US Army Corps
of Engineers ®
Portland District

Environmental Assessment

Sandy River Delta
Section 536 Ecosystem Restoration Project
Multnomah County, Oregon

East Channel Dam under Construction, Sandy River Delta, 1930s

June 2013

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ABBREVIATIONS AND ACRONYMS

ACS	Aquatic Conservation Strategy
BMP	Best Management Practices
BPA	Bonneville Power Administration
cfs	cubic feet per second
Corps	U.S. Army Corps of Engineers
CRGNSA	Columbia River Gorge National Scenic Area
cy	cubic yard(s)
DPS	Distinct Population Segment
DSL	Department of State Lands (Oregon)
EA	Environmental Assessment
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FONSI	Finding of No Significant Impact
FR	Federal Register
GIS	Geographic Information System
HSI	habitat suitability index
HU	habitat unit(s) (in acres)
IDC	interest during construction
IWR	Institute for Water Resources
KVA	Key Viewing Area
LiDAR	light detection and ranging
LRMP	Mount Hood National Forest Land and Resource Plan
NER	National Ecosystem Restoration
NMFS	National Marine Fisheries Service
NWFP	Northwest Forest Plan
NWR	National Wildlife Refuge
O&M	Operation and Maintenance
ODFW	Oregon Department of Fish and Wildlife
PNNL	Pacific Northwest National Laboratory
PWB	Portland Water Bureau
RM	river mile
ROD	Record of Decision
S&G	Standards and Guidelines
SEF	Sediment Evaluation Framework
SHPO	State Historic Preservation Office
SLOPES	Standard Local Operating Procedures for Endangered Species
SMA	Special Management Area
TMDL	total maximum daily load
USFWS	U.S. Fish and Wildlife Service

1. INTRODUCTION

This Environmental Assessment (EA) evaluates the environmental effects of implementing a Section 536 ecosystem restoration project at the Sandy River Delta, located north of Interstate 84 just east of Troutdale in Multnomah County, Oregon (Figure 1). Section 536 of the Water Resources Development Act of 2000 (Public Law 106-541) 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.

In the National Marine Fisheries Service (NMFS) 2008 Biological Opinion for Operation of the Federal Columbia River Power System (NMFS 2008), the FCRPS BiOp, Habitat Strategy 2 directs the Corps to improve juvenile and adult fish survival in estuary habitat. Reasonable and Prudent Alternative number 37, Estuary Habitat Implementation 2010-2018—Achieving Habitat Quality and Survival Improvement Targets—directs the BiOp action agencies—the Corps, Bonneville Power Administration (BPA), and the Bureau of Reclamation— to fund projects as needed to achieve survival benefits in the estuary for listed salmonids as described in the FCRPS Biological Assessment. The 2010 BiOp implementation plan includes habitat restoration in the Sandy River Delta as a specific action that the Corps should pursue. The BiOp requires habitat restoration in the estuary because all the listed salmon and steelhead species in the Columbia River Basin have been found to use estuarine habitat; restoration enhances juvenile survival as they prepare for ocean entry; and reconnecting shallow water habitat to cold water refugia is expected to protect juveniles against expected impacts of climate change.

The Corps has used its Section 536 ecosystem restoration authority to complete a feasibility study on restoring a channel of the Sandy River at its confluence with the Columbia River. To develop the project, the Portland District Corps, the U.S. Forest Service Columbia River Gorge National Scenic Area, Bonneville Power Administration (BPA), and the Portland Water Bureau are cooperating on the project. The Forest Service is the Federal Sponsor under section 536, and its lands comprise most of the proposed project area on and around Sundial Island, and previously wrote a Finding of No Significant Impact (FONSI) for actions to occur on their lands, which are described in this document. BPA will write a FONSI for their actions only, which are described in this document. The Portland Water Bureau has agreed to partially fund dam removal, as it is a requirement of its Habitat Conservation Plan and Implementation Agreement with NMFS for all water supply operational impacts to ESA-listed fish species in the Bull Run watershed. BPA has two high-voltage electric transmission lines and multiple towers on Sundial Island and shares duties with the Corps under the 2008 FCRPS BiOp to implement estuary habitat restoration.

PURPOSE AND NEED

Purpose

The purpose of the proposed restoration action is to improve habitat for juvenile salmonids (salmon and steelhead) in the Sandy River Delta, particularly those species listed under the Endangered Species Act (ESA). To achieve this purpose, the Corps proposes to restore flow to the historic main channel (East Channel) of the Sandy River. Native riparian forest habitat

would also be restored. Restoration would also yield other environmental benefits, which are discussed under the Environmental Consequences section. When implementing Section 536 projects, the Corps looks for cost-sharing restoration projects with substantial support from other affected resource managers. ER 1105-2-100, f. (2) defines the National Ecosystem Restoration (NER) plan: For ecosystem restoration projects, a plan that reasonably maximizes ecosystem restoration benefits compared to costs, consistent with the Federal objective, be selected.

Water flow was changed in the Sandy River Delta in the 1930s when a dam was constructed across the East Channel (Figure 2) in an effort to help perceived problems for smelt (or eulachon, *Thaleichthys pacificus*) and salmon (species of *Onchorynchus*) entering the shallow Sandy River from the Columbia River on their upstream migrations to spawning grounds. The dam was constructed with the efforts of local wildlife organizations and the Oregon State Game Commission (now the Oregon Department of Fish and Wildlife), and was considered part of the New Deal era of wildlife habitat conservation.

The East Channel dam is about 750 feet long, 45 feet wide and 8 feet high and was constructed with pilings in-filled with horizontal timbers. The dam was reinforced in 1938 with large basalt stones and a new channel was dredged. The result of dam construction was that water from two shallower channels was essentially funneled into one deeper channel. Flow was routed into what had been an overflow channel, known at that time as the Little Sandy River (hereafter referred to as the West Distributary Channel, see Figure 1). This channel is currently the main channel through the Sandy River Delta.

The East Channel dam has adversely impacted Salmonid habitat by impeding access and limiting cool water flow from the Sandy River to the East Channel, resulting in summer-time ponding and increased potential for stranding and mortality, which will continue if improvements are not made. Before dam construction, the extensive braided shallow-water habitat in the East Channel and the abundance of backwater habitat throughout the Delta area provided excellent habitat conditions for rearing juvenile salmonids. Since dam construction, the East Channel has gradually silted in and has become a slough, while the Delta area has lost much of its hydrologic complexity and contains greatly reduced areas of backwater habitat (Figures 3 and 4 show the dramatic changes to the Delta).

Figure 1 - Sandy River Delta Vicinity Map.

Figure 2 - East Channel Dam, 1940

Photo taken shortly after completion of construction. The structure today is not readily recognizable as a dam, as it is covered in silt with rock laid on top and thick vegetation is present on both sides of the dam along its length.

Figure 3 - Sandy River Delta, September 1935

The photo shows the relative sizes of the East and West channels (dam partially constructed). Note the extensive braided shallow-water habitat in the East Channel and abundance of backwater habitat throughout the Delta, which provided excellent habitat for rearing juvenile salmon.

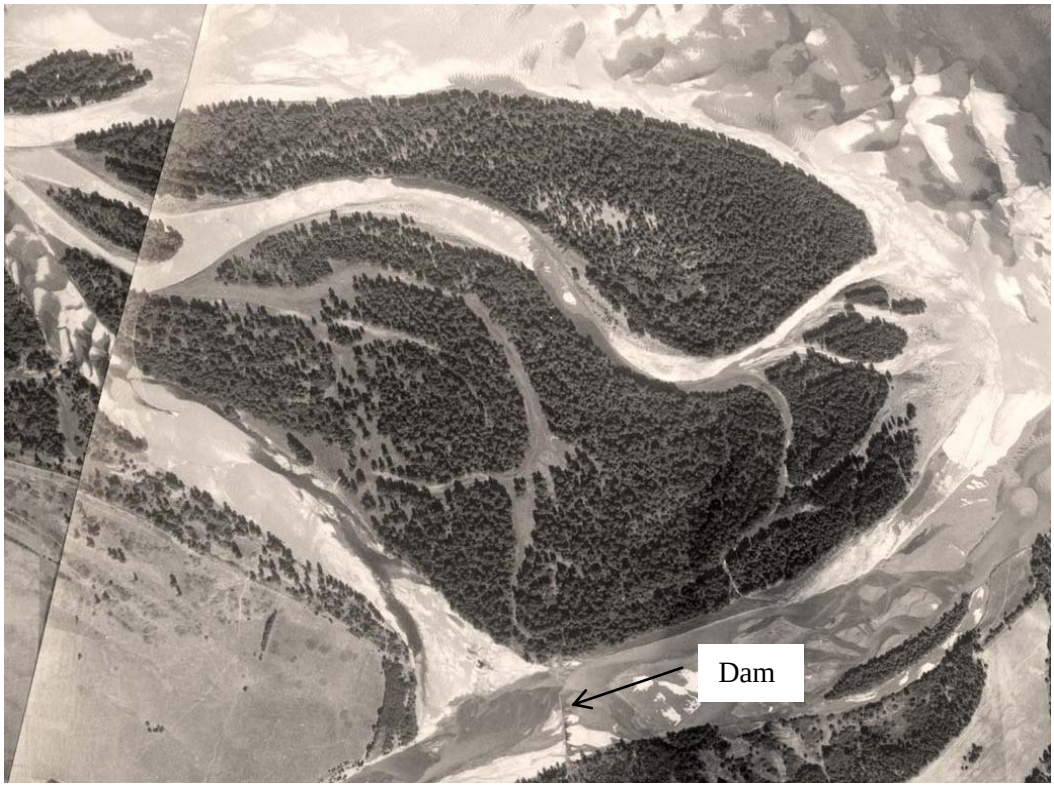


Figure 4 - Sandy River Delta, March 1995

The photo shows flow in the West Channel and restriction of the East Channel from sedimentation as a result of effects over time from changes in hydrology in the Delta because of the dam. Note that the Delta has lost much of its hydrologic complexity, which provides limited habitat for rearing juvenile salmon. Dam is evident as a straight line across the East Channel near where the East and West channels split.

Water flows through the East Channel from east to west (from the Columbia River toward the dam) during the Columbia River spring freshets and is tidally influenced. Only during high flows on the Sandy River does Sandy River water flow over the dam and then west to east through the East Channel to the Columbia River. The East Channel dries to isolated pools during summer, while the West Channel flows year-round. After years of sedimentation, the dam is no longer visually evident. It has been covered over the years by sediment, and basalt rock paving stones are present on top of the dam. None of the wood structure is readily visible.

Need

The Corps intends to use its Section 536 authorities in restoration actions at the Delta, thus helping to fulfill a portion of the 2010–2013 FCRPS BiOp Implementation Plan to improve habitat for ESA-listed salmon and steelhead. Habitat restoration would improve rearing opportunities for juvenile salmon spawned in the Sandy River, including spring and fall Chinook salmon (*Oncorhynchus tshawytscha*), Coho salmon (*O. kisutch*) and winter steelhead (*O. mykiss*). It would also provide off-channel rearing and high flow refugia habitat for juvenile salmon migrating downstream in the Columbia River. The East Channel supports high-quality riparian habitat along much of its length, which increases potential for rearing due to high invertebrate production and opportunities for recruitment of woody debris.

In addition to direct alteration of the Sandy River Delta from construction of the East Channel dam, later construction of hydroelectric dams on the Columbia River also impacted the Delta area. Controlled flows on the Columbia River now result in less dramatic spring freshets that could inundate and scour new channels in the Delta area.

Project Area Description

The Sandy River Delta is located where the Sandy River connects to the Columbia River (river mile [RM] 121 and 123) near Troutdale, Oregon just north of Interstate 84 (see Figure 1). The land north of the original Sandy River channel is known as Sundial Island. The land south of the original channel is often referred to as Thousand Acres, another name from early farming settlement near the turn of the 20th century. Bonneville Dam at RM 146 on the Columbia River is located about 25 river miles upstream of the mouth of the Sandy River.

The East Channel Dam is owned by the Oregon Department of Fish and Wildlife (ODFW) and is located on lands administered by the Oregon Department of State Lands (DSL). The DSL manages Oregon's waterways, and the dam lies on submerged and submersible land. The lands adjacent to the original Sandy River channel are National Forest lands administered by the Columbia River Gorge National Scenic Area of the U.S. Forest Service.

Agency Roles

As described above, in addition to the Portland District Corps, three agencies are cooperating in the project (the U.S. Forest Service Columbia River Gorge National Scenic Area, Bonneville Power Administration, and the Portland Water Bureau) with various roles in the proposed project. In addition, the Oregon Department of State Lands (DSL) has asserted jurisdiction over the channels and the dam.

More specifically, the Portland District Corps is proposing the project and would fund a majority of the work under Section 536 of the Water Resources Development Act of 2000. The U.S. Forest Service manages much of Sundial Island and land on the mainland side of the East Channel. The U.S. Forest Service would authorize work to occur on Forest Service land, as well as issue a determination of consistency with the Management Plan for the Columbia River Gorge National Scenic Area for the project. The Forest Service is also the Federal Sponsor under Section 536. The Portland Water Bureau would partially fund dam removal, as it is a requirement of its Habitat Conservation Plan and Implementation Agreement with NMFS for all water supply operational impacts to ESA-listed fish species in the Bull Run watershed. BPA is involved because it is proposing helicopter landing areas, footpaths, and rock storage on Sundial Island to access transmission towers on the island if the dam is removed; the dam also functions as an access road to and from the island.

