,972	$2,714	45.45%	**$8,687**		$6,084	$2,765	$8,849			$6,297	$2,862	$9,159
01	LANDS AND DAMAGES	$376	$75	20.00%	$451	1.9%	$383	$77	$460	2017Q2	2.5%	$393	$79	$471
30	PLANNING, ENGINEERING & DESIGN													
1.5%	Project Management	$90	$16	18.15%	$106	3.4%	$93	$17	$110	2017Q2	4.9%	$98	$18	$115
1.5%	Planning & Environmental Compliance	$90	$16	18.15%	$106	3.4%	$93	$17	$110	2017Q2	4.9%	$98	$18	$115
4.0%	Engineering & Design	$239	$43	18.15%	$282	3.4%	$247	$45	$292	2017Q2	4.9%	$259	$47	$306
0.5%	Reviews, ATRs, IEPRs, VE	$30	$5	18.15%	$35	3.4%	$31	$6	$37	2017Q2	4.9%	$33	$6	$38
0.5%	Life Cycle Updates (cost, schedule, risks)	$30	$5	18.15%	$35	3.4%	$31	$6	$37	2017Q2	4.9%	$33	$6	$38
1.0%	Contracting & Reprographics	$60	$11	18.15%	$71	3.4%	$62	$11	$73	2017Q2	4.9%	$65	$12	$77
1.5%	Engineering During Construction	$90	$16	18.15%	$106	3.4%	$93	$17	$110	2017Q4	6.9%	$100	$18	$118
1.0%	Planning During Construction	$60	$11	18.15%	$71	3.4%	$62	$11	$73	2017Q4	6.9%	$66	$12	$78
1.0%	Project Operations	$60	$11	18.15%	$71	3.4%	$62	$11	$73	2017Q2	4.9%	$65	$12	$77
31	CONSTRUCTION MANAGEMENT													
6.0%	Construction Management	$358	$93	25.96%	$451	3.4%	$370	$96	$466	2017Q4	6.9%	$396	$103	$499
2.0%	Project Operation:	$119	$31	25.96%	$150	3.4%	$123	$32	$155	2017Q4	6.9%	$132	$34	$166
2.0%	Project Management	$119	$31	25.96%	$150	3.4%	$123	$32	$155	2017Q4	6.9%	$132	$34	$166
	CONTRACT COST TOTALS:	$7,693	$3,080		**$10,774**		$7,858	$3,142	$11,000			$8,164	$3,259	**$11,424**

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APPENDICES

**** TOTAL PROJECT COST SUMMARY ****

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PROJECT: Lower Willamette Ecosystem Restoration Project
PROJECT NO: T26638
LOCATION: Willamette River, OR

DISTRICT: Portland District
PREPARED: 3/9/2015-Updated w/Real Estate cost-4/17/2015
POC: CHIEF, COST ENGINEERING, Eileen Horiuchi

This Estimate reflects the scope and schedule in report; Lower Willamette Ecosys. Rest. Proj. Draft Tech. Memo.

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)						TOTAL PROJECT COST (FULLY FUNDED)			
						Program Year (Budget EC): 2016 / Effective Price Level Date: 1 OCT 15									
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 10/1/2014 ($K)	TOTAL FIRST COST ($K)	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B	C	D	E	F	G	H	I	J		K	L	M	N	O
02	RELOCATIONS	$337	$152	45.02%	$489	1.9%	$343	$155	$498	$0	$498	3.5%	$355	$160	$515
06	FISH & WILDLIFE FACILITIES	$11,066	$3,857	34.85%	$14,923	1.9%	$11,273	$3,929	$15,202	$0	$15,202	2.2%	$11,519	$4,023	$15,542
08	ROADS, RAILROADS & BRIDGES	$1,400	$715	51.05%	$2,115	1.9%	$1,426	$728	$2,154	$0	$2,154	3.5%	$1,476	$754	$2,230
14	RECREATION FACILITIES	$1,103	$271	24.53%	$1,373	1.9%	$1,123	$276	$1,399	$0	$1,399	1.4%	$1,140	$280	$1,419
	CONSTRUCTION ESTIMATE TOTALS:	$13,906	$4,994	35.91%	$18,900	1.9%	$14,166	$5,087	$19,253	$0	$19,253	2.4%	$14,490	$5,216	$19,706
01	LANDS AND DAMAGES	$5,383	$1,077	20.00%	$6,460	1.9%	$5,484	$1,097	$6,580	$0	$6,580	0.2%	$5,493	$1,099	$6,592
30	PLANNING, ENGINEERING & DESIGN	$1,743	$316	18.15%	$2,059	3.4%	$1,803	$327	$2,130	$0	$2,130	2.6%	$1,849	$336	$2,185
31	CONSTRUCTION MANAGEMENT	$1,390	$361	25.96%	$1,751	3.4%	$1,438	$373	$1,811	$0	$1,811	4.6%	$1,503	$390	$1,893
	PROJECT COST TOTALS:	$22,422	$6,747	30.09%	$29,169		$22,890	$6,884	$29,774	$0	$29,774	2.0%	$23,336	$7,040	$30,376

________________ CHIEF, COST ENGINEERING, Eileen Horiuchi

________________ PROJECT MANAGER, Gail Saldana

________________ CHIEF, REAL ESTATE, Amanda Detr

________________ CHIEF, PLANNING, Laura Hicks

________________ CHIEF, ENGINEERING, Lance Helwig

________________ CHIEF, OPERATIONS, Dwane Watsek

________________ CHIEF, CONSTRUCTION, Karen Garmire

________________ CHIEF, CONTRACTING, Ralph Banse-Fay

________________ CHIEF, PM-PB, Don Erickson

________________ CHIEF, DPM, Kevin Brice

ESTIMATED FEDERAL COST:	65%	$18,822
ESTIMATED NON-FEDERAL COST:	35%	$10,135
ESTIMATED TOTAL PROJECT COST:		**$28,957**

RECREATIONAL FACILITIES

ESTIMATED FEDERAL COST:	50%	$710
ESTIMATED NON-FEDERAL COST:	50%	$710
ESTIMATED TOTAL PROJECT COST:		**$1,419**

TOTAL PROJECT COST WITH RECREATIONAL FACILITIES **$30,376**

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LOWER WILLAMETTE RIVER
ECOSYSTEM RESTORATION PROJECT

COST ESTIMATE NARRATIVE

1. Project Description

A. General: This work is in support of the design of the five ecosystem restoration sites located along the Lower Willamette River, Columbia Slough, and Tryon Creek in Multnomah County, Oregon. The design of the five ecosystem restoration sites has been developed to a 35% design level.

B. Purpose: The purpose of this work is to develop a detailed cost estimate – consistent to the level of design – for the cost and quantities of the structural features using Micro-Computer Aided Cost Estimating System (MCACES).

C. Design Features: Features for each of the projects includes:

- Kelley Point Park
    - Restoration measures at these sites include developing side channels or backwater areas, reducing bank steepness, and revegetating with native species and three pedestrian bridges.
- City of Portland Bureau of Environmental Services (BES) Treatment Plant
    - Restoration measures at these sites involve reshaping and restoring banks and/or side slough areas, adding large woody debris (LWD), and revegetating with native species
- Kenton Cove
    - Restoration measures at these sites involve reshaping and restoring banks and/or side slough areas, adding LWD, and revegetating with native species
- Oaks Crossing/Sellwood Riverfront Park
    - Restoration measures at these sites include developing side channels or backwater areas, reducing bank steepness, and revegetating with native species
- Tryon Creek Highway 43 Culvert Replacement
    - Removal of the existing 8 foot by 8 foot box culvert and replacement with an open bottom arch culvert with a span of 30 feet, and creation of a natural stream channel that provides fish passage

2. Basis of Estimate

A. Basis of Design: The project's design documents are listed below. The project site plan is presented in Appendix A. Quantities were developed based off schematics of the proposed construction components.

- Lower Willamette River Ecosystem Restoration Project, Appendix I – Draft 35% Design Report, March 2015

- Lower Willamette River Ecosystem Restoration Project, 35% Design Drawings, June 2011

B. Basis of Quantities: The cost estimate is based on project quantity take-offs that have been calculated from the documents listed above. A quantity summary along with detailed quantity take-offs are presented in Appendix B. The quantities include waste/loss factors for the project materials as listed below:

Geotextile Waste	5%
Stone Waste	15%.
Concrete Waste	10%
Spoils Swell	15%

3. Project Schedule

The project schedule provides the estimated construction durations for each project site. The schedule can be found in Appendix C. The estimated durations have been used in the estimate to determine costs for the contractors to maintain field facilities and construction supervision. The overall schedule is based on the following reasoning and assumptions:

- Typical construction, crew (1 shift) working 8-hr/day and 5-days per week.
- Schedule is based on the assumption that all necessary materials have been ordered and are delivered to the project site as required to be placed during timeframes shown.

4. Acquisition Plan

The cost estimate is based on individual contracts being awarded to a prime contractor for each site. Each prime contractor is assumed to work with subcontractors for pile driving, concrete items, landscaping, railroad, pre-casting, and asphalt work. The prime contractor would be responsible for the preparatory work, and placing all associated site work as well as overseeing the subcontractors' work on all necessary construction activities. The bidding market is expected to be competitive, and is assumed to be awarded by Lowest Price Technically Acceptable Best Value process.

5. Project Coustruction

A. Mobilization/Demobilization: Mobilization costs are based on transporting the land-based equipment and personnel to the project site, as well as preparing site as necessary for construction. All labor and equipment is assumed to be available in the greater Portland area.

B. Staging and Site Access: The staging and access areas for each site are designated in the design plans. The cost estimate includes quantities and costs for developing these areas. The estimate assumes that both the staging area and the access areas would be graded and would have gravel material placed over the entire area. This layer would also require removal at completion of construction.

C. Borrow/Disposal Areas and Materials: Material sources for rock, gravel, wood, and fill material are assumed to originate within a 10-mile radius of the project sites. Disposal sites for clean soils and demolished concrete, asphalt, and other structural materials are also assumed to be within a 10-mile radius of the project site.

The disposal site for contaminated soils is assumed to be the Waste Management Hillsboro Landfill in Hillsboro, Oregon. The procedure for culvert construction assumes culvert fabrication and delivery; installation; construction of footings, headwalls and wingwalls; placement of bed materials; and restoration of the adjacent streambed and banks. Vegetative restoration assumes invasive plant removal by spraying and mowing, and planting materials from locally sourced nurseries.

D. Construction Methodology:

The construction items for this project would be accomplished with land and barge based equipment. There are two separate sequences considered in this section, the fish passage and an additional sequence for the culvert replacement at Highway 43 on Tryon Creek.

1) All Project Sites

The following construction methodology details the steps for construction completion at each of the sites:

- Contractor Mobilize to Site
- Contractor Install Erosion Control Best Management Practices (BMPs) and Create Staging Work Area
- Improve Access, Only as Necessary
- Begin Clearing and Grubbing
- Remove Invasive Species (can go on while other actions are occurring)
- Isolate In-Water Work Areas and Remove Fish
- Conduct Onsite Grading
- Remove Debris/Concrete/Riprap
- Excavate Connector Channels Outside of In-Water Work Areas, including Side Channel and Backwater Areas
- Isolate In-Water Wood and Boulder Work Areas and Remove Fish
- Construct Wood and Boulder Structures
- Remove In-Water Isolation Measures When Work is Complete (Grading or Wood/Boulders)
- Isolate In-Water Work Area for River Channel Connections and Remove Fish
- Excavate Final In-Water Channel Connections, including Side Channel, Backwater Areas, and Confluence/Mouth Areas
- Remove Final Water Isolation Measures
- Grade Site for Plantings

- Remove Staging Area and Access Routes as Appropriate
- Install Plants

2) Culvert replacement at Highway 43 on Tryon Creek

The following *additional* construction methodology details the steps for construction completion at Highway 43 on Tryon Creek site:

- Temporary highway and railroad traffic control and re-route as needed for the duration of project,
- Temporary water management for bypass of flow around work area,
- Placement arch span culvert, streambed material, and streambed grade control features,
- Abandon existing 8 foot by 8 foot box culvert in place or dispose offsite,
- Potential relocation of sewer trunk line and other utilities,
- Placement of fill, and
- Resurfacing of highway and reconstruction of railroad.

E. Unusual Conditions: (Soil, Water, Weather, Traffic). Possible high water levels, flooding, strong currents, barge mounted equipment use, constricted work areas due to existing roadways/railroads.

F. Unique Construction Techniques: In-river work with specialty equipment to for excavating banks.

G. Equipment/Labor Availability and Distance Traveled: All equipment and labor is assumed to be available in the Portland area.

6. Effective Dates for Labor, Equipment and Material Pricing

The labor, equipment, and material pricing were developed using the MCACES 2012 English Unit Cost Library, 2015 Multnomah County Labor Library, and the 2011 Equipment Library (Region VIII) for the base cost estimates. The index pricing data has been prepared in February 2015 dollars.

The cost estimate has been updated with current quoted fuel prices of $2.54/gal for off-road diesel, $3.09/gal for on-road diesel and $2.49/gal for gasoline in the Portland area.

7. Estimated Production Rates

The construction of this project would require many types of specialty crews and equipment due to the unique construction techniques required for in-river work. See Appendix E for the Estimated Production Rates for these specialty crews.

8. Direct and Contractor Markups

A. Direct Markups: The cost estimate does not contain any direct mark-ups as there is no sales tax in the state of Oregon, and no overtime is currently assumed to be required for construction.

B. Contractor Markups: The prime contractor Job Office Overhead (JOOH) markup is calculated within MCACES which accounts for project supervision; The estimated prime contractor Home Office Overhead (HOOH) markup of 8% is a running percentage for all prime contractors; The calculated prime contractor profit has been completed for each prime contractor, and is based on ER 1110-2-1302 Profit Weighted Guideline; The estimated prime contractor insurance markup of 2% is a direct percent to account for overwater work and associated higher equipment insurance premiums.

9. Project Markups

A. Escalation: Price levels have been escalated from effective price levels of the construction cost estimate for February (2015Q2) to the mid-point of construction for each project site. The total construction mid-point is estimated to be 2017Q3. The cost factors for each feature account have been calculated within the Total Project Cost Summary.

B. Contingency: Contingencies represent allowances to cover unknowns, uncertainties and/or unanticipated conditions that are not possible to adequately evaluate from the data on hand at the time the cost estimate is prepared but must be represented by a sufficient cost to cover the identified risks. Contingencies have been calculated for each project site, by utilizing the Abbreviated Risk Analysis spreadsheet which can be found in Appendix G.

10. Functioual Costs

A. 01 Account – Lands and Damages: The costs and contingencies for this account have been taken from the Lower Willamette River Ecosystem Restoration Feasibility Study Real Estate Plan, dated January 2015.

B. 02 Account – Relocations: The Relocations costs shown in the TPCS account for the costs to relocate an existing sewer line at the Tryon Highway 43 Culvert project site.

C. 06 Account – Fish and Wildlife Facilities: The majority of the construction, other than the items in the 02 and 08 Accounts, is included under this feature account.

D. 08 Account – Roads, Railroads, and Bridges - Relocations: The construction activities for thi account are the railroad temporary shoo-fly, and reconstruction required at the Tryon Highway 43 Culvert project site.

E. 14 Account – Recreation: The construction activities for this account are the construction of three pedestrian foot bridges located at Kelley Point Park.

F. 30 Account – Planning, Engineering, and Design: Costs for this account were estimated at 12.5% of the construction costs. This account covers the preparation of plans and specifications that have already been advanced beyond the feasibility level by the City.

G. 31 Account – Construction Management: Costs for this account were estimated to be 10.0% of the construction costs. This account covers construction management during construction.

11. Total Project Cost Summary (TPCS)

The TPCS was prepared using the latest TPCS excel spreadsheet provided by the USACE, Walla Walla District. The TPCS incorporates the construction costs developed in the MII, the project markups, and the functional costs. The cost sharing shown on this spreadsheet is based on the typical cost sharing percentages which are as follows:

- [01] Lands and Damages: 100% Non-Federal** (LERRD)
- [02] Relocations: 100% Non-Federal** (LERRD)
- [06] Fish and Wildlife Facilities: 65% Federal / 35% Non-Federal
- [08] Roads, Railroads & Bridges: 100% Non-Federal** (LERRD)
- [14] Recreation: 50% Federal / 50% Non-Federal
- [30] PED and [31] CM: 65% Federal / 35% Non-Federal

**Counts toward 35% of Non-Federal Costs

12. MCACES Construction Cost Estimate

The construction cost estimate was developed using MCACES 2nd Generation (MII) cost estimating software in accordance with guidance contained in ER 1110-2-1302, Civil Works Cost Engineering. While the MCACES construction cost estimate includes Contingencies as mentioned above, it is not a Total Project Cost estimate as it does not include any Escalation or Functional Costs such as Lands and Damage, Feasibility Studies, Planning Engineering and Design or Construction Management. See Appendix H for the MCACES construction cost estimate output report.

G. 31 Account – Construction Management: Costs for this account were estimated to be 10.0% of the construction costs. This account covers construction management during construction.

11. Total Project Cost Summary (TPCS)

The TPCS was prepared using the latest TPCS excel spreadsheet provided by the USACE, Walla Walla District. The TPCS incorporates the construction costs developed in the MII, the project markups, and the functional costs. The cost sharing shown on this spreadsheet is based on the typical cost sharing percentages which are as follows:

- [01] Lands and Damages: 100% Non-Federal**
- [02] Relocations: 100% Non-Federal**
- [06] Fish and Wildlife Facilities: 65% Federal / 35% Non-Federal
- [08] Roads, Railroads & Bridges: 100% Non-Federal**
- [14] Recreation: 50% Federal / 50% Non-Federal
- [30] PED and [31] CM: 65% Federal / 35% Non-Federal

**Counts toward 35% of Non-Federal Costs

12. MCACES Construction Cost Estimate

The construction cost estimate was developed using MCACES 2nd Generation (MII) cost estimating software in accordance with guidance contained in ER 1110-2-1302, Civil Works Cost Engineering. While the MCACES construction cost estimate includes Contingencies as mentioned above, it is not a Total Project Cost estimate as it does not include any Escalation or Functional Costs such as Lands and Damage, Feasibility Studies, Planning Engineering and Design or Construction Management. See Appendix H for the MCACES construction cost estimate output report.

