US Army Corps of Engineers ®
Portland District

Draft Integrated Implementation Report and Environmental Assessment

Post Office Lake
Ridgefield National Wildlife Refuge

Section 536 Ecosystem Restoration Project
Clark County, Washington

West Shore of Post Office Lake

Project Partners:
U.S. Army Corps of Engineers
U.S. Fish and Wildlife Service

DRAFT Environmental Assessment, January 2013

EXECUTIVE SUMMARY

According to the Lower Columbia River Estuary Partnership, "Habitat restoration is crucial to lower Columbia River recovery efforts. In the last 100 years, wetland habitat within the lower Columbia River corridor has decreased by as much as 75% from historic levels. Marshes and forested wetlands have also decreased, while developed land and open water have increased. Dike and levee construction, development, hydrosystem operations, and other activities all have contributed to habitat loss" (http://www.lcrep.org/habitat-restoration).

The U.S. Army Corps of Engineers, Portland District (Corps) and the project partner, the U.S. Fish and Wildlife Service (USFWS), propose to restore tidal flow and fisheries access to approximately 134 acres (at elevation approximately 18.4 or the 2-year flood event) of Post Office Lake, and to restore approximately 15 acres of native riparian habitat on the Ridgefield National Wildlife Refuge located at Columbia River miles 94.4 to 95.3 near the City of Ridgefield in Clark County, Washington. The proposed restoration actions will most likely benefit a multitude of fish and wildlife species, including Columbia River salmonids that are listed under the Endangered Species Act, as well as some waterfowl and other migratory bird species. The proposed action may also impact some migratory bird species such as diving ducks and grebes as well as some macro-invertebrates that require lacustrine or semi-permanently flooded wetland habitat. Proposed restoration of tidal sloughs and riparian habitat, particularly their connectivity to the mainstem Columbia River, will better mimic the natural wetland/riparian forest/tidal channel sloughs that were historically more prevalent in the Columbia River estuary than under present conditions.

Restoration of habitat for juvenile salmonids migrating through the lower Columbia River and the estuary is an important component of regional recovery plans. The proposed restoration actions address some of the limiting factors in addition to fish and wildlife needs identified in the 2002 *Lower Columbia River and Columbia River Subbasin Summary* prepared by the Columbia Basin Fish and Wildlife Authority (http://www.cbfwa.org/FWProgram/ReviewCycle/fy2003ce/workplan/020517LowerColEstuary.pdf). The proposed restoration actions are consistent with and will help achieve the Northwest Power and Conservation Council's biological objectives outlined in their 2000 *Columbia Basin Fish and Wildlife Program* (http://www.nwcouncil.org/library/2000/2000-19/default.htm). The proposed restoration actions are also congruent with those described in the 2011 *Columbia River Estuary Endangered Species Act Recovery Plan Module for Salmon and Steelhead* developed by the National Marine Fisheries Service. The proposed actions address habitat restoration requirements for salmonids listed under the Endangered Species Act.

This integrated Draft Implementation Report and Environmental Assessment examines existing conditions at Post Office Lake and proposes alternatives for restoring important habitat functions, identifies a National Ecosystem Restoration plan, and evaluates the potential environmental impacts of the preferred alternative in accordance with the Corps' environmental mission and in support of the Federal Columbia River Power System Biological Opinion. This report documents the potential environmental impacts in accordance with the National Environmental Policy Act.

Based on the cost effectiveness and incremental cost analysis, the recommended plan is Alternative 5 (also referred to as the Preferred Alternative plan). This recommended/preferred plan is the National Ecosystem Restoration (NER) plan. This alternative includes north channel improvements, asphalt scarification, levee height reduction measures, and associated riparian habitat improvements that are combined to provide virtually year-round fish access and improved water quality within Post Office Lake, without substantial detrimental effects on the environment and USFWS trust species. The total federal

cost, including costs for operation and maintenance, and monitoring, but excluding feasibility study costs, is estimated at $5,107,000. The total annualized O&M cost is estimated at $4,000. The Corps is expected to pay the costs of construction and the USFWS is expected pay for operation and maintenance, once the project is placed in service.

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ACRONYMS AND ABBREVIATIONS

°C	degrees Centigrade
°F	degrees Fahrenheit
AEMR	Action Effectiveness Monitoring and Research
APE	area of potential effect
BCOE	biddability, constructability, operability and environmental
BiOp	Biological Opinion
BMP	best management practice(s)
BPA	Bonneville Power Administration
CCP	Comprehensive Conservation Plan
cy	cubic yards
Corps	U.S. Army Corps of Engineers
CRE	Columbia River Estuary
CRFM	Columbia River Fish Mitigation program
CRITFC	Columbia River Inter-Tribal Fish Commission
CWA	Clean Water Act
DAHP	Department of Archaeology and Historic Preservation
DO	dissolved oxygen
EFH	essential fish habitat
EPA	U.S. Environmental Protection Agency
ERTG	Expert Regional Technical Group
ESA	Endangered Species Act
ESU	evolutionarily significant unit
FCRPS	Federal Columbia River Power System
FEMA	Federal Emergency Management Agency
FONSI	Finding of No Significant Impact
HEP	Habitat Evaluation Procedure
HSI	Habitat Suitability Index
HU	habitat unit(s)
ISAB	Independent Scientific Advisory Board
IWWW	in-water work window
JARPA	Joint Aquatic Resources Permit Application
LCREP	Lower Columbia River Estuary Partnership
mg/L	milligrams per liter
MHHW	mean higher high water
MLLW	mean lower low water
MOA	Memorandum of Agreement
MRL	method reporting limit
MSL	mean sea level
MTL	mean tide level

ACRONYMS AND ABBREVIATIONS (CONTINUED)

NAVD	North American Vertical Datum
NEPA	National Environmental Policy Act
NER	National Ecosystem Restoration
NLCD	National Land Cover Data
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPCC	Northwest Power and Conservation Council
NPDES	National Pollutant Discharge Elimination System
OHW	ordinary high water
O&M	operation and maintenance
PDT	Project Delivery Team
RM	river mile(s)
ROC	resources of concern
RPA	reasonable and prudent alternative
PAH	polycyclic aromatic hydrocarbon(s)
PCB	polychlorinated biphenyl(s)
PCE	primary constituent element(s)
PDT	project delivery team
SBU	survival benefit unit(s)
SEF	Sediment Evaluation Framework
SI	suitability index
SL	screening level(s)
SPIF	Specific Project Information Form
SWPPP	Stormwater Pollution Prevention Plan
TMDL	total maximum daily load(s)
ug/kg	micrograms per kilogram
USFWS	U.S. Fish and Wildlife Service
USGCRP	U.S. Global Change Research Program
USGS	U.S. Geological Survey
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WDNR	Washington Department of Natural Resources
WDOE	Washington Department of Ecology
WRDA	Water Resources Development Act
WSDOT	Washington State Department of Transportation
WSEL	water surface elevation

1. INTRODUCTION

1.1. STUDY AUTHORITY

This integrated Draft Implementation Report and Environmental Assessment is submitted under authority of Section 536 of the Water Resources Development Act (WRDA) of 2000 (Public Law 106-541), which authorizes the U.S. Army Corps of Engineers (Corps) to conduct studies and implement ecosystem restoration projects necessary to protect, monitor, and restore fish and wildlife habitat in the lower Columbia River and Tillamook Bay estuaries. For planning and program purposes, the limits of the lower Columbia River estuary are defined as the mainstem section and tidally influenced portions of tributaries, extending from the mouth to Bonneville dam at approximately river mile (RM) 145. The physically correct boundary of the estuary is from RM 0 to approximately RM 28, which roughly corresponds with distinctions in tidal effects and extent of the salinity plume. This authorization directs the Corps to use the comprehensive conservation management plans developed by the Lower Columbia River Estuary Partnership (LCREP) as a guide for the development of possible restoration projects. The original management plan guidance developed in 1999 was updated in 2011. This report is being submitted to implement Section 536 projects in accordance with the most recent guidance and procedures for the Continuing Authorities Program described in Appendix F of Engineer Regulation 1105-2-100 for projects under Section 206 of WRDA 1996. This project is being conducted in cooperation with the U.S. Fish and Wildlife Service (USFWS) and meets all the requirements of the 536 authority. The Corps and USFWS also have become cooperating agencies for the purpose of meeting National Environmental Policy Act (NEPA) compliance requirements.

1.2. BACKGROUND

Post Office Lake is located within the Ridgefield National Wildlife Refuge (Refuge) in Clark County, Washington. The lake is situated adjacent to the Columbia River on the east bank approximately centered at RM 95. It is located east of Sauvie Island (located on the Oregon side of the Columbia River), south of the City of Ridgefield and northwest of the City of Vancouver, Washington. The lake is situated south of Campbell Lake and immediately west of Green Lake and Lake River in the southern portion of the Refuge. Figure 1 shows the location of Post Office Lake and Figure 2 shows the Refuge and its units.

Post Office Lake is in the Ridgeport Dairy Unit, the southernmost unit of the Refuge (see Figure 2). The study area is approximately 175 acres and its extent is outlined in red on Figure 1. The restoration project aims to re-establish access to approximately 100 acres of wetland and marsh habitat, including the existing 75 acres of open water.

Post Office Lake was historically connected to the Columbia River and provided floodplain and backwater habitat for a variety of native species including anadromous salmonid fish. The previous connection between the Columbia River and the lake through the existing levee was through a small open channel located on the north end of the lake. In the past, flows were conveyed past Highway 501 (Lower River Road), under a small concrete bridge. The bridge was later removed and replaced with a culvert with a tide gate to regulate flows between the water bodies. The most recent tide gate structure was built in the early 1990s (the exact date of construction is unknown).

Figure 1. Post Office Lake and Vicinity

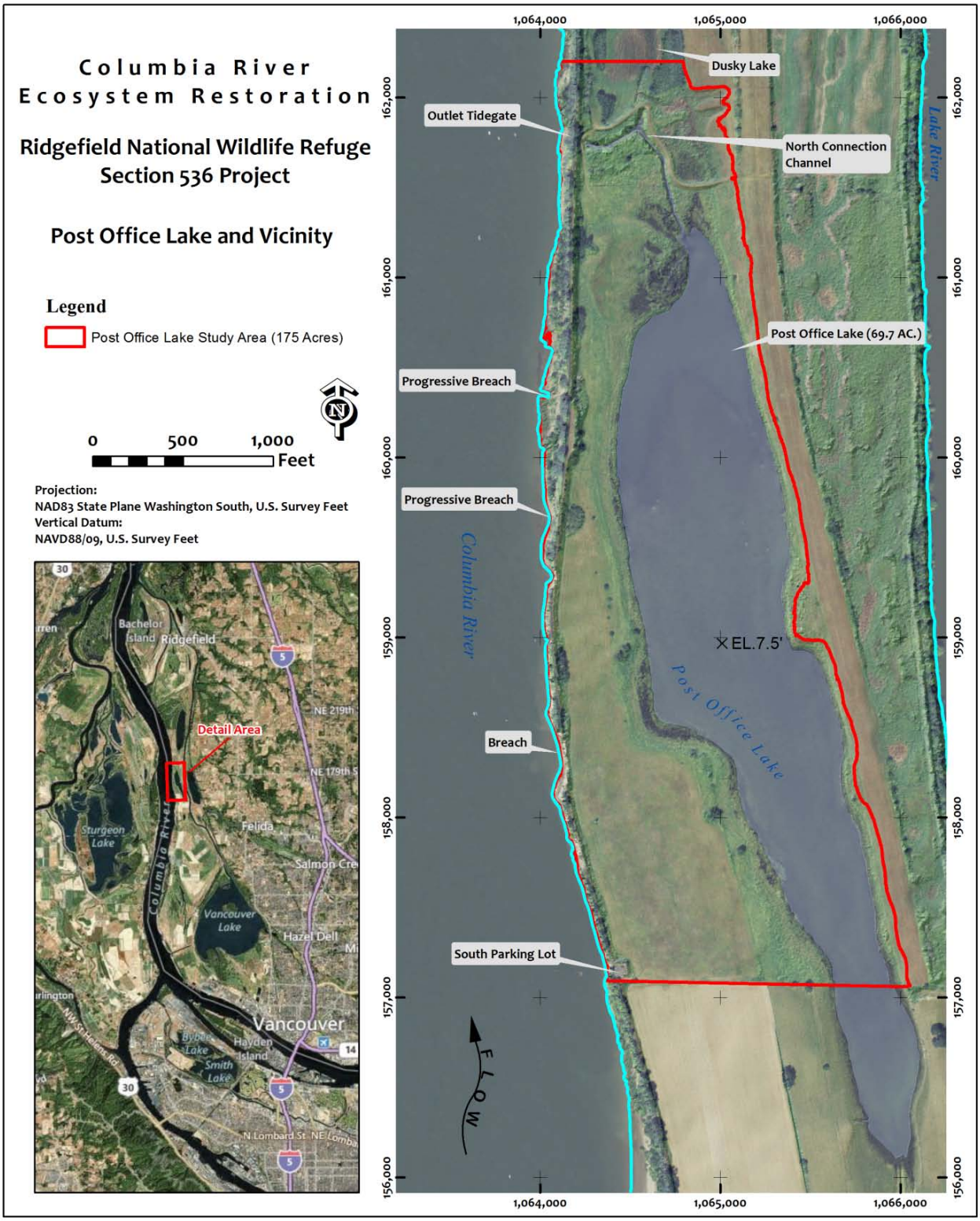
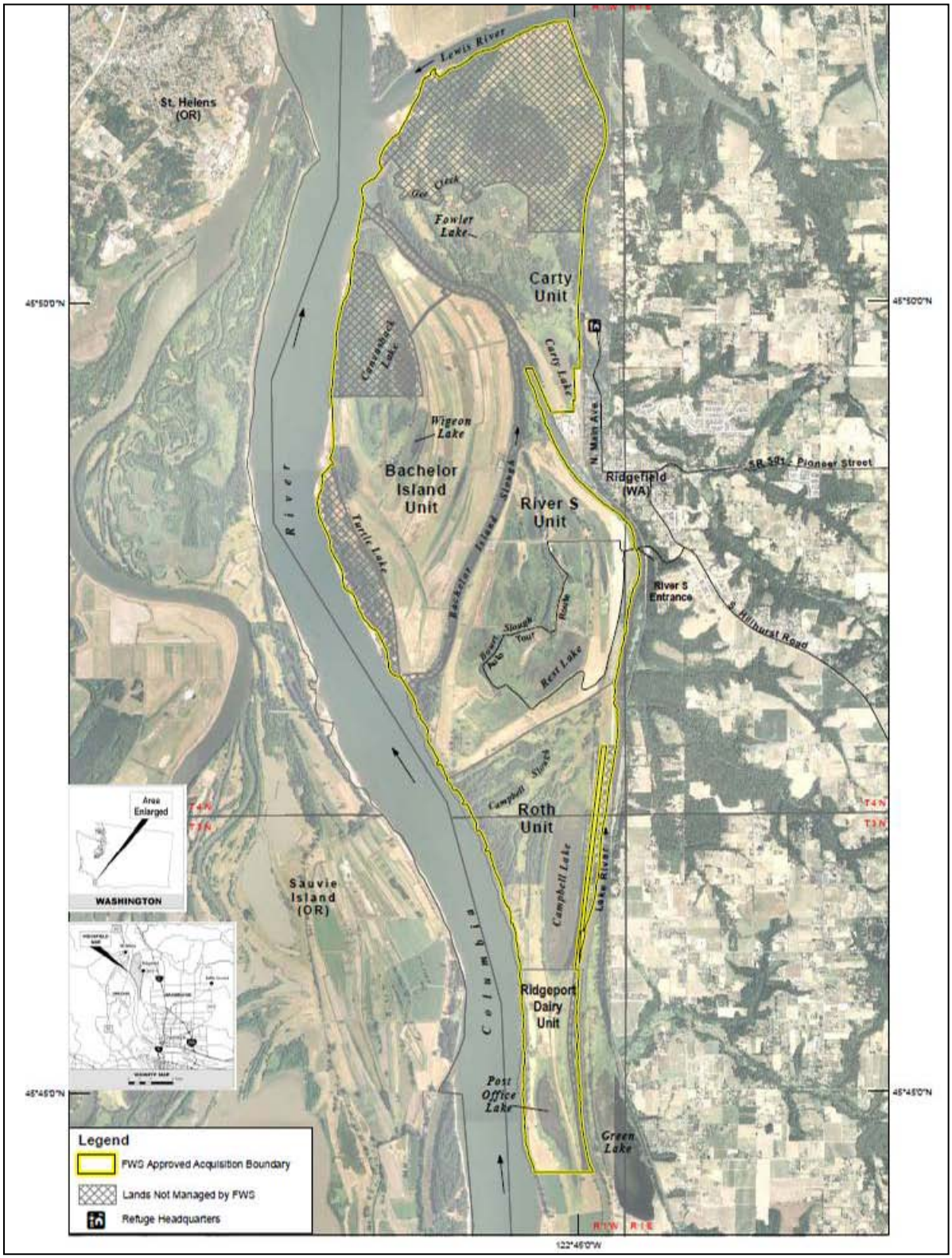


Figure 2. Ridgefield National Wildlife Refuge and Vicinity



The existing (north) connection channel between the water bodies was previously dredged, with dredged material placed along the banks. The current ditch cross-section is characterized as an over-steepened, U-shaped channel with a mix of both invasive and native species. The sides and top of the channel are occupied by Himalayan blackberry (*Rubus armeniacus*) and other invasive species. The water column within the channel supports stands of burr-reed, sago pondweed, *Elodea* spp., as well as coon's tail (*Ceratopyllum demersum*) and Eurasian watermilfoil (*Myriophyllum spicatum*) in the lake (Corps 2011c). It also serves as an outlet channel for the water control structure that manages wetland hydrology in the northern, adjacent Dusky Lake Unit. The tide gate structure regulated flows and thus had a considerable effect on wetland hydrology in the northern portion of Post Office Lake and adjacent Dusky Lake (located immediately north of the connection channel, see Figure 1).

The tide gate structure has become non-functional without regular maintenance and removal of debris. It is believed that the culvert itself has become non-functioning and very limited water exchange can occur due to debris blockage occluding the culvert that restricts flow to periods when there is sufficiently high elevation differences between the river and the lake. It is also thought that beavers may have built up material inside the culvert structure, further impinging connectivity. The duckbill-type aperture at the downstream end of the culvert also appears to have been improperly installed or has shifted to a crushed, non-functional position since installation. Figure 3 shows the existing condition of the culvert. The structure has been left as-is by the USFWS because the culvert/tide gate condition does not interfere with current Refuge wetland management.

Figure 3. Post Office Lake Tide Gate Culvert

Note: Tide structure consists of a 30-inch pipe culvert capped by rubberized duckbill tide gate (tideflex). The pipe is protected by a concrete encasement. The box extends through Lower River Road, Columbia levee to the east, and connects with the channel located north of Post Office Lake. Note the large concrete debris, remnants of old Highway 501 bridge.

The USFWS recognizes that because of the loss of connectivity, the wetland functionality has been reduced, particularly with respect to anadromous fish rearing habitat, wapato (*Saggitaria latifolia*) beds, and native mussel beds. Post Office Lake supports dense to moderately dense stands of sago pondweed, as well as some invasive weed species such as curly-leaved pondweed and Eurasian milfoil that reduce the habitat quality of the wetland.

During the 1996 February flood event, progressive breaches were observed forming at points along sections of the Columbia levee that support the Lower River Road (old Highway 501), adjacent to Post Office Lake, an area not currently under Refuge ownership . As shown in Figure 1, two distinct progressive breach sites are evident, and one complete breach occurred approximately 1,300 feet north of the south parking lot (RM 95.1). The USFWS believes the progressive breach points will fail completely in the near term should the Columbia River experience repeatedly high freshets, as occurred in 2011. Although the levee will eventually deteriorate and erode on its own, the current and future breaches will not result in a permanent tidal reconnection in the near future due to the high banks along this reach of the Columbia River. Although portions of the levee have completely eroded, infrequent overtopping will occur because the lands at the river's edge are at an overtopping elevation corresponding to the 4-year Columbia River stage frequency [elevation 21 feet North American Vertical Datum of 1988 (NAVD88); all elevations in this report are reported in NAVD88 unless otherwise noted].

Currently, erosion and undermining of the levee continues to expand, and the rate of breach progression appears to be increasing. Recent observations, as early as February 2011, have confirmed that water has overtopped the levee crest in at least two locations (about 50 feet apart), likely during the same high water event. Because the levee adjacent to this project is not maintained, it does not function to offer the designed level of flood reduction.

This levee is not a federal levee. The Corps is not responsible for maintenance or inspection to determine level of flood risk reduction. In addition, since the levee is not federal, there are no Section 408 requirements; that is, to obtain approval of alterations to public works projects.

There is a right-of-way deed to Clark County for Lower River Road (on top of the existing levee). Clark County and the Washington State Department of Transportation (WSDOT) agreed that WSDOT would assume jurisdiction over Lower River Road for the purpose of developing it as part of State Route 501, which would be located both to the west and to the east of Post Office Lake. However, in July 2005, WSDOT closed Lower River Road in the vicinity of the lake due to road failure, and in January 2006 transferred jurisdiction of Lower River Road back to Clark County from milepost 11.40 to 12.72 (WSDOT letter dated January 3, 2006 to Clark County). These mileposts correspond to the existing Lower River Road dead end, milepost 11.4 (south perimeter of the Refuge) to approximately half a mile north of the north connection channel of Post Office Lake (milepost 12.7). It is possible that WSDOT may not have formally transferred jurisdiction of the remaining portion of Lower River Road back to Clark County as it crosses the Refuge west of Post Office Lake. Nevertheless, Clark County assumed responsibility for Lower River Road, including the levee, and determined in 2006 that it was not cost effective to repair the progressive breaches threatening the integrity of the levee and roadway (Clark County Interoffice Memorandum dated September 28, 2006).

1.3. PURPOSE AND NEED

Loss of wetland habitat is believed to be one of the causes of declining salmon runs. The National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS) has stated that, "Loss of shallow wetlands may be particularly important to salmonids with sub-yearling life histories that often rear in estuaries for extended periods of time before migrating to the sea." Forested marshes in the lower 48 miles of the river have decreased as much as 75% while less-productive barren lands and open water areas have increased substantially.

In response to the need to lessen the decline in salmonid numbers, stakeholders in the lower estuary, as well as external stakeholder associations, have enacted several management plans aimed to address the

concerns. The predominant management plans are outlined below; however, the following list may not be inclusive of all regional management plans/strategies:

- Mainstem Lower Columbia River and Columbia River Estuary Subbasin Plan (LCREP).
- Columbia River Basin Fish and Wildlife Program (Northwest Power and Conservation Council).
- Salmon at River's End: The Role of the Estuary in the Decline and Recovery of Columbia River Salmon (NMFS).
- Lower Columbia River Estuary Plan, 1999 and 2011 (LCREP).
- Lower Columbia Salmon Recovery and Fish and Wildlife Subbasin Plan, Volume II (Lower Columbia Fish Recovery Board).
- Columbia River Estuary Recovery Plan Module, 2011 (NMFS).
- Protocols for Monitoring Habitat Restoration Projects in Lower Columbia and Estuary (Corps).
- Columbia Estuary Ecosystem Restoration Program Strategy Report and Action Plan (two plans).
- Research, Monitoring, and Evaluation for the Federal Columbia River Estuary Program (BPA).

The Post Office Lake site offers an opportunity to reintroduce juvenile salmonids to an isolated water body. Historically, the lake had been connected to the Columbia River via the northern connection channel. Fish were able to access the lake through this connection and may have been present year-round, although peak usage was likely in the spring with egress in the late summer as observed at Campbell Slough. The restoration of this intertidal connection and fish passage to the Columbia River meets regional goals and objectives stated above, specifically Section 7 of the ESA and the BiOp and Consultation on Remand for Operation of the FCRPS (NMFS 2008b).

The purpose of this proposed project and associated study is to evaluate plans and provide a recommended plan which restores juvenile salmonid access to Post Office Lake on the Ridgefield National Wildlife Refuge, improves tidally-influenced habitat, improves floodplain connectivity, and develops streamside riparian habitat while still ensuring that the primary trust resources associated with the established purpose of the Ridgefield National Wildlife Refuge are maintained. The recommended plan, or preferred alternative for purposes of the National Environmental Policy Act (NEPA), must also maintain and protect the Refuge's trust species and their habitats, which include responsibility for various waterfowl species.

The need for the Post Office Lake restoration project is to restore the loss of off-channel rearing, floodplain, tidal slough and tidal wetland habitats along the Columbia River. The project itself is currently a disturbed ecosystem previously altered by diking and agricultural use. The Post Office Lake project offers an opportunity to regain some of this rearing habitat that has been severely diminished in the lower Columbia River mainstem channel by converting semi-permanently and permanently-flooded submergent wetlands to tidally-influenced wetlands. Post Office Lake does provide quality habitat for many trust wildlife resources.

1.4. Study Area Description

The Post Office Lake study area extends from Columbia RM 94.4 to 95.3. Post Office Lake is bounded to the west by the Columbia levee, a non-federal levee. Lower River Road (old Highway 501) lies on top of the levee in this location. The eastern boundary of the study area is defined by a local topographic divide, a rise corresponding to elevation 18 feet. It also corresponds to approximately the westerly edge of the current WSDOT right-of-way (east Highway 501). The east 501 roadway is impassable and unused.

The owners of the (west) degrading Columbia levee, Clark County, are not contemplating repair to the levee due to extensive erosion and previous determination of minimal risks due to a high flow breach event. In planning studies which contemplate change of ownership to the Refuge, the USFWS has determined that they can manage for future breaching within the context of the current and future management plan of the Post Office Lake area. Clark County and the USFWS are in agreement that complete levee restoration is not feasible.

Post Office Lake is located in a topographic depression. The local contributing drainage is relatively small, approximately 230 acres. Rainwater and restricted inflows from the Columbia during high water periods are the primary water sources for the lake. Figure 4 and Figure 5 show the topographic setting and the elevation gradient at the site. Figure 6 shows the local contributing drainage area. The bottom of lake is at elevation 7.5 feet and the ordinary high water (OHW) mark has been defined at elevation 12 feet. The elevation at toe of levee on the landward (west and east side levees) is about 19 to 20 feet. The top of levee is at elevation 29 to 30 feet. As of summer 2011, the existing levee has been breached for a width of about 20 feet in at least one spot (possibly two) within a distance spanning about 200 feet. Flows overtop at a predominant average elevation of 21 feet. There are some local high points that are remnants for the eroding levee at elevation 26 feet. The lowest overtopping point occurs at elevation 20.4 feet. There are additional low spots that vary longitudinally between the two bounding intact remnant levee sections to the south and north of the breach section. The predominant average overtopping elevation used for most analysis purposes is elevation 21 feet.

Based on water temperature data collected within the lake, no upwelling from springs appears to occur. The bottom of lake is at elevation 7.5 feet. The ground slopes gently up from the lake at approximately 0.5% to an elevation of 20 feet at the west side (Columbia River) and the east Lake River side. At the north end of the lake, there is a local high point of elevation 10 feet. This local high point prevents full drainage out of the lake into the historic connection to the Columbia, a narrow channel which falls away to the north then turns west to outfall at the Columbia River. The southern portion of the lake is under private ownership. Lands to the south are separated by a small local rise at elevation 18.0 feet, which protects lands from being inundated by minor flooding from the north. Currently, when the breach adjacent to Post Office Lake, is overtopped (starting at elevation 20.4 feet) from high Columbia River water stages, the entire area will begin to flood.

Currently, there is no tidal connection between Post Office Lake and the Columbia River. The outlet tide gate and culvert have become non-functional and very limited water flows into the lake only during high water periods. Historically, the northern channel outlet was exposed to Columbia River tidal influence and offered fish ingress and egress opportunities. Before approximately 1950, the site outlet was open, spanned by a concrete bridge. In the 1950s, the levee opening was filled in and a flap-gate type tide gate connection was installed. The action was taken to improve conditions around Post Office Lake for better agricultural usage. In the 1990s, a new tide gate was installed to correct for existing deficiencies which allowed flooding of the landward side of the levee. Existing progressive breaches, first identified in 1996, point to more frequent inundations into the future. The adjacent private property owners to the south understand this and have made plans to reduce future agricultural uses around the lake, as the effects become more pronounced.

The existing levee is undergoing progressive breaching and has completely breached at RM 95.1 (levee section is completely eroded away). The overtopping elevation is approximately 20.4 feet. The breach width is only about 20 feet at the lowest two overflow points, but most of the adjacent levee has been substantially eroded for 200 feet. It is likely to erode the levee completely from a relatively short duration (2-5 days), high water event (20+ feet stage elevation). The breach has not resulted in a permanent reconnection to the Columbia River. Overtopping in the existing condition is infrequent but did occur

during the 2011 high water period (February-early July freshet). Overtopping occurred resulting in limited overland sheet flow into Post Office Lake. The lake did not fill appreciably and interior flooding did not occur.

Figure 4. Post Office Lake Topographic Map

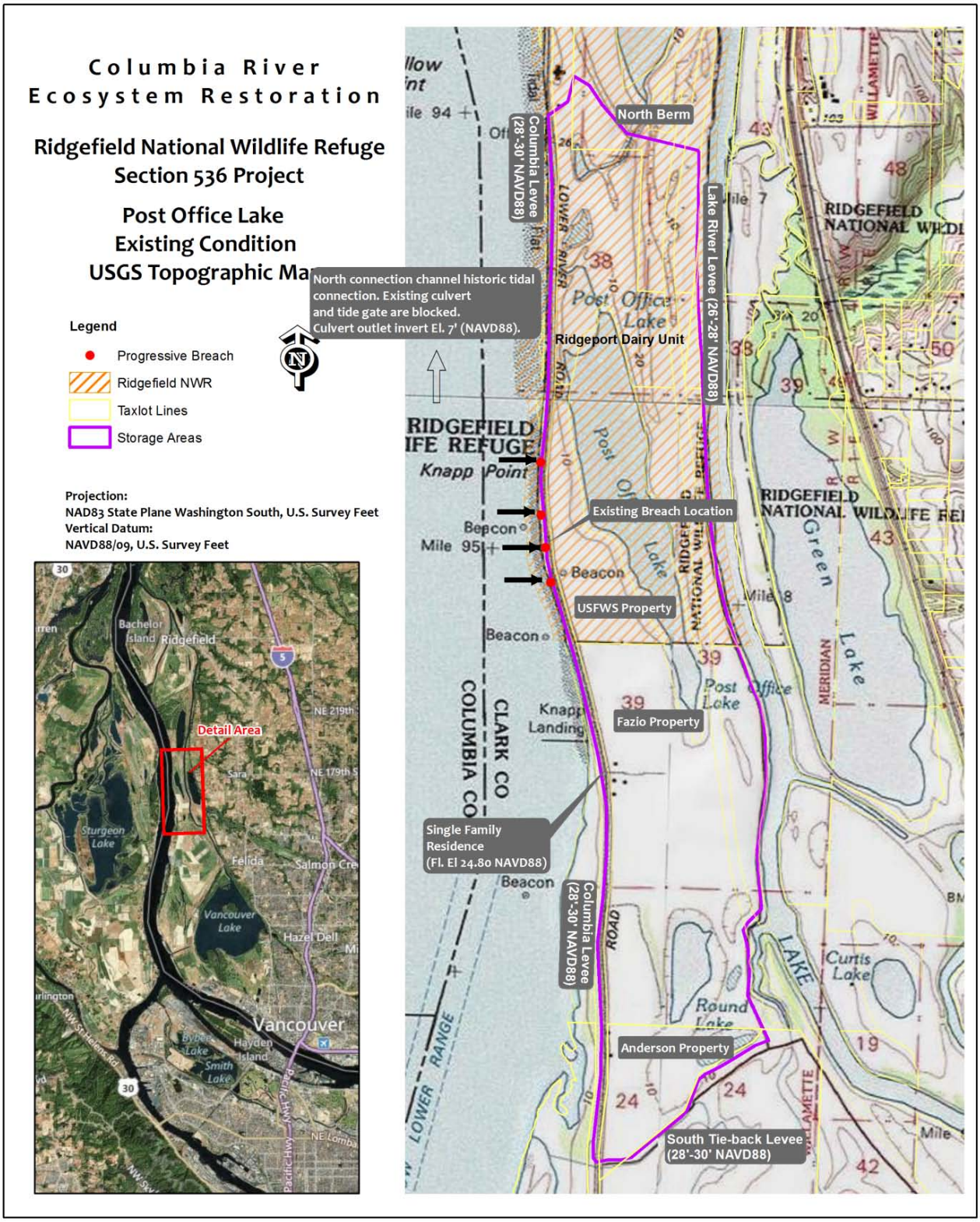


Figure 5. Post Office Lake Classified Elevations

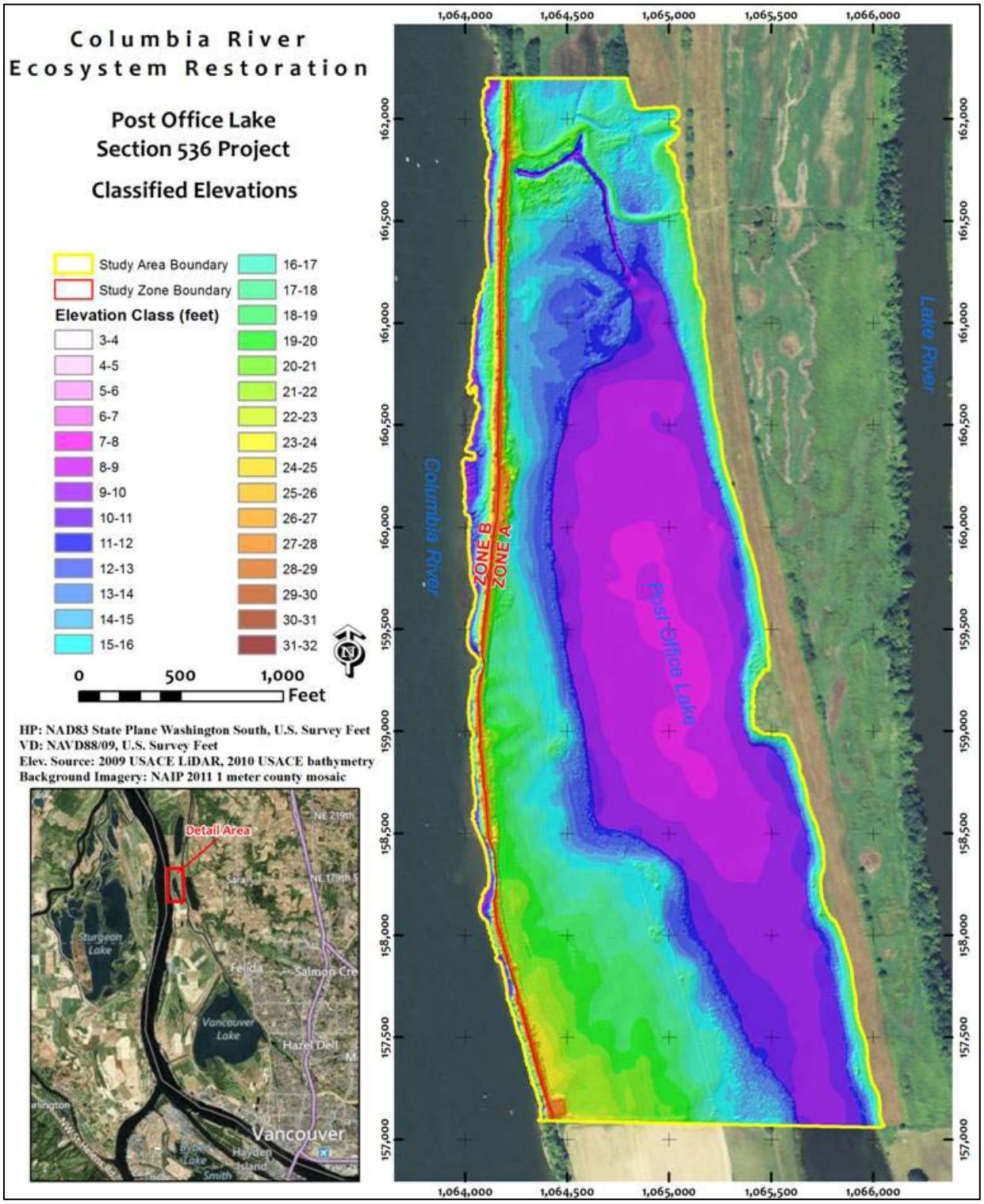
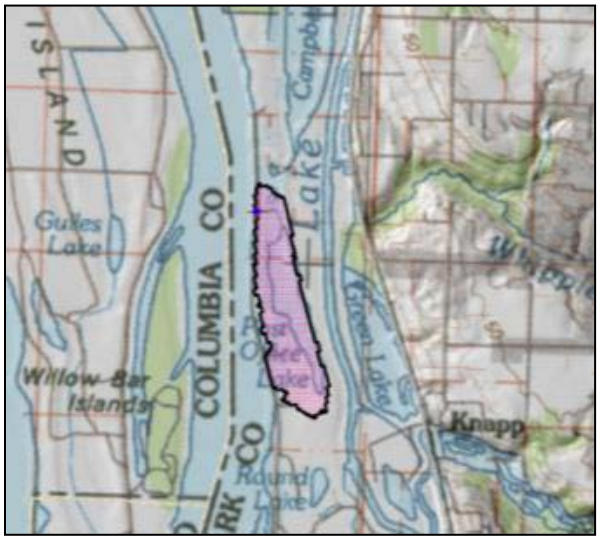


Figure 6. Onsite Contributing Drainage Area



Source: http://streamstatsags.cr.usgs.gov/or_ss

1.5. Relationship to Regional Studies

1.5.1. Federal Columbia River Power System (FCRPS) Biological Opinions

The first Columbia River salmonid species, Snake River sockeye salmon, was listed as endangered in December 1991. The NMFS issued its first BiOp for the FCRPS on April 10, 1992, evaluating a single year of FCRPS hydropower effects on this species and two others, Snake River spring/summer Chinook and Snake River fall Chinook, listed as threatened earlier that year (NMFS 2008b). Since then, there have been additional species listed and new analyses of effects, thus necessitating initiation of subsequent ESA consultations. There were a series of legal actions subsequent to the 2000 BiOp for the FCRPS. Originally, the NMFS evaluated a 10-year operation of the FCRPS proposed by the FCRPS Action Agencies (Corps, BPA and Bureau of Reclamation) in their Biological Assessment dated December 21, 1999. In addition to their proposed action for operation of the FCRPS, the Action Agencies included an adaptive management program intended to achieve performance standards through development and implementation of hydropower, habitat, hatchery, and harvest actions to benefit listed fish. The NMFS (2008b) concluded that the Action Agencies' proposed action was likely to jeopardize 8 of the 12 evolutionarily significant units (ESUs) affected by the FCRPS, largely because its mitigation program was uncertain to fully achieve the survival improvements required for the ESUs.

Subsequently, the NMFS, in coordination with the Action Agencies, developed and officially adopted a reasonable and prudent alternative (RPA) to address the deficiencies of the proposed action. The NMFS RPA for 10 years of FCRPS operation was based on performance standards, regular planning, comprehensive periodic check-ins and peer reviewed scientific determinations. With the Action Agencies' commitment to the RPA, the NMFS (2008b) concluded that jeopardy and adverse modification of designated critical habitat would likely be avoided for all affected anadromous species.

However, litigation has occurred since the 2000 BiOp was issued. On May 7, 2003, Federal District Court Judge James A. Redden invalidated the NMFS 2000 BiOp for the FCRPS. The Court remanded the 2000 FCRPS BiOp to NMFS to address these deficiencies on June 2, 2003. During this remand, the Court decreed that the 2000 FCRPS BiOp would remain in effect. On November 30, 2004, NMFS completed the remand proceedings when it issued a revised BiOp for the FCRPS that evaluated a program

of actions based upon the RPA from the 2000 FCRPS BiOp. The 2004 FCRPS BiOp and FCRPS Action Agencies' updated proposed action replaced the 2000 BiOp and RPA. The plaintiffs (National Wildlife Federation) then amended their complaint on December 30, 2004 and the State of Oregon intervened as a plaintiff on January 28, 2005 to challenge the 2004 FCRPS BiOp. The 2008 FCRPS BiOp was issued in response to a court ordered remand in the litigation entitled *National Wildlife Federation v. NMFS*, CV 01-640 RE (D. Or.) (NMFS 2008b).

Actions proposed by this project are consistent with the 2008 FCRPS BiOp RPA 37: Improve Juvenile and Adult Fish Survival in Estuary Habitat, Estuary Habitat Implementation 2010-2018—Achieving Habitat Quality and Survival Improvement Targets. In relationship to this proposed project, the 2000 FCRPS BiOp Section 9.6.2.2 supports the actions of the *Comprehensive Conservation and Management Plan* (LCREP 1999, updated 2011). A goal of Action 2 of the Plan is to, "Protect, conserve, and enhance identified habitats, particularly wetlands, on the mainstem of the lower Columbia River." The environmental measurement for this action is to permanently enhance, protect, or reclaim 10,000 acres of wetland habitat and 3,000 acres of upland habitat by 2010. Similarly, in order to rebuild productivity in the lower river miles, RPA 160 in the BiOp calls for protecting and enhancing 10,000 acres of intertidal wetlands and other key habitats over the next 10 years. To help achieve these goals, the Corps, BPA, NMFS and LCREP developed a list of proposed habitat restoration projects that included the restoration of Post Office Lake and adjacent areas.

Comprehensive planning efforts have evaluated the Columbia River floodplain beginning at the city limits of Vancouver and extending northward to the mouth of the Lewis River, located immediately north of the city of Ridgefield, Washington, which includes Post Office Lake. These lands are collectively termed the Vancouver Lowlands project area. The study was funded by BPA and carried out by the Washington Department of Fish and Wildlife (WDFW). The basin-level biological objectives set forth in the 1995 *Vancouver Lowlands Shillapoo Wildlife Area* study (WDFW 1995) call for coordinating wildlife habitat restoration and acquisition with aquatic habitat efforts. The habitat restoration objectives (restore tidal reconnection, restore floodplain connectivity, juvenile fish rearing and refuge, maintain waterfowl habitat, and riparian improvements) for the Post Office Lake project are consistent with the general enhancements proposed for the Vancouver Lowlands area.

The Corps' restoration projects in the Columbia River Basin are assigned survival benefit units (SBUs) for salmonids using habitat metrics developed and calculated by the Expert Regional Technical Group (ERTG). The ERTG was convened as a result of RPA 37 in the 2008 FCRPS BiOp, which provides the required federal consultation under the ESA for management of the Columbia River dams. The purpose of ERTG is to assign SBUs for ocean- and stream-type juvenile salmon that are derived from estuary habitat actions implemented by the Action Agencies. The ERTG developed and implements a calculation methodology to estimate changes in overall estuary habitat and resultant changes in salmonid population survival (ERTG 2010). The ERTG uses the associated Columbia River Estuary (CRE) Recovery Plan Module developed by NMFS (2011) to assign project scores prior to project development, and then revisits the scores post-project implementation. Because the Post Office Lake project lies within the lower Columbia River estuary (for these purposes, the estuary's tidal influence extends from the mouth of the Columbia River up to Bonneville Dam), the project is subject to ERTG scoring. These scores will then reflect progress towards the Action Agencies' required restoration projects and 2008 FCRPS BiOp obligations in the estuary. The preliminary anticipated ERTG scoring for the Post Office Lake restoration project is provided in Section 3.9.

1.5.2. Ridgefield National Wildlife Refuge Comprehensive Conservation Plan

The purpose of the final Ridgefield National Wildlife Refuge Comprehensive Conservation Plan (CCP; USFWS 2010b) is to:

> " provide the Service, the Refuge System, partners, and the public with a 15-year management plan for improving the Refuge's habitat conditions and infrastructure, for fish, wildlife, and public use. The CCP will provide reasonable, scientifically grounded guidance for the long-term conservation of native plants and animals, with emphasis on migratory birds and improving the refuge's grassland, wetland, riparian, and woodland habitats. The CCP will identify appropriate actions for protecting and sustaining the cultural and biological features of the refuge; its wintering waterfowl populations and habitats; the migratory land bird and water bird populations that use the refuge; and threatened, endangered, or rare species. A final purpose of the CCP is to provide guidance and evaluate the priority public use programs on the refuge, including hunting, fishing, wildlife observation, photography, environmental education and interpretation."

The Refuge itself was originally established to provide wintering habitat for dusky Canada goose and other waterfowl. The Refuge is mandated to ensure specified peak populations of migratory waterfowl, including 3,000 geese and 125,000 ducks, and that the Refuge would also provide breeding and migration use for waterfowl. The importance of the Refuge to dusky Canada geese was explicitly recognized in the CCP: "The dusky Canada goose has an extremely limited winter range, concentrated along the Willamette and lower Columbia rivers. This subspecies is limited in numbers and requires protection and habitat to insure its continued existence." The Refuge also provides substantial public hunting; a portion of the area in line with management findings but not to exceed 40% will be considered for waterfowl hunting in the future (USFWS 2010b). Hunting and other public uses are currently prohibited in the Ridgeport Dairy Unit, which includes Post Office Lake. The primary wildlife and habitat goals stated in the CCP include:

1. Provide and manage a mixture of secure, diverse, productive grassland habitats for foraging migratory waterfowl and grassland-dependent wildlife.
2. Annually provide agricultural crops as forage for migratory waterfowl and sandhill cranes.
3. Provide, manage, and enhance a diverse assemblage of wetland habitats characteristic of the historic lower Columbia River.
4. Protect, manage, and restore a natural diversity of native floodplain forests representative of the historic lower Columbia River ecosystem.
5. Protect, manage, and restore a natural diversity of native upland forests representative of the historic lower Columbia River ecosystem.
6. Protect, enhance and where feasible, restore riverine habitat and tidal wetlands representative of historic lower Columbia River ecosystem to benefit salmonids and other native aquatic species.
7. Collect scientific information (inventories, monitoring, and research) necessary to support adaptive management decisions on the Refuge associated with goals 1-6.

The habitat restoration objectives for Post Office Lake are consistent with some of the goals stated in the Refuge's CCP and Environmental Assessment (USFWS 2010b). Approximately 75% of the north portion of Post Office Lake is located within the Refuge limits. Post Office Lake was added to the Ridgefield Dairy Unit on March 1, 1991. The lake was included as part of an overall 520.8-acre purchase of Tract 12 (Warranty Deed). It was purchased from the Port of Vancouver and was purchased, "…for the development, advancement, management, conservation and protection of fish and wildlife resources" (USFWS 2010b).

Section 536 and the goals of the Refuge are compatible; however, close cooperation and interaction further ensures that Section 536 goals, which include salmonid habitat creation and enhancement, remain well within the Refuge's mandates. These Refuge mandates and management plans were developed and implemented prior to the Corps' Section 536 proposal and included providing wintering habitat for dusky Canada geese and other waterfowl, as well as minimizing (excluding) public access to this particular unit. The USFWS manages the Ridgefield Dairy Unit primarily as a sanctuary for waterfowl. As such, the Refuge has signs indicating public access is not permitted, although the creation of the salmonid habitat and maintaining waterfowl wintering habitat clearly serve a public purpose. The Refuge will continue this policy of public exclusion to promote the waterfowl sanctuary function.

1.6. EXPECTED SUCCESS OF THE PROJECT

The restoration objectives for Post Office Lake include restoring a more natural hydrologic regime to the lake via reintroduction of the full tidal prism and increased flood inundation and frequency, as well as improved floodplain reconnection between the lake and Columbia River. These actions would restore seasonal juvenile salmonid access to the lake and its associated wetland and floodplain habitats while reducing permanently-flooded wetland acreage.

Furthermore, enhancing the riparian habitat along the northern channel, along the levee, and in the shallow swale from the breach to the lake will increase and restore riparian vegetative communities, improve wood recruitment and allochthonous inputs, and increase vegetative population diversity and complexity. This will further supplement the existing wetland and open water habitat to support juvenile salmonids.

It is anticipated that open water habitat would be reduced for a few months in summer as flows decrease in the Columbia and the lake inlet remains above river levels. Given the possibility of juvenile stranding during such an event, any restoration would be designed to avoid this potential to the greatest extent feasible. It is also unlikely that seasonal drying would negatively impact salmonids. Juvenile Chinook and coho are the most likely salmonid species anticipated to utilize the restoration project for rearing and refugia, though adults and other species would benefit from and could utilize the habitat more transiently. Typically, the overall emigration timing range among ESUs of both juvenile coho and Chinook begins around March and dwindles by sometime in July, with the starts and peaks varying within this timeframe depending on ESU and flow conditions. Though theoretically possible that a small number of juveniles could remain in the Post Office Lake vicinity, a majority would be likely to emigrate prior to lake drying. Additionally, the relatively smaller number of juvenile salmonids remaining in this area in summer would be able to egress via the northern channel following the tidal signals such as low water, increased temperature, and intermittent connectivity. This emigration behavior pattern also has been demonstrated at Campbell Slough (USGS 2010), which is somewhat representative of anticipated post-project hydrologic conditions in Post Office Lake. Even during low water periods, the mean higher high tide elevation could periodically overtop the design elevation of the outlet sill. Additional effects to fish and wildlife resources are discussed in further detail in later sections of this EA.

As a result of increased hydrologic exchange, the existing acreage of permanent open water and submergent and emergent wetlands that fringe Post Office Lake would decrease as this acreage is converted to an increased area of emergent permanent and semi-permanent or seasonal wetlands. It is anticipated that this wetland habitat change would impact nesting and brooding waterfowl species that rely on inundated wetland habitat. Campbell Lake, which is on the Refuge north of Post Office Lake, has a more natural hydrologic regime expected to be similar to that achieved by Post Office Lake, such that it (Campbell Lake) partially dries out during the summer. However, NMFS monitoring at Campbell Slough

demonstrates a continued presence of salmonids in the permanently flooded connecting slough (USGS 2010), and vegetative communities exposed to tidal influence include a higher percentage of native emergent species, including wapato and tule, relative to that present at Post Office Lake (Borde et al. 2011). However, there is also the possibility that the project could result in an increase in non-native species as described in the effects Section 5.3.

Currently, Post Office Lake supports approximately 18 acres of permanent emergent wetland/marsh habitat. It is expected that permanent open water, submergent, and emergent wetland habitat would be converted over the project life and would be replaced by semi-permanent or seasonal emergent wetland habitat that would support a modified assemblage of aquatic fish and wildlife. Enhancement of the riparian buffer along the northern channel would increase complexity in 5 acres (1,000 linear feet) of forested and shrub riparian habitat. Reshaping the northern channel bank contours into a two-stage channel to sustainably accommodate the full tidal prism would provide approximately 75 acres of intertidal habitat. Together, these actions contribute toward achievement of Action 2 goals and RPA Action 160, as well as other FCRPS BiOp actions. These actions also are consistent with some of the goals described in the Refuge's CCP,

Restoring the northern connection channel between the Columbia River and Post Office Lake, planting native riparian vegetation, and providing high-flow floodplain reconnection is anticipated to provide and enhance juvenile salmonid rearing habitat by:

- Providing increased duration and inundation in the lake that can be utilized as juvenile salmonid foraging and refugia during high flows in the winter (for environmental benefit modeling purposes defined as November 1 through end of February) and including the freshet (May through July);
- Reestablishing seasonal intertidal connection and facilitating access to tidal wetland habitat; and
- Providing increased riparian habitat along the levee adjacent to the Columbia and around the north connection channel and levee swale, which provides cooler water temperatures, wood recruitment, additional food sources, and increased detritus for channel and lake complexity.

2. ALTERNATIVES

The following sections discuss criteria used to formulate alternatives, describe the initial measures and alternatives being considered, provide an environmental benefits evaluation, compare the proposed measures and alternatives using cost-effectiveness and incremental cost analyses, and describe the identification of a recommended plan (preferred alternative).

2.1. PLAN FORMULATION

2.1.1. Problems and Opportunities

There are currently 13 Columbia Basin stocks of salmonids listed under the ESA that have potential to use or pass adjacent to the proposed project area. Additionally, the Action Agencies (Corps, BPA and Bureau of Reclamation) have been tasked under the existing 2008 BiOp for the FCRPS to restore habitat in the Columbia Basin in order to avoid jeopardizing the existence of these ESA-listed species.

The loss of riparian forest and wetland habitats in the lower Columbia River and estuary has been well-documented (Graves et al. 1995, Corps 1996). The Northwest Power and Conservation Council's *Lower Columbia River and Columbia River Estuary Subbasin Summary* (NPCC 2002) states that, "Extensive losses of habitat have occurred in the lower Columbia River and Estuary provinces as a result of dredging, filling, diking, and channelization. Estimates from 1870 to 1970 indicate that 20,000 acres of tidal swamps (with woody vegetation; 78% of estuary littoral area), 10,000 acres of tidal marshes (with non-woody vegetation) and 3,000 acres of tidal flats have been lost." The original extent of tidal marsh and swamp habitat has been reduced by more than half (LCREP 1999). The LCREP Management Committee identified habitat loss and modification as one of seven priority issues of concern to the estuary. Also, one of the technical recommendations of *Wy-Kan-Ush-Mi Wa-Kish-Wit Spirit of the Salmon* (CRITFC 1995) is to protect and restore critical estuary habitat. The estuary wetlands provide essential habitat for all Columbia Basin salmon stocks at some period in their life cycle. The Independent Scientific Advisory Board (ISAB) report, *The Columbia River Estuary and the Columbia River Basin Fish and Wildlife Program* (November 2000) hypothesized that the extensive loss of peripheral wetlands and tidal channels in the estuary has been detrimental to salmonids.

Habitat limitations and restoration actions to improve recovery of the species were specifically identified in the CRE Recovery Plan Module developed by the NMFS (2011). The Refuge was also established to protect and restore sensitive and endangered species, with a particular focus on waterfowl species. Responsibility for these trust species entails specific management plans that address problems and opportunities for habitat restoration on the Refuge. As an Action Agency, the Corps must consider and balance these issues along with the authority and requirements under Section 536 of WRDA 2000.

The constriction imposed by a 30-inch culvert and tide gate (tideflex duckbill check valve) installed at the entrance to the lake's historic connection channel at the north end of the lake, causes a virtually complete hydrologic separation between the tidally influenced Columbia River with that of the lake, which essentially prevents salmonid access to the lake. These structures were installed in the 1990s to prevent backwater from the Columbia River flowing into the pasturelands around the lake. Subsequent degradation to the culvert and tide gate has further degraded the connection to the Columbia River. If these structures are removed, Post Office Lake immediately offers approximately 75 acres (corresponding with the Ordinary High Water in the lake, elevation 12.0 feet) of potential winter and rearing and refugia habitat for salmonids, specifically coho and Chinook juveniles. Post Office Lake is also cut-off from regular flooding by the Columbia River, as a degrading levee separates the Columbia River from its

adjacent floodplain and floodplain lake. In conjunction with the removal of the obstruction and further breaching of the levee, ecosystem restoration measures could be implemented to substantially improve overall salmonid habitat in the Post Office Lake vicinity

Problems and opportunities that were identified in the NMFS CRE Recovery Plan Module that apply specifically to the Post Office Lake project include the following.

- Limited and degraded riparian habitat:
    - Infestations of invasive species like Himalayan blackberry, reed canarygrass (*Phalaris arundinacea*), etc;
    - Limited riparian structure and successional capacity;
    - Little to no riparian canopy;
    - Little to no large wood recruitment capacity; and
    - Limited growth potential due to asphalt layer on levee.
- Limited and degraded backwater and off-channel rearing habitat for juvenile salmonids:
    - Lacks complexity;
    - Water quality limited; and
    - Little to no salmonid access during most flow events.
- General limitation and lack of more natural hydrologic and hydraulic flow regimes:
    - Limited or lack of floodplain connectivity;
    - Limited or lack of tidal connectivity;
    - Limited or lack of mixing or hydrologic exchange; and
    - Limited or lack of exposure to a more nature flow/disturbance regime.

2.1.2. Project Goals

This Section 536 ecosystem restoration project seeks to restore and improve important habitat functions on and in the immediate vicinity of Post Office Lake, by restoring tidal and floodplain reconnection to the Columbia River and providing refugia and rearing opportunity for migrating juvenile salmonids, and to a lesser extent, flood refugia for adult salmonids.

2.1.3. Project Objectives

Within the framework and constraints of the Section 536 program and Refuge objectives, the following project objectives were established:

- To re-establish tidal influence to water bodies (Post Office Lake, wetlands, and Dusky Lake) in the project area above elevation 7 feet.
- To provide optimal access to Post Office Lake allowing ingress and egress for rearing juvenile salmonids (coho and Chinook salmon), while reducing the risk of stranding.
- To increase and improve backwater, off-channel habitat quantity and quality for rearing juvenile salmonids and as flood refugia for juveniles and adults.
- To restore more natural floodplain connectivity (exposure to greater frequency interval of flood inundation and flow duration).
- To improve floodplain functions (e.g., habitat complexity, food inputs, source of nutrients and organic materials, flood storage, etc.).
- To increase and improve riparian function (bank stability; water quality; wood inputs, insect, and detrital inputs, energy dissipation, etc.) and canopy cover (shade, water quality, etc.), where feasible.

- To increase and diversify native floodplain and riparian vegetation, where feasible.
- To remove and manage invasive plant species, such as Himalayan blackberry, reed canarygrass, and others, where practical.
- To minimize possible depredation of juveniles in the lake via increased habitat complexity, placement of natural cover and structure where appropriate in the channel and the lake, and excavation of a pool creating depth and temperature refugia.
- Manage semi-permanent and seasonal wetlands for migratory waterfowl, wading birds, shorebirds, and other wetland-dependent wildlife species.
- Enhance tidally influenced freshwater wetlands for the benefit of anadromous fish, waterfowl, and wading birds.

2.1.4. Planning Criteria

The overall purpose of this Section 536 ecosystem restoration project is to restore backwater, off-channel and wetland fringe habitat that is accessible for fisheries access/egress via restored tidal and floodplain hydrology, to the extent practicable, to Post Office Lake which is currently cut off from the Columbia River. Restoration actions would also protect waterfowl habitat, and habitat improvements benefiting salmonids are expected to benefit other terrestrial and aquatic species because salmonids are one of the most sensitive indicator species affected by the ecosystem functions this project seeks to improve. The following planning criteria (general, technical, environmental and social), were used in formulating and evaluating restoration measures and alternatives examined in this report. The successful achievement of many of these criteria is interdependent between categories.

General Criteria

- The Recommended Plan achieves the goals and objectives of the project and is sustainable over the long term (more than 50 years).
- The Recommended Plan is compatible with the Refuge management objectives for migratory waterfowl, wading birds, shorebirds, and other wetland-dependent wildlife species.
- The Recommended Plan is compatible with other salmonid habitat restoration efforts in the lower Columbia River and estuary by federal, state and local agencies, and private organizations.
- The Recommended Plan will be identified based on analyses of environmental benefits and costs in accordance with Corps regulations to ensure that the plan is viable and cost effective.
- The Recommended Plan protects public health, safety, and well-being.