2 ALTERNATIVES

The Corps is proposing to restore the Sandy River Delta habitat by removing the East channel dam, excavating a pilot channel, removing invasive plants and planting native plants. Five alternatives were considered that range from the no action alternative to increasingly more extensive restoration activities. The design of the action alternatives focused on improving conditions for ESA-listed salmonids by restoring, to the extent possible, the conditions that existed in the East and West

channels prior to construction of the dam. All alternatives considered were in accordance with local area policies and regulations; including the Mt. Hood National Forest Land and Resource Management Plan, Standards, and Guidelines, as well as both the Northwest National Forest Plan Standards and the Columbia River Gorge National Scenic Area Management Plan.

Every action alternative includes a pilot channel within the East Channel. The pilot channel is beneficial for all action alternatives, including those that do not include dam removal, in order to maintain flow in the East Channel during lower flows. This would provide a continuous connection through the East Channel to its terminus at the Columbia River and would prevent ponding, which could strand fish in pools during summer when water temperature could cause mortality. Depth would be maintained in the East Channel that would be subject to inundation from the Columbia River for alternatives that do not involve dam removal.

Alternative 1 – No Action/Status Quo

For the No Action Alternative, the East Channel dam would be left intact and no connection would be made between the Sandy and Columbia rivers. Since dam construction, the East Channel has gradually silted in and has largely become a slough. In addition, the Sandy River Delta area has lost much of its hydrologic complexity and contains greatly reduced areas of backwater habitat. This condition provides limited habitat for rearing juvenile salmonids. Water flows through the East Channel from east to west (from the Columbia River toward the dam) during Columbia River spring freshets, and the channel is tidally influenced. Only during high flows on the Sandy River does water flow over the dam and then west to east through the East Channel to the Columbia River. The East Channel dries to isolated pools during summer, while the West Channel flows year-round. Although in deteriorating condition, the construction pattern of the dam is still evident from pilings and bolts visible on the east face of the dam.

Currently, juvenile salmonids spawned in the Sandy River system must outmigrate primarily through the West Channel but may access the East Channel from the Sandy River when flows are high enough to overtop the dam. Juveniles also may enter the East Channel from its mouth after first going into the Columbia River, but must first swim upstream in the Columbia River to do so. Juveniles spawned in the Columbia River upstream of the confluence of the Sandy and Columbia rivers and that migrate downstream are known to use the East Channel for refugia during high flows and for rearing.

For the East Channel, marginal habitat for juvenile salmonids currently exists for part of the year. During spring and summer, water temperatures are likely too warm most of the time to provide adequate rearing habitat for juveniles. During summer, ponding occurs in the East Channel and increases the potential for stranding of juvenile salmonids. During much of the year, this channel is inaccessible to fish coming directly from the Sandy River; it is accessible only during high flows.

For the West Channel, habitat for juvenile salmonids is currently available year-round. During spring and summer, water temperatures may be too warm at times to provide adequate rearing habitat for juveniles. Unlike the East Channel, ponding and the potential for stranding of juveniles is not a factor. The West Channel is accessible from the Columbia River at all times of the year. The West Channel supports much less riparian habitat than the East Channel and riprap occurs along some sections. Shade, detrital input, and invertebrate production in the West Channel is less than in the East Channel because riparian habitat is so sparse. Woody debris is less prevalent in the West Channel, although the East Channel does not support much woody debris either.

Alternative 2—Short Pilot Channel (Considered but dismissed from from further consideration)

Alternative 2 consists of construction of a low-flow pilot channel through the south flow split, creation of a backwater area in the north flow split, removal of invasive plants, and planting of native plants (Figure 5), as described below.

Pilot Channel. The pilot channel would be about 4,750 feet long and would be created by removing high points in the East Channel. A dozer, scraper, or excavator would be used to remove high points in the East Channel (pilot channel) from the dam, through the south flow split to the Columbia River. The pilot channel would have a bottom width of approximately 20 feet and 2.5 to 1, horizontal to vertical side slopes (Figure 6). Approximately 32,400 cubic yards (cy) of material would be excavated for the pilot channel. Some vegetation might need to be removed along the East Channel to provide equipment access. The work would primarily occur in the dry and existing ponds would be avoided as much as possible. Silt fences would be used during construction where ponding occurs in the channel to prevent disturbed soil from entering the water.

Flow to the East Channel can come from the Sandy and Columbia rivers, currently mainly the Columbia. The pilot channel would be of benefit even without dam removal in order to maintain flow in the East Channel from the Columbia River during lower flows and maintain a continuous connection in the East Channel, thereby preventing pooling of water and stranding of fish.

Figure 5 - Alternative 2

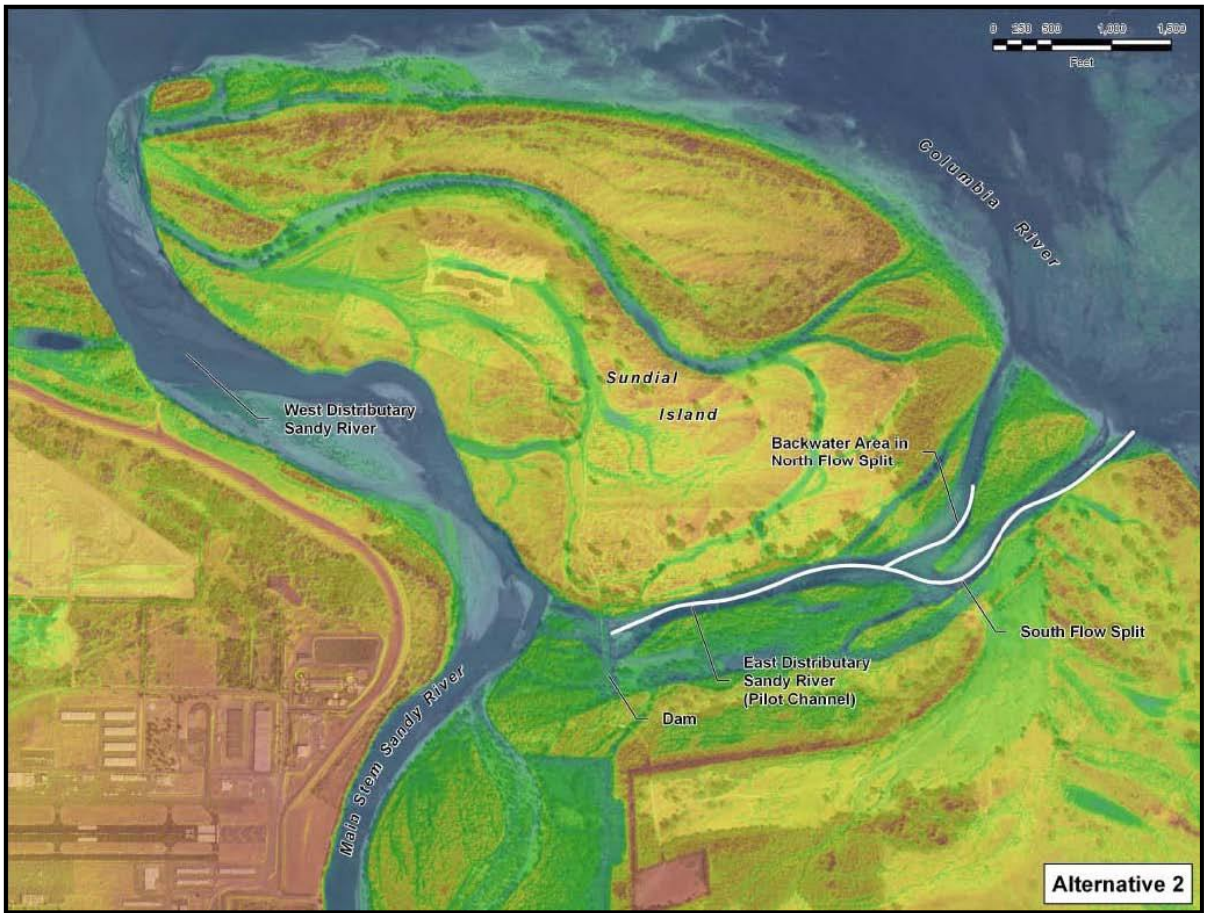
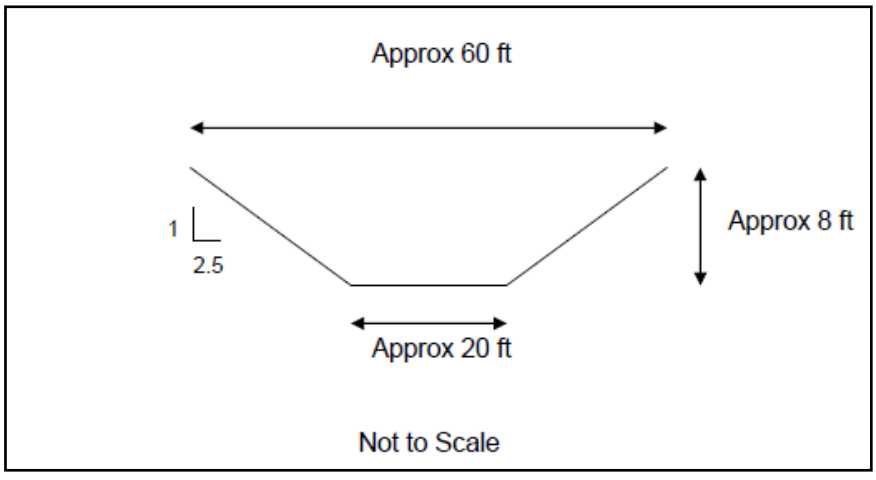


Figure 6 - Schematic of Pilot Channel for Alternatives 2, 3, and 4



Equipment would use the existing road to gain access to the East Channel and would move about in the channel during excavation activities. From inspection of the site during lower water, it is likely that ponds can be avoided by equipment for the most part. Equipment that exerts low pressure on the

ground would be employed in order to move about effectively in the East Channel and to minimize impacts with respect to soil compaction.

Excavated material would be hauled by truck or scraper to a rock storage area which would be identified prior to construction. Vegetation at the REA would be restored post construction. Construction equipment would access the REA using existing roads. A construction staging area would be located near the work site in accordance with environmental regulations. An existing locked gate at the entrance of Thousand Acres Road would keep public vehicles from entering the site; because pedestrians are able to walk around the gate, signage would be posted to keep the public from entering the construction areas.

Backwater Area. The backwater area would be constructed in the north flow split and would fill with water during high flows in the Columbia River providing rearing and refuge habitat for salmonids. The backwater area in the north flow split would be approximately 900 feet long and would be created in the same manner as the pilot channel. Approximately 960 cy of material would be excavated for the backwater area and hauled to the REA designated by the U.S. Forest Service.

Plantings. Native plants such as willow, hardhack, dogwood, and other water tolerant species would be planted over approximately 22 acres in areas disturbed by construction and along both sides of the toe in the existing channel bank where native plants are scarce. Approximately 3.5 acres of existing invasive species such as thistle and blackberry would be removed. Plants would be monitored with success criteria of at least 80% (including other alternatives here that include plantings). There are no specific criteria for invasive plants. The monitoring plan is included in the attached Appendix.

Activities on National Forest Land. The following activities would occur in upland areas that are National Forest lands:

- Utilization of two currently treeless areas as temporary equipment staging areas. These areas would be used to park equipment and vehicles during project implementation and would be rehabilitated, including revegetation, after project completion. The areas are approximately 20 acres in size and located just south of the dam site.
- Temporary use of the existing National Forest road system by equipment and vehicles to facilitate work.

Alternative 2 would not increase accessibility of juvenile salmonids directly from the Sandy River. This alternative would minimize the potential for juvenile stranding in the East Channel during summer months and would, at least to some extent, provide cooler waters since a pilot channel with deeper water would be present. The backwater area would provide additional winter refugia habitat. Water conditions and the wetted area in the West Channel would not change.

Alternative 3—Longer Pilot Channel (considered but dismissed from further consideration)

Alternative 3 consists of construction of a low-flow pilot channel through both the north and south flow splits (Figure 7), removal of invasive plants, and planting of native plants as described below.

Pilot Channel. The pilot channel would be about 6,750 feet long and would be created by removing high points through both the north and south flow splits. A dozer, scraper, or excavator would be

used to dig the pilot channel from the dam, through the north and south flow splits, and to the Columbia River. Figure 6 provides a schematic of the pilot channel. Approximately 37,300 cy of material would be excavated for the pilot channel. Some vegetation might need to be removed to provide equipment access. As described for Alternative 2, the work would primarily occur in the dry, and silt fences would be used where ponding occurs to prevent material from entering the water. Excavated material would be hauled by truck or scraper to the REA described for Alternative 2. Equipment access and staging would be the same as described for Alternative 2.