11. References

U.S. Army Corps of Engineers, 1993, *Engineering and Design Cost Engineering Policy and General Requirements, Engineering Regulation 1110-1-1300,* Department of the Army, Washington D.C., 26 March 1993.

U.S. Army Corps of Engineers, 1999, *Engineering and Design For Civil Works Projects, Engineering Regulation 1110-2-1150,* Department of the Army, Washington D.C., 31 August 1999.

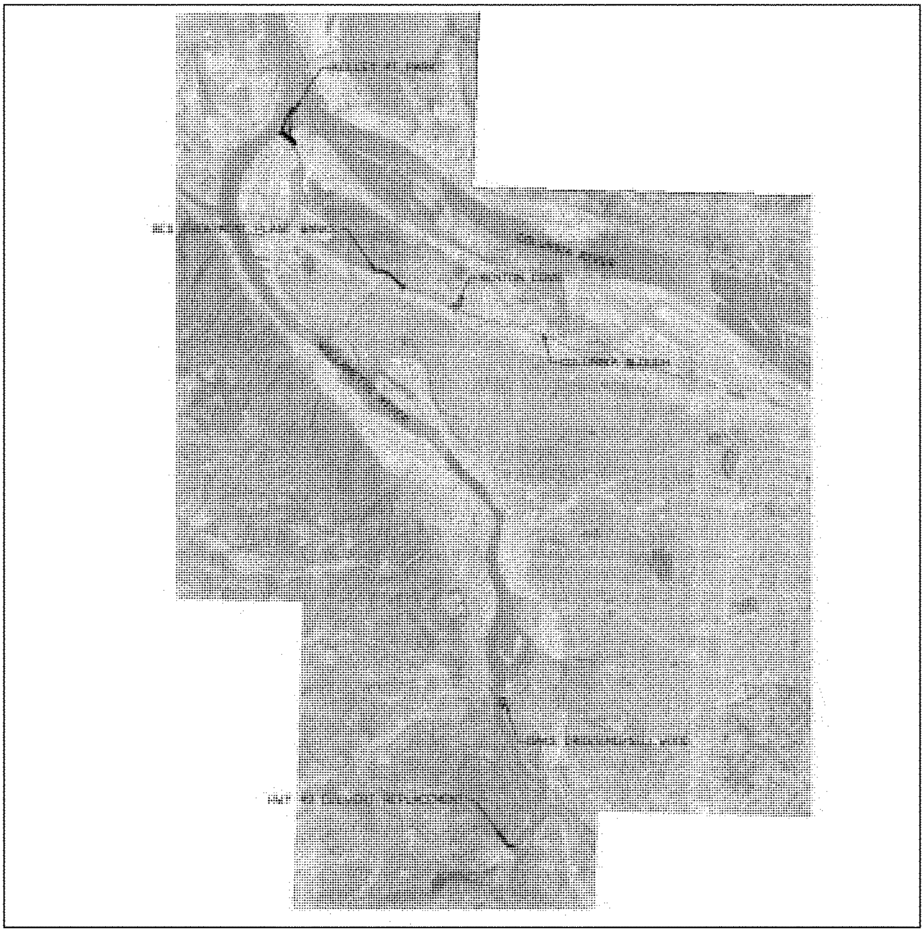
U.S. Army Corps of Engineers, 2008a, *Civil Works Cost Engineering, Engineering Regulation 1110-2-1302,* Department of the Army, Washington D.C., 15 September 2008.

U.S. Army Corps of Engineers, 2008b, *Construction Cost Estimating Guide For Civil Works, Engineering Technical Letter 1110-2-573,* Department of the Army, Washington D.C., 30 September 2008.

U.S. Army Corps of Engineers, 2009, *Civil Works Construction Cost Index System, Engineering Manual 1110-2-1304,* Department of the Army, Washington D.C., 31 March 2009.

APPENDIX A

Site Plan



APPENDIX B

Project Quantity Take-Offs

Quantities taken out of this report during reviews - Available upon request

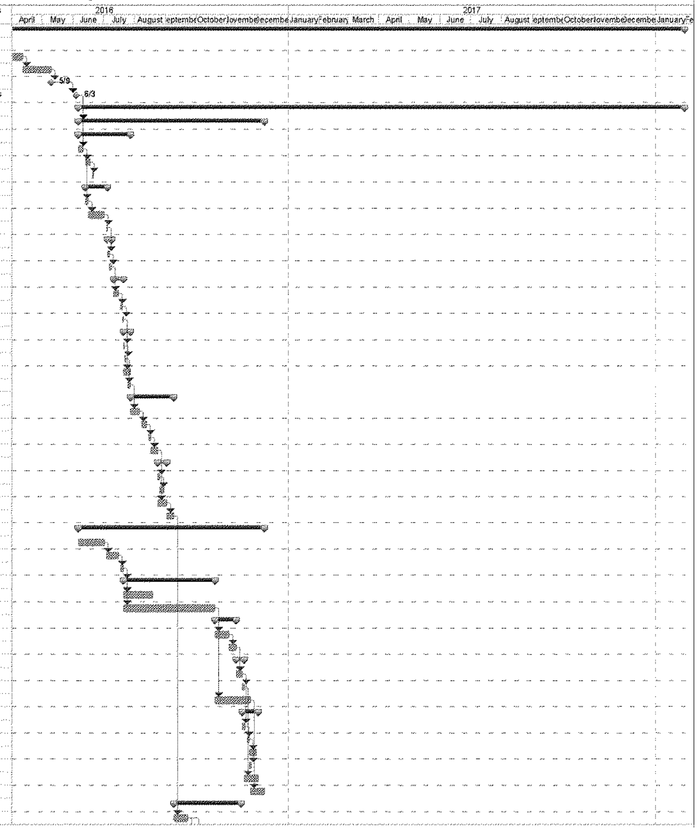
APPENDIX C

Construction Schedule

Lower Willamette River Ecosystem Restoration
Tentative Project Schedule

Fri 2/20/15

ID	Task Name	Duration	Start	Finish	Predecessors
1	**Lower Willamette Ecosystem Restoration Project**	**768 days**	**Thu 2/19/15**	**Mon 1/29/18**	
2	Feasibility Phase	145 days	Thu 2/19/15	Wed 9/9/15	
3	Final Design	153 days	Thu 9/10/15	Mon 4/11/16	2
4	Bidding Phase	20 days	Tue 4/12/16	Mon 5/9/16	3
5	Award	0 days	Mon 5/9/16	Mon 5/9/16	4
6	Notice to Proceed	0 days	Fri 6/3/16	Fri 6/3/16	5FS+19 days
7	**Construction**	**431 days**	**Mon 6/6/16**	**Mon 1/29/18**	
8	**Phase 1**	**133 days**	**Mon 6/6/16**	**Wed 12/7/16**	6
9	**BES TREATMENT PLANT**	**38 days**	**Mon 6/6/16**	**Wed 7/27/16**	
10	Mobilization	5 days	Mon 6/6/16	Fri 6/10/16	6
11	Site Preparation	5 days	Mon 6/13/16	Fri 6/17/16	10
12	Invasive Species Removal	1 day	Mon 6/20/16	Mon 6/20/16	11
13	**Regrade Banks**	**16 days**	**Mon 6/13/16**	**Mon 7/4/16**	
14	Barge Excavation	3 days	Mon 6/13/16	Wed 6/15/16	10
15	Channel Bank Excavation	12 days	Thu 6/16/16	Fri 7/1/16	14
16	Grading	1 day	Mon 7/4/16	Mon 7/4/16	15
17	**High Water Refugia**	**4 days**	**Tue 7/5/16**	**Fri 7/8/16**	
18	Channel Bank Excavation	2 days	Tue 7/5/16	Wed 7/6/16	16
19	Filling and Grading	2 days	Thu 7/7/16	Fri 7/8/16	18
20	**Low Flow Channel Excavation**	**8 days**	**Mon 7/11/16**	**Wed 7/20/16**	
21	Low Flow Excavation	5 days	Mon 7/11/16	Fri 7/15/16	19
22	Demo Existing Culvert	2 days	Mon 7/18/16	Tue 7/19/16	21
23	Filling and Grading	1 day	Wed 7/20/16	Wed 7/20/16	22
24	**Landscape**	**5 days**	**Thu 7/21/16**	**Wed 7/27/16**	
25	Riparian Shrubs	1 day	Thu 7/21/16	Thu 7/21/16	23
26	Cuttings	1 day	Fri 7/22/16	Fri 7/22/16	25
27	Large Woody Debris	5 days	Thu 7/21/16	Wed 7/27/16	23
28	Demobilization	3 days	Mon 7/25/16	Wed 7/27/16	26
29	**KENTON COVE**	**31 days**	**Thu 7/28/16**	**Thu 9/8/16**	
30	Mobilization	7 days	Thu 7/28/16	Fri 8/5/16	28
31	Site Preparation	5 days	Mon 8/8/16	Fri 8/12/16	30
32	Invasive Species Removal	2 days	Mon 8/15/16	Tue 8/16/16	31
33	Sand Placement	5 days	Wed 8/17/16	Tue 8/23/16	32
34	**Landscape**	**7 days**	**Wed 8/24/16**	**Thu 9/1/16**	
35	Riparian Shrubs	2 days	Wed 8/24/16	Thu 8/25/16	33
36	Cuttings	2 days	Fri 8/26/16	Mon 8/29/16	35
37	Large Woody Debris	7 days	Wed 8/24/16	Thu 9/1/16	33
38	Demobilization	5 days	Fri 9/2/16	Thu 9/8/16	37
39	**KELLEY POINT PARK**	**133 days**	**Mon 6/6/16**	**Wed 12/7/16**	
40	Mobilization	20 days	Mon 6/6/16	Fri 7/1/16	
41	Site Preparation	10 days	Mon 7/4/16	Fri 7/15/16	40
42	Invasive Species Removal	3 days	Mon 7/18/16	Wed 7/20/16	41
43	**Regrade Banks**	**65 days**	**Thu 7/21/16**	**Wed 10/19/16**	42
44	Barge Excavation	21 days	Thu 7/21/16	Thu 8/18/16	42
45	Channel Bank Excavation	65 days	Thu 7/21/16	Wed 10/19/16	42
46	**Main Channel**	**15 days**	**Thu 10/20/16**	**Wed 11/9/16**	
47	Low Flow Channel Excavation	10 days	Thu 10/20/16	Wed 11/2/16	45
48	Filling and Grading	5 days	Thu 11/3/16	Wed 11/9/16	47
49	**Low Flow Channel Excavation**	**6 days**	**Thu 11/10/16**	**Thu 11/17/16**	
50	Low Flow Excavation	4 days	Thu 11/10/16	Tue 11/15/16	48
51	Filling and Grading	2 days	Wed 11/16/16	Thu 11/17/16	50
52	Footbridges	25 days	Thu 10/20/16	Wed 11/23/16	45
53	**Landscape**	**12 days**	**Wed 11/16/16**	**Thu 12/1/16**	
54	Riparian Shrubs	3 days	Wed 11/16/16	Fri 11/18/16	50
55	Cuttings	2 days	Mon 11/21/16	Tue 11/22/16	54
56	Upland Shrubs	5 days	Wed 11/23/16	Tue 11/29/16	55
57	Upland Trees	2 days	Wed 11/23/16	Thu 11/24/16	55
58	Large Woody Debris	10 days	Fri 11/18/16	Thu 12/1/16	51
59	Demobilization	10 days	Thu 11/24/16	Wed 12/7/16	52
60	**OAKS CROSSING/SELLWOOD RIVERFRONT PARK**	**47 days**	**Fri 9/9/16**	**Mon 11/14/16**	
61	Mobilization	10 days	Fri 9/9/16	Thu 9/22/16	38

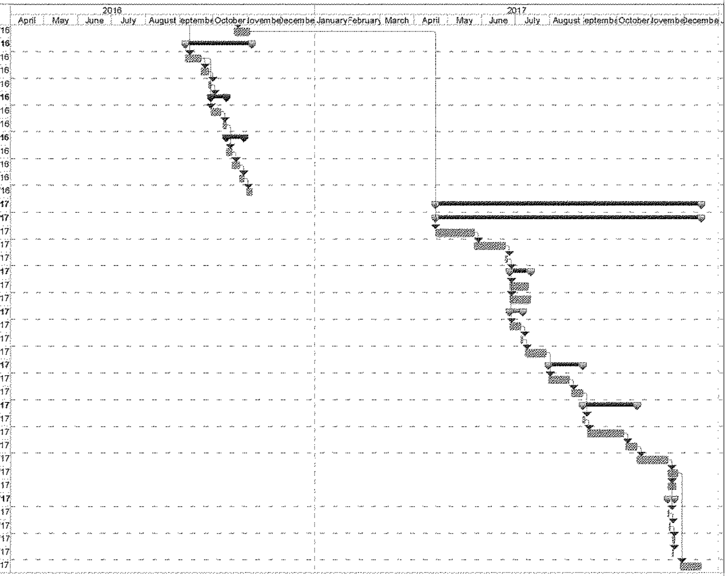


Task | Split | Milestone | Summary | Project Summary | External Tasks | External MileTask | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | Progress | Split

Lower Willamette River Ecosystem Restoration
Tentative Project Schedule

Mon 2/24/14

ID	Task Name	Duration	Start	Finish
59	Demobilization	10 days	Thu 10/20/16	Wed 11/2/16
60	**OAKS CROSSING/SELLWOOD RIVERFRONT PARK**	**44 days**	**Tue 9/6/16**	**Fri 11/4/16**
61	Mobilization	10 days	Tue 9/6/16	Mon 9/19/16
62	Site Preparation	5 days	Tue 9/20/16	Mon 9/26/16
63	Invasive Species Removal	2 days	Tue 9/27/16	Wed 9/28/16
64	**Backwatered Wetland**	**10 days**	**Thu 9/29/16**	**Wed 10/12/16**
65	Channel Bank Excavation	7 days	Thu 9/29/16	Fri 10/7/16
66	Fine Grading	3 days	Mon 10/10/16	Wed 10/12/16
67	**Landscape**	**12 days**	**Thu 10/13/16**	**Fri 10/28/16**
68	Riparian Shrubs	3 days	Thu 10/13/16	Mon 10/17/16
69	Cuttings	5 days	Tue 10/18/16	Mon 10/24/16
70	Large Woody Debris	4 days	Tue 10/25/16	Fri 10/28/16
71	Demobilization	5 days	Mon 10/31/16	Fri 11/4/16
72	**Phase 2**	**172 days**	**Thu 4/20/17**	**Fri 12/15/17**
73	**TRYON HIGHWAY 43 CULVERT**	**172 days**	**Thu 4/20/17**	**Fri 12/15/17**
74	Mobilization	25 days	Thu 4/20/17	Wed 5/24/17
75	Site Preparation	20 days	Thu 5/25/17	Wed 6/21/17
76	Invasive Species Removal	2 days	Thu 6/22/17	Fri 6/23/17
77	**Shoring (Culvert)**	**15 days**	**Mon 6/26/17**	**Fri 7/14/17**
78	H Pile Placement	13 days	Mon 6/26/17	Wed 7/12/17
79	Timber Lagging	15 days	Mon 6/26/17	Fri 7/14/17
80	**Roadway Demolition**	**10 days**	**Mon 6/26/17**	**Fri 7/7/17**
81	Asphalt Demolition	8 days	Mon 6/26/17	Wed 7/5/17
82	Base Course Excavation	2 days	Thu 7/6/17	Fri 7/7/17
83	Railroad Demolition	15 days	Mon 7/10/17	Fri 7/28/17
84	**Earthwork**	**23 days**	**Mon 7/31/17**	**Wed 8/30/17**
85	Excavation	15 days	Mon 7/31/17	Fri 8/18/17
86	Bedrock Removal	8 days	Mon 8/21/17	Wed 8/30/17
87	**Culvert**	**35 days**	**Thu 8/31/17**	**Wed 10/18/17**
88	Culvert Demolition	2 days	Thu 8/31/17	Fri 9/1/17
89	Install Culvert and Footings	25 days	Mon 9/4/17	Fri 10/6/17
90	Install Wingwalls	8 days	Mon 10/9/17	Wed 10/18/17
91	Backfill	20 days	Thu 10/19/17	Wed 11/15/17
92	Install New Railroad	7 days	Thu 11/16/17	Fri 11/24/17
93	Repave Roadway	5 days	Thu 11/16/17	Wed 11/22/17
94	**Landscape**	**4 days**	**Thu 11/16/17**	**Tue 11/21/17**
95	Riparian Shrubs	1 day	Thu 11/16/17	Thu 11/16/17
96	Cuttings	1 day	Fri 11/17/17	Fri 11/17/17
97	Upland Shrubs	2 days	Mon 11/20/17	Tue 11/21/17
98	Upland Trees	1 day	Mon 11/20/17	Mon 11/20/17
99	Demobilization	15 days	Mon 11/27/17	Fri 12/15/17



Task	Project Summary	Inactive Milestone	Manual Summary Rollup	Progress
Split	External Tasks	Inactive Summary	Manual Summary	Split
Milestone	External MileTask	Manual Task	Start-only	
Summary	Inactive Task	Duration-only	Finish-only	

APPENDIX D

Local Market Labor Rates

>

General Decision Number: OR150059 01/23/2015 OR59

Superseded General Decision Number: OR20140059

State: Oregon

Construction Type: Heavy

County: Multnomah County in Oregon.

HEAVY CONSTRUCTION PROJECTS

Note: Executive Order (EO) 13658 establishes an hourly minimum wage of $10.10 for 2015 that applies to all contracts subject to the Davis-Bacon Act for which the solicitation is issued on or after January 1, 2015. If this contract is covered by the EO, the contractor must pay all workers in any classification listed on this wage determination at least $10.10 (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on the contract. The EO minimum wage rate will be adjusted annually. Additional information on contractor requirements and worker protections under the EO is available at www.dol.gov/whd/govcontracts.