Technical Criteria

- Technical analysis shall conform to USACE guidance found in Engineer Regulations (ER) and Engineering Technical Letter (ETL): ER 1110-2-1150 Engineering and Design for Civil Works Projects, ER 1105-2-100, and ETL 1110-2-573; Construction Cost Estimating Guide for Civil Work.
- The project location is centered at Columbia River Mile 95. This portion of the reach is characterized as a hydraulic transition zone between tidal dominated flow patterns and terrestrial flood flows. Therefore the hydrologic and hydraulic analysis should incorporate metrics which address tidal variability (tidal prism) as well as flood stage (annual expected probability) flows.
- Hydraulic analysis shall incorporate official NWP “Columbia River Combines Probability Flood Profiles 9 April 2007”.
- This project is located within the FEMA regulatory floodplain. Therefore, this project shall adhere to all applicable floodplain ordinances.

- Size and capacity of channels shall be based on acreage, depth of excavation and flood tide elevation.

Environmental Criteria

- Maintain habitat for dusky Canada geese, sandhill crane and other waterfowl, for which the Refuge is mandated to provide, by ensuring the restored tidal and floodplain connections do not result inconsiderable adverse effects. The ecosystem restoration actions would not substantially change the Refuge's 15-year land-use planning horizon goals (i.e., no reduction in pasture areas for wintering birds, etc) that benefit waterfowl management.
- The restoration would not negatively affect waterfowl habitat by reducing sight distances or causing undue segmentation of pasture habitat. For example, the project would avoid providing riparian plantings around the lake itself; segmentation of the pasture land would be avoided by limiting the number of ingress points from the river to a single breach location and shallow swale through current pasture lands; and plantings that may affect sight distance preferences for waterfowl would be avoided in the pasture and swale. All measures have been considered in collaboration with USFWS refuge personnel (including avian biologists).
- The Corps would rely on Refuge staff and Refuge monitoring protocols to determine if and how these avian criteria are being met. Restoration actions were developed to avoid negative impacts to waterfowl along with development of riparian canopies in limited locations and potential conversion of wetlands due to the re-introduced hydroperiod.
- Restore hydrology and hydrologic exchange via passage of the full tidal prism and allow fisheries ingress/egress to the lake; improve access and opportunity.
- The Corps would assume that a self-sustaining outlet and stable northern channel, along with a stable, self-sustaining breach and swale section would meet these criteria. If the ingress/egress points remain open and the hydraulics and hydrology criteria are met, the Corps would assume full hydrologic exchange towards these criteria.
- Allow juvenile salmonid access to restored habitat. Minimize the risk of depredation and stranding for juvenile salmonids.
- Restore and improve off-channel rearing/foraging habitat for listed salmonids and other native fish species; increase habitat complexity and quality.
- Habitat improvements towards meeting environmental criteria would be partially gauged on whether or not increases in canopy structure and development have occurred in those areas where it is not limited due to maintenance of sight distances. Increases in percentages of native composition relative to current non-native percentages would also be considered an improvement in quality. Water quality parameters would be measured to determine if they fall within the range of Suitability Indices scores for salmonids with respect to dissolved oxygen (DO) and temperature. Criteria would be met when water quality conditions improve and/or parameters in deeper portions of the lake are maintained within non-lethal ranges during the spring and fall periods.
- Restore and improve riparian habitat for salmonids and maintain appropriate habitat characteristics for migratory birds; increase potential for complex canopy and large wood recruitment to increase habitat benefits.
- Limited removal of invasive species like Himalayan blackberry, reed canarygrass, and others.
- Reestablish regular floodplain reconnection and more frequent inundation, mixing, and hydrologic exchange.

Besides the criteria above, the Corps along with NMFS, USFWS, and Washington Department of Fish and Wildlife (WDFW) have given much consideration regarding how to minimize risk of stranding

juveniles when water levels are low, and how to protect from predation any potential rearing fish that do not egress with the ebb tide in the warmer summer months.

To address stranding concerns, the elevation of the invert at the outlet of the lake would be designed in order to maximize fish passage and while still retaining some water in the lake to maintain moisture levels for pelecypods and other macroinvertebrates and submergent vegetation. These bivalves provide important forage for waterfowl. Even during low-water months in the Columbia, there will also be times when the elevation of the sill is overtopped by mean higher high-tides, allowing lake inputs and fish to egress on the ebb-tide signal. To minimize predation, careful deliberation was also given to excavation of a deeper hole at the outlet of the lake near the sill separating the lake from the northern channel. The intent would be to provide enough depth to develop thermal refugia via stratification of the lake. There was concern that this pool would not be a sustainable habitat feature due to the silty nature of the bottom substrate in the pond and the potential migration of fines back into the hole.

This pool measure was considered further and simple sedimentation accretion model helped predict the potential sources and rate of infill. A deeper pool would be a larger construction cost, and the unknown burden of maintenance this could impose on the Refuge in the future is a further risk. The Refuge has requested a pool depth limit of 6-feet based on assumptions about declining submergent vegetation survival at greater depths. A single conical pool or series of smaller holes/pocket pools have been considered at the head of the lake near the outlet in order to minimize costs, wetland impacts, and future maintenance, while still providing pockets of depth and thermal refugia. However, these pool design alternatives are somewhat constrained by equipment limitations, characteristics of the bottom sediments, and the additional environmental impacts resulting from work deep/further into the lake itself.

In order to further reduce the risks to salmonids and protect any over-summering juveniles, the Corps would implement an appropriate sill elevation and pool design along with an adaptive management approach that is triggered should monitoring of post-project site conditions and fish use indicate an unacceptable risk of stranding or predation. Close coordination would continue with the resource agencies in order to determine the appropriate response for this event.

Social Criteria

Current primary public usage for the entire Refuge includes hunting, fishing, wildlife observation and photography, and environmental education and interpretation. These public uses occur only on the Carty and River "S" Units of the Refuge, all other areas of the Refuge are closed to the public to meet the necessity for sanctuary areas as identified in management plans, and this includes the Ridgeport Dairy Unit which contains Post Office Lake. The only exception would be refuge management approved special guided tours. According to the CCP (USFWS 2010b), waterfowl hunting, along with protection of migration and wintering habitat for waterfowl, was made a Refuge purpose in 1964. The waterfowl hunting program is operated in a manner that is consistent and compatible with the Refuge's purposes and goals. The project team developed the following criteria affecting the Refuge's social objectives:

- Maintain adjacent landowners' current water usage, as well as other usages such as hunting, mitigation banking potential, etc.
- Continue restriction of public access per the CCP unit management objectives.

2.1.5. Project Constraints

The project team identified the following project constraints.

- Maintain established purpose of the Refuge to provide migration and wintering habitat for waterfowl, especially dusky Canada geese. No planting of transitional wetland vegetation and riparian vegetation around the perimeter of the lake was included due to conflict with a primary refuge strategy of managing short grasslands to benefit dusky Canada geese and Sandhill cranes by allowing these species to utilize short grass areas for foraging, improve sight distance for predator detection, reduce concealment cover for predators and provide clear flight paths for escape.. Additional scrub/shrub plantings were also excluded from the proposed floodplain swale for the same reasons. To allow enough light penetration for submergent vegetation growth, the Refuge has requested any excavations in the lake be limited to a depth no greater than 6-ft below the elevation of the 9-ft sill.
- Provide a hydrologic regime that does not adversely impact adjacent landowners.
- Continue restriction of public access to Post Office Lake and adjacent Refuge lands (Ridgefield Diary Unit) as mandated under the current regulations and described in the 2010 CCP.
- Maintain current Refuge habitat management activities, in particular mowing of the west side of Post Office Lake for grassland management purposes. This occurs twice a year and movement of mowing equipment is via the north end. Refuge equipment is moved over the northern connection channel near the toe of levee to access the west side of the lake. The proposed alternatives would eliminate such access when the levee section and culvert are completely removed and the channel section is opened up. The Project Delivery Team (PDT) was required to replace the equipment access function so that future habitat management was not unduly hindered. This would be accomplished via construction of a bridge spanning the channel near the existing toe of levee.
- Maintain water management capabilities at the Refuge (e.g., Dusky Lake). Eliminate any project-induced adverse water usage impacts to adjacent landowners.
- Balance the goals and objectives so that third party landowners are supportive and in agreement with planning objectives.

2.1.6. Risk and Uncertainty

A number of risks have been identified that have the potential to impact the constructability, expected benefits, and/or long-term operating costs associated with the restoration project. All identified risks are in part driven by uncertainties associated with the project. Qualitative analysis of these uncertainties and their likely effects indicate that overall, the identified risks can be perceived as moderate to low in nature. A list and discussion of ten identified risks and their associated uncertainties is provided below.

1. Negative impacts to Refuge priority species (i.e., waterfowl).
2. Unintended new channel development.
3. Aggradation potential or sedimentation of the northern connection channel.
4. ESA take of aquatic species.
5. Reduced project efficacy for successful native and re-vegetation establishment.
6. Inability to remove tide gate and levee (Measure 1 project components).
7. Potential landowner objections to altered project hydrology.
8. Negative impact to project from adjacent landowner actions.
9. Project features required by the project partner.
10. Effects and infill rate of proposed pocket pool.

The uncertainties identified for each of the above risks are discussed below.

1. Currently, Post Office Lake usually maintains a constant water level (elevation 10 to 12 feet; 12 feet is OHW). The proposed restoration includes provisions that would allow water to drain out with the tide to an elevation equal to the lake outlet invert (approximately 9 feet) when water levels within the Columbia River drop during August and September. It is expected that Post Office Lake would retain water during most of the year but it is possible that the lakebed could become dry in drought cycles, similar to nearby Campbell Lake. There is uncertainty as to how this drier condition may impact the invertebrate and vegetative communities supported within the lake and the effect that would have on waterfowl. The risk associated with a drier lake condition is that conversion of vegetation and invertebrate communities would have detrimental effects on avian species managed by the Refuge. Preliminary indication is that some invertebrates would survive the drier times by either migrating to the remaining watered areas or would find sub-surface refuge in the marshy soils. USFWS has also required provision of pumping capacity to supply water to Post Office Lake when water levels drop to unacceptable levels within the lake. Impacts will likely include changes to invertebrate populations and sago pondweed forage and less open water habitat during early fall migration. However, overall the expected risk of impact to avian species population is low.

2. Existing conditions along the Columbia River within the project area include active areas of bank and levee erosion. Observation indicates that the primary mechanism of erosion is mass mechanical bank failure due to wave action caused toe erosion coupled with situations of increased pore water pressure and saturated soil conditions. Rates of erosion are affected by Columbia River water surface elevations, and shipping vessel traffic coupled with degree of soil saturation. Accurate prediction of these conditions is difficult, introducing considerable uncertainty in the actual rates and therefore extent of bank and levee erosion inland within the project area. The risks, both opportunity risk and threats involved with extensive inland erosion are that channels beyond those included as part of the proposed project would develop. The opportunity is that additional channels connecting to Post Office Lake allow for increased natural geomorphic process, increased tidal connection to the Columbia River and other benefits associated with such connections. The Refuge manages this area with a focus on listed avian

species that prefer open water and/or large, open and non-segmented fields. The threat is that additional channels segmenting the large open area between Post Office Lake and the Columbia River have potential to discourage use of this area by the avian species of interest. The proposed project measures are not expected to affect Columbia River bank and levee areas in a manner that would increase likelihood of erosion. Evaluation of historic aerial photography suggests that bank erosion before heavy ship traffic and levee construction was minimal. Reference zones on the left side of the Columbia River that are vegetated and lack levee construction do not exhibit severe bank erosion and channel formation. The proposed project includes measures to increase riparian vegetation along the levee, and woody vegetation that develops is expected to provide a means of toe protection as the area evolves. This leads to a moderate to low risk associated with bank erosion.

3. Implementation of the proposed project would subject the northern channel to hydraulic conditions widely varying from the existing conditions. The exact geomorphic response to reestablishment of tidal cycles cannot be determined with absolute certainty. If large-scale sedimentation and aggradation occur there is a risk of cutting off the planned tidal connection between the river and lake thus greatly reducing the efficacy of the proposed actions. Based on historic aerial photographs, the northern channel would likely be self-maintaining. The photos show very little change from existing conditions, even when the channel was exposed to the Columbia River (the tide gate was installed in the early 1990s). Fine sediments would likely move in and out of the channel due to tidal and flow rate fluctuations. Some accumulation may occur with low flows, but would likely be flushed out with higher seasonal flows. When considering a temporal period greater than one season, the risk of channel disconnection is low.

4. Post Office Lake and Dusky Lake, in their current isolation from the Columbia River, likely experience conditions of poor water quality for salmonids during summer periods. This includes water quality parameters of concern to salmonids such as temperature and DO. During low stage periods within the Columbia River, the proposed project may result in water level conditions within Post Office Lake that could present potential for stranding of fish species. This would also be the case in Dusky Lake, as fish would have access if a 2-yr flood event overtopped the berm separating it from the northern connection channel. Extreme heat and or draught periods could exacerbate risk to juveniles that did not egress from the lakes during normal peak emigrations in such situations by degrading temperature and DO conditions below the current, already assumed degraded conditions. It warrants mention that the Corps' 2011 water quality sampling snapshot taken during daylight hours indicated that there were pocket of cooler, stratified water available for juveniles, and DO was within survivable ranges but water levels will likely be lower with the proposed reconnection and cooler stratified water may not always be available. However, DO can undergo dramatic diel swings, especially in isolated waters, with extremely low levels due to respiration at night/morning, and high levels due to photosynthesis during the day. USFWS has data from Julia Butler Hansen indicating this trend (Lohr, 2012). NOAA snapshot sampling mentioned in the USGS report (2010) for the Campbell Lake reference site observed juvenile salmon as late as July in representative hydrologic conditions. Therefore, large numbers are unlikely to be present during low-water periods. There is some uncertainty in the potential salmonid response to lowering water levels within the lakes and connection channel as well as to decreasing DO levels and increasing temperatures (typically important biological signals that trigger an egress response). The associated risk is that if salmonids and other aquatic species become stranded during periods of declining water quality, ESA take could occur. However, it is expected that juveniles would be able to exit the lakes when cued by temperature and water level changes during their normal migration timing. Dusky Lake is managed such that any water control devices area removed and drainage occurs naturally in the June or July months when fish would normally be cued to egress. Furthermore, by lowering the existing Post Office Lake invert

to elevation 9 feet, even during low-water months there would be times that fish could egress during the high tide since the mean highest high-tide would occasionally exceed elevation 9 feet. Further, the project would allow for tidal mixing of Columbia River waters with Post Office Lake which is expected to elevate the water quality from current baseline conditions. Finally, a single or series of deeper pocket pools would be excavated near the northern outlet of Post Office Lake in the vicinity of the sill separating the lake from the channel. This would be expected to create some thermal stratification and temperature refugia within the lake for fish that did not egress. Habitat features such as addition of large wood would also provide cover from depredation when water depths were shallower. Because juveniles are expected to egress based on biological signals related to tidal flux and temperature changes, creating pool habitat in-and-of-itself is not expected to induce additional risk of stranding. Rather, pools are proposed to provide cover from predation and thermal refugia in the event a fish misses the environmental cues to egress. Potential habitat benefits of the project are perceived to outweigh risks. The project would also complete ESA Consultation which would specifically address potential effects to listed species. All of these factors in combination are expected to minimize both the likelihood of potential stranding and any potential associated depredation, and thus, present a low risk of ESA take.

5. The proposed project includes the planting of native riparian vegetation, and the expectation of the return of native plant communities, including wapato and tule, within the area affected by reestablishment of tidal connection between the Columbia River and Post Office Lake. However, anticipated reduction in deep water would likely favor an expansion of reed canarygrass, and opening the channel to increased tidal exchange could increase influx of non-native plant propagules. It is uncertain what the interaction between these species and the numerous non-native species would be post-project. In addition, the project area is known to support a population of beaver and carp. It is not known how many beaver are in the area is and what impact they would have on establishment of woody vegetation. There is a risk that browsing from beaver and competition from undesirable vegetation would reduce the efficacy of plantings and native vegetation establishment. Carp can cause problems with water quality and destruction of submergent vegetation. Implementation of the proposed project would include design and construction features such as sleeves for woody vegetation plantings in an effort to minimize effects from browse. The Refuge has pest management and control components in its CCP, and additional management actions (additional mechanical, hydrologic pumping, and chemical treatments) may, as a contingency, be necessary to reduce the effects of competition from undesirable plant species. This will be determined based on results of monitoring and adaptive management evaluations. Further, it is expected that the more dynamic hydrologic regime implemented by the proposed project favors desirable native emergent vegetation and fish over nuisance species, such as reed canarygrass and carp. However, there is the possibility of increased reed canarygrass coverage, which will be assessed during monitoring. Implementation of appropriate design elevations would also improve the potential success of native species establishment over reed canarygrass dominance. These factors provide for a low risk reduced efficacy with respect to the vegetation components of the proposed project.

6. Tide gate and levee removal activities associated with Measure 1 of the proposed project involves work within Clark County land and Washington Department of Natural Resources (WDNR) land below OHW. Prior to implementation, permission to remove the tide gate, culvert, and a portion of the levee constituting a portion of Lower River Road at the entrance channel to Post Office Lake would need to be obtained. A consent letter would be required stating removal of the tide gate/culvert and portion of levee below OHW has been approved and would be duly signed by WDNR. Clark County has abandoned O&M of Lower River Road and the levee and has expressed its wish to convey fee interest to the USFWS. At the time of this report, there is some uncertainty in the exact vehicles for conveyance of Clark County fee interest and WDNR

approval for the proposed work. The risk associated with this uncertainty is that Measure 1 components would not be included as part of any work performed. This is problematic as the main ecologic uplift is associated with reconnection of Post Office Lake and the proposed project plans to accomplish this through removal of tide gate infrastructure and levee prism. It is assumed that the risk of not being able to obtain the proper clearances in order to perform work on the levee and below OHW is low due to the interest in cooperation expressed by both agencies.

7. Although the proposed project will increase the frequency and extent of inundation on adjacent properties, this will have no adverse effect on use or value. In October 2010, a takings analysis was prepared by the Office of Counsel in the Corps' Seattle District, and amended in July 2012 as a result of real estate appraisal findings. It concluded that no taking would result from the induced flooding and thus, acquisition of additional lands or real estate interests will not be required for the proposed project. The WSDOT owns an adjacent strip of land to the east of the project footprint that could be subject to some inundation. This strip of land was intended for development of State Route 501, which has been placed on indefinite hold. However, local WSDOT personnel in Vancouver expressed concern over possible hydrological change to this strip of land. A meeting was held with Vancouver WSDOT representatives to explain the project's purpose and scope; as a result, they committed to elevate the proposed project information to WSDOT's Olympia office along with their positive opinion of proposed project benefits. The Corps is waiting for a response as of this writing. This leads to the perception of a low to moderate risk to the proposed project.

8. The adjacent landowners to the south end of Post Office Lake plan to engage in an enterprise that includes actions similar to those included in the proposed project (i.e., aquatic habitat restoration). Although the Corps project team has coordinated with the landowners to ensure that these actions can be mutually beneficial, there is some uncertainty as to the ultimate effect that the proposed project could have on the others. However, it is felt by both parties that the proposed project and landowner actions would be beneficial to each and thus, there is a low risk that future work on adjacent private property could had a negative impact to and/or response from the adjacent landowners. It is perceived that there is opportunity for additive ecological benefits resulting in increased success for both efforts. Therefore, the risk of negative impacts from the actions of adjacent landowners (Fazio family) to the proposed project is considered minimal. The property owners are cognizant of the risk and the Corps and USFWS will continue to coordinate up to, and including, construction to ensure the project does not adversely affect their property.

9. The project partner (USFWS) requires access to the west side of Post Office Lake to maintain their vegetative management practices to optimize the habitat for their trust species. The current practice is to access the west side via soils covering the existing culvert at the landward toe of the levee at the north connection channel. Should access to the west side of the lake be precluded, the risk to the proposed project is extremely high. The current preferred alternative concepts include building a single span bridge about 16 to 18-ft wide near the toe of levee/existing north connection channel which would span the mean high tide and two-year flood elevation and allow for Refuge to access the west lake during most high water periods. By request, USFWS engineers will also be reviewing the bridge designs.

   Additionally, the Refuge requested that the PDT supply a (contingency) means for keeping Post Office Lake from completely drying out during an infrequent drought periods (2- to 5-year frequency event) or up to annually during low-water events to ensure open water is available to waterfowl and other waterbirds during fall migration. USFWS is concerned that drying out of the lake could negatively impact the existing invertebrate populations residing in the lake, a food

source of wintering waterfowl. Recent hydraulic analysis indicated that with some modification and minimal replacement, the Refuge's pump scenario and pipe conveyance system is capable of being expanded to meet this contingency requirement. The existing water right also appears to cover pumping the necessary volumes to Post Office Lake under descriptions for the amount of withdraw and place of water use/application (WADOE permit # S2-29210). Overall, project risk of and from not accommodating Refuge requirements for measures necessary to address current mandated objectives and practices is low.

10. Concern has been expressed regarding possible infill of any constructed thermal refugia pool. This has been initially evaluated and is further detailed in the Hydrology and Hydraulics Appendix. Three mechanisms were identified as potential causes for sedimentation infill of the refugia pool. 1) Sediment entering the lake and the refugia pool brought in by high Columbia River flows laden with turbidity; 2) Sediment delivered via erosion from the surrounding land as well as some potential offsite source; and 3) Refugia pool is filled from the mobilization of lake bed fines due to regular tidal influx. Based on qualitative and gross approximate quantitative assessments, it is believed that the most likely and frequent potential mechanism for infill would be via mobilization of lake fines. The Columbia River does not have a high turbidity level due to hydro-regulation, and even during the February 1996 flood event the lake did not infill with sediment when flood waters completely inundated the area. Local erosion from the surrounding area is unlikely unless areas are denuded of vegetation. Additionally, there are no incoming creeks or streams from offsite which could contribute sediment to fill the pool. It appears that the regularly expected tidal induced velocity of 2-3 fps velocity is close to the calculated 3.3 fps of allowable mobilizing velocity. Therefore, best professional judgment of the Corps' Hydraulic Engineer indicates there is potential for infill with adjacent bed material based on a rough order of magnitude estimate. The potential likely frequency is quite frequently, maybe once a year, and perhaps more. This potential effect would be evaluated via the monitoring plan detailed later in this report. Discussion with the resource agencies and associated biological monitoring results will determine whether or not the pool would require regular excavation maintenance. Initial conversation with NMFS indicates that operations and maintenance to restore an unsustainable pool feature would not be required in the event that infill frequency predictions were correct (Fisher, 2012b).

2.2. Initial Screening of Potential Restoration Measures

For Post Office Lake, an initial screening of potential restoration measures was based on interagency meetings with the USFWS and the Corps, including site visits, to assess current management and potential future (with project) objectives for the Post Office Lake study area and potential restoration measures to accomplish them. The primary management objectives included management for waterfowl species (ducks, geese and cranes), through mowing/targeted vegetation removals, and herbicide applications. Development of riparian forest habitat on the adjacent lands is limited by the need to maintain adequate pasture and/or forage areas for the waterfowl. Additionally, sight distance requirements based on sandhill crane and dusky Canada geese behavior and activity characteristics have also reduced the opportunities for late successional riparian habitat expansion and enhancement at the site. Permanent tidal wetland restoration measures include reconnecting the lake via the north connection channel and by removing the existing tide gate and culvert. Additional enhancements to the habitat would be accomplished by removing Himalayan blackberry and reed canarygrass, where feasible. There would not be substantial altering of the site elevations, due to the site being located entirely within the Columbia River floodplain and the fact that such alterations were not perceived to result in an additional increase in benefits. Alterations were limited to removal of segments of the dike and minimal contouring to direct some overland flows during overtopping of breach locations. Other local changes were

reductions in elevations that would not have detrimental floodplain impacts. Substantial increase in the intertidal inundation period would be accomplished by simply reconnecting the lake via the north connection channel and removal of existing structures and levee sections.

The future without-project condition (no action) would result in extremely limited tidal influence and exchange with the Columbia River limited to periods when the elevations of the river and lake are substantially different. The Corps and Refuge jointly developed measures to improve the site's physical characteristics within the management constraints of the Refuge, in order to favor native tidal wetland and riparian vegetation establishment primarily around the north connection channel, along the levee and in limited areas in the pasture not used by waterfowl. The provision of reconnection at existing progressive breaches was identified as a possible means to improve use by juvenile salmonids (high flow period only) and allow for greater exchange of detrital material between the lake and Columbia River.

2.3. CONCEPTUAL RESTORATION MEASURES

Based on the results of the initial screening, several possible conceptual restoration measures, including taking no action, were considered for Post Office Lake. Proposed restoration measures were considered based on their ability to meet the project objectives and limit constraint impacts, and had sufficient implementation opportunity (e.g., lands available). The formulation of conceptual restoration measures for the project began at a meeting held on March 24, 2011. The Corps project team and USFWS staff evaluated a multitude of potential measures that could meet the restoration objectives within project constraints. The primary goals of the project were tidal and floodplain reconnection and restoration of Post Office Lake as juvenile salmonid rearing and refugia habitat, as well as improvement of riparian habitat and removal of local invasive species, where feasible. The primary constraints were operating within the mandates of protection for and promotion of waterfowl, primarily dusky Canada geese and sandhill cranes. In addition, managing potential detrimental impacts to adjacent property owners was evaluated. Table 1 summarizes the list of conceptual restoration measures evaluated and their determinations. Those measures shown in bold were deemed adequate to become final measures. The conceptual restoration measures are discussed in the following subsections.

Table 1. Summary of Conceptual Restoration Measures for Post Office Lake

Note: Measures shown in bold were included as final measures.

No.	Measure Description	Project Objectives Fulfilled	Determination
1	**Remove existing outlet structure and levee**	**Tidal reconnection and fish passage**	**Contingent upon maintaining O&M access to the west side of the lake in order to mow, apply herbicides and remove undesirable vegetation. Likely to be provided by a bridge crossing over north connection channel. Agreement with the south property owner to allow Refuge access via the south end of the lake was explored but found infeasible due to owner's future plans. New bridge considered an implementation cost for formulation purposes.**
2	Repair existing outlet structure	Tidal reconnection	Screened out. This measure did not meet the fish passage objective.
3	Replace existing tide gate with upgraded tide gate	Tidal reconnection and fish passage	Screened out. Over a 50-year planning horizon, structure likely would be 'short circuited' by progressive breaches flanking this location; measure was deemed ineffectual.
4	**Single 'large' controlled breach**	**Tidal/floodplain reconnection and fish passage**	**Final measure is in form of floodplain reconnection. The overtopping elevation would be set at 18.7 feet allowing for higher river stage overtopping.**
5	Multiple controlled breaches	Tidal/floodplain reconnection, and fish passage	Screened out. Refuge did not want waterfowl pasture areas segmented.
6	Terracing of portion of Post Office Lake	Increase habitat quality	Screened out. Insufficient benefits for fish. Some concern as to whether the terracing would hold up over time, based on percent fines soils in and around the lake and the wave/tidal actions.
7	**Deepen north end of Post Office Lake/south end of the channel**	**Increase fish habitat quality, tidal reconnection, provide fish ingress/egress**	**Involves lowering elevation of a sill at channel connection to lake to increase connectivity into the lake while allowing lake to store some water during summer, low-flow season when Columbia is below the inlet. Habitat features such as large wood would be included to provide complexity and cover. Deeper pocket pool would also be excavated near the outlet to provide thermal refugia for fish that might not egress with the tide during low-water conditions.**
8	Reconnect Campbell Lake area	Tidal and floodplain reconnection, provide fish ingress/egress	Screened out. Objectives could be met by simpler/less expensive reconnection via north connection channel to the Columbia River. Also, longer connection distance away from the Columbia River via Campbell Lake would adversely impact ERTG project score compared to direct north connection.
10	**Create/restore riparian buffer zone (along north channel,** floodplain swale **and levee)**	**Increase habitat quality**	**Note the geese pasture areas were excluded as potential riparian improvement zones. Planting scrub-shrub vegetation in the swale was also considered but later excluded to reduce any interference with sight distances of trust resources.**
11	**Provide limited aquatic, emergent and upland invasive species control**	**Increase habitat quality**	**Primary invasive to control is Himalayan blackberry.**
12	Creation of adjacent wetland pockets	Increase habitat quality	Screened out. Insufficient opportunity, minimal benefits.
13	Connect Post Office Lake to Lake River	Tidal and fish passage	Screened out. Poor water quality in Lake River could further degrade water quality in Post Office Lake. Also, measure did not provide sufficient fish ingress and egress; simpler measures accomplished same objective. High potential for spread of ricefield bulrush if area inundated.
14	**Improve existing northern channel**	**Increase habitat quality**	**Measure includes dredging channel bottom to remove fish passage barriers and improving banks to create a two-stage channel to pass full tidal prism and facilitate fish passage into lake. Habitat features such as large wood would be included to provide complexity and cover.**
15	Stabilize or correct progressive breaches	Mitigation for potential flooding impacts	Screened out. Measure is technically impractical and cost prohibitive. Also, the County decided to not repair the levee as of 2006.
No Action	No measures implemented	None	Does not meet planning criteria and restoration objectives and constraints. Carried forward to final list of measures as baseline for comparison purposes.

2.3.1. Tidal Reconnection and Fish Passage Measures

Several methods of tidal reconnection were evaluated for the restoration project. They included versions of reconnecting Post Office Lake to Lake River and Campbell Lake to the north. The Lake River connection was subsequently screened out due to water quality concerns in Lake River and the likelihood that these suboptimal conditions would adversely impact Post Office Lake. Also, connecting these two water bodies has the potential to spread ricefield bulrush (*Schoenoplectus mucronatus*) into the Post Office Lake system. The Campbell Lake reconnection measure was eliminated because reconnection did not gain additional advantages over a direct and closer reconnection to the Columbia River via the north connection channel. The Refuge was also concerned about impacts the connection would have on management practices at Dusky Lake, between the two water bodies. The north reconnection was seen as the most feasible and economic reconnection option. This option included removal of the tide gate/30-inch culvert structure and bounding levee, as well as improvements to the channel geometry, side slopes and channel bottom. A desire to provide fish passage included consideration of reducing the topographic sill located at the north end of the lake (south end of the connection channel). The proposed measure included provision to slightly lower (by 1 foot) from elevation 10 feet to elevation 9 feet. Excavation to a lower level was also considered, but ultimately eliminated to prevent full drainage of the lake during summer low flows on the Columbia River (average of about 6 feet mean low water elevation), thus preventing an adverse impact to invertebrates; which serve as forage for some wintering waterfowl. These improvements are necessary to compensate for degradation occurring from the lack of tidal flux and the addition of dredged material that had been dumped into and adjacent to the ditch.

There has also been on-going discussion with NMFS regarding additional excavation of a larger, deeper area at the north end of the lake in order to provide thermal refugia during the summer months in the event that fish are unable to egress if water quality conditions become suboptimal. Concerns that such a feature would experience rapid infill were evaluated via a simple sediment accretion model. A single large area and a smaller number or pocket pools excavated near the outlet of the lake into the northern channel were considered. Also, the hydrograph and inlet elevations at the channel confluence with the Columbia and between the lake and northern channel were re-evaluated along with existing water quality data at Post Office and the Campbell Slough reference site (Borde et al. 2011). It was determined that the risk of long-term stranding would be minimal because the sill between the lake and the channel would be set at elevation 9 feet, which is lower than the average mean higher high tide for the entire year. Therefore, fish should be able to egress at somewhat regular intervals on the high tide, even during low-flow months when river levels may cause short periods of disconnection between the Columbia and the lake and when the channel experiences drying.

The Corps, NMFS, and USFWS also discussed the potential of stranding in adjacent Dusky Lake. The water control structure between Dusky Lake and the north connection channel is at an elevation of about 14.7 ft NAVD, and a 2-year flood event above 18.7 ft NAVD would overtop the existing berm which houses the structure. Therefore, fish could enter when water levels went above 18.7 ft NAVD but could be excluded from egress unless the structure remained open. Disconnection from the north connection channel would occur when river flows dropped below 14.7 feet. Much consideration was given to evaluating this potential risk along with management practices related to the Dusky Lake Unit and water control structure. The current management strategy at Dusky Lake involves blocking the structure to retain water for arrival of waterfowl in September or October. Boards are left in place over winter and are eventually removed in July or August to allow mowing and spraying for invasive species control. In light of this, three alternatives were considered to mitigate any stranding issues. The first option considered screening the inlet structure in order to exclude ingress at all flows below 18.7 ft. The Refuge would then be required to remove the screens and implement any maintenance once water levels fell below 14.7 ft NAVD. The second option included the potential to lower the inlet elevation so that the duration of

connectivity with the north connection channel was maintained. The final and preferred measure involved "no-action" such that the Refuge would continue to manage the Dusky Lake Unit as described in the CCP. The Services and the Corps agreed that the risk for stranding was considered low because the shallower nature of Dusky Lake would heat up faster than the adjacent habitat and therefore fish were more likely to egress to the north connection channel or Post Office before the connection was lost. As demonstrated in Campbell Lake, fish were also likely to be leaving or have left the system at the time the lake would be re-opened. Therefore the management timing was considered complementary to the normal expected rearing and migration strategy. The potential benefits of increased forage and rearing acreages were thought to outweigh the potentially low-risk of stranding. These assumptions would be monitored and addressed via an adaptive management approach resolving whatever developing risks that potentially indicated by monitoring results.

2.3.2. Riparian Habitat Improvement Measures

Potential riparian habitat improvements were limited, especially with regards to development of a late-successional canopy complex. The areas around the lake which were historically wooded are now reserved as goose use areas under current and future Refuge and Pacific flyway management plans. Opportunities for enhancing riparian habitat exist around the north connection channel, near the southern parking lot, and linearly along the levee. Subsequent refinements led to the concept of a 50-foot riparian buffer around the north connection channel, with some expansion at the northwest corner. The buffer would reconnect to a stand of existing willows and cottonwood. On the levee, it was decided that removal or scarification of the existing pavement and establishment of trees to supplement the existing cottonwood and alders would be an appropriate measure towards improving riparian habitat. Scarification would be selected over removal if it retained more of the existing mature woody vegetation relative to removal methods. Heavy equipment required for asphalt removal would be more likely to damage the existing limited riparian buffer. Scrub willow was proposed at locations within the pasture area in the swale adjacent to the lake. The scrub was considered to minimize impact to waterfowl and keep the landscape open for sight distance needs, while also providing some energy dissipation in the swale during flood events. However, this component is no longer proposed, as is does not align with Refuge management practices in the unit.

2.3.3. Floodplain Reconnection Measures

There are four existing progressive breach points in the Post Office Lake study area. Of these, one has completely eroded the prism of the non-federal levee allowing infrequent over-topping. However, because the landward side of the levee is elevated with respect to the lake, a permanent tidal connection was not established. The project team evaluated multiple and single breach points reconnection options. The reconnections would only function during high flow periods, unless a deep channel was excavated, reconnecting the water bodies. Subsequent discussions with USFWS staff concluded that a deep channel would likely be unstable over time and that O&M was a concern. It was concluded that a high-stage floodplain reconnection swale was more appropriate for these locations. The question of multiple versus single (breach point) floodplain reconnections was decided by a desire to avoid segmenting the grass pastures around the lake. Therefore, the site of the greatest current breach erosion was selected as the location for a high-stage floodplain reconnection. Mimicking historic patterns, the reconnection would allow woody debris and other beneficial material to wash into and out of the floodplain, while also providing complexity, energy dissipation, and nutrient exchange.

2.3.4. No Action (Future Without-Project Condition)

If no action is taken, Post Office Lake would continue to be managed essentially as it is now, but with wet meadow replacing early successional floodplain forest at the north end, and the pasture crop providing dusky Canada geese foraging opportunities as described in the Refuge draft CCP and illustrated in Figure 7 and Figure 8. Cottonwoods and willows are increasing at the north end of the Post Office Lake/south end of Dusky Lake, and this would be allowed to continue. In the figures, this is reflected as a change at the north end of the lake (pale green to green stripes) and around the lake (yellow to orange with dots), respectively. To aid waterfowl sight distances, riparian vegetation would be controlled and limited. Post Office Lake would remain degraded with respect to water quality and temperature due to lack of tidal influence and limited flooding regimes and hydrologic exchange. The existing tide gate and blockage would continue to prevent salmonid ingress and egress. The site would provide infrequent and limited fish habitat only during more extreme flood events with potential fish stranding once flood stages recede.

Figure 7. Current Management of Wetlands and Habitat for Roth and Ridgeport Dairy Units

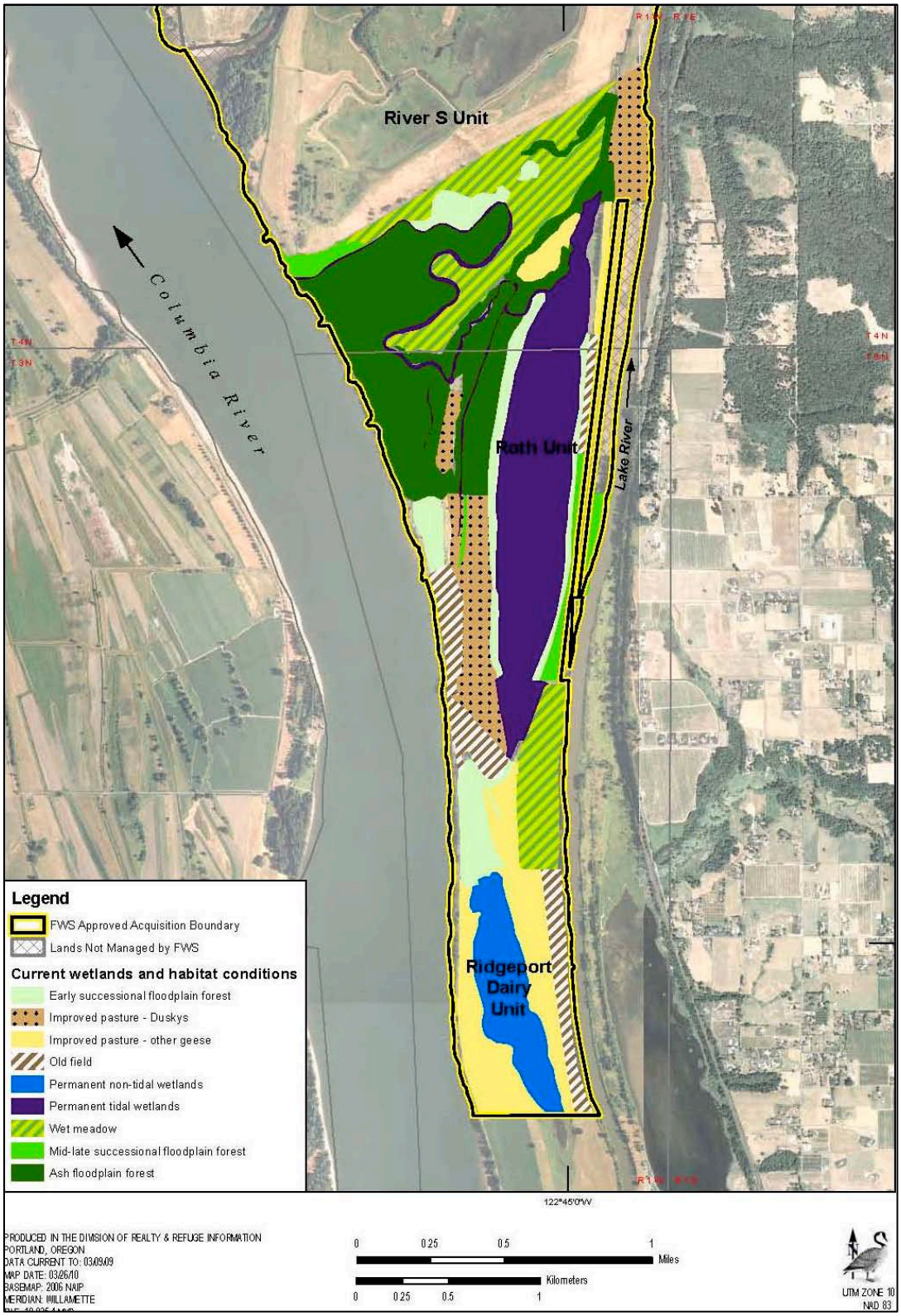
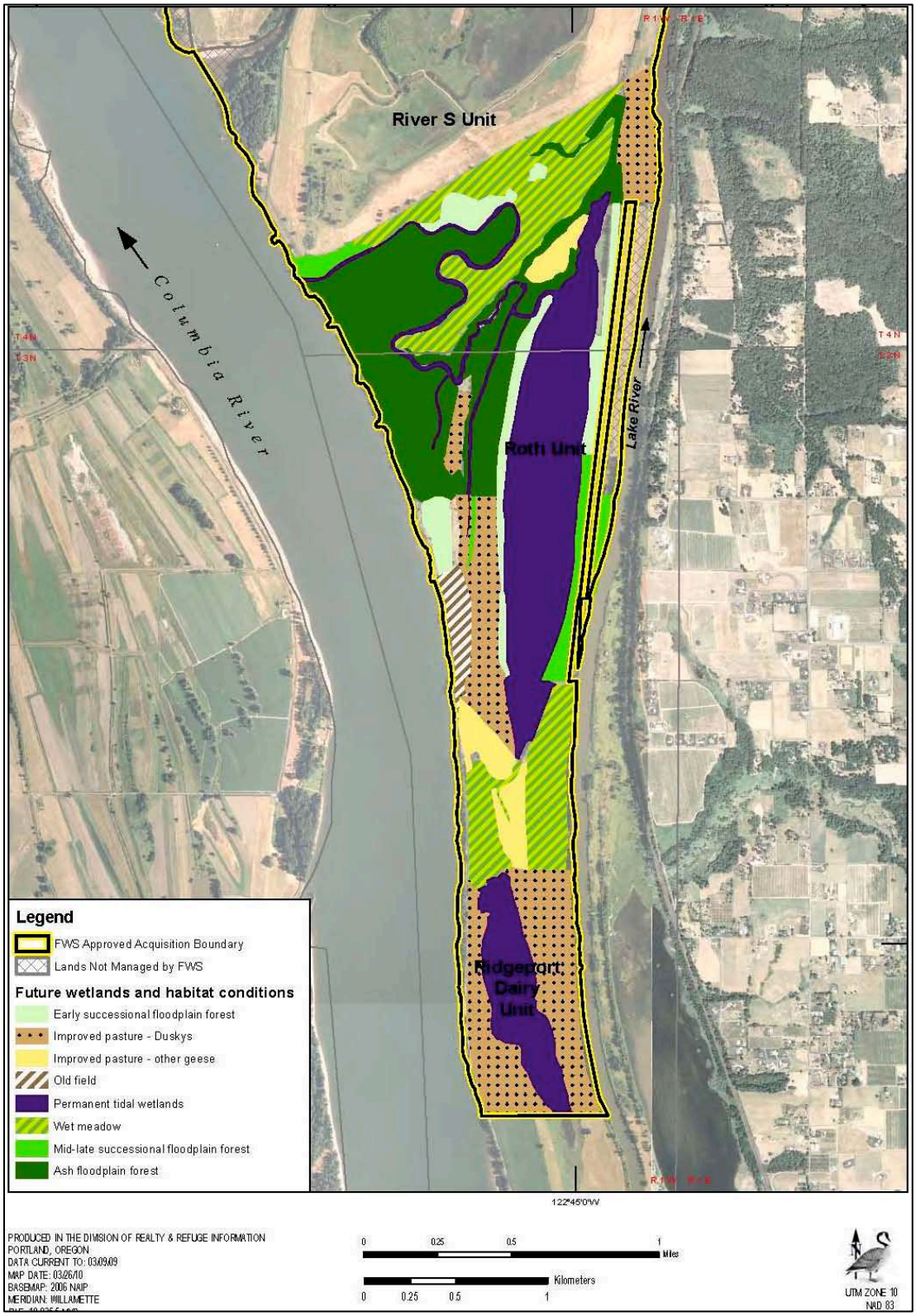


Figure 8. Future Management of Wetlands and Habitat for Roth and Ridgeport Dairy Units



The levee would degrade further via the observed pattern of progressive erosion, primarily caused by ship waves and large flood events (e.g., spring 1996 flood). The 2011 water year was a La Niña year, a cooling of surface waters in the eastern and central Pacific Ocean, pushing wetter airflows north into the northwest. This generally results in wetter, cooler winters. The resultant spring 2011 freshet at Portland was approximately 500,000 cubic feet per second in the Columbia River and resulted in overtopping at the landward side of the eroded levee section at Post Office Lake. It is possible that the overtopping accelerated the erosion at the site and that further La Niña occurrences would result in accelerated degradation of the levee. The geometry of degradation was and would likely continue to be characterized as longitudinal (toe) erosion, along the Columbia River shoreline. No over-topping was observed in 2012. It is not anticipated that a permanent tidal connection between the Columbia River and the lake would be established.

Removal of historic riparian forest around Post Office Lake and along the levee has resulted in a reduction in wood and detrital inputs that would normally replenish and add complexity and nutrients to the mainstem Columbia River, backwater channels, wetlands, and floodplains in the vicinity of the lake. As the levee is naturally eroded, it is anticipated that the frequency of high flow overtopping would increase and that a somewhat more natural, but still limited, disturbance regime would slightly increase the potential replenishment of wood and detrital export at Post Office Lake and vicinity. However, fish would be excluded from benefits except during extreme flow events.

The level of riparian complexity and floodplain functions would remain constrained by the infestation of invasive species, the current lack of regular hydrologic connectivity, and the minimal amount of native riparian vegetation left to serve as a recruitment source. Wetlands would likely remain as currently classified and vegetative succession would be limited by management strategies practiced by the Refuge. Hydrology to the wetlands could increase somewhat over longer time horizons depending on rate of levee deterioration and inundation by seasonal flooding.

The Refuge outlined in the CCP (Chapter 2, *Alternatives, Objectives and Strategies*) that the future condition of the Post Office Lake area (Ridgeport Dairy Unit) includes examining the feasibility of re-connecting the lake to the Columbia River and maintaining dusky Canada geese pasture lands in the immediate vicinity of the lake. Reestablishment of tidal wetland is contingent upon tidal connection resulting from a levee breach. However, due to the constraints of local topography, it is evident that full tidal connection would only take place when the culvert and tide gate (and levee) are removed.

If there is no restoration project at Post Office Lake, current management activities ensure that the Ridgeport Dairy Unit would continue to primarily serve as waterfowl and waterbird habitat. However, as the levee continues to degrade and overtopping waters inundate the lake bottom more frequently, the habitat character around the lake would change somewhat with slightly more frequent and potentially higher levels of winter water levels. The lake would remain inaccessible to fish except at the highest flow levels. If no action is taken, the regional goal of restoring wetland and riparian habitats in the lower Columbia estuary for the conservation and recovery of listed salmonid populations would take longer to accomplish, and the 75 to 100 acres of potential salmonid habitat at Post Office Lakes would remain unrealized. Wintering waterfowl and waterbirds such as grebes and coots, and wading birds would continue to use the lake for forage and roosting at current levels.

If no action is taken, the socio-economic conditions are expected to remain along the same trajectory described in the CCP with regards to hunting, recreation, and community development.

2.4. FINAL LIST OF RESTORATION MEASURES

The final list of restoration measures for Post Office Lake is described below. Figure 9 graphically shows the final restoration measures for Post Office Lake and their extents/locations.

Measure 1. Remove culvert and the tide gate 'plug' at outlet of the north connection channel, restoring tidal reconnection and fish access. Remove tide gate and culvert, as well as adjacent levee segment over the culvert. For this measure, it was originally assumed that an easement agreement would include a provision for the Refuge to access the west side of the lake via crossing the private property at the south end of the lake. It was determined that the agreement was feasible based on informal conversations with adjacent property owners. However, subsequent analyses determined that sufficient access would still not be possible and that a bridge would be required for the USFWS to continue with their O&M activities. At the request of the Refuge, the Corps would be providing a bridge across the north connection channel in order to maintain access during high flows in the Columbia. Also at the request of the Refuge, after levee breach and tide gate removal, the Corps would leave some of the remaining concrete in place on the Columbia River side. Proper signage would be installed to indicate closure to public access.

Measure 2. Create controlled floodplain reconnection at the worst progressive breach location, approximately RM 95.1. The entrance elevation of the breach point would be set at the 2-year Columbia River flood stage of 18.7 feet. The approximate width of the expanded breach would be 250 feet. Existing overtopping is at 20.4 feet, 4-year overtopping frequency. A connection swale would be graded in, connecting the breach to the lake. The swale would facilitate controlled overland flows and provide some passage opportunity for fish ingress from the river during the high stage events. Planting scrub willow and dogwood in the swale was considered but was ultimately precluded by USFWS in order for t the Refuge to meet habitat requirements for dusky Canada geese and Sandhill cranes.

Measure 3a. Improve north connection channel configuration for better fish access. Create a two-stage channel that passes the full tidal prism. Stabilize the side slopes, terrace and or flatten side slopes. Remove high points along the north connection channel which may impede fish passage. Where feasible, any required stabilization would be by 'eco-friendly' bioengineering methods. Habitat features such as large wood and rootwads would be included to add immediate complexity and cover, and is expected to increase over time as energy and wood move through the system. During the 2-year flood event, water would overtop the low berm between Dusky Lake and the northern connection channel, allowing fish to ingress into Dusky Lake as well. Water management practices of the Refuge entail flooding and draining this area on an interval roughly coincident with predicted flooding and fish egress timing (flooding or holding back water beginning in October, with opening and draining sometime between July and August (Chmielewski 2012b)). Fish that entered during a flood would be able to leave when water quality conditions declined and they would normally be cued to egress because the gates would be open by then.

Measure 3b. Create riparian buffer in vicinity of the northern channel. Enhance the native riparian buffer and allow late successional development within 50 feet of bankfull width. Extend plantings on north end to the existing willow/cottonwood stands adjacent to the Columbia River. Remove localized patches of invasive species in order to ensure successful establishment of native plantings.

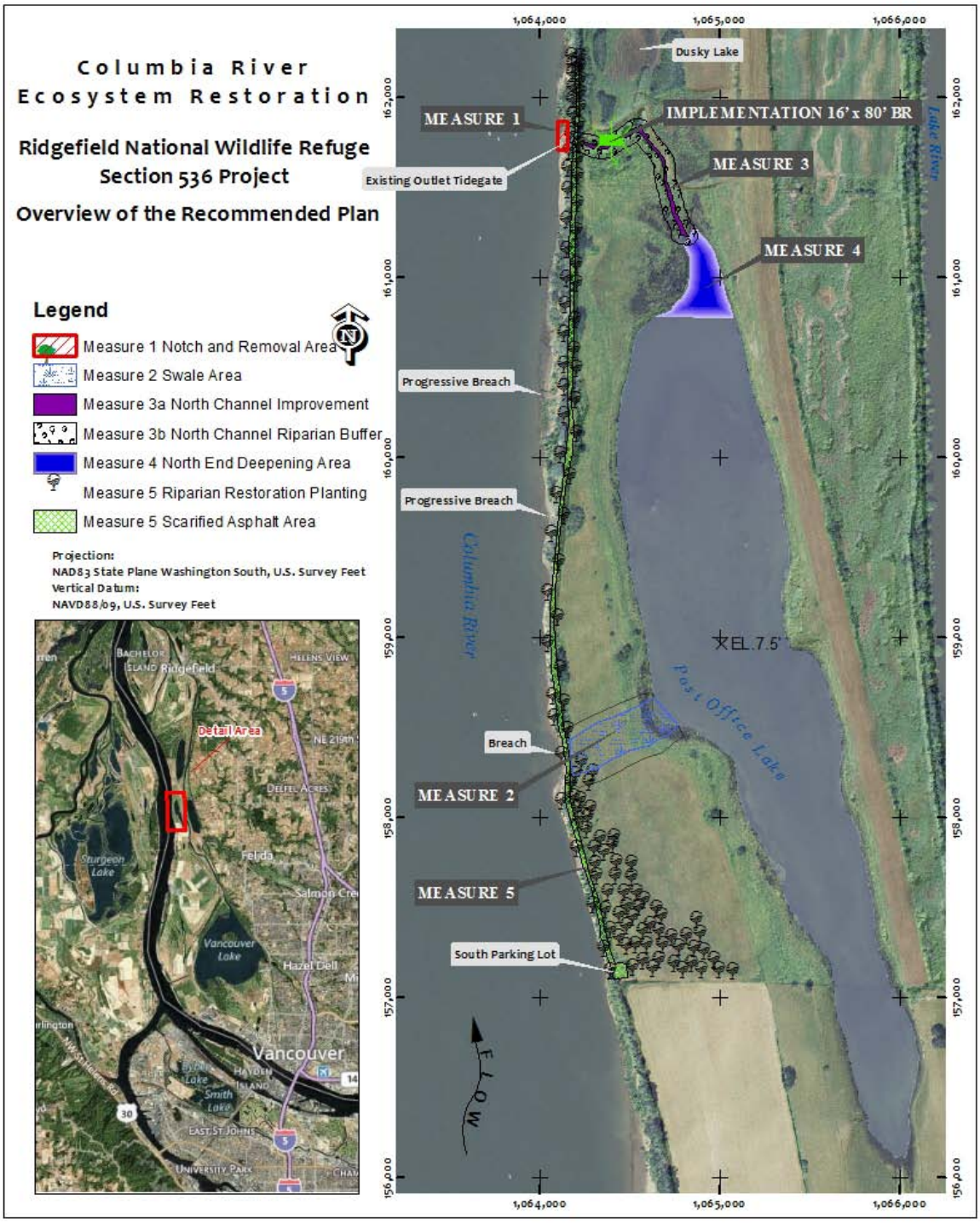
Measure 4. Deepen north end of Post Office Lake/south end of ditch. Deepen the lake at the north end to elevation 9 feet. Remove the high ground knob at the north outlet of lake, which is currently at elevation 10 feet. To avoid erosion, the remaining 9-ft sill will be appropriately armored or similarly protected. This high point holds water in the lake to elevation 10 feet, but would block fish passage at lower stages. Note that the deepest elevation of lake is 7.5 feet. Habitat features such as large wood and

rootwads would be included to add immediate complexity and cover, and is expected to increase over time as energy and wood move through the system. Deeper pocket pools or a single pool also would be excavated near the outlet to provide thermal refugia for fish that might not egress with the tide during low-water conditions.

Measure 5. Riparian restoration along the levee including removal of asphalt.
Scarify remnant asphalt thereby facilitating expansion of riparian vegetation. Scarification would be selected over removal in areas where it is determined to be less impactful to existing, mature woody riparian vegetation. An additional area for riparian plantings has been indentified beginning at the south boundary parking lot (terminus of River Road, milepost 11). This secondary area is not widely used by waterfowl and would create additional floodplain forest habitat to benefit a multitude of wildlife species. Remove localized patches of invasive species in order to ensure successful establishment of native plantings.

No Action. No habitat restoration measures would be implemented at Post Office Lake. Current Refuge management practices would not substantially change. The dike would continue to progressively erode.

Figure 9. Final Restoration Measures for Post Office Lake



2.5. FINAL ARRAY OF ALTERNATIVES

The final restoration measures were further developed, and in some cases combined, into alternatives to meet all of the project objectives and constraints. The list of alternatives was based on which set of measures was necessary to meet minimal benefit objectives. For example, a suite of measures at the northern connection channel was necessary to meet the objective of tidal reconnection *and* fish passage. That is, the removal of the tide gate and culvert would need to be combined with the ditch channel improvements to adequately facilitate fish passage. Table 2 summarizes the combinations of measures going into each alternative evaluated. Alternative 1 is the No Action Alternative (without-project condition). The resulting alternatives are described below the table.

Table 2. Measure Combinations and Alternatives

Measures	***Alternatives***						
	1	**2**	**3**	**4**	**5**	**6**	**7**
1. Remove culvert/tide gate to reconnect north channel and provide fish access.	--	X	X	X	X	--	--
2. Reconnect floodplain at worst progressive breach (RM 95.1).	--	--	--	X	X	X	X
3 (a+b). Improve north channel configuration and create riparian buffer.	--	X	X	X	X	--	--
4. Deepen north end of lake.	--	X	X	X	X	--	--
5. Riparian restoration/asphalt scarification along levee.	--	--	X	--	X	--	X

Alternative 1. No Action. No habitat restoration actions would be implemented at Post Office Lake. Current Refuge management practices would not substantially change. The dike would continue to progressively erode. No permanent or substantive repairs would be performed as part of the Refuge's long-term management/contingency strategy.

Alternative 2. North channel tidal reconnection/fish access + improve north channel configuration/create riparian buffer + deepen north end of lake (measures 1+3a+3b+4). Remove tide gate (across the north channel entrance, in the event that an access easement cannot be obtained) for O&M access purposes, improve north channel configuration, add riparian buffer, improve lake at its north end to minimize fish stranding.

Alternative 3. North channel tidal reconnection/fish access + improve north channel configuration/create riparian buffer + deepen north end of lake + riparian restoration/asphalt scarification along levee (measures 1+3a+3b+4+5). This alternative does not include the floodplain reconnection (measure 2).

Alternative 4. North channel tidal reconnection/fish access + floodplain reconnection + improve north channel configuration/create riparian buffer + deepen north end of lake (measures 1+2+3a+3b+4). This alternative does not include riparian restoration/asphalt scarification along the levee (measure 5).

Alternative 5. North channel tidal reconnection/fish access + floodplain reconnection + improve north channel configuration/create riparian buffer + deepen north end of lake + riparian restoration/asphalt removal along levee (measures 1+2+3a+3b+4+5). This alternative includes the full suite of restoration measures.

Alternative 6. Floodplain reconnection at worst progressive breach, RM 95.1 (measure 2). Create controlled floodplain reconnection at worst progressive breach location, ~ RM 95.1. The entrance elevation of the breach point would be set at 2-year, elevation 18.7 feet. Existing overtopping is at elevation 20 to 21 feet, 4.8-year overtopping frequency. A connection swale would be graded in from the breach to the lake. Only allowable plantings would be forbs or similar appropriate low-growing species (low height vegetation for bird sight distance considerations).

Alternative 7. Reconnection at worst progressive breach (RM 95.1) + riparian restoration/asphalt scarification along levee (measures 2 +5). This alternative does not include the north channel reconnection/fish access (measure 1), improving north channel configuration/create riparian buffer (measure 3a + 3b), and deepening north end of lake to minimize fish stranding (measure 4).

2.6. ADDITIONAL IMPLEMENTATION OPTIONS

The USFWS currently accesses the west side of Post Office Lake to mow the grassland areas and to apply herbicides, mosquito control, etc. This occurs twice a year – in spring (February) and the beginning of fall (October). The current route of access is over the existing (buried) 30-inch culvert on the landward side of the dike. If the north connection channel were opened to tidal fluctuation, this access would be disrupted. The USFWS has requested that the feasibility study consider ways to ensure access is provided after project implementation. The following options were evaluated for meeting this objective. Items 2, 3, 4, and 5 were not feasible or carried forward for further evaluation.