Flow to the East Channel can come from the Sandy and Columbia Rivers, and currently this mainly comes from the Columbia. The pilot channel would provide benefits even without dam removal in order to maintain flow in the East Channel from the Columbia River during lower flows and maintain a continuous connection in the East Channel, thereby prevent pooling of water and stranding of fish.

Figure 7 - Alternative 3

Plantings. Same as Alternative 2.

Activities on National Forest Land. Same as Alternative 2.

Alternative 3 would not increase accessibility of juvenile salmonids directly from the Sandy River. This alternative would minimize the potential for juvenile stranding in the East Channel during

summer months and would, at least to some extent, provide cooler waters since two pilot channels with deeper water would be present. This alternative would provide additional benefits in comparison to Alternative 2 by providing an additional side channel from the East Channel to the Columbia River. Water conditions and wetted area in the West Channel would not change.

Alternative 4—Pilot Channel + Partial Dam Removal (considered but dismissed from further consideration)

Alternative 4 consists of construction of a low-flow pilot channel from the Sandy River to the Columbia River, partial dam removal, removal of invasive plants, and planting of native plants (Figure 8), as described below.

Pilot Channel. The pilot channel would be about 7,350 feet long. A dozer, scraper or excavator would be used to remove high points through the south flow split to create a continuous connection between the Sandy and Columbia rivers. Approximately 23,000 to 24,000 cy of material would be excavated for the pilot channel. Some vegetation may need to be removed to provide equipment access. As described for Alternatives 2 and 3, the work would primarily occur in the dry, and silt fences would be used where ponding occurs to prevent material from entering the water. Excavated material would be hauled by truck or scraper to the REA described for Alternatives 2 and 3. Equipment access and staging would be the same as described for Alternatives 2 and 3. A schematic with proposed dimensions is shown in Figure 6.

Partial Dam Removal. The dam is approximately 750 feet long, 45 feet wide and 8 feet high. A 60 foot wide notch would be removed from the northern Sundial Island side of the dam. Approximately 1,000 cy of rock, pilings, timbers, and sediment material would be excavated in the dry by using a dozer or excavator, and hauled off-site. This cut section through the dam would be approximately 8 feet deep with a bottom width of approximately 20 feet, a top width of approximately 60 feet, and 2.5 horizontal to 1 vertical side slopes (Figure 9). Some of the pilings are still visible on the east side of the dam. The pilings from the dam were analyzed for arsenic and creosote compounds and no contaminants were detected. The rock, timbers, and material removed from the dam would be trucked to the REA described for Alternatives 2 and 3. Equipment access and staging would be the same as described for the pilot channel.

Plantings. Same as Alternatives 2 and 3.

Activities on National Forest Service Land. The activities would be the same as with Alternative 2 and 3 (staging areas, use of road system) with the additional following activities that would occur in upland areas that are National Forest lands:

- **Helicopter Landing Areas.** BPA would construct three helicopter landing areas on Sundial Island to provide BPA maintenance access to its Ostrander-Troutdale 500-kV and Big Eddy-Troutdale 230-kV transmission lines and towers. These proposed helicopter landing areas were chosen for close proximity and safe access to BPA transmission towers and for site characteristics that would minimize potential impacts to environmental resources. The primary landing area, proposed in an area north of the two westernmost towers along the Ostrander-Troutdale transmission line on Sundial Island, would utilize a 100-foot diameter circular area that would be cleared of existing vegetation and topped with geotextile fabric and 3-inch minus rock (i.e. 3 inches and smaller). Existing grasses would be cleared and about ten small trees would be flush-cut to the ground level. Two smaller satellite helicopter landing areas would be constructed in 45-foot diameter circular areas near the easternmost

and westernmost towers of the Big Eddy-Troutdale transmission line. The western satellite helicopter landing area would be cleared of existing vegetation and topped with geotextile fabric and 3-inch minus rock. The eastern satellite helicopter landing area would be cleared of existing vegetation and require the removal of about ten trees. Construction activities would require use of existing access roads on Sundial Island and across the dam by vehicles and equipment. No grading or ground disturbance would occur in the helicopter landing areas.

- **Footpaths.** BPA would construct two footpaths to connect one of the satellite helicopter landing areas to existing roads for maintenance access by foot. These footpaths would measure approximately 1,750 feet long and 4 feet wide and would be located under the Ostrander-Troutdale and Big Eddy-Troutdale transmission lines entirely within BPA's existing right-of-way. For the footpath under the Ostrander-Troutdale line, 3-inch minus rock would be applied to the existing wheel tracks that have been cleared of most vegetation from prior vehicle travel. For the footpath under the Big Eddy-Troutdale transmission line, existing vegetation would be cleared and 3-inch minus rock would be applied along a rudimentary trail that has begun to form from prior foot travel. No grading or ground disturbance would occur to construct footpaths.

Partial removal of the dam would benefit juvenile salmonids spawned in the Sandy River system by allowing access to the East Channel during a variety of flow conditions, by reducing stranding potential during summer months when ponding occurs in the East Channel, by providing cooler water to the East Channel from the Sandy River during summer, and by providing additional area that meets appropriate depths and velocities for juvenile salmonids. Water conditions and wetted area for the West Channel might have a minor loss of habitat because of flow diversion into the East Channel during certain times of the year.

Figure 8 - Alternative 4

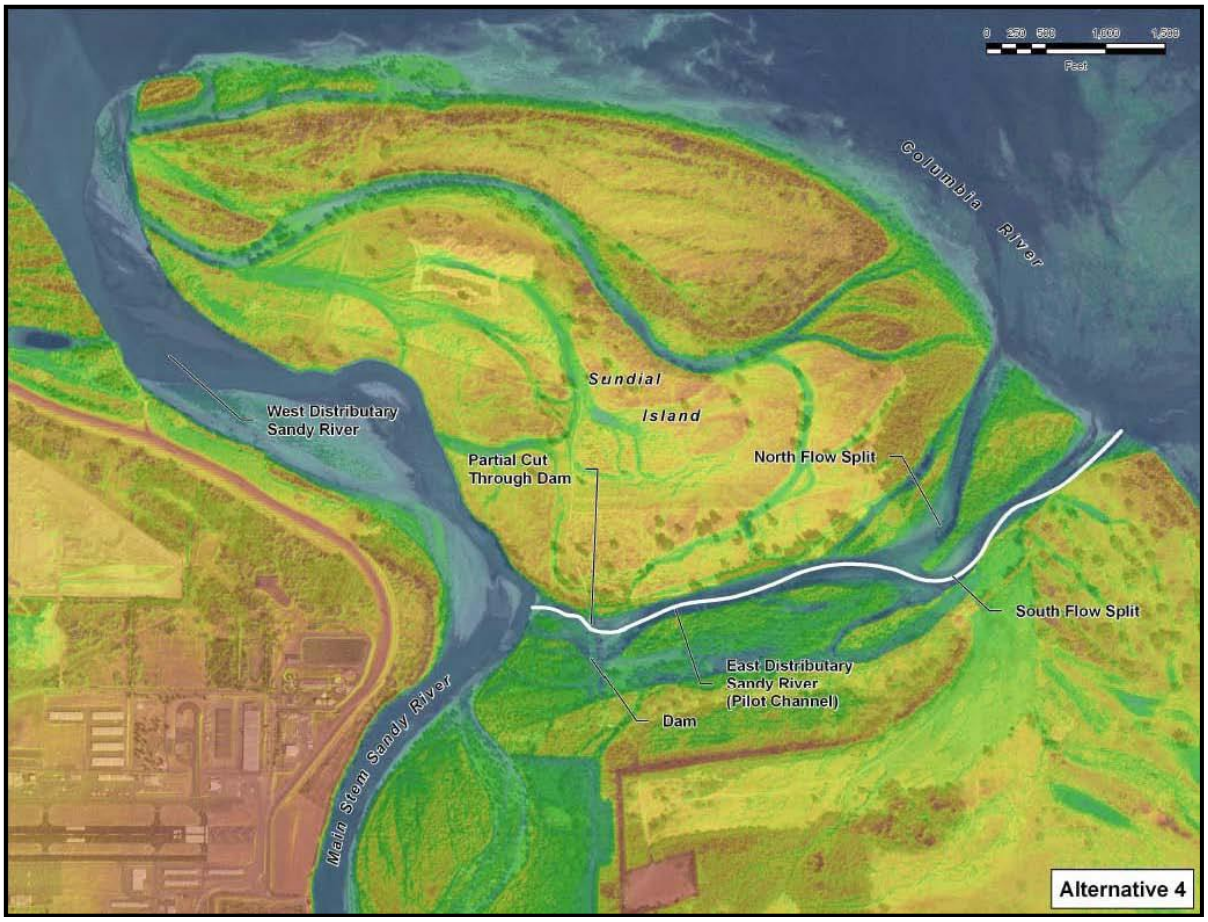
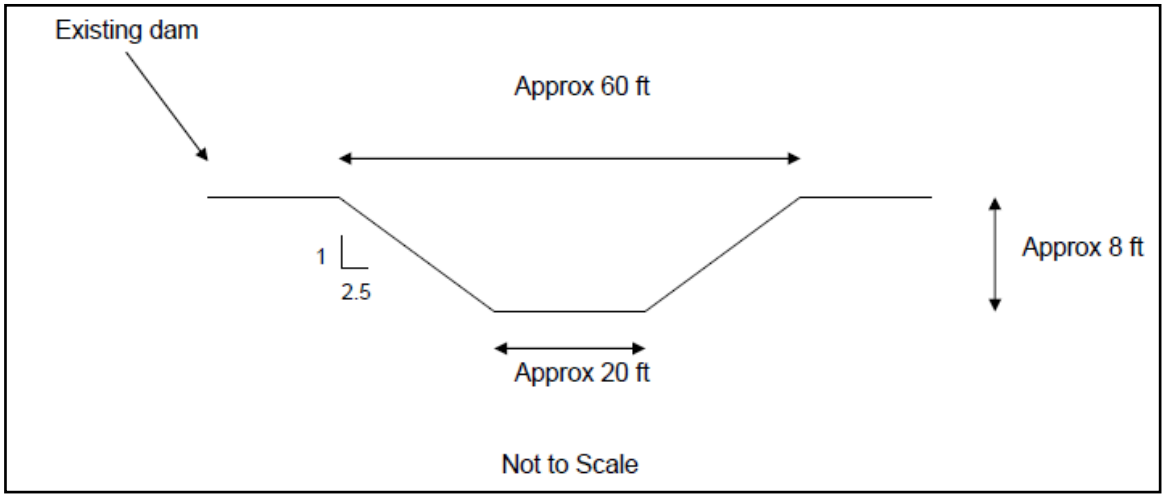


Figure 9 - Schematic for Partial Dam Removal, Alternative 4



Alternative 5—Full Dam Removal (Preferred Alternative)

Alternative 5 (Figure 10) is the same as Alternative 4 except that the entire East Channel dam would be removed, as described below.

Pilot Channel. Same as Alternative 4.