Modification Number	Publication Date
0	01/02/2015
1	01/16/2015
2	01/23/2015

BROR0001-013 06/01/2014

	Rates	Fringes
BRICKLAYER......................	$ 25.31	8.77

CARP0001-035 06/01/2012

	Rates	Fringes
CARPENTER (Including Form Work).........................	$ 32.61	14.44
MILLWRIGHT......................	$ 33.11	14.44
PILEDRIVERMAN...................	$ 33.61	14.44

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* ELEC0048-018 01/01/2015

	Rates	Fringes
ELECTRICIAN.....................	$ 40.20	21.50

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* ELEC0048-026 01/01/2015

	Rates	Fringes
ELECTRICIAN		
Low voltage wiring		

installer for all other work	$ 24.50	15.93
Low voltage wiring installer for fire alarm, nurse call, burglar alarm, security and voice evacuation systems and other systems that are part of a fire or life safety system	$ 30.75	17.07

ENGI0701-034 01/01/2015

	Rates	Fringes
POWER EQUIPMENT OPERATOR		
GROUP 1	$ 39.47	14.10
GROUP 1A	$ 41.44	14.10
GROUP 1B	$ 43.42	14.10
GROUP 2	$ 37.58	14.10
GROUP 3	$ 36.44	14.10
GROUP 4	$ 35.36	14.10
GROUP 5	$ 34.13	14.10
GROUP 6	$ 30.94	14.10

POWER EQUIPMENT OPERATORS CLASSIFICATIONS

GROUP 1: CRANE: Helicopter Operator, when used in erecting work; Whirley Operator, 90 ton and over; LATTICE BOOM CRANE: Operator 200 tons through 299 tons, and/or over 200 feet boom; HYDRAULIC CRANE: Hydraulic Crane Operator 90 tons through 199 tons with luffing or tower attachments;

GROUP 1A: HYDRAULIC CRANE: Hydraulic Operator, 200 tons and over (with luffing or tower attachment); LATTICE BOOM CRANE: Operator, 200 tons through 299 tons, with over 200 feet boom;

GROUP 1B: LATTICE BOOM CRANE: Operator, 300 tons through 399 tons with over 200 feet boom; Operator 400 tons and over

GROUP 2: CRANE: Cableway Operator, 25 tons and over; HYDRAULIC CRANE: Hydraulic crane operator 90 tons through 199 tons (without luffing or tower attachment); TOWER/WHIRLEY OPERATOR: Tower Crane Operator; Whirley Operator, under 90 tons; LATTICE BOOM CRANE: 90 through 199 tons and/or 150 to 200 feet boom; HYDRAULIC CRANE: Hydraulic crane operator, 50 tons through 89 tons (with luffing or tower attachment); Rubber tired scraper with tandom scrapers, multi-engineTrenching Machine-Wheel Operator; Loader 120,000 lbs and above; BLADE: Auto Grader; Blade Operator-Robotic; Bulldozer over 120,000 lbs and above; CRANE: Derrick Barge Operator 30 ton but less than 150 ton; Excavator over 130,000 lbs and above

GROUP 3: HYDRAULIC CRANE: Hydraulic crane operator, 50 tons through 89 tons (without luffing or tower attachment); LATTICE BOOM CRANES: Lattice Boom Crane-50 through 89 tons (and less than 150 feet boom); Rubber Tired Scraper: with tandom scrapers; self loading, paddle wheel, auger type, finish and/or 2 or more units; Loader 60,000 lbs and less than 120,000 lbs; Bulldozer over 70,000 lbs up to and including 120,000 lbs; Excavator over 80,000 lbs through 130,000 lbs

GROUP 4: CRANE: Hydraulic Crane Operator, under 50 tons; LATTICE BOOM CRANE OPERATOR: Lattice Boom Crane Operator, under 50 tons; TRACKHOE/BACKHOE-ROBOTIC: track and wheel type, up to and including 20,0000 lbs. with any or all attachments; BLADE: Blade Operator; Tractor operator with boom attachment; DRILLING: Churm Drill and Earth Boring Machine Operator; Directional Drill Operator over 20,000 lbs pullback; CRANE: Chicago boom and similar types; Boom type lifting device, 5 ton capacity or less; Asphalt Paver; Rubber-Tired Scraper, single engine, single scraper; Compactor-Self Propelled; Loaders 25,000 lbs and less than 60,000 lbs; Bulldozer over 20,000 lbs and more than 100 horse up to 70,000 lbs; Mechanic;CRANE: Derrick Barge Operator less than 30 ton; Piledriver; Excavator over 20,000 lbs through 80,000 lbs; Screed; compactor with blade

GROUP 5: TRACKHOE/BACKHOE HYDRAULIC: Track type up to and including 20,000 lbs, Wheel type (Ford, John Deer, Case Type); Boom truck operator; DRILLING: Churm Drill and Earth Boring Machine Operator; Directional Drill Operator less than 20,000 lbs pullback; Concrete Pumper; Concrete Paver: Compactor; Loaders, rubber tired type , less than 25,00 lbs; Forklift over 5 ton, Bulldozer 20,000 lbs or 100 horses or less; Mixer operator; Roller; Compactor without blade

GROUP 6: LOADERS: (less than 1 cu yd.); Oiler; Bobcat/Skid Loader; Grade Checker; Crane oiler; Asphalt Spreader; Broom Operator; Forklift; Roller (non-asphalt)

Zone Differential (add to Zone 1 rates):
Zone 2 - $3.00
Zone 3 - $6.00

For the following metropolitan counties: MULTNOMAH; CLACKAMAS; MARION; WASHINGTON; YAMHILL; AND COLUMBIA; CLARK; AND COWLITZ COUNTY, WASHINGTON WITH MODIFICATIONS AS INDICATED:

All jobs or projects located in Multnomah, Clackamas and Marion Counties, West of the western boundary of Mt. Hood National Forest and West of Mile Post 30 on Interstate 84 and West of Mile Post 30 on State Highway 26 and West of Mile Post 30 on Highway 22 and all jobs or projects located in Yamhill County, Washington County and Columbia County and all jobs or porjects located in Clark & Cowlitz County, Washington except that portion of Cowlitz County in the Mt. St. Helens "Blast Zone" shall receive Zone I pay for all classifications.

All jobs or projects located in the area outside the identified boundary above, but less than 50 miles from the Portland City Hall shall receive Zone II pay for all classifications.

All jobs or projects located more than 50 miles from the Portland City Hall, but outside the identified border above, shall receive Zone III pay for all classifications.

For the following cities: ALBANY; BEND; COOS BAY; EUGENE; GRANTS PASS; KLAMATH FALLS; MEDFORD; ROSEBURG

All jobs or projects located within 30 miles of the respective city hall of the above mentioned cities shall receive Zone I pay for all classifications.

All jobs or projects located more than 30 miles and less than 50 miles from the respective city hall of the above mentioned cities shall receive Zone II pay for all classifications.

All jobs or projects located more than 50 miles from the respective city hall of the above mentioned cities shall receive Zone III pay for all classifications.

IRON0029-011 07/01/2013

	Rates	Fringes
IRONWORKER (Ornamental, Reinforcing, and Structural).....	$ 34.12	21.35

LABO0001-030 09/01/2014

	Rates	Fringes
Laborers: (Mason Tender-Cement/Concrete)..........	$ 27.44	13.10

LABO0001-031 06/01/2014

	Rates	Fringes
Laborers: (Mason Tender-Brick)...	$ 27.44	13.10

LABO0003-023 06/01/2014

	Rates	Fringes
Laborers:		
GROUP 1.....................	$ 26.43	13.10
GROUP 2.....................	$ 27.44	13.10
GROUP 3.....................	$ 22.86	13.10

LABORER CLASSIFICATIONS:

GROUP 1: Blaster, Demolition; General Laborer; Chain Saw

GROUP 2: Vibrating Plate; Pipelayer; Grade Checker

GROUP 3: Traffic Control-Cone Setter

PAIN0055-002 11/01/2014

	Rates	Fringes
PAINTER		
HIGHWAY & PARKING LOT STRIPER	$ 33.43	11.08

PAIN0055-022 07/01/2013

	Rates	Fringes
PAINTER		
BRUSH, ROLLER AND SPRAY	$ 21.01	8.83

PLAS0555-006 06/01/2014

	Rates	Fringes
CEMENT MASON/CONCRETE FINISHER	$ 29.98	17.76

PLUM0290-012 04/01/2012

	Rates	Fringes
PIPEFITTER	$ 38.20	21.36

TEAM0037-010 06/01/2014

	Rates	Fringes
TRUCK DRIVER		
GROUP 1	$ 26.90	14.37
GROUP 2	$ 27.02	14.37
GROUP 3	$ 27.15	14.37
GROUP 4	$ 27.41	14.37

TRUCK DRIVERS CLASSIFICATIONS

GROUP 1: Flatbed Truck; Off the Road Truck; Water Truck up to 3,000 gallons

GROUP 2: Vactor Truck; Water Truck over 3,000 to 5,000 gallons

GROUP 3: Water Truck over 5,000 to 10,000 gallons

GROUP 4: Water Truck over 10,000 to 15,000 gallons

SUOR2009-057 11/23/2009

	Rates	Fringes
LABORER: Asphalt Spreader	$ 22.18	9.39
LABORER: Flagger	$ 20.85	7.40
LABORER: Form-Stripping	$ 19.27	6.32
LABORER: Landscape	$ 22.18	7.45

LABORER: Water, Sewer, Underground......................$	17.00	1.75
OPERATOR: Rotomill..............$	28.25	9.70
OPERATOR: Tractor...............$	20.00	0.73
TRUCK DRIVER: Dump Truck........$	18.11	5.50
TRUCK DRIVER: Lowboy Truck......$	17.07	5.50

WELDERS - Receive rate prescribed for craft performing operation to which welding is incidental.

==

Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clauses (29CFR 5.5 (a) (1) (ii)).

The body of each wage determination lists the classification and wage rates that have been found to be prevailing for the cited type(s) of construction in the area covered by the wage determination. The classifications are listed in alphabetical order of "identifiers" that indicate whether the particular rate is a union rate (current union negotiated rate for local), a survey rate (weighted average rate) or a union average rate (weighted union average rate).

Union Rate Identifiers

A four letter classification abbreviation identifier enclosed in dotted lines beginning with characters other than "SU" or "UAVG" denotes that the union classification and rate were prevailing for that classification in the survey. Example: PLUM0198-005 07/01/2014. PLUM is an abbreviation identifier of the union which prevailed in the survey for this classification, which in this example would be Plumbers. 0198 indicates the local union number or district council number where applicable, i.e., Plumbers Local 0198. The next number, 005 in the example, is an internal number used in processing the wage determination. 07/01/2014 is the effective date of the most current negotiated rate, which in this example is July 1, 2014.

Union prevailing wage rates are updated to reflect all rate changes in the collective bargaining agreement (CBA) governing this classification and rate.

Survey Rate Identifiers

Classifications listed under the "SU" identifier indicate that no one rate prevailed for this classification in the survey and the published rate is derived by computing a weighted average rate based on all the rates reported in the survey for that classification. As this weighted average rate includes all rates reported in the survey, it may include both union and non-union rates. Example: SULA2012-007 5/13/2014. SU indicates the rates are survey rates based on a weighted average calculation of rates and are not majority rates. LA indicates the State of Louisiana. 2012 is the year of survey on which these classifications and rates are based. The next number, 007 in the example, is an internal number used in producing the wage determination. 5/13/2014 indicates the survey completion date for the classifications and rates under that identifier.

Survey wage rates are not updated and remain in effect until a new survey is conducted.

Union Average Rate Identifiers

Classification(s) listed under the UAVG identifier indicate that no single majority rate prevailed for those classifications; however, 100% of the data reported for the classifications was union data. EXAMPLE: UAVG-OH-0010 08/29/2014. UAVG indicates that the rate is a weighted union average rate. OH indicates the state. The next number, 0010 in the example, is an internal number used in producing the wage determination. 08/29/2014 indicates the survey completion date for the classifications and rates under that identifier.

A UAVG rate will be updated once a year, usually in January of each year, to reflect a weighted average of the current negotiated/CBA rate of the union locals from which the rate is based.

WAGE DETERMINATION APPEALS PROCESS

1.) Has there been an initial decision in the matter? This can be:

* an existing published wage determination
* a survey underlying a wage determination
* a Wage and Hour Division letter setting forth a position on a wage determination matter
* a conformance (additional classification and rate) ruling

On survey related matters, initial contact, including requests for summaries of surveys, should be with the Wage and Hour Regional Office for the area in which the survey was conducted because those Regional Offices have responsibility for the Davis-Bacon survey program. If the response from this initial contact is not satisfactory, then the process described in 2.) and 3.) should be followed.

With regard to any other matter not yet ripe for the formal process described here, initial contact should be with the Branch of Construction Wage Determinations. Write to:

Branch of Construction Wage Determinations
Wage and Hour Division
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

2.) If the answer to the question in 1.) is yes, then an interested party (those affected by the action) can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Write to:

Wage and Hour Administrator
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

The request should be accompanied by a full statement of the interested party's position and by any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3.) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative Review Board (formerly the Wage Appeals Board). Write to:

Administrative Review Board
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

4.) All decisions by the Administrative Review Board are final.

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END OF GENERAL DECISION

APPENDIX E

Estimated Production Rates

TITLE:	Lower Willamette Ecosystem Restoration		
SUBJECT:	Output Rates for Loading and Hauling of Excavated Materials		
MADE BY:	SKV	JOB NO.:	
CHECKED BY:		DATE:	10/15/2013

CSI TASK:

LOAD AND HAUL EXCAVTED MATERIAL
3-cy Loader, 12-cy Dump Truck, 20-mile Haul, 30-mph Avg.

CREW:		*Load and Haul Concrete Crew*	20 crew members
	1	Equip. Oper. Heavy	
	1	Oiler	
	18	Truck Driver, Heavy	
	1	Front End Loader, 6-cy Bucket	
	17.42	16-cy Dump Truck	
	0.58	Dump Truck on Stand-By	

OVERALL PRODUCTION RATE — **128 cy/crew hr** →

LOADING

CREW:		Loading Crew	2 crew members
	1	Equip. Oper. Heavy	
	1	Oiler	
	1	Front End Loader, 6-cy Bucket	

PRODUCTION

3	cy bucket
0.85	% fill
50	min/hr
1.00	cycle/min

128 cy/crew hr — 128 cy/crew hr →

TITLE:	Lower Willamette Ecosystem Restoration		
SUBJECT:	Output Rates for Loading and Hauling of Excavated Materials		
MADE BY:	SKV	JOB NO.:	
CHECKED BY:		DATE:	10/15/2013

Sheet No. 2 of 2

HAUL TO DISPOSAL SITE

CREW:	Truck Haul Crew	1 crew members
	1 Truck Driver, Heavy	
	1 16-cy Dump Truck	

PRODUCTION

12 cy truck
0.85 % fill
2.1 min. for loading
20 mi. to disposal location
30 mph haul speed
1.5 min. dump time

Quantity per Truck 10.2 cy/truck

Duration of Hauling 1.39 hr

7.3 cy/hr →

17.42 crews/equipment members to match overall production rate

18.00 total number of crews needed

0.58 equipment standby time

TITLE:	Lower Willamette Ecosystem Restoration		
SUBJECT:	Output Rates for Earthwork		
MADE BY:	SKV	JOB NO.:	
CHECKED BY:		DATE:	10/15/2013

EXCAVATION
1.5-cy Hydr. Excavat., Dry Conditions

CREW: 1.5-cy Hydraul. Excavt. Crew — 3 crew members

1 Equip. Oper. Medium
1 Oiler
1 Equip. Oper. Heavy
1 Front End Loader
1 Excavator, 1.5-cy

PRODUCTION

1.5 cy bucket
0.85 % fill
50 min/hr
0.50 cycle/min

32 cy/crew hr

OVERALL PRODUCTION RATE — 32 cy/crew hr

EXCAVATION
2.5-cy Hydr. Excavat., Open Site

CREW: 2.5-cy Hydraul. Excavt. Crew — 3 crew members

1 Equip. Oper. Medium
1 Oiler
1 Equip. Oper. Heavy
1 Front End Loader
1 Excavator, 1.5-cy

PRODUCTION

2.5 cy bucket
0.85 % fill
50 min/hr
0.50 cycle/min

53 cy/crew hr

OVERALL PRODUCTION RATE — 53 cy/crew hr

TITLE:	Lower Willamette Ecosystem Restoration		
SUBJECT:	Output Rates for Earthwork		
MADE BY:	SKV	JOB NO.:	
CHECKED BY:		DATE:	10/15/2013

CHANNEL BANK EXCAVATION
3-cy Hydraul. Excavator

CREW:	Bank Excavation Crew	3 crew members
	1 Equip. Oper. Medium	
	1 Oiler	
	1 Equip. Oper. Heavy	
	1 Front End Loader	
	1 Excavator, 1.5-cy	

PRODUCTION

2	cy bucket
0.85	% fill
50	min/hr
1.00	cycle/min
85	cy/crew hr

OVERALL PRODUCTION RATE — **85 cy/crew hr**

PIPE TRENCHING
1.5-cy Hydr. Excavat., Dry Conditions

CREW:	1.5-cy Hydraul. Excavt. Crew	3 crew members
	1 Equip. Oper. Medium	
	1 Oiler	
	1 Equip. Oper. Heavy	
	1 Front End Loader	
	1 Excavator, 1.5-cy	

PRODUCTION

1.5	cy bucket
0.85	% fill
50	min/hr
1.00	cycle/min
64	cy/crew hr

OVERALL PRODUCTION RATE — **64 cy/crew hr**

TITLE:	Lower Willamette Ecosystem Restoration		
SUBJECT:	Output Rates for Earthwork		
MADE BY:	SKV	JOB NO.:	
CHECKED BY:		DATE:	10/15/2013

TRENCH BACKFILL
300-ft Haul, 3-cy Bucket, Vibro-Compacted

CREW: Fill and Compact From Stockpile Crew — 5 crew members

3 Equip. Oper. Medium
1 Truck Driver
1 Laborer
1 Vibratory Roller
1 Water Truck
1 Front End Loader
1 Dozer

PRODUCTION

3 cy bucket
0.85 % fill
50 min/hr
0.60 cycle/min

77 cy/crew hr

OVERALL PRODUCTION RATE 77 cy/crew hr

FILL AND COMPACT FROM STOCKPILE
300-ft Haul, 3-cy Bucket, Vibro-Compacted

CREW: Fill and Compact From Stockpile Crew — 5 crew members

3 Equip. Oper. Medium
1 Truck Driver
1 Laborer
1 Vibratory Roller
1 Water Truck
1 Front End Loader
1 Dozer

PRODUCTION

3 cy bucket
0.85 % fill
50 min/hr
0.75 cycle/min

96 cy/crew hr

OVERALL PRODUCTION RATE 96 cy/crew hr

TITLE:	Lower Willamette Ecosystem Restoration		
SUBJECT:	Output Rates for Earthwork		
MADE BY:	SKV	JOB NO.:	
CHECKED BY:		DATE:	10/15/2013

LOW FLOW CHANNEL EXCAVATION
1.5-cy Hydr. Excavat

CREW: 1.5-cy Hydraul. Excavt. Crew — 3 crew members

1 Equip. Oper. Medium
1 Oiler
1 Equip. Oper. Heavy
1 Front End Loader
1 Excavator, 1.5-cy

PRODUCTION

1.5	cy bucket
0.85	% fill
50	min/hr
0.95	cycle/min
61	cy/crew hr

OVERALL PRODUCTION RATE 61 cy/crew hr

TITLE:	Lower Willamette Ecosystem Restoration		
SUBJECT:	Output Rates for Loading, Hauling and Disposal of Concrete		
MADE BY:	SKV	JOB NO.:	
CHECKED BY:		DATE:	10/15/2013

CSI TASK:

CONCRETE LOAD AND HAUL
12-cy Dump Truck, 20-mile Haul, 40-mph Avg.