1. Span the north connection channel with a large span arch culvert or bridge (at the existing landward side, toe of levee).
2. Obtain right of entry across the south property owners lands and or as a perpetual road easement.
3. Modify the O&M plan at the site. The new plan would include hauling equipment from current sheds located in the north to the south side of Post Office Lake by the circuitous and long route using Interstate 5 and passing through the City of Vancouver. The trip time would be significantly longer (estimated 1.5 hours), but would be a minimum of two times a year.
4. Construct an onsite shed and purchase dedicated O&M equipment.
5. Employ a herd of goats to seasonally manage weed removal and mowing needs.

The implementation cost for a new bridge was estimated to be $132,000. This is based on the preliminary configuration summarized below.

- 16 feet x 80 feet U80 with occasional L93 over load
- Weathering steel W-beams
- Weathering steel guard rail system
- Pre-cast concrete bolt on deck panel
- Pre-cast concrete sills 18 inches x 30 inches x 16 feet
- Pre fabricated steel back walls
- Excludes any and all unloading
- Excludes taxes, if applicable
- 90-120 days for delivery
- FOB job site

The Refuge would like to be able to prevent Post Office Lake going completely dry during a severe drought year (frequency about 3-5 years). Should the lake evaporate/percolate and go dry, the Refuge

requested the ability to fill the lake. This would be a contingency action only but could occur as an annual practice through adaptive management to insure quality aquatic habitat and forage is available for migratory waterfowl prior to the fall migration.

Hydraulic analysis was performed to determine the pumping and conveyance line requirements. Based on initial analysis, the existing 40 horsepower pump located at the south end of Campbell Lake (approximately 0.3 mile from the north end of Post Office Lake) and supplemental conveyance line (18-inch pipe) would be sufficient to meet Refuge requirements. The Refuge currently has a water right from Lake River for 900 acre-feet per year. The right is sufficient to accommodate the approximately 32 acre-feet necessary to fill Post Office Lake to a depth of 1 foot should drought conditions dictate. Subsequent pump analysis indicated that a new pump in the existing location would be required to meet the Refuge's requested capacity.

The Refuge also requested 10-foot chain-link fence across the property boundary at the southern border. This was to prevent public access to the Refuge in support of the wildlife sanctuary purpose and to reduce liability. Subsequent conversations with adjacent landowners indicated that the current access road is likely to be breached so that passage from the south to the Refuge is no longer possible. Though temporary construction fences are likely to be implemented, breaching of the southern access road eliminates the need for additional fencing along the border. The mitigation banking plans of the adjacent landowners further reduce the likelihood of public disturbance near the Refuge boundary.

The bridge cost and cost to increase the existing 18-inch conveyance pipe were not included as part of the implementation costs considerations (Section 2.8) or the cost effectiveness/incremental cost analysis (Section 2.9), since these potential project constraints are not selection requirements for project implementation.

After multiple conversations with Refuge staff, it was determined that these measures would be required in order to address requirements necessary for meeting Refuge management objectives. Although the current understanding is that the adjacent property owners, the Fazio family, would open to granting access to USFWS for part of their property on the west side of Post Office Lake, the hydrologic reconnection and mitigation banking plans they intend to implement in the future would preclude USFWS passage during the seasons required by the Refuge. Under this eventuality, the bridge was considered necessary.

These potential project features and project impacts are presented for disclosure purposes and are continuing to be discussed and negotiated. When the PDT does obtain certainty regarding these actions, the items will be refined and presented in later (design) cost estimates.

2.7. EVALUATION OF RESTORATION BENEFITS BY ALTERNATIVE

The potential impacts to fish and wildlife habitat at Post Office Lake were evaluated using Habitat Suitability Index (HSI) framework, based on the Habitat Evaluation Procedure (HEP) developed by USFWS to assess specific habitat requirements for a suite of fish and wildlife species. For this analysis, four primary habitat types were the initial focus identified by the Corps and USFWS in the study area: emergent wetlands, open water, riparian habitat, and tidally influenced riverine/instream habitat. The species used to model impacts were selected based on their specific habitat needs relative to current and expected changes in habitat conditions at Post Office Lake. Each species' habitat needs can be modeled using specific metrics evaluated in terms of anticipated changes following implementation of each alternative.

For each habitat type (wetland, open water, riparian, and instream), species were selected to represent existing and future conditions. Gadwall (*Anas strepera*), a dabbling duck, was used to model changes to wetland and riparian habitats at Post Office Lake following the dynamic hydrologic and tidal regimes anticipated under the various alternatives. Lesser scaup (*Aythya affinis*), a diving duck, was selected to show changes in both open-water and wetland habitat during the over-wintering season. Two species of salmon, Chinook and coho, were selected to reflect changes anticipated to both riparian and instream habitats, as well as emergent wetlands. Several habitat metrics overlapped between species and served to reinforce the importance of these habitat components in the overall model results. Appendix A, *Environmental Modeling*, provides a complete discussion and explanation of the HSI development and methodology for all species. In addition, the assumptions used for calculating species-specific HSI values and the results from the model are presented. The HEP model was applied to these species for the following alternatives. Results are predictions describing the potential effects to these species via their habitat parameters that change due to changes to the environmental conditions when implementing the proposed alternatives:

Alternative 1. No Action. Post Office Lake would remain non-tidally connected and the restricted exchange between the Columbia and the lake would continue to prevent juvenile passage into the lake. The north connection channel would remain degraded and marginal and unavailable to salmonids. The breach areas would increase in size and likely erode the shoreline towards the lake. Uncontrolled overtopping during the winter and spring freshet period could fragment and transform waterfowl pasture areas and cause other O&M issues Existing high quality sago pondweed beds and open water semi-permanent and permanently-flooded wetland habitat would persist. This alternative does not meet the Corps' planning criteria and restoration objectives and constraints discussed in Section 2.1. However, the No Action Alternative is included in the output and economic evaluations as a baseline against which the other alternatives are compared.

Alternative 2. North channel tidal reconnection/fish access + improve north channel configuration/create riparian buffer + deepen north end of lake (measures 1+3a+3b+4). Alternative 2 establishes tidal connection between Post Office Lake and the Columbia River, thereby providing access to additional rearing habitat and flood refugia for juvenile salmonids. This off-channel habitat would provide increased opportunity for rearing and growth before juveniles migrate downstream into the estuary. There is likely to be a seasonal conversion in summer from permanent, submergent wetlands to a larger area of emergent, shallower wetland areas. In winter, re-establishing salmonid access to these wetland and backwater off-channel areas would restore access to important refugia and rearing areas for out-migrating juveniles.

Waterfowl would retain access to over-wintering habitat, as Post Office Lake would continue to experience elevated water levels during the winter and spring freshets. Because some water would remain in the lake throughout the year following deepening the north end, invertebrate populations would continue to provide foraging opportunities for a suite of waterfowl, primarily the diving ducks though these foraging opportunities may be reduced. While wetland habitats would likely transition from open water and emergent permanent to semi-permanent/seasonal, the lake would still support emergent and submergent vegetation for foraging opportunities and cover for young throughout the year.

Enhancing the riparian habitat along the northern channel of Post Office Lake would increase the complexity of the landscape immediately adjacent to the lake, which would further support detrital inputs into the northern channel and lake, sustaining important aquatic biota. The added riparian component would help to ameliorate the impacts of water quality (temperature, DO)

issues along the northern channel. Most improvements to water quality would result from increased tidal fluctuations regularly transporting nutrients into and out of the lake system. This would moderate temperature and increase DO concentrations. Also, reducing the density of invasive species would boost native composition and survivability, further supporting a more diversified landscape adjacent to the lake. A more natural and dynamic hydroperiod would also help sustain a more native plant community that has evolved under such water regimes.

Alternative 3. North channel tidal reconnection/fish access + improve north channel configuration/create riparian buffer + deepen north end of lake + riparian restoration/asphalt scarification along levee (measures 1+3a+3b+4+5). Similar to the effects from Alternative 2, this alternative adds removal or scarification of the asphalt along the levee with additional riparian plantings to increase cover and complexity. This added complexity along the levee would support additional wildlife (songbirds, mammals, amphibians, others) and increase the riparian buffer adjacent to the Columbia River. Increasing this buffer width would provide benefits to salmonids and other fish utilizing the near-shore habitat by increasing shade and allochthonous inputs into the river. It also improves the age-class diversity and establishes a more sustainable source of woody and detrital inputs which further increase habitat complexity and food web inputs.

Removal of the asphalt would also serve to reduce human disturbance by minimizing the access of foot traffic along the levee. Reducing access to the lake area would positively benefit waterfowl which prefer secluded areas, free from interruption. The impacts from this measure would increase over time, as the shrubs and trees mature to block the pathway that currently exists along the levee. Additional efforts by the USFWS to reduce and/or block access to the lake may be warranted, but are not addressed as part of this alternative.

Alternative 4. North channel tidal reconnection/fish access + floodplain reconnection + improve north channel configuration/create riparian buffer + deepen north end of lake (measures 1+2+3a+3b+4). Similar to the effects from Alternative 2, this alternative adds floodplain reconnection at the most progressive breach along the levee. Lowering of the levee to elevation 18.7 feet would allow water to crest over the levee along a controlled path. Currently, water crests over the levee at approximately elevation 20 to 21 feet, and the water sheet flows over the pasture and drains toward Post Office Lake. Any fish that are swept or volitionally swim over the levee at high flows have an increased risk of stranding as the lake is not tidally connected and egress is limited.

Lowering the levee and providing a depressional swale into Post Office Lake in tandem with reconnecting the tidal prism to the lake would provide ingress into the lake during high flows while simultaneously providing egress from the lake via the north channel. In addition, lowering the elevation of the levee would provide more frequent access into the lake and for longer durations, giving juveniles increased opportunities to access and use the off-channel and fringe wetland habitat in the lake. Concentrated flows with vegetation would also provide high flow passage with energy dissipation components to ensure swale stability and juvenile refugia between the mainstem Columbia River and Post Office Lake.

Lowering the levee increases the opportunity for re-introduction of more natural and frequent flood inundations and disturbance regimes, which would facilitate restoration of floodplain functions and biota. Levee breach would provide somewhat more opportunity for additional flushing and circulation through the lake during more frequent flood intervals. Besides

floodplain exports and aquatic refugia, opening access to the floodplain provides some flood storage capacity as well.

Alternative 5. North channel tidal reconnection/fish access + floodplain reconnection + improve north channel configuration/create riparian buffer + deepen north end of lake + riparian restoration/asphalt scarification along levee (measures 1+2+3a+3b+4+5). Alternative 5 presents the full suite of measures, where the lake would be connected to the Columbia River in two locations, the tidal prism is restored and enhancement of the riparian habitat is maximized. Under this alternative, fish passage opportunities are maximized via lowering of the levee to facilitate access at high flows. Removing the tide gate and restoring the tidal prism provides ingress/egress (for most of the year). Riparian habitat would be enhanced both along the northern channel and along the levee following asphalt scarification, increasing overall complexity, density and composition of plant communities. In turn, this would benefit the waterfowl which use the lake and its associated wetlands to over-winter and breed. Increasing buffer width would provide benefits to salmonids and other fish utilizing the near-shore habitat in the Columbia River by increasing shade, cover, and allochthonous inputs.

Alternative 6. Floodplain reconnection at worst progressive breach, RM 9.1 (measure 2). Unlike Alternatives 4 and 5 where floodplain reconnection is implemented in tandem with removing the tide gate to restore access via the northern channel, Alternative 6 solely reconnects Post Office Lake to the Columbia River by lowering the levee elevation at the worst progressive breach. While lowering the levee would increase the frequency and duration for which juvenile salmonids would have access into the lake, there is limited egress opportunity from the lake. Fish would have to cue their egress to falling water elevations, and the risk of stranding in the lake is higher under this alternative.

While there is conversion of wetland habitat for Alternatives 2 through 5, there would be no impact (negative or positive) to wetland habitat under Alternative 6. As such, lowering the elevation of the levee would provide little benefit to waterfowl. Additionally, there would be no riparian plantings under this alternative, leaving the existing riparian condition.

Alternative 7. Reconnection at worst progressive breach (RM 95.1) + riparian restoration/asphalt scarification along levee (measures 2 +5). Similar to Alternative 6, the floodplain reconnection at the worst progressive breach would increase the frequency and duration for which juvenile salmonids would have access to the lake, although there is limited egress opportunity from the lake. Similar to Alternative 6, fish would have to cue their egress to falling water elevations and the risk of stranding in the lake would be high.

Similar to effects under Alternative 3, Alternative 7 adds the scarification of the asphalt along the levee with additional riparian plantings to increase cover and complexity. This added complexity would support additional wildlife (songbirds, mammals, amphibians, others) and increase the riparian buffer adjacent to the Columbia River. Increasing this buffer width would provide benefits to salmonids and other fish utilizing the near-shore habitat in the Columbia River by increasing shade and allochthonous inputs into the river. Scarification of the asphalt would also serve to reduce human disturbance by minimizing the access of foot traffic along the levee.

The habitat units (HU) calculated for each alternative was derived by first calculating the HSI for each focal species (gadwall, lesser scaup, Chinook and coho salmon) by creating and applying the following models.

Gadwall. Gadwall can be represented with three primary life stages: pairing, breeding and brood rearing. The HSI model directs that the overall HSI determination for gadwalls can be simplified to the life stage with the lowest potential to support the specific habitat needs (Sousa 1985). Of the three life stages, it was determined by the Corps and USFWS that brood rearing was the limiting factor for production of dabbling ducks at Post Office Lake, and is therefore the most applicable life stage to represent changes to wetland habitats. See Appendix A for a complete discussion regarding the different life stages and their application in this analysis.

It is anticipated that wetland habitats would transition from being largely permanent to one of semi-permanence and/or seasonal availability. The brooding variables for gadwalls should capture these conversions when comparing the suitability index (SI) and ultimately the HU between the proposed alternatives. Because gadwalls prefer semi-permanent wetland habitat, the variables are weighted according to the type of wetland (seasonal, semi-permanent, permanent, open water). The variables calculate the optimum number ($SI_1 = V_{\text{number of wetland classes}}$) and area ($SI_2 = V_{\text{area of wetlands}}$) of different wetland classes. In summary, the HSI for gadwall broods can be represented using the equation:

$$HSI_{Gadwall} = (V_{number\ of\ wetland\ classes} * V_{area\ of\ wetlands})^{1/2}$$

Lesser Scaup. Lesser scaup use Post Office Lake as over-wintering habitat, resting on the open water and foraging for invertebrates. Lacustrine habitat would likely be altered (both depth and area of inundation) under the different alternatives. Because the lesser scaup variables are capturing changes to the winter conditions, all variables used to calculate the scaup HSI were evaluated during winter water conditions from November to mid-July. This time period effectively captures the winter rainy season and the spring freshet. In addition to changes in open water and emergent wetland habitat, it is possible that vegetative communities would convert to more native composition following restoration of a dynamic hydrologic regime. This transition could improve both the variety and quality of food resources available to fish and wildlife using Post Office Lake However, uncertainty remains regarding the extent of the establishment of native and invasive vegetative communities.

The needs and requirements for over-wintering habitat can be represented as foraging and shelter/cover opportunities (Mulholland 1985). The suitability of over-wintering habitat for scaup can be described using four variables to capture changes between the proposed alternatives. The (potential) abundance of invertebrates, percent of emergent vegetation and average winter water depth characterize foraging opportunities. The level of human disturbance has a strong effect on resting and foraging behavior. Because scaup use open water habitats for foraging, resting and loafing, the relative level of disturbance on the adjacent landscape influences these behaviors and the overall suitability of the habitat. These variables are represented as: $SI_1 = V_{\text{pelecypods}}$, $SI_2 = V_{\text{emergent vegetation}}$, $SI_3 = V_{\text{water depth}}$ and $SI_4 = V_{\text{human disturbance}}$. The coverage and abundance of invertebrates and mollusks are considered the limiting factors in determining the carrying capacity of a habitat for over-winter scaup; thus, this variable is weighted more heavily than the others. The overall equation for calculating the HSI for scaup is:

$$HSI_{Scaup} = ((V_{pelecypods})^2) * V_{emergent\ vegetation} * V_{water\ depth} * V_{human\ disturbance})^{1/5}$$

Chinook and Coho Salmon. It was determined by the Corps and USFWS that changes to tidally connected wetlands and instream habitat types could reasonably be represented by combining suitability indices for juvenile Chinook and coho salmonids. While multiple life stages of salmonids are found in the mainstem Columbia River year-round, Post Office Lake does not currently consist of habitat to support adult migration (though it could provide flood refugia), spawning, egg and fry development or smoltification. The only life stage supported by the current and expected habitat characteristics is

juvenile rearing. The study area is expected to provide beneficial off-channel and backwater rearing and flood refugia habitat.

Floodplain connectivity, riparian structure, and tidal regimes provide important ecosystem functions which are reflected by combining coho and Chinook variables (McMahon 1983, Raleigh et al. 1986) as a general salmonid representative species. Of the HSI variables for coho, only those most relevant to the current and potential habitat in the study area were applied to the model framework. These include variables to assess water quality ($SI_1 = V_{\text{water temperature}}$, $SI_2 = V_{\text{dissolved oxygen}}$) vegetation composition and density ($SI_3 = V_{\text{canopy}}$, $SI_4 = V_{\text{vegetation composition}}$), percent *winter* cover or shelter opportunity ($SI_5 = V_{\text{winter cover}}$). The expected habitat changes resulting from implementation of the alternatives and subsequent anticipated benefits are similar between coho and Chinook. However, the only distinct Chinook variable that was not captured by coho was the amount of available escape cover during the *summer*, low-flow period ($SI_6 = V_{\text{summer cover}}$). All variables are expected to be of equal importance. Therefore, the equation to represent the salmonid HSI can be viewed as:

$$\boldsymbol{HSI_{Salmon} = (V_{\text{water temperature}} + V_{\text{dissolved oxygen}} + V_{\text{canopy}} + V_{\text{vegetation composition}} + V_{\text{winter cover}} + V_{\text{summer cover}})^{1/6}}$$

For this analysis, the project boundaries for the Post Office Lake serve as the base area for calculating the overall HU in acres for scaup and gadwall. For the benefits analysis, the study area is 175 acres. This can be represented as a function of the HSI relative to the overall project area for each alternative. Habitat units can also be determined by measuring the acreages extents at specified inundation levels and water depths for salmonids in conjunction with associated riparian areas. The result would be habitat units reflecting the quality-weighted habitat acreage usable by salmonids.

For gadwall, the HSI model developed by USFWS calculates the SIs over a 640 acre plot. The SIs for this analysis were scaled to reflect the project area. This ratio is consistent both with- and without project conditions. The overall HU calculation for gadwall is:

$$\boldsymbol{HU_{gadwall}\ (acres) = HSI_{gadwall} * 175\ acres}$$

Likewise, the HU for scaup is:

$$\boldsymbol{HU_{lesser\ scaup}\ (acres) = HSI_{lesser\ scaup} * 175\ acres}$$

However, because the alternatives present two different hydrologic regimes and two separate passage opportunities, the HU for salmonids considered and incorporated both frequency and duration of access. Seasonality of fish access to the floodplain and to the lake in conjunction with the potential inundation area is partially dependent on levee and water surface elevations and duration of the overtopping event. The flood profile evaluates the frequency and duration of access over the levee during high-flow conditions, relative to the area of inundation following an overtopping event [Flood Profile = duration (based on frequency of event and duration of time it occurs throughout the year)* area]. Similarly, access to the lake via the northern channel would not occur year-round as the water levels in the Columbia River are expected to drop below the inlet of the northern channel. The stage profile evaluates the frequency and duration of access via tidal fluctuations in the northern channel for the entire hydrograph (Stage Profile = duration * area). Finally, to capture the effects of riparian habitat condition on the overall HU for salmonids, the acreage of riparian habitat is added to flood and stage profiles. The overall HU calculation for salmonids can be represented as:

$$\mathbf{HU_{Salmon}\ (acres) = HSI_{Salmon} * (Flood\ Profile + Stage\ Profile + Riparian\ Acreage)}$$

The following equation determines the overall HU for Post Office Lake with all species weighted equally:

$$^{i}HU_{years\ 1\text{-}50} = HU_{gadwall} + HU_{lesser\ scaup} + HU_{salmon}$$

Using the above equation, the HU for each alternative can be calculated and annualized over the 50-year project life:

$$HU_{alternative} = \sum_{i=1}^{50} [\ ^{i}HU_{years\ 1\text{-}50}] * 1/50$$

These values are then used to determine what, if any, changes occur between alternatives.

As mentioned previously, see Appendix A for a complete demonstration of the scoring and resulting HSI for each species. Table 3 summarizes the HSI and HU results for gadwall, showing the change in average annual benefits. The suitability for both the number and area of wetlands and anticipated changes to wetland habitats did not change under any of the alternatives. The suitability of current habitat conditions at Post Office Lake is maximized to support brood rearing for gadwall. While portions of habitats are expected to transition from permanent open water, submergent, and emergent wetlands to semi-permanent/seasonal wetlands, the suitability of these transitions cannot exceed current values. As a result, the anticipated changes to the wetland habitat and subsequent HUs are not a significant factor in determining the overall impact to Post Office Lake under the different alternatives. That being said, it is important to note that while no alternatives show direct benefits to the species/variables, an HU value of 0.00 indicates that there simultaneously are *no adverse impacts* to brood rearing potential even as wetland habitat changes from current conditions.

Table 3. HSI and HU Model Results for Gadwall

	Target Year	Without Project	With Project					
			Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Gadwall	**Suitability Indices**							
	Target Year 0 - 5 (x5)	1.00	1	1	1	1	1	1
	Target Year 6 - 15 (x10)	1.00	1	1	1	1	1	1
	Target Year 16 - 25 (x10)	1.00	1	1	1	1	1	1
	Target Year 26 - 50 (x 25)	1.00	1	1	1	1	1	1
	Habitat Units							
	Target Year 0 - 5 (x5)	175	175	175	175	175	175	175
	Target Year 6 - 15 (x10)	175	175	175	175	175	175	175
	Target Year 16 - 25 (x10)	175	175	175	175	175	175	175
	Target Year 26 - 50 (x 25)	175	175	175	175	175	175	175
	Total	8750	8750	8750	8750	8750	8750	8750
	Avg. Annual Benefits	175	175	175	175	175	175	175
	Change in Habitat Units							
	Target Year 0 - 5 (x5)	0	0	0	0	0	0	0
	Target Year 6 - 15 (x10)	0	0	0	0	0	0	0
	Target Year 16 - 25 (x10)	0	0	0	0	0	0	0
	Target Year 26 - 50 (x 25)	0	0	0	0	0	0	0
	Change Total	0	0	0	0	0	0	0

	Change Avg. Annual Benefits	0	0	0	0	0	0	0

Table 4 summarizes the HSI and HU results for lesser scaup. Current conditions at Post Office Lake reveal SI values of 0.83, showing that the current habitat conditions at the lake are suitable, but not maximized as shown above. Because Alternatives 2-5 open the northern channel to the Columbia River, it is expected the lake would experience drier conditions. These drier conditions limit potential suitability of the overall habitat for scaup and other diving ducks that prefer deep, open water habitats. Lower water conditions would occur in summer when there is less likelihood of scaup use and would be more varied in winter. However, the model took a conservative approach in estimating benefits. The resulting negative HU values do not necessarily mean that the habitat is unsuitable under any specific alternative, but rather that it is *less suitable* than current conditions.

Table 4. HSI and HU Model Results for Lesser Scaup

	Target Year	Without Project	With Project					
		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
	Suitability Indices							
	Target Year 0 - 5 (x5)	0.83	0.54	0.54	0.54	0.54	0.83	0.83
	Target Year 6 - 15 (x10)	0.83	0.54	0.58	0.54	0.58	0.83	0.88
	Target Year 16 - 25 (x10)	0.83	0.54	0.58	0.54	0.58	0.83	0.88
	Target Year 26 - 50 (x 25)	0.83	0.54	0.58	0.54	0.58	0.83	0.88
	Habitat Units							
	Target Year 0 - 5 (x5)	55.03	32.05	32.05	32.05	32.05	55.03	55.03
	Target Year 6 - 15 (x10)	55.03	32.05	34.42	32.05	34.42	55.03	57.95
Lesser Scaup	Target Year 16 - 25 (x10)	55.03	32.05	34.42	32.05	34.42	55.03	57.95
	Target Year 26 - 50 (x 25)	55.03	32.05	34.42	32.05	34.42	55.03	57.95
	Total	2751.44	1602.45	1709.09	1602.45	1709.09	2751.44	2882.9
	Avg. Annual Benefits	55.03	32.05	34.18	32.05	34.18	55.03	57.66
	Change in Habitat Units							
	Target Year 0 - 5 (x5)	0	-22.98	-22.98	-22.98	-22.98	0	0
	Target Year 6 - 15 (x10)	0	-22.98	-20.61	-22.98	-20.61	0	2.92
	Target Year 16 - 25 (x10)	0	-22.98	-20.61	-22.98	-20.61	0	2.92
	Target Year 26 - 50 (x 25)	0	-22.98	-20.61	-22.98	-20.61	0	2.92
	Change Total	0	-1148.99	-1042.35	-1148.99	-1042.35	0	132.15
	Change Avg. Annual Benefits	0	-22.98	-20.85	-22.98	-20.85	0	2.64

The HSI and HU results for Chinook and coho salmon (Table 5) show the largest net benefit under the various alternatives. While current conditions at Post Office Lake offer moderate suitability, there is no passage or ingress/egress for the lake and the resulting HUs are null. Alternatives 2-5 all introduce passage opportunity into the lake, subsequent HU values are considerably higher than current, without-project conditions. While Alternatives 6 and 7 increase the frequency of access into the lake, they do not provide comparable egress opportunities out of the lake, which reduces the potential HU. As such, the overall change in benefits is amplified following reconnection of the northern channel.

Comparing overall benefits between alternatives is a function of adding the total change for each species, per alternative and annualizing this value over the life of the project (50 years). The resulting overall change in average annual benefits (Table 6) demonstrates the anticipated benefit each alternative provides relative to current conditions at Post Office Lake.

Table 5. HSI and HU Model Results for Chinook and Coho Salmon

	Target Year	Without Project	With Project					
			Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Juvenile Salmon	**Suitability Indices**							
	Target Year 0 - 5 (x5)	0.39	0.55	0.55	0.55	0.55	0.39	0.39
	Target Year 6 - 15 (x10)	0.39	0.58	0.58	0.58	0.58	0.39	0.39
	Target Year 16 - 25 (x10)	0.40	0.60	0.60	0.61	0.61	0.40	0.40
	Target Year 26 - 50 (x 25)	0.41	0.63	0.63	0.63	0.63	0.41	0.41
	Habitat Units							
	Target Year 0 - 5 (x5)	3.32	25.60	26.69	28.41	29.50	5.88	5.88
	Target Year 6 - 15 (x10)	3.35	27.61	28.96	30.80	32.15	6.16	6.16
	Target Year 16 - 25 (x10)	3.42	29.08	30.57	32.68	34.17	6.29	6.29
	Target Year 26 - 50 (x 25)	3.49	30.19	31.72	34.09	35.65	6.42	6.44
	Total	171.57	1449.53	1521.80	1629.12	1701.88	314.4	314.9
	Avg. Annual Benefits	3.43	28.99	30.44	32.58	34.04	6.29	6.3
	Change in Habitat Units							
	Target Year 0 - 5 (x5)	0	22.28	23.37	25.09	26.18	2.56	2.56
	Target Year 6 - 15 (x10)	0	24.26	25.61	27.45	28.80	2.81	2.81
	Target Year 16 - 25 (x10)	0	25.66	27.15	29.26	30.75	2.87	2.87
	Target Year 26 - 50 (x 25)	0	26.69	28.23	30.60	32.15	2.93	2.94
	Change Total	0	1277.96	1350.23	1457.56	1530.31	142.88	143.1
	Change Avg. Annual Benefits	0	25.56	27.00	29.15	30.61	2.86	2.86

Table 6. Combined Species Summary of Benefits in Habitat Units

Parameter	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Overall Summary Total	11,673.01	11,801.98	11,980.89	11,981.58	12,160.97	11,815.89	11,947.8
Overall Summary Avg. Annual Benefits	233.46	236.04	239.62	239.63	243.22	236.32	238.96
Overall Change Total	0	128.97	307.88	308.57	487.96	142.88	274.56
Overall Change Avg. Annual Benefits	0	2.58	6.16	6.17	9.76	2.86	5.49

Alternative 5 (full suite of measures) maximizes benefits for all three species. While Alternative 4 provides direct benefits to salmonids, the habitat becomes less suitable for lesser scaup under this alternative, reducing overall suitability for all species. Likewise with Alternative 2, salmonids benefit directly and suitability for scaup is reduced more than in Alternative 3, bringing down the overall benefit for the study area. Because Alternatives 6 and 7 do not provide egress opportunities for salmon, they provide little additional benefit to salmon. However, while direct benefits to scaup are not present, they are less impacted by implementing Alternatives 6 or 7 than Alternatives 2-5. The overall change in average annual benefits for all measures is used to evaluate the incremental cost effectiveness of each alternative, as described in the following sections.

2.8. IMPLEMENTATION COSTS FOR ALTERNATIVES

Implementation costs include the current estimated costs for construction; preconstruction engineering and design; construction management; monitoring costs; real estate costs; operation and maintenance; and interest during construction. Additional details about some of these cost assumptions are described in later sections, particularly Section 3. Due to the point-in-time analysis, the implementation costs do not consider feasibility study costs or all costs where contingencies may be appropriate. All costs in Table 7 are in terms of present value. The base year for the project is 2013, when benefits should begin to accrue. The Civil Works Construction Cost Index System Guide was implemented when drafting the project cost estimate, resulting in a 2.7% increase in 2012 prices, as construction is expected to begin in 2013. More detailed information is provided in Section 2.9.

Additional details regarding the construction costs considerations can be found in Appendix D, *Cost Summary*. Monitoring costs were assumed to be the Corps' responsibility for 3 years to ensure appropriate conditions for salmonid refugia. However, a final monitoring plan may include a longer duration, up to five years. Assumptions include the need to set up field sampling points, labor for sampling data, the crafting of associated reports, and mileage for transportation. Real Estate costs include considerations for the federal acquisition of real property interests required from Clark County and the adjoining property owners to the south of Post Office Lake. Additional description of the real estate costs can be found in Appendix F. None of the alternatives is believed to cause a significant difference to the actual O&M practices taking place by the USFWS. Interest during construction was calculated based on a federal interest rate of 4%, assumed 2 months for construction and middle of the month payments. Table 7 provides the expected implementation costs for each alternative.

Table 7. Implementation Costs for Alternatives

Alternative	Construction Costs	Monitoring Costs	Real Estate Costs	Operation & Maintenance	Interest During Construction	Total Implementation Costs
#1: No Action	--	--	--	--	--	--
#2: North channel reconnection plus improvements	1,973,382	22,259	11,000	no change	9,700	2,016,341
#3: Alternative 2 plus levee improvements	2,385,096	24,485	11,000	no change	11,700	2,432,281
#4: Alternative 2 plus floodplain reconnection	2,381,344	28,937	11,000	no change	11,700	2,432,981
#5: Implement all measures	2,793,058	31,163	11,000	no change	13,700	2,848,921
#6: Floodplain reconnection at levee breach point	407,962	6,678	10,000	no change	2000	426,640
#7: Floodplain reconnection at levee breach point plus levee improvements (remove asphalt)	819,676	8,904	10000	no change	4,000	842,580

Monitoring costs are assumed to be less costly for Alternatives 6 and 7, since the controlled floodplain reconnection at RM 95.1 would have an overtopping frequency of a 2-year event, reducing the frequency juvenile salmonids access Post Office Lake, as opposed to through the tidal reconnection alternatives afforded by Alternatives 2 through 5. With the salmonids accessing Post Office Lake less frequently, some monitoring costs are assumed to be either not required or absorbed by USFWS current operation and maintenance activities.

2.9. COST EFFECTIVENESS AND INCREMENTAL COST ANALYSES

In the absence of a common measurement unit for comparing the non-monetary benefits with the monetary costs of environmental plans, cost effectiveness and incremental cost analyses are valuable tools to assist in decision making. The results can be displayed as graphs of outputs against costs and permit decision makers to progressively compare alternative levels of environmental outputs and ask the questions: are the least cost alternatives being identified and is the next alternative worth the investment? In other words, is the additional environmental output of the next attainable level worth the additional cost? To identify a preferred alternative for Post Office Lake, cost effectiveness and incremental cost analyses of the potential alternatives were conducted. The following explanations clarify the difference between cost effectiveness and incremental cost analyses and the purposes for each.

- *Cost effectiveness analysis* is conducted to ensure that the least cost plan alternative is identified for each possible level of environmental output, and that for any level of investment, the maximum level of output is identified. Filtered out are plans that produce the same level as another plan, but cost more; or cost either the same amount or more than another plan, but produce less output. It eliminates inefficient alternatives based on comparing environmental outputs with the *average annual cost* of an alternative.
- *Incremental cost analysis* is conducted to show changes in costs for increasing levels of environmental outputs. It provides data for decision-makers to address the question "Is the next level worth it?" It measures the incremental or *additional cost* of the next additional level of environmental output.

The No Action Alternative (without-project condition) represents the conditions in the study area in the absence of a restoration project. For Post Office Lake, the without-project condition is presumed to be no tidal reconnection between the Columbia River and Post Office Lake. The No Action Alternative serves as the basis for comparison with the alternatives serving to produce the "with-project" conditions. In addition to no action, there are six action alternatives (with-project conditions) being considered.

The non-monetary benefits (habitat units resulting from HEP) of the environmental restoration alternatives are measured in terms of average annual outputs. Average annual environmental outputs represent the net increase in output above and beyond the without-project condition. The implementation costs for the project include the costs associated with the project, including outlays for preconstruction engineering and design, real estate costs, O&M costs, and monitoring costs. To compare costs with average annual environmental outputs, it is necessary to convert implementation costs to average annual costs. The stream of costs associated with the project occurs at various points in time. Therefore, to develop equivalent average annual costs, all costs were present-valued and amortized at the fiscal year 2012 federal discount rate of 4% over the project life of 50 years.

To bring implementation costs, including planning, engineering and design, and land acquisition costs forward to the base year so that average annual costs can be compared with the average annual benefits on an equivalent time basis, a calculation of interest during construction was determined and implemented. This interest is added to the other costs of the project and is included as part of the average annual cost. The IDC is calculated using the fiscal year 2012 discount rate of 4%, a remaining construction period projected to be 2 months in duration, and assumes middle of the month payments during the construction period. Operation and maintenance costs for the project include upkeep of plantings, waterfowl management and removal of invasive plant species. Since these management measures are currently being practiced by USFWS and all project alternatives are not expected to add to or alter the current federal management measures in any appreciable way, the O&M costs were estimated to be zero dollars

for each alternative. Real estate costs include the direct administrative costs of overseeing and implementing a Memorandum of Agreement (MOA) with the Washington Department of Natural Resources, divisible equally between the federal project partners, for measures implemented below the OHW mark. Because this project is in keeping with the state's public trust doctrine and provides for greater access to state resources, very little, if any, federal acquisition costs are expected; therefore, the cost for executing the MOA is expected to be approximately $1,000.

For both alternatives considered for this ecosystem restoration project, the project partner (USFWS) will need use of their ownership on the west side of the project that is currently encumbered by a county road right-of-way that is no longer maintained. In the past, jurisdiction over this right of way was transferred by the county to the Washington State Department of Transportation for the purpose of developing the State Route 501 highway, but this never occurred. The transfer of jurisdiction over the right of way back to the county must be confirmed at which time USFWS can make application with Clark County to vacate the right of way. The cost should be nominal and limited to the administrative cost incurred by the county to process the right of way vacation.

The District has concluded that any induced flooding that might occur on the private property owned to the south of the project will not rise to the level of a taking of a real property interest that would justify the acquisition of additional real property rights.

Monitoring costs assume that the Corps would monitor changes in juvenile salmonid habitat for a 5-year period after construction. The USFWS would monitor the project for the remaining project life. Monitoring costs included the establishment of sampling points, recording and collection of data, labor for drafting reports, and mileage to and from the project site. All implementation costs are expressed in terms of average annual dollars, combining all construction, monitoring, O&M, real estate, and IDC costs.

After estimating the costs and outputs of each alternative, the alternatives were sorted in terms of increasing output. This is done as a prelude to the cost effectiveness and incremental cost analysis to determine which alternative cost the least for each level of output and to determine when/if the law of diminishing returns will apply when analyzing the efficiency of each of the cost effective plans. The Corps' Institute for Water Resources Cost-Effectiveness and Incremental Cost Analysis software (IWR-PLAN located at http://www.pmcl.com/iwrplan/GenInfoOverview.asp) was used to analyze the alternatives. There are many ways to formulate alternative plans. One way is to identify all of the possible combinations of a given set of management measures and the measure's increments by:

- Step 1: Display the environmental outputs and cost estimates of the increments of management measures;
- Step 2: Review the management measures to separate those that can be implemented together from those that cannot be implemented together; and
- Step 3: List all combinations of the combinable management measures' increments and calculate each combination's output and cost.

The process of evaluating combinable measures has the advantage of formulating combinations whereby no solution will be overlooked and the full range of solutions will be included in the analysis. Step 2 above is crucial when conducting incremental cost analysis (for further details, see *Cost Effectiveness Analysis for Environmental Planning: Nine Easy Steps*, IWR Report 94-PS-2, October 1994).

For Post Office Lake, the reduction in levee height to restore the floodplain (Alternative #6) is much like fencing, a common management practice that is often used in combination with other measures, but may also achieve the project goal(s) and objective(s) independently. When evaluating measures that are not

combinable, they are added to the list of all possible solutions, and then graphically combined with other potential solutions to visually illustrate the large number and range of possible choices when determining the cost effective and efficient alternatives.

When formulating plans, it is important to understand which management measures under consideration could be combined. Analysis of functionally dependent, mutually dependent and independent management measures becomes especially important for plan formulation and use of the IWR-PLAN. For this particular ecosystem restoration project, the floodplain reconnection feature serves not only as a standalone alternative (Alternative 6) but also as an incrementally added measure when analyzing Alternatives 4 and 5. In addition, measures 1, 3a, 3b and 4 (remove culvert and tide gate 'plug' at outlet of the north connection channel + improve north connection channel configuration + create riparian buffer in vicinity of the north channel + deepen north end of lake) were considered mutually dependent and were grouped as a single measure for purposes of analysis.

For purposes of decision making, it was decided to compare the potentially viable, yet not combinable alternatives, through a phased approach by conducting incremental cost analysis on each solution separately. Phase 1 prepared the use of the IWR-PLAN to conduct incremental cost analysis on Alternative 2 (the northern channel improvements), along with all additional combinable measures that could serve as increments. The second phase uses plans and plan components to conduct incremental cost analysis on Alternative 6. And the third phase compares the efficient and effective results from the prior two phases of analysis. The justification for use of this phased approach is based upon Alternative 2 not being combinable with Alternative 6, when Alternative 6 is considered a functionally independent alternative; therefore, Alternative 6 can never be an increment to Alternative 2. However, it is important to decision makers to compare the efficiency and effectiveness of these two alternatives from a cost perspective to accomplish the project goals and objectives.

The first phase of analysis included the evaluation of the north connection channel improvements (Alternative 2) in combination with the other dependent measures: (1) asphalt scarification to create Alternative 3, (2) the floodplain reconnection to generate Alternative 4, and (3) the full suite of measures to construct Alternative 5. The second phase considered the production efficiency of the floodplain reconnection as a standalone alternative, and then in combination with the asphalt scarification to generate Alternatives 6 and 7. The third phase determines the relative efficiency of the two "best" alternatives of the first two phases of analysis by comparing the cost per unit of each plan over the "baseline" (without-project condition). Typically the selection criteria is based upon the plan that provides the lowest incremental cost per unit, since it is the "best deal" from a production perspective, producing output at the lowest unit cost. By comparing the plans, a priority for the potential solutions can be established, and the National Ecosystem Restoration (NER) plan can be derived.

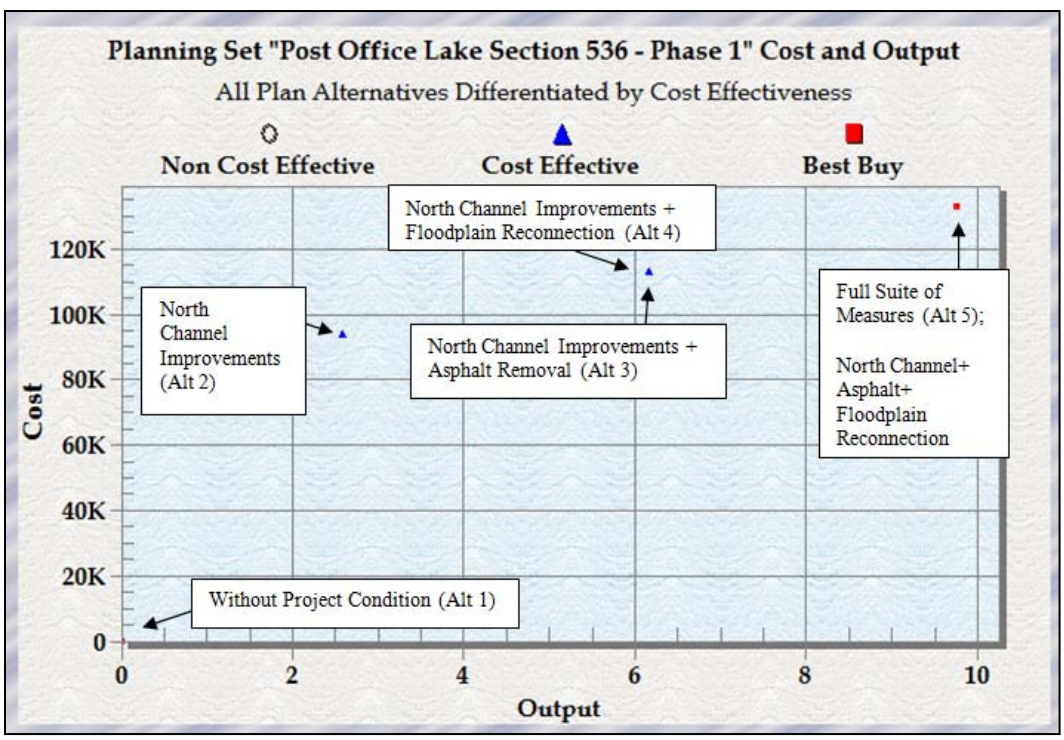
The data for the cost effectiveness and incremental cost analysis, sorted by output from low to high for each of the two phases of analysis is depicted in Table 8. Yellow highlights indicate solutions with the lowest average cost for each level of output. As stated above, average annual costs are based on an interest rate of 4% and a 50-year project life.

Table 8. Data by Alternative to Calculate Lowest Average Cost for Additional Output

Alternative	Description	Average Annual Habitat Units	Average Annual Costs ($)	Total Implementation Costs	Average Annual Cost per Ave Annual Habitat Unit
1	Without Project Condition	0	0	0	0
Phase 1					
2	North Channel Tidal Reconnection + Fish Passage + Riparian Restoration + Deepen N. End of Lake	2.58	93,861	2,016,343	36,380
3	Alternative 2 Plus Asphalt Removal	6.16	113,225	2,432,311	18,381
4	Alternative 2 Plus Levee + Floodplain Reconnection	6.17	113,256	2,432,990	18,356
5	All Measures	9.76	132,619	2,848,948	13,588
Phase 2					
6	Floodplain Reconnection at Breach	2.86	19,861	426,647	6,944
7	Floodplain Reconnection at Breach + Asphalt Removal.	5.50	39,223	842,605	7,132

For the first phase of analysis, all alternatives were considered to be cost effective, as shown in Figure 10. The without-project condition and the alternative constituting the suite of all measures (Alternative 5) were the only alternatives to be incrementally justified as "best buy" solutions, or the solutions with the lowest average cost per unit. Graphically, the points denoting Alternatives 3 and 4 virtually overlap, making it difficult to distinguish between the two cost effective alternatives.

Figure 10. Cost Effective and Best Buy Alternatives



Alternative 5, the suite of all measures, provides the lowest average annual cost per average annual HU, serving as the basis from which to derive the incremental cost analysis. Typically, incremental cost analysis is required to address whether the additional (incremental) cost of the next level of output is worth the added benefit. Because Alternative 5 (with the maximum level of output) has been identified as the solution with the lowest average cost, of the remaining alternatives there are none that could potentially have a lower average cost for additional output; therefore, incremental costs for the remaining levels of output cannot be calculated. Graphically, the depiction of the incremental cost analysis would result in a single bar, providing very little assistance to decision makers, as the incremental cost per unit of output is identical to the average cost per unit.

Therefore the "best deal" from a production perspective, producing output at the lowest incremental cost per unit output, as well as the lowest average cost per unit output, is Alternative 5 for this phase of analysis. This alternative reconnects Post Office Lake with the Columbia River via improvements within and along the north entrance channel and includes the additional measures of reducing the levee height at the south breach point and scarifying the asphalt along the levee from the south parking lot to the north entrance channel.

Phase two of the analysis examines the cost effectiveness and incremental changes to costs and outputs between Alternative 6 (floodplain reconnection) and Alternative 7 (asphalt scarification + floodplain reconnection). In this particular case, Alternative 6 creates a floodplain reconnection at the worst progressive breach location (~RM 95.1) of the Columbia River, by reducing the levee overtopping elevation to 18.7 feet with no adverse or beneficial impact to the four classes of wetlands within Post Office Lake due to water elevations changing resulting from opening the north channel. Although there is no tidal reconnection with the Columbia River, this alternative does increase the frequency and duration for which juvenile salmonids would have access to the lake. Due to the limited egress opportunity from the lake as water elevations recede, however, the risk of salmonid stranding in the lake is very high.

Scarification of the remnant asphalt along the levee from the south parking lot to the north entrance channel of Post Office Lake is added to Alternative 6 to create Alternative 7. This asphalt scarification measure is the only increment to be added to the floodplain restoration alternative for this phase analysis, since these alternatives are not combinable with the measures previously assessed during phase one analysis.

As shown in Table 9, the average annual costs, using an interest rate of 4% and a 50 year project life, for these two alternatives were calculated to be $19,861 for Alternative 6 and $39,223 for Alternative 7. The average annual habitat units for these alternatives were determined to be 2.86 and 5.5, respectively.

Table 9. Summary of Average Cost for Alternatives 6 and 7

Alternative	Average Annual Habitat Units	Average Annual Costs ($)	Total Implementation Costs ($)	Average Annual Cost per Average Annual Habitat Units ($)
Alternative 1 (No Action)	0	0	0	0
Alternative 6 (Floodplain reconnection)	2.86	19,861	426,647	6,944
Alternative 7 (Alt 6 + asphalt scarify along levee)	5.50	39,223	842,605	7,132

Results from implementing the IWR-PLAN revealed Alternative 6 and Alternative 7 as cost effective and as "best buy" solutions (Figure 11). The three best buy alternatives (if including the No Action Alternative and the two with-project condition alternatives) serve as the basis from which to derive the incremental cost analysis. When calculating the incremental cost per unit of output, each of the recalculations begins with the previous step's lowest average annual cost level of output set as the new "zero level." In other words, the calculation in this step uses the additional cost and additional outputs from those of the previously identified level of output (for further details on this process, refer to *Cost Effectiveness Analysis for Environmental Planning: Nine Easy Steps*, IWR Report 94-PS-2, October 1994). In order to facilitate the required calculations, IWR-PLAN was used to calculate and eliminate the irregular, non-continuously increasing cost changes that potentially could occur in the incremental average annual cost per output calculations. The results from implementing the incremental cost analysis in the IWR-PLAN are depicted in Figure 12.

Figure 11. Cost Effectiveness for Alternatives 6 and 7

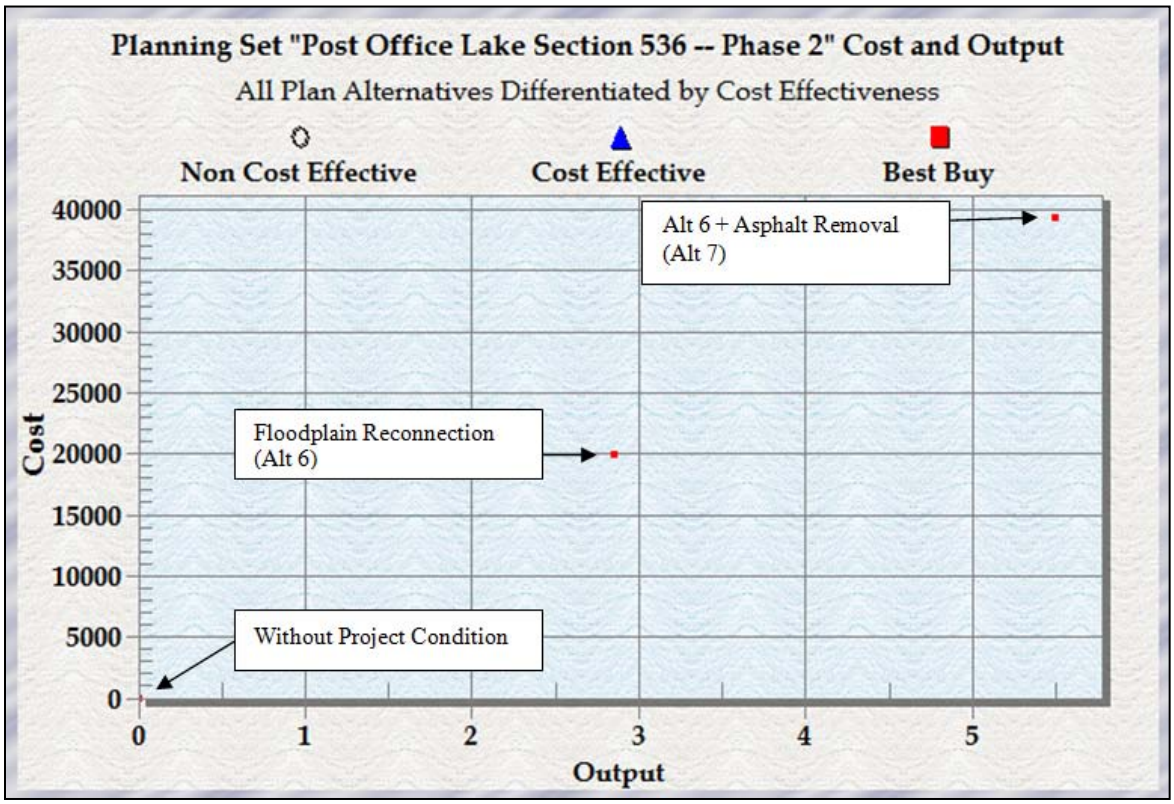
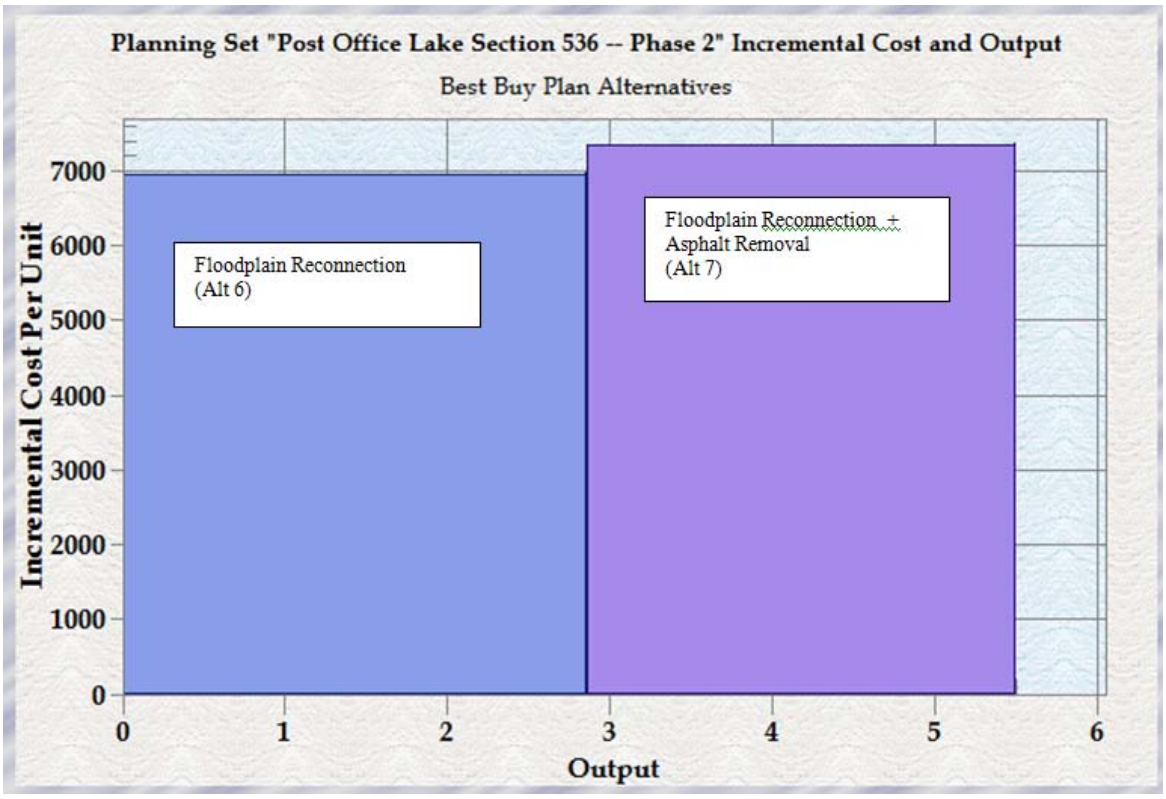


Figure 12. Incremental Cost Analysis for Alternatives 6 and 7



From a production perspective, arguably Alternative 6, the floodplain reconnection alternative, is the "best deal" for producing output at the lowest unit cost. Not only is the average cost per unit of output lower for Alternative 6, but the incremental cost per unit of output is also less, as shown in Table 10.

Table 10. Summary of Final Incremental Cost Analysis for Alternatives 6 and 7

Alternative	Average Annual Habitat Units	Average Annual Costs ($)	Average Cost/ Average Habitat Units	Incremental Costs	Incremental Output	Incremental Cost per Unit of Output
Alternative 1 (No Action)	0	0	0	0	0	0
Alternative 6 (Floodplain reconnection)	2.86	19,861	6,944	19,861	2.86	6,944
Alternative 7 (Alt 6 + asphalt scarify along levee)	5.50	39,223	7,131	19,362	2.64	7,334

Phase three of the economic analysis prioritizes Alternative 5, the suite of all measures, with Alternative 6, the floodplain restoration alternative, based upon their relative production efficiency determined by comparing their unit costs of producing output. The data for comparing these two alternatives is displayed in Table 11. The table does not include the incremental cost per unit of output because Alternative 5, the suite of all measures is functionally independent, and therefore not combinable with Alternative 6, the floodplain reconnection alternative. Rather than using zero as the basis to calculate the incremental cost per unit of output, if incremental cost analysis was implemented, the incremental cost

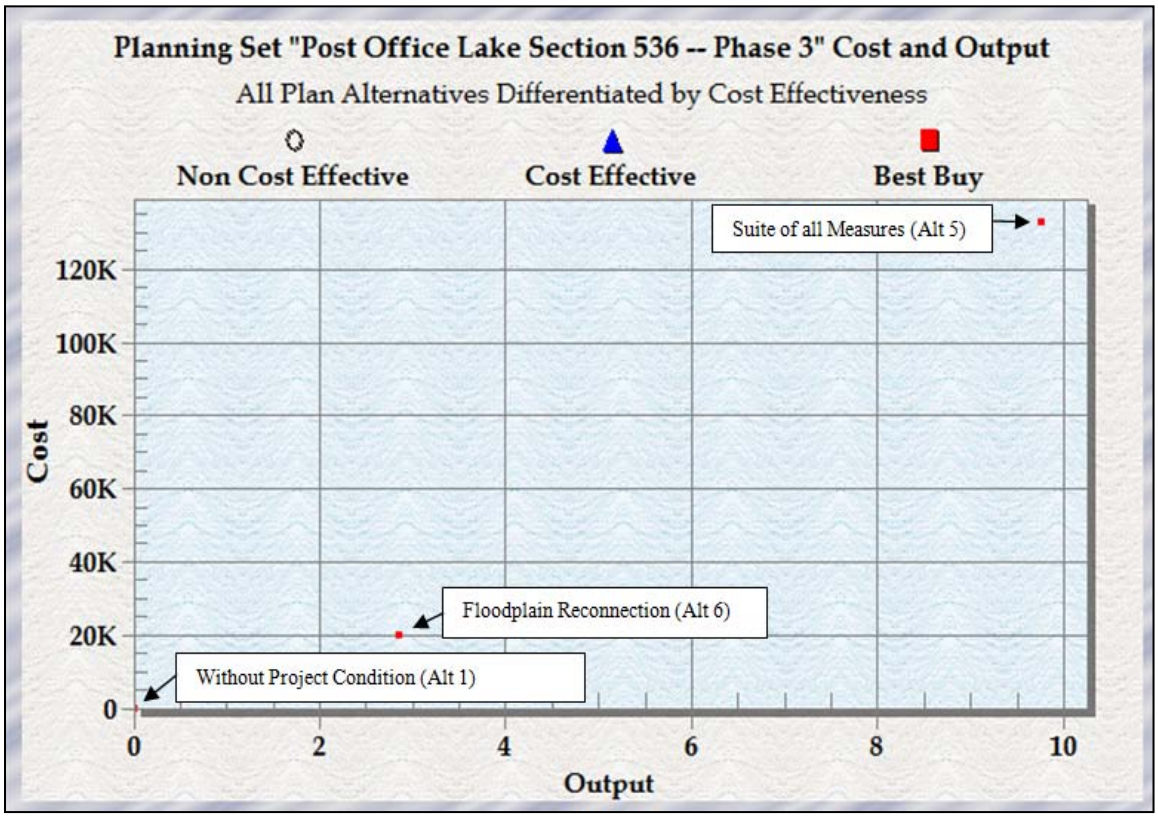
per unit of output would be based on the average annual costs and average annual output for Alternative 6. Calculation of the incremental cost per unit of output would result in an inaccurate comparison of the two non-combinable alternatives. Decision makers may want to ask the question if it is worth it to increase output by 6.90 units should the average annual cost per habitat unit almost double (going from 6,944 to 13,588 units).

Table 11. Summary for Final Cost Analysis for Alternatives 6 and 5

Alternative	Average Annual Habitat Units	Average Annual Costs ($)	Total Implementation Costs ($)	Cost per Habitat Unit (avg. annual basis)	Incremental Output (avg. annual HU)
Alternative 1 (No Action)	0	0	0	0	--
Phase 3					
Alternative 6 (Floodplain reconnection)	2.86	19,861	426,647	6,944	2.86
Alternative 5 (Suite of all measures)	9.76	132,619	2,848,948	13,588	6.90

The IWR-PLAN was implemented to compare these two alternatives and the results revealed each of these alternatives as cost effective and "best buy" solutions to meet the project objectives, as shown in Figure 13.