Figure 10 - Alternative 5

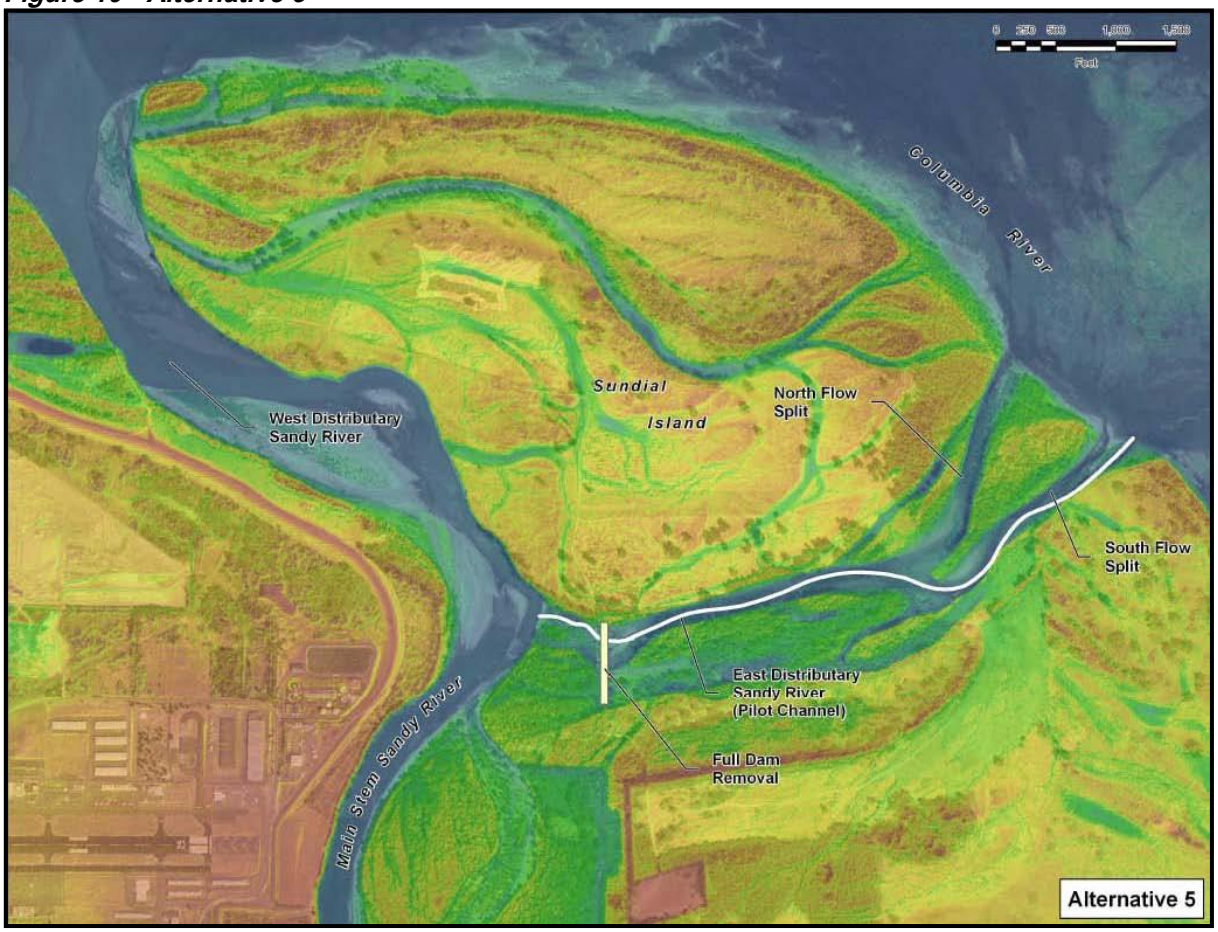
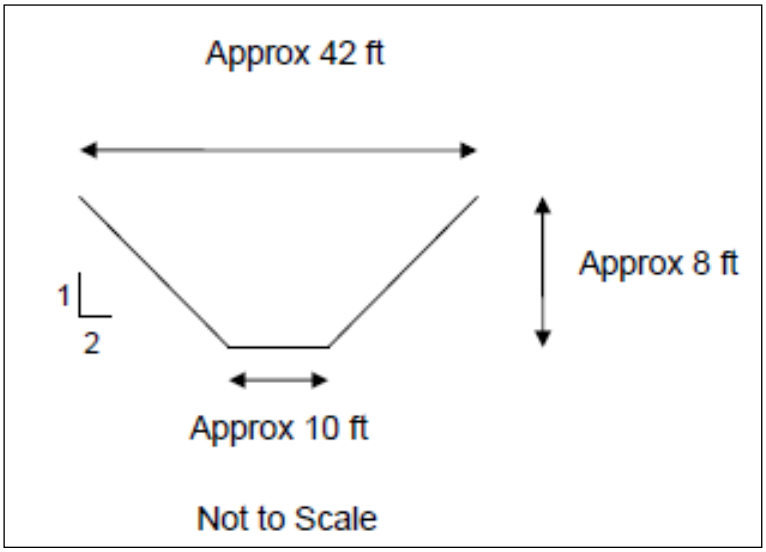
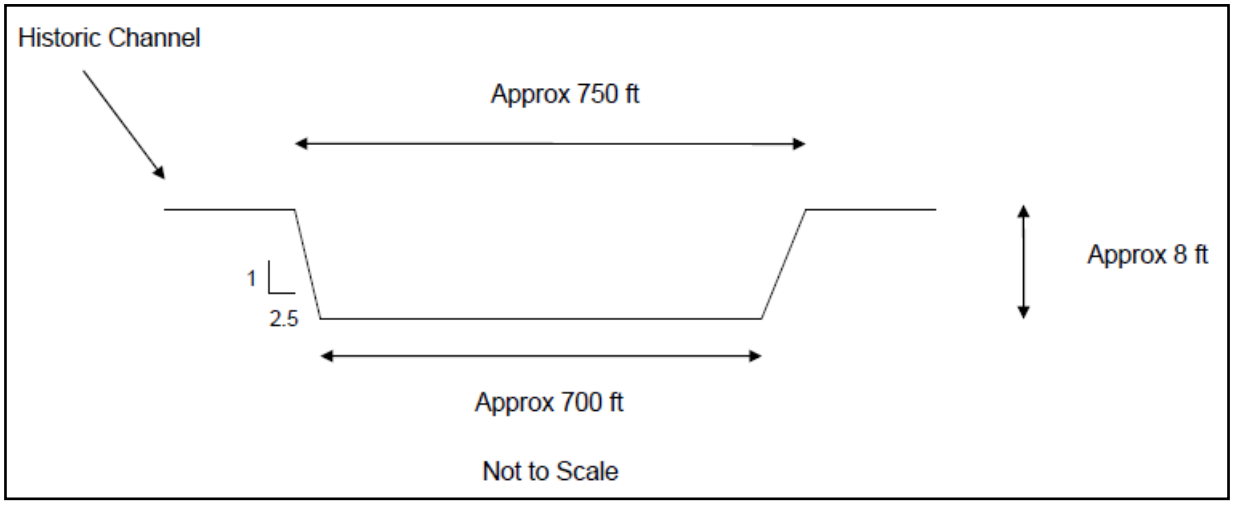


Figure 11 - Schematic of Pilot Channel for Alternative 5



Full Dam Removal. With this alternative, the entire dam (750 feet long, 45 feet wide and 8 feet high) would be removed. Removing the entire dam would require excavation of up to approximately 13,200 cy of rock, pilings, timbers, and sediment material using a dozer or excavator. Figure 12 shows a full dam removal schematic. The pilings from the dam were analyzed for arsenic and creosote compounds and no contaminants were detected; therefore, removal of this material will not result in mobilization of contaminants. Only rock removed from the dam would be trucked to the rock storage areas, as described below.

Figure 12 - Schematic for Full Dam Removal, Alternative 5



Plantings. Same as Alternatives 2, 3, and 4.

Activities on National Forest Land. The activities would be the same as Alternative 4 with the additional following activities that would occur in upland areas that are National Forest lands:

Storage of up to approximately 13,200 cubic yards of rock material in up to four locations in the Thousand Acre and Sundial Island area (storage areas shown on Figure 13). The rock material would be riprap size and come from removal of the dam. Areas that would have rock storage have been previously disturbed and are located in areas that have been graded and had tree removal. The rock would be shaped into a stable configuration and have soil placed over the top and planted with vegetation. These sites would be outside of the Riparian Reserve for the most part and on flat, stable ground.

Alternative 5 is similar to Alternative 4, full dam removal would benefit juvenile salmonids spawned in the Sandy River system by allowing access to the East Channel during a variety of flow conditions; reducing stranding potential during summer months when ponding occurs in the East Channel; providing cooler water to the East Channel from the Sandy River during summer; and providing additional area that meets appropriate depths and velocities for juvenile salmonids. Removing the entire dam would provide more immediate shallow water habitat and allow the river to reestablish a more natural flow pattern, which could create additional shallow water habitat by scouring. Water conditions and wetted area for the West Channel might have a minor loss of habitat because of the diversion of flow into the East Channel during certain periods of the year.

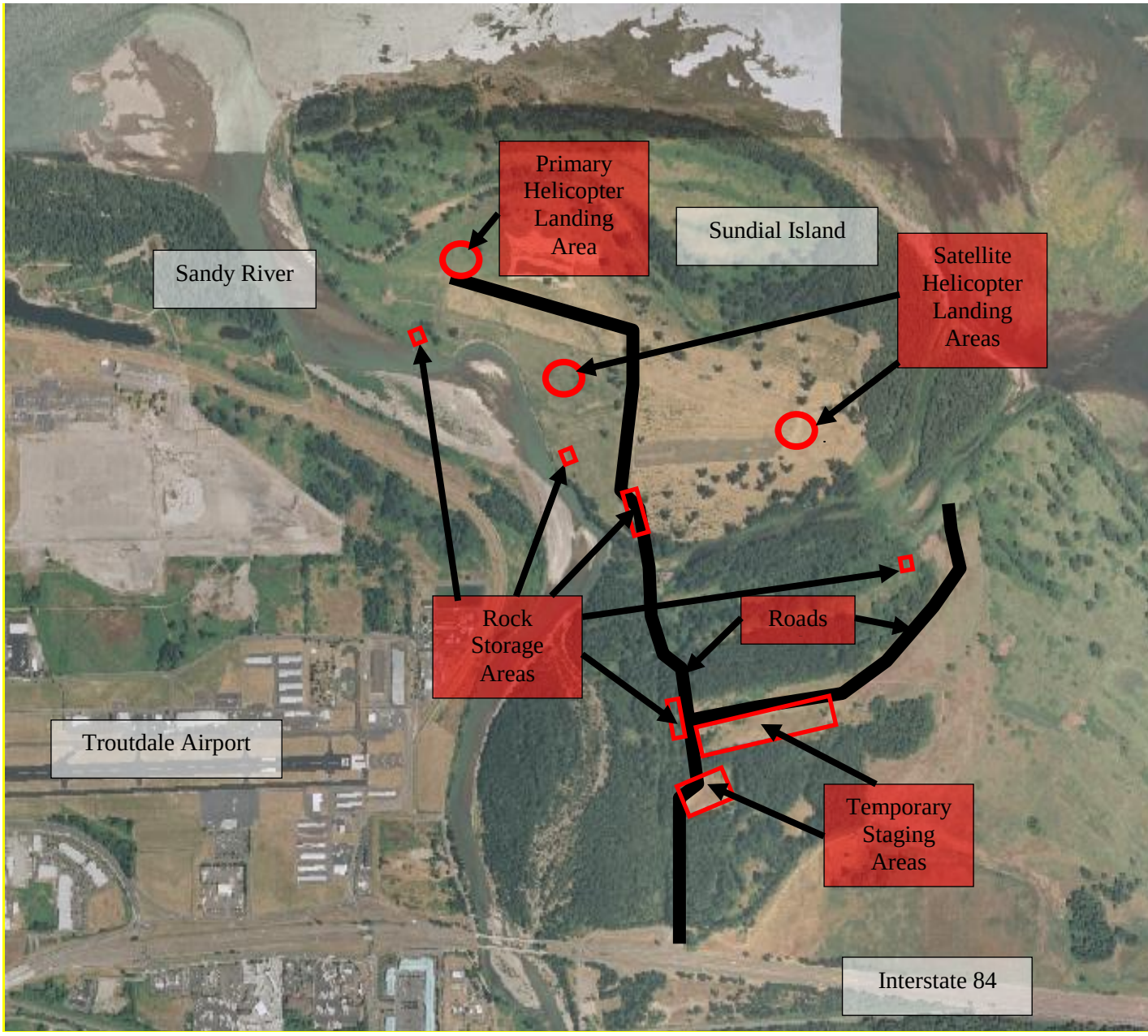


Figure 13 - Project area showing potential rock storage areas, helicopter landing areas, staging areas, and existing roads.

Rating the Alternatives for Salmonid Habitat Value

Habitat suitability index (HSI) scores for ESA-listed juvenile salmonids using the Sandy River were determined for each alternative. Runs contributing to the HSI scores included salmonids listed under the Endangered Species Act most likely to use the Sandy River Delta: Spring Chinook salmon, fall Chinook salmon, coho salmon, and winter steelhead. Spring Chinook salmon are present year-round, including during the summer when East Channel water temperatures are high and stranding

potential exists. Fall Chinook salmon are primarily present during spring and summer. Coho and Steelhead juveniles are present year-round.

Using this method, scores range from zero to one. Score assignment is qualitative and incorporates habitat features such as depth, velocity, temperature, stranding, and access. Habitat units (HUs) were developed for comparing alternatives with respect to juvenile salmonid benefits. To compute HUs, the average HSI scores for the four types of juvenile salmonids considered were obtained, averaged, and then multiplied by the acreage of the project footprint, 14 acres for the East Channel and 30 acres for the West Channel. This resulted in a final HU score for each channel for each of the five alternatives.