CREW: *Load and Haul Concrete Crew* — 16 crew members

1	Equip. Oper. Heavy
1	Oiler
14	Truck Driver, Heavy
1	Front End Loader, 6-cy Bucket
13.07	16-cy Dump Truck
0.93	Dump Truck on Stand-By

OVERALL PRODUCTION RATE — 75 cy/crew hr

LOADING

CREW: Loading Crew — 2 crew members

1	Equip. Oper. Heavy
1	Oiler
1	Front End Loader, 6-cy Bucket

PRODUCTION

3	cy bucket
0.50	% fill
50	min/hr
1.00	cycle/min

75 cy/crew hr — 75 cy/crew hr

TITLE:	Lower Willamette Ecosystem Restoration		
SUBJECT:	Output Rates for Loading, Hauling and Disposal of Concrete		
MADE BY:	SKV	JOB NO.:	
CHECKED BY:		DATE:	10/15/2013

Sheet No. 2 of 2

HAUL TO DISPOSAL SITE

CREW: Truck Haul Crew — 1 crew members

1 Truck Driver, Heavy
1 16-cy Dump Truck

PRODUCTION

12	cy truck
0.50	% fill
1.3	min. for loading
20	mi. to disposal location
40	mph haul speed
1.5	min. dump time

Quantity per Truck 6.0 cy/truck

Duration of Hauling 1.05 hr

5.7 cy/hr →

13.07 crews/equipment members to match overall production rate

14.00 total number of crews needed

0.93 equipment standby time

TITLE:	Lower Willamette Ecosystem Restoration		
SUBJECT:	Output Rates for Stone Placement		
MADE BY:	SKV	JOB NO.:	
CHECKED BY:		DATE:	10/15/2013

BOULDERS, PLACEMENT

CREW: Riprap Crew — 4 crew members

2 Laborers
1 Labor Foreman
1 Equip. Oper. Medium
1 Loader, 1.5-cy Bucket

5.00 min/boulder
1.00 tons/boulder

OVERALL PRODUCTION RATE → **12 cy/hr**

FOOTER STONES, PLACEMENT

CREW: Riprap Crew — 4 crew members

2 Laborers
1 Labor Foreman
1 Equip. Oper. Medium
1 Loader, 1.5-cy Bucket

PRODUCTION

1.5 cy bucket
0.50 % fill
45 min/hr
0.60 cycle/min
1.50 tons/cy

→ **30 ton/hr**

SPAWNING GRAVELS

CREW: Rock Placement Crew — 4 crew members

2 Laborers
1 Oiler
1 Equip. Oper. Medium
1 Loader, 3-cy Bucket

PRODUCTION

3 cy bucket
0.85 % fill
45 min/hr
0.75 cycle/min

→ **86 cy/crew hr**

TITLE:	Lower Willamette Ecosystem Restoration		
SUBJECT:	Output Rates for Stone Placement		
MADE BY:	SKV	JOB NO.:	
CHECKED BY:		DATE:	10/15/2013

STREAMBED STONE

CREW: Rock Placement Crew — 4 crew members

2 Laborers
1 Oiler
1 Equip. Oper. Medium
1 Loader, 3-cy Bucket

PRODUCTION

3	cy bucket
0.85	% fill
45	min/hr
0.90	cycle/min

103 cy/crew hr

TITLE:	Lower Willamette Ecosystem Restoration		
SUBJECT:	Output Rate for Clearing and Grubbing		
MADE BY:	SKV	JOB NO.:	
CHECKED BY:		DATE:	10/15/2013

Sheet No. 1 of 1

CLEARING AND GRUBBING

SUB-CREW: Clear and Grub Crew — 3 crew members

1 Equip. Oper. Medium
2 Laborers
1 Dozer

PRODUCTION 480.00 min/acre

OVERALL PRODUCTION RATE **0.125 ea/hr**

APPENDIX F

Phone Logs and Emails

(For Official Use Only)

APPENDIX G

Abbreviated Risk Analysis

Abbreviated Risk Analysis

Lower Willamette Ecosystem Restoration
Feasibility (Alternatives)

Meeting Date: 1-Oct-13

PDT Members
Note: PDT involvement is commensurate with project size and involvement.

OWPR Formulator	Lee Ware, HQ
Planning Facilitator	Maria Placht
Sr. Envir. Planning Spec.	Valerie Ringold, NWD
Biologist	Elliott Stefanik, MVP
Sr. Planning Specialist	Jim Fredericks, NWD
Deputy Chief of Engineering	Doug Putman, NWD
Environmental Engineer	Alison Burcham, Portland District
Real Estate Specialist	Doris Cope, Seattle District
Biologist	Kris Lightner, Portland District
Economist	Chris McCann
Project Manager:	Dave Munro, Tetra Tech
Project Engineer:	Ike Pace, Tetra Tech
Cost Estimator:	Scott Vose, Tetra Tech

Abbreviated Risk Analysis

Project Name & Location: **Lower Willamette Ecosystem Restoration** — **District:** NWP
Project Development Stage/Alternative: **Feasibility (Alternatives)** — **Alternative:**
Risk Category: **Moderate Risk: Typical Project Construction Type** — **Meeting Date:** 10/1/2013

Total Estimated Construction Contract Cost = $ 13,905,858

	CWWBS	Feature of Work	Contract Cost		% Contingency	$ Contingency	Total
	01 LANDS AND DAMAGES	Real Estate	$ 5,187,000		20.00%	$ 1,037,400	$ 6,224,400
1	06 FISH AND WILDLIFE FACILITIES	**BES Treatment Plant**	$ 580,501		31.48%	$ 182,757	$ 763,258
2	06 FISH AND WILDLIFE FACILITIES	**Kelley Point Park (Fish & Wildlife)**	$ 5,428,443		30.06%	$ 1,631,616	$ 7,060,059
3	06 FISH AND WILDLIFE FACILITIES	**Kenton Cove**	$ 366,320		23.65%	$ 86,639	$ 452,959
4	06 FISH AND WILDLIFE FACILITIES	**Oaks Crossing/Sellwood Riverfront Park**	$ 455,424		23.65%	$ 107,713	$ 563,136
5	02 RELOCATIONS	**Tryon Highway 43 Culvert (Relocations)**	$ 336,595		45.02%	$ 151,535	$ 488,130
6	06 FISH AND WILDLIFE FACILITIES	**Tryon Highway 43 Culvert (Fish & Wildlife)**	$ 4,235,369		43.63%	$ 1,847,808	$ 6,083,176
7	08 ROADS, RAILROADS, AND BRIDGES	**Tryon Highway 43 Culvert (Roads/Railroads)**	$ 1,400,429		51.05%	$ 714,883	$ 2,115,312.56
8	14 RECREATION FACILITIES	**Kelley Point Park (Recreation)**	$ 1,102,777		24.53%	$ 270,496	$ 1,373,272.42
9			$ -		0.00%	$ -	$ -
10			$ -		0.00%	$ -	$ -
11			$ -		0.00%	$ -	$ -
12	All Other (less than 10% of construction costs)	**Remaining Construction Items**	$ 0	*0.0%*	0.00%	$ -	$ 0
13	30 PLANNING, ENGINEERING, AND DESIGN	**Planning, Engineering, & Design**	$ 1,743,000		18.15%	$ 316,296	$ 2,059,296
14	31 CONSTRUCTION MANAGEMENT	**Construction Management**	$ 1,390,000		25.96%	$ 360,849	$ 1,750,849
XX	FIXED DOLLAR RISK ADD (EQUALLY DISPERSED TO ALL, MUST INCLUDE JUSTIFICATION SEE BELOW)					$ -	

Totals				
Real Estate	$ 5,187,000	20.00%	$ 1,037,400	$ 6,224,400.00
Total Construction Estimate	$ 13,905,858	35.91%	$ 4,993,446	$ 18,899,304
Total Planning, Engineering & Design	$ 1,743,000	18.15%	$ 316,296	$ 2,059,296
Total Construction Management	$ 1,390,000	25.96%	$ 360,849	$ 1,750,849
Total	**$ 22,225,858**	**30.18%**	**$ 6,707,991**	**$ 28,933,849**

	Base	50%	80%
Range Estimate ($000's)	$22,226k	$26,251k	$28,934k

* 50% based on base is at 50% CL.

Fixed Dollar Risk Add: (Allows for additional risk to be added to the risk analsyis. Must include justification. Does not allocate to Real Estate.	

Lower Willamette Ecosystem Restoration
Feasibility (Alternatives)
Abbreviated Risk Analysis
Meeting Date: 1-Oct-13

Risk Register

Risk Level

	Negligible	Marginal	Moderate	Significant	Critical
Very Likely	2	3	4	5	5
Likely	1	2	3	4	5
Possible	0	1	2	3	4
Unlikely	0	0	1	2	3

Risk Element	Feature of Work	Concerns	PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)	Impact	Likelihood	Risk Level
Project Scope Growth				Maximum Project Growth		60%
PS-1	BES Treatment Plant	• Potential for scope growth, added features and quantities? • Investigations sufficient to support design assumptions? • Design confidence? • Water care and diversion fully understood, planned?	Project is at early design stage. Construction activities and quantities are subject to change as project progresses. Changes to design/quantities are likely to occur but are not likely to increase greatly.	Marginal	Likely	2
PS-2	Kelley Point Park (Fish & Wildlife)	• Potential for scope growth, added features and quantities? • Investigations sufficient to support design assumptions? • Design confidence? • Water care and diversion fully understood, planned?	Project is at early design stage. Construction activities and quantities are subject to change as project progresses. Changes to design/quantities are likely to occur but are not likely to increase greatly.	Marginal	Likely	2
PS-3	Kenton Cove	• Potential for scope growth, added features and quantities? • Investigations sufficient to support design assumptions? • Design confidence? • Water care and diversion fully understood, planned?	Project is at early design stage. Construction activities and quantities are subject to change as project progresses. Changes to design/quantities are likely to occur but are not likely to increase greatly.	Marginal	Likely	2
PS-4	Oaks Crossing/Sellwood Riverfront Park	• Potential for scope growth, added features and quantities? • Investigations sufficient to support design assumptions? • Design confidence? • Water care and diversion fully understood, planned?	Project is at early design stage. Construction activities and quantities are subject to change as project progresses. Changes to design/quantities are likely to occur but are not likely to increase greatly.	Marginal	Likely	2
PS-5	Tryon Highway 43 Culvert (Relocations)	• Investigations sufficient to support design assumptions? • Design confidence? • Water care and diversion fully understood, planned?	Further investigations remain to determine construction types required to relocation existing utilities. Until then, significant risks remain if alignment/placement method/quantity/number of utilities changes.	Moderate	Likely	3
PS-6	Tryon Highway 43 Culvert (Fish & Wildlife)	• Potential for scope growth, added features and quantities? • Investigations sufficient to support design assumptions? • Design confidence? • Water care and diversion fully understood, planned?	Further analysis remains to be completed into construction sequencing for this site. Also, large shoring walls are assumed to be placed and these need further investigation as well. Scope of site could change based on future findings.	Moderate	Likely	3
PS-7	Tryon Highway 43 Culvert (Roads/Railroads)	• Potential for scope growth, added features and quantities? • Investigations sufficient to support design assumptions? • Design confidence? • Water care and diversion fully understood, planned?	Further analysis remains to be completed into construction sequencing for this site. Also, large shoring walls are assumed to be placed and these need further investigation as well. Scope of site could change based on future findings.	Moderate	Likely	3
PS-8	Kelley Point Park (Recreation)	• Potential for scope growth, added features and quantities? • Investigations sufficient to support design assumptions? • Design confidence? • Water care and diversion fully understood, planned?	Project is at early design stage. Construction activities and quantities are subject to change as project progresses. Changes to design/quantities are likely to occur but are not likely to increase greatly.	Marginal	Likely	2
PS-9	0					N/A
PS-10	0					N/A
PS-11	0					N/A
PS-12	Remaining Construction Items					N/A
PS-13	Planning, Engineering, & Design	• Potential for scope growth, added features and quantities? • Project accomplish intent? • Investigations sufficient to support design assumptions? • Design confidence? • Water care and diversion fully understood, planned?	Many investigations remain to be completed in order to finalize the design. If the scope grows in extent then the cost to complete the PED phase would grow as well.	Marginal	Likely	2
PS-14	Construction Management	• Potential for scope growth, added features and quantities? • Project accomplish intent? • Investigations sufficient to support design assumptions? • Design confidence? • Water care and diversion fully understood, planned?	The primary concern for construction management, is the possible encountering of a large area of HTRW. This would create a significant impact on the management costs.	Marginal	Likely	2

Acquisition Strategy				Maximum Project Growth		40%
AS-1	BES Treatment Plant	• Contracting plan firmly established? • 8a or small business likely? • Accelerated schedule or harsh weather schedule? • Bid schedule developed to reduce quantity risks?	Contracting plan has not been firmly established. Estimate assumes each site would have it's own prime contractor with sub-contractors for various specialty items. 8a business may occur, which is not assumed currently in the MII. Some scheduling issues may arise to due to traffic, weather and environmental concerns.	Marginal	Possible	1
AS-2	Kelley Point Park (Fish & Wildlife)	• Contracting plan firmly established? • 8a or small business likely? • Accelerated schedule or harsh weather schedule? • Bid schedule developed to reduce quantity risks?	See discussion in first box above.	Marginal	Possible	1
AS-3	Kenton Cove	• Contracting plan firmly established? • 8a or small business likely? • Accelerated schedule or harsh weather schedule? • Bid schedule developed to reduce quantity risks?	See discussion in first box above.	Marginal	Possible	1
AS-4	Oaks Crossing/Sellwood Riverfront Park	• Contracting plan firmly established? • 8a or small business likely? • Accelerated schedule or harsh weather schedule? • Bid schedule developed to reduce quantity risks?	See discussion in first box above.	Marginal	Possible	1
AS-5	Tryon Highway 43 Culvert (Relocations)	• Contracting plan firmly established? • 8a or small business likely? • Accelerated schedule or harsh weather schedule? • Bid schedule developed to reduce quantity risks?	See discussion in first box above.	Marginal	Possible	1
AS-6	Tryon Highway 43 Culvert (Fish & Wildlife)	• Contracting plan firmly established? • 8a or small business likely? • Accelerated schedule or harsh weather schedule? • Bid schedule developed to reduce quantity risks?	See discussion in first box above.	Marginal	Possible	1
AS-7	Tryon Highway 43 Culvert (Roads/Railroads)	• Contracting plan firmly established? • 8a or small business likely? • Accelerated schedule or harsh weather schedule? • Bid schedule developed to reduce quantity risks?	See discussion in first box above.	Marginal	Possible	1
AS-8	Kelley Point Park (Recreation)	• Contracting plan firmly established? • 8a or small business likely? • Accelerated schedule or harsh weather schedule? • Bid schedule developed to reduce quantity risks?	See discussion in first box above.	Marginal	Possible	1
AS-9	0					N/A
AS-10	0					N/A
AS-11	0					N/A
AS-12	Remaining Construction Items					N/A
AS-13	Planning, Engineering, & Design	• Contracting plan firmly established? • 8a or small business likely? • Accelerated schedule or harsh weather schedule? • Bid schedule developed to reduce quantity risks?	See discussion in first box above.	Marginal	Possible	1
AS-14	Construction Management	• Contracting plan firmly established? • 8a or small business likely? • Accelerated schedule or harsh weather schedule? • Bid schedule developed to reduce quantity risks?	See discussion in first box above.	Marginal	Possible	1