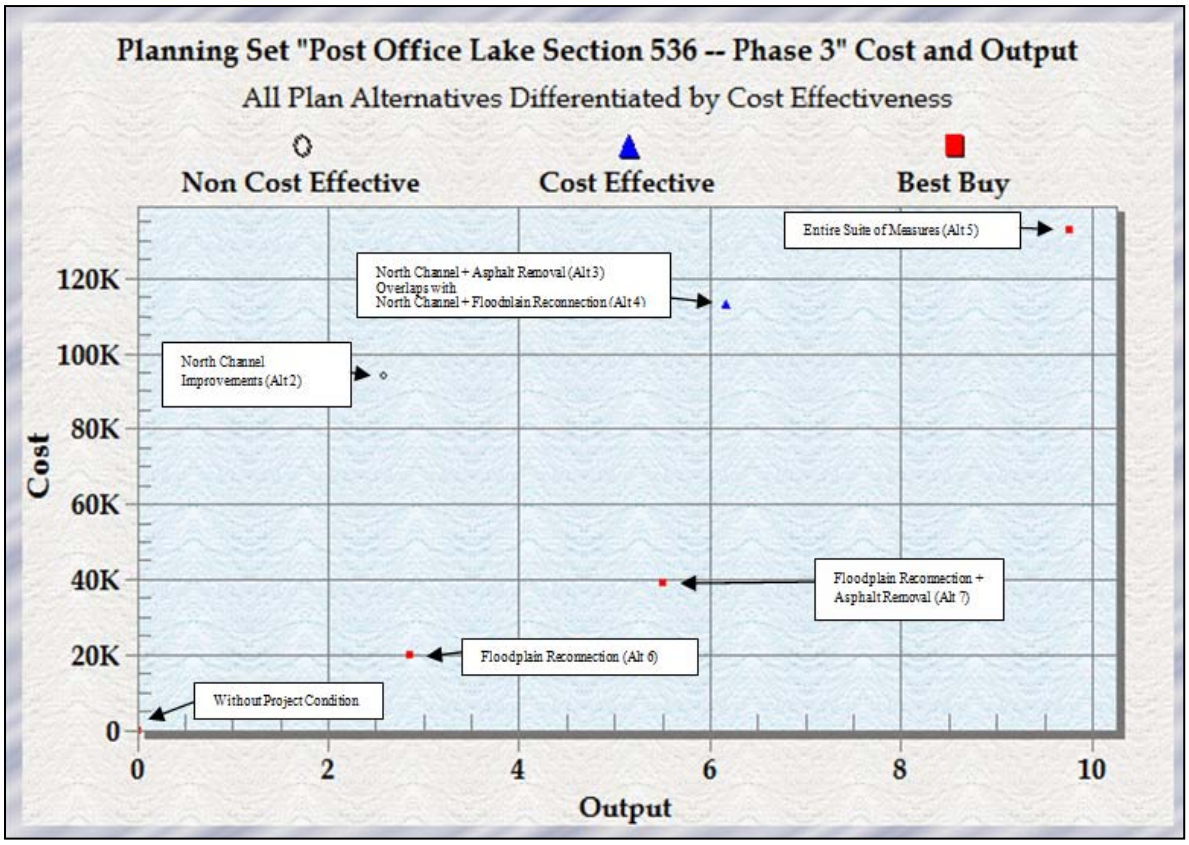
Figure 13. Cost Effectiveness for Alternatives 6 and 5



When viewing these alternatives as separate potential solutions or programs, as further described in the *Evaluation of Environmental Investments Procedures Manual* (IWR Report 95-R-1, May 1995), the cost effectiveness of each alternative was based on an average annual cost of $19,861 for Alternative 6 (floodplain restoration) and $132,619 for Alternative 5 (north channel improvements + floodplain reconnection + asphalt scarification). The average annual habitat units for each respective alternative are 2.86 and 9.76, resulting in the average cost per habitat unit of $6,944 ($19,861/2.86) and $13,588 ($132,619/9.76), respectively.

Since economics is a science of choices, the IWR PLAN was implemented using all alternatives, with none of the solutions being combinable, as a means to check the value of this phased approach. As demonstrated in Figure 14, the results were replicated showing that Alternative 6 and Alternative 5 are the two "best buy" plans.

Figure 14. Cost Effectiveness for All Alternatives (1-7)



It may appear that Alternative 6 (floodplain reconnection) is the National Ecosystem Restoration (NER) plan since the average annual cost per habitat unit is considerably less, approximately 51% of the average annual cost per habitat unit for Alternative 5 ($6,944/$13,588).

Cost effectiveness and incremental cost analysis assures planners that a range of cost effective plans are identified and provides for the explicit comparison of relevant changes in costs and outputs on which decisions may be based.

The decision criteria for the evaluation of all plans include environmental significance, completeness, effectiveness, efficiency and acceptability. Clearly based on the incremental and average cost per unit, Alternative 6 can easily be argued as the preferred alternative to recommend as the NER plan. However, the floodplain reconnection component of this alternative simply lowers the levee height to elevation 18.7 feet mean sea level, where mean sea level for the Columbia River during June (when river levels are highest after the freshet) is approximately at an elevation of 13 feet. One has to question if Alternative 6 truly meets the project objectives considering that: (1) water quality would likely remain "as is" without any tidal reconnection, (2) fish access would be seldom, at best, and (3) the likelihood of fish stranding within the lake is extremely high as there would be no signal for fish to exit the lake with declining river elevations.

Under Alternative 5, there would be virtually year-round fish access to the lake as a result of restoring the tidal prism by improving the north channel with little expectation fish would ever be stranded, and water quality benefits that would arise from greater flushing of the lake. Therefore, Alternative 5 proves to be the best alternative to recommend as the NER plan based on the acceptability and completeness of meeting the project objectives, along with effectiveness and efficiency that results from the cost effectiveness and incremental cost analysis.

The foregoing analysis has been presented using conservative professional opinion when it comes to vegetative succession rates and uncertain hydrologic regimes. There is uncertainty as to how dry the lake will become, especially during the months of August and September, when Columbia River water levels drop below the lake bottom and north connection channel inverts. It is expected some water will remain within the lake year-round since the exit invert from the lake to the north connection channel will be set 1 to 2 feet higher than the lake bottom. This may or may not require pumping depending on precipitation events, monitoring outcomes, and waterfowl needs. There is some uncertainty with respect to emergent wetland vegetation growth rates and patterns and the survival of invertebrates, especially pelecypods. It is expected the invertebrates either will migrate to the remaining watered areas or will find sub-surface refuge in the marshy soils. Both of these variables were important components to determining the habitat suitability index for scaup. The foregoing analysis assumed a conservatively high adverse effect on scaup due to implementation of this project to meet the project partner's concerns regarding sufficient resources for the waterfowl species. A slight change in the variable's values when calculating the suitability index would have likely altered the results of the economic analysis. A sensitivity analysis without additional data, however, makes further analysis impracticable.

The economic analysis does not include project features (the bridge and pump) that do not contribute to the execution of project goals and objectives. These project features are desired exclusively by the project partner and have been considered "project constraints" that will be further analyzed, negotiated, and engineered during the design and implementation phase of the project. These project features do add risk to project execution, but for purposes of analysis are considered outside the project authority. The addition of these project features with the NER plan would constitute a locally preferred alternative. The economic analysis only derived the NER plan, the economically selected plan for further consideration.

2.10. Identification of Recommended Plan (Preferred Alternative)

Evaluation of the alternatives is based on a comparison of the without-project condition (no action) and each of the with-project alternative conditions. The benefits are measured as the net gain (change) in environmental outputs over the existing condition. The costs of implementing each of the alternatives are then compared with the benefits of each alternative, using both a cost-effectiveness analysis and an incremental cost analysis as described in the previous section. The results of the cost effectiveness and incremental cost analyses show that the most cost effective and incrementally justified alternative for the

Post Office Lake restoration project is Alternative 5, the suite of all measures. This alternative has the lowest average annual cost per average annual HU for those alternatives that have a direct tidal connection, providing the greatest opportunities for fish ingress to Post Office Lake and egress to the Columbia River, and thereby providing the greatest "natural" restoration of Post Office Lake. Consequently, the NER plan is Alternative 5; this alternative is consistent with Engineer Regulation 1105-2-100 [p.2-7, f.(2)], which states the selection of the NER plan shall be, ". . . a plan that reasonably maximizes ecosystem restoration benefits compared to costs, consistent with the federal objective. . . "

There were several related factors that also contributed to the recommendation for Alternative 5. First, the HEP-HSI model created for the Post Office Lake project is adequate to help quantify certain biological benefits that facilitate ranking and evaluating measures and alternatives developed and described in this report. However, as with any model, it has limitations that fail to capture or predict the full suite of ecological benefits possible as a result of implementing the complete suite of restoration opportunities at the site. Limitations, assumptions, and uncertainty are described in the benefits model documentation and are further compounded when combined with the hydrological and incremental cost-benefit models. This is not to say that any of the models are faulty or that results should be discarded. However, it warrants mention that ecological systems are far too complex to predict and model their benefits with a high level of accuracy, while simultaneously remaining within a scale of analysis appropriate to the project and decision-making tools. As a result, it is likely that not all ecosystem benefits were fully captured by the benefits model; uncertainty regarding effects is compounded by the use of hydrology and hydraulic models, and further assumptions were made when developing the incremental cost-benefit model comparisons. Therefore, although model results were useful and adequate to analyze, evaluate, and compare cost-benefit ratios, they were not a complete reflection of the amount of restoration benefits per cost.

Restoration benefits would occur on multiple spatial scales, including at the Columbia River itself, (which is a large order stream), at the north outlet channel, (a pseudo first-order stream), in the floodplain, in the terrestrial uplands, and in Post Office Lake itself. Benefits would also occur on multiple temporal scales with the development and evolution of riparian zone components such as fully functioning canopies with vertical complexity, succession of vegetative communities, changes to soil structure, improvements to hydrology, and others. The benefits model attempts to capture these scales over the 50-year time horizon, but is limited by the variables and data available for the HSIs. The full suite of proposed measures provides greater benefits and connectivity than achieved by the other alternatives.

Adequate, functioning riparian zones and regularly accessible floodplain habitat provide several important ecological benefits. One of these benefits affecting both fisheries and wildlife includes improvement and protection of water quality. Riparian zones provide this ecosystem service via several mechanisms such as bank and erosion stabilization; energy dissipation, especially during high-flow and channel forming events; stormwater mitigation and treatment via dissipated flows, improved infiltration, and filtration from increased soil pathways, root uptake, and conversion of potential pollutants by plants; and temperature regulation via shade and canopy cover. Improved floodplain connectivity also contributes to water quality by providing energy dissipation and flood storage capacity, which helps preserve hydrologic and channel structures downstream, reducing bank erosion, head-cutting, lowered water-tables and scour.

At Post Office Lake, the current riparian zones both along the levee adjacent to the Columbia and along the northern channel are degraded and insufficient. Current riparian zones are of inadequate width to provide sustainable ecosystem functions or to maintain successional processes. In several places, remaining vegetation has been carved off as levee failure progresses, and in other areas the maximum width is about 150-feet of non-herbaceous vegetation (some tree or shrub cover exists), including the backside of the levee. The buffer around the north channel is comprised almost exclusively of blackberry

except where mowing has maintained a reed canarygrass dominated pasture. Some wetland plant vegetation fringes the lake but succession is controlled via regular mowing. Along the levee, riparian development is further confined by the relic road asphalt, fill prism, bank riprap, mowing, and an abundance of invasive Himalayan blackberry and other nonnative species. There is also some presence of black cottonwood, snowberry, and willows (in the wetter portions of the site). The age classes and vertical complexity of the present riparian vegetation is limited in its ability to provide a sustainable wood recruitment source, and remains at further risk as portions of the levee continue to fail and bank cuts proceed in along the profile. There is an inadequate source of replacement vegetation for shrub and tree species. By increasing the area of riparian restoration as incorporated by Alternative 5, this would provide more restoration benefits.

The Columbia River is also water quality limited for several parameters. Though not 303(d) listed, current conditions at Post Office Lake could potentially have sub-optimal temperature and DO parameters for native species including salmonids during hotter portions of the year. Further, current practices on the Refuge include management of agricultural fields with avian pollutant loads and herbicide spraying that could affect water quality in the adjacent north channel and Columbia River. Adequate buffer width and vegetation density is important for treatment provisions. Though the riparian vegetation at the top of the levee may have somewhat limited direct water contact, all of the proposed riparian vegetation would have more frequent hydrologic contact as water reaches both sides of the levee during more regular flood and tidal intervals. Increased hydrologic exchange via both flooding and tidal exchange could also have beneficial effects to temperature and DO levels due to increased mixing and flushing. Improved floodplain connectivity also provides storage and energy dissipation that could have downstream benefits not reflected in any of the models. These potential benefits to water quality would be provided more fully by Alternative 5 relative to the other alternatives.

Riparian zones and floodplain access also play a critical role in providing habitat structures and diversity for both upland and aquatic species. Wood export from riparian zones provides important habitat features for salmonids and other fish by adding instream complexity and pocket habitats. Access to wetland fringe and floodplain habitat is also important feeding and refugia for salmonids and other aquatic species. Floodplains provide important refugia habitat during high flow events so that important energy reserves are protected during both immigration and emigration. Wood inputs on banks, floodplains, and in channels provides structural refuge from floods and predators, as well as contributing to channel formation processes resulting in a variety of habitat units like step-pool systems, backwater sloughs etc. Wood inputs may provide immediate benefits onsite where the wood originated or further downstream as energy and inputs move through the river system.

The same is true for floodplain habitats and access, which are equally important features and hydrologic events. Floodplains provide important energy dissipation to maintain system structure and to provide flood storage alleviating pressure on features downstream. Flood refugia allow juvenile fish and salmonids to move out of the higher velocity channel flows into slack backwaters and up into the floodplains. Healthy riparian zones and floodplains also offer a variety of habitat structures for terrestrial species, including a vertically complex canopy, standing snags, cavities, downed-wood, perching sites, and nesting features for multiple avian and ground species. Alternative 5 more fully captures and facilitates development of these restoration benefits.

Alternative 5 would provide full access to and frequency of floodplain inundation relative to the other alternatives. Without including riparian plantings along the levee, the benefits to both Post Office Lake and the Columbia mainstem are more limited. Without the swale and increased breach dimensions, hydrologic flows/exchange are reduced and fish accessibility to the lake via the breach is limited by the likelihood of overland sheet flow rather than a small area of more channelized, passable flow into the

lake. Although the levee would continue to breach and some floodplain connectivity would be restored without measures to create a swale and increase the breach, this is predicted to only occur over a 5-10 year timeline. Furthermore, it is unlikely even with progressive breaching that fish would be able to access the area via the breach location, or if fish did overtop the levee, they would sheet-flow into the field and be unable to reach the lake. These issues are more fully addressed and benefits of increased flood frequency and access to the lake are immediately and more likely to be fully realized by Alternative 5 rather than the other alternatives.

Floodplain and riparian zones contribute to the food web by providing substrate and food for a variety of macroinvertebrates that comprise the diet of many aquatic and waterfowl species. Riparian zones and floodplain habitat provide allochthonous inputs and detritus which provide important energy resources, particularly in higher order streams where autochthonous sources can be limited by water depths and light penetration. During high flow events, aquatic species like juvenile salmonids are able to conserve important energy resources and to access food supplies otherwise unavailable during normal flow events. Implementation of Alternative 5 would come closer to allowing restoration of the full suite of food web benefits possible at the site, which was not fully reflected in the benefits model. Detrital and prey export potential is also greatly increased by increased floodplain connectivity facilitated by the proposed enlarged levee breach.

From a species-specific perspective, in the benefits analysis Alternative 5 reflects fewer detrimental impacts to scaup relative to some of the other alternatives. Asphalt scarification may also facilitate management actions that reduce disturbance of waterfowl because the existing trail would be vegetated, which complements part of the USFWS management plan for this section of the Refuge. In addition, Alternative 5 better incorporates restoration measures described in the salmon-centric Columbia River Estuary (CRE) module (NMFS 2011), including riparian restoration, levee revegetation, and floodplain connectivity. Floodplain reconnection and additional habitat improvements via levee and swale plantings provide further uplift to quality and access opportunity for salmonids relative to the other alternatives. This is reflected in the capacity/quality scores and access/opportunity scores developed during SBU calculations. These measures in Alternative 5 should therefore result in higher SBU scores for Alternative 5 compared to the other alternatives. The difference in these score may be small, but could be considerable in the overall effort to achieve species recovery in the basin and to meet requirements under the 2008 FCRPS BiOp.

3. RECOMMENDED PLAN (PREFERRED ALTERNATIVE)

3.1. PLAN FEATURES

The recommended plan (or preferred alternative for NEPA purposes) is Alternative 5, the full suite of restoration measures. Figure 15 shows the features of the recommended plan and these features include:

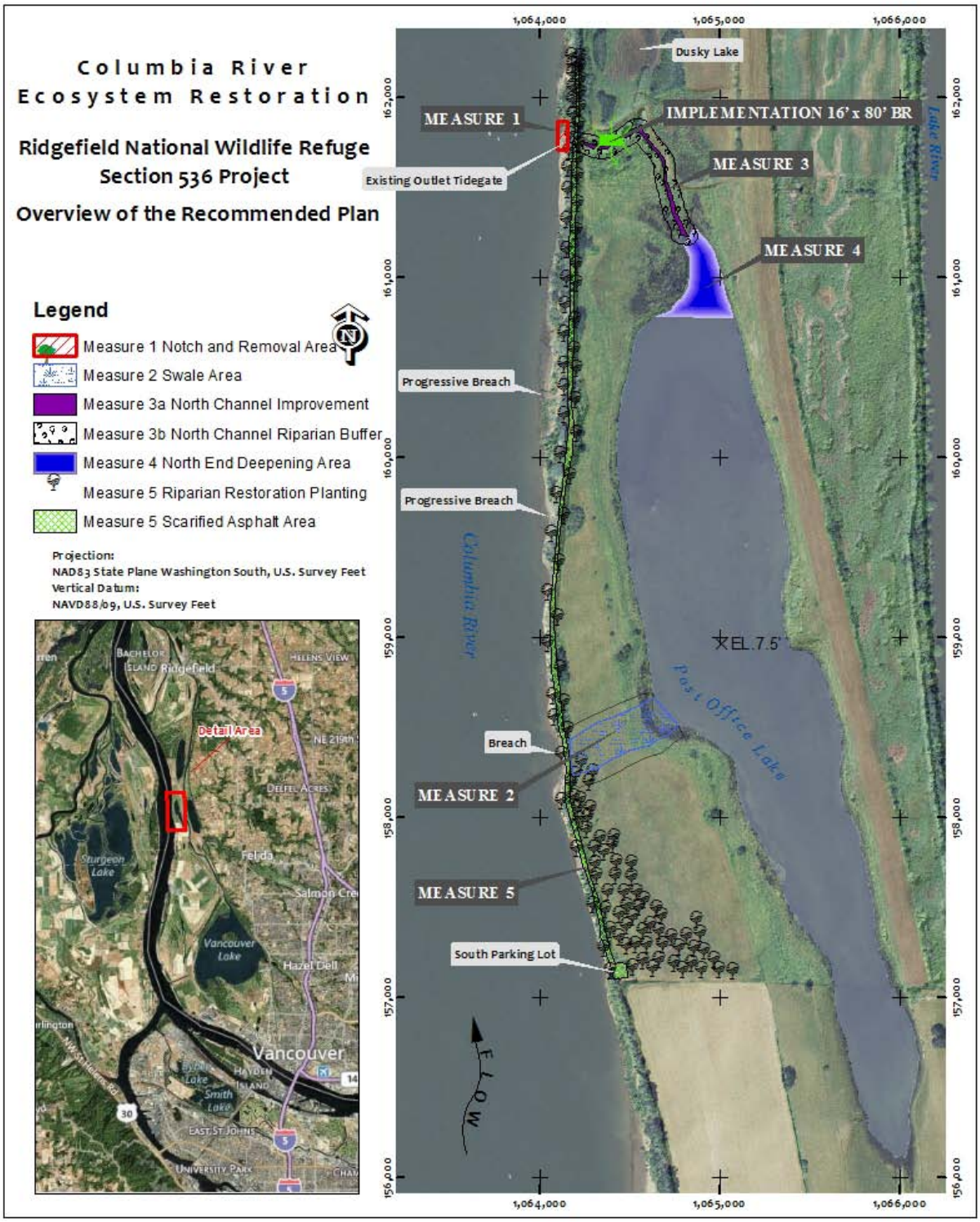
- Removal of the existing tide gate (tideflex, rubberized aperture), 170 feet of concrete encased 30-inch steel culvert and adjacent levee segment, restoring tidal connection to Post Office Lake.
- Create controlled floodplain reconnection at the worst progressive breach location, approximately RM 95.1. The entrance elevation of the breach point would be set at the 2-year Columbia River stage of 18.7 feet. The approximate width of the expanded breach will be 250 feet. A connection swale, 250 wide would be graded conforming to the existing topographic contouring. The swale would extend for approximately 500 feet from the breach to the Post Office Lake shoreline (roughly the OHW line, elevation 12 feet). The swale will facilitate controlled overland flows and provide some passage opportunity for fish ingress from the river during the high water events. The Refuge has prohibited scrub/shrub plantings to meet the sight distance requirements for birds.
- Improve northern connection channel configuration for better fish access. Create a two-stage channel that passes the full tidal prism. Stabilize the side slopes, terrace and or flatten side slopes. Remove high points along ditch which may impede fish passage. Where feasible, any required stabilization would be by eco-friendly bioengineering methods. Adding large wood and root wads to immediately increase cover, structure and habitat complexity.
- Creation of 50-foot riparian buffer (approximately 1,000 linear feet) on either side of the north connection channel. Tree plantings from west end of channel to existing willow/cottonwood stands at north end of the lake. Extend plantings on north end to the existing willow/cottonwood stands adjacent to the Columbia River. Remove localized patches of invasive species in order to ensure successful establishment of native plantings.
- Lower the existing topographic sill at the north outlet of Post Office Lake. Excavate and stabilize the lake sill at the north end from elevation 10 to 9 feet to improve fish passage while providing some water in the lake during the summer months and to facilitate the survival of shallow water invertebrates. Create a temperature and predation refugia pool near the sill to an approximate depth of 6-ft below the 9-ft sill at an approximate 1:5 slope. Adding large wood and root wads to immediately increase cover, structure and habitat complexity.
- Riparian restoration near the southern parking lot and along the levee including removal of asphalt, or scarification if method is less impactful to existing mature vegetation. Scarify remnant asphalt thereby facilitating expansion of riparian vegetation.

Implementation of the culvert/tide gate/levee segment removal element is contingent on a letter of consent from Clark County Transportation Department, the signing of a MOA with the WDNR for those project elements below the OHW mark, and the acquisition of easement agreement(s) with property owners to the south. All or most elements of the recommended plan are expected to be constructed concurrently.

Construction staging at the site would begin in mid-June to first of July. Excavation would occur between July 1 and October 1 of the first construction year, depending upon funding availability. Planting likely would occur November through January. Construction is planned for the lowest water season on the Columbia River and the anticipated season of driest soil conditions at the site. Not only would this timing facilitate most efficient project completion, it would create the least amount of

temporary impacts by reducing the need for use of graveled areas and would potentially reduce the proximity of construction activities to inundated water bodies.

Figure 15. Features of Recommended Plan



Construction during this time also reduces the scale of instream structures needed for in-water work area isolation, and reduces the potential risk involved with high water events overtopping these structures during construction in winter and spring seasons. In order to work outside the in-water work window (IWWW) on the Columbia River, and potentially within the lake and connection channel, a variance would be requested from NMFS and WDFW. From initial conversations with these agencies, obtaining such a variance is not anticipated to be problem. Herbicide application, tillage and plantings would likely occur in various stages from June to October in a sequence that optimizes planting seasons, environmental protection, and efficient project staging and execution, potentially concurrent with or shortly after other various excavation elements are completed.

Excavated materials may be stockpiled, spread in land application, or hauled off site for disposal. Refuge staff indicated that they have a disposal area for up to 42,000 cubic yards (cy) of excavated material. A haul distance of 4 miles is assumed. If the Refuge is unable to take all the material, then the haul distance could be 20 to 30 miles. Possible methods of deepening the north end of the lake include excavation from shore, flexi-floats, or in-water pontoon-mounted excavator.

- *Excavation from shore*. The current concept is for excavating from the shoreline using a long-reach backhoe loading excavated materials directly into trucks for disposal. The equipment would be supported by heavy wood timber decking at water's edge. As work progresses the decking will be relocated so the excavator and trucks can reach unexcavated areas. This method is likely the most destructive to wetland areas along the shoreline. Damage can be minimized with strategic placement of equipment, but some damage is unavoidable.
- *Excavation from flexi-floats.* This option is equipment intensive (expensive) and includes barge sections trucked to the site on 18-wheeled flatbed truck and trailer. A crane would be required for offloading the float sections. A material barge with tug boat is also necessary for transporting excavated materials to shore and a second excavator (or other equipment) for offloading to trucks for disposal. This method would likely be the most expensive and would have considerable impact due to the amount of equipment required and would require a large area for maneuvering large truck and trailer rigs. If there is inadequate water depth along the shore excavation would be required for erecting flexi-float sections, which may increase wetland impacts.
- *Pontoon-mounted excavator*. This option was considered but is not commonly used. It would require a material barge with tug boat for transporting excavated materials to shore and a second excavator (or other equipment) for off-loading to trucks for disposal. This method may be the least destructive to the wetland area since the offload area and water entrance would be a relatively small area.

Construction access would be primarily from the south parking lot with hauling primarily along the toe of levee. Temporary staging areas would be onsite. Access routes should have sufficient width and weight bearing capability to handle a relatively large tracked excavator, tracked or off-road trucks, a D-4 sized Cat, and fuel trucks. Excavated materials would be stockpiled and allowed to drain prior to final disposal.

Additional information on the specific features of the project can be found in Appendix C, *Conceptual Plan*. It is expected that one summer/fall construction period will be required to complete construction efforts for excavation and disposal of soil, although an additional season may be necessary to accommodate any contingencies or funding shortfalls. Tillage operations would occur the next spring. Plantings of tree seedlings and cuttings would occur on 12 acres the winter after construction involving excavation and disposal of soil.

3.2. CONSTRUCTION ISSUES

The majority of the recommended plan is earthwork. The excavation is in an environmentally sensitive area and near designated wetlands. Careful attention to construction period, access and onsite monitoring is part of the implementation process. Earthwork will be performed during dry weather (i.e., late summer/early fall) to minimize the adverse environmental effects caused by construction activities and minimize project costs associated with temporary project impacts.

Gravel placement, often required for temporary access roads or for equipment setup, is generally considered adverse to environmentally sensitive areas. Therefore, these areas will be kept to a minimum and use of removable mats and/or complete removal will follow completion of the project; haul roads will be restored to their original preconstruction condition. Invasive species control (herbicide spraying and mechanical removal) would be minimally affected by weather. Permanent revegetation work would not take places until construction activities are completed and weather conditions will support the highest survivability of plantings.

The following discussion addresses constructability issues of the recommended plan.

Remove tide gate, culvert and levee (north). Removal of these structures should be performed in late summer or early fall when river level is lowest. This may avoid in-water work restrictions and reduce or eliminate turbidity in the river. An IWWW variance will be requested from NMFS and WDFW. Dewatering and re-watering will follow protocols described in the joint programmatic restoration BiOp (NMFS and USFWS 2008) (see Section 7.5), and a fish salvage and work area isolation plan will be developed during development of plans and specifications. Some dewatering in the excavated area may be needed to help control turbidity. Several truck loads of concrete and steel will need to be disposed of offsite. If on-site disposal is not allowed for levee fill material, then truck traffic will increase from ±10 loads to ±400 loads. Access roads in and around the work area appears to be soil. If work is performed during wet weather muddy conditions would hamper excavation and hauling activities. In these cases, road improvements (gravel placement) would be required for haul roads to hold up to truck traffic.

Improve northern channel geometry for better fish access. This task includes re-grading of channel bottom to a more uniform slope and laying back side slopes. This work will expose soils in a large area and will require considerable equipment traffic, thus should be performed during dry weather. If excess excavated material requires off-site disposal, a minor amount of haul road work will be needed and would be negatively affected by wet weather. A coffer dam and dewatering may be required to reduce turbidity and better control channel grade.

Create riparian buffer around north connection channel. This work will take place after re-grading of channel bottom and laying back side slopes is complete. Planting should take place in late fall or early winter.

Deepen at north end of lake/south end of connection channel. This work item involves in-water excavation to remove high ground that may block fish passage and to construct the refugia pool. Access onto the lake should be limited to the northeast shore to minimize impacts to designated wetland. Due to sloping ground a haul road will be required. It will be necessary to gravel the sloping section as a minimum in order for trucks and a crane to reach the shoreline. Since the excavated material will contain water that will leak onto the road, additional gravel placement may be required to minimize muddy roads. Excavation may be accomplished using a floating hydraulic excavator capable of driving directly onto and off the lake minimizing

wetland impacts. Excavated material will be loaded onto a small material barge and motored to shore using a small work boat/tug placed on the lake using a crane, minimizing wetland impact. At or near the same location where the excavator enters the water, plank decking would be placed near the water's edge to support trucks. Depending on water depth along the shoreline, some excavation may be required to allow the loaded barge to be reachable for offloading.

Placement of fill material removed from project area. There are several ways fill could be placed including: stockpiling for later use elsewhere; placing the material in a thin layer to build elevation permanently in-place; and removal off-site. The Refuge initially proposed five potential locations for consideration to stockpile or place fill material resulting from the project. If these locations are eliminated due to potential environmental impacts and the Corps and Refuge cannot identify a suitable location, materials will be taken to an offsite, approved upland location. Unnecessarily impacting wetlands if alternative stockpile sites are available would not meet the intent of NEPA or the Clean Water Act (CWA), which stresses impact avoidance and minimization measures before considering mitigation. Stockpiling fill is not a water-dependent activity. This ecosystem restoration project would avoid impacts that require wetland mitigation.

The following initial assessment was made regarding each of the potential sites.

<u>Area 1 – River "S" Unit</u>: Characteristics such as topographic breaks in the landscape, distinct changes in vegetation, wet soil conditions, and concentrated presence of amphibians lend to suspicions that the proposed fill location in the River "S" Unit contains wetlands. The National Wetland Inventory also indicates likely wetland areas in the vicinity of the proposed fill location. Wetland presence would be confirmed by a wetland determination followed by an official delineation to indicate boundaries if this location is pursued as an alternative.

In the vicinity of the proposed River "S" Unit fill location, two of the visually dominant plant species that appear to in the wet areas, Canada thistle (*Cirsium arvense*) and curly dock (*Rumex crispus L.*) are considered facultative species and are, therefore, may be indicative of hydric conditions according to the Western Mountains, Valleys, and Coast Region National Wetlands Plant List found at the Corps website http://rsgisias.crrel.usace.army.mil/NWPL/#. Wetlands can occur on slope of levees due to seepage, and wetland protections apply regardless of wetland quality.

Given the location of the sites within the 100 year floodplain, the regularity of seasonal flooding by navigable waters from Lake R. and the Columbia R., and by the position of the Refuge within the Columbia River Basin, it would be highly likely that any wetland sites would be considered jurisdictional, as they would likely meet the significant nexus tests based on physical, chemical, and biological functions described in the Rapanos court ruling (*Rapanos v. United States*, 547 U.S. 715 (2006)).

The stockpile material placed in the River "S" location is likely to experience regular contact with floodwaters (as indicated by Refuge staff during the site visit) which could re-distribute and suspend materials and erode the stockpile. Besides losing the materials for future use, uncontrolled re-distribution and suspension of stockpiled materials could cause water quality issues and make efficient use of the remaining materials more difficult. Stockpiles are required to be adequately stabilized and contained under CWA and NPDES. Stockpiling along or on top of the levee also creates a greater risk of cutting into and compromising the levee when the material is later removed for use elsewhere.

Access to the construction area via the northern route through the Refuge is not the preferred route due to the presence of a residential neighborhood through which construction vehicles would regularly travel. This could create a noise and traffic nuisance. The north construction route would also potentially increase the interaction between construction traffic and visitor traffic on the audio tour, which could be a safety issue. There is limited availability of turn-outs along the northern route. Without a northern construction route, there is no reason project-related equipment would travel the additional distance from POL to the northern portions of the Refuge, except to access the stockpile. For all of these reasons, placement of the stockpile in the River S unit does not appear to be the environmentally preferred alternative.

Area 2 – Roadway near Campbell Lake: The area of the roadway proposed for fill near Campbell Lake (area 2) would likely be inundated regularly with floodwaters. The silty-elastic composition of the expected materials does not initially seem suitable as inundated road grade material. As with the River "S" unit location, this material may be more susceptible to re-distribution and suspension during backwatering events. Any placement considerations should include avoiding the high potential for water quality impacts and the low suitability and durability of using this material as a fix for the roadway in such a location. This does not appear to be an environmentally preferred option if these concerns cannot be addressed.

Area 3 – Upland old house site: The location at the house site is the environmentally preferred options because it avoids many of the issues stated above. It does not appear to have any wetland indicators, and this would be confirmed with an official wetland determination. The elevation of the site –which is outside of the 100-year floodplain, would reduce the risk of contact with floodwaters that could re-distribute and suspend stockpiled material. Stockpiling in an upland location would allow better containment and stabilization per requirements under NPDES and the CWA.

The house site is currently maintained in a mown state. If the area was used for future streaked horned lark habitat creation (as mentioned by USFWS staff), appropriate stockpiled fill could be concentrated or spread out over the area to accommodate this use, and should not preclude such future habitat creation.

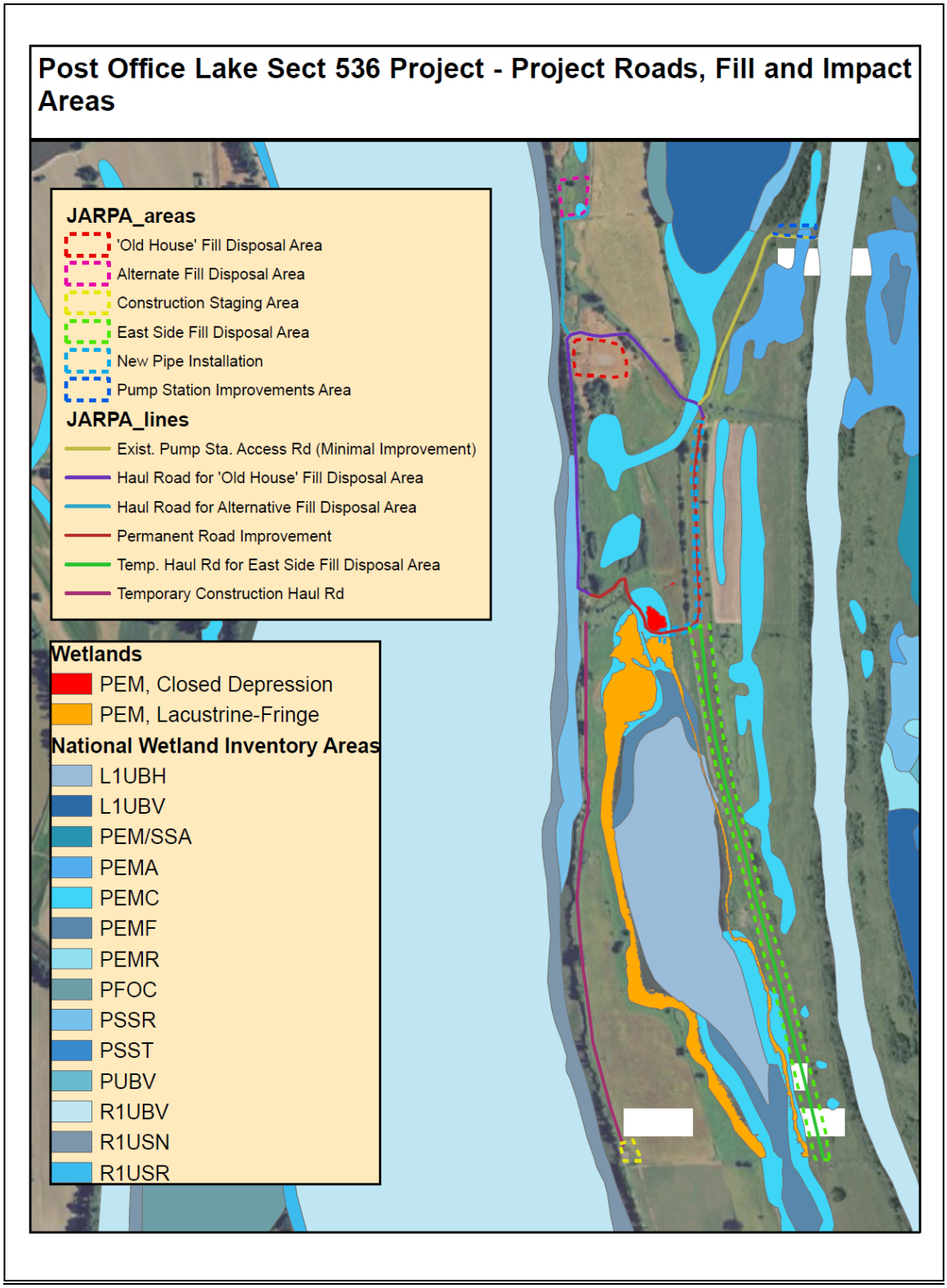
The route from Post Office Lake to the house site would also reduce the haul distance vehicles would be traveling, and would therefore lessen the emissions and area of sound disturbance created by construction equipment. This would reduce impacts to trust species at the Refuge, since shorter distances better contain acoustic and human activity disturbance to a more localized area.

<u>Area 4 – Adjacent berm east of Post Office Lake</u>: The area on the east side of the lake along the berm was not visited. If this route/ location is used for stockpile or fill, it is likely that turnouts would be necessary to accommodate construction traffic. This placement method would most likely be in the form of a thin spread rather than a stockpile, which entails more work by construction equipment and impacts over a greater area. According to the NWI, there are adjacent wetlands along both sides of this levee, though there may be a wider swath of higher ground and uplands along the berm. It is also highly likely that low spots would have wetland characteristics, but this was not confirmed on site. The same issues described above would be of concern in this location if wetlands were present or if the area was subject to regular inundation. A wetland determination would be conducted to confirm findings either way.

Area 5 – North of abandoned house site: This area has not been surveyed. It is about ¼ mile further from the construction site and appears to be in an area covered in blackberries. The wetland status is unknown, and all factors described above would be considered during evaluation of this alternative. A wetland determination would be conducted prior to any selection of final fill placement locations.

The following figure illustrates the locations and required haul routes for the potential stockpiles or placement of fill including the old house site, north of the old house site, and east of the lake. These are overlain with data from the National Wetland Inventory (NWI), which provides coarse estimates of potential wetland sites based on photogrammetric evaluation of vegetation types. The other two locations mentioned above (River S and along the northern roadway) were not included, because they were not likely to be selected based on assumptions that both construction costs and environmental impacts would be more likely to be higher for these location relative to the others. Stockpile areas could take about ½ acre space or depending on amount and height of the pile (estimate is for 15, 000 cy at 8-10 ft.) Otherwise, fill spread about 1-ft deep could take around 10 acres.

Figure 16. Features of Construction Implementation, Stockpile Areas, and Potential Wetland Locations



3.3. OPERATION AND MAINTENANCE

Operation and maintenance of the restored ecosystem as a result of the Post Office Lake, Section 536 project will be the responsibility of USFWS. The Refuge's current O&M operations include mowing to manage reed canarygrass, herbicide application and mechanical removal to control noxious weeds and limited pesticides for mosquito control. Further, the Refuge does perform water management and other activities to the north in Dusky Lake. These activities impact Post Office Lake.

The Refuge allows Dusky Lake to drain in late July through early August. Reed canarygrass areas of the existing wetlands are mowed in late August or early September. Following mowing, the Refuge services and blocks up the existing drain structure that leads to Post Office Lake. Currently, the Refuge cannot fill Dusky Lake due to non-functioning valves on the conveyance system. Normal practice is to pump water into Dusky Lake in mid-September prior to waterfowl migration to provide forage for dabbling ducks and cranes, and roosting areas for geese. It is anticipated that the proposed project will repair the existing conveyance system and the intended operations will be reinstituted.

In spring when suitable weather arrives and the geese leave (usually mid to late April), the Refuge sprays adjacent uplands for poison hemlock (*Conium maculatum*) and Canada thistle (*Cirsium arvense*). In June or July, the Refuge performs spot spraying for Canada thistle and tansy ragwort (*Senecio jacobaea*) trying to treat it before it seeds.

There are several project features that will introduce additional operation and maintenance activities as a result of the proposed ecosystem restoration activities. These project features are described below. The total annualized O&M cost for these project features is estimated at $4,000.

1. Riparian management along the north connection channel, the floodplain overtopping and connection swale, and in the open area located at the south end of the Refuge.

   The tidal reconnection via the north connection channel is expected to lead to a different hydrologic regime than present conditions, favoring native emergent tidal wetland/marsh vegetation and reducing the coverage of submergent vegetation. According to USFWS staff, it is also possible that shallower water during the summer growing season may favor reed canarygrass, although this is uncertain. The USFWS would continue to manage the possible new reed canarygrass areas as they appeared, with current management practices, which consists of mechanical treatments. The extent of additional mechanical treatments is expected to remain the same as current practice, since the water levels of the lake will likely remain approximately elevation 9.0 feet. No additional O&M expenditures are anticipated for the Refuge's additional mechanical treatment practices, as details regarding the pumping plan will be analyzed during plans and specifications.

   The construction of a riparian buffer within 50 feet of the North Channel would require the occasional removal of invasive vegetative species, presumably through spot spraying, mechanical removal, and others. Typical compounds used for invasive control are Weedmaster (2, 4-d and dicamba), imazapyr, aquatic formulations of glyphosate for thistle, iris, and poison hemlock.

   Beavers live in the area and some effort may be required to ensure that they do not adversely impact the development of the riparian buffer. It is anticipated that Refuge staff would annually perform necessary removal of invasive species and perform low level

mitigation for beaver activity affecting riparian vegetation development. The preliminary O&M cost for the north connection channel is estimated at $500/year.

The natural erosion of the existing levee and the construction of a swale between the existing levee (former Lower River Road) and Post Office Lake may result in recruitment of large woody debris from the river, and may require either removal of non-natural debris or the relocation of desirable natural detritus (large woody debris). The preliminary O&M cost for handling this debris is estimated at $500/year.

2. Maintenance of northern connection channel.

   When the culvert and tide gate are removed and hydraulic reconnection is made, the channel bottom will adjust to an equilibrium state and some local sediment accretion may result. Additionally, shifts in flows rates may mobilize some fines from one location to another. Overall, the channel is expected to be stable based on analysis of sediment sources (none of significance); however, temporary sediment accretions in inconvenient locations may occur and necessitate some observation and or/may require some maintenance action to remove. Also, natural features such as large woody debris may be re-introduced, replenished, or rearranged by incoming river flows, adding complexity and cover. The preliminary O&M cost for this activity is estimated at $500/year. This is based on an annualized cost over a 50-year project life.

3. Maintenance of the bridge to access the west side of Post Office Lake.

   To allow for current Refuge O&M activities, a bridge is required along the toe of the levee above the tidal prism to allow equipment to access the west side of Post Office Lake. Normal practice anticipates the bridge will require periodic inspections, including inspections of the approaches and abutments, possible occasional removal of dirt and debris as a result of extremely high freshets, and the repair, replacement and/or restoration of the concrete surface. The preliminary O&M cost for these activities is estimated at $1,500/year.

4. Maintenance and operations of water conveyance piping and valves. (See previous figure)

   The Refuge currently pumps water from Lake River near the south end of Campbell Lake to manage water elevations in Campbell and Dusky lakes. The USFWS requires the existing piping be extended to the north end of Post Office Lake to manage its water elevations. It is expected that a pump and three new valves will be required as a result of this project constraint, which will require lubrication and actuation. The preliminary O&M cost for maintenance of the new valves and pipe extension is estimated at $500/year. The new pump is expected to be more efficient such that there would be equivalent costs despite the longer pumping period.

5. Maintenance of water control structure between north connection channel and Dusky Lake.

   Initially, there was concern that high flows may bring fish into Dusky Lake as water overtops all levees within the vicinity of the project. Alternatives such as a fish screen, and an entirely new water control structure at the south end of the Dusky Lake were considered. An evaluation was made as to whether or not potentially replacing the nearby existing structure would facilitate fish reentering the north connection channel and

returning to the Columbia River. The precise structure configuration was not determined. However, for O&M purposes and cost estimation, it was expected that the water control structure would require annual inspections, periodic maintenance, and some reporting. The preliminary O&M cost for these activities was estimated at $500/year. The installation of a fish screen would also require similar maintenance but would be on the existing structure. Based on evaluation of Refuge water management practices and predicted fish behavior, conversations with NMFS and USFWS have determined that the preferred measure for accommodating fish egress from Dusky is No-Action. This is discussed further in the section describing potential effects to fish species and will be covered in the associated Biological Assessment and Biological Opinion.

3.4. PRE- AND POST-CONSTRUCTION MONITORING

Per CECW-PB Memorandum for Commanders, Major Subordinate Commands, dated 31 August, 2009, *Headquarters Implementation Guidance for Section 2039 of WRDA* … "When conducting a feasibility study for a project (or component of a project) for ecosystem restoration [ensure] that the recommended project includes a plan for monitoring the success of the ecosystem restoration. The monitoring plan shall include a description of the monitoring activities, criteria for success, and the estimated cost and duration of the monitoring as well as specify that monitoring will continue until such time as the Secretary determines that the success criteria have been met. Within a period often years from completion of construction of an ecosystem restoration project, monitoring shall be a cost-shared project cost."

Per Engineer Regulation 1105-2-100 Appendix F, Amendment 2, "(8) Monitoring and adaptive management. Monitoring may be necessary to determine if the predicted outputs are being achieved and to provide feedback for future projects. Cost shared post-implementation monitoring will rarely be required. If cost shared post implementation monitoring is being considered, it must be clearly defined, justified and the period of cost shared monitoring shall not exceed five years following completion of construction. *The cost of monitoring included in the total project cost and cost shared with the non-Federal sponsor shall not exceed 1 percent of the total first cost of ecosystem restoration features.* For complex specifically authorized projects that have high levels of risk and uncertainty of obtaining the proposed outputs, *adaptive management may be recommended. The cost of the adaptive management action, if needed, will be limited to 3 percent of the total project cost excluding monitoring costs.*"

Under the pending Memorandum of Agreement , with the USFWS, the Corps would monitor ecosystem habitat changes and species response during the transition from the current disconnected state of Post Office Lake area, floodplain, and wetlands to more frequently inundated floodplain and tidally connected wetlands. The duration of monitoring would be for at least 3 years, but is more likely to be up to 5 years after constructing the project features described in Section 3.1. Subsequent to this initial monitoring period, continued monitoring would be conducted by the Refuge. The details of the final monitoring plan would be finalized and codified in the associated Operations and Maintenance Manual for the project, which would be developed in cooperation between the Corps and USFWS. The following sections layout the initial plans for pre-, during, and post-project data collection.

3.4.1. Monitoring Criteria

Post-construction monitoring consists of evaluating five ecosystem functions:

1. Water quality (e.g., temperature, DO, pH, turbidity).
2. Hydrologic function (flow, depth, inundation extent, duration and frequency).
3. Wetland, riparian, and floodplain vegetative health, cover, and composition.

4. Geomorphic function expressed as natural and stable channel, bank, lake, and swale structures maintained via balanced sediment degradation and accretion under more dynamic flood and tidal disturbance regimes.
5. Species response to ecosystem change, noting the presence of juvenile salmonids and other fish species. USFWS would also be conducting surveys to document any changes to waterfowl habitat or usage that could occur as a result of the project. Additional surveys to document changes to macro-invertebrate may be included.

The condition of each functional category would be measured up to twice per year using the following instruments and protocols, and a site visit report would be made documenting the findings and data collected. Location of specific monitoring points would be further refined when design details are determined in the plans and specifications stage.

Water Quality: A water quality data logger, a Hydrolab DS5 multi-parameter instrument, or equivalent instrumentation would be used to measure in-situ water quality function (e.g. temperature, DO, pH, and turbidity) and used to ascertain and log data at each observation point. Hobo data loggers or equivalent may be deployed to collect continuous data for various parameters if more intensive monitoring becomes possible under the current Action Effectiveness Monitoring and Research (AEMR) being conducted by the Corps under the FCRPS BiOp.

Hydrology: Water stage data loggers would be located to record depth of the water within the channel, near the mouth, and within the lake if more intensive monitoring becomes possible under the AEMR program. Alternatively, less intensive sampling would occur via observation of the high water mark and gage comparisons and may be conducted in combination with aerial image analysis surveys of inundation extent and frequency. This would likely be accomplished during the 2-year flood event and during the mean low tide events during the same interval as fish sampling.

Vegetation: Permanent photo point monitoring would be utilized at selected (and permanent) camera points identified during refinement of plans and specification. Photogrammetric points would monitor overall ecosystem change by indentifying alterations in vegetation and landscape as well as introduction of large wood resulting from tidal and floodplain reconnection. Photos would be taken, collected, and qualitatively evaluated at least once per year during the months of May, July, or August. Photo monitoring site consistency will be ensured through use of GPS locators and enabled cameras. The Corps would also conduct vegetation monitoring surveys via selection of a few representative transects in the riparian area along the levee, in the floodplain swale, along the north connection channel, and in the southern area of floodplain plantings. Transects would be sampled for coverage density, composition, structure, and canopy/vegetation height (via clinometers, ocular, or imagery measures, as appropriate). Vegetation surveys would be conducted at least once annually during the growing season in May, July, or August. Two to three wetland monitoring points would also be chosen from previous delineation sample locations around the fringe of the wetland to document the transition of wetland type and extent. The site visit would evaluate the success of the project's plantings and tidal wetland succession. A site visit report would be made documenting the findings and data collected. The USFWS is also planning to conduct baseline mapping of the emergent and submergent vegetative community which may include boat transects to identify the extent of the submergent communities during the summer of 2012. Additional future surveys to document changes to macro-invertebrate may be included.

Geomorphology: Survey transects at up to three locations in the northern channel would be made, as well as a channel thalweg profile and transect of the pool elevation.

Species Response: Beach seining (i.e., sweeping fish nets across a body of water) would be conducted at the entrance of the Columbia, the northern connection channel, at the northern end of the lake, and at the south end of the lake at least twice each year to test for the presence/absence of juvenile salmonids and to identify the general fish community composition. Two site visits made annually during the months of May (anticipated peak usage), and either August or September (under anticipated conditions of limited water quality) would document ecosystem conditions during critical fish windows. A site visit report would be made documenting the findings and data collected. The USFWS also regularly conducts waterfowl surveys to estimate numbers for hunting and achievement of Refuge goals. The Refuge has been and would continue to conduct weekly winter bird counts for the next couple of years at least, though they may be cut back to bi-weekly or monthly. There is also a marsh bird point at the north end of the lake which is a point-count site where as part of a nationwide USGS program a set call sequence is played to elicit responses from secretive marsh birds. The USFWS would conduct a macro-invertebrate survey under a 1-year USFWS inventory and monitoring grant to enumerate type and abundance of waterfowl forage. This may be extended for multiple years and may be supplemented by Corps efforts to sample benthic macroinvertebrates seasonally via ponar grab samples, artificial substrates, or activity traps.

Field surveys and collection of monitoring samples expected to take a minimum of 2 days per year, 1 day dedicated for a low water (possibly August or September) and 1 day dedicated for high water events (possibly May or June). Additional time may be needed to account for unexpected conditions, and other unanticipated issues.

Monitoring for water quality function would include:

- DO.
- pH.
- Temperature. Water temperature would be recorded in the center of the watered portion of the north connection channel, the north end of Post Office Lake (in the excavated pool area), and at the south end of the lake.
- Turbidity.

Monitoring for hydrologic function would include:

- *Tidal reconnection* to the Columbia River would be verified by data supplied by stage data loggers and visual inspections during periodic inspections.
- *Validation of hydrologic regime changes*, e.g.; duration and frequencies anticipated from feasibility analysis would be verified through analysis of stage data logger information.

Monitoring vegetative health, cover, and composition would include:

- Photographs would capture vegetation succession extents. Photos would be taken separately at distances necessary to aid in survival documentation; this would supplement counting of live and dead plantings over a representative planting area using a 50-meter line transects at 5-meter intervals using a 1 meter x 1 meter quadrants, or throughout randomly sampled areas.
- Site visit and vegetative survey of coverage, composition, and canopy survey estimates in representative locations along the levee, the north connection channel, the floodplain swale, and in the floodplain forest using a 50-meter line transects at 5-meter intervals using a 1 meter x 1 meter quadrants, or throughout randomly sampled areas. Representative wetlands would be sampled at previously identified paired locations documented in the original delineation report. This would provide documentation of biota health and survival. Monitoring would include

walking the north connection channel from its confluence with the Columbia River to the north end of Post Office Lake, once during late spring to capture the spring freshet and once during the fall (probably July or August) to capture the low flows.
- Document large woody debris.

Monitoring for natural stable geomorphic function would include:

- Survey transects to monitor channel and pool stability.
- Sediment pins or equivalent to monitor accretion/erosion/settlement. It is recommended that a survey bench mark be located on the project area at a suitable hard point, such as bridge abutment. Elevations can be tied to the NAVD88 vertical datum.

Monitoring for species response to ecosystem change would include:

- Note presence and enumeration of juvenile salmonids and other fish species that may be present.
- Note production of invertebrates . USFWS would conduct surveys the first year, and then additional surveys conducted by USFWS and/or by the Corps AEMR program.
- USFWS to conduct weekly waterfowl count and marsh bird point surveys.

3.4.2. Location

The locations for the monitoring measures would be further refined as plans and specifications are developed in greater detail. A minimum of six sites would be required for obtaining data to determine project success. The identical three sites required for beach seining would be required for obtaining water quality and hydrologic data via Hydrolab instrumentation and HOBO® data loggers. In addition, three more sites are required to determine project success: (1) one site would be along the top of the levee for evaluating vegetative succession resulting from the proposed scarification; (2) a second site within the floodplain reconnection channel to photograph any changes with regards to the amount of woody debris settling within the channel; and (3) a HOBO® data logger is required near the confluence of the north connection channel with the Columbia River to ascertain potential shoaling.

3.4.3. Success Criteria

Ecological success for this project is defined in terms of the overall goal of the project and the project objectives. The goal of the project is to restore and improve important habitat functions on and in the immediate vicinity of Post Office Lake by restoring tidal and floodplain reconnection to the Columbia River and providing refugia and rearing opportunity for migrating juvenile salmonids, and to a lesser extent, flood refugia for adult salmonids.. Specific objectives include:

- Re-establish tidal influence to water bodies (Post Office Lake and wetlands) in the project area above elevation 7 feet.
- Provide optimal access to Post Office Lake allowing ingress and egress for rearing juvenile salmonids (coho and Chinook salmon), while reducing the risk of stranding.
- To increase and improve backwater, off-channel habitat quantity and quality for rearing juvenile salmonids and as flood refugia for juveniles and adults.
- Restore more natural floodplain connectivity (exposure to greater frequency interval of flood inundation and flow duration, along with multiple flood access points).
- To improve floodplain functions (e.g., habitat, food, source of nutrients and organic materials, flood storage, etc.).

- Increase and improve riparian function (bank stability; water quality; woods, insect, and detrital inputs, energy dissipation, etc.) and canopy cover (shade, water quality, etc.), where feasible.
- Increase and diversify native floodplain and riparian vegetation, where feasible.
- Remove and manage invasive plant species, such as Himalayan blackberry, reed canarygrass and others, where practical.
- To minimize depredation of juveniles in the lake via increased habitat complexity, placement of natural cover and structure where appropriate in the channel and the lake, and excavation of a pool creating depth and temperature refugia.
- Manage semi-permanent and seasonal wetlands for migratory waterfowl, wading birds, shorebirds, and other wetland-dependent wildlife species.
- Enhance tidally influenced freshwater wetlands for the benefit of anadromous fish, waterfowl, and wading birds.

Specific success criteria and thresholds are discussed below.

Water quality: The primary water quality function provided by this project is to improve wetland habitat and overall water quality conditions for rearing salmonids after tidal and floodplain reconnection to the Columbia River. The water quality parameter thresholds for temperature, dissolved oxygen, pH, and turbidity should fall within scientifically established and acceptable criteria for Coho and Chinook juvenile salmonids at most locations in the lake when salmon are expected to be present and in pocket refugia during summer months when most juveniles are anticipated to have moved to the mainstem. The condition of these water quality criteria would be presented in the annual monitoring reports. Adaptive management triggers would occur in consultation with Refuge and NMFS biologists regarding necessary changes in hydrology and inundation extent and duration if after 3 years there was a declining trend in water quality.

Hydrologic function: The primary hydrologic function provided by this project is (tidal and floodplain) reconnection to the Columbia River. Hydrologic and biologic connectivity are cornerstones elements for the promotion of ecosystem diversity and complexity.

- Verification of expected high water level monthly average inundation/duration (e.g., November through July) should be monitored in the Columbia River and compared to inundation and duration in the lake area. Stage data logger information taken at the lake and interior should be compared to the monthly averages determined in previous sections of this report and detailed in the Water Quality Report (see Appendix E). If expectations are not being met, a determination on cause and potential detrimental impact (to habitat and species) would be conducted.
- Columbia River and lake inundation and duration of water levels would be monitored/verified for low water stage months (August through October) and compared to expected values determined as part of this study. Shallow water depths are expected in the lake during the summer months; however, if the flow regimes are not as expected, the cause and sensitivity to the change would be identified and quantified and measures to ameliorate the situation determined. Similar methods for tracking water level fluctuation noted previously would be used to make these determinations (e.g., data loggers, analysis of gage data, etc).
- Occurrence of sediment accumulation would be monitored. If it is determined that hydrologic and species connectivity (ingress/egress opportunity) is negatively impacted, the barrier would be considered for removal to restore the intended ecosystem function. Visual inspection, inspection of water level data, and tracking of sediment accretion rates (sediment pins) would detect these potential stressors to ecosystem hydrologic function.