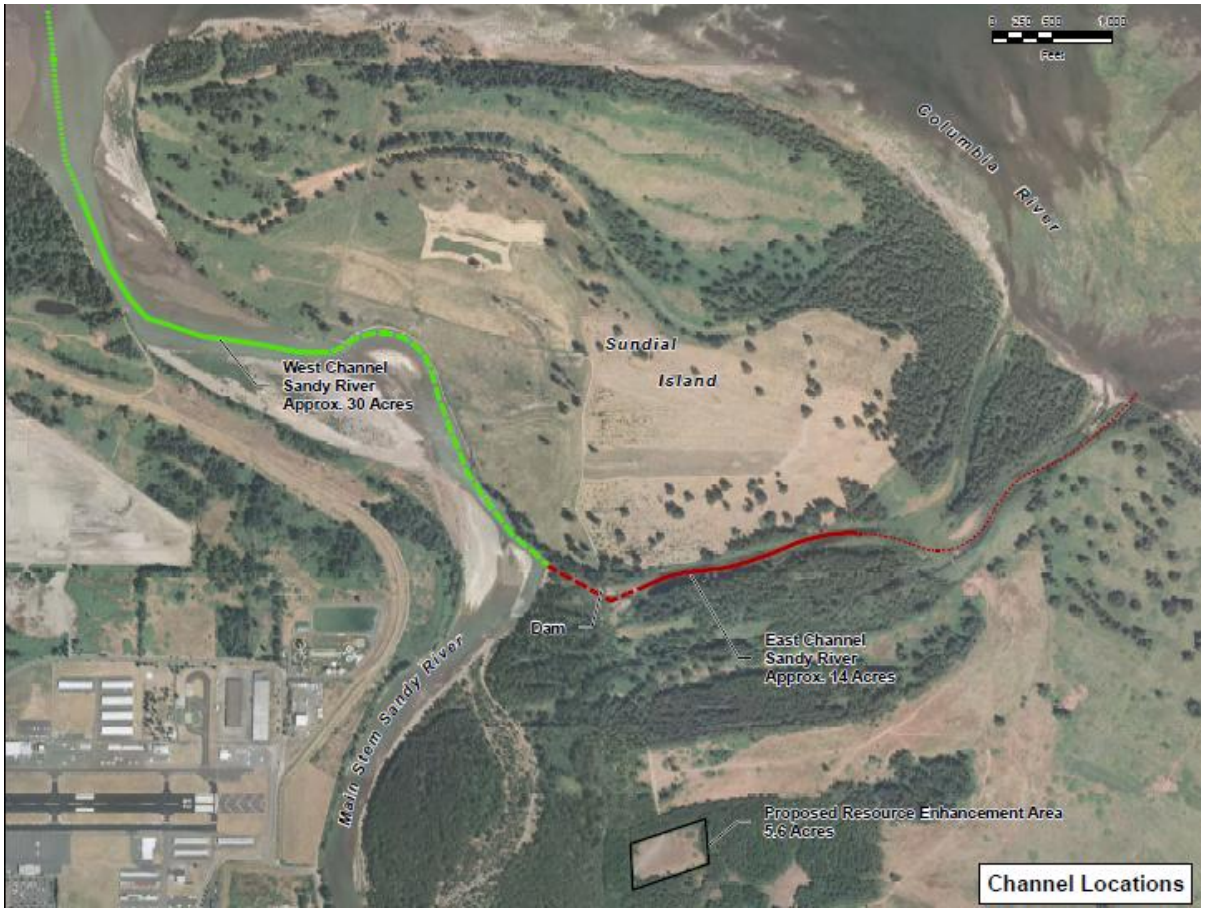
For the purposes of the benefits analysis, only the existing affected wetted areas within the East and West Channel were incorporated into the analysis. The average annual wetted area potentially affected by the proposed restoration alternatives estimated approximately 14 acres in the East Channel and approximately 30 acres in the West Channel. The HSIs for the alternatives were assumed to be constant during the project life for the four types of juvenile salmonids that were assessed in the area.

Velocity and depth criteria were obtained from Corps' fisheries biologists and ODFW literature (Baxter 2002; Moore et al. 1997; Reiser and Bjornn 1979).

These criteria, which represent ranges of good habitat conditions, are as follows:

- Spring Chinook: depth $\geq$ 1.6 feet, velocity 0-1 foot per second.
- Fall Chinook: depth $\geq$ 1.6 feet, velocity 0-1 foot per second.
- Coho: depth $\geq$ 3.3 feet, velocity 0-1 foot per second.
- Winter Steelhead: depth $\geq$ 1.6 feet, velocity 0.2-2.2 feet per second.

Figure 14 - Project Footprint



These criteria are provided for informational purposes; the environmental benefits modeling considered depth and velocity in a more general sense, however. All factors were considered in a qualitative, predictive context. A qualitative assessment of how these factors may change with implementation of the alternatives is presented below. Depth, velocity, as well as access, stranding potential, and water temperature were considered in a rather qualitative, predictive context. Scores for the various runs for each alternative were considered relative to one another based on factors such as the quality of the area when fish are expected to be present. Qualitative assessments of how these factors may change with implementation of the alternatives are presented below. A hydraulic engineering study was also completed to determine habitat area based on water flow depth and velocity throughout the channel. Ultimately, these results were useful but a more broad-based qualitative approach was adopted to reflect a more comprehensive assessment. The following information explains the basis of benefits value assessment.

East Channel Evaluation

Table 1. Habitat Suitability scoring criteria for the East Channel.

Score	Criteria Met
0	No access to East Channel at any time from Columbia R. and Sandy R.
0.1	Access to East Channel mainly from Columbia R.; access to East Channel from Sandy R. is minimal, (i.e. only during high flows); fish occurrence mainly during time of stranding potential.
0.2	0.1 met but fish occurrence year-round; habitat criteria met in much of East Channel at times but duration limited.
0.3	0.2 met plus stranding potential minimized with pilot channel; additional habitat with backwater refugia.
0.4	0.3 met plus additional habitat with side channel from East Channel to Columbia.
0.5	0.3 met plus low access to East Channel from Sandy R. when fish present.
0.6	0.3 met plus moderate access to East Channel from Sandy R. when fish present.
0.7	0.3 met plus high access to East Channel from Sandy R. when fish present.
0.8	0.3 met plus access from Sandy R. always available.
0.9	0.8 met plus substantial large woody debris in East Channel or riparian habitat providing shade along the majority of the length of the East Channel.
1	0.8 met plus substantial large woody debris and riparian habitat providing shade along the majority of the length of the East Channel.

Note 1: Additions or deductions of 0.05 to the scores in the above table were made for each of the following conditions being met:

1. Stranding potential minimized with pilot channel but dam still present.
2. Additional shallow water habitat created (where dam was present).
3. Additional shallow water habitat created (side channel).
4. Depth criteria met more often.
5. Velocity criteria met more often.
6. Temperature criteria met more often.
7. Timing of use.

West Channel Evaluation

The West Channel was scored on a lower scale than that of the East Channel because it is a common habitat type, while the East Channel represents off-channel refuge habitat that has become rare in the Columbia River Basin.

The No Action Alternative was scored relative to the corresponding No Action Alternative to the East Channel.

Alternatives 2 and 3 were the same as the No Action Alternative because actions in the East Channel would not affect the West Channel.

For Alternative 4, additions of 0.05 from the No Action Alternative were given in each case because of an increase in shallow-water habitat along the margins of the West Channel that would occur because some water would be diverted into the East Channel.

Summary of HSIs and HUs by Alternative

Alternative 2 would have a moderate increase in HSIs and HUs in the East Channel compared to the No Action Alternative because while access to the East Channel from the Sandy River remains limited, improvements are made by excavation of a pilot channel from the Columbia River to the dam, which would minimize stranding, provide somewhat cooler water, and add refugia area. Alternative 3 would have a small increase in HSIs and HUs from Alternative 2 because an additional channel connecting the Columbia River with the East Channel would be constructed, which is considered more valuable than the added refugia area of Alternative 2. Alternatives 4 and 5 would have a large increase in HUs over the other alternatives because partial or full dam removal would allow likely year-round access and influx of cooler water into the East Channel. A small increase in HUs occurs with Alternative 5 (full dam removal) as compared to Alternative 4 (partial dam removal) because of additional shallow water habitat that would be provided where the remainder of the dam would occur.

Table 2 provides a summary of the yearly HSIs and HUs determined for each alternative.

Table 2. Habitat Suitability Index (HSI) and Habitat Units (HUs) by Alternative (note: average HSIs are multiplied by project footprint in acres for the West Channel and East Channel to obtain Channel-specific HUs, and Channel-specific HUs are summed to obtain

Alternative	Average HSIs East Channel	Average HSIs West Channel	HUs East Channel	HUs West Channel	Total HUs
No Action	0.175	0.225	2.45	6.75	9.2
Alternative 2	0.275	0.225	3.85	6.75	10.6
Alternative 3	0.325	0.225	4.55	6.75	11.3
Alternative 4	0.725	0.275	10.15	8.25	18.4
Alternative 5	0.775	0.275	10.85	8.25	19.1

HSI and HU changes in the West Channel result from less water in the channel with Alternatives 4 and 5 leading to a slightly greater amount of shallow water habitat along the margins of the channel relative to Alternatives 1-3.

East Channel HIS Scores and HUs

Alternative 1 (No Action)
The No Action Alternative in the East Channel offers juvenile Salmonid habitat for only part of the year. During spring and summer months, however, water temperatures are likely too warm to provide adequate rearing habitat for juvenile salmonids. Also during summer, ponding occurs in the East Channel increasing the potential for stranding of juveniles. The East Channel is only accessible to fish coming directly from the Sandy River during high flows. Fish have access to the East Channel from the Columbia River; however, fish must swim through shallow water to reach the channel during times of lower flow in the Columbia River. .

HSI Values

Spring Chinook Salmon: 0.20
Spring Chinook salmon are present year-round including summer when water temperatures are high in East Channel and when stranding potential exists. The East Channel is accessible the remainder

of the year from the Columbia River and during high flows from the Sandy River, with appropriate depth and velocity criteria present in much of the East Channel.

Fall Chinook Salmon: 0.10
Fall Chinook salmon are present mainly during spring and summer when high water temperatures and potential for stranding exist in the East Channel.

Coho Salmon: 0.15
Similar to spring Chinook, but a lower score because appropriate water depth in the East Channel occurs less often for Coho than for spring Chinook.

Winter Steelhead: 0.25
Similar to spring Chinook, but a higher score because the velocity criterion is met more often.

Habitat Units
HU = [(0.2 + 0.1 + 0.15 + 0.25) / 4] x 14 = 2.45

Alternative 2 (Channel from Columbia River into East Channel to dam and backwater refugia area)
Alternative 2 would not increase accessibility of juveniles directly from the Sandy River. The benefits of this alternative include minimizing the potential for stranding during summer months and providing cooler waters by deepening the channel and creating additional refugia.

HSI Values

Spring Chinook Salmon: 0.30
Potential for stranding is minimized, depth and velocity criteria are met more often during low flows, and additional refugia habitat is created.

Fall Chinook Salmon: 0.20
Similar to spring Chinook, but a lower score because of spring and summer use. East Channel water temperatures may be too warm during late spring and summer months for juvenile Salmonid rearing.

Coho Salmon: 0.25
Similar to spring Chinook, but a lower score because appropriate water depth in the East Channel occurs less often for Coho than for spring Chinook.

Winter Steelhead: 0.35
Similar to spring Chinook, but a higher score because the velocity criterion is met more often.

Habitat Units
HU = [(0.3 + 0.2 + 0.25 + 0.35) / 4] x 14 = 3.85

Alternative 3 (Channel from Columbia River into East Channel to the dam and side channel from East Channel to Columbia River)
Alternative 3 would not increase accessibility of juveniles directly from the Sandy River. The benefits of this alternative include minimizing the potential for stranding during summer months and providing cooler waters by deepening the channel. This alternative provides additional benefits over Alternative 2 because of the side channel connection from the East Channel to the Columbia River.

HSI Values

Spring Chinook Salmon: 0.35
Potential for stranding is minimized, depth and velocity criteria are met more often during low flows. HSI value would be higher than Alternative 2 because of additional side channel connection.

Fall Chinook Salmon: 0.25
Similar to spring Chinook but a lower score because of spring and summer use. East Channel water temperatures may be too warm during late spring and summer months for juvenile Salmonid rearing. HSI value is higher than Alternative 2 because of additional side channel connection.

Coho Salmon: 0.30
Similar to spring Chinook, but a lower score because appropriate water depth in the East Channel occurs less often for Coho than for spring Chinook. HSI value is higher than Alternative 2 because of additional shallow side channel connection.

Winter Steelhead: 0.40
Similar to spring Chinook, but a higher score because the velocity criterion is met more often. HSI value is higher than Alternative 2 because of additional side channel connection.

Habitat Units
HU = [(0.35 + 0.25 + 0.3 + 0.4) / 4] x 14 = 4.55

Alternative 4 (Channel from Columbia River into East Channel to the dam and partial dam removal)
Alternative 4 would likely allow year-round access of juveniles directly from the Sandy River, minimize the potential for stranding during summer months and provide cooler waters by deepening the channel.

HSI Values

Spring Chinook Salmon: 0.75
Partial dam removal would reduce the potential for stranding, depth and velocity criteria are met more often during low flows, year-round access directly from the Sandy River is provided, and cooler water would flow through the East Channel during summer months. East Channel water temperatures may be too warm during late spring and summer months for juvenile Salmonid rearing.

Fall Chinook Salmon: 0.65
Similar to spring Chinook but a lower score because of spring and summer use. East Channel water temperatures may be too warm during late spring and summer months for juvenile Salmonid rearing.

Coho Salmon: 0.70
Similar to spring Chinook, but a lower score because appropriate water depth in the East Channel occurs less often for Coho than for spring Chinook.

Winter Steelhead: 0.8
Similar to spring Chinook, but a higher score because the velocity criterion is met more often.

Habitat Units
HU = [(0.75 + 0.65 + 0.7 + 0.8) / 4] x 14 = 10.15

Alternative 5 (Channel from Columbia River into East Channel to the dam and full dam removal) Alternative 5 would allow for likely year-round access of juveniles directly from the Sandy River. It would provide cooler Sandy River water into the East Channel year-round and would minimize the potential for stranding during the summer. More shallow water habitat would be available with removal of the remainder of the dam.