Construction Elements				Maximum Project Growth		30%
CON-1	BES Treatment Plant	• High risk or complex construction elements, site access, in-water? • Water care and diversion plan? • Special mobilization? • Special equipment or subcontractors needed?	This site requires barge mounted equipment for excavation. This work is common in the area but has inherent risks in terms of productivity and constructibility. Diversion and control of water has not been designed, and could be subject to change from what is in MII. These risks are possible to occur, and could impose significant changes to cost.	Significant	Possible	3
CON-2	Kelley Point Park (Fish & Wildlife)	• Water care and diversion plan? • Potential for construction modification and claims?	Water care and diversion plan has not been fully developed. General assumptions have been used for the MII. The work at this site is pretty typical and therefore no significant risks are anticipated.	Marginal	Possible	1
CON-3	Kenton Cove	• Water care and diversion plan? • Potential for construction modification and claims?	Water care and diversion plan has not been fully developed. General assumptions have been used for the MII. The work at this site is pretty typical and therefore no significant risks are anticipated.	Marginal	Possible	1
CON-4	Oaks Crossing/Sellwood Riverfront Park	• Water care and diversion plan? • Potential for construction modification and claims?	Water care and diversion plan has not been fully developed. General assumptions have been used for the MII. The work at this site is pretty typical and therefore no significant risks are anticipated.	Marginal	Possible	1
CON-5	Tryon Highway 43 Culvert (Relocations)	• High risk or complex construction elements, site access, in-water? • Water care and diversion plan? • Unique construction methods?	The relocation as currently estimated, assumes some of the utility line would be placed with use of horizontal drills. There is no set diversion and control of water plan either. Thus the placement of the utility line could be more difficult than assumed.	Significant	Possible	3
CON-6	Tryon Highway 43 Culvert (Fish & Wildlife)	• Accelerated schedule or harsh weather schedule? • High risk or complex construction elements, site access, in-water? • Water care and diversion plan? • Unique construction methods? • Special equipment or subcontractors needed? • Potential for construction modification and claims?	The placement of the culvert is going to be difficult due to the depth and the fact that the roadway and railroad lines run through the footprint. Sequencing the construction could change drastically as the project progresses. Also, the need for different structures may be required to keep railroad open. Demo and removal of existing railroad bridge could be more difficult since it is not known what exactly may be underground there.	Moderate	Likely	3
CON-7	Tryon Highway 43 Culvert (Roads/Railroads)	• Accelerated schedule or harsh weather schedule? • High risk or complex construction elements, site access, in-water? • Water care and diversion plan? • Unique construction methods? • Special equipment or subcontractors needed? • Potential for construction modification and claims?	The placement of the culvert is going to be difficult due to the depth and the fact that the roadway and railroad lines run through the footprint. Sequencing the construction could change drastically as the project progresses. Also, the need for different structures may be required to keep railroad open. Demo and removal of existing railroad bridge could be more difficult since it is not known what exactly may be underground there.	Moderate	Likely	3
CON-8	Kelley Point Park (Recreation)	• Water care and diversion plan? • Potential for construction modification and claims?	Water care and diversion plan has not been fully developed. General assumptions have been used for the MII. The work at this site is pretty typical and therefore no significant risks are anticipated.	Marginal	Possible	1
CON-9	0					N/A
CON-10	0					N/A
CON-11	0					N/A
CON-12	Remaining Construction Items					N/A
CON-13	Planning, Engineering, & Design	• High risk or complex construction elements, site access, in-water? • Water care and diversion plan? • Potential for construction modification and claims?	Designs will need to be very detailed in order for the large scale structures to be constructed properly. Extra time and oversight may be required, but current PED cost should be more than adequate to complete the design work. Thus no impacts to costs are assumed.	Negligible	Unlikely	0
CON-14	Construction Management	• High risk or complex construction elements, site access, in-water? • Water care and diversion plan? • Potential for construction modification and claims?	Assumed CM costs could differ from actual if some of the risks noted above occur. Primarily if there are mods to the contract, there could be need for more management costs.	Marginal	Possible	1

Quantities for Current Scope

				Maximum Project Growth		20%
Q-1	BES Treatment Plant	• Level of confidence based on design and assumptions? • Sufficient investigations to develop quantities?	Level of detail in design is still low, and thus quantities are at risk of increasing as further drawings are created. Conservative assumptions were used, so the likelihood should not be great, but the impacts could be significant.	Moderate	Possible	2
Q-2	Kelley Point Park (Fish & Wildlife)	• Level of confidence based on design and assumptions? • Sufficient investigations to develop quantities?	Level of detail in design is still low, and thus quantities are at risk of increasing as further drawings are created. Conservative assumptions were used, so the likelihood should not be great, but the impacts could be significant.	Moderate	Possible	2
Q-3	Kenton Cove	• Level of confidence based on design and assumptions? • Sufficient investigations to develop quantities?	Level of detail in design is still low, and thus quantities are at risk of increasing as further drawings are created. Conservative assumptions were used, so the likelihood should not be great, but the impacts could be significant.	Moderate	Possible	2
Q-4	Oaks Crossing/Sellwood Riverfront Park	• Level of confidence based on design and assumptions? • Sufficient investigations to develop quantities?	Level of detail in design is still low, and thus quantities are at risk of increasing as further drawings are created. Conservative assumptions were used, so the likelihood should not be great, but the impacts could be significant.	Moderate	Possible	2
Q-5	Tryon Highway 43 Culvert (Relocations)	• Level of confidence based on design and assumptions? • Sufficient investigations to develop quantities? • Appropriate methods applied to calculate quantities?	The length and number of pipelines that need to be relocated are not based on complete utility knowledge. Further designs remain, and more relocations may be required than are included in the estimate. At this time, no other utilities are known, other than the one estimated.	Significant	Possible	3
Q-6	Tryon Highway 43 Culvert (Fish & Wildlife)	• Level of confidence based on design and assumptions? • Appropriate methods applied to calculate quantities? • Sufficient investigations to develop quantities?	Quantities for this site are based on conservative assumptions. There is still a chance that furthur design could change these. The design level is still low and thus there is a likelihood for change.	Moderate	Possible	2
Q-7	Tryon Highway 43 Culvert (Roads/Railroads)	• Level of confidence based on design and assumptions? • Appropriate methods applied to calculate quantities? • Sufficient investigations to develop quantities?	Quantities for this site are based on conservative assumptions. There is still a chance that furthur design could change these. The design level is still low and thus there is a likelihood for change.	Moderate	Possible	2
Q-8	Kelley Point Park (Recreation)	• Level of confidence based on design and assumptions? • Sufficient investigations to develop quantities?	Level of detail in design is still low, and thus quantities are at risk of increasing as further drawings are created. However, bridge quantities are not likely to change.	Moderate	Unlikely	1
Q-9	0					N/A
Q-10	0					N/A
Q-11	0					N/A
Q-12	Remaining Construction Items					N/A
Q-13	Planning, Engineering, & Design	• Appropriate methods applied to calculate quantities? • Level of confidence based on design and assumptions? • Sufficient investigations to develop quantities?	Design level is very low at this time. Many investigations still remain to be order to accurately calculate quantities. Current PED percentage should be adequate, but there is some small chance it might not be.	Marginal	Possible	1
Q-14	Construction Management	No significant risks anticipated.	CM is not anticipated to affected by risks to the quantities of the project.	Negligible	Unlikely	0

Specialty Fabrication or Equipment				Maximum Project Growth		75%
FE-1	BES Treatment Plant	No significant risks anticipated.	This construction feature does no require specialty fabrication or equipment and thus no risks are anticipated.	Negligible	Unlikely	0
FE-2	Kelley Point Park (Fish & Wildlife)	No significant risks anticipated.	This construction feature does no require specialty fabrication or equipment and thus no risks are anticipated.	Negligible	Unlikely	0
FE-3	Kenton Cove	No significant risks anticipated.	This construction feature does no require specialty fabrication or equipment and thus no risks are anticipated.	Negligible	Unlikely	0
FE-4	Oaks Crossing/Sellwood Riverfront Park	No significant risks anticipated.	This construction feature does no require specialty fabrication or equipment and thus no risks are anticipated.	Negligible	Unlikely	0
FE-5	Tryon Highway 43 Culvert (Relocations)	No significant risks anticipated.	This construction feature does no require specialty fabrication or equipment and thus no risks are anticipated.	Negligible	Unlikely	0
FE-6	Tryon Highway 43 Culvert (Fish & Wildlife)	• Ability to reasonably transport? • Risk of specialty equipment functioning first time? Test?	This site requires a large culvert to be precast and delivered to the product site. Issues could arise from site accessibility to traffic control. Contractor should be able to transport as necessary but costs could increase significantly if there are issues.	Moderate	Possible	2
FE-7	Tryon Highway 43 Culvert (Roads/Railroads)	No significant risks anticipated.	This construction feature does no require specialty fabrication or equipment and thus no risks are anticipated.	Negligible	Unlikely	0
FE-8	Kelley Point Park (Recreation)	• Ability to reasonably transport? • Risk of specialty equipment functioning first time? Test?	The recreation account at this site features several pedestrian bridges. There could be increased costs or delays due to the delivery of the bridges. The bridges are expected to be typical pedestrian bridges though, and therefore not likely to cause major impacts.	Moderate	Unlikely	1
FE-9	0					N/A
FE-10	0					N/A
FE-11	0					N/A
FE-12	Remaining Construction Items					N/A
FE-13	Planning, Engineering, & Design	No significant risks anticipated.	This construction feature does no require specialty fabrication or equipment and thus no risks are anticipated.	Negligible	Unlikely	0
FE-14	Construction Management	• Unusual parts, material or equipment manufactured or installed? • Ability to reasonably transport?	Primary risk is the capability of the contractors to keep the transporation of the materials to the site on schedule (especially the planters). If materials are not provided on schedule significant impact to costs may be accrued.	Moderate	Possible	2

Cost Estimate Assumptions

				Maximum Project Growth		35%
EST-1	BES Treatment Plant	• Reliability and number of key quotes? • Assumptions regarding crew, productivity, overtime? • Site accessibility, transport delays, congestion?	Assumptions regarding crew productivity are at risk of being different at time of construction. No overtime is currently assumed, which could be needed. Site accessibility may be more difficult than assumed as well. These are not likely to occur but could cause significant impacts to costs and schedule.	Moderate	Possible	2
EST-2	Kelley Point Park (Fish & Wildlife)	• Reliability and number of key quotes? • Assumptions regarding crew, productivity, overtime? • Site accessibility, transport delays, congestion?	Assumptions regarding crew productivity are at risk of being different at time of construction. No overtime is currently assumed, which could be needed. Site accessibility may be more difficult than assumed as well. These are not likely to occur but could cause significant impacts to costs and schedule. Also, bridges are not designed, and thus a MII cost item was used to estimate, which could vary from what is to be required.	Moderate	Likely	3
EST-3	Kenton Cove	• Reliability and number of key quotes? • Assumptions regarding crew, productivity, overtime? • Site accessibility, transport delays, congestion?	Assumptions regarding crew productivity are at risk of being different at time of construction. No overtime is currently assumed, which could be needed. Site accessibility may be more difficult than assumed as well. These are not likely and should only have a marginal impact to overall costs at this site.	Marginal	Possible	1
EST-4	Oaks Crossing/Sellwood Riverfront Park	• Reliability and number of key quotes? • Assumptions regarding crew, productivity, overtime? • Site accessibility, transport delays, congestion?	Assumptions regarding crew productivity are at risk of being different at time of construction. No overtime is currently assumed, which could be needed. Site accessibility may be more difficult than assumed as well. These are not likely and should only have a marginal impact to overall costs at this site.	Marginal	Possible	1
EST-5	Tryon Highway 43 Culvert (Relocations)	• Reliability and number of key quotes? • Assumptions regarding crew, productivity, overtime? • Site accessibility, transport delays, congestion?	Large volumes of stone would be required, and thus would heavily depend on the material and trucking costs. If these costs are different at time of construction, which is likely, then there would be significant impacts to costs.	Moderate	Likely	3
EST-6	Tryon Highway 43 Culvert (Fish & Wildlife)	• Reliability and number of key quotes? • Assumptions regarding crew, productivity, overtime? • Site accessibility, transport delays, congestion?	Culvert material cost have been obtained from contractor referenced in design, and are not likely to be significantly off. Productivity for placing the culverts and the shoring could be more difficult due to the scale of the open cut excavation. Significant cost increases could occur if shoring is not adequate.	Moderate	Possible	2
EST-7	Tryon Highway 43 Culvert (Roads/Railroads)	• Site accessibility, transport delays, congestion? • Reliability and number of key quotes? • Assumptions regarding crew, productivity, overtime? • Lack confidence on critical cost items?	The removal, shoo-fly, and reinstallation of the railroad has not been fully developed. Key assumptions regarding how this is all to be completed could change drastically. The cost impacts to this could shift greatly depending on finalized plan.	Significant	Likely	4
EST-8	Kelley Point Park (Recreation)	• Reliability and number of key quotes? • Assumptions regarding crew, productivity, overtime? • Site accessibility, transport delays, congestion?	Pedestrian bridge quotes could be different as project progresses, as there are no details for the current bridges. These bridges are assumed to be standard with no significant modifications required. Therefore it is not likely to change.	Moderate	Unlikely	1
EST-9	0					N/A
EST-10	0					N/A
EST-11	0					N/A
EST-12	Remaining Construction Items					N/A
EST-13	Planning, Engineering, & Design	• Lack confidence on critical cost items?	Current percentage used for PED should be adequate. Thus the likelihood of it increasing is minimal, and the impact would be marginal if it did increase.	Marginal	Unlikely	0
EST-14	Construction Management	• Lack confidence on critical cost items?	Current CM percentage used should be sufficient. However, some of the risks outlined above may cause increases to CM. These risks are not likely to impact CM greatly but could cause marginal increases here.	Marginal	Possible	1

External Project Risks					Maximum Project Growth	40%
EX-1	BES Treatment Plant	• Potential for severe adverse weather? • Political influences, lack of support, obstacles? • Unanticipated inflations in fuel, key materials? • Potential for market volatility impacting competition, pricing?	There are several external risks that could delay the project and/or impact the overall costs. One risk is in regard to the interactions between all the agencies that would be involved in this project. Getting all the agencies on the same page could be a cause for concern moving forward. Also dealing with the multiple project locations could cause some issues. Weather is not anticipated to be a huge risk, but could impact the costs if something drastic occurred. The finding of unexpected cultural resources could also delay construction. Lastly, inflation in fuel and some materials would impact costs. Overall, these are not likely to occur, but most likely would be an impact to schedule and only marginal to costs.	Marginal	Possible	1
EX-2	Kelley Point Park (Fish & Wildlife)	• Potential for severe adverse weather? • Political influences, lack of support, obstacles? • Unanticipated inflations in fuel, key materials? • Potential for market volatility impacting competition, pricing?	See discussion in first box above.	Marginal	Possible	1
EX-3	Kenton Cove	• Potential for severe adverse weather? • Political influences, lack of support, obstacles? • Unanticipated inflations in fuel, key materials? • Potential for market volatility impacting competition, pricing?	See discussion in first box above.	Marginal	Possible	1
EX-4	Oaks Crossing/Sellwood Riverfront Park	• Potential for severe adverse weather? • Political influences, lack of support, obstacles? • Unanticipated inflations in fuel, key materials? • Potential for market volatility impacting competition, pricing?	See discussion in first box above.	Marginal	Possible	1
EX-5	Tryon Highway 43 Culvert (Relocations)	• Potential for severe adverse weather? • Political influences, lack of support, obstacles? • Unanticipated inflations in fuel, key materials? • Potential for market volatility impacting competition, pricing?	See discussion in first box above.	Marginal	Possible	1
EX-6	Tryon Highway 43 Culvert (Fish & Wildlife)	• Potential for severe adverse weather? • Political influences, lack of support, obstacles? • Unanticipated inflations in fuel, key materials? • Potential for market volatility impacting competition, pricing?	See discussion in first box above.	Marginal	Possible	1
EX-7	Tryon Highway 43 Culvert (Roads/Railroads)	• Potential for severe adverse weather? • Political influences, lack of support, obstacles? • Unanticipated inflations in fuel, key materials? • Potential for market volatility impacting competition, pricing?	See discussion in first box above.	Marginal	Possible	1
EX-8	Kelley Point Park (Recreation)	• Potential for severe adverse weather? • Political influences, lack of support, obstacles? • Unanticipated inflations in fuel, key materials? • Potential for market volatility impacting competition, pricing?	See discussion in first box above.	Marginal	Possible	1
EX-9	0					N/A
EX-10	0					N/A
EX-11	0					N/A
EX-12	Remaining Construction Items					N/A
EX-13	Planning, Engineering, & Design	• Potential for severe adverse weather? • Political influences, lack of support, obstacles? • Unanticipated inflations in fuel, key materials? • Potential for market volatility impacting competition, pricing?	See discussion in first box above.	Marginal	Possible	1
EX-14	Construction Management	• Potential for severe adverse weather? • Political influences, lack of support, obstacles? • Unanticipated inflations in fuel, key materials? • Potential for market volatility impacting competition, pricing?	See discussion in first box above.	Marginal	Possible	1

Lower Willamette Ecosystem Restoration
Feasibility (Alternatives)
Abbreviated Risk Analysis

Risk Evaluation

WBS	Potential Risk Areas	Project Scope Growth	Acquisition Strategy	Construction Elements	Quantities for Current Scope	Specialty Fabrication or Equipment	Cost Estimate Assumptions	External Project Risks	Cost in Thousands
01 LANDS AND DAMAGES	**Real Estate**								$5,187
06 FISH AND WILDLIFE FACILITIES	**BES Treatment Plant**	2	1	3	2	0	2	1	$581
06 FISH AND WILDLIFE FACILITIES	Kelley Point Park (Fish & Wildlife)	2	1	1	2	0	3	1	$5,428
06 FISH AND WILDLIFE FACILITIES	Kenton Cove	2	1	1	2	0	1	1	$366
06 FISH AND WILDLIFE FACILITIES	Oaks Crossing/Sellwood Riverfront Park	2	1	1	2	0	1	1	$455
02 RELOCATIONS	Tryon Highway 43 Culvert (Relocations)	3	1	3	3	0	3	1	$337
06 FISH AND WILDLIFE FACILITIES	Tryon Highway 43 Culvert (Fish & Wildlife)	3	1	3	2	2	2	1	$4,235
08 ROADS, RAILROADS, AND BRIDGES	**Tryon Highway 43 Culvert (Roads/Railroads)**	3	1	3	2	0	4	1	$1,400
14 RECREATION FACILITIES	**Kelley Point Park (Recreation)**	2	1	1	1	1	1	1	$1,103
0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$0
0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$0
0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$0
All Other (less than 10% of construction costs)	Remaining Construction Items	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$0
30 PLANNING, ENGINEERING, AND DESIGN	Planning, Engineering, & Design	2	1	0	1	0	0	1	$1,743
31 CONSTRUCTION MANAGEMENT	Construction Management	2	1	1	0	2	1	1	$1,390
									$17,039
Risk		$ 1,266	$ 356	$ 1,870	$ 485	$ 343	$ 995	$ 356	**$5,671**
Fixed Dollar Risk Allocation		$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$0**
	Risk	$ 1,266	$ 356	$ 1,870	$ 485	$ 343	$ 995	$ 356	**$5,671**
								Total	**$22,709**

APPENDIX H

MCACES Construction Cost Estimate Summary Report

Estimated by Tetra Tech, Inc
Designed by Tetra Tech, Inc
Prepared by Tetra Tech, Inc
Preparation Date 2/20/2015
Effective Date of Pricing 2/20/2015
Estimated Construction Time 560 Days