Wetland, riparian, and floodplain vegetative health and succession function:

- Wetland, floodplain, and riparian transition are expected to occur. Success would be indicated by changes in % cover; increase % of native vs. non-native vegetation; increased canopy height in appropriate locations; changes in hydric soil conditions where appropriate; changes in hydrology; and changes in the relative % composition of herbaceous, shrub and tree cover in appropriate locations.
- Success would be defined as increases in native cover and composition, and changes in hydrologic indicators.
- Adaptive management triggers would occur if native revegetation establishment did not occur in replanted areas in the first 3 years, if the canopy cover did not increase in the first 3 years at specific locations, and if the extent of usable cover was not established in the first 3 years. Invasive species would be controlled to the maximum extent practicable, but would not be a trigger for adaptive management unless there was a complete failure of some native establishment within the first 3 years.

Natural and stable geomorphic function expressed as channel stability and streambed shoaling via sediment degradation and accretion. Processes such as accretion, degradation, and other minor overall channel morphology are expected to develop over time as part of the natural tidal exchange process. It is believed that the designed channel profile, elevations, and cross-sectional area would allow for exchange of the full tidal prism during most time periods without creating conditions which would affect significant morphological change. As such, the channel can be considered stable and meeting targeted function under the following three conditions:

- Channel cross sectional area remains sufficient enough to pass the full tidal prism throughout the year when water levels in the river are sufficient to overtop the inlet elevation of the north connection channel and then the inlet elevation of the lake sill.
- Accretion of the channel invert to an elevation approaching or eclipsing elevation 9 feet would be considered unacceptable and would not allow for full tidal exchange. Additionally, destabilization and erosion of the levee breach area resulting in restriction or significant accumulation of debris at the channel inlet would be considered unacceptable.
- Channel degradation and erosion that results in either significant bank destabilization or a threat to the elevation 9 feet sill would be considered unacceptable.

Species response to ecosystem change, noting the presence of juvenile salmonids:

- Success would be determined by achievement of physical habitat parameters conducive to fish use and survivability.
- Presence of carp is expected, though undesirable. A majority percentage composition of native species would be considered a higher level of success.
- Adaptive management triggers would occur if salmonids were not observed within the first 3 years of monitoring but were otherwise present on the Columbia, or if the population of carp reaches a level that jeopardizes the aquatic environment to a degree that threatens survival of juvenile salmonids that enter and utilize the habitat or degrades habitat for salmonids or waterfowl.
- Project goals would result in the maintenance of waterfowl habitat at or near existing levels. Declining waterfowl return numbers or pelecypod counts would not necessarily indicate a failure of the restoration project, but would be evaluated in light of changing conditions and restored

hydrology. Adaptive management triggers would occur in consultation with Refuge and NMFS biologists regarding necessary changes in hydrology and inundation extent and duration.

3.4.4. Reporting

Two site visit reports combined into one annual report would be produced as a result of monitoring at Post Office Lake. Annual Reports would include: project summary; monitoring day, date, and weather conditions; monitoring locations with GPS coordinates; and photos at each sampling location. Reports would also contain water quality readings, data on plant health for each species planted, low-flow hydrology discussion, and locations where exposed ground (if any) due erosion along the north connection channel or stream bank. The report component would also include the location, if any, of the presence of large woody debris that has entered the project area due to natural high-flow inundations.

A direct connection would be made between the performance criteria and the goals and objectives of the proposed ecosystem restoration project. At least 5 elements would be required within the report to clearly define the performance standards: (1) an identification of the habitat indicator (e.g., water depth, water quality, etc) that would support the juvenile salmonids; (2) the location of the monitoring site (sample or observation point); (3) the attribute to be monitored (e.g., density, % cover, size, etc); (4) the quantity or status (measurable status or degree of change of the attribute); and (5) the timeframe, noting when the observation took place so that comparisons can be made.

The performance measures would be used to guide site management activities during the monitoring period and to help evaluate project success and compliance with regulatory requirements. The monitoring allows for evaluation of the habitat conditions over time to determine if the expectations as described in this feasibility report are coming to fruition. This initial monitoring plan (i.e. Section 3.4) also serves to identify areas where adaptive management actions may be necessary, depending on results generated by monitoring the project. In the event that performance measures were deemed to adversely affect the project goals and objectives, then the project partner, stakeholders, and the Corps would evaluate the cause of the issue and determine the path forward to address any potential concern.

3.4.5. Monitoring Cost Estimate

Alternative 1 (no action): No costs for any year.

Recommended Plan (Alternative 5, suite of all measures): Estimated costs are shown in Table 12.

Table 12. Monitoring Cost Estimate for Recommended Plan

Activity	Year 1 ($)	Year 2 ($)	Year 3 ($)
Set up field sampling points: 8 hrs x $100/hr	800	--	--
Sampling: 1 low flow day and 1 high flow day; 32 hours (4 FTEs) at $100/hr	3,200	3,200	3,200
Reporting: 24 hours at $100/hr	2,400	2,400	2,400
Mileage: $60 per car per day (4 days)	240	240	240
Total Estimated Cost	6,640	5,840	5,840

It is possible that monitoring of the fisheries response would fall under the more intensive Columbia River Fish Mitigation program (CRFM), as an action effectiveness study. Additional monitoring indicators and derived variables would enhance and supplement the parameters described above. This would include additional information such as:

- Describe juvenile salmon feeding preferences in mainstem Columbia and backwater habitats.
- Compare relative productivity of mainstem Columbia to Post Office Lake and north connection channel areas.

As mentioned in the criteria discussions, the Corps would implement adaptive management actions if monitoring demonstrates that there is a discernible risk of juvenile stranding and mortality due to extreme water conditions. Pumping is also a contingency should the Refuge determine that the duration of dry conditions in the lake bed poses a considerable risk to pelecypod populations such that forage resources are put at risk. Pumping may be implemented during a 3-5 year drought scenario, or more frequently as needed.

3.5. PROJECT COST ESTIMATE

For implementation, the Corps considers the fully funded cost estimate. This cost estimate reflects expected inflation t midway through project construction. The fully funded cost estimate for the recommended plan (the preferred alternative, the suite of all measures) is shown in Table 13. The overall estimated cost of the Preferred Alternative, including the feasibility study cost, is $4,713,000. The cost estimate is broken down in greater detail in Appendix D for each project development stage and discipline.

Construction cost for Alternative 5 (the suite of all measures, the preferred alternative) is consistent throughout the report. Only the contingency and price escalation has been refined throughout the feasibility study.

- Earlier in Section 2.8 (see Table 7) and Section 2.9 (using spreadsheet to estimate total construction costs, with detailed assumptions), total construction cost was derived using:
    - Construction Cost = $2,105,379
    - Contingency = 5%
    - PED = 10%
    - Construction Management = 10%
    - Price escalation for project elements anticipated to be completed in fiscal year 2013 = 2.72%
    - Total Project Construction Cost = $2,793,058

- In this Section 3.5 (using MCASES), total estimated project cost was derived using:
    - Construction Cost = $3,763,000
    - Contingency = 24% derived from feasibility study abbreviated risk analysis
    - PED = 13%
    - Construction Management = 15%
    - Price escalation = 0.0%
    - Fully Funded Cost (including $800,000 feasibility study cost) = $5,897,000

Table 13. Fully Funded Cost Estimate, Preferred Alternative (Alternative 5, suite of all measures)

Cost Category	Estimated Costs ($1,000)
Total Construction Cost	3,763
Feasibility Study Cost	800
Lands and Damages	14
Planning, Engineering and Design	812
Construction Management	508
Total	5,897

NOTE: Costs include contingency (~ 25%) derived from the feasibility study abbreviated risk analysis; PED (10%); construction management (10%); and price escalation (0.9%) for project elements completed in subsequent fiscal year.

The fully funded cost shown in Table 13 does not include recurring O&M costs or costs associated with monitoring the ecosystem restoration project. The total annualized O&M cost is estimated at $4,000 (see Section 3.3 for further information on O&M project features).

3.6. DESIGN AND CONSTRUCTION SCHEDULE

Table 14 provides the completion dates for selected tasks for the recommended plan. For a detailed construction sequence and schedule narrative, see Appendix D.

Table 14. Project Schedule for Recommended Plan

Task	Date
Public Notice, Draft Implementation Document and Environmental Assessment	20 January 2013
Agency Technical Review	30 April to 10 August 2012
Plans and Specifications	30October 2012to 31 28 February 2013
Biddability, Constructability, Operability and Environmental (BCOE) Review	1 March to 15 April 2013
Incorporate BCOE and Review Comments	15 April to 30 April 2013
Plans and Specifications to Contracting	1 May 2013
Contract Advertisement	1 May to 1 June 2013
Bid Opening	2 June to 15 June 2013
Contract Award	30 June 2013
Notice to Proceed	14 June 2013
Construction (excavation and plantings)	17 June 2013 to 1 November 2013

It is important that planned activities and water levels are consistent with each other. Construction of the main implementation elements (north connection channel excavation and channel improvements, floodplain reconnection, levee roadway scarification) are currently planned to be implemented during July through October time period.

Exact IWWW are defined by NMFS and the State of Washington. Exact dates are known at this time and it is expected that a variance from the IWWW will be requested from NMFS and a variance from the closure restrictions from the Refuge, and coordination with the agencies is on-going. Additionally, the Refuge use period around Post Office Lake is dictated by wintering waterfowl management considerations. The schedule will be finalized by the time of project implementation.

3.7. SPONSOR RESPONSIBILITIES

The Section 536 authority allows for projects on federal land. These projects are sponsored by the agency that owns the land, which in the case of Post Office Lake is the USFWS. There is no cost share associated with the implementation phase of the project as well as O&M, as defined in the pending MOA. The Corps will fund the construction of the restoration action and USFWS will provide land and O&M requirements.

3.8. REAL ESTATE

A takings analysis was prepared by Seattle District's Office of Counsel. It concluded that no taking would result from the induced flooding and thus, acquisition of additional lands or real estate interests will not be required for the proposed project. (See Appendix F for more detail).

The following real estate acquisition will be required:

Clark County, WA Vacation of the Lower River Road/Highway 501 Right-of-Way along the entire west side of the Refuge (SE 1/4 Sec 12 T3 R1W WM).

3.9. ESTIMATED SURVIVAL BENEFIT UNIT CALCULATION

Because the Post Office Lake project lies within the lower Columbia River estuary, it is subject to ERTG scoring. These scores reflect progress towards the Action Agencies' required restoration projects in the estuary. As part of this project, the PDT used ERTG's spreadsheet calculator to estimate possible SBUs for the recommended plan. The ERTG used the module/Biological Assessment goals on acreages and survival benefits in terms of total possible fish numbers to compute a "module fish density" value (#/m^2). Then, the ERTG used existing literature to ascribe an "optimal fish density" value for each sub-action. A weighting factor was derived by dividing the optimal density by the module density. The weighting factor was incorporated into the calculator as another multiplier. Further explanation is located in the ERTG 2011 document.

For this project, the Corps input values for inundation and impact acreage as well as affected reach lengths (measured in miles). The inundation is based on an SBU profile defined by the Corps in February 2012 (Crain and Nygaard 2012). In an effort to quantify this ERTG guidance on determining inundation acreage, the Corps calculated the 50% annual expected probability stage for the lower Columbia River estuary (mouth to Bonneville dam). This was done by determining maximum water surface elevations along the reach annually for the period of complete main stem regulation and performing statistics on the annual dataset to determine a 50% annual expected probability stage.

The 50% annual expected probability stage profile was produced utilizing USACE approved programs, procedures and products. The HEC-RAS, HEC-DSS and HEC-SSP models are all on the Corps' Science and Engineering Technology Initiative approved software list. The HEC-RAS model was produced and calibrated with best available data. The procedure used to calculate annual expected probability follows Engineering Manual 1110-2-1415.

Other measurements were derived from Geographic Information System analysis and the most current site layout concepts. The SBU water surface elevation at Post Office Lake (RM 95) was elevation 18.7 feet. The resulting inundation within the Refuge boundary was estimated to be 130.6 acres (which is input under the "project goal" column). The PDT is also able to estimate values under "certainty of success," "potential access/opportunity" and "potential habitat/capacity." These are calculated via a second ERTG scoring worksheet that feeds values into the final score sheet. For more details, the scoring sheets have been provided in Appendix G.

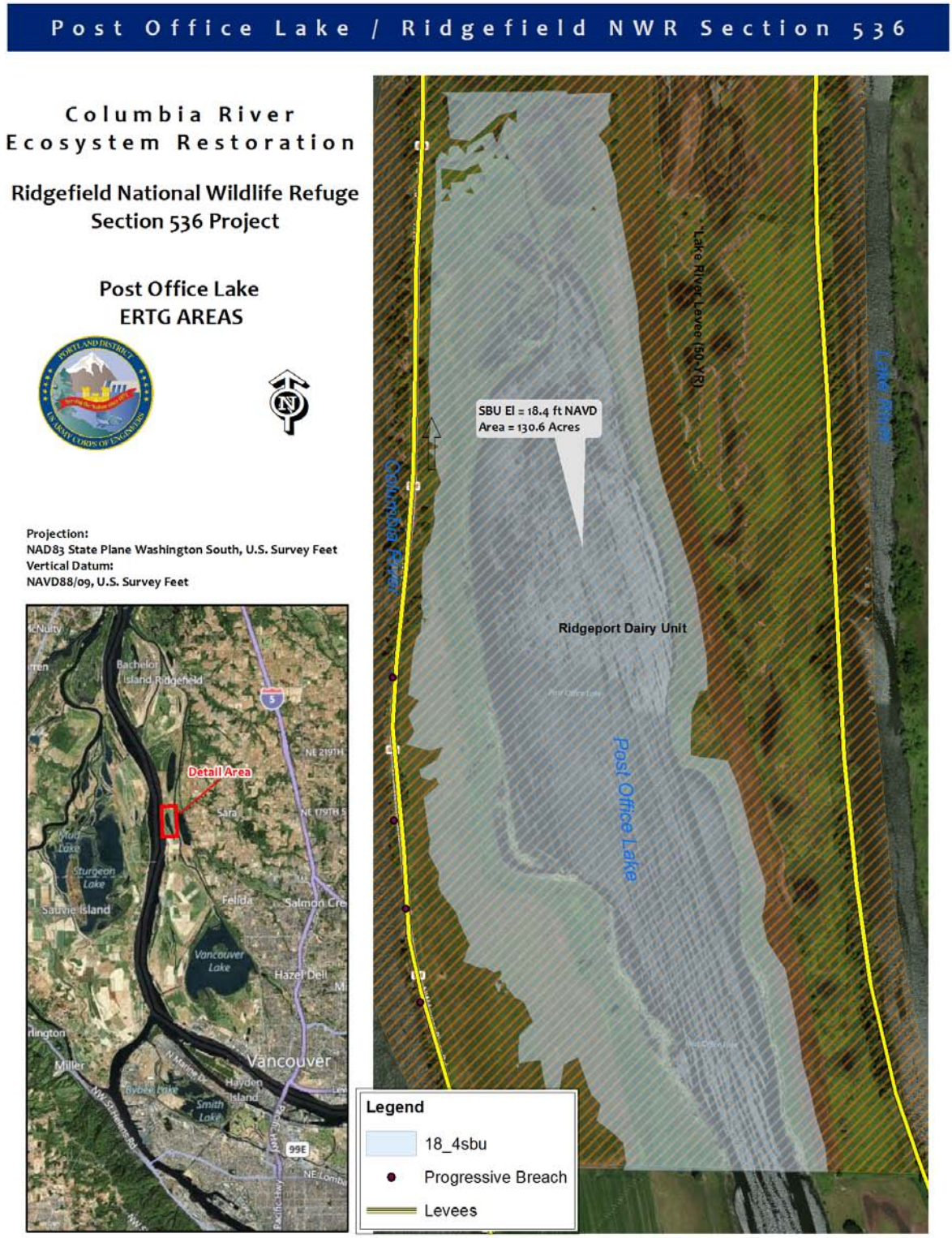
Table 15 summarizes the project's potential estimated ERTG score for the applicable CRE modules. After completion of the feasibility study, the required evaluation template will be prepared and submitted to the ERTG for assessment of a final SBU score. This proposal is estimated to generate about 4.3% ocean and 2.8% stream SBU credits towards the overall goals in the FCRPS BiOp

Table 15. Post Office Lake Potential ERTG Estimated Scores

CRE Module Description	CRE Module	Project Goal	Proportion of Certainty of Success	Proportion of Potential Access/ Opportunity	Proportion of Potential Habitat Capacity	Ocean	Stream
Breach dikes	10.1	130.6	0.74	0.8	0.71	0.899	0.277
Protect and restore riparian areas	1.4	1.2	0.66	0.8	0.69	0.006	0.006
Restore degraded off-channel habitat	9.4	0.46	0.74	0.8	0.69	0.003	0.002
Project Totals	--	--	--	--	--	**0.91**	**0.28**

The restoration project would provide benefits under restoration actions captured by CRE 10.1, 9.4, and 1.4. The benefit area is approximately 130 acres (per ERTG guidance) and is shown in Figure 17. The SBU credit was not claimed on Dusky Lake or the adjacent private properties to the south or north.

Figure 17. ERTG Benefit Area



4. AFFECTED ENVIRONMENT

4.1. PHYSICAL CHARACTERISTICS

4.1.1. Geology and Soils

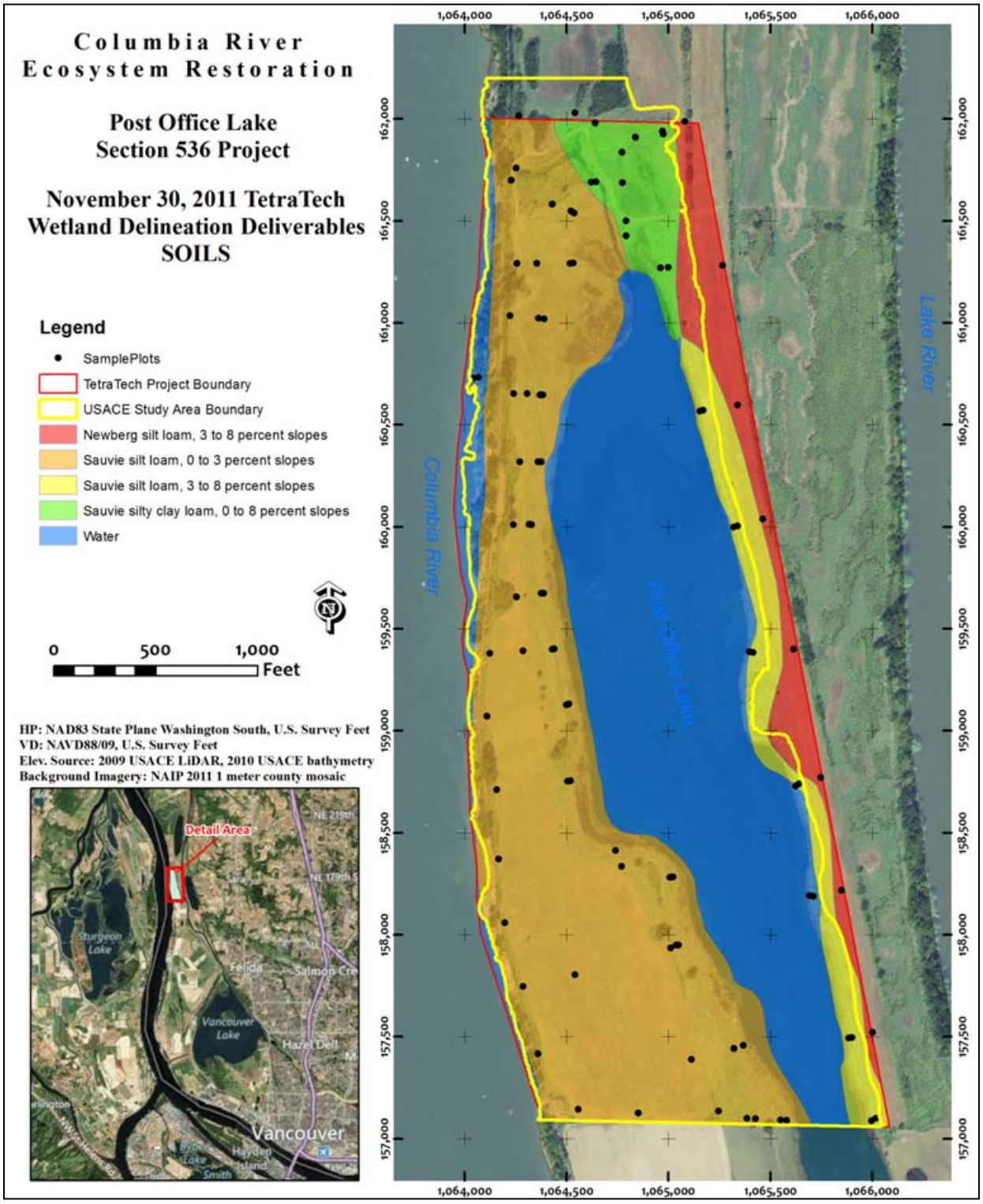
Soil maps by the National Resources Conservation Service show that topsoils of the Post Office Lake area contain mostly silt loams of the Sauvie and Newberg series. Sauvie soils are found on the broad tops of old natural levees on bottom lands along the Columbia River and in many depression areas. It is moderately well drained. Newberg soils occur chiefly on Columbia River bottom lands and where the Lewis and Washougal rivers join the Columbia River. The Newberg series consists of deep, well-drained, nearly level to gently sloping soils on floodplains. Figure 18 shows the soils in the project area.

Deeper soil conditions in the project area have not been explored. Based on well logs on record for Campbell Lake, which is to the north of Post Office Lake and exhibits similar elevations and geomorphology, the topsoils are likely underlain by clay soils low in permeability. The combination of well log data and soil survey data suggest that the transition from moderately well-drained topsoils to impermeable clay subsurface layers occurs between 6 and 9 feet in elevation. These soils create a confining layer, reducing subsurface drainage below the lake. Based on sampling and anecdotal evidence, there does not appear to be a strong subsurface connection between the lake and Columbia River. This condition is supported by anecdotal observations of Post Office Lake levels exhibiting a "muted" tracking of stages in the Columbia River during high flow and tide elevations during winter and spring. Anecdotal information indicates that lake levels remain higher in elevation through much of the summer and fall periods when Columbia River stage levels are below an elevation of 6 feet.

The Post Office Lake area is partially isolated from the Columbia River by a now defunct, non-federal flood control levee that was part of the Clark County Diking Improvement District Number 14 (referred to as the Columbia levee). In 1967, Highway 501 was constructed and extended adjacent to the Post Office Lake area. A soil blanket was spread in the area protected by the Columbia levee, but detailed information is not available. As discussed in Section 1, the portion of the levee adjacent to Post Office Lake was turned over to Clark County, who subsequently abandoned maintenance responsibilities. Construction materials for the levee, as well as the highway, are unknown, but visual site inspection of active levee erosion indicates that the original levee was constructed using local borrow material, topped in areas with what appears to be dredge disposal material, finally topped with road grade materials including asphalt. Pre-acquisition survey information from the Refuge for the Ridgeport Dairy Unit, including Post Office Lake, indicates that depression areas filled with dredged material may exist within the project site.

No other soil types were discovered during initial site investigations within the project boundaries; however, further investigations are warranted. A detailed geotechnical report would be prepared during the implementation phase of the project to confirm soil conditions and to provide more accurate excavation quantities and condition assessments (side slope stabilities, etc).

Figure 18. Post Office Lake Soils



4.1.2. Sediment Quality

Three locations on the western side of Post Office Lake between the lake to the east and the levee to the west were selected for sediment sampling based on past site use and potential future project conditions. A surface and subsurface sample were collected from each of these three locations on June 28, 2011 (see Appendix E). All sediment samples were submitted for physical and chemical analyses. The sediment quality guidelines used are those adopted for use in the *Sediment Evaluation Framework for the Pacific Northwest* (SEF 2009). The material sampled was classified as silty sand, poorly graded sand and silt with sand with an average of 21% sand and 79% fines. Six samples from each location were tested for metals, pesticides (DDT, DDE), polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), chlorinated hydrocarbons, phenols, phthalates, miscellaneous extractables, and total organic carbon.

Total organic carbon levels averaged 0.685%. Levels of metals were lower than SEF screening levels (SLs). Very low levels of DDT and DDE were detected in several samples but were well below SLs. No PCBs were detected in any of the Post Office Lake samples above the laboratory method reporting limits (MRLs). All MRLs for pesticides and PCBs were well below the SEF SLs. No chlorinated hydrocarbons were detected above MRLs in any sample; all were below the SEF SLs with the exception of 2.4-dimethylphenol, which was slightly above the SL of 29 micrograms per kilogram (ug/kg). The lack of other detected semi-volatile organic compounds and the low laboratory detection limits (5.5 ug/kg) make it highly unlikely that 2,4-dimethylphenol would be detected in any sample between 29 ug/kg and the non-detect levels of 34 to 40 ug/kg. Only very low concentrations of low- and high-molecular weight PAHs were detected in the samples. All PAH-detected values and MRLs were low and well below SEF screening levels. Six samples were submitted for total petroleum hydrocarbon identification. No gasoline-, diesel-, or residual-range organics were detected in any sample.

The Portland Sediment Evaluation Team reviewed the sediment quality data report described above and on September 29, 2011 determined that the sediments were suitable for unconfined aquatic exposure and placement. No additional sediment testing was considered necessary pending review of final project design. Results and further details are available in Appendix E.

4.1.3. Hydrology

The climate in the Post Office Lake project area is characterized by mild temperatures, wet winters, and relatively dry summers. The region is dominated by the maritime weather patterns developed in the Pacific Ocean located about 55 miles to the west (straight line). The Coast Range reduces the severity of the ocean storms coming inland resulting in a predominantly mild and rainy winter climate at the Refuge. Cold ‘snaps’ in the area are infrequent but develop as ‘arctic blasts’ originating from the north and east, and are funneled west through the Columbia Gorge. Days with temperatures below 32°F are infrequent and are usually associated with the strong east winds from the Columbia Gorge (USFWS 2010b).

According to the CCP (USFWS 2010b), prevailing winds are from the northwest from late spring through September. This cold and relatively dry air becomes warmer and drier as it moves inland, resulting in a dry season from late spring to September. Summer high temperatures during July and August are generally around 80°F. The drier conditions result in only 20% of the annual precipitation occurring between June 1 and September 30. Relative humidity is typically high in the winter and spring, but can reach single digits in the summer and fall months. Table 16 summarizes other climate and basin characteristics of the Post Office Lake site (source http://streamstatsags.cr.usgs.gov).

Table 16. Post Office Lake Climate Characteristics

Parameter	Value
Mean basin elevation, in feet (NAVD88)	12.7
Mean basin precipitation, in inches.	42
Maximum 24-hour precipitation that occurs on average once in 2 years equivalent to precipitation intensity index, in inches	1.69
Mean maximum daily January temperature, 1961-1990, in Fahrenheit	45.1°
Mean maximum January temperature, 1971-2000, in Fahrenheit.	45.3°
Mean minimum daily January temperature, 1961-1990, in Fahrenheit	32.5°
Mean minimum January temperature, 1971-2000, in Fahrenheit	33.8°
Average maximum air temperature in Fahrenheit	62.8°
Average minimum air temperature in Fahrenheit	43.2°
Percent of area covered by forest	5.57
Percentage of area covered by impervious surface area, from NOAA 1-kilometer sprawl impervious surfaces grid	1.01
Percentage of impervious area determined from National Land Cover Data (NLCD) 2001 dataset	0
Percentage of urban land cover determined from NLCD 2001 land cover dataset	0
Average soil permeability, in inches per hour	3.57
Available water capacity of the top 60 inches of soil - determined from State Soil Geographic (STATSGO) data, in inches	0.14

The Columbia freshet (spring snow melt) occurs in the months of May through June, depending upon snow pack and climatic (e.g., temperature) conditions in the basin. The freshet may be delayed through early to mid July. Extreme flood events can also result from wintertime flooding on major tributaries such as the Willamette River (e.g., February 1996 flood). This occurs when snow pack and frozen ground conditions that exist early in the winter season are melted by warm, moist air masses moving onshore from the ocean overtopping cold air from the Columbia River Gorge. Rapid snow melt and runoff result. The moist warm air adds volume to the flood deluges in the Columbia River.

4.1.3.1. Precipitation

Annual precipitation at the Refuge is approximately 42 inches, the majority (about 80%) falling as rain from October through April. More than half of annual rainfall occurs from November through February, and less than 7% of annual precipitation falls during June, July, and August. On average, precipitation greater than 0.50 inches occurs 30 days per year. The wettest season on record was the winter of 1996-1997, with 60.13 inches of precipitation between October 1996 and May of 1997. The wettest year on record, 1996, precipitation measured 64.39 inches. There was widespread flooding in 1996, with the highest floods on record for many southwest Washington rivers (see below). In 2004, the driest year, only 25 inches of precipitation was measured. The driest season was the summer of 1987, with only 1.84 inches of precipitation. Snow events are infrequent. Over the past 30 years, measurable precipitation as snow has occurred once every 6 years on average, which contributed to a 30 year average of 2.9 inches per year. A record monthly snowfall of 24.3 inches occurred in January 1980.

4.1.3.2. Historic Flooding

Columbia River annual maximum flood levels are associated with the spring snow melt in the Columbia Basin (Corps 1996). This occurs primarily in May and June but may extend into July in some years. There are 14 major flood control projects providing 39.7 million acre feet of flood storage. These projects provide important flood protection from winter rain and the annual spring melt runoff, freshet.

This represents approximately 41% of the average annual runoff at The Dalles, Oregon (Corps 1991a). Low average water levels at RM 95 range from a minimum of approximately elevation 5 to 6 feet during the summer months (August through end of October). The record has shown that February and March may experience low water levels (6-7 feet) if the local inflows (e.g., Willamette and Cowlitz rivers, etc) are low due to an abnormally dry winter.

However, the site experiences average stage elevations of 11 to 12 feet during winter and the freshet (November through June/July). The annual average river level for the Columbia River is usually elevation 9 to 10 feet. The average high stage associated with the freshet is elevation 13 feet with annual peaks of elevations 14 to 20 feet being experienced regularly every 2 to 5 years. The Corps accepted annual expected probability stage frequency for RM 95 ranges from a 50% chance or 2-year stage elevation of 18.7 feet to the 1% chance or 100-year stage elevation of 23.3 feet. The 0.5% chance or 500-year stage elevation is approximately 32.5 feet.

During the February 1996 flood, the river crested at just over elevation 26 feet. Overall damage to Clark County businesses, residences and infrastructure was estimated to be roughly $25 million. In the February 1996 flood, the Bachelor Island dike was overtopped and breached, inundating the entire island and all of its croplands (USFWS 2010b). Water was 15 to 20 feet deep in some fields. In December 1996, mild subtropical moisture once again led to extensive flooding. While the 1996 floods were devastating, the floods of December 1861 (the "Great Flood"), February 1890, and December 1964-January 1965 exceeded the 1996 events in terms of velocity and volume of water (Clark County 2009). During the Christmas Flood of 1964, the Columbia River reached elevation 27.6 feet at Vancouver causing $157 million in damage and the loss of 47 lives in Clark County and the Portland metro area. Major spring floods have also occurred on the Columbia River during years of unusually heavy snowpack, followed by heavy spring rains. In June 1894, the Columbia River reached elevation 33.6 feet at Vancouver, the highest flood stage ever recorded there. Actionable stage is elevation 16 feet, beginning of flooding is elevation 17 feet, and moderate flood damages result at elevation 20 feet (see http://water.weather.gov/ahps2/hydrograph.php?wfo=pqr&gage=shno3&toggles=&view=1,0,1,1,1,1,1,1).

4.1.3.3. Intertidal Regime

Maximum tidal effects on the Columbia River occur from the coast to about Longview, Washington, at approximately RM 66. Tidal effects progressively diminish proceeding upstream. The maximum tidal range for Post Office Lake (RM 95) is 2 to 4 feet (average), which occurs during winter. A typical yearly tidal cycle is shown in Figure 19 and the typical diurnal tidal cycle for December is shown in Figure 20.

Figure 19. Year-long Tidal Cycle at Vancouver, Washington

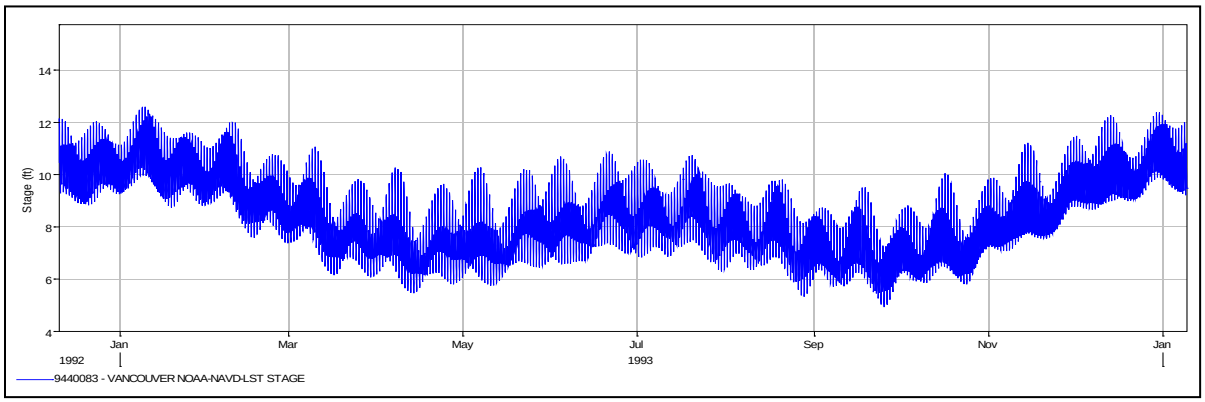
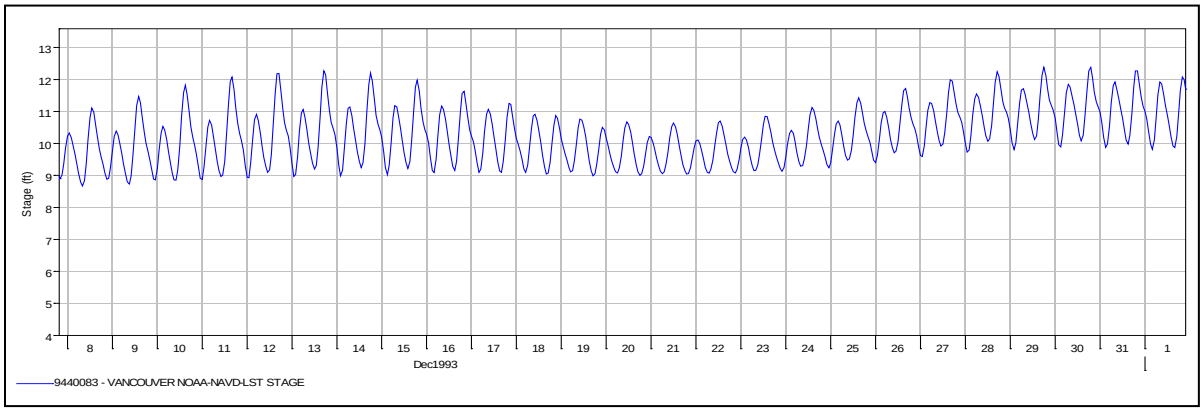


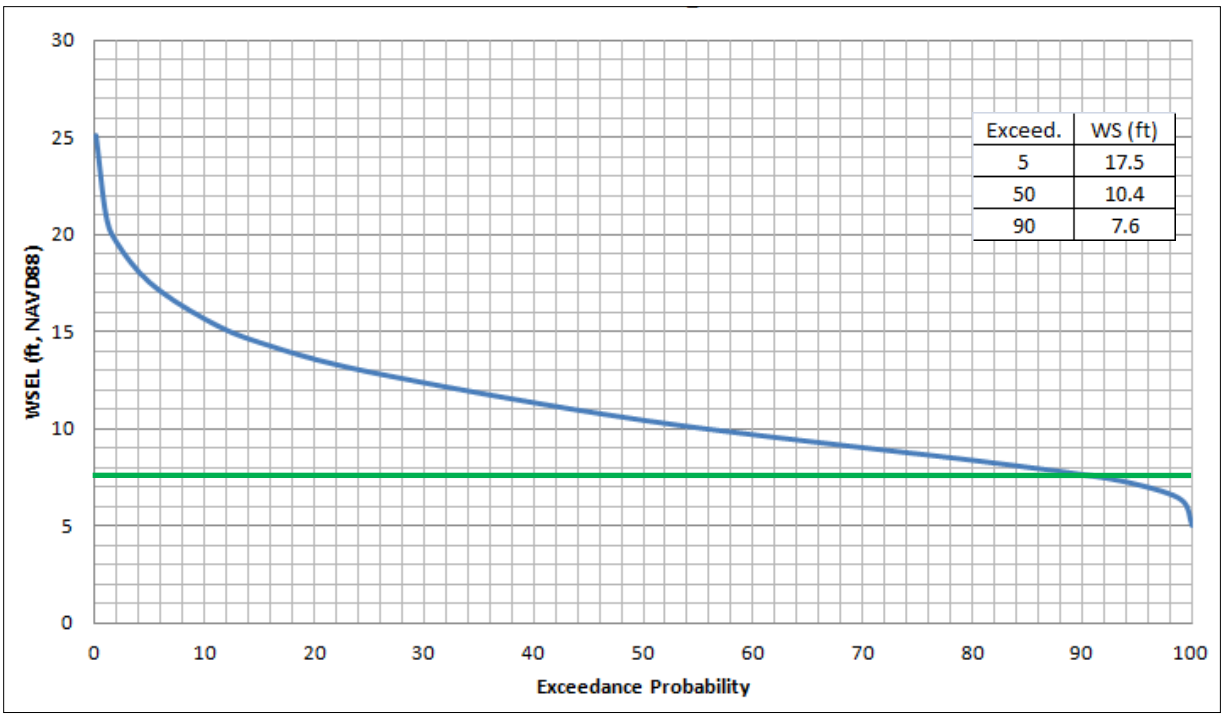
Figure 20. Diurnal Tidal Cycle at Vancouver, Washington



Note: Stage is water surface elevation in the NAVD88 vertical datum.

Figure 21 graphically summarizes the annual stage duration for the project area. The duration data was based on NOAA stage gages at Saint Helens (#9439201) and Vancouver (#9440422). Additional data derived from a 37-year HEC-RAS model run (October 1972 to September 2010) of the lower Columbia River (Crain and Nygaard 2012) were also utilized to improve definition of historic high flows. The two sets of data were compared and found to agree well. The differences were observed in the high stage data frequency because the HEC-RAS run had several additional high stage events incorporated. For calculation purposes, the RAS time series at RM 95.1 was used as input into the salmonid HEP/HSI benefit models.

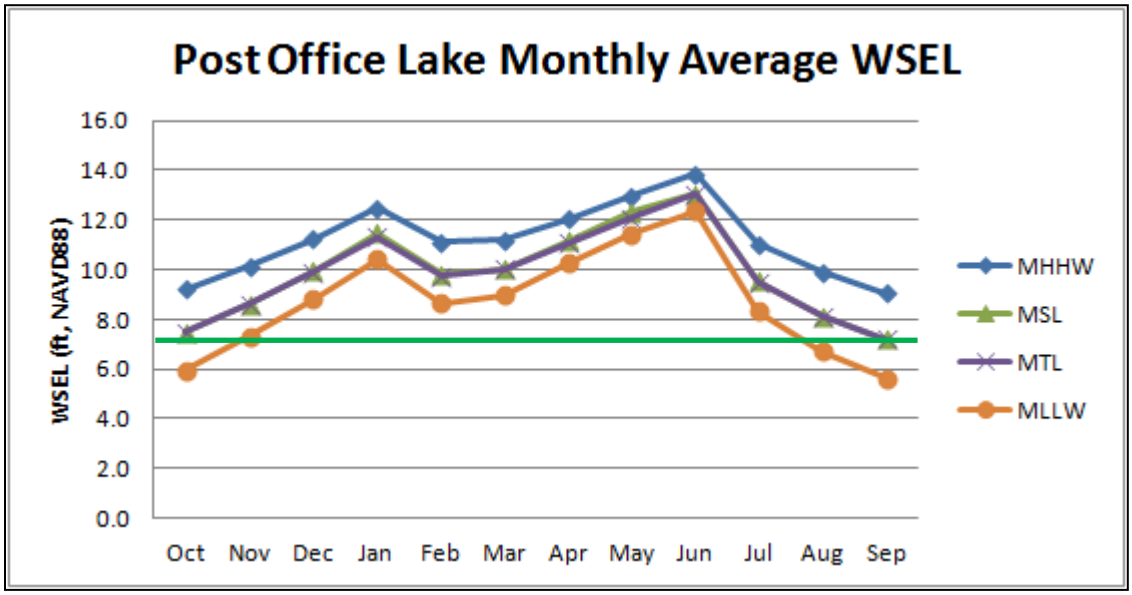
Figure 21. Post Office Lake Stage Duration Curve



WSEL = water surface elevations

The monthly average water surface elevations are shown in Figure 22 and this data is also based on the two NOAA stage gages. The green line represents a threshold, the bottom of lake elevation at 7.5 feet. Note that the dry period (lower than bottom of lake elevation 7.5 feet) occurs on average during August to October, although dry periods could begin earlier and end later (e.g., June and November, respectively).

Figure 22. Post Office Lake Monthly Average Stages



WSEL = water surface elevations; MHHW = mean higher high water; MSL = mean sea level; MTL = mean tide level; MLLW = mean lower low water.

For analysis purposes, the MHHW and MLLW were determined by taking the mean monthly highest MHHW and average of the MLLWs. The lowest MLLW occurs at Columbia River water surface elevation 6.7 feet in September. However, this is below the invert of the lake bottom; thus, it was appropriate to use the average of the monthlies. Therefore, the MHHW and MLLW are defined for this site to be at elevation 13.9 feet and elevation 8.7 feet, respectively.

4.1.4. Climate Change

In the Pacific Northwest, climate change may play an increasingly important role in determining the abundance of ESA-listed species and the conservation value of designated critical habitats. Such change would also affect the quality and success of ecosystem restoration projects. During the last century, average regional air temperatures increased by 1.5°F, and in some areas increased up to 4°F (USGCRP 2009). Warming is likely to continue during the next century as average temperatures increase another 3°F to 10°F (USGCRP 2009). Overall by the end of this century, about one-third of the current cold-water fish habitat in the Pacific Northwest is likely to exceed key water temperature thresholds (USGCRP 2009). For this reason, projects focused on restoring salmonid habitat are particularly important.

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 may cause earlier runoff so stream flows in late spring, summer, and fall may be lower and water temperatures warmer (ISAB 2007, USGCRP 2009). Restoring floodplain connectivity will help temper some of these flows by providing storage capacity as well as off-channel flood refugia.

Higher winter stream flows increase the risk that winter floods in sensitive watersheds may damage spawning redds and wash away incubating eggs (USGCRP 2009). Earlier peak stream flows may also flush some young salmon and steelhead from rivers to estuaries before they are physically mature, increasing stress and the risk of predation (USGCRP 2009). Lower stream flows and warmer water temperatures during summer may degrade summer rearing conditions, in part by increasing the prevalence and virulence of fish diseases and parasites (USGCRP 2009). Other adverse effects likely include altered migration patterns, accelerated embryo development, premature fry emergence, and increased competition and predation from non-native species (ISAB 2007). Restoration of Post Office Lake is expected to provide flood refugia and rearing habitat, and restoring the tidal regime will help reduce the risk of limited water quality conditions that could increase stress and predation in the lake.

The earth's oceans are also warming with considerable inter-annual 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).

4.1.5. Floodplains

Post Office Lake is completely within the Federal Emergency Management Agency's (FEMA) regulatory 1% chance exceedence (100-year) floodplain. Post Office Lake is centered at approximately Columbia RM 95 and is subject to tidal fluctuation. The tidal range is approximately 2 to 4 feet. Stage frequency relationships were developed by the Corps. Combined probability flood profiles were produced for the lower Columbia River based on unsteady flow model results and statistical analyses. These data describe the possibility of large (peak) flood events occurring over a period of time, along with the corresponding water surface elevation. These data do not include low-flow events or average yearly flows.

The profiles were useful indicators for expected probability and defining of critical flooding events for the lake/river reconnection. The elevations were used for regulatory flood impacts assessments such as defining potential easement limits (note that FEMA 100-year base flood elevations and Corps 100-year profile elevations are the same at this site) but also had bearing on determining acceptable invert elevations at the channel outfall (existing culvert location), breach overtopping elevation (at RM 95.1 where the existing levee has been eroded), as well as the topographic sill elevation at the north end of Post Office Lake. The applications are described in more detail in subsequent sections of this report. Table 17 summarizes the flood frequency elevations computed for Post Office Lake.

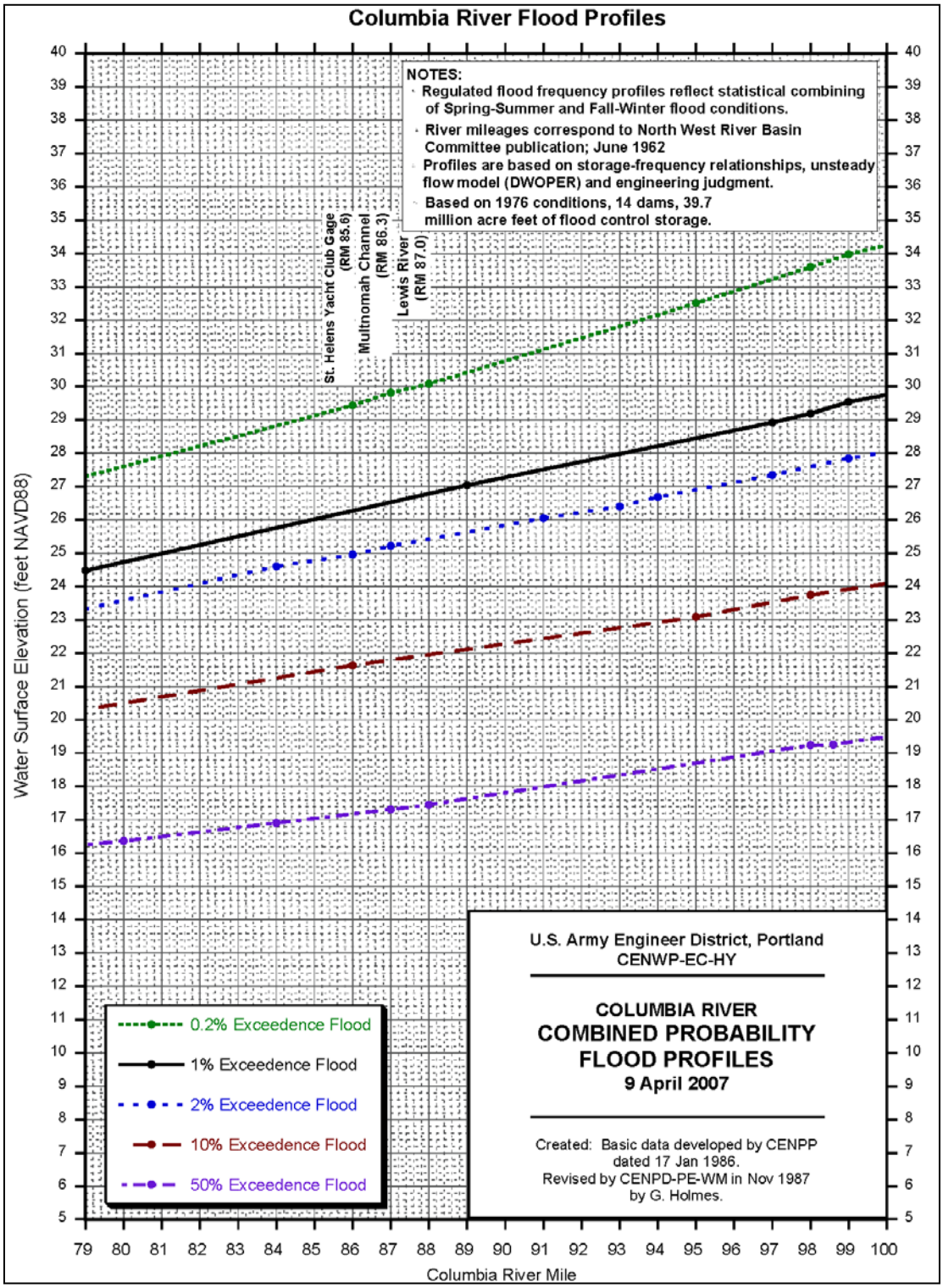
Table 17. Combined Probability Flood Elevations at RM 95.1

Event Frequency	Water Surface Elevation (feet NAVD88)
2-year (50%)	18.72
10-year (10%)	23.11
50-year (2%)	26.93
100-year (1%)	28.48
500-year (0.2%)	32.55

From this set of elevation-frequency information, the breach-overtopping elevation was determined by interpolation, and the frequency was determined to correspond to the 4.8-year return period river stage or

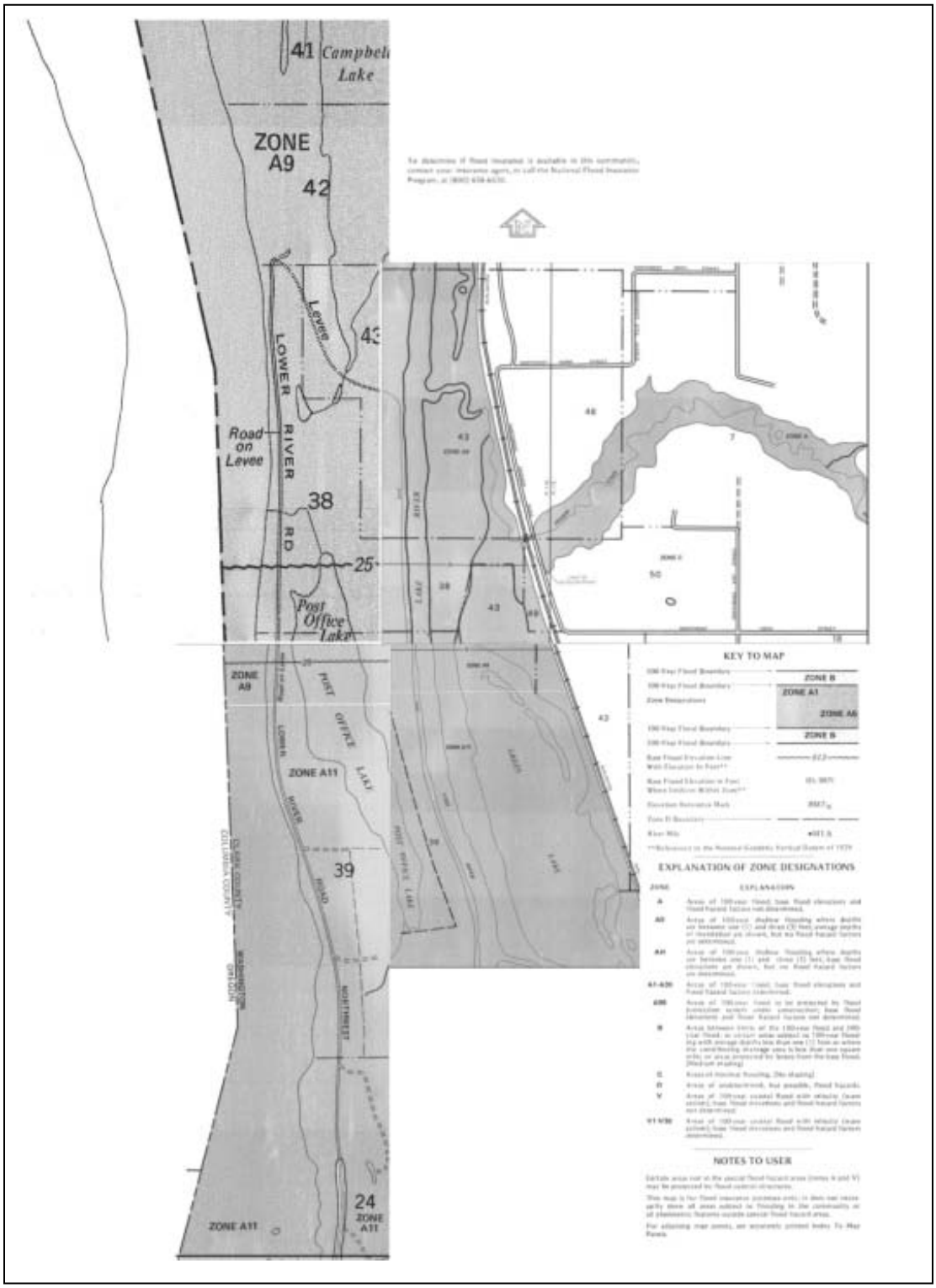
21% exceedence frequency). The Corps 2-year return interval (50% frequency) at RM 95 is elevation 18.7 feet as shown in Figure 23.

Figure 23. Columbia River Flood Profiles (RM 79-100)



The base flood elevations are denoted on FEMA FIRM panels 5300240150C, 5300240260C and 5300240276B; Figure 24 shows the FEMA 100-year floodplain limits.

Figure 24. FEMA Floodplain in Post Office Lake Area



4.1.6. Water Quality and Quantity

Construction of the Columbia and Lake River levees around the west and east edges of Post Office Lake have altered the connectivity of the inland wetlands and intertidal channel to the Columbia River. Direct fill, siltation, tilling for crops, and trampling by cattle have degraded historic tidal habitat. The culvert/tide gate on the north end of the lake eliminated intertidal connectivity.

The Post Office Lake property has historically been used for farming (on the southwestern portion), a dairy operation (on the northwestern portion) and, most recently, as a foraging area for geese. The area immediately around the lake, and east of the levee, is dominated by reed canarygrass that is regularly mowed to provide foraging habitat for geese that frequent the Refuge.

According to the Washington Department of Ecology (WDOE) 2008 Water Quality Assessment online query tool (accessed 4/20/11), in the stretch of the Columbia River in Clark County (to which the Refuge is adjacent and will become tributary in the event of a levee breach), the river is classified as water quality limited under the Clean Water Act Section 303(d) list of impaired water bodies for temperature, fecal coliform, dissolved oxygen, and invasive exotic aquatic plant species. There is also an approved U.S. Environmental Protection Agency (EPA) Total Maximum Daily Load (TMDL) for dissolved gas and dioxin, and the reach is listed as "of concern" for pH. Post Office Lake is not currently listed on the Section 303(d) list. A snapshot of water quality data for the lake was obtained via sampling in fall 2011 and can be found in Appendix E.

According to the final Water Quality Evaluation Report, the overall average temperature for Post Office Lake was about 66.1°F (18.94°C) with average DO at 7.4 milligrams per liter (mg/L). Both of these values were well within the SI range for salmon. Further, below depths of about 2 feet the temperatures dropped quickly from about 69°F to as cool as 60°F at about four feet deep. A temperature decrease of nearly 9°F within a 2 feet drop in depth indicates the lake was stratified with a distinct thermocline beginning 2 feet below the surface. Though this was a single snapshot taken during the daytime, it does indicate that conditions may be suitable for juvenile salmonids under the current hydrologic regime; however access is not available. It also may indicate that excavation of pocket pools at the north outlet of the lake could provide adequate thermal refugia, though mixing is expected to occur more than under current conditions. It is also notable that DO measurements were not taken in the evening, when a shift from photosynthesis to respiration may result in levels outside of salmon-suitable ranges.

4.1.7. Hazardous, Toxic and Radioactive Waste

Although the project site is located within an National Wildlife Refuge, historically the lands have been owned by others and may have been subject to contaminant sources. According to USFWS, many sites in the Portland-Vancouver area have experienced contaminant issues related to the Columbia River and Lake River. The Post Office Lake area has long been bound by levees limiting the influence that Lake River and the Columbia River have on this area. The area also has been used as agriculture/pasture land prior to becoming part of the Refuge. Considering this history, pesticide usage and presence of compounds such as DDT in other nearby historic agricultural lands was a concern. If soils were contaminated, increased exposure to fish and wildlife could pose a discernible risk. As discussed in Section 2.1.1, three locations in the project area were selected for soil sampling based on past use and potential future project conditions. A total of six samples were submitted for physical and chemical analysis and results indicated that all contaminants were well below levels of concern (see Appendix E).

Documents prepared for USFWS acquisition of the Ridgeport Dairy Unit (1989 and approved 1991), including Post Office Lake, indicate an onsite presence of minor household and farm-type waste

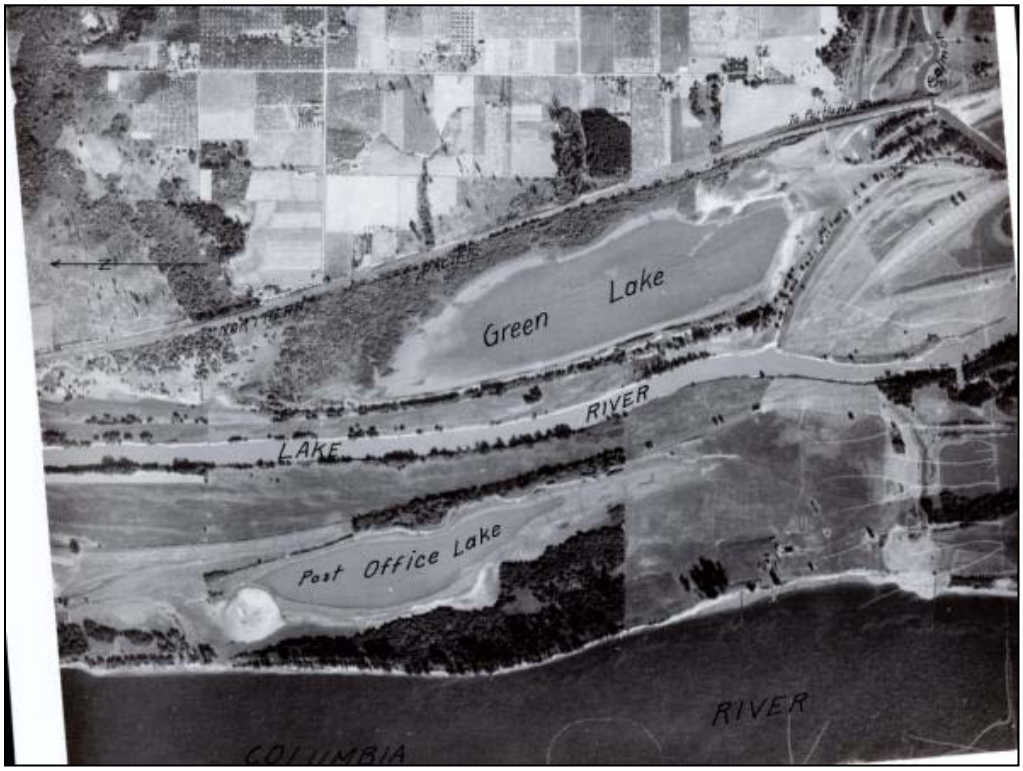
materials, two areas of dredge material fill, two above ground gasoline storage tanks, buildings/structures containing sprayed-on asbestos fireproofing and electrical power lines across the property. The document determined that, "Overall, the pre-acquisition survey did not identify any contaminant sources of concern…we believe that this property will not pose any contaminant threat to fish and wildlife or be a liability to the Service. No evidence of significant pollution sources or contaminant damage was found on the 508-acre tract, nor does historical information indicate any significant exposure to hazardous materials." The Level 1 contaminant survey and approval letter is located in Appendix E.