HSI Values

Spring Chinook Salmon: 0.80
Potential for stranding is minimized, depth and velocity criteria are met more often during low flows. Year-round access directly from the Sandy River is provided, and cooler water is provided to the East Channel during summer. East Channel water temperatures may be too warm during late spring and summer months for juvenile Salmonid rearing. HSI value is higher than Alternative 4 because of additional shallow water habitat available with removal of the remainder of the dam.

Fall Chinook Salmon: 0.70
Similar to spring Chinook but a lower score because of spring and summer use. East Channel water temperatures may be too warm during late spring and summer months for juvenile Salmonid rearing. HSI value is higher than Alternative 4 because of additional shallow water habitat available with removal of the remainder of the dam.

Coho Salmon: 0.75
Similar to spring Chinook, but a lower score because appropriate water depth in the East Channel occurs less often for Coho than for spring Chinook. HSI value is higher than Alternative 4 because of additional shallow water habitat available with removal of the remainder of the dam.

Winter Steelhead: 0.85
Similar to spring Chinook, but a higher score because the velocity criterion is met more often. HSI value is higher than Alternative 4 because of additional shallow water habitat available with removal of the remainder of the dam.

Habitat Units
HU = [(0.8 + 0.7 + 0.75 + 0.85) / 4] x 14 = 10.85

Summary of Habitat Units for East Channel
Alternative 1: HU = 2.45
Alternative 2: HU = 3.85
Alternative 3: HU = 4.55
Alternative 4: HU = 10.15
Alternative 5: HU = 10.85

Table 3 summarizes the above scores for the East Channel.

Table 3. HSI scores for each type of juvenile Salmonid considered by Alternative for the East Channel.

Fish Run	*Alternative 1*	*Alternative 2*	*Alternative 3*	*Alternative 4*	*Alternative 5*
Spr. Chinook	***0.2***	***0.3***	***0.35***	***0.75***	***0.8***
Fall Chinook	***0.1***	***0.2***	***0.25***	***0.65***	***0.7***
Coho	***0.15***	***0.25***	***0.3***	***0.7***	***0.75***

Wi. Steelhead	***0.25***	***0.35***	***0.4***	***0.8***	***0.85***

West Channel HSI Scores and HUs

Alternative 1 (No Action)
The No Action Alternative (existing condition) in the West Channel offers habitat for juvenile salmonids year-round. During spring and summer months, however, water temperatures may be too warm at times to provide adequate rearing habitat for juvenile salmonids. Unlike the East Channel, ponding and the potential for stranding of juveniles is not a factor. The West Channel within the project area is accessible from the Columbia River year-round. The West Channel supports less riparian habitat than the East Channel and has riprap along some sections. Shade, detrital input, invertebrate production, and woody debris in the West Channel along the area of interest is less than in the East Channel due to sparse riparian habitat.

HSI Values

Spring Chinook Salmon: 0.20
The HSI value is equivalent to the East Channel because stranding is not an issue, the area is accessible year-round, and water temperatures are cooler. However, the West Channel has poorly developed riparian habitat, less detrital input and insect production, and less woody debris.

Fall Chinook Salmon: 0.30
The HSI value is higher than the East Channel because juvenile salmonids would be present during spring and summer; there is no potential for stranding in the West Channel, and no restrictions on access from the Columbia River.

Coho Salmon: 0.15
The HSI value is equivalent to the East Channel because stranding is not an issue, the area is accessible year-round, and water temperatures are cooler. However, the West Channel has poorly developed riparian habitat, less detrital input and insect production, and less woody debris.

Winter Steelhead: 0.25
The HSI value is equivalent to East Channel because stranding is not an issue, the area is accessible year-round, and water temperatures are cooler. However, the West Channel has poorly developed riparian habitat, less detrital input and insect production, and less woody debris.

Habitat Units
HU = [(0.2 + 0.3 + 0.15 + 0.25) / 4] x 30 = 6.75

Alternative 2 (Channel from Columbia River into East Channel to the dam and backwater refugia area)

The HSI values are the same for West Channel Alternative 1, as water in West Channel would not be affected.

Habitat Units
HU = [(0.2 + 0.3 + 0.15 + 0.25) / 4] x 30 = 6.75

Alternative 3 (Channel from Columbia River into East Channel to the dam and side channel from East Channel to Columbia River)

The HSI values are the same for West Channel Alternative 1, as water in West Channel would not be affected.

Habitat Units
HU = [(0.2 + 0.3 + 0.15 + 0.25) / 4] x 30 = 6.75

Alternative 4 (Channel from Columbia River into East Channel to the dam and partial dam removal)
A minor improvement to the wetted area in the West Channel would likely occur.

HSI Values

Spring Chinook Salmon: 0.25
Slight increase from Alternatives 1, 2, and 3 because additional shallow-water habitat may be present along the margins of the channel.

Fall Chinook Salmon: 0.35
Slight increase from Alternatives 1, 2, and 3 because additional shallow-water habitat may be present along the margins of the channel.

Coho Salmon: 0.20
Slight increase from Alternatives 1, 2, and 3 because additional shallow-water habitat may be present along the margins of the channel.

Winter Steelhead: 0.30
Slight increase from Alternatives 1, 2, and 3 because additional shallow-water habitat may be present along the margins of the channel.

Habitat Units
HU = [(0.25 + 0.35 + 0.2 + 0.3) / 4] x 30 = 8.25

Alternative 5 (Channel from Columbia River into East Channel to the dam and full dam removal)
Same for West Channel Alternative 4, as water conditions and wetted area would not change.

Habitat Units
HU = [(0.25 + 0.35 + 0.2 + 0.3) / 4] x 30 = 8.25

Summary of Habitat Units for West Channel
A summary of the annual HUs for the restoration alternatives is shown below:
Alternative 1: HU = 6.75
Alternative 2: HU = 6.75
Alternative 3: HU = 6.75
Alternative 4: HU = 8.25
Alternative 5: HU = 8.25

Changes result from less water in the West Channel with Alternatives 4 and 5 leading to a slightly greater amount of shallow water habitat along the margins of the channel relative to Alternatives 1, 2, and 3. Table 4 summarizes the above scores for the West Channel.

Table 4. HSI scores for each type of juvenile Salmonid considered by Alternative for the West Channel.

Fish Run	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Spr. Chinook	0.2	0.2	0.2	0.25	0.25
Fall Chinook	0.3	0.3	0.3	0.35	0.35
Coho	0.15	0.15	0.15	0.2	0.2
Wi. Steelhead	0.25	0.25	0.25	0.3	0.3

Cost Effectiveness and Incremental Cost Analysis

In order to select the preferred alternative for the Sandy River Delta ecosystem restoration project, 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 solution is identified for various levels of environmental output. Its purpose is to eliminate inefficient alternatives, based on comparing environmental outputs with *average 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. It serves as the basis for comparison with the alternatives or with-project conditions. In addition to the No Action Alternative, there are four action alternatives (with project conditions) being considered.

The non-monetary benefits (environmental outputs) of the environmental restoration alternatives are measured in average annual environmental outputs. It should be noted that the average annual environmental outputs listed 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 development costs and operation and maintenance (O&M) costs. In order 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, all costs were present-valued and amortized at the fiscal year 2011 federal discount rate of 4.125% over the project life, to develop equivalent average annual costs.

For determining the economic cost of the project and its various components, a calculation is made to determine the cost of interest during construction (IDC). 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 2011 discount rate of 4.125% for costs incurred during construction of the project. The O&M costs for the project include upkeep of plantings and removal of invasive plant species (approximately $2,000 per year for 3 years, following construction of the project). The project costs are expressed in terms of average annual dollars, combining implementation and O&M costs.

Table 6 summarizes the net gains in average annual environmental outputs, the average annual costs, and the average annual cost per environmental output for each site. The table shows that the average annual cost per environmental output is directly associated with the number of environmental outputs gained by development of each site. Note that the No Action Alternative is listed first and the average annual environmental outputs represent the net gain over No Action.

Table 5. Average Annual Environmental Outputs, Average Annual Costs and Average Annual Cost per Environmental Output

Sites	Average Annual Output	Average Annual Costs ($)	Average Annual Cost per Output ($)
Alternative 1 (No Action)	0	0	0
Alternative 2	1.4	29,287	20,919
Alternative 3	2.1	29,719	14,152
Alternative 4	9.2	30,282	3,292
Alternative 5	9.9	43,616	4,406

The Corps Institute for Water Resources (IWR) Cost-Effectiveness and Incremental Cost Analysis software (IWR-PLAN, located at http://www.pmcl.com/iwrplan/GenInfoOverview.asp) was used to analyze the alternatives. Each of the alternatives was cost-effective. The five cost-effective alternatives serve as the supply schedule of the average annual cost for each level of output, which serves as the basis from which to derive the incremental cost analysis. Incremental cost analysis is required to address whether the incremental or additional cost of the next level of output is worth it. In environmental studies, the comparison is between dollar incremental costs and non-dollar incremental units of output. In order to facilitate the required calculations, IWR-PLAN was used to do the calculations necessary to eliminate the irregular, non-continuously increasing cost changes that occur in the incremental average annual cost per output calculations.

A series of calculations were necessary for the final incremental cost analysis to determine the lowest average cost for additional output from amongst the remaining levels of output. Each of the recalculations begins with the previous step's lowest average cost level of output set as the new "zero level." The calculation in this step uses the additional cost and additional outputs above those of the previously identified level of output with the lowest average cost (for further details on this process, refer to *Cost Effectiveness Analysis for Environmental Planning: Nine Easy Steps*, IWR Report 94-PS-2, October 1994).

The IWR-PLAN calculations showed that Alternatives 1, 2, 3, 4, and 5 were cost effective and that Alternatives 1, 4 and 5 were incrementally justified, making them "best buy" plans. Table 6 summarizes the final incremental cost analysis results and shows the incremental changes from Alternative 1 to Alternative 4, and then from Alternative 4 to Alternative 5. For instance, moving from the Alternative 1 to Alternative 4 shows a change of 9.2 additional average annual environmental outputs; an additional average annual cost of $30,282; and an incremental average annual cost per average annual environmental output of $3,292 ($30,282 incremental cost divided by 9.2 incremental environmental outputs).

Table 6. Summary of Final Incremental Cost Analysis

Alternative	Total Average Annual Output	Total Average Annual Costs ($)	Added Average Annual Costs ($)	Added Average Annual Output	Incremental Average Annual Cost per Output ($)

Alternative 1 (No Action)	0	0	0	0	0
Alternative 4	9.2	30,282	30,282	9.2	3,292
Alternative 5	9.9	43,616	13,334	0.7	19,049

In Table 6, the right column summarizes the incremental average annual cost per output; its purpose is to show potential breakpoints where gaining the next level of output shows a large increase in costs. In this case, the largest breakpoint is between Alternative 4 and Alternative 5.

Selection of the Preferred Alternative

Evaluation of the alternatives is based primarily on a comparison of the without project (or existing) condition with each of the with-project alternative conditions. The benefits of the alternatives 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 *Evaluation of Environmental Investments Procedures Manual, Interim Cost Effectiveness and Incremental Cost Analyses*, IWR Report 95-R-1 (May 1995).

The preferred alternative is Alternative 5, which includes full dam removal, as described below. The results of the quantitative cost effectiveness and incremental cost analyses described above was completed before the 2011 EA in order to select a preferred alternative. This analysis showed that the most cost effective and incrementally justified alternative for the Sandy River Delta restoration project was Alternative 4, which includes only partial dam removal. Consequently, the National Ecosystem Restoration (NER) plan was identified as Alternative 4 in the 2011 EA. ER 1105-2-100 (p.2-7), f. (2) defines the NER plan: "For ecosystem restoration projects, a plan that reasonably maximizes ecosystem restoration benefits compared to costs, consistent with the Federal objective, shall be selected."

The preferred alternative identified in this EA (and the proposed action identified in the 2011 EA), however, is Alternative 5 (full dam removal). Natural Resource Agencies including NMFS and ODFW as well as the Sandy River Basin Partners expressed interest in full dam removal in order to achieve complete ecological functionality. Implementation of the preferred alternative would be a jointly funded project with the Portland Water Bureau; the Corps and the Water Bureau sharing construction costs. Under the Water Bureau's Bull Run Water Supply Habitat Conservation Plan (HCP), conservation measure H-8, contribution of funding of dam removal at the Sandy River Delta is identified as a requirement. A letter from NMFS to the Water Bureau and Corps (dated February 4, 2010) specified that the requirement of the Water Bureau would be met with partial funding to implement Alternative 5, and it was clarified that the Corps would receive mitigation credit toward the FCRPS BiOp for full dam removal.

3 AFFECTED ENVIRONMENT

Physical Characteristics

Geology and Soils

The affected environment, the Sandy River Delta, was formed by volcanism, sequences of uplift and erosion, and flooding (including the Missoula floods) from the Columbia and Sandy rivers. In the past few thousand years, the Delta has enlarged primarily from catastrophic lahars (volcanic debris flows) from volcanic activity on Mount Hood, combined with alluvial deposits (water lain) from the Columbia and Sandy rivers. The Delta now comprises approximately 1,400 acres and is composed largely of sediment that traveled about 45 miles down the Sandy River valley and into the Columbia River during two Mount Hood eruptive episodes.