Description	Quantity	UOM	ContractCost	ProjectCost	C/O
Project Cost Summary Report			13,905,858	13,905,858	
Lower Willamette River Ecosystem Restoration	1.00	LS	13,905,858	13,905,858	
BES BES Treatment Plant	1.00	LS	580,501	580,501	
06 Fish and Wildlife Facilities	1.00	LS	580,501	580,501	
06 01 Mobilization and Demobilization	1.00	LS	85,152	85,152	
06 02 Site Preparation	1.00	LS	91,394	91,394	
06 03 High Water Refugia	1.00	LS	20,709	20,709	
06 04 Regrade Bank	1.00	LS	286,823	286,823	
06 05 Low-Flow Channel	1.00	LS	56,741	56,741	
06 07 Landscape	1.00	LS	39,681	39,681	
KENTON Kenton Cove	1.00	LS	366,320	366,320	
06 Fish and Wildlife Facilities	1.00	LS	366,320	366,320	
06 01 Mobilization and Demobilization	1.00	LS	43,500	43,500	
06 02 Site Preparation	1.00	LS	207,441	207,441	
06 03 Sand	1.00	LS	76,627	76,627	
06 04 Landscape	1.00	LS	38,752	38,752	
KELLEY Kelley Point Park	1.00	LS	6,531,220	6,531,220	
06 Fish and Wildlife Facilities	1.00	LS	5,428,443	5,428,443	
06 01 Mobilization and Demobilization	1.00	LS	206,369	206,369	
06 02 Site Preparation	1.00	LS	291,733	291,733	
06 03 Regrade Banks	1.00	LS	4,358,040	4,358,040	
06 05 Main Channel	1.00	LS	363,299	363,299	
06 06 Low-Flow Channel	1.00	LS	73,715	73,715	
06 07 Landscape	1.00	LS	135,287	135,287	
14 Recreation	1.00	LS	1,102,777	1,102,777	
14 01 Foot Bridges	1.00	LS	1,102,777	1,102,777	
OAKS Oaks Crossing/Sellwood Riverfront Park	1.00	LS	455,424	455,424	
06 Fish and Wildlife Facilities	1.00	LS	455,424	455,424	
06 01 Mobilization and Demobilization	1.00	LS	52,625	52,625	
06 02 Site Preparation	1.00	LS	121,599	121,599	
06 03 Backwatered Wetland	1.00	LS	206,073	206,073	
06 04 Landscape	1.00	LS	75,127	75,127	

Description	Quantity	UOM	ContractCost	ProjectCost	C/O
TRYON Tryon Highway 43 Culvert	1.00	LS	5,972,393	5,972,393	
			336,595.41	*336,595.41*	
02 Relocations	1.00	EA	336,595	336,595	
02 00 Mobilization and Demobilization	1.00	LS	36,229	36,229	
02 01 Sewer Trunk Relocation	1.00	LS	300,366	300,366	
06 Fish and Wildlife Facilities	1.00	LS	4,235,369	4,235,369	
06 01 Mobilization and Demobilization	1.00	LS	150,113	150,113	
06 02 Site Preparation	1.00	LS	555,218	555,218	
06 03 Culvert Replacement	1.00	LS	3,517,664	3,517,664	
06 04 Landscape	1.00	LS	12,375	12,375	
08 Roads, Railroads and Bridges	1.00	LS	1,400,429	1,400,429	
08 00 Mobilization and Demobilization	1.00	LS	119,621	119,621	
08 01 Roadway	1.00	LS	574,593	574,593	
08 02 Railroad	1.00	LS	706,216	706,216	

APPENDIX I

Real Estate Report

Table of Contents

Exhibits

1. Introduction

1.1. Real Estate Plan Purpose:

This Real Estate Plan (REP) is presented in support of the Lower Willamette River Ecosystem Restoration Project and the Feasibility Study and Integrated Programmatic Environmental Assessment Report dated February 2014 (The Study). This REP describes the real estate required to evaluate five selected sites and programmatic measures within the Lower Willamette River project area. The purpose of the REP is to: 1) identify the lands, easements, rights-of-way, relocations and disposal areas (LERRD) necessary to support construction, operation and maintenance of the project sites contained in the ecosystem feasibility report; 2) to outline the costs and real estate considerations associated with project implementation; and 3) to assess the Non-Federal Sponsor's (NFS) capability for LERRD acquisition. The City of Portland, Oregon is the NFS.

The Study includes plan formulation, the recommended plan, feasibility level design and project implementation cost estimates. The Study was prepared according to SMART (specific, measurable, attainable, relevant, and time-sensitive) planning guidelines, which have been instituted to make completion of feasibility studies more efficient and to shorten the time period between starting the study and completing a Chief's Report. This project was reset in November 2012, with a series of design charrettes at USACE Portland District. The purpose of the charrettes was to redefine the scope of the planning study, brief the vertical team on the status of the project, and start the timeline under which the Feasibility Study would be completed.

1.2. Previous Study Components and Study Authority:

The first component of the Study was the Lower Willamette River Ecosystem Restoration Analysis (USACE 2000a) dated December 2000 and amended in July 2002, which served as the basis for scoping the feasibility phase studies. The Study was originally intended to support an Environmental Dredging project for which general authority is contained in Section 312 of the Water Resources Development Act (WRDA) of 1990 as amended by Section 205 of WRDA 1996 and Section 224 of WRDA 1999. 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 initiated under Section 312(b) of WRDA 1990, 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.

Specific recommendations were not made in the Reconnaissance Report for addressing contaminated sediments or conducting ecosystem restoration studies. However, the report did specify that:

> *Environmental dredging authority for general ecosystem restoration, otherwise known as 312(b), could be used in any location in the study area to remediate ubiquitous contamination that is orphaned and not allocable to specific parties."*

Although the environmental dredging component of the Reconnaissance Study has not been implemented to date, the NFS and USACE have used this authority and subsequent congressional authorization passed in 2002 to prepare plans to restore habitat functions at five locations 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. General Project Description

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 Study area includes the Lower Willamette River Watershed as well as tributaries, Tryon Creek, and Columbia Slough. Access to the proposed sites will be by way of existing public roads unless otherwise stated.

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 RM 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.

Based on an assessment of the problems and opportunities along with the City-wide watershed framework and in consideration of the USACE ecosystem restoration mission, a set of goals and objectives were established for this study. Most of the study area is within the city limits of Portland, Oregon; however, the upper six river miles are in Clackamas County. USACE objectives for the Lower Willamette River Ecosystem Restoration effort are shown in the table below:

USACE Objectives for Lower Willamette River Ecosystem Restoration

USACE Objective	Restoration Measures
Reestablish communities of native plants in the floodplain and riparian areas.	Remove invasive species and minimize disturbance of native habitats. Re-vegetate 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 conditions to support the quality and diversity of biological communities.	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 by reestablishing key components of bank configuration and floodplain connectivity while continuing to support river dependent activities.	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.

From the 24 locations studied, the five (5) sites listed below were selected as potential restoration projects:

Kelley Point Park (Off-Channel and Riparian Restoration, Floodplain Enhancement): The intent of this alternative is to excavate two off-channel backwater areas, remove invasive plants, re-vegetate with native species, re-grade steep banks for floodplain enhancement, and place large woody debris (LWD) to enhance habitat complexity. Three prefabricated pedestrian bridge will be installed. Trails throughout the park would be adjusted to allow for restoration. Meandering channels will be cut along existing swales to allow for off-channel refugia. This will reduce the amount of fill to be removed.

The NFS owns 45.41 acres of the 47.37 acres required to support the proposed project in fee. The remaining 1.96 acres include Oregon Department of State Lands (DSL) controlled aquatic lands (see Sheet 3 of the attached Real Estate Maps).

BES Plant: (Off-Channel and Riparian Restoration, Bank Enhancement): The intent of this alternative is to excavate a more frequent connection to a floodplain backwater/swale area and enhance the riparian zone along Columbia Slough. Steepened bank angles would be reduced and LWD 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 enhanced 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 re-vegetating with native trees and shrubs. Pond turtle habitat would be enhanced by addition of LWD and boulders near the mouth of the channel between the slough and the low swale.

The NFS owns 7.74 acres in fee of the 11.6 acres required to support the proposed project. The remaining 3.86 acres include DSL controlled aquatic lands (see Sheet 1 of the attached Real Estate Maps).

Kenton Cove (Off-Channel Enhancement 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 canary grass. The intent of this alternative is to enhance this backwater cove with LWD, remove invasive species, and re-vegetate 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.

The NFS owns 1.59 acres of the 3.1 acres required to support the project; .83 acres are privately owned – the NFS will be requested to acquire those acres in fee; and the remaining .68 acres are DSL controlled aquatic lands (see Sheet 4 of the attached Real Estate Maps).

Oaks Crossing/Sellwood Riverfront Park (Off-Channel and Riparian Restoration, Wetland Enhancement): The site is located along the east bank of the Willamette River. Actions proposed at this site include excavation to create off-channel habitat, placement of LWD and revegetation with native riparian species. Excavation, grading, and planting removal would result in the disturbance of soils and movement of sediments.

The NFS owns 3.39 fee acres of the 9.96 acres proposed project lands; METRO owns 5.42 acres of the lands required to support the project, Oaks Park Association owns .46 acres. There are an additional .69 acres required for the project (Real Estate Map I.D. 256). County Assessor records do not reflect ownership information. The acreage appears to be part of the NFS owned Sellwood Recreation Park. These .69 acres are currently included in the miscellaneous acreages. The NFS will confirm its fee ownership during the next project phase (See Sheet 5 of the attached Real Estate Maps).

Highway 43 Tryon Creek Culvert (Culvert replacement for fish passage): The intent of this alternative is to replace the culvert beneath Highway 43 and the train line, which is a fish barrier under most flow conditions. The train line is operated by Portland and Western Railroad (PWR) formerly known as the Willamette Pacific Railroad. Preliminary project plans have been discussed with the PWR and with the Union Pacific Railroad (UP). The PWR is willing to operate on a functionally equivalent temporary rail line during project construction. The UP owns the railroad tracks and the underlying lands in fee but does not operate along the subject tracks. The UP leases the tracks to the PWR instead. The PWR and the UP will be treated as Relocations since the PWR's operations will be disrupted as a result of the project. The installation of a larger fish-friendly culvert beneath UP owned lands will be functionally equivalent to the existing culvert. The functionally equivalent work may take the form of alteration, lowering, raising, or replacement and attendant demolition of the affected facilities or modification or alteration of subject UP owned lands and should qualify as a facility relocation as defined by a PPA. Highway 43 will also be treated as a Relocation because it must be altered in order to accommodate the culvert removal and replacement actions. The Willamette Shorelines Trolley Lines is a tourist attraction that sporadically runs on UP tracks depending upon funding availability. The project has been discussed with the Trolley Lines Management. They raised no objections to the proposed project since their operating schedule is so erratic. Close coordination will be exercised during implementation planning to insure minimal if any disruption of the Trolley Line operations. Trolley Lines operating needs will be discussed with the Union Pacific Railroad as the project proceeds into design.

The City of Portland owns .76 acres of this 2.7 acre site; the Oregon Parks and Recreation Department owns .70 acres of proposed project lands; The City of Lake Oswego owns .11 acres of proposed project lands; the METRO owns .26 acres; .09 acres are privately owned; State of Oregon owns .67 acres; and the UP Right of Way is estimated to be .10 acres. (See Sheet 2 of the attached Real Estate Maps).

2. Description of Lands, Easements, Right Of Ways (By Site)

The NFS must provide the appropriate realty interest in all lands required for the construction operation and maintenance of the project. Features were designed to minimize the amount of land the sponsor should acquire. Estimated real estate values were sourced from a Gross Appraisal Report prepared by USACE Appraiser Jeff Atwood, Walla Walla, WA, District. The Effective Date of Value is April 15, 2014. The appraisal report was approved by NWD Chief Appraiser, Steve Herzog on 10 June 2014. The 2014 Gross Appraisal replaced the 2012 Gross Appraisal valuations prepared by USACE Appraiser Gregory N. Carnes, Louisville, KY because the proposed project footprint has been significantly refined and the acreages required to support the project have been reduced. Lands owned by the Non-Federal Sponsor are available and sufficient for the proposed project features. There are no special valuation considerations covering the Non Federal Sponsor's owned project lands.

2.1 Kelley Point Park

Map Key	Parcel ID	Owner	Project Acres	Estate	Land Use
164	R708882600	City of Portland	0.62	Fee	Recreation
253	Water	Oregon Dept of State Lands (DSL)	1.96	Channel Improvement Easement	Aquatic Lands
159	R708885000	City of Portland	44.79	Fee	Recreation
	Subtotal (rounded)		**47.37**		
A	Associated Map Key 159		.40	TWA Access	
B			.05	TWA Access	

	Subtotal Access and TWA (rounded)		**.45**		
	TOTAL Acreage (rounded)		**48.0**		

2.2 BES Plant

Map Key	Parcel ID	Owner	Project Acres	Estate	Land Use
123	R941050220	City of Portland	2.20	Fee	Industrial .
124	R941050180	City of Portland	5.54	Fee	Industrial
258	Water	DSL	3.86	Channel Improvement Easement	
Subtotal			**11.60**		
		ROW	.45		
A	Associated with MAP ID 123 – not valued		.01	TWA Access	
B			.16	TWA Access	
C			.01	TWA Access	
D			.38	TWA Access	
E			.04	TWA Access	
F			.13	TWA Access	
G			.81	TWA Staging	
H			.05	TWA Access	
Subtotal			**2.04**		
		TOTAL (rounded)	**14.00**		

2.3 Oaks Crossing/Sellwood Riverfront Park

Map Key	Parcel ID	Owner	Project Acres	Estate	Current Land Use
2	R991220510	METRO	.46	Channel Improvement Easement	Vacant
25	R991220570	METRO	4.71	Channel Improvement Easement	Vacant
26	R991220280	City of Portland	.22	Fee	Recreation
27	R991220410	City of Portland	2.89	Fee	Recreation
30	R752721360	City of Portland	.28	Fee	Recreation
177	R991220430	Oaks Park Association	.46	Fee	Misc. Recreation
179	R991230730	METRO	.25	Channel Improvement Easement	Recreation
256	Unknown	Unknown	.69	Easement	Open Space
		Subtotal (Rounded)	**9.97**		
E			.03	TWA Access	
F			.33	TWA Staging	
G			.12	TWA Access	
H			.02	TWA Access	
		Subtotal TWA Access and Staging	**.50**		
		TOTAL	**10.46**		

2.4 Kenton Cove

Map Key	Parcel ID	Owner	Project Acres	Estate	Land Use
99	R708885000	City of Portland	1.59	Fee	Imp. Recreation
251		DSL	.68		Aquatic Land
118	R314799	Dyno Overlays, Inc	.83	Fee	Recreation
		Subtotal (rounded)	**3.10**		
A			.36	TWA Staging	

B			.05	TWA Access	
C			.03	TWA Access	
		Subtotal (rounded)	**.44**		
		TOTAL (rounded)	**3.54**		

2.5 Tryon Creek Highway 43

Map Key	**Parcel ID**	**Owner**	**Proj. Acres**	**Estate**	**Land Use**
191	182037	City of Portland	.08	Fee	Industrial
195	5021791	City of Lake Oswego	.06	NSE Easement	Vacant
196	5021792	METRO	.26	Channel Improvement Easement	Vacant
199	5021795	City of Portland	.14	Fee	Vacant
237	186248	Oregon Parks & Recreation	.37	NSE Easement	Vacant
238	186257	Oregon Parks & Recreation	.33	NSE Easement	Vacant
240	193560	City of Portland	.54	Fee	Vacant
242	193604	Palahniuk Bender Properties LLC	.09	Fee	Single Family Residence
243	193613	City of Lake Oswego, OR	.05	NSE Easement	Vacant
245	193631	State of Oregon	.02	NSE Easement	Open Space
300	RR ROW	Union Pacific Railroad	.10	Relocation	Rail operations
		Total (rounded)	**2.7**		
		Total Fee	**.85**		
		Total Easement (rounded)	**1.85**		

Notes: Temporary Work Areas have not been finalized for Hwy 43 site as of this writing. Major railroads such as Union Pacific are reluctant to grant easement agreements to support pipeline/utility construction. A Utility Pipeline Easement or its equivalent is mandatory to support the project. The Risk Register reflects this concern. Since there is no parcel number for the subject UP owned lands, NWS-RE Cartography estimated .10 of an acre of Union Pacific lands are required to support the project. The acreage will be refined during the next project phase. The Non Federal Sponsor will work with the Union Pacific to secure the appropriate real estate interests.

3. **Disposal**: Excavated materials will be reintroduced to the project areas. Hazardous Materials (if any) will be transported to a commercial site. No real estate acquisitions are anticipated for disposal or borrow purposes.

4. **Federally Owned Lands Within Proposed Project LER**: There are no federally owned lands included within the LER required for the project.

5. **Existing Federal Projects Within Proposed Project LER:** There are no existing federal projects within the LER required to support the project.

6. **Estates**

6.1 Standard Estates

The standard estates that follow are from ER 405-1-12, Chapter 5, Change 7 of 8 Feb 79.

Fee:
The fee simple title to land described in Exhibit A, subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

Temporary Work Area Easement (TWAE):

A temporary easement and right-of-way in, on, over, and across (the land described in Schedule A) (Tracts Nos. ___, ___, and ___), for a period not to exceed ______________, beginning with date possession of the land is granted to the United States, for use by the United States, its representatives, agents, and contractors as a (borrow area) (work area), including the right to (borrow and/or deposit fill, spoil, and waste material thereon) (move, store, and remove equipment and supplies, and erect and remove temporary structures on the land and to perform any other work necessary and incident to the construction of the ___________________ Project, together with the right to trim, cut, fell, and remove therefrom all trees, underbrush, obstructions, and any other vegetation, structures, or obstacles within the limits of the right-of-way; reserving, however, to the landowners, their heirs and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired; subject however, to existing easements for public roads and highways, public utilities, railroads, and pipelines.