4.2. AQUATIC AND RIPARIAN HABITAT

The following review of biological resources and information is taken directly from the May 2010 *Ridgefield National Wildlife Refuge Draft Comprehensive Conservation Plan and Environmental Assessmen*t (noted as Draft CCP in this report, USFWS 2010a). This reference should be considered a citation for all of the following biological survey information about the Refuge and Ridgefield Dairy Unit where Post Office Lake is located.

According to the summary of accounts in the Refuge CCP, the vegetative communities at the Refuge and in Post Office Lake have been drastically transformed since Euro-American settlement in the 19th century. Although Native Americans inhabited parts of the Refuge and likely managed portions of it through periodic burning and harvesting, their populations were small and management minimal in comparison to subsequent changes. Vegetative communities historically may have been composed of wapato in the river bottoms and islands, with thick growths of cottonwood, ash, and willow. In addition, bottomland forests were interspersed with sloughs, shrub and willow swamps, overflow lakes and ponds, and wet meadows. As late as the 1930s, historical photos (Figure 25) indicate swathes of remaining riparian forest adjacent to Post Office Lake.

Figure 25. Post Office Lake 1929



Note the extensive riparian vegetation on the east and west sides of Post Office Lake and that the north inflow channel is at its approximate current location.

The transformation that occurred had multiple causes, including the heavy harvest of beaver, which prior to their reductions had helped maintain the wet landscapes. Another cause was the development of agriculture, which drained, filled, leveed, and cleared the landscape, drastically altering hydrologic regimes and vegetative communities.

Grazing caused further modification and facilitated the establishment and spread of non-native and invasive species like reed canarygrass such that the native understory plant community was replaced. Hydropower and diking along the Columbia River reduced scour and altered hydrographs, sediment transport, and flow patterns. These actions reduced recruitment and establishment of woody riparian vegetation and riverine wetlands, while also changing channel, ponding, and wetland forming processes. Finally, urban and industrial development has had direct and indirect effects on the vegetative and ecological communities at the Refuge via the hardening of banks, accelerated bank erosion from boat wakes, dredging, and channelization.

At the Ridgeport Dairy Unit, grazing was phased out in 1996 and then reintroduced as a limited management tool in 2003. Between 1998 and 2000, the Ridgeport Dairy Unit underwent a massive wetland restoration effort that resulted in construction and rehabilitation of contour dikes, a main delivery canal, installation of water control structures and pipeline, and disking of 450 acres of reed canarygrass. Water depths are managed by these structures and periodic irrigation occurs, mostly north of Post Office Lake in the Dusky Lake Unit. By 2009, some of the unit (~30 acres) had been planted in corn with the area around Post Office Lake currently managed as improved pasture for other geese. This is flanked in the north by an area managed as early successional floodplain forest, and on the east by an old field.

Future management plans expand the improved pasture to the east and change the focus to specify management for dusky Canada geese. Management at the adjacent northern border would change from early successional floodplain forest to wet meadow management.

The Refuge manages several riparian areas to reduce successional development and to maintain open water and longer sight distances preferred by waterfowl. There is also a federally threatened plant, the water howellia (*Howellia aquatilis*), which has been identified as a priority resource of concern, but no known occurrences are in or near the project impact area. The Refuge also attempts to address any exotic and invasive species that occur in the riparian and wetland systems.

Habitat and vegetation inventories, surveys, and monitoring that have been conducted on the Refuge include water howellia and wetland plant surveys, pasture vegetation monitoring, Lower Columbia River Natural Area Inventory, Columbia River Riparian Habitat Inventory, as well as multiple invasive species monitoring and eradication projects. There has also been some consideration and implementation of experimental plant reintroduction of the federally endangered Bradshaw's lomatium (4-71 CCP, USFWS 2010b) and threatened Nelson's checker-mallow in 2007 and 2008. In 2007, the Refuge worked with the Service's Ecological Services offices and the Washington Natural Heritage Program to outplant 1,000 seedlings of Nelson's checkermallow. The initial planting occurred in fall 2007, with subsequent plantings conducted in following years. Experimental plantings were done in Smith Lake Field (11.5 acres) and Hundred Acre Field (43.6 acres) on Bachelor Island; and Texas Island and the Kiwa Trail on the River 'S' Unit (p2-58 CCP, USFWS 2010b). Some checker-mallow plants were found in subsequent surveys (p 4-76 CCP, USFWS 2010b). Within the River 'S' and Bachelor Island Units, the Service has established populations of the Federally-listed threatened Nelson's checkermallow by planting individual seedlings in three separate pasture sites (pB-52, CCP, USFWS 2010b). The current CCP also mentions intent to identify appropriate locations for reintroduction of these species. An evaluation of the refuge indicated that some marginal habitat for Bradshaw's lomatium was present along the Auto Tour Route, and seeding occurred in 2007. No plants have been detected during subsequent visits and no replanting has occurred (4-77 CCP, USFWS 2010b). The proposed action would occur on the Ridgeport Dairy unit, which is not in the vicinity of these plant species.

4.2.1. Wetlands

According to the Refuge CCP (USFWS 2010a), little is known about the submerged vegetation and other aquatic species occupying Post Office Lake. Recent investigations have determined that marsh habitat in the lower Columbia River estuary exists, on average, between elevations 6.69 and 11.25 feet (Borde et al. 2011). The marsh zone at nearby Campbell Lake and Slough lies between elevations 8.03 and 13.18 feet and is dominated largely by sedges and willows. This information supports the earlier soil/sediment discussion that clay zone starts at approximately elevation 9 feet.

In its current, state, Post Office Lake is considered a permanent, lacustrine wetland with a moderate to dense stands of sago pondweed with small patches of curly-leaved pondweed, coontail, smartweeds, and milfoil. Emergent aquatic vegetation consists of the following species: spike rushes, swamp smartweed (*Persicaria hydropiperoides*), nodding beggartick (*Bidens cernua*), , duckweed, cattail, spotted ladysthumb (*Polygonum persicaria*), bur-reed (*Sparganium* spp.), The presence of these species would vary with water depth and hydro-period, depending on wetland type and management strategy. The exact composition of wetland points can be found in the wetland delineation data.

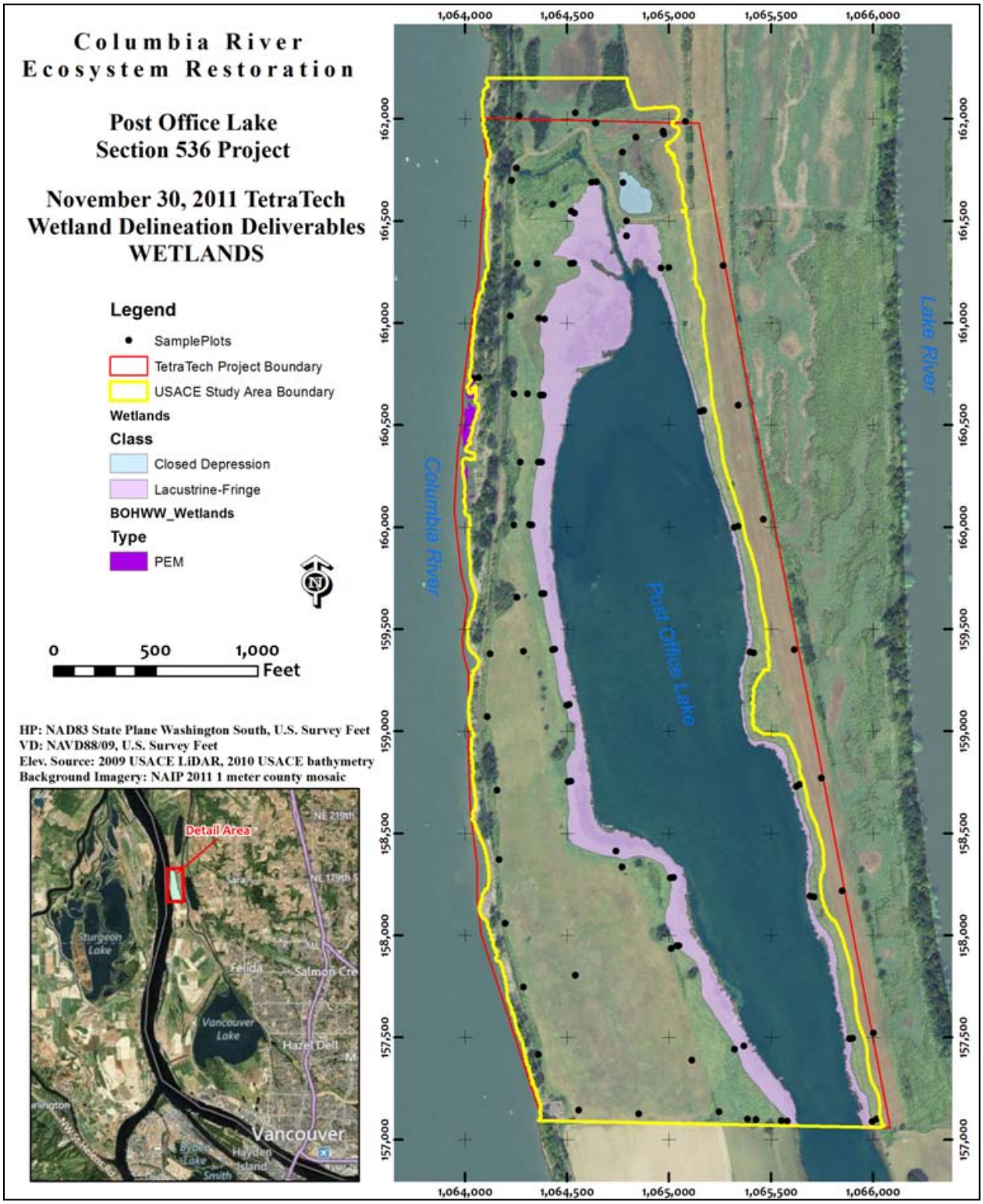
Management objectives described in the CCP for semi-permanent wetland plant species include maintaining coverage of 60% to 80% of native annuals and submergents, with 20% to 40% cover of tall persistent emergent species (cattails, hardstem bulrush, wapato, and bur-reed). Management objectives

for permanent wetland plant species include open water and native submergent coverage of 70% to 75% during peak water elevations, with less than 25% coverage of emergent vegetation. For permanent wetlands, there is also a desire to limit woody vegetation like willow and spirea, as well as monocultures of tall persistent emergent vegetation and smartweeds. The presence of carp in adjacent water bodies is a concern because carp can severely damage submergent and emergent aquatic vegetation, which also serves as an important component of the food web for many waterfowl and other aquatic species. Reed canarygrass is another invasive species that out-competes native aquatic vegetation. These invasive species are difficult to manage successfully when maintaining or restoring wetlands.

A wetland delineation and functional analysis was conducted in October 2011 (Corps 2011c) and further characterized wetlands in the Post Office Lake area. The delineation was required for permitting (WDOE) and NEPA compliance documentation. The delineation was necessary to assess the baseline habitat conditions with the level of detail sufficient to evaluate ecological effects. The wetland delineation (Figure 26) evaluated wetlands within a 175-acre study plot that consisted of mostly uplands (denoted with a red line in the figure). The boundary used to identify the study area is denoted with a yellow line in the figure. Six wetlands were delineated in the study area: one lacustrine-fringe wetland surrounding the perimeter of the lake (wetland 1), two closed depressional/flats wetlands situated northeast of the lake (wetlands 2 and 3) and three riverine/freshwater tidal wetlands located immediately adjacent to the Columbia River west of the study area (wetlands 4, 5 and 6). The three riverine wetlands are located below OHW and thus, fall under the jurisdiction of the WDNR. For this analysis and evaluation of habitat benefits, wetlands 4-6 are not being considered as part of the wetland matrix associated with Post Office Lake because proposed alternatives will have no effect on these areas (these wetlands are not discussed further). A total of 19.0 acres of wetland and 63.7 acres of other waters of the U.S. were identified in the survey area. All riverine/freshwater tidal wetlands, totaling 0.37 acres, were found below the OHW mark adjacent to the Columbia River and could alternatively be considered other waters of the U.S.

Based on Corps' regulations, OHW is, "that line on the shore established by the fluctuations of water and indicated by physical characteristics such as clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas." Given the presence of shelving, litter and debris, matted vegetation and the transition between plant communities, the OHW for the Post Office Lake area was determined to be elevation 12 feet.

Figure 26. Wetland Delineation for Post Office Lake



Wetland 1 (18.03 acres in area) varies considerably in width around the perimeter of the lake. Of the three indicators supporting wetland characteristics (hydrology, vegetation and hydric soils), hydrology was the strongest indicator. Wetland 1 is below elevation 14 feet. Soil saturation in the sample plots was apparent above 12 inches, and standing water was present in most areas. In some cases, coloration of the soil did not meet hydric requirements, but the presence of hydrogen sulfide provided strong evidence that soils were hydric. In addition to the hydrologic and soils features, vegetation was strongly hydrophytic (thrives in wet conditions). The dominant vegetative cover consists of reed canarygrass (almost 100% absolute cover) and cattail (*Typha latifolia*) , along the east and west sides of the lake. Reed canarygrass is a vigorous wetland species that is known to grow in both wetland and upland areas, and is adapted to a wide range of soil conditions. Soft rush (*Juncus effusus*) was mixed in with the reed canarygrass near the north end of the lake and along the north channel.

Wetlands 2 and 3 (total 0.61 acres) are located in slight topographic depressions north of Post Office Lake and east of the outlet channel. Vegetation was the strongest indicator of wetland characteristics, in addition to evidence of ponding supporting hydrologic characteristics. The vegetative community of Wetland 2 was dominated by reed canarygrass, but also supports swamp smartweed and poison hemlock (*Conium maculatum*). Wetland 3 is similarly dominated by reed canarygrass, but also contained soft rush, arctic rush (*Juncus arcticus*) and curled dock (*Rumex crispus*). Both wetlands fell above elevation 14 feet and evidence of wetland hydrology was present in the form of ponding, soil saturation, drift deposits and drainage patterns. Soil pits revealed hydric coloration and the presence of a depleted matrix.

The wetland boundaries for each of wetlands 1-3 were delineated primarily by hydrology and secondarily by vegetation and soil condition. According to the wetland classification by Cowardin et al. (1979), Wetland 1 is classified as a palustrine, emergent, persistent, seasonally/flooded/saturated wetland (PEM1E). Wetlands 2 and 3 are classified as palustrine, emergent, persistent, seasonally flooded wetlands (PEM1C). The determination forms and wetland rating forms for all delineated wetlands in the Post Office Lake study area are available with the wetland delineation report in Appendix E. Wetland ratings (Hruby 2004) were calculated for each wetland identified by this delineation. All of the wetlands received a functional rating of Category IV, with the exception of the lacustrine-fringe wetland 1, which was rated as Category III.

Based on historic aerial photography, it was initially thought a large portion of the study area had been previously farmed. Under the Clean Water Act (CWA), Corps regulations for wetlands converted to agriculture lands prior to 1985 (commonly referred to as “prior converted croplands”) are exempt from CWA jurisdictions if the land remains in farmland and is subject to tilling and crop production at least 1 year out of every 5 years. Designated prior converted croplands are not considered wetlands and subject to CWA Section 404 regulation because the soils have been substantially altered and considered to be of low ecological value. During the site visit, there was evidence of mowing, but no evidence of continued and/or recent farming activities. Thus, it is presumed that the wetlands delineated in this report are subject to CWA regulation.

4.3. AQUATIC RESOURCES AND WILDLIFE

4.3.1. Amphibians and Reptiles

Reptiles and amphibians that are known to occur on the Refuge include northern red-legged frog (*Rana aurora)*, Pacific chorus (tree) frog (*Pseudacris regilla*), northwestern salamander (*Ambystoma gracile*), long-toed salamander (*Ambystoma macrodactylum*), and western painted turtle (*Chrysemys picta*). These species are most closely associated with wetland habitats. Reptile and amphibian surveys were conducted in 1995-1997 (frogs and salamanders) and 1996-2001 (painted turtles). Additionally, a malformed

amphibian study was conducted in 2000 to determine the extent of abnormalities on national wildlife refuges. However, most of these surveys were focused on the River S and Bachelor Island units rather than Post Office Lake. The wetland management area north of Post Office Lake may have similar suitable habitat for the above listed amphibians, as do many areas within and around Post Office Lake; however, this has not been confirmed. Bullfrogs (*Rana catesbeiana*) also occur on the Refuge. They were introduced to the Pacific Northwest in the 1920s to be raised as food, but are problematic because they prey on native amphibians, turtle hatchlings, and even ducklings. The Refuge does not currently have a bullfrog control program. Unidentified garter snakes and frogs have been observed and heard in the project area, and it is assumed that the species composition in the unit would be similar to that described above and found in the rest of the Refuge in the wetland, riparian, and pasture habitats.

4.3.2. Fish

There are several exotic warm water fish species present at the Refuge. The warm, slow backwater habitats and reduced flooding regimes create ideal habitat for these species, which then prey on and/or outcompete with native fish, amphibians and turtles. Non-native species include, but are not limited to, brown bullhead (*Ameiurus nebulosus*), bluegill (*Lepomis macrochirus*), pumpkinseed (*L. gibbosus*), largemouth bass (*Micropterus salmoides*), smallmouth bass (*M. dolomieu*), black crappie (*Pomoxis nigromaculatus*), white crappie (*P. annularis*), goldfish (*Carassius auratus*), walleye (*Sander vitreus*), and American shad (*Alosa sapidissima*). Common carp (*Cyprinus carpio*) are also a widespread problem on the Refuge. They out-compete native species for aquatic invertebrates and destroy emergent aquatic vegetation while simultaneously degrading water quality. In the spring, they are most abundant and congregate in Gee Creek and Campbell Slough to spawn. The CCP mentions that Post Office Lake was drawn down in summer 2000 to control carp and other rough fish. The drawdown was partially successful as it is believed that there is only a small population of carp in the lake (Chmielewski 2012).

Fish surveys on the Refuge were conducted between 1993 and 2009 by both the Columbia River Fisheries Program Office and NMFS. Most of the survey work focused on the Carty Unit within the Gee Creek system, as well as Campbell Slough. In the Gee Creek system, coho, Chinook, and cutthroat trout were documented. Brook lamprey and smelt (eulachon) were also documented on Gee Creek. This remains a more riverine, tidally connected system relative to what is likely to occur at Post Office Lake. In contrast, Campbell Slough to Campbell Lake may be a more relevant reference for what is hydrologically possible at Post Office Lake. The NMFS surveys at Campbell Slough to Campbell Lake documented both juvenile Chinook and juvenile chum, among several non-native warmwater fish (Draft CCP, 4-76).

Table 18 shows the listed native anadromous fish species that may be present on the Refuge itself or within the Columbia River mainstem, to which Post Office Lake will become connected. Emigrating juvenile salmonids use backwater areas for off-channel resting and flood refugia. Rearing juveniles use off-channel habitat for further growth, over-wintering, and feeding prior to completing emigration to the ocean. It is also possible, though less likely, that upstream migrating adults could transiently use off-channel habitat for resting, holding, and flood refugia on their way to spawning grounds.

Table 18. Regional Fish Presence

Fish presence in lower mainstem Columbia River below Sauvie Island (CRM 87) (Columbia River-Baker Bay HUC #170800060501; Columbia River-Cathlemet Channel HUC #170800030701)

Sources: Bradwood LNG Project BA, June 2009
Eulachon Status Review Update (2010)
Good et al. 2005
WDFW (Brad James, Olaf Langness, and Steve West), ODFW (Tom Rien)

Internal Input: NWFSC (Curtis Roegner)
PRD (Marc Romano)

=present; = relatively abundant; = peak occurrence

Species	Life Stage	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Eulachon													
Southern DPS	Adult migration & holding[1, 2]												
	Adult spawning[2]												
	Egg incubation[3]												
	Larvae emigration												
Sturgeon: Green													
Southern DPS	Juvenile rearing[2]												
Salmon: Chinook													
Lower Columbia River	Adult migration and holding												
	Adult spawning												
	Eggs & pre-emergence												
	Juvenile rearing												
	Juvenile emigration												
Upper Columbia River	Adult migration and holding												
	Adult spawning												
	Eggs & pre-emergence												
	Juvenile rearing												
	Juvenile emigration												
Upper Willamette River	Adult migration and holding												
	Adult spawning												
	Eggs & pre-emergence												
	Juvenile rearing												
	Juvenile emigration												
Snake River - Spring/Summer	Adult migration and holding												
	Adult spawning												
	Eggs & pre-emergence												
	Juvenile rearing												
	Juvenile emigration												
Snake River - Fall	Adult migration and holding												
	Adult spawning												
	Eggs & pre-emergence												
	Juvenile rearing												
	Juvenile emigration												
Salmon: Chum													
Columbia River	Adult migration and holding												
	Adult spawning												
	Eggs & pre-emergence												
	Juvenile rearing												
	Juvenile emigration[4]												
Salmon: Coho													
Lower Columbia River	Adult migration and holding												
	Adult spawning												
	Eggs & pre-emergence												
	Juvenile rearing												
	Juvenile emigration												
Salmon: Sockeye													
Snake River	Adult migration and holding												
	Adult spawning												
	Eggs & pre-emergence												
	Juvenile rearing												
	Juvenile emigration												
Steelhead													
Lower Columbia River	Adult migration and holding												
	Adult spawning												
	Eggs & pre-emergence												
	Juvenile rearing												
	Juvenile emigration												
Middle Columbia River	Adult migration and holding												
	Adult spawning												
	Eggs & pre-emergence												
	Juvenile rearing												
	Juvenile emigration												
Upper Columbia River	Adult migration and holding												
	Adult spawning												
	Eggs & pre-emergence												
	Juvenile rearing												
	Juvenile emigration												
Upper Willamette River	Adult migration and holding												
	Adult spawning												
	Eggs & pre-emergence												
	Juvenile rearing												
	Juvenile emigration												
Snake River	Adult migration and holding[5]												
	Adult spawning												
	Eggs & pre-emergence												
	Juvenile rearing												
	Juvenile emigration												

[1] Eulachon Status Review Update, 20 January 2010. Available at: http://www.nwr.noaa.gov/Other-Marine-Species/upload/eulachon-review-update.pdf
[2] Personal communication. Conversation between WDFW (Brad James, Olaf Langness, and Steve West), ODFW (Tom Rien), and NMFS (Rob Markle, Bridgette Lohrman) regarding green sturgeon and eulachon presence in the Columbia River. June 23, 2009.
[3] Eulachon egg incubation estimated relative to spawning timing and 20 to 40 day incubation period.
[4] Carter et al. 2009 (Seasonal juvenile salmonid presence and migratory behavior in the lower Columbia River).
[5] Good et al. 2005 (Updated status of federally listed ESUs of West Coast salmon and steelhead

Citations:

Carter, J.A., G.A. McMichael, I.D. Welch, R.A. Harnish, and B.J. Bellgraph. **2009**. Seasonal juvenile salmonid presence and migratory behavior in the Lower Columbia River. PNNL-18246, Pacific Northwest National Laboratory, Richland, Washington. Available at: www.pnl.gov/main/publications/external/technical_reports/PNNL-18246.pdf.

FERC (Federal Energy Regulatory Commission). **2009**. Bradwood Landing Project biological assessment and Essential Fish Habitat assessment (Table 7.3.1-1). Available at: www.ferc.gov under accession #20090624-4002). Division of Gas-Environment and Engineering.

For the Post Office Lake project, the most likely species to utilize Post Office Lake are juvenile Chinook and juvenile coho, although previous surveys indicate chum were also present at Campbell Slough, which is close to Post Office Lake. Although the most likely evolutionarily significant unit (ESU) to be present is the Lower Columbia River ESU, other juvenile migrants from upstream could use the habitat transiently depending on the spring freshets and the need for flood refugia. Both emigrating and rearing juvenile salmonids may be present in the Columbia River year-round, with peak usage occurring in early spring through the summer months[1]. According to the USGS Water Quality Report (2010), references to NMFS data indicate juvenile salmonid presence was observed in Campbell slough into mid-July.

In order to avoid and minimize impacts to listed species, the WDFW and NMFS set and enforce IWWW that occur when vulnerable life histories are least likely to occur in a water body. According to WDFW guidance, times when salmonids are least likely to occur in Clark County generally ranges from July 16 - September 30 (WDFW 2010). The specific IWWW for the Columbia mainstem adjacent to Post Office Lake has two listings. One from WDFW is identified as August 1 - March 31 (http://wdfw.wa.gov/licensing/hpa/freshwater_incubation_avoidance_times_28may2010.pdf). However, NMFS and the Corps' Seattle District note that the Columbia mainstem IWWW adjacent to Post Office Lake is November 1 through February 28 (Fisher, NMFS personal communication on 3-12-2012, and see http://www.nws.usace.army.mil/PublicMenu/documents/REG/Waters_in_NPs,_CR,_SR_&_Lakes__2010-03-09_.pdf). For lakes, the IWWW is July 1- August 15 (see http://www.nws.usace.army.mil/PublicMenu/documents/REG/Waters_in_NPs,_CR,_SR_&_Lakes__2010-03-09_.pdf). However, for Lake River, which borders the Refuge on the east, the least likely timing for presence is January 1 - December 31 (WDFW 2010).

4.3.3. Birds and Mammals

As with changes to vegetative communities, habitat modifications have altered the faunal communities in the Columbia River Basin and at the Refuge itself. The processes and evolution described above reduced beaver and Columbian white-tailed deer (*Odocoileus virginianus leucurus*) populations, while conversely improving habitat for waterfowl, specifically geese. It is speculated that in the early 1900s, dusky Canada geese were previously more abundant along the coast and their wintering habitat has shifted inland towards the Willamette and lower Columbia River valleys as a result of increased pasture and seed production and a decrease in suitable habitat on the coast. The Refuge also hosts a plethora of other migrating and nesting waterfowl and bird species (see Appendix F of USFWS 2010a).

Refuge management has a strong focus on providing wintering habitat for dusky Canada geese and other waterfowl, as well as providing public waterfowl hunting opportunities. While preservation and protection of other fish and wildlife species is also part of the mission, additional species identified as management priorities include bald eagle, sandhill crane, great blue heron, peregrine falcon, shorebirds, marsh birds, and songbirds.

The Refuge has specific management strategies for species selected as priority resources of concern (ROC). These ROCs frame the development of goals and objectives for wildlife and habitat. The 15 priority species include dusky Canada goose, cackling goose, Savannah sparrow, northern harrier, mallard, tundra swan, lesser scaup, Canada sandhill crane, water howellia, coastal cutthroat (Southwest Washington/Columbia River ESU), Willow flycatcher, Swainson's thrush, Bewick's wren, slender-billed

1 Washington Department of Fish and Wildlife. 2010. Times when Spawning or Incubating Salmonids are Least Likely to be within Washington State Freshwaters.
http://wdfw.wa.gov/licensing/hpa/freshwater_incubation_avoidance_times_28may2010.pdf

white-breasted nuthatch, and the orange-crowned warbler. Based on the ROCs, the associated types of supporting habitat were categorized in the CCP and include improved pasture and cropland, native grasslands, upland dry prairie, bottomland wet prairie, wetland and deepwater habitats, riparian and floodplain forests, Oregon white oak woodlands, upland mixed woodlands, and instream habitats. Each of these habitat types had associated ecological attributes that describe desired conditions and criteria for each attribute (USFWS 2010a).

Other wildlife that reside on the Refuge include but are not limited to great blue heron, shrews, voles, various mice species, coyote, river otter, raccoon, squirrels, beaver, muskrat, weasel, and black-tailed deer. The Refuge also has introduced species like nutria, grey squirrel, and eastern cottontail. These species can sometimes outcompete for and/or alter habitat and food resources to the detriment of native fauna (USFWS 2010a). Recent conversations with the Refuge have also indicated that endangered Columbia white-tailed deer may be relocated to the Refuge beginning as early as January 2013 (Lapp 2012).

The Refuge provides opportunity for hunting waterfowl, as well as recreational wildlife viewing, bird watching, and photography. Several previous and current wildlife studies have been conducted at the Refuge including midwinter waterfowl surveys, dusky Canada and cackling goose surveys and collaring, sandhill crane roost, great blue heron rookery surveys, bald eagle, and purple martin nest surveys and monitoring, and a study on the paternity of American kestrels. Monitoring Avian Productivity and Survivorship (MAPS) is a nationwide research program that also has a sampling station at the Refuge to help assess and monitor vital rates and population dynamics of North American land birds (USFWS 2010a).

4.4. THREATENED AND ENDANGERED SPECIES

Table 19 and Table 20 show the federally listed species and their critical habitats that may occur on the Refuge or those species which may be migrating through the mainstem Columbia corridor and adjacent to Post Office Lake. Table 19 describes species under the purview of NMFS and Table 20 includes species protected by USFWS. Presence at the Refuge is indicated in the table when it was noted in the CCP documentation. The CCP also mentions several State listed species, species of concern, candidate species, as well as Birds of Conservation Concern that are not included here. For a complete listing, see pages 4-62 through 4-65 in the draft CCP (USFWS 2010a).

Table 19. NMFS Protected Species

Federal Register Notices for Final Rules that List Threatened and Endangered Species, Designate Critical Habitats, or Apply Protective Regulations to Species under Consideration

Species		Listing Status	Critical Habitat	Protective Regulations	Current Occurrence on Refuge
MARINE AND ANADROMOUS FISH					
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	Columbia River migration takes fish past Refuge. Refuge waterways may be utilized for rearing habitat. Juveniles trapped in Gee Creek in 1990s but not in 2002-2005 surveys. Juveniles trapped in Campbell Slough June 2007.
	Upper Willamette River	T 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160	
	Upper Columbia River spring-run	E 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630	ESA section 9 applies	
	Snake River spring/summer run	T 6/28/05; 70 FR 37160	10/25/99; 64 FR 57399	6/28/05; 70 FR 37160	
	Snake River fall-run	T 6/28/05; 70 FR 37160	12/28/93; 58 FR 68543	6/28/05; 70 FR 37160	
Chum salmon (*O. keta*)					
	Columbia River	T 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160	Refuge not utilized. Columbia River migration takes fish past Refuge. Reported in Gee Creek in 1940s; extirpated.
Coho salmon (*O. kisutch*)					
	Lower Columbia River	T 6/28/05; 70 FR 37160	1/14/13; . 78 FR, 2726 Proposed	6/28/05; 70 FR 37160	Refuge waterways may be utilized for rearing habitat. Juveniles trapped in Gee Creek in 1990s and 2002-2005 surveys. Spawning not known in watersheds adjoining the Refuge.
Sockeye salmon (*O. nerka*)					
	Snake River	E 6/28/05; 70 FR 37160	12/28/93; 58 FR 68543	ESA section 9 applies	Refuge not utilized. Columbia River migration takes fish past Refuge.
Steelhead (*O. mykiss*)					
	Lower Columbia River	T 1/05/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160	Refuge not utilized. Columbia River migration takes fish past Refuge. Spawning not known in watersheds adjoining the Refuge. Juveniles trapped in Gee Creek in 1990s, but not in 2002-2005 surveys.
	Upper Willamette River	T 1/05/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160	
	Middle Columbia River	T 1/05/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160	
	Upper Columbia River	T 1/05/06; 71 FR 834	9/02/05; 70 FR 52630	2/018/06; 71 FR 5178	
	Snake River Basin	T 1/05/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160	
Green sturgeon (*Acipenser medirosris)*					
	Southern	T 4/07/06; 71 FR 17757	10/09/09; 74 FR 52300	P 5/21/09; 74 FR 23822	Refuge is outside of critical habitat boundaries (RKM 74)
Eulachon (*Thaleichthys pacificus*)					
	Southern DPS	T 3/18/10; 75 FR 13012	11/20/11;76 FR 65324	Not applicable	Present in Gee Creek in low numbers; Columbia River migration takes fish past Refuge.

Listing status: 'T' means listed as threatened under the ESA; 'E' means listed as endangered; 'P' means proposed.

Table 20. USFWS Protected Species

Federal Register Notices for Final Rules that List Threatened and Endangered Species, Designate Critical Habitats, or Apply Protective Regulations to Species under Consideration for Clark County, WA

Species	Listing Status	Critical Habitat	Current Occurrence on Refuge
BIRDS			
Northern Spotted Owl *(Strix occidentalis caurina)* **T**	6/26/90; 55 FR 26114	1/15/92; 57 FR 1796; 08/13/08 73 FR 47325	No critical habitat identified for Clark County.
Streaked Horned Lark *(Eremophila alpestris strigata)***P/T**	10/11/12:77 FR 61937	10/11/12:77 FR 61937	The proposed listing does not include Clark County, or adjacent sites along the Columbia. However, Refuge staff has indicated there may be future plans for habitat restoration.
MAMMALS			
Columbian White-tailed Deer *(Odocoileus virginianus leucurus)* **E**			
Columbia River Population	03/11/67; 68 FR 43647	Not applicable	Historically occurred on Refuge; last confirmed sighting on Refuge 1974-1975 (Tabor 1976). The Refuge may be receiving up to 50 transplants to the Carty and Roth units as early as January 2013.
FISH			
Bull Trout *(Salvelinus confluentus)* **T**			
Columbia Distinct Population Segment	06/10/98; 63 FR 31647	10/18/10 75 FR 63897	Records from Clark County, use of Refuge unlikely.
PLANTS			
Nelson's Checker-mallow *(Sidalcea nelsoniana)* **T**	02/12/93; 58 FR 8235	Not applicable	Occurs in Cowlitz and Lewis counties; not documented in Post Office Lake vicinity. Experimental plantings on Refuge in 2007. Habitat: A variety of open of habitats that undergo periodic flooding or soil saturation for extended periods of time; associated with tall fescue, common velvet grass, common rush, oxeye daisy, sweet vernal grass, and Canada thistle.
Golden paintbrush *(Castilleja levisecta)* **T**	06/11/1997; 62 FR 31740 31748	Not applicable	Historic record from Clark County; not documented on Refuge. Habitat: Open grasslands, esp. glacial soils; often associated with *Festuca idahoensis* and *F. rubra* (Wentworth 2000).
Bradshaw's desert parsley/lomatium *(Lomatium bradshawii)* **E**	09/30/1988; 53 FR 38448 38451	Not applicable	Two known locations in Clark County; not documented in Post Office Lake vicinity. Experimental plantings on Refuge in 2007. Habitat: wet, seasonally flooded prairies and grasslands around creeks and small rivers. Associated species include tufted hairgrass, slender rush, sawbeak sedge, one-sided sedge.
Water howellia *(Howellia aquatilis)* **T**	07/14/1994; 59 FR 35860 35864	Not applicable	Occurs in small vernal ponds in the Carty Unit (only Clark County record). Habitat: vernal pools and seasonal ponds.

Listing status: 'T' means listed as threatened under the ESA; 'E' means listed as endangered; 'P' means proposed.

4.5. CULTURAL AND HISTORIC RESOURCES

Post Office Lake, located in the State of Washington near Columbia River RM 95 immediately north of the confluence with the Willamette River, lies within the northern reach of the ecologically-rich Wapato

Valley. The surroundings consist of low-relief, wetland-dominated areas that supported a variety of fauna, flora and other natural resources well-suited to human exploitation. Although the Wapato Valley has been the scene of a number of widely-scattered, prominent archaeological investigations, the immediate Post Office Lake area had not been examined prior to this proposed project (Virginia Parks, USFWS, personal communication, May 2011). Adjacent places such as Vancouver Lake (Dunnell et al. 1973, Skolnik et al. 1979, Wessen 1983), Shillapoo Lake (Skolnik et al. 1979, Onat 1997, Becker and Roulette 2005), portions of Lake River (Skolnik et al. 1979, Onat 1997, Foreman and Foreman 1977) and Sauvie Island (Pettigrew 1977), however, have been subject to extensive field surveys and offer detailed summaries of findings and previous work.

Analysis of archaeological sampling from Cathlapotle (45CL1), a Native American town site near the mouth of Lake River, includes detailed studies of artifacts, faunal and floral remains, and discussions of house activity areas (Ames 1994, 1999, Ames et al. 1999, Smith 2004, Sobel 2004). Cathlapotle is located about six miles north of Post Office Lake on the west bank of Lake River near its confluence with the Columbia River. Two other important village sites in the vicinity include the Meier Site (35CO5) (The Virtual Meier Site website) and Herzog Site (45CL11) (Foreman and Foreman 1977), located to the northwest and southeast of the project area, respectively. In addition, Post Office Lake is in close proximity to Vancouver and Shillapoo Lakes, both of which contain a high density of archaeological features and sites. Although no archaeological sites have been identified within the Post Office Lake Section 536 Project area of potential effect (APE), Post Office Lake lies within the boundaries of the Vancouver Lake Archaeological District.

Past subsistence activities of peoples who lived near the Post Office Lake area have been reconstructed from the fish remains and floral remains recovered from archaeological excavations (Butler 2000, 2002, 2004, Butler and O'Connor 2004) conducted in various locations of the Lower Columbia River. Fish remains indicate the aboriginal procurement of not just various species of salmonid and white sturgeon, but also local fresh water fish such as peamouth, stickleback and others, which suggests the use of backwater lakes and tributaries as resource areas. A variety of floral remains including wapato and camas were also gathered.

The Post Office Lake area is bounded on the west by the Columbia River and Lake River to the east, both of which were important water ways used by the lower Chinook Indians for transport. An important resource in close proximity to Post Office Lake included extensive beds of wapato. Wapato, a wetland plant that produces a tuber, was extensively gathered in the wetlands of the lower Columbia River. Darby's (1996) research indicates that the tuber production may have been positively affected by Native women who were responsible for its collection. The gathering process thinned beds of wapato and redistributed tubers, perhaps facilitating their continued growth. The presence of people may have also protected wapato beds from predators, waterfowl and marine mammals, possibly causing the beds to flourish. As re-use and exploitation continued over time, marginal wapato growing areas may have become more productive and increased in importance.

While the gathering of wapato may not have left archaeologically-identifiable marks (i.e., gathering was conducted using the hands and feet in shallow lakes and ponds), support camps and camps for people monitoring and protecting beds may be associated with fire-cracked rock distributions, a common site type found in the nearby Vancouver and Shillapoo Lake areas (Onat 1997). The location, use and extent of wapato beds are examples of current archaeological questions that focus on the extent that humans in the Pacific Northwest engaged in horticulture and small-scale agricultural production (Ames 1994, 1999; Onat 1997).

A variety of site types may be present in the Post Office Lake project area, including the remains of small structures, canoe landings and places where stone tool production and game processing occurred. Based on its presence in other areas within the Post Office Lake vicinity, the most common site type can be expected to be fire-cracked rock concentrations distributed around the shoreline of the lake. These concentrations are the least likely to have been collected or looted, and, are usually apparent along beaches and/or in shallow water. In some cases, fire-cracked rock distributions exposed in cut banks may include hearth features.

Historical and cultural summaries of past use of the Wapato Valley and larger Lower Columbia region are documented in a variety of accounts. The *Handbook of North American Indians: Northwest Coast* (Suttles and Sturtevant, eds. 1990) provides context overviews of the region's prehistory (Pettigrew 1990) and a history of lower Chinook Indian occupation from the mouth of the Columbia River to Celilo Falls (Silverstein 1990). The City of Portland Bureau of Planning and Sustainability's (n.d.) *Native Peoples & Archaeology of the Portland Area & Lower Columbia Region* website offers a frequently-updated, extensive bibliography of sources, references, studies and investigative reports relating to the prehistory, history, culture and archaeology of Native groups of the southern Northwest Coast culture area, with particular focus on the Portland Basin and Lower Columbia region.

4.6. SOCIOECONOMICS AND LAND USES

The town closest to the Refuge is Ridgefield in Clark County, Washington. Ridgefield is located adjacent to and across the Lake River channel northeast from the Refuge. According to 2010 demographic data from the Washington State Office of Financial Management (WA OFM 2011), Ridgefield has a population of about 4,763 people, with about 26.8% under the age of 19, and 7.6% over the age of 65. A majority (92.4%) of the population is identified as Caucasian; 5.1 % as Hispanic or Latino (of any race) 2.0% as Asian; 0.9 % as Black or African American; 0.8% as American Indian or Alaska Native; 0.1% as Native Hawaiian and Other Pacific Islander; and 1.5% some other race (WA OFM, 2011). About 76% of the population owns their own home, with 26% renting. According to City-data.com (2011), Ridgefield's median resident age is 35.5, with the median household income at $66,978 in 2009 (City-data.com 2011). Occupations in Ridgefield include construction 20%; manufacturing 17%; transportation and warehousing 9%; professional, scientific, and technical services 7%; retail trade 7%; finance and insurance 6%; and public administration 5% (City-data.com 2011).

According to census data in the CCP (USFWS 2010a), Clark County is also experiencing both population and economic growth in its transition from mostly rural farm populations surrounding small urban areas to a suburban-urban setting that serves as a bedroom community to the Vancouver area. Clark County was the most rapidly developing county in Washington in the 1990s and is one of the faster growing areas nationwide (census data in Draft CCP). Clark County's economy has also transitioned from being largely dependent on the wood products industry and agriculture, to a diversified economic base. Port of Ridgefield adjacent to the Refuge's Carty Unit has continued to experience industrial growth, and there are plans for a large multi-use development on Port of Ridgefield property (the old Pacific Wood Treatment site). This is located downstream (near Lewis River confluence) and it is not anticipated that there will be impacts to Post Office Lake. There has also been a transition away from larger agriculturally based farms, to smaller farms and more commercial development, which have important implications for Refuge management. With fewer cooperative growers in the region and higher land costs, foraging opportunities provided by the Refuge are even more important, even though depredation complaints have decreased with the transition (USFWS 2010a).

As mentioned previously, the Refuge provides various recreational activities for visitors, including hunting, bird-watching, auto tours, geo-caching, photography, environmental education, cultural

resources interpretation, and hiking. Between 2005 and 2007, there was an average annual visitation of about 160,000 visitors (USFWS 2010a). According to the CCP, "Total expenditures during FY 2004 were $1.38 million, with nonresidents accounting for 56% of this expenditure. The majority of expenditures ($1.3 million or 95.2%) were attributed to non-consumptive uses, while waterfowl hunting generated $60,800 (4.4 %) and freshwater fishing accounted for $5,300, or 0.4%." Therefore, the Refuge plays an important role in the local and county economies.

5. ENVIRONMENTAL CONSEQUENCES

5.1. PHYSICAL CHARACTERISTICS

5.1.1. Geology and Soils

5.1.1.1. Preferred Alternative

Overall, the geology and soils of the project area would not be measurably affected by the preferred alternative. Soil elevations will be not be substantially altered by the restoration actions in the preferred alternative. The guiding principle is to match, as far as feasible, the natural condition/patterns of the study area. At the north connection channel, the dredge material evident on the banks and in the channel bottom will be removed, thereby improving fish passage. The north connection channel outlet will be re-opened to intertidal flows through the removal of the existing duckbill aperture tide gate and 30-inch circular culvert, as well as a 60-foot side segment of levee section.

Throughout restored riparian areas, the top 2 feet of soils will be excavated to allow increased intertidal inundation. This area includes a 50-foot buffer zone around both banks of the north connection channel and on the levee. On the levee, the remaining roadway asphalt pavement will be scarified to reduce impacts to existing mature riparian vegetation. To avoid redistribution of the invasive species seed bank and rhizomes, amended soil will then be evenly redistributed at a depth of 2-3 feet throughout areas to be planted with riparian vegetation. The interface between the existing upland and disposal site will be graded to provide gradual slopes. Although soils will be disturbed, there will be no overall shift in soil type, and soils are expected to continue to provide a suitable growing medium for native species. Excavation of the existing northern channel to provide sufficient capacity for intertidal flows associated with the restored intertidal marsh habitat will provide reduced bank erosion.

As noted in Section 2.1 describing risk, there is some likelihood of lake bottom sediment re-distributing and possibly infilling the constructed refugia pool. This has been initially evaluated and is further detailed in the *Hydrology and Hydraulics* Appendix. The potential frequency could occur yearly, or more often. This potential effect will be evaluated via the monitoring plan detailed later in this report. Discussion with the resource agencies and associated biological monitoring results will determine whether or not the pool will require regular excavation maintenance. Initial conversation with NMFS indicated that operations and maintenance to restore an unsustainable pool feature would not be required in the event that infill frequency predictions were correct (Fisher, 2012b).

5.1.1.2. No Action Alternative

If no action is taken, Post Office Lake will continue to be managed essentially as it is now, but, according to the CCP, with wet meadow replacing early succession floodplain forest at the north end, and the mowed pastures providing Canada goose and sandhill crane foraging opportunities. Cottonwoods and willows are increasing at the north end of the Post Office Lake/south end of Dusky Lake, and this would be allowed to continue. The future without-project condition at Post Office Lake area will also see continued progressive erosion to the Columbia levee. The levee would be allowed to degrade via the observed pattern of progressive erosion, primarily caused by ship waves and large flood events (e.g., spring 1996 flood). The erosion is longitudinal along the Columbia River shoreline. However, because the landward side of the levee is elevated with respect to Post Office Lake, a permanent tidal connection would not be established naturally. Overtopping and floodplain connectivity events would become more common as the levee is eroded down to the landward ground elevations.

5.1.2. Sediment Quality

5.1.2.1. Preferred Alternative

As discussed previously, sediment sampling did not detect any levels of chlorinated herbicides, organochlorine pesticides, PCBs, and metals above the SEF screening limits. All sediments tested were determined to be suitable for unconfined, in-water disposal, or could be exposed to water after excavation without further characterization. The Corps is not proposing any actions that are expected to measurably affect sediment quality.

In order to reduce sediment suspension where dredging or culvert removal is required, plans would call for installing interior and exterior cofferdams (sheet piling) and the use of pumps to maintain a dry environment at the tide gate construction area. Construction in the dry would minimize sediment escape from restoration actions into the waters of the Columbia River. Construction of exterior channels would occur at low tide to minimize sediment discharge into waters of the Columbia River and Post Office Lake. Turbidity monitoring and appropriate BMPs would be implemented to avoid and minimize erosion and discharge.

Some sediment discharge from tidal sloughs would be expected once tidal flows are restored to the area. These discharges would lessen over time as the tidal channel reaches equilibrium relative to the volume of water within ditch and the lake and velocities associated with tidal flood and ebb. Riparian restoration actions plus pioneering vegetation should minimize the potential for sediment runoff from areas targeted for riparian forest reestablishment. Slow re-watering and allowing sediment to settle out would also reduce turbidity and, if feasible, a turbidity curtain may also be deployed to minimize any resulting plume.

Finally, there may be some sediment discharge associated with pumping from Lake River during the 3-5 year drought events. This discharge would likely be reduced by the implementation of stand-pipes which allow the sediment to settle-out of pipe flows prior to discharge. Sediment remaining in the pipe would then be removed during regular O&M activities. Further details would be developed during the plans and specifications phase of the project to ensure sediment build-up and discharge does not impede flows to or water quality at Post Office Lake. Due to the short-term duration and intermittent nature of expected pumping events along with design and O&M BMPs, sedimentation and sediment quality issues resulting from pumping from Lake River are anticipated to be minimal in scale and effect.

5.1.2.1. No Action Alternative

For the No Action Alternative, water and sediment quality and channel stability would remain unchanged. No net changes would be expected for sediment quantity.

5.1.3. Hydrology

5.1.3.1. Preferred Alternative

Excavation and reforming the northern connection channel geometry would allow for more frequent and longer duration intertidal inundation. Reforming the channel geometry also would allow space for a larger volume of water to enter and exit the restoration area during each intertidal cycle. This volume of water is termed the tidal prism. Intertidal channels form to accommodate this transfer of water and to dissipate its energy. The size and shape of the channel network is dependent on several factors including hydrodynamics, substrate, and vegetation and is necessarily unique to each system.

Intertidal channel sizing is based on empirical relationships derived from several west coast intertidal marshes (Williams et al. 2002). Applicability of these empirical relationships to the Columbia River is verified to the extent possible with historic aerial photos. The geometry for design of the channel in the tidal restoration area was selected to make best use of the micro-topography of the existing wetland area. Channel alignment was designed, but essentially matched the historic course of the ditch/channel, to move water into and out of the lake and surrounding wetland/lowlands. A one-dimensional unsteady state model was used to size the inlet/outlet channels to the marsh restoration area.

The tidal reconnection associated with the removal of the culvert and tide gate alternatives will change the frequency of inundation at the site. The without-project condition (no action) is defined as the existing condition, no tidal connection to Post Office Lake with a progressively eroding/breaching Columbia River levee. Inundation begins when the Columbia River stage is sufficient to overtop the most eroded and lowest portions of the adjacent levee. Currently, that is at approximately elevation 21 feet. This corresponds to a 20% chance, 5-year frequency flood stage on the Columbia River. The existing Post Office Lake shoreline is seasonably stable over the year and remarkably consistent. The normal shoreline is approximately equal to the OHW mark and normally fluctuates between elevations 10 to 12 feet. The exact OHW was determined to be elevation 12 feet (see wetland delineation report in Appendix E).

For the preferred alternative, there is one low flow (elevation 7.0 feet) opening at the north connection channel confluence with the Columbia River. It is the primary instrument of tidal reconnection to the Columbia River. The connection allows Columbia River flows into Post Office Lake, thereby increasing the frequency of inundation relative to that experienced currently. Therefore, yearly inundations will become more frequent between the OHW and the overtopping event, approximately the 2 to 4-year frequencies (about elevations 19-20 feet NAVD). Fazio lands are directly south of the Refuge and include the southern portion of Post Office Lake.. These lands will be inundated more frequently by Columbia River flood levels by the preferred alternative (Alternative 5). Because the Fazio lands will be more frequently inundated under the preferred alternative, a flowage or conservation easement was investigated. Subsequently, the Corps prepared a Takings Analysis of the properties in question. The analysis determined that there was no negative economic effect to the properties. Therefore, because there were no damages incurred, it was determined that there was no need for a flowage easement.

Figure 27 depicts the inundation footprint resulting from reconnecting the Columbia River to Post Office Lake for the preferred alternative. The reconnection would occur via the historic north connection channel entrance. In addition, the floodplain reconnection piece would add river flows at stages above elevation 18.7 feet (i.e., a 50% chance exceedence, 2-year overtopping event, Columbia River profiles).

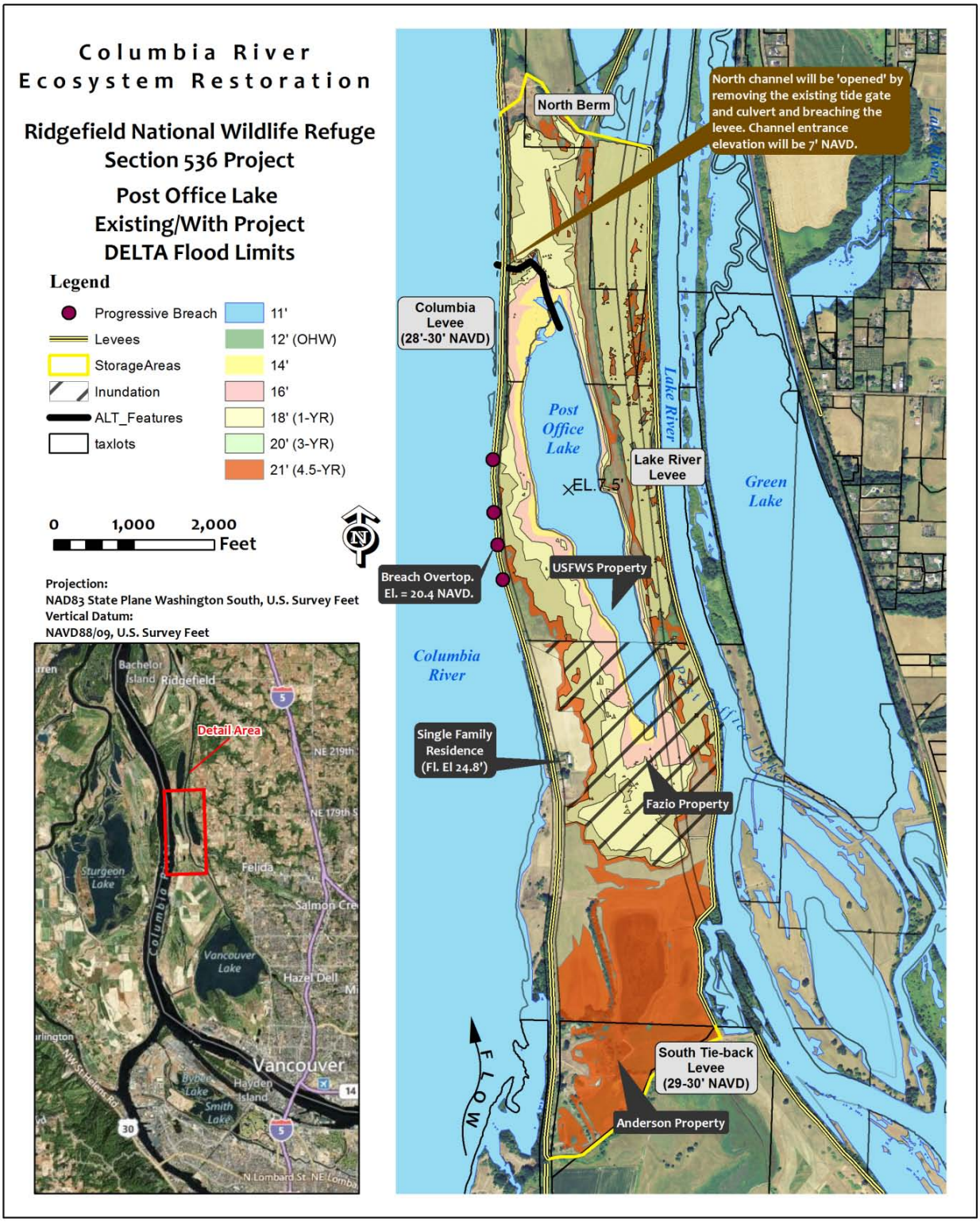
For the preferred alternative action, Fazio lands will see increased flooding starting at OHW to approximately the 4.5-year overtopping flow. Due to topographic divide (approximately elevation 20 feet), the Andersen parcels will not experience increased flooding compared to the existing condition, 4.5 year return interval. Beyond the 4.5-year event inundation, there is no substantial difference between the no-action and preferred alternative flooding limits.

Figure 27 shows the “delta” inundation between the no action and preferred alternative conditions. Of special note is the hatched area. This represents the Fazio lands that are primarily affected by flooding. The local high point divide (approximately elevation 21 feet) is the point at which inundation begins on the Fazio properties to the south.

The inundation limits shown are conservative (from a flooding perspective). Grounds are assumed to be saturated and infiltration of incoming water does not occur. Additionally, it is assumed that that the

duration of inflow at the existing breach (RM 95.1) at the corresponding stage is long enough so that the inflow volume fills to the maximum potential extents. Preliminary estimates to inundate the maximum area of extent range from a month at the given stage to 15 days, based on an 80 and 150-foot-wide breach opening and a 1- to 1.25-foot assumed weir head, respectively. However, over the 50-year planning horizon, as the existing breach develops and is eroded further, the likelihood for higher inflow volumes increases. Further, general climate change forecast over the next 50 years points to more frequent and extreme flooding events. Therefore, the conservative nature of the flooding extents is likely warranted and applicable in the context of development of the proper easements.

Figure 27. Post Office Lake Delta Flood Limits



5.1.3.1. No Action Alternative

For the No Action Alternative, the hydrology of the lands in the Post Office Lake area will remain unconnected to intertidal inundation and all but extreme flood flows. Erosion of the existing levee will continue at a slow pace. High stage (above stages at elevation 21.0 feet) overtopping will occur more frequently as the erosion of the levee continues (i.e., overtopping elevation is continually reduced).

5.1.4. Floodplains

5.1.4.1. Preferred Alternative

Proposed restoration measures are intended to reconnect Post Office Lake including the floodplain habitats (at higher stage events) to more frequent intertidal and flood inundation. First, existing 30-inch culvert and tide gate appurtenance would be removed, the adjoining levee would be removed, and a 60-foot wide opening to the ditch would be excavated. Second the north connection channel entrance would be expanded to allow for passage of the full tidal prism and increased bankfull width. The north connection channel bottom is currently irregular in profile and would be dredged at high spots that could impede fish passage, and the entrance would be widened resulting in a more uniform channel invert. This would allow for improved fish passage, as well as allow the movement of sediments and passage of debris along and through the channel during the tidal diurnal cycles. The overbanks would be reformed and dredge material removed.

Approximately 5 acres of riparian habitat along the north connection channel would be restored, improving riparian habitat. The upstream end of Post Office Lake would be excavated by approximately 1 foot (reduced from elevation 10 to 9 feet) to facilitate increased fish ingress and egress opportunity during drier cool water months (November through first part of July, end of freshet).

The floodplain reconnection would occur at approximately RM 95.1, the worst progressive breach area. The overflow elevation (from the Columbia River into Post Office Lake area) would occur at elevation 18.7 feet. This corresponds to a 2-year Columbia River stage elevation frequency. A floodplain swale would be excavated between the breach and the lake in order to provide some channelized flow during flood events so that fish may pass to the lake rather than sheet-flow into the adjacent pastures. The swale would be planted with forbs and is expected to help dissipate flood flows and provide off-channel refugia during the 2-year flood event. At the south end of the unit near the parking area, additional plantings are expected to mature into a late-successional floodplain forest with development of a vertically complex canopy. Floodplain reconnection and plantings are expected to improve access to restored habitat, increase exchange within the floodplain, and provide important detrital and food-web inputs both on the Refuge and downstream. Increased floodplain access also is expected to provide some flood storage capacity and could help retain some amount of water for base flows.

Because there are no meaningful changes in onsite existing ground elevations, there would be no impact to the existing (100-year) FEMA regulatory floodplain. No rise is expected because any fill or riparian plantings are offset by the amount of removal such that the mass balance would result in a net removal of material from the floodplain.

During construction, the flow to the existing northern channel would be temporarily restricted by a cofferdam. The impact to hydrology and the floodplain would be brief and imperceptible. The preferred alternative is not expected to have adverse effects to regulatory floodplain conditions. The restoration measures are intended to increase frequency of intertidal inundation during the winter and freshet periods (October through July), while the drawdown in the Columbia River during August and September is as

low as 5 feet, but average of 7 feet, which would lead to drier conditions in Post Office Lake than currently experienced. As noted previously, the effects on the south property owners have been determined and the owners are aware of the impacts.

The wetter winter conditions in Post Office Lake are expected to improve native tidal wetland plant establishment, floodplain connectivity, and habitat accessibility and condition. During summer, the lake depths would draw down to within 1 or 2 feet of water depth. Normally, fish would exit as the waters warm up and water levels go down. It is expected that fish would move out and stranding would not be an issue. Excavation of intertidal marsh habitat and channels was engineered based on reference sites and/or historic information on channel restoration. The objective is to improve intertidal inundation, floodplain connectivity, and facilitate growth of natural floodplain fish, wildlife, and plant communities.