The Sandy River Delta is generally flat and was subject to annual inundation before human alterations in the Columbia River Basin. There is evidence of this flooding in the remnant channels and islands which give the site its rough, hummocky terrain within the overall flat profile. Three soils types are found in and adjacent to the original Sandy River channel: (1) Sauvie silt loam is a poorly drained hydric soil typically associated with wetlands and is found on Sundial Island; (2) riverwash occurs extensively along the south shoreline of the Columbia River and in the Sandy River drainage and includes sand and gravel deposits – new surface material is added and removed with each overflow occurrence; and, (3) Faloma silt loam is a poorly drained hydric soil that typically occurs in wetlands and is found in the Delta south of Sundial Island.

Hydrology and Geomorphology

The Columbia River drains an area of 259,000 square miles and the Sandy River drains an area of 508 square miles. Historically, the lower Columbia River flooded under two distinct seasonal regimes. Winter floods were initiated by winter rains west of the Cascades and spring floods by snowmelt east of the Cascades. Spring floods affected the entire Columbia River system and was the primary force influencing the landforms and vegetation on the river bottoms. These floods were caused by snowmelt usually between April and August, although concentrated in May or June. Average annual spring floods had flows of about 600,000 cubic feet per second (cfs). These average flows were punctuated by huge flows with tremendous impact on the lower river. Spring floods greater than 600,000 cfs occurred 46 times between 1858 and 1956, with six floods between 800,000 and 900,000 cfs. The largest flood in 1894 reached 1,254,000 cfs (Christy 1992).

Spring floods on the Columbia River were often higher and lasted longer than winter floods. Sandy River winter floods were caused by seasonal rainstorms and rain-on-snow events and generally crested and abated in 1 or 2 days. The frequent Sandy River floods would have created more channel scouring than the longer Columbia spring floods. Major Columbia River tributaries, including the Sandy River, historically formed large deltas at their mouths. Debris and sediment deposited in the deltas would have been carried downriver during the Columbia's high water events.

Columbia River damming and diking have led to a large change in the hydrologic processes in the Sandy River Delta. Currently because of the presence of dams, large spring floods on the Columbia are less frequent, of shorter duration, and of much less volume. Events in even the 200,000 to 300,000 cfs range are now infrequent; extreme low water is infrequent as well. Water volumes are now much more uniform seasonally, but can vary daily with Columbia River water control strategies

from the Columbia River dams. Dikes and levees along the Columbia River have greatly reduced the lateral floodwater flow pattern.

The Sandy River Delta is predominantly within the 100-year floodplain of the Columbia River, the Sandy River, and both in some parts of the Delta area. Since no dams are located downstream of the confluence of the Sandy and Columbia rivers, the Columbia River at the Delta is tidally influenced, and tidal water enters the Delta. Without the influence of scouring flood events from the Columbia River, vegetation is more stable. Water levels in the Columbia River affect groundwater levels in the lowlands with lower river levels contributing to shrinking wetlands. Side channels have not been as regularly inundated as they were prior to dam construction on the Columbia. Upstream of Bonneville Dam, the deltas of major tributaries have been flooded under the reservoirs.

The lower Columbia River has experienced impacts from settlement and commerce for 170 years; the entire floodplain has been altered by 100 years of channel manipulation, including but not limited to dredging, pile dike construction, and decades of flood control. Virtually all floodplain features have been affected to some degree. The remaining sizable elements of a pre-settlement landscape are the landforms themselves, such as floodplain terraces, old flood channels, and shallow overflow lakes and ponds that are physical reminders of fluvial processes that largely no longer occur.

At the Sandy River Delta, levees block historic flood pathways and a dam blocks the East Channel (the original Sandy River main channel) from Sandy River flows most of the time. The East Channel now receives Sandy River water only under high Sandy flows. The East Channel is controlled mainly by Columbia River water and dries to isolated pools during summer. A light detection and ranging (LiDAR) image (Figure 15) shows the dam and sediment plug that has accumulated on the west side of the dam from river deposition of silt. As more flow has been directed through the West Channel since damming the East Channel, severe degradation (down cutting) has occurred and a meander (river bend) is forming downstream of the split between the East and West channels. Prior to dam installation, Sandy River flow was able to go through both the East and West channels, which reduced stream energy and allowed sediment deposition to be spread out over a broader area. Now that the majority of the Sandy River flow is contained in the West Channel, excess stream energy and sediment deposition is causing channel degradation and meandering as it is adjusting to this change. An emerging meander, shown in Figures 14, 15 and 16, is causing stream bank erosion that is threatening a BPA transmission line tower located on the Sundial Island at the edge of the West Channel. In the last 15 years, the average erosion rate has been about 15 feet per year of stream bank loss with greater losses resulting during higher flows.

Removal of Marmot Dam in 2007 and the Little Sandy Dam in 2008 likely increased sediment deposition in the Sandy River Delta. Figure 17 illustrates the locations of previous dam sites. Based on the numerical model of Stillwater Sciences (2000), the Bureau of Reclamation estimated that the Sandy River Delta area would likely aggrade up to 1.3 feet with sand-sized sediment (Bureau of Reclamation 2006), and sediment from behind the Little Sandy Dam would likely also contribute to accretion in the Delta. Over time, this sediment would be transported through the river system and out to the Columbia River.

In addition to sediment directly transported from storage behind the Marmot and Little Sandy dams, removal of the dams influenced sediment transport and deposition to the Sandy River Delta area in another way. These dams have acted as barriers to sediment movement by storing material behind them. With dam removal, sediment that is generated upstream of the dams would be able to move freely to downstream reaches of the river instead of being trapped behind the structures. This would likely increase sediment transport and deposition in the Delta in the future.

Figure 15 - LiDAR Image Showing Dam, Sediment Plug, and Emerging Meander

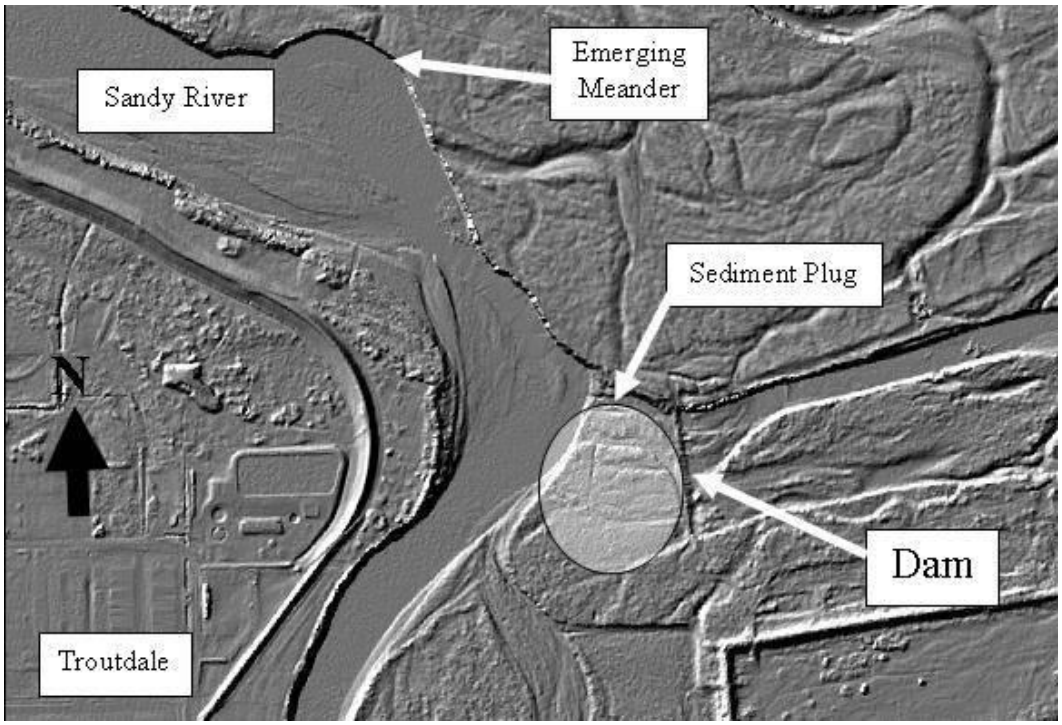


Figure 16 - Limits of an Emerging Meander in West Channel in Relation to BPA Transmission Tower (Note that orange = 1991, red = 2000, yellow = 2006)

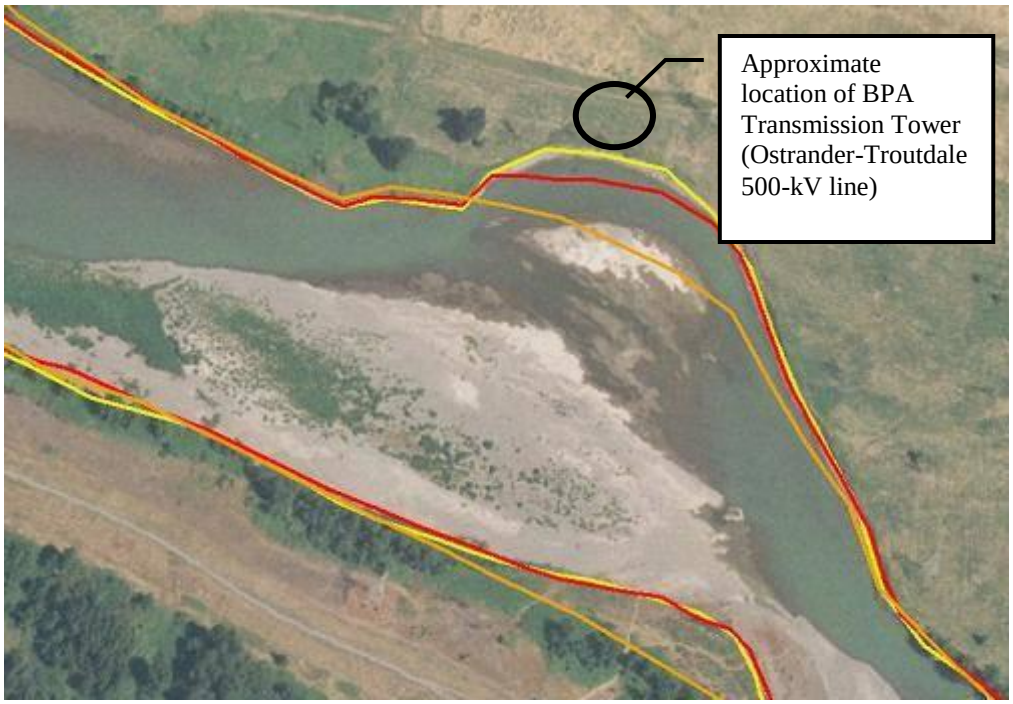
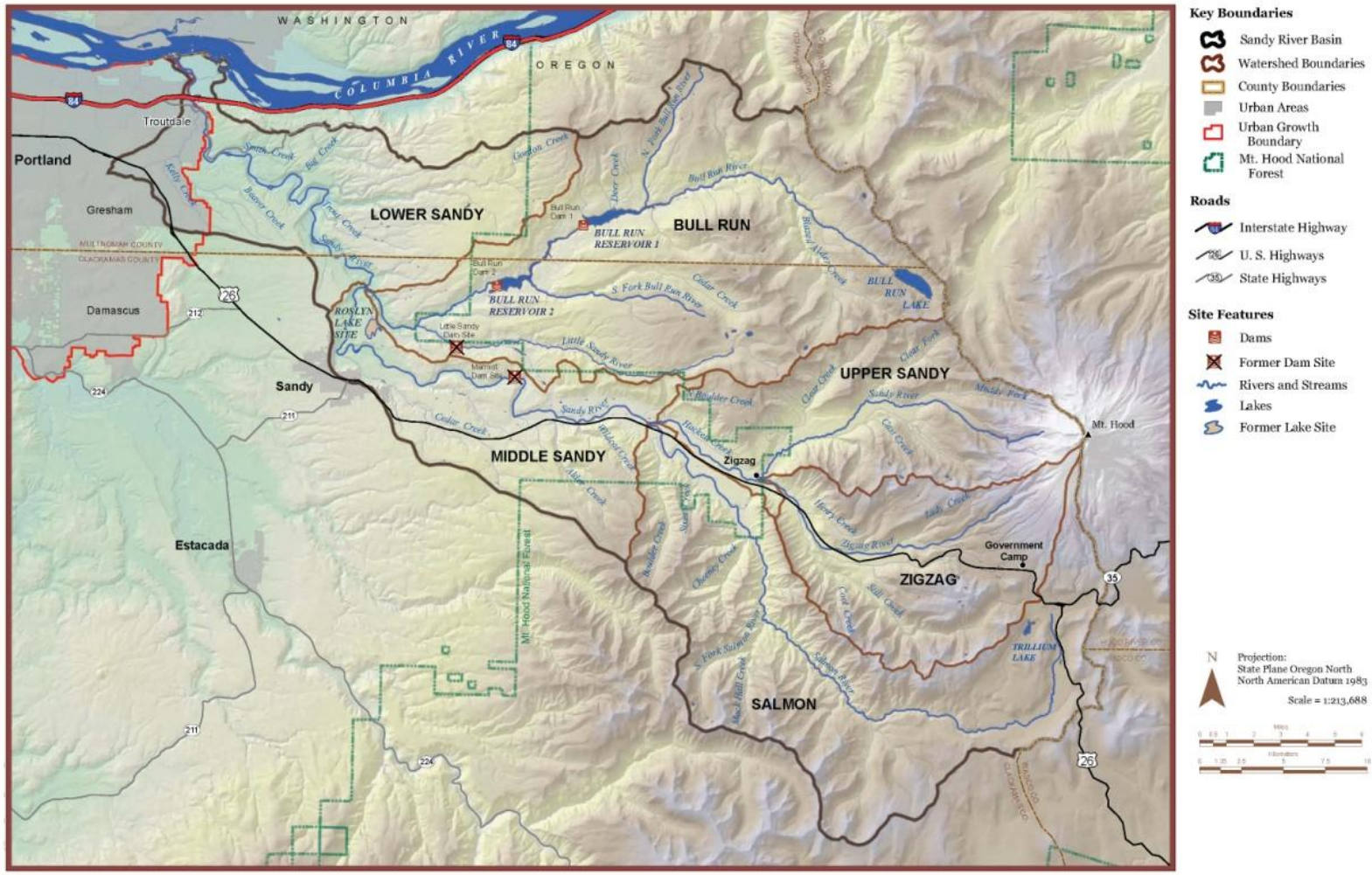


Figure 17 - Emerging Meander in the West Channel Showing the Severely Cut Bank, looking upstream

Figure 18 - Map of the Sandy River Basin illustrating the location of previously removed dams.