6.2 Non Standard Estate:

Permanent Ecosystem Restoration Easement (Non-Standard Estate):

A request for HQUSACE approval of a non-standard estate (NSE) consisting of a perpetual ecosystem restoration easement in lieu of fee has been submitted separately. At issue is publically owned lands where fee interest is not available to the NFS because. Public entities are charged with managing the land as a public resource and will not part with ownership. The NSE is required to cover public lands at the Tryon Creek and Oak

Parks/Sellwood sites. NWS-OC and HQUSACE-OC have reached vertical alignment and have agreed to the following minimal NSE language:

A perpetual and assignable right and easement in, on, over and across the lands of the Grantor to construct, operate, maintain, repair, alter, rehabilitate, remove, replace and monitor features of the Lower Willamette Ecosystem Restoration General Investigation Study; vegetative plantings, modifications and improvements within and adjacent to the stream or shore for grade control, or bank stabilization purposes; fish and wildlife habitat or other ecosystem restoration improvements; placement of materials or structures in the bed, banks, or shorelines that influence stream velocity or channel form; removal or placement of gravels, cobbles, and boulders, and other structures or conveyances to recharge or maintain flow to existing wetlands; together with the right to remove structures or obstructions including levees; reserving, however, to the owners, their heirs and assigns, all other rights and privileges, including but not limited to, those that may be used without interfering with or abridging the purposes of restoring and maintaining fish and wildlife habitat and ecological resource values and without interfering with or abridging the enumerated rights and easement hereby conveyed and acquired. Provided, specific use categories of the property shall not be permitted by the Grantor, their heirs and assigns, without the consent of the Grantee, including, but not limited to; the construction or erection of any buildings or structures; grading, excavating, re-contouring or removing soil or vegetation or the deposit of fill or spoil material; any use that will result in any change to streams, channels, drainage, flowage or watercourses on the property whether occurring naturally or artificially; the use of motorized vehicles or machinery; vegetation removal, cutting or the application of pesticides, herbicides, fertilizers or chemicals of any nature; the planting of vegetation or artificial seeding; and any activity that although otherwise permitted, causes the degradation of soil, water or air quality; all subject to existing easements for public roads and highways, public utilities, railroads and pipelines. Final NSE language approval will be sought post-project approval and subsequent to final language negotiations with the NFS.

7. Navigational Servitude

The Federal Navigational Servitude doctrine arises from two related components: navigation power which is derived from the commerce clause of the U.S. Constitution giving Congress regulatory power over navigable waters; and navigation servitude which provides that certain private property may be taken, without compensation to the landowner, if the taking is necessary to exercise the navigation power. Private ownership of land below navigable or tidal waters is acquired and held subject to the dominant public right of navigation. This dominant public right may be exercised by Congress without giving rise to a compensable taking. Navigational Servitude is not applicable and will not be exercised for this project.

8. Real Estate Map

Maps clearly depicting the project area, the tracts required to support the project is attached as Exhibit A.

9. Induced Flooding

No induced flooding is anticipated as a result of the proposed project.

10. Non Federal Sponsor Real Estate Acquisition Capability Assessment

The Non Federal Sponsor has fully demonstrated its real estate acquisition capability for the LERR required to support federal ecosystem restoration projects within the Portland District i.e. Westmoreland Section 206 Ecosystem Restoration Project 2012 – all LER required to support the project were acquired by the Non Federal Sponsor and the Non Federal Sponsor's interest in the real property required to certify the project was certified without incident. A Real Estate Acquisition Capability Assessment covering the proposed project is shown as Exhibit B to this Real Estate Plan.

11. Public Law 91-646 Relocations

The NFS is knowledgeable about Public Law 91-646 and is aware of the obligation to ensure compliance. It is not anticipated that Relocation Assistance Benefits will be provided as a result of this project. Prior to beginning land acquisition, the NFS will hold a public meeting to inform landowners of their rights and benefits available under Public Law 91-646, as amended.
There are no families or businesses that will be permanently displaced as a result of the project. However, there is a railroad whose operations may have to be altered during the construction of the Highway 43 culvert. (See discussion in Section 13 - Utilities and Facility Relocations below).

12. Zoning

There are no known zoning ordinances proposed in lieu of or to facilitate acquisition in connection with this project.

13. Mineral Interests

There are no known mineral interest right holders within project footprint.

14. Hazardous, Toxic and Retroactive Wastes
Due to the levels of pollution in the Lower Willamette River sediment from 100(+) years of industry Portland Harbor superfund site was added to the federal Superfund cleanup list in December 2000. The Portland Harbor Superfund site is designated as being from River Mile (RM) 1.9 up to downtown Portland at RM 11.8. As a result of a the policy decision dated_May 2013 to exclude sites that were identified as potential contaminated sites (referred to as Section 312b sites), all sites that were within the Portland Harbor area were removed from this project. A comprehensive investigation of the entire lower Willamette River area has been conducted by the Lower Willamette Group in the past two decades assuring that the designated Portland Harbor CERCLA site is well defined with appropriate best management practices in place on clean up protocol. Potential ecosystem restoration locations that were identified as having potential HTRW issues were removed during the screening process. Sites remaining in this

study were determined through this phase 1 site evaluation that the potential for significant HTRW presence appears to be low.

For the ecosystem restoration sites included in this study, a phase 1 site assessment for HTRW was conducted to determine if there is any current and/or historical contamination that could adversely influence the implementation of any future planned ecosystem restoration measures identified in this study. An HTRW professional conducted this phase 1 site assessment in accordance to ASTM E 1527.05 which included an environmental database search and site inspections. Relevant environmental databases included lists compiled by the Environmental Protection Agency (EPA) and the State of Oregon (EDR 2009). The Environmental Data Resources (EDR) database identified sites within a reasonable distance from our sites that will require further investigations as we move into design and construction phases of this project to assure no new incidences occur and that the regulations, monitoring and cleanup actions at those sites do not adversely affect surrounding properties or migrate into the groundwater or nearby water bodies.

- **The Kelley Point Park** site is downstream of the Portland Harbor area and concerns about contamination from the superfund site is considered to be low due to the strict restrictions placed on any type of disturbance or activities occurring in this area. The contaminated sediment in the Portland Harbor area is stable unless disturbed through dredging type activities, which is being strictly regulated by EPA. The Record of Decision (ROD) on the Portland Harbor CERCLA is estimated to be issued in late 2017. Any Portland Harbor CERCLA current or future clean up action(s) will require the site to be fully contained and controlled to prevent offsite migration of contaminants. Other HTRW properties (outside of the superfund site) were identified during the database search. Three sites were within a mile of Kelley Point Park. One identified site was listed for being on the underground injection control program maintained and regulated by ODEQ, one site for having a permit to discharge into the Columbia Slough via a NPDES permit, which also regulates and monitors any discharge. The other property was located across the slough, with permitted and listed contaminants on the property, a NPDES permit to discharge into the Columbia Slough, owner of the property on a voluntary clean-up program with oversite by ODEQ, past records of spills from the 1980's and 1990's that have been remediated. Potential for contamination from these sites to Kelley Point Park are low. Additional research and documentation of existing sampling data or the collection of new samples sufficient to confirm that there is a minimal risk of HTRW at Kelley Point Park will be completed during the PED phase of the project. Inclusion of Kelley Point Park in the project that will be constructed is conditioned on the analysis of this additional data confirming that the HTRW risk is minimal.

  The Bes Plant site is primarily in an industrial zone adjacent to the Columbia Slough. The search of available environmental databases for potential hazardous materials indicates 43 initial findings in the broad vicinity of the ecosystem restoration site. Three sites were within a mile of the site, none of these sites were closer than one-quarter mile from the limits of excavation of the ecosystem restoration project. The City of Portland, Bureau of Environmental Services has a Columbia Slough Watershed management group that manages, regulates, and oversees activity within this watershed area, along with EPA and DEQ. In 2014 the City completed an ecosystem restoration activity on the opposite shore of the BES plant site and no HTRW was recorded, observed, or identified.

- **The Kenton Cove** site is an off-channel cove surrounded by a maintained levee along the north side of the Columbia Slough. The search of available environmental databases for potential hazardous materials indicates 14 initial findings in the broad vicinity of the ecosystem restoration site. One site was indentified across the slough and on the other side of a peninsula from the limits of the Kenton Cove ecosystem restoration project. The City of Portland, Bureau of Environmental Services has a Columbia Slough Watershed management group that manages, regulates, and oversees activity within this watershed area, along with EPA and DEQ. Potential for contamination at this site is low.

- **The Oaks Crossing/Sellwood Riverfront Park** site is located along the east bank of the Willamette River. This site is upstream of the Superfund site by 4.2 river miles. This site has a low potential for contamination. There are no recorded instances of contamination near this site on this side of the river. There are two sites identified on the opposite shore and approximately one mile downstream of this site. The Willamette River is a major river with a consistently strong CFS flow year round creating the potential for contamination from these sites to the Oaks crossing site as very low.

- **Tryon Creek Highway 43 Culvert Site**. This site is located ¼ mile upstream on Tryon Creek from its confluence with the Willamette River. The culvert replacement would pass under existing highway and rail lines. Tryon Creeks confluence with the Willamette River is upstream of the Superfund site by about 8.2 river miles. Tyron Creek has no record of contamination. The potentially contaminated site identified through the HTRW site investigations that may have impacted this site when the study area extended to the confluence with the Willamette River. The study area has since been reduced, and the potentially contaminated site is now down-gradient of the project area, so the risk of contamination is lower than previously expected. This site has a low potential for contamination.

As a result of the phase one site investigation, no impacts on the real estate acquisition process and the LER value estimate due to known or suspected presence of contaminants that are located in, on, under, or adjacent to the LER required for the construction, operation, or maintenance of the project are anticipated or assumed. Recommend continued HTRW testing during the next phase and during construction of approved projects.

15. Landowner's Views and Public Opposition

The local community, neighborhood residents and other public stakeholders appear to be supportive of the proposed project. There have been no reports of public opposition to the project.

16. Outstanding Third Party Interests

All property interest acquired in support of the proposed project must take priority over any third party interests such as: public roads and highways, public utilities, railroads, and pipelines. Any third party interests that could defeat or impair the NFS's title to the property or interfere with construction, operation and maintenance of the project must be cleared from the title or subordinated to the interest made being available for the project.

Any other outstanding third party interests that will interfere with the Project that will not be cleared or subordinated must be satisfactorily addressed by the NFS attorney in the attached Risk Assessment document (See Exhibit C).

17. Risks Associated with Advanced Land Acquisition

The NFS was advised in writing of the risks (summarized below) associated with advance land acquisition activities. A summary of risks associated with advance land acquisition activities include, but is not limited to the following:

- Congress may not appropriate funds to construct the proposed project;
- The proposed project may otherwise not be funded, or approved for construction;
- A Project Cooperation Agreement (PCA) mutually agreeable to the NFS and the Government may not be executed and implemented;
- The NFS may incur liability and expense by virtue of its ownership of contaminated lands, or interests therein, whether such liability should arise out of local, state, or Federal laws or regulations including liability arising out of CERCLA, as amended;
- The NFS may acquire interests or estates that are later determined by the Government to be inappropriate, insufficient, or otherwise not required for the project;
- The NFS may initially acquire insufficient or excessive real property acreage which may result in additional negotiations and/or benefit payments under Public Law 91-646 as well as the payment of additional fair market value to affected landowners which could be avoided by delaying acquisition until after PCA execution and the

Government's notice to commence acquisition and performance of their lands, easements, and rights-of-way activities; and

- The NFS may incur costs or expenses in connection with its decision to acquire or perform their lands, easements and rights-of-way activities in advance of the signing of the PCA and the Government's notice to proceed which may not be creditable under the provisions of Public Law 99-662 or the PCA.

18. Utility and Facility Relocations- Tyron Creek Highway 43

Costs associated with relocations have been developed in the MCACES report and are only identified at the Tryon Creek Highway 43 site.

- Utility Relocations: There is a sewer main at the Tyron Creek Highway 43 site which must be relocated. There's also a power line tower at the Oaks Crossing site which will be protected in place during construction so that relocation will be unnecessary. NWP Costs engineers estimated the relocation costs as follows:

- $337,000 - Tryon Creek Highway 43 – (02 account – MCACES) Public Storm Utility Drainage and Sewage pipe line ~750 lf including 100 lf horizontal bore.

- $1,400, 429 – (08 account – MCACES) Highway 43 & Railroads Relocations:

  The PWR must temporarily reroute rail traffic during construction of the Tyron Creek Highway 43 site. Relocation compensation will apply to demolition and reconstructing of approximately 500 lineal feet of railroad, cost of temporarily operating along a temporary shoo-fly structure, fees and railroad flaggers. NWP, NWS officials met with PWR officials to launch initial discussion and to review the proposed project plans. PWR was supportive of the project and thought there would be no significant impact on their operations.

ANY CONCLUSION OR CATEGORIZATION CONTAINED IN THIS REAL ESTATE PLAN, OR ELSEWHERE IN THIS PROJECT REPORT, THAT AN ITEM IS A UTILITY OR FACILITY RELOCATION TO BE PERFORMED BY THE NON-FEDERAL SPONSOR AS PART OF ITS LERRD RESPONSIBILITIES IS PRELIMINARY ONLY. THE GOVERNMENT WILL MAKE A FINAL DETERMINATION OF THE RELOCATIONS NECESSARY FOR THE CONSTRUCTION, OPERATION, OR MAINTENANCE OF THE PROJECT AFTER FURTHER ANALYSIS AND COMPLETION AND APPROVAL OF FINAL ATTORNEY'S OPINIONS OF COMPENSABILITY FOR EACH OF THE IMPACTED UTILITIES AND FACILITIES.

19. Preliminary Opinion of Compensability/Real Estate Assessment

A formal Attorney's Opinion of Compensability will be prepared by NWS Office of Counsel as the project moves forward into the design planning stage. Meanwhile, a Real Estate Assessment has been developed as follows:

(a). A culvert will be installed beneath Union Pacific Railroad fee owned lands at the Tryon Creek site. A preliminary review indicates Union Pacific appears to have a compensable interest in the subject lands.

(b). City of Portland owned sewer lines will have to be relocated as a result of the project. The City of Portland also owns a public storm utility drainage and sewage pipe line that must be relocated. The City of Portland appears to have a compensable interest in those lines.

(c). The Portland Western Railroad (PWR) owns and operates a local short-line service on railroad real property owned by Union Pacific Railroad. PWR leases the tracks and lands from Union Pacific Railroad and appears to have a compensable interest. The proposed alternative to address PWR interest impacted by the Tyron Creek project is to provide PWR with a temporary rail line so that rail service to their customers will not be interrupted.

20. Baseline Cost Estimate for Lands Easements and Rights-of-Way

The Baseline Cost Estimate presented in the table below includes a breakdown of the estimated fair market value of project lands, the NFS's acquisition costs, and Federal review and assistance costs. NFS acquisition costs include incidental acquisition costs such as title, survey and appraisal, and negotiation costs; recording fees; and legal fees. Federal review and assistance costs include those associated with providing the NFS with LERR requirements, review of acquisitions and LERRD crediting appraisal reports, coordination meetings, title analysis actions, legal support, and crediting activities. The total estimated cost of Lands and Damages plus relocations and administrative costs is approximately $7.1Million. For inflation and contingencies see the "Total Project Cost Summary" sheet in Appendix H.

Estimated land valuations were sourced from a USACE Gross Appraisal prepared by Jeff Atwood of NWW. The effective date of value is April 15, 2014. The Gross Appraisal Report was approved by NWD's Chief Appraiser Steve Herzog. Estimated flagger/fees Relocation Costs were secured from NWP Cost Engineer, Joseph Russell on July 26, 2013. Sewer line relocation, Highway 43 and railroad relocation cost were quoted from the 2015 MCACES cost estimation report see Appendix H.

Site No.	Site Name	Total Project Acres	Estimated Land and Damages Values (Fee) 01 account MCACES	Estimated Easement Values	Land Values (TWAE)	Non-Federal Sponsor's Admin Costs	Federal Gov't Review & Assistance Costs	Total LER per Site (rounded)
2.1	Kelley Point	48	$2,043,000	$2205	$2295	$50,000	$20,000	**$2,118,000**

2.2	BES	14	$2,212,000	$28,950	$23,000	$20,000	$10,000	**$2,300,000**
2.3	Oaks Crossing	10.46	$291,000	$124,000	$900	$30,000	$12,000	**$458,000**
2.4	Kenton Cove	3.54	$110,000	765	$600	$10,000	$10,000	**$131,000**
2.5	Tryon Creek Culvert (Hwy 43)	2.70	$326,000	$22,500*	-	30,000	20,000	**$376,000**
2.5	Tryon Creek Sewer line relocation		$337,595 (Relocation) 02 account MCACES	-	-	-	-	**$337,595**
2.5	Tryon Creek Hwy 43 Road and Railroad Relocations		$1,400,429* (Relocation) 08 account MCACES	-	-	-	-	**$1,400,429**
	Sub Total All Sites	**78.70 Acres**	**$6,850,024**	**$155,920**	**$26,795**	**$140,000**	**72,000**	**$7,121,024**

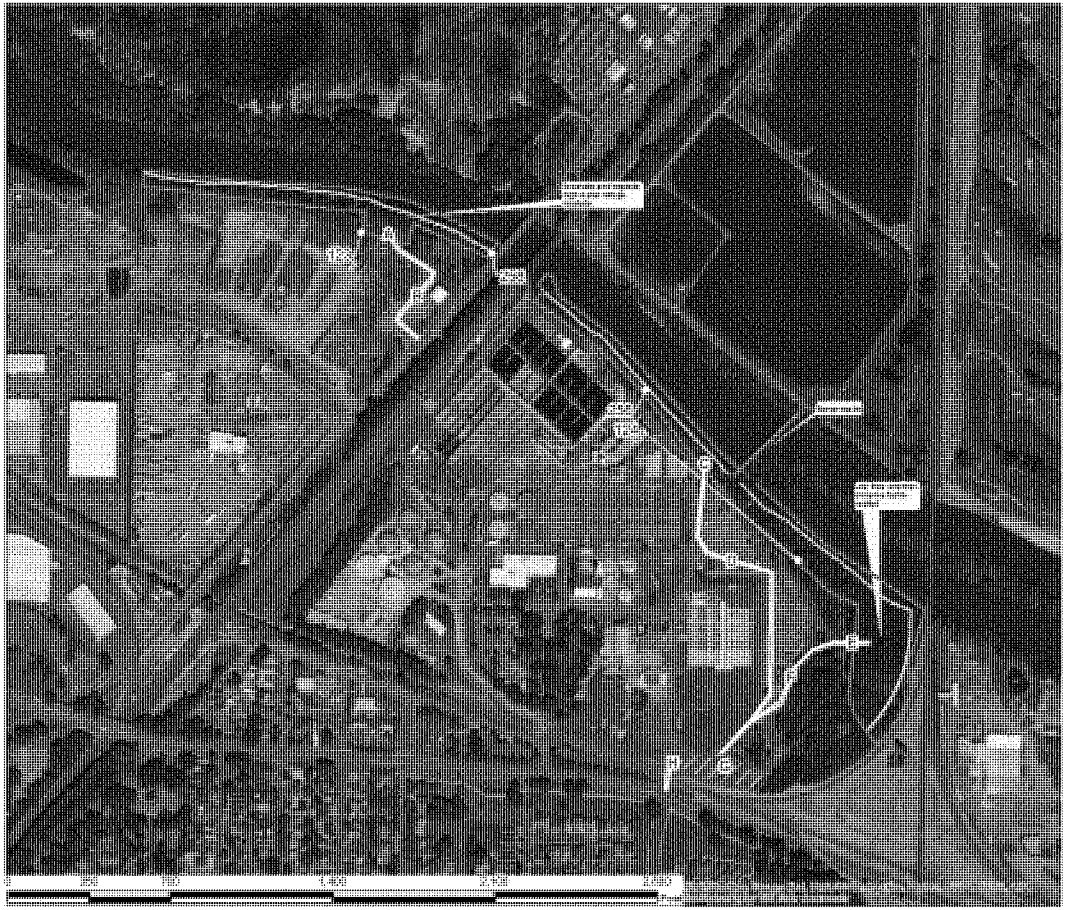
Note: *Estimated value includes $10,000 Union Pacific permitting cost

21. Other Real Estate Matters

The Risk Register will be amended to reflect the PWR rail operations relocation, Highway 43 Relocations, and the Union Pacific Relocation issues.