5.1.4.2. No Action Alternative

For the No Action Alternative, floodplain habitats at the lake would remain disconnected from intertidal inundation and more regular flood flows. Erosion of the existing levee would continue at a slow pace. High stage (above stages at elevation 21.0 feet) overtopping would occur more frequently as the erosion of the overbanks continues (i.e., overtopping elevation is continually reduced). Floodplain vegetation communities would remain limited in species diversity, habitat complexity, and recruitment/establishment capacity, as the bulk of the area would remain dominated by reed canarygrass. Regular fish passage and site access would not be available, as the window for ingress and egress would be very limited during flood stages and passage would not be available at the north channel outlet.

5.1.5. Water Quality and Quantity

5.1.5.1. Preferred Alternative

In order to protect water quality standards and the beneficial uses they support, the Corps would conduct a CWA Section 404(b) (1) Evaluation of project effects or utilized the evaluation associated with Nationwide #27, as appropriate, as well as maintain compliance with conditions imposed by the State CWA Section 401 water quality certification. The Corps would also comply with the EPA's National Pollution Discharge Elimination System (NPDES) construction general permit conditions, which results in the protection of water quality via development and implementation of a Stormwater Pollution Prevention Plan (SWPPP). More details about these compliance requirements are described in the *Compliance with Laws and Regulations* section of this report.

Construction activities that require use of heavy equipment and excavation of substrate may affect water quality. However, effects are expected to be short-term (limited to one season), localized at the point source of the action, and of short duration. A temporary and localized increase in turbidity may result from input of sediment into the slough during construction. However, since the majority of excavation work would be done behind cofferdams (sheet piling or comparable structure) and in the dry, introduction of sediment into the channels is expected to be minor, and settlement should occur prior to releasing water into the Columbia River. Cofferdams would be removed at low tide to minimize impacts upon completion of each individual structure. An exception would be exterior channel construction; these areas would not be enclosed by cofferdams. The Corps would follow dewatering and rewatering guidelines provided in the anticipated BiOp, which is expected to reflect requirements similar to those in the joint programmatic restoration BiOp described in Section 7.5 of this report. The Corps would also comply with any conditions in the Section 401 water quality certification in order to avoid and minimize negative effects to water quality. Implementation of appropriate BMPs would further ensure that no measurable adverse effects result from construction activities. Turbidity monitoring would also be

conducted so that the duration and threshold of any turbidity exceedences remained protective of aquatic resources and within the conditions of the water quality certification.

Without appropriate stabilization, bare ground exposed during construction and throughout the revegetation period may contribute turbidity to the surrounding waters through runoff. However, this would be avoided and minimized through the development and implementation of a SWPPP with erosion controls that would be compliant with both the BiOp and the Clean Water Act NPDES construction general permit conditions the Corps would obtain from the USEPA in Washington. Straw, compost, hydroseeding, or other erosion protection measures would be used to avoid and control erosion and sediment runoff. Work would be sequenced to reduce the duration of soil exposure.

Water quantity (tidal flow) would be temporarily restricted in the project area by the cofferdams during the construction period, but would be restored following completion of construction activities. A work area isolation plan and fish salvage plan would be developed during the Plans and Specifications stage in order to avoid and minimize impacts during dewatering and re-watering actions, and to avoid and minimize impacts to aquatic resources. The Corps would follow dewatering guidelines provided in the representative programmatic restoration BiOp described in Section 7.5 of this report.

Overall, water quantity levels are expected to become much more variable as water levels move higher in the winter and lower in the summer, including tidal fluctuations throughout the year. Post Office Lake is expected to experience drier conditions in the summer months when Columbia River water surface elevations fall below the northern channel inlet. Some water would be retained behind the 9-foot sill at the north end of the lake, and the mean higher high tide is expected to overtop the sill periodically even during the low-water months. The pumping contingency that could be implemented by the USFWS during the 3- to 5-year drought event (or annually, as needed) means the lake is not likely to completely dry out even if river levels remain low. Ultimately in the long-term, the project would return more natural tidal fluctuations to Post Office Lake than presently occurs.

If the pumping contingency is implemented by the Refuge, the source of water would be Lake River. Lake River is of poorer quality than the Columbia River and is on the Section 303(d) list for several water quality parameters including temperature, fecal coliform, 2,3,7,8-TCDD, 4,4'-DDE, PCB, and dieldrin. The concentration of Lake River water in Post Office Lake during a pumping scenario would likely be relatively high, although the volume of water relative to the full potential lake capacity would likely be low. However, this pumping scenario would only occur at a limited frequency and for a short-term duration. When the mean higher high tide overtopped the sill and when river water levels increased, additional mixing and exchange would occur that would likely dilute and flush the smaller volume of Lake River pumped water back out of Post Office Lake.

Best management practices during construction would be employed to reduce the pollutant discharge from heavy equipment, such as oils, fuels, or grease. Equipment would be appropriately cleaned and diapered prior to work in water, and staging areas would be located at least 150 feet from wetlands and waters as much as possible. A spill prevention and response plan would be implemented to further reduce the likelihood of any measurable adverse effects from construction actions.

Cofferdams would be installed at low tide to minimize turbidity and sediment discharge to the adjacent water bodies. Erosion protection measures would be used to control sediment runoff from excavated material. Soil excess to backfill requirements would be removed and carried offsite. Material may be provided to the USFWS or disposed offsite. Identified wetlands areas would be avoided (see Appendix E for wetland delineation report). Riparian forest restoration scarification actions would occur in late summer when the site is dry and runoff from precipitation is least likely. Buffer strips of dense vegetation

would be left around riparian restoration areas to capture sediments in any runoff. Additional erosion control measures may be employed, if necessary.

The construction measures associated with implementation of the preferred alternative may result in temporary reductions in water quality. However, it is unlikely that water quality conditions in the Columbia River would be measurably degraded. Water quality or quantity is not expected to experience long-term, adverse effects as a result of the proposed project.

5.1.5.1. No Action Alternative

For the No Action Alternative, water quality would remain degraded in Post Office Lake. No net changes would be expected for water quantity. Minimal hydrologic exchange would occur during higher flow event on the Columbia, and no mixing with Lake River would occur.

5.1.6. Hazardous, Toxic, and Radioactive Waste

5.1.6.1. Preferred Alternative

As discussed in Section 4.1.6, a Level I Contaminant Survey (Environmental Site Assessment) for the site was conducted (1989) by USFWS environmental contaminant specialists. Based on the site history, this report, the Sediment Evaluation Framework (SEF) results, and conditions observed during the site visits, the Corps concluded that there would be no apparent contaminant threats to fish and wildlife resources on or near the property.

The Corps would also require implementation of all appropriate Best Management Practices (BMP) relating to spill prevention and containment measures and general site house-keeping.

Additionally, asphalt from the relic roadway on top of the levee would be scarified, and for the most part would be left in place. The reason for this is that machinery and equipment required to complete removal of the roadway would create more riparian impacts during removal. Because the intent of the project is to restore riparian habitat and age-class heterogeneity, scarification will be implemented to avoid loss of the mature and limited woody vegetation stock. This will preserve existing mature vegetation while allowing new plantings and recruitment.

Questions were raised regarding the assumed inert nature of the scarified asphalt. Based on Washington Administrative Code (WAC) 173-303-071, asphalt is included in the “excluded categories of waste”, because “they [excluded wastes] generally are not dangerous waste, are regulated under other state and federal programs, or are recycled in ways which do not threaten public health or the environment”. The exclusion pertinent for this project is defined according to WAC 173-303-071 (3) (e) as: “Asphaltic materials designated only for the presence of PAHs by WAC 173-303-100(6)…. For the purposes of this exclusion, asphaltic materials means materials that have been used for structural and construction purposes (e.g., roads, dikes, paving) that were produced from mixtures of oil and sand, gravel, ash or similar substances”. Per the Department of Ecology’s website, “Excluded wastes remain solid wastes, but they generally are not subject to most of the dangerous waste rules, including counting and annual reporting requirements (DOE 2012). Multiple investigations and research have been conducted addressing this question of asphalt as an environmental contaminant.

The WAC exclusion of asphalt from categorization as a hazardous waste is further supported by various research findings. As a result of the chemical composition of asphalt or from contamination occurring from vehicle traffic on the roadway, there has been concern that chemical compounds such as polycyclic

aromatic hydrocarbons (PAHs) and heavy metals might be present in and leach from recycled asphalt pavement (RAP) (Townsend, 1998).

Timothy Townsend of the Florida Center for Solid and Hazardous Waste Management performed an investigation conducting a series of batch tests and column studies to evaluate the leaching characteristics of reclaimed asphalt pavement. The primary chemicals investigated were volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), and heavy metals. The overall results of this research project indicated that reclaimed asphalt pavement of the nature examined (natural aggregate vs. waste materials such as slag, spent sandblast grit and ash, etc.) poses minimal risk to groundwater as a result of pollutant leaching under normal land disposal scenarios. The results of the leaching tests indicated that in most cases RAP would pose minimal environmental risk when used as fill in regard to the leaching of the pollutants. Conditions of possible concern would be RAP used in saturated environments where little dilution occurred. This study did not, however, address that implication of direct exposure (Townsend, 1998).

Another study by Pribanic (1994) investigated the potential for soil, and/or groundwater, and/or surface water contamination arising from the stockpiling, use, or disposal of salvaged asphalt pavement in Montana. No substances tested (volatile and semi-volatile compounds, polynuclear aromatics, and certain metals) were observed above the stated threshold values. Therefore, the potential for soil or water contamination as a result of use, stockpile, or disposal of typical MT asphalt paving mixtures was deemed to be minimal (Pribanic 1994).

The weathered asphalt on the Post Office Lake project is assumed to be comprised of a typical paving mixture. It is not expected to be in a prolonged saturated state, though the levee could be overtopped. As a result of these various findings coupled with the fact that the asphalt at Post Office Lake will not be used as fill in waters, there is deemed minimal likelihood of resulting contamination from proposed scarification measures or other project activities.

5.1.6.2. No Action Alternative

For the No Action Alternative, there are no apparent contaminant threats to fish and wildlife resources on or near the property. Any potential concern with asphalt leachate would remain relevant/similar under without-project conditions, though this risk in either scenario was deemed extremely unlikely.

5.2. AQUATIC AND RIPARIAN HABITAT

5.2.1. Preferred Alternative

Temporary impacts to about 6 acres of the riparian area would occur with the implementation of restoration features. Some vegetation and tree removal would occur at the levee breach locations and along the north connection channel. These areas would be replanted after additional work removing invasive species was completed. Riparian habitat would be increased and improved by implementation of the preferred alternative since plantings would supplement sparse existing vegetation on and adjacent to the levee, along the northern channel, and in the floodplain swale. This would help improve the resilience of the riparian area by providing new recruitment and re-establishment potential to an area that has little remaining large wood or riparian structure. Removal of invasive species in the proposed and re-vegetated areas would further enhance the quality and function of the restored areas since there would be greater likelihood of return to a more native and diverse vegetative community. An increase is expected in the level of canopy cover and large wood recruitment provided by these riparian areas as community succession occurs. It is also expected that the age-class structure would become more diverse, and that

native species would begin to dominate the community structure. All of these factors provide additional and improved habitat for both upland and aquatic species. Large wood in the channel, lake, and along the Columbia would provide cover for juvenile salmonids as well as habitat structure and substrate for macroinvertebrates. Canopy cover would provide shade and potentially improve water quality while also dispersing energy and flows during flood regimes.

5.2.2. No Action Alternative

For the No Action alternative, there is little likelihood of riparian recruitment or replacement since the remaining riparian zone is minimal, is flanked by mown pastures, and is overrun by invasive species. Without project implementation, more large wood would likely be input into the Columbia as the levee degraded, and this would likely be replaced by invasive species. This would further jeopardize the existing canopy along the Columbia River, and the northern channel would remain overrun with Himalayan blackberry. There is further indication in the CCP that some of the area north of the project would be transitioned from early floodplain forest to wet meadow, which would further reduce the riparian recruitment potential. The existing native riparian cover would remain inadequate and at risk of loss by invasive species infestation, bank failure, and lack of replacement/recruitment vegetation.

5.3. WETLANDS

5.3.1. Preferred Alternative

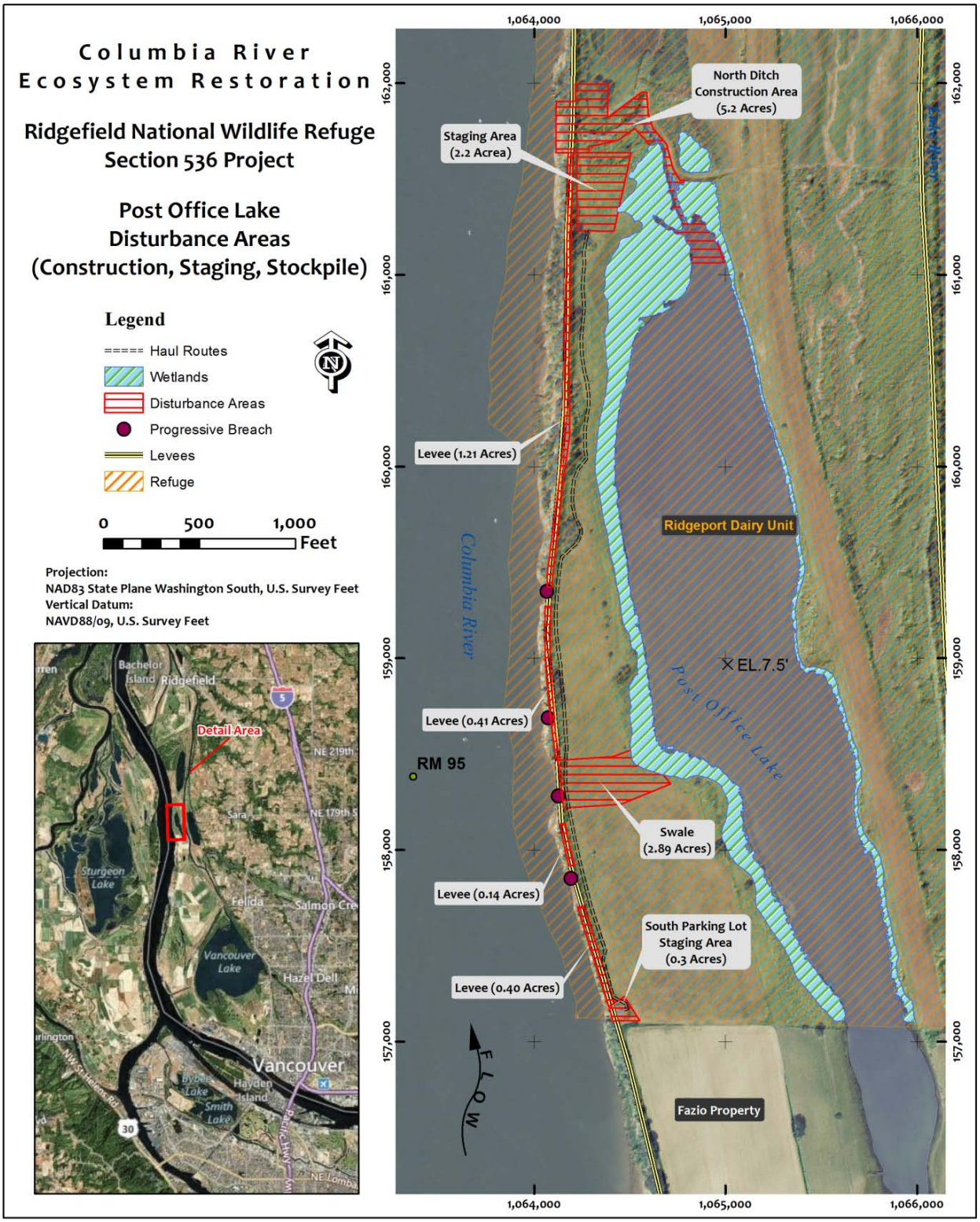
There would be temporary and permanent impacts to wetlands for the preferred alternative. Temporary impacts would occur as a result of construction and staging activities related to channel and bank work along with bridge construction. Figure 28 shows the proposed disturbance areas relative to delineated wetlands and other waters of the U.S. Efforts would be made to avoid wetlands and other sensitive areas. Where activity is unavoidable, it would be minimized to the maximum extent practicable. Table 21 summarizes fill and removal and quantities resulting from project actions:

Table 21. Initial Estimates of Project Fill and Removal Above and Below OHW

OHW	Fill Volume Temp. (cy)	Fill Volume Permanent (cy)	Fill Area Temp. (acres)	Fill Area Permanent (acres)	Removal Volume Temp. (cy)	Removal Volume Permanent (cy)	Removal Area Temp. (acres)	Removal Area Permanent (acres)
Above OHW	0	0	13.7	0	0	17986	0	6.3
Below OHW	375	0	0.01	0	0	13447	0	3.8

The recommended plan design and construction methods for restoration at Post Office Lake have been developed and refined to take advantage of opportunities to avoid and minimize the project's ecological impacts to habitats and species. However, there would be temporary unavoidable effects to wetlands and shallow-water habitat that would be converted and excavated as a result of the project. Official wetland delineations have been completed. After avoidance and minimization measures, the following effects were unavoidable.

Figure 28. Approximate Site Disturbance Areas and Wetlands



Above OHW effects would include the following estimated acreages and volumes of removal and associated *de minimus* discharge. At the northern levee breach and tide gate removal area, approximately 3,261 cy of material would be permanently removed from the site in an area about 0.1 acre in size. To accommodate the southern breach in the levee, approximately 2,231 cy would be permanently removed above OHW also from an area about 0.1 acre in size. In order to construct the haul road and staging areas, about 22,044 cy or temporary materials would be placed in an uplands area of about 13.7 acres. An additional estimated 2 acres of temporary upland impacts would accommodate remaining staging needs.

Impacts to wetlands would be minimal and would be associated with accessing and implementing the restoration features below OHW. Temporary impacts would be associated with fill to provide equipment access and are expected to be around 0.5 acres in the fringe wetland around the lake itself. Removable matting would be used to minimize temporary impacts and reduce soil compaction.

Excavation of the floodplain swale and the north connection ditch would entail permanent removal of materials from both above and below OHW. Construction of the floodplain swale would include permanent removal of about 4,804 cy of material from above OHW, and about 1,740 cy of material from an area below OHW over a stretch of about 4.3 acres. Laying back the banks and removing fish passage barriers in the north connection channel would entail permanent removal of about 7,690 cy of material from an area above OHW estimated to be about 3.48 acres and removal of about 1,957 cy of material from below OHW over an area of about 0.88 acre.

Lake excavation to accommodate the pocket pool at the north end and to lower the outlet sill would occur completely below OHW and would entail permanent removal of about 9,750 cy of material over an area of approximately 1.9 acres. There would also be temporary fill for installation of coffer dams in the amount of approximately 375 cy over 0.01 acres.

In total, the estimated temporary impacts above OHW would be approximately 15.7 acres and 22,044 cy of fill. Permanent impacts via restoration features would entail removal of about 17,986 cy of material from above OHW of an area of about 7.9 acres. Below OHW, there would be temporary effects to .01 acre in the amount of 375 cy of temporary fill. There would be a total of about 13,447 cy of permanent removal of material from about 2.8 acres.

Temporary impacts would accommodate equipment and staging operations required for in-water channel and lake work. This would occur in the form of temporary fill in order to move materials and equipment into and out of the project area. If there are project delays or restrictions imposed by the Refuge, then the work could occur over two seasons. If the project required two seasons for completion, appropriate BMPs would be implemented including site stabilization, coverage and stabilization off stockpile areas, appropriate implementation of the SWPPP, and appropriate demobilization and staged restoration in appropriate areas. The Corps is not proposing mitigation as it is expected that there will be long-term beneficial effects to the wetlands with project implementation, including restoration of the tidal regime and return of a more native-dominated vegetative community as a result of the more natural hydroperiods. The Corps would re-vegetate disturbance areas along with removal and re-grading of some of the temporary roadways and access sites so that the post-construction site was returned to pre-construction conditions or better in certain locations.

The tidal reconnection via the north connection channel is expected to lead to a different hydrologic regime than present conditions, favoring emergent tidal wetland/marsh vegetation and reducing the coverage of submergent vegetation. According to USFWS staff, it is also possible that shallower water during the summer growing season may favor reed canarygrass, although effects are uncertain. The

USFWS would continue to manage possible new reed canarygrass areas as they appear, usually via seasonal mowing.

According to Refuge staff (Chmielewski 2013), reed canarygrass is an aggressive, non-native perennial grass that readily establishes in a variety of wet meadow and seasonally flooded wetlands, and along shoreline of shallow lakes and slow-flowing streams. Reed canarygrass grows most vigorously in wetlands that are seasonally-flooded/saturated, but can establish and out-compete many native species in areas of prolonged flooding as long as the substrate is not flooded during at least part of the growing season. Able to reproduce both vegetatively and through seed, it is one of the most abundant species in emergent wetlands of the Lower Columbia River Valley. Rhizomes form a thick mat, and over time can raise the elevation of the wetland substrate slightly, which can enhance its spread. At Post Office Lake, reed canarygrass is the dominant species along the immediate shoreline and, particularly on the west side, extends into the lake where the shoreline slopes gradually into the lake. Permanently inundated portions of the lake support species such as pondweeds, smartweeds, and some robust emergents like cattail that are more adapted to prolonged inundation. Like many plants adapted to seasonal flooding, exposing reed canarygrass rhizomes to prolonged (multi-year) inundation suppresses rhizomes by oxygen deprivation (oxygen cannot readily diffuse from the atmosphere through flooded stems to rhizomes). Reducing the period of inundation by establishing a more natural tidal circulation pattern and increasing the seasonal variation in water elevation will likely allow reed canarygrass rhizomes to be exposed to atmospheric oxygen either directly or through diffusion through grass stems for a portion of the growing season and allow this species to extend its coverage further into the current lake footprint (Chmielewski 2013).

As discussed in the benefits analysis, some wetlands around the lake are also expected to transition from permanent emergent and submergent, lacustrine fringe wetlands and open water to permanent or semi-permanent emergent wetlands. This change in composition and seasonal availability is due to the reintroduction of a greater range of tidal inundation and water level elevations. The transition would occur as a result of re-introduction of a more natural hydro-period and disturbance regime. Lacustrine habitat would also likely be altered seasonally (both in reduced depth and area of inundation). In addition to changes in open water and emergent wetland habitat, it is anticipated that vegetative communities would convert to a more diverse composition following restoration of a dynamic hydrologic regime. However, it is also possible that re-introduced tidal exchange could increase influx of non-native plant propagules from the Columbia River.

Reconnecting Post Office Lake to the Columbia River would impact the vegetation community both in the lake itself and in the associated shoreline emergent wetlands. Currently the lake supports small scattered occurrences of invasive plants like curly-leaved pondweed and Eurasian milfoil. Emergent invasive plants are primarily reed canarygrass. Species such as false indigo bush and yellow flag iris are rarely encountered during annual invasive plant searches. Connecting the lake to the Columbia River would allow propagules of various plant species to more easily enter the lake and connecting channel. Using Campbell Slough and the emergent wetland portions of Campbell Lake as a model, USFWS expects invasive plants such as yellow flag iris, false indigo bush and purple loosestrife to become established, particularly around the edge of the seasonally-flooded/seasonally saturated wetland perimeter. Many of these invasive plants produce copious amounts of seed (a mature purple loosestrife plant, for example can produce 2 to 3 million seeds) and these seeds are viable for decades in the soil. They also may spread vegetatively through root or lower stem fragments settling in suitable substrate. Seed and plant fragments are readily transported by water and are present in the Columbia River. Plant propagules from native species such as wapato and tule may also enter the lake and become established in areas of appropriate habitat (primarily emergent wetlands that are too wet for reed canarygrass to establish), but these species typically produce far fewer propagules and are less competitive than the invasive species and their establishment is likely to take longer.

The Refuge currently spends one to two weeks each year searching for, and controlling invasive plants on Campbell Slough and Campbell Lake. Teams consisting of staff, contractors and volunteers are used to spray or physically remove plants and propagules. USFWS expects that the Refuge will need to spend 3 to 5 days each year searching for and controlling invasive plants in the wetlands and lake following the reconnection of the lake to the Columbia River. Herbicide used will include aquatic formulations of glyphosate and imazapyr (both with appropriately-labeled surfactants). If infestations are small and scattered, the primary application technique will be spot-spraying with backpack sprayers or small tanks with hand wands. If populations become established in larger areas, boom spraying from tracked vehicles or ATVs may be required. Any application would occur in compliance with application Clean Water Act and ESA laws and regulations.

Although USFWS does not have sufficient information to predict the acreages of infestation, in the absence of this effort, the Service expects areas that are seasonally-flooded to the point where reed canarygrass is suppressed to support stands of purple loosestrife and yellow flag iris. Indigo bush would likely establish at slightly higher elevations (decreased period of inundation) or on coarser soils. These species do not provide high quality wildlife forage and have the potential to crowd out plant species with higher wildlife value. Established infestations of these species would significantly impact the plant community and wildlife use of the wetlands and the lake, but are unlikely to measurably impact regional populations of native wetland vegetation or wildlife.

Besides transition of existing wetlands, restored tidal and flood regime influences also *may* increase the range of emergent wetlands beyond the current extent. The area would be newly exposed to the 2-year flood event at a higher water elevation (18.7 ft), increasing the frequency, extent, and duration of flood events during which the area is exposed to water. Just as the current 12-ft OHW elevation around the lake is fringed by wetlands (in a range up to about 14-ft), the new wetland range could expand to around the 18-ft mark. Tidal effects would occur daily over the year and include a broader range of data so that the MHHW over the course of the year is at about 13.9 ft elevation, and MLLW is at about 8.7 ft. This area within this elevation range would be expected to experience the most effects of tidal influence (water exchange and disturbance via wetting and drying). This is the elevation range where wetland transitioning may be most pronounced. However, the range of elevations up to and beyond the 18ft elevation may also have some ability to transition into seasonal emergent wetlands as a result of the newly restored hydrology.

The exact location and design of the pipe infrastructure to support the pumping operation requested by USFWS has been estimated during development of project plans and specifications. It is anticipated that pipe would be laid from the existing pump-station and piping north of Dusky Lake immediately adjacent to the existing road right-of-way on the eastern border of the unit. From the existing piping, new pipe would then branch and continue to Post Office Lake. Wetland impacts may occur from the placement of the stand pipe or equivalent structure in the area already slated for disturbance at the north end of the lake. If concrete is used, then a pre-formed design would be preferable. If this is not possible, BMPs would be implemented to ensure that green concrete would be protected from contact with waters until completely cured. During plans and specifications development, designs would be implemented to ensure avoidance of unintended draining of the wetlands during installation of the piping and associated structures. This may be accomplished via bentonite plugs or some equivalent at points where the piping or structure enters and exits the wetlands, if necessary. Additional wetland impacts are not expected given the adjacency of the upland right-of-way berm, and this will be confirmed as final designs are determined.

A wetland determination was conducted for the route of the proposed pipe extension that would facilitate pumping into Post Office Lake. It is known that the current pump location and new outlet into Post

Office Lake would likely be located in wetlands. The effects are expected to be minimal, as the existing pump housing would be reused. The outlet structure would be a standpipe-like structure with a minimal geographic footprint that provides additional hydrology to the lake in case of a drying event. There would also be some permanent wetland impacts from installation of the pipe extending the pumping capacity from the existing pump station to the lake. This would be placed beneath an existing unimproved road. Gravel would be placed on the unimproved road in order to provide equipment access to and from the lake, staging areas, and stockpile. The road would be left in-place, so wetland impacts for the road would overlap those of the pipe. Without survey level delineation boundaries in this specific location, the permanent wetland impacts of installing the pipe and the access road are estimated to be 0.6 acres, (which assumes the entire area is wetland and would be covered by a road of 13-ft width and 0.4 miles length). The actual effects and footprint of wetlands removal and fill are expected to be much less.

Wetland impacts would be avoided during any placement or stockpiling of excess material. In locations where placement is being proposed, a wetland determination has been or will be conducted to ensure that placement of materials does not result in wetland fill.

5.3.1.1. No Action Alternative

For the No Action Alternative, there would be no wetland or riparian areas disturbed by construction. Some wetland conversion may occur on a limited basis as flood inundations gradually increase over a long duration, but this is expected to be minimal since the lake would remain excluded from tidal variation.

5.4. AQUATIC RESOURCES AND WILDLIFE

Overall, effects to fish, wildlife and plants are expected to be beneficial and long-term in nature. While the uplift for aquatic species is particularly meaningful, it provides incremental improvement within the context of ecosystem conditions and effects occurring on a much greater scale (e.g. artificial flood control, climate change, various land use practices, etc.). As an example or reflection of this larger scale framework, the proposed action will be given a Salmon Benefit Unit (SBU) score by the ERTG, which was described previously. This score is expected to be a relatively small percentage of the overall habitat actions necessary for the recovery of the species. While the proposed action is expected to provide measurable ecosystem benefits, these remain necessarily limited given the scope and size of the project area (albeit of notable acreage) and the larger processes also affecting multiple fish and wildlife species.

Additionally, there would be some acute temporary effects in the form of short-term disturbance by construction activities and ground-disturbance of the landscape. However, the construction schedule is expected to be limited to a single season in the summer and fall months, and all applicable conservation measures, reasonable and prudent measures, BMPs, and terms and conditions would be implemented according to the anticipated Biological Assessment, the referenced programmatic restoration BiOp or the anticipated final BiOps, and the Section 401 water quality certification. If the construction schedule is extended to two seasons, then appropriate BMPs, demobilization/remobilization, and site stabilization measures will be implemented in compliance with all environmental clearance documents.

5.4.1. Amphibians and Reptiles

5.4.1.1. Preferred Alternative

Transitions in vegetative communities and hydrologic regimes would likely have some effect on amphibian and reptile species. With a more dynamic and natural hydro-period, there would be more variation in the wetted areas, and there could be some expansion of wetlands since inundation extents would be greater in the winter. There could be some increase in available wetland area for amphibian use, though amphibians generally breed in non-tidally influenced sites to avoid exposing eggs. There may also be increased circulation within the lake that could improve mixing and cause more variation in water levels on a daily basis. Reconnection of the channel, lake, and floodplain should provide greater frequency and extents of inundation, while also improving water quality in the winter months (though water temperatures may warm up slower in the spring). Effects on reptiles are expected to be minimal in nature, though there may be transition of some uplands areas as vegetative communities are exposed to more frequent cycles of flood and tidal inundation.

5.4.1.2. No Action Alternative

Without-project conditions would still experience some limited degree of change over time, as the levee would continue to experience a greater frequency of overtopping and a small increase in hydrologic exchange. However, this is expected to be minimal and is not likely to affect either amphibians or reptiles in a measurable way.

5.4.2. Fish

5.4.2.1. Preferred Alternative

Long-term improvements to habitat conditions resulting from the preferred alternative (e.g., access to tidal wetlands, water quality, and forage availability) are expected to incrementally contribute to improvements to abundance, productivity, and the spatial distribution of various native fish species since the action would affect common habitat needs of multiple species. Because salmon are often considered an important indicator species reflecting ecosystem conditions, this discussion focuses on juvenile salmon.

Reductions in availability of tidal and floodplain wetlands from diking and filling in the Columbia River estuary have likely reduced the salmon-rearing capacity of the lower river (Bottom et al. 2005). Estimates of wetland loss due to diking in various reaches of the Columbia River estuary are greater than 50% of that historically present (Thomas 1983; Bottom et al. 2005). Although subject to uncertainties associated with the remote sensing methods used (see Independent Scientific Advisory Board (ISAB) 2011 relative to Garono et al. 2003), about 703 km2 (173,711 acres) of total wetlands were estimated in the entire estuary, Columbia River mouth to Bonneville Dam, of which 53% was behind dikes (92,067 acres). The preferred alternative will reconnect 130 wetland acres to the Columbia River, which incrementally will reduce the amount of wetlands isolated behind dikes and provide access to wetland habitat for juvenile salmon and other fish species.

The value of reconnecting Post Office Lake to the Columbia River for juvenile salmon can be described in context of three categories of assessment criteria (Simenstad and Cordell 2000), habitat capacity (i.e., factors promoting production), opportunity (i.e., ability of fish to access a habitat's capacity), and realized function (i.e., fish response from access to habitat capacity that promotes survival). For habitat capacity, Post Office Lake and the north channel are expected to be areas highly conducive to rearing by providing

off-channel habitat with adequate physical structure where juvenile fish may reside; producing abundant invertebrate prey in both aquatic and riparian habitats directly associated with the site, as well as transported with tides; and maintaining water quality conditions largely dependent on the tidal regime. For opportunity, fish access would be dependent on stage of the Columbia River and is expected to be possible during most times of the year with the exception of during the lowest river flows, typically in late summer and the fall. For example, river stage exceeding 9.0 feet would provide fish access to Post Office Lake and would occur about 70% of the year, whereas stage exceeding 7.0 feet would provide fish access to the north channel and would occur about 90% of the year (see Appendix A). Thus, ample opportunity would exist for fish to access capacity of the channel and lake habitats. For realized function, the preferred alternative would allow volitional residency of fish in channel and lake habitats, which would be influenced by the physiological condition of individuals as well as the physical and biological conditions in the habitats. Growth and ultimately survival of fish using the habitats is expect to be substantially greater overall than would be possible in the absence of the habitat capacity and opportunity provided by the preferred alternative.

Beneficial effects from the preferred alternative on other fish species, similar to those discussed for salmon, and conditions more conducive for native species are expected. For instance, species composition in sloughs directly open to the Columbia River contained more native fish species than sloughs with tide gates or no direct connection to the river (Johnson et al. 2009). Indirect effects of the preferred alternative that incrementally benefits the food web of native fish downstream by providing a source of macrodetritus from wetland and riparian plants (ISAB 2011) are also expected. Overall, the preferred alternative will provide habitat and associated resources to fish that would not otherwise be available.

Overall ecosystem restoration benefits were introduced in Section 2.10 in the justification for selection of the preferred alternative. As summarized, restoration benefits for aquatic species would occur on multiple spatial scales, including at the Columbia River itself, (which is a large order stream), at the north outlet channel, in the floodplain, in the terrestrial uplands, and in Post Office Lake itself. Restoration benefits are also expected to extend over multiple temporal scales with the development and evolution of riparian zone components such as fully functioning canopies, increased vertical complexity, succession of vegetative communities, changes to soil structure, improvements to hydrology, among other benefits. Restoration of more natural ecosystem functions within the contemporary setting is expected to benefit multiple species. Salmon are often considered an important indicator species reflecting ecosystem conditions, and for the Refuge, the abundance of various waterfowl species is also an important mandate. More details regarding assumptions about specific habitat benefits derived from the project can be found in the *Benefits Analysis* section of the Appendices.

Aside from the long-term benefits expected from restoration actions, there would also be some construction-related, short-term, minor, unavoidable, adverse effects like increased turbidity, and potential harm of individual fish associated with work site isolation that requires fish capture and handling. These adverse effects are predictable.

Dewatering the work area is a conservation measure that is applied to reduce the risk of potential injury to aquatic species associated with increased sedimentation and equipment operating in the channel. The Corps restoration activities that involve dewatering stream segments would follow the Dewatering and Fish Capture Protocol (see Appendix E), which is designed to minimize impacts to fish including salmonids and other species from worksite isolation, mainly stranding, capture, handling and electro-fishing.

Work in water bodies with sandy and finer substrate is reasonably certain to expose aquatic species and fish to increased levels of turbidity. For projects constructed in isolation from the flowing water, the increase in turbidity would occur after reintroduction of flow into the work area. The combination of fine substrates and larger flows would result in higher levels of turbidity that would extend further downstream than in situations where the substrates are larger and flows are lower. Generally, the increase in turbidity could last for as little as several hours but may last for several days. With finer substrates the turbidity is likely to result in negative effects to fish. For projects constructed in the wet with short in-stream action, the increase in turbidity is also expected to be short in duration. All practical BMPs would be implemented and methods would follow relevant criteria in the anticipated BiOp and Section 401 water quality certification.

The use of chemical treatment for invasive species removal is likely to directly affect fish and indirectly affect their food sources. The effects range from killing fish outright as a result of subtle, sub-lethal changes in behavior or physiology, to reductions in the availability of prey (Scholz et al. 2005 in NMFS and USFWS 2008). Most of the adverse effects from the preferred alternative are short-term in nature and are caused by invasive plant treatments in or adjacent to the stream. Practices prescribed by the preferred alternative would greatly minimize exposure of aquatic resources to materials that might otherwise adversely affect them. These measures include: (1) selection of five low-risk chemicals; (2) use of surfactants or adjuvants that do not contain any ingredients on EPA's List 1 or 2; and (3) exclusion of activities that introduced the greatest risk to aquatic resources (i.e., aerial application).

Any treatment method could introduce small amounts of herbicide into adjoining waters as a result of proposed applications. Exposure risk in the larger rivers and tributaries is considered to be extremely low because the larger size of the channels and higher base flows would dilute any chemicals that may accidently enter the water from overspray or runoff after rain events to such low levels that they are not expected to have measureable effects on fish or aquatic organisms. In these larger streams, the herbicides proposed for use are not expected to reach streams or the lake in concentrations that would kill fish, or in sufficient quantity to degrade water quality. Where concentrations could be higher, effects are expected to be sub-lethal and limited to short-term alteration of olfactory function. This may result in temporary behavioral changes that could include delayed predator avoidance response.

Short-term adverse effects on water quality are likely to occur when near or in-water invasive plant treatment occurs. Increased levels of chemical contaminants resulting from treatment would last for a few hours to a maximum of a few weeks. Minor inputs of chemical herbicides as described above would degrade water quality for a period of hours to days. In the long term, the removal of invasive plants is designed to improve habitat quality. Planting riparian areas creates shade and thus reduces summer stream temperatures.

Removing, breaching and lowering dikes and regrading/restoring hydrology in the proposed floodplain areas involves the use of heavy equipment in the floodplain. Regrading of topography in the reopened area usually can be done prior to and in isolation from the water. However, levee removal work, even if done at low tides, would involve some water contact towards the end of construction. This would adversely affect water quality by increasing turbidity during construction. Increases in turbidity would periodically occur with major flow events and tidal cycles, until floodplain and wetland marsh vegetation is fully established. Turbidity is not expected to persist at the project site, as the channel is expected to be relatively stable in its current location and form, and the proposed changes are minor, with revegetation expected to occur within the season.

The construction process for removing debris and bank protection would in some cases adversely affect water quality by resulting in a short-term increase in turbidity during construction, and shortly thereafter.

In the freshwater environment increased turbidity can result in increased substrate embeddedness and pool filling during and after construction. However, the habitat type in and near the project site is characteristic of backwater sloughs and does not have spawning gravels or adequate flows. By the time any turbid releases reach the mainstem Columbia, they are expected to be minor and quickly dissipated by the larger flow volumes of the mainstem. Finally, construction may involve partial worksite isolation (lateral coffer dams) to avoid some aquatic resources exposure to the acute effects of instream construction. While worksite isolation is a minimization practice consisting of several measures meant to decrease fish exposure to the effects of construction activities, it could injure or kill some organisms. Minor reductions in invertebrate forage would occur as a result of short-term, small scale construction related increase in fine sediment or worksite isolation. The affected construction area would be recolonized by invertebrates within a few months. Invertebrates would quickly move into restored stream areas by drift from upstream and by eggs from adults. Short-term reductions in algae and macroinvertebrates would occur as described in the analysis of herbicide effects.

The Refuge may implement a pumping contingency in order to keep the lake levels higher than would naturally occur under drought conditions. Unscreened or improperly screened pumping diversions can entrain fish into canals where they become trapped and die. If approach velocities are too fast, fish can also be impinged against the screen surface. To avoid any effects from improperly designed screens, all proposed screen installations or replacements for contingency pumping would meet NMFS fish screening criteria (NMFS 1997). Possible screening needs were considered at the Dusky Lake water control structure, as fish may pass into the management area and become stranded depending on water management conditions. However, these were deemed unnecessary based on conversations with NMFS and the Refuge (NMFS USFWS 2012). Pumping intake location would also be taken into consideration, as the Refuge has mentioned concern with the spread of rice field bulrush, and water quality in Lake River is considered poor, especially relative to that of Post Office Lake or the Columbia River. The amount of water pumped from Lake River into Post Office would result in a greater concentration of Lake River water in the lake in the summer months when dry conditions in the lake would necessitate pumping. However, increased tidal exchange and floodplain connectivity is also expected to increase connectivity and accelerate the potential for water to flush through the system. Pumping is also expected to occur yearly for a relatively short duration. For these reasons, though Lake River water quality is likely poorer than that expected in Post Office, the effects on aquatic organisms are expected to be minimal.

The proposed activities would not reduce water quantity with the exception of short-term construction actions that require work area isolation. In these cases, water quantity in a very small area may be impacted for a maximum of several days. Project elements that are designed to improve stream and floodplain connection such as levee removal and modification and side channel/off channel habitat restoration would result in greater storage of water in the floodplain. This water would then be available for late season in-stream recharge.

In the long term, restoration activities that improve riparian function reduce inputs of fine sediments and help to encourage establishment of healthy riparian plant community, which would result in increased terrestrial and aquatic forage. Riparian disturbance caused by construction activities for access and site preparation would result in some minor reduction of overhead cover at project sites. Many restoration activities such as large wood placement and riparian plantings would improve cover for fish and invertebrates. Construction activities may temporarily impede fish passage for a maximum of a few days. In the long term, the proposed tide gate removal and floodplain reconnection would improve fish passage.

With restoring access to the mainstem Columbia, there is also the possibility that non-native carp would access Post Office Lake. These species can be detrimental to water quality as well as the emergent and submergent vegetation. This could result in an increase in turbidity not related to construction actions,

along with a decrease in aquatic emergent vegetation. However, it is anticipated that the restored hydrologic regime and variable water levels would reduce the likelihood of a complete infestation and may somewhat limit carp spawning success due to factors such as water level fluctuation noted in HEP/HSI for carp (Edwards 1982) and seasonal drying. Overall, other fish and aquatic resources would be able to coexist with carp, but could be limited in the event of a carp population explosion. Carp are present in Campbell Lake and Slough (which are somewhat representative of potential post-project conditions at Post Office Lake) and other species populations and native emergent vegetation communities have remained viable.

Macroinvertebrates serve as a forage resource for both fish and wildlife species. There would be some minimal loss of invertebrates during construction-related disturbance; however, those species occupying the lake and channel bottom are expected to rapidly recolonize the area. It is also possible that the lake bed would experience drier conditions in the summer months with restoration of a more natural hydroperiod. Tidal reintroduction would increase the dynamic vertical movement of water surface elevations, with current wetter areas receiving less permanent water levels. The lake may also drain and become disconnected during periods when the Columbia River water elevations are below the inlet of the lake. This could negatively affect macroinvertebrates reliant on permanent saturated or inundated conditions. However, there would also be better opportunity for macroinvertebrate recruitment from the Columbia Mainstem, and restoration of hydrologic and disturbance regimes would facilitate development of a native, more diverse prey base that includes riverine species. Additionally, based on Refuge requests there may be pumping contingencies implemented during the 3-5 year drought cycle (up to annually) such that the lake does not remain dry for any extended period of time. Macro-invertebrate populations would be protected by pumping, and would not be reduced in way that would detrimentally limit forage for populations on the Refuge. For these reason, no permanent, large-scale adverse effects to macroinvertebrate populations that provide forage for both waterfowl and salmonids are expected.

Additional salmon-specific effects are discussed further in Section 5.5.

5.4.2.2. No Action Alternative

Without restoration, fish access to Post Office Lake would remain extremely limited. It is likely that under current conditions, the fish community is composed mainly of warmer-water species, If the proposed restoration project is not implemented, there would also be a lost opportunity to restore resident and anadromous fish access to backwater slough and floodplain habitat types that are very limited on the Columbia River mainstem.

5.4.3. Birds and Mammals

5.4.3.1. Preferred Alternative

Terrestrial wildlife may demonstrate some short-term flushing and avoidance behavior associated with general construction activities. Because actions are expected to be limited to daylight hours and span a single season, this is not expected to have discernible negative impacts to foraging or breeding behavior. This portion of the Refuge is typically closed to recreational or hunting activities from October to the end of January to minimize disturbance to waterfowl. Much of the construction would be completed by this time; however, additional planting activities may be required. In this case, the Corps would work closely with Refuge staff in order to minimize impacts while efficiently and effectively completing the necessary project elements.

Effects to non-listed aquatic and terrestrial species would be similar to those described below for listed species. None of the described effects are expected to rise to the level of adverse impacts. This conclusion is supported by the consultation evaluation and determination described in the next section and in Section 7 of this report. This project is expected to either proceed as an informal consultation, or receive coverage for listed species under USFWS jurisdiction under an existing programmatic restoration BiOp described in Section 7.5 of this report. Otherwise, under individual consultation the anticipated BiOp is expected to reflect analyses and conditions similar to those in the programmatic restoration BiOp.

In order to determine how different alternatives affected various suites of species, the previously described benefits analysis predicted how restoration actions would impact species specific habitat components for gadwall and scaup. The preferred alternative does not measurably impact gadwall habitat, as it remains optimal. Scaup are less impacted by the preferred alternative relative to some of the other alternatives, as it assumes lake levels remain higher in the winter when they are most likely to be present on the Refuge. There was some concern that drier summer conditions may be detrimental to food sources (pelecypods), although this has yet to be determined. For this reason, the Refuge has requested a pumping contingency in the event that the lake goes dry during a 3-5 year drought interval. However, pumping may occur on a yearly basis. Specific criteria have yet to be determined regarding the triggers that would necessitate pumping. However, it is assumed that even under drier conditions, there would not be a measurable or detrimental decrease in forage resources for scaup. Temporary impacts to macroinvertebrates during construction are expected to be short-term due to rapid recolonization of species, such that food resources for waterfowl would not be permanently impacted by acute construction activities.

Wetlands would be temporarily impacted and could have indirect effects on sandhill cranes, gadwall, and other wetland-dependent waterfowl. However, these construction effects are expected to be short-term and the bulk of the activities should be completed prior to the arrival of peak migrations. There may be some planting and revegetation activities after October 1, but these temporary disturbances are expected to be minimal and easily avoidable. Over the long-term, it is expected that the transition in wetlands and greater frequency and extent of inundation during winter months could improve the quality and extent of wetland habitat used by various waterfowl, especially dabbler species.

Restoration of the riparian areas and planting of the floodplain forest is also expected to benefit species that utilize this habitat by improving the age-class diversity, increasing the canopy complexity, and improving the percent composition of native species. These areas would provide greater cover and habitat complexity, including additional opportunities for cavity nesters. Succession will be limited in the floodplain swale and in the pasture in order to maintain sight distances that are required by several species, therefore, any potential negative impacts for certain waterfowl from the vegetative transition would be limited and of minimal effect.

Post Office Lake currently provides wintering waterfowl with two important types of forage, macro invertebrates such as snails and bivalves, and pondweed tubers. Both types of forage require flooded conditions. Restoring tidal influence would reduce the amount of permanently flooded wetland area and change the availability of both forage types. Permanently flooded area would be reduced to approximately 40% of the current (summer average) area following re-connection of the lake to the Columbia, if the Refuge maintains the portion of the lake behind the sill at full pool by occasional pumping. In the absence of pumping, permanently flooded wetlands area would be reduced. The remaining inundated wetland would be shallower and more suitable to robust emergent vegetation which would further reduce pondweed tuber abundance.

The reduction in submergent vegetation and the anticipated increase in emergent vegetation would impact waterfowl use of the site. USFWS anticipates that use by diving ducks such as canvasback and lesser scaup would be measurably reduced by the reduction in forage and open water habitat, particularly during early migration. Later in the winter when river levels rise and Post Office Lake is deeper than it is under current conditions (1 to 2 m), submergent tubers will be less available and the deeper water will increase the energetic costs of foraging. Other forage may be available during flood periods in higher elevation wetlands in the project area, but this is uncertain.

The invertebrate community would also change following restoration of tidal influence. Invertebrates such as snail and bivalves that require permanent inundation would decline with a possible increase in species such as mosquitoes and midges which are well adapted to seasonally flooded wetlands. In the northern channel, invertebrates that thrive in highly oxygenated riverine conditions such as stoneflies may become more abundant. As stated above, it is expected that the snails and bivalves are likely to decrease, although some species are mobile and would stay in the flooded areas, many may not find areas of permanent inundation and desiccate. It is difficult to determine the magnitude of the change in the community as those invertebrates that do remain in the inundated areas may be more susceptible to predation and competition as the water is shallower and the portions of the vegetative community would change. The Refuge has conducted limited monitoring of the invertebrate community in Post Office Lake. Data from the lake following construction would be needed to accurately assess the invertebrate community and the forage availability for both avian and fish communities.

In response to the changing physical and biological conditions, USFWS expects the community of wintering waterfowl and waterbirds using the lake would change significantly and more closely resemble to bird use of Campbell Lake. The area would likely continue to see some use by diving ducks, coots, and grebes for foraging and sanctuary, particularly during the hunting season, but at a reduced rate from current levels. Some of the dabbling duck species such as gadwall, American wigeon and northern pintail would likely shift some of the use from using Campbell Lake to Post Office Lake depending on vegetation community and water conditions. These changes would likely be local and it is not expected that regional populations of any of the avian or invertebrate species discussed above would be measurably impacted.

5.4.3.2. No Action Alternative

Without implementation of the preferred alternative, the Refuge would continue to manage the Ridgefield Dairy Unit for waterfowl species with a focus on Canada dusky geese and sandhill cranes. The area would remain managed pasture that experiences somewhat more frequent inundation as the levee continues to breach. There could be some transition of wetlands with greater inundation and no outlet, but the lake would remain disconnected from the tidal regime. Waterfowl would not experience the temporary impacts from construction activities, and would also not experience the benefits of a restored adjacent riparian zone with more age-class and species diversity.

5.5. THREATENED AND ENDANGERED SPECIES

5.5.1. Fish Species

5.5.1.1. Preferred Alternative

Of the nine project categories evaluated in the joint programmatic restoration BiOp (is likely to somewhat reflect the BiOp the Corps anticipates receiving after individual consultation is complete; see Section 7.5), several apply to actions proposed by the Corps at Post Office Lake. These categories include fish passage

(removal of the tide gate, modification of the channel); installation of instream structures (placement of woody debris and live stakes); levee removal and modification; side channel/off-channel habitat restoration and reconnection; and debris and structure removal. The nine restoration categories addressed and evaluated by the representative programmatic BiOp are designed for the sole purpose of improving habitat conditions for listed salmonids and other terrestrial species. In the restoration BiOp, the NMFS and USFWS (the Services) expected these long-term improvements to habitat conditions to incrementally result in improvements to abundance, productivity, and the spatial distribution of all listed salmonids.

These categories of habitat projects benefit listed salmonids by improving the primary constituent elements (PCEs) of their habitat. Primary constituent elements are physical and biological features essential to conserve a species and are identified in designating critical habitat. For listed salmonids, PCEs consist of sites supporting life history stages (e.g., spawning, rearing, migration and foraging) and associated site features (e.g., spawning gravels, water quality and quantity, forage species). Critical habitat recently was proposed for Columbia River coho salmon (78 FR 2726) and has been designated for all other listed salmon and steelhead in the Columbia River basin (58 FR 68543; 64 FR 57399; 70 FR 52630). The preferred alternative is expected to benefit several PCEs of listed salmon and steelhead (Table 22) and also benefit other aquatic and terrestrial species that share common habitat needs.

Table 22. Relevant Salmonid Primary Constituent Elements (PCEs)

Select PCEs of critical habitats designated for ESA-listed salmon and steelhead species (based on 70 FR 52630) and their corresponding life history events with potential to be in or affected by the proposed action area

Primary Constituent Elements		**Species Life History Event**
Site Type	**Site Attribute**	
Freshwater rearing	Floodplain connectivity Forage Natural cover Water quality	Fry/parr/smolt growth and development
Freshwater migration	Free of artificial obstruction Natural cover Water quality Water quantity	Adult upstream migration and holding Kelt (steelhead) seaward migration Fry/parr/smolt growth, development, and seaward migration
Estuarine areas	Forage Free of artificial obstruction Natural cover Water quality	Adult upstream migration and holding Kelt (steelhead) seaward migration Fry/parr/smolt growth, development, and seaward migration

The PCE's indicated above area expected to experience direct or indirect improvements as a result of this ecosystem restoration project. The project seeks to improve riparian and floodplain function and access. Adequate, functioning riparian zones and regularly accessible floodplain habitat provide several important ecological benefits. One of these benefits affecting both fisheries and wildlife includes improvement and protection of water quality. Riparian zones provide this ecosystem service via several mechanisms such as bank and erosion stabilization; energy dissipation, especially during high-flow and channel forming

events; stormwater mitigation and treatment via dissipated flows, improved infiltration, and filtration from increased soil pathways, root uptake, and conversion of potential pollutants by plants; and temperature regulation via shade and canopy cover. Improved floodplain connectivity also contributes to water quality by providing energy dissipation and flood storage capacity, which helps preserve hydrologic and channel structures downstream, reducing bank erosion, head-cutting, lowered water-tables, and scour. Increased hydrologic exchange via both flooding and tidal exchange could also have beneficial effects to temperature and DO levels due to increased mixing and flushing.

Riparian zones and floodplain access also play a critical role in providing habitat structures and diversity for both upland and aquatic species. Wood export from riparian zones provides important habitat features for salmonids and other fish by adding instream complexity and pocket habitats. Access to wetland fringe and floodplain habitat is also important feeding and refugia for salmonids and other aquatic species.

Floodplain and riparian zones contribute to the food web by providing substrate and food for a variety of macroinvertebrates that comprise the diet of many aquatic and waterfowl species. Riparian zones and floodplain habitat provide allochthonous inputs and detritus which provide important energy resources, particularly in higher order streams where autochthonous sources can be limited by water depths and light penetration. During high flow events, aquatic species like juvenile salmonids are able to conserve important energy resources and to access food supplies otherwise unavailable during normal flow events. Floodplain reconnection and additional habitat improvements via levee plantings provide further uplift to quality and access opportunity.

In addition, the preferred alternative incorporates restoration measures prescribed in the salmon-centric Columbia River Estuary (CRE) module (NMFS 2011), including riparian restoration, levee revegetation, and floodplain connectivity. Opportunities at Post Office Lake that have been identified to address problems areas also align with those identified in the NMFS CRE Recovery Plan Module:

- CRE-1.4: Restore and maintain ecological benefits in riparian areas; this includes managing vegetation on dikes and levees to enhance ecological function and adding shoreline/instream complexity for juvenile salmonid refugia.
    a. The preferred alternative would both restore and enhance vegetation beside the instream habitat of the northern connection channel, along the levee, and around the portions of the floodplain southwest of the lake.
- CRE-6.2: Identify and implement dredged material beneficial use demonstration projects, including the notching and scrape-down of previously disposed materials and placement of new materials for habitat enhancement and/or creation.
    a. The preferred alternative includes laying back previously excavated banks that were created from dredging the existing lake outlet channel, as well as from an old dredge disposal site. This would restore a 2-stage tidal channel connecting the lake to the Columbia River. A new swale would also be dredged from the new breach to the lake to slightly concentrate flows in during flood events and salmonid ingress.
- CRE-9.4: Restore degraded off-channel habitats with high intrinsic potential for increasing habitat quality.
    a. Post Office Lake is marginally connected to the Columbia River in one location via a non-functioning tide gate. However, this connection offers minimal to non-existent hydrologic exchange and no fish passage. There are also a series of breaches beginning to form in the levee itself in one main location and two other locations. Restoring connectivity in these locations would open access to additional habitat that can be further improved through other project measures. This would also restore hydrologic and tidal

regimes to the lake and floodplain that have been disconnected in recent history due to the existing levee.

- CRE-10.1: Breach, lower the elevation of, or relocate dikes and levees; create and/or restore tidal marshes, shallow-water habitats, and tide channels.
    a. These components are elements of this restoration project. The current levee is failing, but hydrologic connectivity is not yet optimal for salmonid access or regular floodplain connectivity.
- CRE-10.2: Remove tide gates to improve the hydrology between wetlands and the channel and to provide juveniles with physical access to off-channel habitat; use a habitat connectivity index to prioritize projects.
    a. This is a component of the preferred alternative to remove the water control structure and to pass the full tidal prism.
- CRE-15.3: Implement projects to address infestations on public and private lands.
    a. There are several invasive species on site that would need to be removed and managed at least minimally in order to restore a native riparian community, which is a measure within several alternatives.
- CRE-15.4: Monitor infestation sites.
    a. Site restoration and management by the Refuge would likely require and entail monitoring and managing for native revegetation success.
- CRE-20.2: Implement pesticide, fertilizer, and nutrient best management practices (BMPs) to reduce contaminants entering the estuary.
    a. The Corps would follow the more restrictive of: the new National Pollution Prevention Discharge Elimination System Section (NPDES) 402 Pesticide General Permit administered by the Environmental Protection Agency (EPA) under the Clean Water Act (CWA); or related conditions in the joint programmatic restoration BiOp (NMFS and USFWS 2008); or conditions described in the Refuge's integrated pest management plan to protect water quality and species.

Aside from the long-term benefits that the Corps expects, the proposed actions would have some construction-related, short-term, minor, unavoidable, adverse effects like increased turbidity, embeddedness, and harm of individual fish associated with work site isolation that requires fish capture and handling. These adverse effects are predictable.

The effects to non-listed fish described in Section 5.3.2 also generally reflect potential effects to listed fish. Dewatering the work area is a conservation measure that is applied to reduce the risk of potential injury to salmonids associated with increased sedimentation and equipment operating in the channel. The Corps restoration activities that involve dewatering stream segments would follow the Dewatering and Fish Capture Protocol from the programmatic restoration BiOp (see Appendix A), which is designed to minimize impacts to salmonids from worksite isolation, mainly stranding, capture, handling and electrofishing.

It is very unlikely that there are any listed species present in the project area, with the possible exception of the portion adjacent to the mainstem Columbia when the levee is excavated and the tide gate is removed. Fish are currently excluded from the lake and channel. Adverse impacts to adult salmonids from worksite isolation would likely be limited to temporary displacement. Due to their size salmonids are generally successfully seined out of the construction area. The effects on sub-adult salmonids are limited to temporary displacement, seining and handling. Sub-adults generally cannot hide in the gravel and thus, are easier to seine. Should they still be in the construction area during gradual dewatering, they are easier to detect than juveniles and are likely to be rescued with sanctuary nets. Juvenile salmonids (0+) are the only age class that is likely to experience effects from electrofishing and stranding in addition

to temporary displacement, seining and handling. Electrofishing would be used as a last resort, and NMFS electrofishing guidelines would be followed (NMFS 2000).

Temporary effects from short-term turbidity; chemical treatment for invasive species removal; construction processes for removing debris, bank protection, breaching and lowering dikes and regrading/restoring hydrology; and pumping would all be similar to the potential effects to fish and aquatic resources described in Section 5.3.2 and are not repeated here.

Juvenile, sub-adult and adults salmonids may be present post-project in areas where herbicides could be used, though their current presence at the site is highly unlikely. Timing restrictions prohibit instream activities during spawning and incubation periods, so herbicide exposure for spawning adults or incubating eggs and alevins is not expected. This area also does not support habitat associated with these life stages. However, any work outside the IWWW would be scheduled to occur mostly in the dry and would be less likely to come into contact with waters. Any treatment method could introduce small amounts of herbicide into adjoining waters as a result of proposed applications. Exposure risk in the larger rivers and tributaries is considered to be extremely low because the larger size of the channels and higher base flows would dilute any chemicals that may accidently enter the water from overspray or runoff after rain events to such low levels that they are not expected to have measureable effects on fish or aquatic organisms. In these larger streams, the herbicides proposed for use are not expected to reach streams in concentrations that would kill salmonids, or in sufficient quantity to degrade water quality. In smaller streams, effects to salmonids from exposure to herbicides, where concentrations could be higher, are expected to be sub-lethal and limited to short-term alteration of olfactory function. This may result in temporary behavioral changes that could include delayed predator avoidance response.

Additionally, resource agencies have expressed post-project concerns regarding potential juvenile stranding and creation of an attractive nuisance such that juveniles could be exposed to higher summer water temperatures in a potentially shallower lake. The shallower lake conditions may also create depredation issues as piscivorous birds could have an easier time capturing juveniles in shallower water conditions. These concerns have been addressed in project design via several factors. First, hydrologic data suggests that mean higher high tide will overtop the lake inlet elevation well into the low-water months. Therefore, it is likely fish egress will remain possible several times monthly, or as frequent as several times a week at the proposed design elevation. This greatly reduces the likelihood of stranding and allows some mixing of cooler river waters with warmer lake waters. Data at Campbell Slough (USGS 2010), which is of similar habitat type and is north of and adjacent to the project, indicates that juveniles move out of the slough in June and July, which would avoid the lower water periods in Post Office Lake if the behavior is similarly reflected in the proposed action area. For juveniles that miss the tidal and temperature triggers cuing egress, large wood and rootwads with high degrees of interstitial spaces will be placed in the channel and lake to provide habitat complexity and cover. There will also be a temperature and depth refugia pool excavated at the north end of the lake in order to provide some thermal stratification so that temperature refugia and depth cover is available for juveniles that over-summer in the lake. For these reasons, negative effects to salmonids are expected to be minimal. Monitoring and adaptive management actions will address any of these issues if it is determined that project assumptions were incorrect.

During the 2-year flood event, water will overtop the low berm between Dusky Lake and the north connection channel. The water control structure between these two water bodies is actively managed by USFWS in order to maintain wetland conditions for migrating waterfowl. The structure is typically boarded closed in late September or October in order to hold back water for returning birds. The structure remains closed until June or July when it is opened and the lake is allowed to drain for mowing and spraying of invasive species. During a 2-year event, fish could ingress into Dusky. The water control

structure would be opened in July or August when fish would typically egress, as demonstrated in the Campbell Lake unit. Because of the timing of the water management practices, the predicted coincident general egress timing of fish movement, the shallower depth of Dusky Lake, and the limited water quality conditions relative to Post Office Lake and the northern connection channel, it is predicted that fish would cue to egress into the adjacent water bodies (northern connection channel, Post Office Lake, or the Columbia) in a manner that is complementary to USFWS management practices. Therefore, the risk of stranding is considered relatively low compared to the benefits of access to additional forage and rearing areas.

It is extremely unlikely for bull trout to be present in the bulk of the project area, though they could be migrating in the adjacent mainstem Columbia during tide gate and levee removal. Most of the preferred alternative's adverse effects on bull trout stem from short-term exposure of sub-adults and adults to elevated levels of turbidity in areas that are used seasonally for migration or foraging. The exposure to turbidity is not likely to kill individual fish. Sub-adult and adult bull trout could be stressed or injured during attempts to remove fish from work areas, though their presence is not expected in the project area. Project-related effects to individuals are the same as may be expected for all salmonids.

Salmonid primary constituent elements (PCEs) relevant for the project site include: Freshwater rearing sites, freshwater migration corridors, and estuarine areas. For bull trout, PCEs affected both positively and negatively (short-term) include temperature (which could improve with riparian plantings); complex stream channels; natural hydrograph, (which could improve with restored hydrology); migratory corridors with minimal physical, biological, or water quality impediments; abundant food base including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish (which could improve with riparian plantings). Critical habitat includes the stream channels within the designated stream reaches, the shoreline of designated lakes, and the inshore extent of marine nearshore areas, including tidally influenced freshwater heads of estuaries.

The Services established in the programmatic restoration BiOp (see Section 7.5) that the only adverse effects on habitat would be short-term and construction related, mainly water quality effects in the form of increased suspended fine sediment and sediment deposition. Implementation of the preferred alternative would cause some minor, predictable, construction related, short-term adverse effects to critical habitat PCEs.

The proposed activity categories would not reduce water quantity with the exception of short-term construction actions that require work area isolation. In these cases, water quantity in a very small area may be impacted for a maximum of several days. Project elements that are designed to improve stream and floodplain connection such as levee removal and modification and side channel/off channel habitat restoration would result in greater storage of water in the floodplain. This water would then be available for late season in-stream recharge. Minor reductions in invertebrate forage would occur as a result of short-term, small scale construction related increase in fine sediment or worksite isolation. The Services expect that the affected construction area would be recolonized by invertebrates within a few months. Invertebrates would quickly move into restored stream areas by drift from upstream and by eggs from adults. Short-term reductions in algae and macroinvertebrates would occur as described in the analysis of herbicide effects.

In the long term, restoration activities that improve riparian function reduce inputs of fine sediments and help to encourage establishment of healthy riparian plant community, which would result in increased terrestrial and aquatic forage. Riparian disturbance caused by construction activities for access and site preparation would result in some minor reduction of overhead cover at project sites. In the long term, many restoration activities, such as large wood placement and riparian planting would improve cover for

salmonids and steelhead. Construction activities may temporarily impede fish passage for a maximum of a few days. In the long term, the proposed tide gate removal and floodplain reconnection would improve fish passage.

These negative effects to critical habitat would last for a few days to a few months. However, these short-term adverse effects would be far outweighed by the long-term beneficial effects of the preferred alternative. The conservation value of critical habitat would increase as a result of the preferred alternative. As summarized above, the preferred alternative would have long-term beneficial effects to critical habitat PCEs at the watershed scale. The construction-related adverse effects to PCEs are expected to be minor and short term (typically a few days).

Green sturgeon are not likely to be present in the project area. Observations of green sturgeon in the Columbia River are concentrated in the estuary but have been made as far upriver as Bonneville Dam. No evidence exists for spawning in this system (Rien et al. 2002). Although information on habitat preferences is limited for sub-adult and adult green sturgeon in the Columbia River, information on white sturgeon in the Columbia River suggests that larger fish tend to congregate in deep pools. Parsley and Beckman (1994) reported average water depths for juvenile white sturgeon in the Columbia River of 55 feet. This suggests, assuming habitat preferences are similar between the two species, that green sturgeon are unlikely to be found in proximity of the project footprint or construction zone. Impacts to green sturgeon critical habitat and the estuarine PCEs are similar to those described for salmonids, and are not expected to reach measurable levels, as effects would be short-term and of low intensity.

A large percentage of the total eulachon production originates in the Columbia River Basin. Spawning occurs in the mainstem of the Columbia River upstream of the estuary (Emmett et al. 1991, Musick et al. 2000) in January or February (Beacham et al. 2005). Additionally, eulachon usually spawn every year in the Cowlitz River, with inconsistent runs and spawning events occurring in the Gray's, Elochoman, Lewis, Kalama, and Sandy rivers (ODFW and WDFW 2009). Prior to the construction of Bonneville Dam, occasional reports were received of smelt occurring upstream as far as Hood River, Oregon, and possibly farther (Smith and Saalfeld 1955). In times of great abundance, (e.g., 1945 and 1953) eulachon have been known to migrate as far upstream as Bonneville Dam (Smith and Saalfeld 1955, Howell et al. 2001), and are suspected of passing through the ship locks, having reached the Klickitat River (Smith and Saalfeld 1955). Although eulachon have been observed migrating up the Columbia River, spawning has not been documented in the mainstem above RM 80 (Romano et al. 2002).

Larval forms of eulachon out-migrate through the estuary and juvenile forms rear in marine waters extending out along the continental shelf (NMFS 2008a). Eulachon larvae are approximately 0.2 inches in length and, are rapidly flushed to the ocean, often within days of hatching, and subsist on their yolk sac during this downstream dispersal (WDFW and ODFW 2001). Most larval eulachon should have been flushed out of the estuary to the ocean prior to the July through October in-water construction period.

Eulachon return to fresh water to spawn at 2 to 5 years of age. Spawning in the lower Columbia River can occur soon after freshwater entry (ODFW and WDFW 2009). Eulachon typically enter the Columbia River in early to mid-January (although a small 'pilot' run may occur in December), followed by tributary entry in mid- to late January. Peak tributary abundance is usually in February, with variable abundance through March and an occasional showing in April (ODFW and WDFW 2009). Therefore, adult eulachon are unlikely to be present during in-water work, which is scheduled for July through October. Impacts on eulachon critical habitat and the PCEs is similar to that described for salmonids, and is not expected to reach measurable levels, as effects would be short-term and of low intensity. Long-term beneficial effects are expected.

5.5.1.1. No Action Alternative

If no action is taken, the existing conditions on the restoration portion of Post Office Lake would continue to provide poor fish habitat and would fail to support the fish and wildlife habitat restoration objectives of the FCRPS BiOp. The north connection channel and surrounding riparian habitats would remain degraded. Over the years the north channel has been degraded by land use practices (e.g., cattle grazing causing bank and channel degradation, as well as dredge material deposition, etc) that have created a steep banked, ditched waterway geometry dominated by non-native plants (reed canarygrass and Himalayan blackberry). This was worsened by the channel and wetland being disconnected in the 1950s from intertidal flow. Intertidal circulation would continue to be blocked by the culvert and tide gate, as well as the levee. In addition, the elimination of the old riparian forest has limited detritus production and export. The pastureland adjacent to the marsh and slough habitat would remain in its current managed condition, which limits riparian forest recruitment. Although recruitment would somewhat increase as the levee naturally degrades, it would be a slow process.

If no action is taken, the capacity of Post Office Lake to support salmonids would be limited. The backwater slough and lake would remain partially isolated from the river and would be unable to fully contribute to the productivity and fish community of the lower Columbia River and estuary. The regional goal to restore and protect 10,000 acres of wetland and riparian habitats in the lower Columbia River and estuary for the conservation and recovery of ESA-listed salmonid populations would take longer to accomplish, and the 130 acres of protected, restorable habitat at Post Office Lake would remain underutilized by salmonids.

5.5.2. Wildlife, Birds, and Plant Species

5.5.2.1. Preferred Alternative

There are no known listed terrestrial species expected to be present in the project area. However, the Corps has informed and would continue to coordinate with USFWS to ensure compliance with the joint programmatic restoration BiOp (see Section 7.5) for the preferred alternative. This includes notification for work in Clark County for the protection of Columbian white-tailed deer (CWTD). According to the programmatic restoration BiOp, to avoid and minimize impacts to Columbian white-tailed deer during the fawning period, restoration activities 2 miles inland from the Columbia River between 2 miles east of Cathlamet and 2 miles west of the community of Ridgefield would not occur from June 1 to June 30. Refuge staff has indicated that there are currently no known deer on the Refuge and this exclusion is not likely to apply to the preferred alternative at Post Office Lake (Chmielewski 2012).

It has also been mentioned that sometime in the future there may be plans to conduct an emergency transplant of Columbian white-tailed deer to the Refuge in order to address a potential flooding issue due to levee failure at another Refuge. If this occurs (which may be more likely based on recent conversations with the Refuge (Lapp 2012), the addition of the riparian and floodplain forest plantings would provide additional cover adjacent to the existing pasture. There may be temporary flushing from acoustic and human disturbance during construction activities. However, because of their geographically isolated and short-term nature, effects would not be expected to have any lasting negative effects to habitat use or foraging opportunities. The Corps would continue coordination with Refuge staff in the event that deer were transferred to the Refuge, but at this time it is expected that the preferred alternative would not have any detrimental effects on deer if they were present in the unit (Lapp 2012).

Streaked horned lark are proposed for listing under ESA, however there are no confirmed cases of them in Clark County, nor is the Refuge or sites adjacent along the Columbia listed as critical habitat. However,

Refuge staff has indicated there may be future plans for habitat restoration. The proposed action is not expected to have negative impacts on potential streaked horned lark habitat. If anything, selection of the location for fill placement may be used to create bare ground habitat more suitable for streaked horned lark.

According to the CCP, golden paintbrush is not located on the Refuge (p 4-65, CCP, USFWS 2010b). Nelson's checker-mallow, Bradshaw's desert-parsley, and water howellia also are not located on the Ridgeport Dairy unit, so none would be affected by proposed actions. The joint programmatic BiOp also requires notification for work in Clark County to protect Bradshaw's desert-parsley and water howellia. Prior to initiating restoration activities in or within 50 meters of ephemeral or vernal pool wetlands ringed by primarily deciduous vegetation in Clark Counties, the Corps would contact USFWS staff: (1) to avoid and minimize impacts to Bradshaw's desert-parsley and water howellia and their habitat; and (2) to ensure no effect on Bradshaw's desert-parsley and water howellia. These plants were not found during wetland delineations and are not expected to be present in the project area. However, the Corps would confirm this with appropriate USFWS staff per conditions of the programmatic BiOp.

5.5.2.2. No Action Alternative

Without project implementation, the site would remain as a managed pasture with limited hydrologic connection via the existing levee over-topping. The benefits of restored disturbance regimes, tidal, and floodplain connectivity would not be realized. The area would remain drier in the winter than with-project conditions, though not as dry as it is currently since the levee will continue to overtop. Vegetative community succession would remain limited, and the composition of non-native verses native species would remain similar to the current state, which appears to be dominated by non-native species. The riparian areas would remain degraded and would not reach recruitment or complexity capacity that could provide more diverse habitat for cavity nesters and other riparian-dependent species. Such habitat would remain at risk of further loss without improving the recruitment and sustainability capacity of the existing buffer areas.

5.6. CULTURAL AND HISTORIC RESOURCES

5.6.1. Preferred Alternative

The APE for the project consists of 5.2 acres surrounding of the north ditch construction area and associated 2.2 acres of staging area, 2.5 acres of the levee asphalt scarification, a proposed pumping station with a pipeline to the lake, and replant construction area, and 4.5 acres of floodplain reconnection area. The South Parking Lot Staging Area (0.3 acre), also to be used as a staging area, consists of an already-existing, asphalt-and-concrete pad; its use is expected to pose no possibility of impact to any cultural resources. Haul routes throughout the project area consist of unimproved, graveled roads, and their use is expected to present no potential to impact cultural resources as long as the roads are not used during saturated ground conditions. The APE was formulated in consultation with Washington Department of Archaeology and Historic Preservation (DAHP).

A cultural resources survey of the APE was performed in late September and early October 2011 by Portland District archaeologists. Ground inspections and subsurface shovel testing did not reveal any historic properties or archaeological deposits in the vicinity of the tide gate corridor located at the northern end of Post Office Lake where the drainage channel appears to have been dredged in the past. Soil profiles and the presence of crushed, angular basalt gravels found in portions of the northern and southern work areas, as well as mottled soils and foreign materials observed during testing, suggest the project area has been subjected to considerable previous disturbance. Furthermore, exposed profiles in

native soils observed along the river bank did not reveal any hearth features or fire-cracked rock; buried wood debris, however, presumably from past overbank flooding episodes, was noted in a few areas. In the time since the October 2011 survey was done, modifications to the project have been proposed, including a new disposal area and a pumping station which would include a pipeline to the lake. Given that these specific actions within the APE were not previously addressed, further archaeological fieldwork has been scheduled.

The levee paralleling the Columbia River along the project's west side contains portions that were constructed over 50 years ago. However, the present levee has undergone multiple construction periods, degradation and erosion; it contains a wide variety of building materials in various layers and along sections of its length, and portions of earlier levee "roads" have also been incorporated. Although the alignment of the original levee, which was an augmentation of the natural levee, has remained the same, its constituent materials have varied through time. There is little formal construction; the original structure was probably built by farmers who simply added soil from fields onto the natural levee. As such, it is not unique and does not warrant consideration for inclusion in the National Register of Historic Places.

Based on the findings from the fieldwork completed in October 2011, the Corps determined this action would likely have "No Effect" on historic properties. Early coordination of these findings was sent to Washington DAHP. The new areas of ground disturbance, including the disposal, pumping station, and pipeline appear to be in previously disturbed areas, but this will be confirmed by further fieldwork. The full results of this survey and the October 2011 survey will be coordinated with Washington DAHP and interested Native American Tribes. Although the Corps initially determined this project is likely to have "No Effect" on historic properties, coordination with Washington DAHP and Native American Tribes is ongoing, and additional stipulations that require monitoring by a professional archaeologist during ground disturbing activities and development of an approved, long-term monitoring plan may be issued.

5.6.2. No Action Alternative

For this alternative, cultural resource conditions are not likely to measurably change. However, natural river and climate fluctuations may contribute to the degradation of resources that may be present.

5.7. SOCIOECONOMICS AND LAND USES

5.7.1. Preferred Alternative

The Ridgeport Dairy Unit (and specifically Post Office Lake) is part of the Ridgefield National Wildlife Refuge, which contributes to the local economy. According to the Refuge CCP (2010a), in 2004 about $1.3 million was estimated as expenditures attributable to the Refuge. The Ridgefield Dairy Unit provides habitat and over-wintering forage for waterfowl that might otherwise land in private agricultural fields, and supports waterfowl and wildlife that serve as a source for recreational viewing and hunting on Refuge and private lands.

Until 2005, the public had access to the Ridgeport Dairy, Post Office Lake from Vancouver, Washington, along Lower River Road (old Highway 501). The state closed Lower River Road at the refuge's boundary due to road failure in July of 2005. In January 2006, the state abandoned its right of way from milepost 11.40 to 12.72, and transferred jurisdiction for that road segment to Clark County. Prior to the closure, Lower River Road offered elevated views of both the Columbia River and Post Office Lake on the refuge. The paved road was utilized by the public for driving, hiking, and biking. All refuge lands in the Ridgeport Dairy Unit, including Post Office Lake, are now closed to public access.

Currently, Highway 501 on the south end of the refuge is a popular site for bird watching. The road is eroding and has been closed and fenced off since 2005 to protect visitors and prevent entry into closed Refuge areas. However, pedestrians and bicyclists routinely trespass into Refuge fields to get around fences and eroded areas, and continue down the closed portion of Highway 501. A small turn-around at the Refuge's boundary gate is serving as a parking lot and some pedestrians and bicyclists are ignoring boundary signage and gates, and trespass along service roads into the Ridgeport Dairy Unit. This isolated "dead end" road has also attracted a variety of illegal uses, including shooting and trash dumping.

No adverse effects for public services or utilities, or effects to land uses are expected as a result of the preferred alternative. Restoration of tidal connection, wetland and riparian habitats at Post Office Lake would enhance fish and wildlife habitat once construction is complete. The preferred alternative is not expected to have adverse effects to recreation at the Refuge as a whole. Due to the presence of sensitive species and biological resources, guided/structured wildlife observation and photography opportunities would be the only public use emphasized on the Ridgeport Dairy Unit, but Refuge management would only approve such special guided tours considering season, resource impacts, disturbance potential, timing, group size, and frequency of tours. The preferred alternative would not negatively impact the public's experience on the Refuge, but would instead enhance habitat for trust species and restore leveed areas to more natural conditions. The preferred alternative is aligned with Refuge management goals described in the CCP, which involves public exclusion from this unit so that it may serve as a sanctuary for overwintering waterfowl. The preferred alternative is not providing additional public exclusion or access measures outside of CCP management parameters.

Some minimal impact is anticipated due to current agriculture and hunting practices conducted by the adjacent private landowners to the south. This includes farming, cattle ranching, and waterfowl hunting. Currently, livestock have unimpeded access to the lake and graze in the adjacent pasture during most of the year. Some crops such as corn and hay are raised in the area. Hunters utilize this habitat along the shoreline (duck blinds, etc) during September and October.

In discussions with the landowners, it was determined that they anticipate changed hydrologic conditions. They expect more frequent flooding as the levee continues to erode and drier conditions in the lake during the summer (following tide gate removal). They may need to move cattle to higher ground more frequently in the future. Waterfowl hunting blinds may need to be moved higher up to compensate for higher average winter water depths. Hunting would only be precluded during high river flooding events. Crop type and location/rotation may be changed to compensate for the drier conditions in the summer and wetter times during the winter. These changes could be more likely with implementation of the preferred alternative. However, new hydrologic conditions could increase the likelihood of success should landowners choose to develop a mitigation banking option. In such a case, the landowners may choose to transition the areas more completely from agricultural to conservation purposes.

5.7.2. No Action Alternative

Under the No Action Alternative, no perceptible changes are expected. There would be minimal change in Refuge management practices in the area. The dike would continue to erode and more frequent high stage (on the Columbia River) would be experienced. Wetland plants around the lake would likely respond to the more frequent and spatially greater inundation limits experienced during the freshet season (late May through early to mid July). However, the pasture areas would be managed by the Refuge with no appreciable changes in land use type.

5.8. CUMULATIVE EFFECTS

Cumulative effects are defined as, "The impact on the environment which results from the incremental impact of an action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 C.F.R. § 1508.7). Cumulative impacts can result from individually minor, but collectively significant actions taking place over a period of time. The past actions that have occurred in and near the Post Office Lake project area are identified below and have been described throughout this report. Together, these actions have resulted in the existing conditions in the vicinity of Post Office Lake.

- European settlement and associated modifications in the vicinity of Post Office Lake, including the construction and decommissioning of the Highway 501, the construction of the levee and previous residential and agricultural practices on and adjacent to the lake.
- Agricultural and recreational development including clearing riparian forests, dairy operations, and cattle grazing along with hunting and recreational bird watching at the Refuge and on the adjacent private lands.
- Conversion to a National Wildlife Refuge with a mandate to protect and enhance waterfowl habitat. The unit is currently managed as a sanctuary area and the public is mostly excluded.
- Operation and maintenance of the Columbia River federal navigation channel including navigational structures, periodic dredging and disposal, surveying, water management, etc.
- Use of dredge material disposal sites. At least one disposal site is operated south of the project area near the Fazio property, and it does not appear that any other disposal sites have been used regularly prior to 1991 (Corps 1991b). The Fazio use the dredged material in their sand and gravel operations. Historic photos also seem to indicate that the area adjacent to the northwest corner of the lake received dredged materials at some point in the past.
- Dredging of the northern connection channel.
- Deepening of the Columbia River federal navigation channel and passage by various vessel types ranging from recreational kayaks to transoceanic barges.

The reasonably foreseeable future actions under consideration in this analysis are identified below. The list includes relevant foreseeable actions in and near Post Office Lake including those by the Corps, other federal agencies, state and local agencies, and private/commercial entities.

- Salmonid habitat improvements associated with the preferred alternative.
- Operation and maintenance of the federal navigation channel for authorized project purposes.
- Additional protection and restoration of existing natural areas and potential acquisition, restoration and protection of natural areas in the vicinity of Post Office Lake by federal, state, and local agencies. These actions could also include future environmental restoration actions implemented by the Corps under WRDA Section 536 authority.
- Operation and maintenance of existing recreational facilities in the Refuge.
- Continued use and development in upland areas for residential, commercial and agricultural use by adjacent private land owners.
- Potential implementation of a fish or wetland mitigation bank by adjacent landowners.

The potential cumulative effects associated with the preferred alternative were evaluated with respect to each of the resource evaluation categories in this integrated Draft Environmental Assessment. For the preferred alternative, water quality impacts (suspended sediment and turbidity increases) are expected to be temporary and localized, and BMPs would further reduce effects. Water quality impacts from the preferred alternative or any foreseeable actions are not expected to be cumulatively measurable.

Future commercial or residential development is limited in the vicinity and construction activities related to other foreseeable future projects, in combination with their respective restoration actions, would produce improvements in the overall habitat quality in the Vancouver lowlands. Any mitigation bank projects would be expected to provide synergistic benefits to restoration actions already implemented at the Refuge. Furthermore, the NMFS would be reviewing the restoration and habitat efforts in the preferred alternative under ESA consultation requirements and would review any future private mitigation bank proposals. There is little likelihood of NMFS supporting future mitigation actions that are detrimental to the restoration and habitat efforts proposed here.

Biological resources in the vicinity include fish and wildlife, vegetation, wetlands, federal threatened and endangered species, other protected species, and natural resources management. While historic development has caused losses of aquatic and riparian habitats, especially in the lower Columbia River and estuary with resulting adverse impacts to fish and wildlife resources, these actions occurred in a regulatory landscape that is very different from that which exists today. While future development in Clark County and areas adjacent to the Refuge would likely have localized direct and indirect impacts on these resources, under the current regulatory regime these resources are unlikely to suffer discernible losses. Moreover, initiatives by federal, state, and local agencies and groups would operate to mitigate the unavoidable environmental impacts of any future development.

There are a number of actions that are ongoing or planned that would provide a cumulative, long-term improvement to fish resources and habitat, especially for ESA-listed salmonid species, including conservation recommendations and RPAs specified in the 2008 FCRPS BiOp and more stringent non-point source pollution standards. This includes potential restoration projects in the vicinity of the project area and a potential fish mitigation bank adjacent to the project area. This also includes future WRDA Section 536 environmental restoration projects in the vicinity and greater estuary area that may be implemented in the estuary between the mouth of the Columbia and Bonneville Dam. Any future federal actions would require evaluation under the National Environmental Policy Act at the time of development. In the long term, restoration and habitat efforts in the preferred alternative would provide the benefits previously described, including increased floodplain connectivity and fisheries access to backwater slough and wetland fringe habitat. These habitat types are currently limited in the lower Columbia River. The preferred alternative also potentially improves hydrologic functions in the Columbia River floodplain. Cumulatively, the intention of this preferred alternative and associated future restoration actions under the Section 536 authority is to improve salmonid habitat and survival, which also complements other ecosystem restoration actions in the basin. The combination of such projects facilitates the Corps' and its partners' efforts to conserve and improve habitat for and survival of listed species in the Columbia River estuary.

The preferred alternative and future activities are not expected to cause a cumulative, adverse change to population or other indicators of social well being, and should not result in a disproportionately high or adverse effect on minority populations or low-income populations. No cultural and historic resources are expected to be impacted by the preferred alternative. Reasonably foreseeable future actions would be subject to review and approval by the Washington DAHP.

The preferred alternative would restore important habitat and ecosystem functions in a key location adjacent to the mainstem Columbia River. It would benefit salmonid species by improving and restoring riparian plant communities, restoring more natural hydrologic regimes, including floodplain and tidal reconnections, and restoring more natural disturbance regimes to a system that is currently disconnected from natural river processes.

In conclusion, this cumulative effects analysis considered the effects of implementing the preferred alternative in association with past, present, and reasonably foreseeable future Corps' and other parties' actions in and near the Post Office Lake, Ridgefield Dairy Unit of the Ridgefield National Wildlife Refuge. The potential cumulative effects associated with the preferred alternative were evaluated with respect to each resource evaluation category and no cumulative, adverse effects were identified. In addition, there are a number of actions that are ongoing or planned that would provide a cumulative, long-term improvement to fish and wildlife resources and habitat.

6. COORDINATION AND LOCAL SUPPORT

6.1. PUBLIC AND AGENCY COORDINATION

The Post Office Lake Section 536 habitat restoration project has received substantial public and agency coordination. The restoration proposal would receive further public and agency review during a public comment period prior to approval of the recommended plan (preferred alternative).

The restoration measures have been coordinated with the USFWS, NMFS, WDFW, WDOE, Washington DAHP, and adjacent landowners regarding habitat objectives and design. The Corps has also initiated government to government consultations with the Department of Natural Resources of the Cowlitz tribe. Since the summer of 2011, multiple meetings have occurred between the Corps and these various entities. The USFWS participated in site visits and provided information on the management objectives, environmental and species constraints for the study area. Meetings have been held involving the adjacent property owners for general informational purposes and to coordinate with their future plans to build a fish mitigation bank on their property, which would tie into the south end of Post Office Lake.

The integrated Draft Implementation Report and Environmental Assessment will receive a 30-day public and agency review comment period. Prior to finalization of the document, any comments received from this review will be considered and incorporated into the proposed project, as appropriate. The Corps and USFWS have become cooperating agencies under NEPA and each would develop their own decision document based on this integrated Draft Implementation Report and Environmental Assessment and public review comments.

6.2. VIEWS AND PREFERENCES OF PROJECT PARTNERS

The USFWS, BPA, NMFS, USGS and other resource agencies, including non-governmental organizations, are strongly supportive of the restoration of intertidal marsh wetlands and riparian forest habitat along the lower Columbia River. These habitat elements have incurred substantial historic losses due to diking and conversion of lands to urban and agricultural development. Invasive plants, particularly reed canarygrass and Himalayan blackberry, also contribute to the qualitative loss of habitat.

The preferences of project partners regarding the nature and extent of riparian habitat and permanent tidal wetland areas have been vetted through numerous interagency meetings and site visits. Costs and incremental gain in habitat and/or value to species groups were considered in the restoration analysis and were the basis for modification of some restoration actions proposed by participants. Overall, the proposed Section 536 ecosystem restoration project at Post Office Lake attains the general preferences of the project partners.

7. COMPLIANCE WITH LAWS AND REGULATIONS

7.1. CLEAN AIR ACT

This Act established a comprehensive program for improving and maintaining air quality throughout the United States. Its goals are achieved through permitting of stationary sources, restricting the emission of toxic substances from stationary and mobile sources, and establishing National Ambient Air Quality Standards. Title IV of the Act includes provisions for complying with noise pollution standards. The preferred alternative does not appear to be located in a non-attainment area for limited air quality.

There would be an intermittent, short-term, extremely localized reduction in air quality during construction of the preferred alternative due to emissions from construction equipment. Any emissions that do occur during construction from motor vehicles are expected to be *de minimus*. After construction, emissions from activities would be of a similar scope to those of the original facility. There also would be an intermittent increase in noise levels from construction equipment. Efforts to avoid and minimize these effects have been considered when comparing and evaluating construction methods. All efforts would be made under consultation with USFWS to maintain the normal unit closure schedule and to reduce disturbance to waterfowl. Effects to waterfowl have been evaluated in further detail in pertinent sections of this report and under the Endangered Species Act.

7.2. MARINE PROTECTION, RESEARCH, AND SANCTUARIES ACT

The Corps would place dredged or excavated materials in an appropriately authorized upland site. Therefore, there is no proposed transportation of dredged material for placement or disposal in ocean waters. For this reason, this Act is not applicable to the proposed project.

7.3. CLEAN WATER ACT

There are various sections of the CWA with which the Corps must comply. These sections include:

Section 404. Section 404 authorizes the Secretary of the Army to permit the discharge of dredged or fill material into waters of the United States, only at specified disposal sites. Disposal sites are evaluated and authorized through the application of the Section 404(b) (1) guidelines further described in 40 C.F.R. pt. 230. Although Corps Civil Works does not permit itself through Section 404, per 33 C.F.R. § 336.1(a) it complies with all applicable substantive legal requirements, including application of section 404(b)(1) guidelines to evaluate compliance with the CWA. If this project does not fit under Nationwide Permit (NWP) #27, then a 404(b) (1) Evaluation will be prepared for this project and submitted in conjunction with the Draft Environmental Assessment for Public Notice comments. However, at this time it appears the restoration project will meet NWP 27 criteria, in which case the 404(b) (1) Evaluation covering the NWP would be considered sufficient to meet Civil Works requirements.

Section 401. Section 401(a)(1) requires certification from the state in which a discharge would occur to waters of the U.S., and is applicable to construction and operation of facilities The state must certify that the discharge would not violate the states' water quality standards and is in compliance with established federal and state effluent limitations. The EPA retains jurisdiction in limited cases. Although the Corps does not permit itself, the Corps seeks a State Water Quality Certification per 33 C.F.R. § 336.1(a)(1) when its activities result in a discharge. The required 401 Water Quality Certification would be obtained from the WDOE. The wetland delineation and any additional necessary information, such as a Joint Aquatic Resources Permit Application (JARPA), would be submitted to the WDOE. This agency would

be responsible for project review and issuance of the 401 Water Quality Certificate, which would likely include terms and conditions to avoid and/or ameliorate impacts from the preferred alternative including BMPs and turbidity monitoring requirements. The possibility of using certification under the existing Nationwide Permit #27 is very likely, in which case the Corps would submit a letter detailing compliance along with the JARPA and would then receive positive confirmation from WDOE for use of the certification. Nationwide Permit and Water Quality Certification conditions can be found in the User's Guide (Corps 2012) and at:
http://www.usace.army.mil/Portals/2/docs/civilworks/nwp/2012/NWP_27_2012.pdf; and http://www.nws.usace.army.mil/Portals/27/docs/regulatory/NWPs/2012%20NWP%20Users%20Guide.pdf. Otherwise, the Corps would pursue individual State 401 Water Quality Certifications prior to any in-water work or wetland fill.

Section 402. Section 402(a)(1) authorizes the EPA or states in which the EPA has delegated such authority to issue permits for the discharge of any pollutant or combination of pollutants under procedures established to implement the NPDES program. Regulated categories of discharges generally include point-source discharges and storm-water runoff, and permit conditions are usually required to ensure compliance with all applicable effluent and water quality standards. For this project, a NPDES permit would be required from the EPA and obtained prior to disturbance and work performed on federal lands in Washington. The Corps intends to use the EPA's 2012 NPDES construction general permit (CGP) (EPA 2012) (found at http://www.epa.gov/npdes/pubs/cgp2012_finalpermit.pdf) after development of an appropriate Stormwater Pollution Prevention Plan (SWPPP) and completion of ESA consultation requirements. In order to use the construction general permit, the Corps would complete an online electronic Notice of Intent at least 14 days prior to any ground-disturbing activities.

Overall effects to water quality and effects from discharges and disposal into navigable waters, including wetlands, have been described in the pertinent sections of this integrated Draft Implementation Report and Environmental Assessment, and are further described in the Section 404(b) (1) Evaluation located in Appendix E.

7.4. COASTAL ZONE MANAGEMENT ACT

This Act requires federal agencies to comply with the federal consistency requirement of the Coastal Zone Management Act. The proposed activities at Ridgefield do not occur within the regulatory boundaries of this Act and therefore, are not pertinent to this evaluation.

7.5. ENDANGERED SPECIES ACT

In accordance with Section 7(a) (2) of this Act, federally funded, constructed, permitted, or licensed projects must take into consideration impacts to federally listed or proposed threatened or endangered species. Information on federally listed species and designated critical habitat is presented in this integrated Draft Implementation Report and Environmental Assessment.

The Corps anticipates that for terrestrial species the preferred alternative for Post Office Lake would receive a no-effect concurrence or fall within the purview and effects evaluation covered by the existing 2008 *Joint Programmatic Biological Opinion: Endangered Species Action Section 7 Formal Consultation and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for the Washington State Fish Passage and Habitat Restoration Programmatic*. This programmatic Biological Opinion (BiOp) is held by the Corps Seattle District and its use by the Portland District has been discussed with the Services. Information regarding the Biological Assessment and BiOp

covering these actions along with additional criteria for use can be found at http://www.nws.usace.army.mil/PublicMenu/Menu.cfm?sitename=REG&pagename=2008FishRestoration.

In order to develop the joint programmatic restoration Biological Assessment and subsequently to obtain a BiOp with coverage for various species and actions, on June 10, 2008 the Corps Seattle District submitted a final Biological Evaluation requesting consultation on a suite of nine categories of restoration actions. The Portland District Corps intends to use this programmatic restoration BiOp for coverage of species under USFWS jurisdiction, and as a guide for conservation measures related to NMFS species. The preferred alternative for Post Office Lake is characteristic of activities described in these nine categories of restoration actions proposed by the Seattle District for projects in Washington. The preferred alternative would be within the scope of both the programmatic restoration categories of proposed actions and the Consultation effects evaluated in the BiOp obtained by Seattle District. There was also initial agreement that Portland District Civil Works actions could use this programmatic restoration BiOp. Therefore, the effects evaluations and determination for each species is also relevant to the Post Office Lake project and would be applicable in describing the effects expected from Portland District's preferred alternative.

During development of this programmatic restoration BiOp with the Services, the Seattle District initiated informal consultation to address species and critical habitat that the restoration actions were not likely to adversely affect. Though several of these species are not present in the Post Office Lake project, they are included here since they were covered in the consultation and effects analysis. The Services gave concurrence with the effects determinations of "*may affect, but not likely to adversely affect*" Hood Canal summer-run chum salmon (*O. keta*), Columbia River chum salmon, brown pelican (*Pelecanus occidentalis)*, Columbian white-tailed deer (*Odocoileus virginianus leucurus*), Canada lynx (*Lynx canadensis*), gray wolf (*Canis lupus*), pygmy rabbit (*brachylagus idahoensis*), woodland caribou (*Rangifer tarandus caribou*), grizzly bear (*Ursus arctos = U.a. horribilis*), marbled murrelet (*Brachyramphus marmoratus*), northern spotted owl (*Strix occidentalis caurina*), Oregon silverspot butterfly (*Speyeria zerene hippolyta*), western snowy plover (*Charadrius alexandrines nivosus*), golden paintbrush (*Castilleja levisecta*), water howellia (*Howellia aquatilis*), Nelson's checker-mallow (*Sidalcea nelsoniana*), Kincaid's lupine (*Lupinus sulphureus ssp. Kincaidii*), showy stickseed (*Hackelia venusta*), Bradshaw's desert-parsley (*Lomatium bradshawii*), Spalding's silene/catchfly (*Silene spaldingii*), Ute ladies'-tresses (*Spiranthes diluvialis*), and all designated critical habitat.

The Services also initiated an ESA Section 7 formal programmatic consultation for restoration projects. The Services concluded that the proposed actions in the programmatic restoration Biological Evaluation were *not likely to jeopardize* the continued existence of the following of ESA-listed species: Columbia River and Coastal-Puget Sound interim recovery units of bull trout (*Salvelinus confluentus*), Puget Sound Chinook salmon (*Oncorhynchus tshawytscha*), Lower Columbia River Chinook salmon, Upper Columbia River spring-run Chinook salmon, Snake River spring/summer run Chinook salmon, Snake River fall-run Chinook salmon, Lower Columbia River coho salmon (*O. kisutch*), Snake River sockeye salmon (*O. nerka*), Puget Sound steelhead (*O. mykiss*), Lower Columbia River steelhead, Middle Columbia River steelhead, Upper Columbia River steelhead, and Snake River Basin steelhead. The Services concluded that the proposed actions in the Seattle District programmatic Biological Assessment would not result in the destruction or adverse modification of designated critical habitats for all of the above-listed species except Lower Columbia River coho salmon (for which critical habitat has not been designated), the results of which are reported for both Services in this BiOp document (NMFS Tracking No. 2008/03598; FWS No. 13410-2008-FWS # F-0209). The NMFS also initiated and conducted an essential fish habitat (EFH) consultation, the results of which were also reported in this document (NMFS Tracking No. 2008/03598; FWS No. 13410-2008-FWS #F-0209).

The Portland District intends to use this Seattle joint programmatic BiOp to cover USFWS species and to implement all applicable conservation measures, as well as all terms and conditions, if it cannot reach a no-effect call with USFWS. The exemption from the take prohibition in the BiOp incidental take statement is limited to those species listed in the section above. The duration of the programmatic BiOp is stated as 5 years from the date of signature. However, the programmatic language also indicates an expiration date of December 31, 2013 (p 107, NMFS and USFWS 2008). At the end of this period in 2013, the Corps and Services can reinitiate this consultation, if necessary, to adjust or add activities or conservation measures. This expiration could occur prior to completion of construction of the preferred alternative in the summer of 2013.

The NMFS has been involved in project development at Post Office Lake and had initially indicated that the Seattle District programmatic BiOp was likely to provide the necessary consultation coverage. In this case, the appropriate documentation, including the Specific Project Information Form (SPIF), would be provided to the respective agencies including NMFS, USFWS, and Seattle Regulatory Offices (which are responsible for reporting requirements under the BiOp) for review, coordination, and consultation.

The NMFS (Fisher 2012) had also tentatively indicated that species listed subsequent to this BiOp, such as eulachon, may be consulted on in a separate but related evaluation to supplement coverage under the existing BiOp. The Corps would also pursue this approach for Willamette River stocks and green sturgeon.

However, at this time, the Corps and NMFS have determined that the individual consultation route is more appropriate to cover NMFS species that could be affected by the project. In this case, a Biological Assessment will be prepared for the project for formal individual Consultation. In a meeting on March 27, 2012, the NMFS (Fisher) ultimately indicated that in order to better incorporate adaptive management measures and to address any concerns with juvenile stranding or depredation, to the proposed action would require an individual consultation.

The Corps does not anticipate that implementation of the preferred alternative for Post Office Lake would result in measurable short- or long-term adverse impacts to ESA-listed species. All conservation measures, terms and conditions, and reasonable and prudent measures would be implemented to the maximum extent. Long-term effects are expected to benefit aquatic species without detriment to waterfowl or other terrestrial species. These effects were described in detail in associated portions of this integrated Draft Integrated Implementation Report and Environmental Assessment, and would be included in the Specific Project Information Forms (SPIF) (submitted if using the programmatic BiOp), Biological Assessment, and supplemental ESA documentation. These findings are also aligned with the effects determinations outlined in the joint programmatic restoration BiOp.

7.6. Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act of 1934 states that federal agencies involved in water resource development are to consult with the USFWS and state agencies administering wildlife resources concerning proposed actions or plans. Any coordination under the Act would be in accordance with the 2003 *Agreement Between the US Fish and Wildlife Service and the US Army Corps of Engineers for Conducting Fish and Wildlife Coordination Act Activities*.

The proposed action is on a USFWS Refuge has been coordinated with the USFWS and WDFW in accordance with the Act. The Corps has also been in regular coordination with NMFS regarding plan selection and development of the proposed habitat and wetland improvements. Further, the Corps and

USFWS have become cooperating agencies and each would develop their own decision document based on the integrated Implementation Report and Environmental Assessment and public review comments.

7.7. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT

The Magnuson-Stevens Fishery Conservation and Management Act, Public Law 94-265 as amended by the Sustainable Fisheries Act of 1996, established procedures designed to identify, conserve, and enhance Essential Fish Habitat (EFH) for fisheries regulated under a federal fisheries management plan. The amended Magnuson-Stevens Act establishes requirements for EFH for commercially important fish. Federal agencies must consult with NMFS on all proposed actions authorized, funded, or carried out by the agency that may adversely affect EFH.

Pursuant to the Magnuson-Stevens Act, an EFH consultation is necessary for the proposed action at Post Office Lake. Essential fish habitat is defined by the Act as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." The Columbia River is designated as EFH for salmon species. The proposed actions would directly affect EFH for Chinook and coho salmon, though any negative effects are expected to be short-term, followed by permanent beneficial effects. An EFH assessment under the Magnuson-Stevens Act was provided as part of the joint 2008 Programmatic BiOp (Joint NMFS and USFWS 2008 Opinion) provided by NMFS for the restoration actions. As described under the ESA Compliance section, this project is likely to be covered under this programmatic restoration BiOp or an individual BiOp reflecting similar consultation determinations, effects, analyses, and terms and conditions, which would also include compliance with this Act.

7.8. MARINE MAMMAL PROTECTION ACT

The 1972 Marine Mammal Protection Act established a federal responsibility to conserve marine mammals. With certain specified exceptions, the Act establishes a moratorium on the taking and importation of marine mammals, as well as products taken from them, and establishes procedures for waiving the moratorium and transferring management responsibility to the states. This Act prohibits the take or harassment of marine mammals. The location of the proposed action is not within the vicinity of marine mammals or their critical habitat; therefore, this Act is not pertinent to this evaluation. Although sea lions may transit through the Columbia River past the project area, the project does not provide habitat for nor would proposed actions have any impact on transiting sea lions.

7.9. MIGRATORY BIRD TREATY ACT

This Act requires that migratory birds not be harmed or harassed. Under this Act, "migratory birds" essentially includes all birds native to the U.S. and the Act pertains to any time of the year, not just during migration. Impacts of construction at Post Office Lake could temporarily displace birds by causing flushing, altering flight patterns, or causing other behavioral changes. However, it is not expected that effects would rise to the level of harm or harassment.

7.10. BALD AND GOLDEN EAGLE PROTECTION ACT

This law provides for the protection of the bald eagle and the golden eagle by prohibiting, except under certain specified conditions, the taking, possession and commerce of such birds. The proposed action is not expected to have an adverse effect on eagles present in or flying through the project area.

7.11. NATIONAL HISTORIC PRESERVATION ACT

Section 106 of this Act requires that federally assisted or federally permitted projects account for the potential effects on "historic properties" such as prehistoric or historic sites, districts, buildings, structures, traditional cultural properties, historic landscapes, national historic landmarks or objects that are included in or eligible for inclusion in the National Register of Historic Places, as defined by 36 C,F,R, parts 60, 63 and 65. Architectural and archaeological resources that are at least 50 years old, or those that have achieved significance within the past 50 years, may be viewed as potential historic properties where such properties meet the criteria of eligibility. Traditional cultural properties, places of traditional religious and/or cultural importance to Indian tribes or Native Hawaiian organizations, may also be eligible for inclusion on the National Register. The project's proposed actions are being coordinated with the Washington DAHP, and consultation under Section 106 of the Act has been initiated with the DAHP, the Confederated Tribes of Grand Ronde and Cowlitz Indian Tribe. Results of cultural resources surveys and consultations conducted to date have revealed the presence of no eligible cultural resources within the project area and support a determination of no effect on historic properties.

7.12. NATIONAL ENVIRONMENTAL POLICY ACT

The integrated Draft Implementation Report and Environmental Assessment will receive a 30-day public and agency review comment period. Prior to finalization of the document, any comments received from this review would be considered and incorporated into the proposed project, as appropriate. After such time, the Corps will determine if the effects of the preferred alternative would reach a threshold that could significantly affect the quality of the human environment, and whether or not an Environmental Impact Statement is required, or conversely, if the analyses results in a Finding of No Significant Impact (FONSI). The Corps and USFWS have become cooperating agencies under NEPA and each would develop their own decision document based on the integrated Implementation Report and Environmental Assessment and public review comments.

7.13. ARCHAEOLOGICAL AND HISTORIC PRESERVATION ACT

This Act directs the preservation of historic and archaeological data in federal construction projects. The Act authorizes federal agencies to seek future appropriations, to obligate available funding, or to reprogram existing appropriations to provide for the identification and preservation of data. Agencies may elect to undertake the necessary recovery, protection and preservation themselves, or may transfer up to one percent of total project funds to the National Park Service for assistance in recovering data. This one percent limit does not apply to projects of $50,000 or less. No historic or archaeological resources have been identified within the project area.

7.14. AMERICAN INDIAN RELIGIOUS FREEDOM ACT

This law establishes as the policy of the United States the protection and preservation for American Indians of their inherent right of freedom to believe, express, and practice their traditional religions. 42 U.S.C. § 1996. The Act directs agencies to consult with interested or affected Native American Tribes to determine appropriate policy changes necessary to protect and preserve Native American religious cultural rights and practices. No religious cultural rights or practices are expected to be affected by the proposed project.

7.15. ARCHAEOLOGICAL RESOURCES PROTECTION ACT

This Act protects materials of archaeological interest that are greater than 100 years old on public and Indian lands from unauthorized removal or destruction. This Act allows the federal land management agency to issue permits for the excavation or recovery of archaeological resources. Individuals who destroy, deface or remove archaeological resources from public lands are subject to penalties and fines under the Act's provisions.

7.16. NATIVE AMERICAN GRAVES PROTECTION AND REPATRIATION ACT

This Act, passed in 1990, provides for the protection, inventory and return of certain Native American cultural items – human remains, funerary objects, sacred objects and objects of cultural patrimony – to lineal descendents and culturally affiliated Indian tribes and Native Hawaiian organizations. This Act also includes provisions for unclaimed and culturally unidentifiable Native American cultural items, intentional and inadvertent discovery of Native American cultural items on federal and tribal lands, and penalties for noncompliance and illegal trafficking. There are no documented historic properties and/or burials in the immediate project area and the probability of locating human remains during the restoration work is low. However, if human remains are discovered during construction, all work in the immediate vicinity of the discovery would cease, and the federal landowner and appropriate cultural resources staff would be contacted to initiate requirements of the Act.

7.17. EXECUTIVE ORDER 13007 – INDIAN SACRED SITES

This executive order charges federal agencies to: (1) accommodate access to and ceremonial use of Indian sacred sites by Indian religious practitioners; and (2) avoid adversely-affecting the physical integrity of such sites. Where appropriate, agencies shall maintain the confidentiality of sacred sites. To date, the Corps has no knowledge of sacred sites in or near the project area.

7.18. EXECUTIVE ORDER 13175 – CONSULTATION AND COORDINATION WITH INDIAN TRIBAL GOVERNMENTS

This executive order directs federal agencies to coordinate and consult with Indian tribal governments whose interests might be directly or substantially affected by activities on federally administered lands. The directive reiterates the unique legal relationship the United States Government has with Native American tribal governments as set forth in the Constitution of the United States, treaties, statutes and court decisions. As executive departments and agencies undertake activities affecting Native American tribal rights or trust resources, such activities should be implemented in a knowledgeable, sensitive manner respectfully of tribal sovereignty. The executive order outlines principles that executive departments and federal agencies, including all component bureaus and offices, are to follow in interactions with Native American tribal governments. The purpose of these principles is to clarify the United States Government's responsibility to ensure that it operates within a government-to-government relationship with federally-recognized Native American tribes.

7.19. EXECUTIVE ORDER 13287 – PRESERVE AMERICA

This executive order directs federal agencies to: (1) actively advance the protection, enhancement and contemporary use of the historic properties owned by the Federal Government; (2) promote partnerships and cooperation with state, tribal and local governments and the private sector for the preservation and use of historic properties; (3) recognize and manage historic properties in its ownership as assets that can

support department and agency missions while contributing to the vitality and economic well-being of the Nation's communities and other public benefits; and (4) better combine historic preservation and nature tourism by directing the agencies to assist in the development of local and regional nature tourism programs using the historic resources that are a significant feature of many state and local economies. The Corps is working in partnership with USFWS and Ridgefield National Wildlife Refuge staff to ensure that provisions of this executive order are appropriately carried out.

7.20. EXECUTIVE ORDER 12898-- ENVIRONMENTAL JUSTICE

Executive Order 12898 requires federal agencies to consider and minimize potential impacts on subsistence, low-income, or minority communities. The goal is to ensure that no person or group of people shoulder a disproportionate share of any negative environmental impacts resulting from programs. The proposed action is on a National Wildlife Refuge for the benefit of ecosystem restoration and listed species. There would be no "takings" associated with this project. The project is not expected to disproportionately affect low income and/or minority populations and is in compliance with this Executive Order.

7.21. EXECUTIVE ORDER 11988-- FLOODPLAIN MANAGEMENT

Executive Order 11988 regarding floodplain management was signed May, 24, 1977. The order requires federal agencies to recognize the value of floodplains and consider the public benefits from their restoration and preservation. The objective is to avoid long and short-term adverse impacts to the base floodplain (100-year flood interval), and to avoid direct and indirect support of development in the base floodplain when there is a practicable alternative. This order directs federal agencies to evaluate the potential effects of proposed actions on floodplains and to avoid undertaking actions that directly or indirectly induce growth in the floodplain or adversely affect natural floodplain values.

Although the Post Office Lake and the levees are located in the floodplain, the proposed action would not further encourage development in, or measurably alter any floodplain areas in a negative manner. In their restored condition, these areas may provide some floodplain storage or peak attenuation capacity. Furthermore, as the levees are already breaching in specific areas of the proposed project, there are few other more practicable alternative locations to consider breaching, as the levees are in a fixed location which is water and location dependent.

Additionally, the construction activities and fill would not be affecting important structures within the vicinity of the Refuge lands and action area. The location of the Refuge also precludes additional development in the vicinity of the levees. Hydrologic analyses have been conducted to evaluate inundation effects to adjacent landowners, and any necessary flowage easements, agreements, or similar real estate instruments would be acquired from affected entities. Landowners have been involved in project discussions and have potential plans to create a fish mitigation bank and implement additional breaches.

Finally, the Corps does not expect any loss of beneficial values in the floodplain and would be conducting some actions that would improve wetland and riparian floodplain functions. In order to inform the public of the proposed action, this integrated Draft Implementation Report and Environmental Assessment would be widely distributed and public comments solicited.

7.22. EXECUTIVE ORDER 11990-- PROTECTION OF WETLANDS

Executive Order 11990 regarding protection of wetlands was signed May, 24, 1977. The order requires federal agencies to minimize the destruction, loss or degradation of wetlands. Wetlands and open water may be converted and expanded due to the proposed action. This was discussed in detail in the pertinent sections of this integrated Draft Implementation Report and Environmental Assessment and in the scoring assumptions in the benefits analysis. There is not expected to be a loss of wetlands due to the proposed action. More natural hydrologic and disturbance regimes would be re-introduced to the wetland and lake system and are expected to improve native emergent and submergent plant communities, water regimes, and soil characteristics. Plans for reintroducing a more natural hydrograph that could affect wetlands has been documented further through the Section 404 (b)(1) Evaluation that has also been prepared for the proposed action.

7.23. PRIME AND UNIQUE FARMLANDS

As a result of a substantial decrease in the amount of open farmland, the Farmland Protection Policy Act was put forth by Congress. In the statement of purpose, federal programs which contribute to the unnecessary and irreversible conversion of farmland to nonagricultural uses would be minimized. It follows that federal programs shall be administered in a manner that, as practicable, would be compatible with state and local government and private programs and policies to protect farmland. Although portions of the affected area outside of the Refuge are currently managed as pasture for cattle, no prime or unique farmlands would be affected by the proposed action.

7.24. COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT AND RESOURCE CONSERVATION AND RECOVERY ACT

The location of the proposed action is not within the boundaries of a site designated by the U.S. Environmental Protection Agency or State of Washington for a response action under Comprehensive and Environmental Response, Compensation and Liability Act, nor is it a part of a National Priority List site. There is no indication that any hazardous, toxic, and radioactive wastes are in the vicinity of Post Office Lake. Any presence of these types of wastes would be responded to within the requirements of the law and Corps' regulations and guidelines.

7.25. WILD AND SCENIC RIVERS ACT

Under this Act, a federal agency may not assist the construction of a water resources project that would have a direct and adverse effect on the free-flowing, scenic, and natural values of a federally designated wild or scenic river. There are no designated wild or scenic rivers in the project area.

7.26. EXECUTIVE ORDER 13514-- FEDERAL LEADERSHIP IN ENVIRONMENTAL, ENERGY AND ECONOMIC PERFORMANCE

Executive Order 13514 requires federal agencies to increase energy efficiency; measure, report, conserve and reduce their greenhouse gas emissions from direct and indirect activities; conserve and protect water resources through efficiency, reuse, and stormwater management; eliminate waste, recycle, and prevent pollution; leverage agency acquisitions to foster markets for sustainable technologies and environmentally preferable materials, products, and services; design, construct, maintain, and operate high performance sustainable buildings in sustainable locations; strengthen the vitality and livability of the communities in

which federal facilities are located; and inform federal employees about and involve them in the achievement of these goals.

The preferred alternative is in compliance with this Executive Order because no development would occur and all actions would be conducted in a manner as to prevent pollution and chemical spills. Material removed would be reused by the Refuge to the extent possible. The project would not result in changes in pre-project hydrology from additional impervious surfaces or changes in stormwater drainage and/or runoff patterns at the project.

8. CONCLUSIONS AND RECOMMENDATION

8.1. CONCLUSIONS

This integrated Draft Implementation Report and Environmental Assessment has included an examination of all practicable alternatives for meeting the study purposes to restore juvenile salmonid access and restore permanent tidal, floodplain, and riparian habitat at Post Office Lake to benefit many anadromous fish and wildlife species in the lower Columbia River and estuary. The need for habitat restoration at Post Office Lake is predicated upon the considerable historic losses of tidal wetlands and riparian habitat along the lower Columbia River.

The recommended plan (Alternative 5) is an incrementally justified and cost-effective alternative that also meets the needs of the agency partner and owner, the U.S. Fish and Wildlife Service. The alternative includes restoration of tidal wetlands/riparian forest, levee breach, and culvert/tide gate removal to restore intertidal flow to interior lake areas. It includes a Real Estate Plan that addresses changed hydrologic conditions and their impacts to the private landowners located immediately to the south of the Ridgefield National Wildlife Refuge.

The recommended plan provides substantial benefits to many fish and wildlife species, including federally listed salmonids, , at a reasonable construction and operation and maintenance cost. A monitoring program would measure the response of fish and some waterfowl, especially juvenile salmonids, dusky Canada geese, sandhill crane, ducks, invertebrates, and vegetation to the restoration measures.

Restoration of habitat for juvenile salmonids migrating through the lower Columbia River and estuary is an important component of regional recovery plans. The proposed project addresses numerous limiting factors and fish and wildlife needs identified in the 2001 *Lower Columbia River and Columbia River Subbasin Summary*. It is consistent with and would help achieve the Northwest Power and Conservation Council's biological objectives outlined in their 2000 *Columbia Basin Fish and Wildlife Program.* The proposed project addresses the 2000 and 2008 FCRPS BiOp's reasonable and prudent alternatives for listed salmonids.

Project partners include the U.S. Army Corps of Engineers and the U.S. Fish and Wildlife Service. The recommended plan has been reviewed in light of overall public interest, which includes the views of the sponsor and interested agencies. The Portland District has concluded that the total public interest would be served by the implementation of the recommended plan for habitat restoration on Post Office Lake.

8.2. RECOMMENDATION

Careful consideration has been given to the overall public interest, including the environmental, social, economic, engineering, and the requirements of the partner, the U.S. Fish and Wildlife Service. The recommended plan described in this integrated Draft Implementation Report and Environmental Assessment for Post Office Lake provides the optimum solution for restoring juvenile salmonid access and permanent tidal, floodplain, and riparian habitat. This habitat would be available to most migrating adult and juvenile fish for all Endangered Species Act fish runs in the Columbia/Snake Rivers.

I recommend implementing the recommended plan for the Post Office Lake habitat restoration project under Section 536 of the Water Resources Development Act of 2000 (Public Law 106-541). The fully funded project cost estimate for the recommended plan including monitoring and O&M is $5,107,000.

The recommendations contained herein reflect the information available at this time and current Department of Army policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of national Civil Works construction program nor the perspective of higher review levels within the Executive Branch.

Date: _____

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JOHN W. EISENHAUER, P.E.
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