22. Real Estate Acquisition and Milestones

Congressional authorization of the proposed projects must be secured in order to begin Real Estate acquisition planning. Further, real estate acquisitions will begin once a PPA is fully executed between USACE and the Non Federal Sponsor. The Non Federal Sponsor will be asked to certify the proposed minimum real property interests necessary to support project construction and subsequent operation and maintenance of the perpetual project elements. The PPA is scheduled to be signed sometimes during FY2015. A separate request for approval of the Non-Standard Ecosystem Restoration Estate language was submitted through NWD for HQ USACE approval. Vertical alignment has been reached between the District's Office of Counsel and HQUSACE Office of Counsel with reference to the minimal Non Standard Estate language. Final Non Standard Estate language will be submitted for approval after the project has been approved and prior to the signing of the PPA.



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Notes:

1) Design drawings and project boundaries provided by TetraTech on Sep 28,2011 and Feb 20, 2012.

2) Parcel lines and acreage from Metro Taxlots GIS layer.

Legend

- Project Areas
- Taxlots in Project Areas
- Temporary Construction Access
- Temporary Construction Staging
- Woody Debris

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SEATTLE, WASHINGTON

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BES Treatment Plant Banks
Lower Willamette River
Ecosystem Restoration
General Investigation
OREGON STATE Multnomah County

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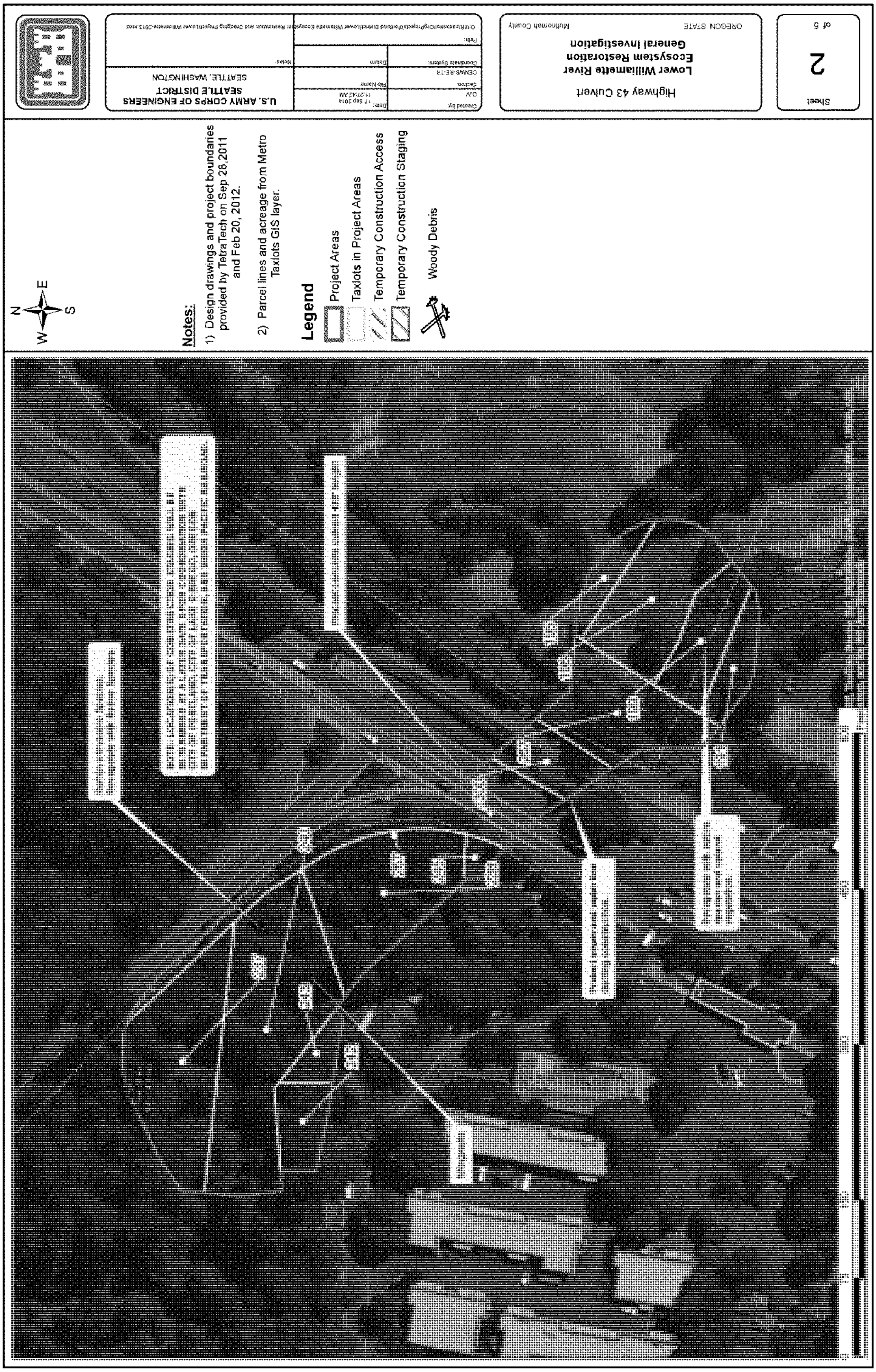
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Taxlots in Project Areas
Temporary Construction Access
Temporary Construction Staging
Woody Debris
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Highway 43 Culvert
Lower Williamette River
Ecosystem Restoration
General Investigation
Multnomah County
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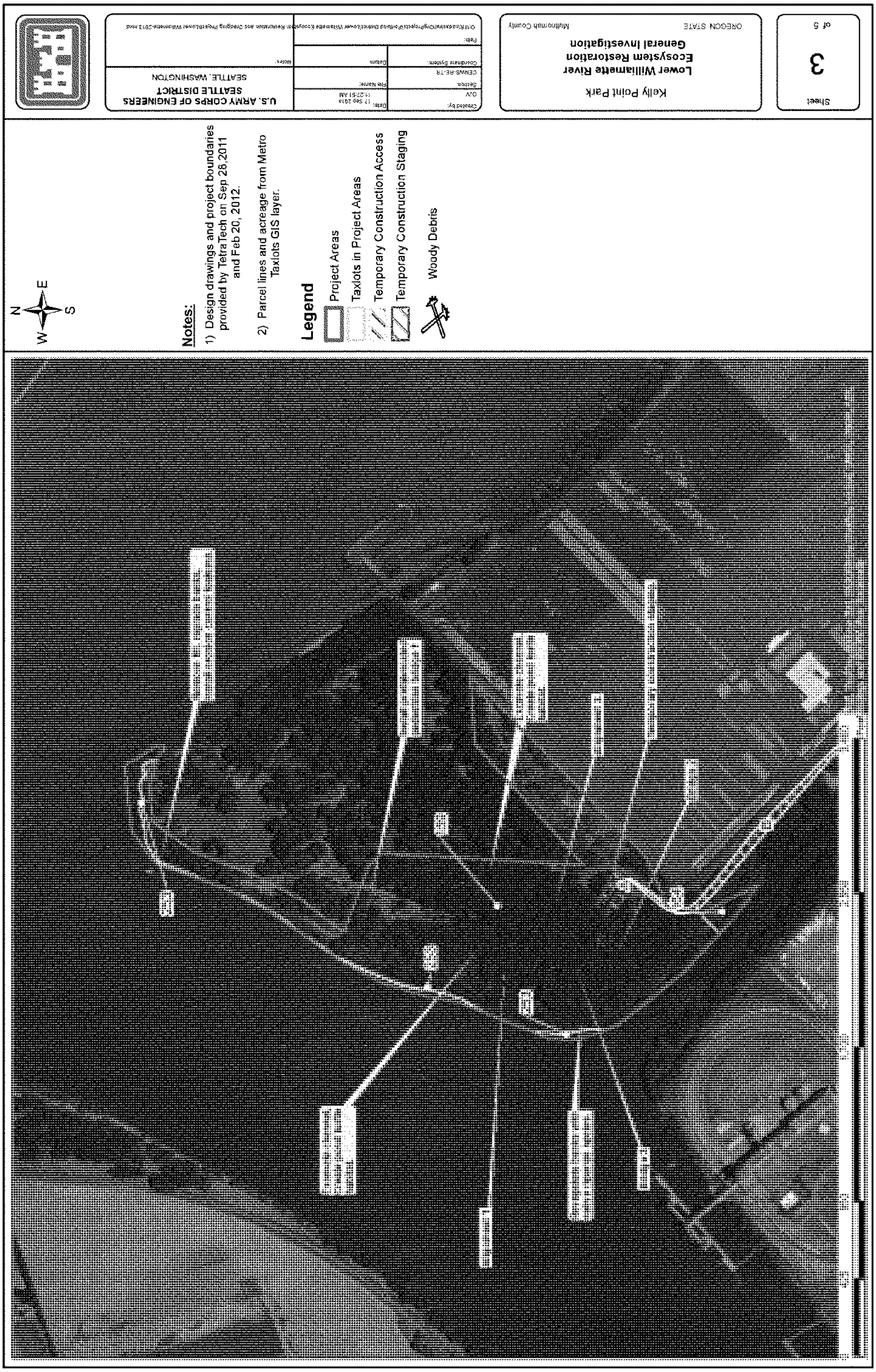
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Project Areas
Taxlots in Project Areas
Temporary Construction Access
Temporary Construction Staging
Woody Debris

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Legend

- Project Areas
- Taxlots in Project Areas
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- Woody Debris

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Kenton Cove

Lower Williamette River
Ecosystem Restoration
General Investigation

OREGON STATE Multnomah County

Sheet
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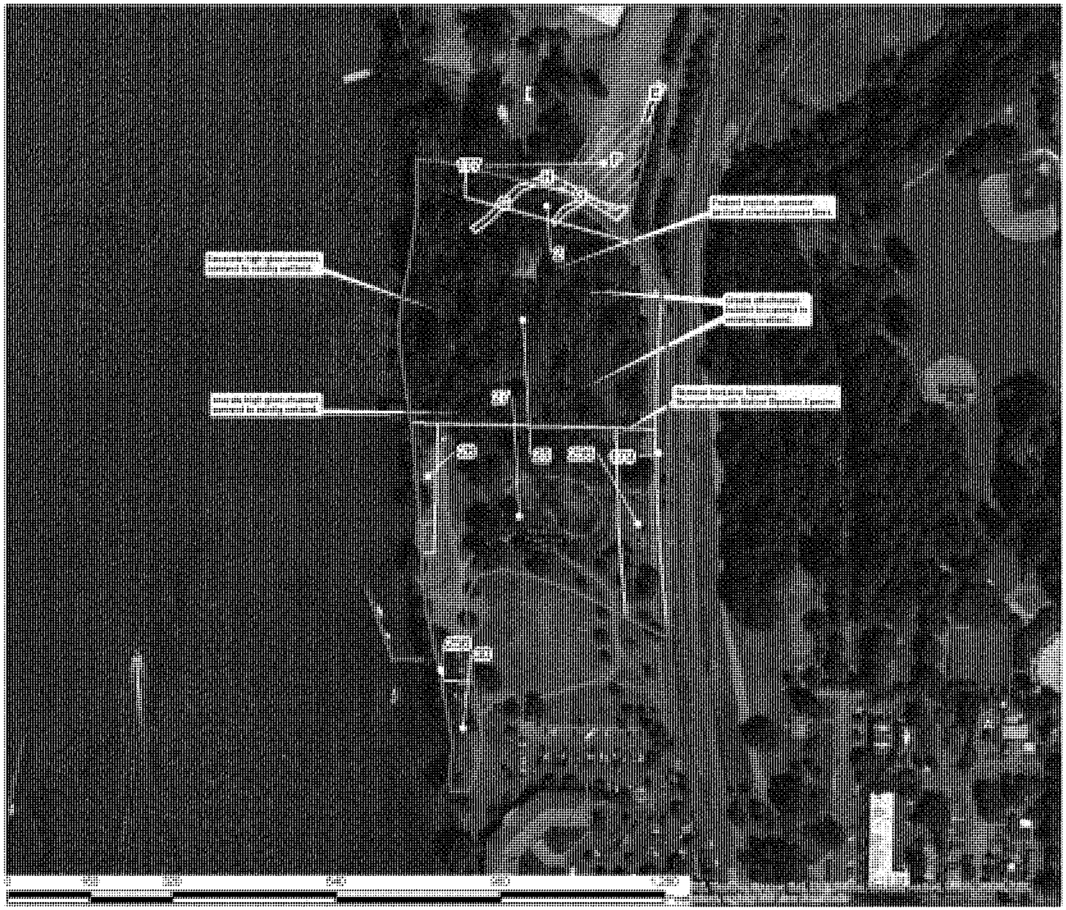

N W E S

Notes:

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2) Parcel lines and acreage from Metro Taxlots GIS layer.

Legend

- Project Areas
- Taxlots in Project Areas
- Temporary Construction Access
- Temporary Construction Staging
- Woody Debris

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Oaks Crossing Sellwood
Lower Willamette River
Ecosystem Restoration
General Investigation

OREGON STATE Multnomah County

Sheet **5** of 5

LOWER WILAMETTE ECOSYSTEM RESTORATION PROJECT AND FEASIBILITY STUDY AND INTEGRATED PROGRAMMATIC ENVIRONMENTAL ASSESSMENT OF NON-FEDERAL SPONSOR'S REAL ESTATE ACQUISITION CAPABILITY

I. **Legal Authority:**

a. Does the sponsor have legal authority to acquire and hold title to real property for project purposes? YES

b. Does the sponsor have the power of eminent domain for this project? YES

c. Does the sponsor have "quick-take" authority for this project? NO

d. Are any of the lands/interests in land required for the project located outside the sponsor's political boundary? YES -- some project lands are located in the City of Lake Oswego.

e. Are any of the lands/interests in land required for the project owned by an entity whose property the sponsor cannot condemn? Yes -- The City of Portland cannot condemn State of Oregon owned real estate interests or lands.

II. **Human Resources Requirements:**

a. Will the sponsor's in-house staff require training to become familiar with the real estate requirements of Federal projects including P.L. 91-646, as amended? NO

b. If the answer to II.a. is "yes," has a reasonable plan been developed to provide such training? N/A

c. Does the sponsor's in-house staff have sufficient real estate acquisition experience to meet its responsibilities for the project? YES

d. Is the sponsor's projected in-house staff level sufficient considering its other work load, if any, and the project schedule? YES

e. Can the sponsor obtain contractor support, if required, in a timely fashion? YES

f. Will the sponsor likely request USACE assistance in acquiring real estate? NO (If "yes," provide description). NO

III. **Other Project Variables:**

a. Will the sponsor's staff be located within reasonable proximity to the project site? YES

b. Has the sponsor approved the project/real estate schedule/milestones? YES

Sections I, II, III prepared by:

Kaitlin L. Lovell

KAITLIN L. LOVELL
Division Manager
Bureau of Environmental Services
City of Portland

Sections I, II, III reviewed/approved by NFS

Kaitlin L. Lovell

KAITLIN L. LOVELL
Division Manager
BES
City of Portland

Sections IV/V to be completed jointly by NFS and USACE Real Estate Specialist

IV. **Overall Assessment:**

a. Has the sponsor performed satisfactorily on other USACE projects? Yes, Westmoreland Section 206 Ecosystem Restoration Project

b. With regard to this project, the sponsor is anticipated to be Highly Capable

V. **Coordination:**

a. Has this assessment been coordinated with the sponsor? YES

b. Does the sponsor concur with this assessment? YES

Prepared by:

Doris L. Cope

DORIS L. COPE
Realty Specialist

Reviewed and approved by:

Christopher D. Borton

CHRISTOPHER D. BORTON
Chief, Real Estate Division

EXHIBIT E

D R A F T

RISK ANALYSIS FOR OUTSTANDING THIRD PARTY INTERESTS

RE: Certification of Lands and Authorization for Willamette Floodplain Ecosystem Restoration GI Study

There are outstanding third party interests of record in and to the lands required for the Project. An evaluation of those interests is as follows:

1. **IDENTIFICATION OF THIRD PARTY INTERESTS**:

2. **ASSESSMENT:** (Discuss whether the exercise of that interest is likely to physically impair the Project. Discuss the legal implications if the interest is not cleared or subordinated. Discuss the practical impediments to the exercise of the interest such as any required permits, land use restrictions, or compensation.)

3. **PLAN TO RESOLVE:** (Discuss recourse available to protect the Project in the event the outstanding interest is exercised).

Signed:

__________________________________ DATE _____________

Attorney for The City of Portland