Water and Sediment Quality

Water temperature data is being collected using continuous water temperature data loggers by the Pacific Northwest National Laboratory (PNNL 2008) in and near the Sandy River Delta area. In the Delta, the data is collected at the historic mouth of the Sandy River and at the upper extent of the East Channel. Data collected in 2007-2008 showed water temperatures exceeding 20°C at the two sites from August through September.

In the 2004/2006 State of Oregon Water Quality Integrated Report, the Sandy River is listed for water temperature as "Category 4A: Water quality limited, but has a Total Maximum Daily Load (TMDL) plan." The river is listed as limited for salmon and steelhead summer rearing and year-round rearing and migration for water temperatures that exceed a 7-day average maximum of 17.8°C and 18.0°C, respectively. These listings are for the section of river at the Sandy River Delta upstream to the former Marmot Dam. A Sandy River Basin TMDL was approved by the U.S. Environmental Protection Agency (EPA) in 2005 and lays out how landowners in the basin would operate to improve water temperature in the river. Reasonable assurances that federal forestlands (National Forest) would meet the load allocation are identified in the TMDL.

The Sandy River is listed for sedimentation on the 2004/2006 State of Oregon Water Quality Integrated Report as "undefined" due to the lack of sufficient data; the listed segment extends from the mouth to RM 29.5. In August 2009, sediment samples were taken by the Corps in the East Channel both upstream and downstream of the dam (Corps 2009). The data showed that one copper and one zinc sample were slightly elevated but were below screening levels for unconfined in-water disposal in accordance with the *Sediment Evaluation Framework* (SEF 2009).

Vegetation

The Sandy River Delta is a highly dynamic floodplain habitat that transitions seasonally from aquatic to terrestrial habitat, depending upon the level of precipitation, episodic flood events, and tidal influence. At the time of the Lewis and Clark expedition in the early 1800s, the Sandy River Delta was heavily forested. The area also harbored numerous wetlands and sloughs that were hydrologically connected to the Columbia and Sandy rivers. General Land Office survey notes in 1854 describe the annual winter inundation of the area's lowland that typically lasted to early May, and as late as mid-July. At only 32 feet above mean sea level, the Delta was dominated by flood-tolerant deciduous hardwoods, such as black cottonwood (*Populus balsamifera*), Oregon ash (*Fraxinus latifolia*), red alder (*Alnus rubra*), Pacific willow (*Salix lasiandra*), and red-osier dogwood (*Cornus sericea*). Oregon white oak (*Quercus garryana*), Douglas-fir (*Pseudotsuga menziesii*), and western red cedar (*Thuja plicata*) also were present, largely in higher elevation areas. Today, less than 25% of the Delta area is forested and much of the wetland and slough habitat has been diked to facilitate agriculture, utility roads, and other land-based uses. However, despite these habitat alterations, the Delta area still harbors some of the best remaining Columbia River bottomland habitat remaining in the lower Columbia River.

With the general drying out of the Delta with hydrologic alterations on the Sandy and Columbia Rivers and subsequent cattle grazing and other disturbances in the Delta, non-native invasive species including Himalayan blackberry (*Rubus discolor*) and reed canary grass (*Phalaris arundinaceae*), for example, have become established and have thrived in parts of the Delta. Recent efforts by the Corps and Forest Service, however, to remove these and other undesirable species followed by planting of natives on Sundial Island have proved effective.

Fish and Wildlife

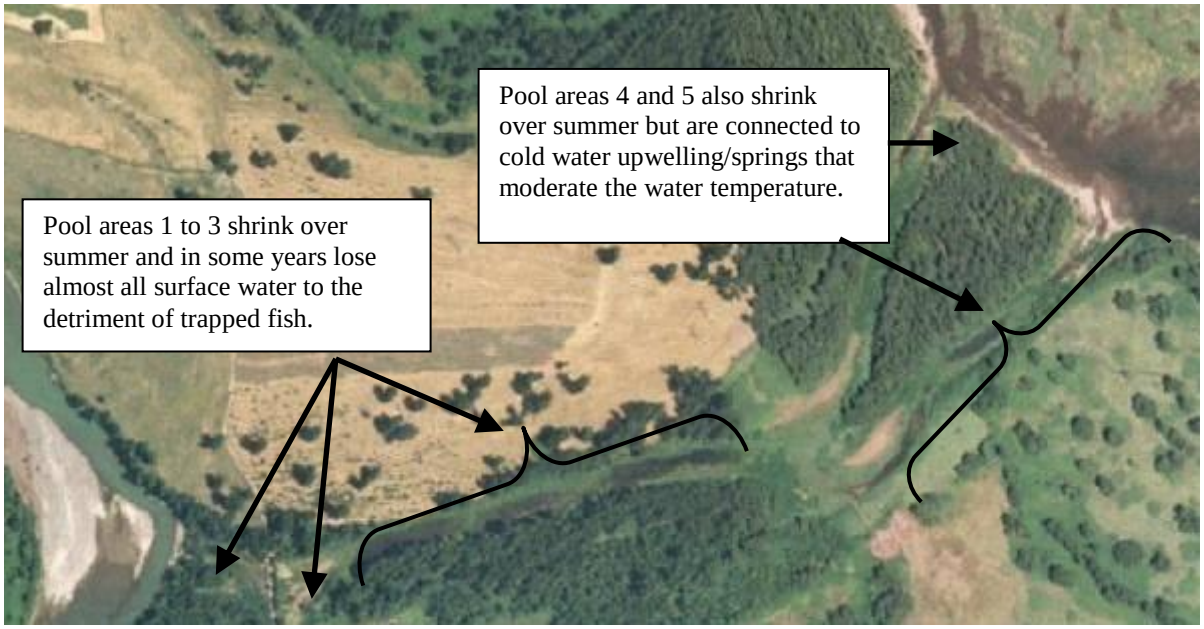
Fish and Aquatic Invertebrates

The Sandy River supports several species of native fish, such as spring and fall Chinook salmon, coho salmon, winter steelhead, cutthroat trout (*Oncorhynchus clarki*), rainbow trout (*Oncorhynchus mykiss*), eulachon (smelt), Pacific lamprey (*Lampetra tridentata*), mountain whitefish (*Prosopium williamsoni*), and threespine stickleback (*Gasterosteus aculeatus*). Sandy River chum salmon runs are considered to be extirpated at this time. Some introduced species found in the lower Sandy River include American shad (*Alosa sapidissima*), brook trout (*Salvelinus fontinalis*), and summer steelhead. The delta region is characterized by low gradient (<0.5%) and a predominantly sand or silt substrate. The sandy substrate provides spawning habitat primarily for eulachon, as well as rearing habitat for lamprey ammocoetes (juveniles). There are pockets of gravel that are available below bridge footings, sand bars, and accumulated wood pieces that may opportunistically be used by spawning anadromous salmonids in late fall through spring.

Typically from May to November, the East Channel ceases surface flow and transforms into discrete pools (Figure 19). Pool areas in the East Channel were surveyed by the Forest Service in May-June of 2007. Pool areas 1, 2 and 3 had temperatures from 21° to 26°C in early June 2007, with the warmest areas in about the top 8 inches of water. The adjacent area of the Sandy River, at this time was 18°C, while the Columbia River was 18.7°C. The pools become disconnected from river flows and heat up over the summer as ambient temperature increase. In contrast, pool areas 4 and 5 have coldwater spring water sources. Pool area 4 was 16.5°C overall, with 14° to 15°C springs on its north edge. Pool area 5 (nearest to Columbia River) varied from 16.5° to 18.4°C in the shallow areas, with deeper water temperatures ranging from 12.3° to 15.7°C. There was a visually evident, cold spring upwelling in the lower portion of this pool near the north bank.

All pools have dense patches of rooted aquatic vegetation. In some years, these pools dry up almost entirely with varying levels of fish kill due to high water temperature and/or low dissolved oxygen levels. Presently, these backwater ponds favor warm-water species that annually move in from the Columbia River, such as introduced largemouth bass (*Micropterus salmoides*), and bluegill (*Lepomis macrochirus*), as well as native species such as peamouth chub (*Mylocheilus caurinus*) and threespine stickleback. A few (<10) Salmonid fry are typically found during late spring surveys, but those present likely suffer almost complete mortality in the pools as summer temperature rises. Most rearing salmonids likely emigrate from the pools as flows decrease and water temperature increases.

Figure 19 - Summer Habitat Conditions in the East Channel



In addition, surveys of the pool areas found a moderate population of freshwater mussels, the Oregon floater (*Anodonta oregonensis*) and California floater (*Anodonta californiensis*). In pool areas 4 and 5, the dominant species caught were threespine stickleback (juveniles and adults), and damselfly nymphs. Other species caught in beach seines included largemouth bass juveniles, bluegill juveniles, banded killifish (*Fundulus diaphanous*), and peamouth chub juveniles. Pool areas 4 and 5 maintain surface flow contact with the Columbia River longer than pool areas 1 to 3, but eventually, around August, the connection dwindles to a small, shallow, and warm rivulet winding through the silt flats.

In winter or high flow months, the East Channel likely provides high-quality off-channel refugia habitat for coldwater species, such as juvenile salmonids. Conditions vary from year to year, but generally the Sandy River overtops the dam only during episodic rain events. This slough habitat likely provides quality off-channel refuge, as well as rearing habitat for both Sandy River and Columbia River salmonids, providing slower waters and riparian vegetation along with emergent vegetation at times and some woody debris. During high flows, cover within the East Channel is largely provided by dense emergent vegetation, a few pieces of large down wood, as well as dense riparian vegetation along the edge of the floodplain and banks. Two islands are also present in the channel that increases the margin and shallow water habitat within the channel.

Wildlife

The Sandy River Delta supports many common species of birds and mammals due to the diversity of habitat types, accompanying edge habitat, seasonal and permanent water features, and connectivity to the Sandy and Columbia River corridors. These habitat types include a mosaic of both young and older stands of bottomland hardwood forests, open meadows, wetlands, and permanent water. The Delta is in the Pacific flyway and links to other river corridor wildlife refuges, such as the Ridgefield National Wildlife Refuge (NWR), Sauvie Island Wildlife Management Area, Steigerwald NWR and Franz Lake NWR. The high diversity of bird species that share this habitat is unique in the local area and includes over 80 neo-tropical migrant species and over 20 waterfowl species. Aquatic and winged species (birds, bats, and insects) have good access to the Delta, while terrestrial species are

hampered by Interstate 84 to the south and the city of Troutdale to the west and south. Interstate 84 disrupts the connection to forested lands to the south of the Delta for terrestrial wildlife species. Semi-aquatic species (amphibians, turtles, mink, otter, beaver) and species that can swim well (deer) can likely use the river and adjacent shores to immigrate to and from the Delta. A population of painted turtles (*Chrysemys picta*) is known to inhabit the southeast portion of the Delta and may use one seasonal pond on the south edge of the East Channel. Northern red-legged frogs (*Rana aurora aurora*), a Federal species of concern, also use the Delta. This species is largely terrestrial during the non-breeding season. They have been found in the above-mentioned pools 1 and 2. Tadpoles of the introduced bullfrog (*Rana catesbeiana*) have been found in surveys to be abundant in the pools mentioned above. Bull frogs use aquatic habitats year-round.

The bald eagle (*Haliaeetus leucocephalus*) is closely associated with freshwater and estuarine ecosystems that provide abundant prey and suitable habitat for nesting and roosting. Breeding territories are typically located within 1 mile of permanent water in predominantly coniferous, uneven-aged stands with old-growth structural components (Anthony et al., 1982; Stalmaster 1987; Anthony and Isaacs 1989). Bald eagles over-winter along ice-free lakes, streams, and rivers where food and perch sites are abundant. Night roosts are used primarily during the winter months and generally occur in multi-layered mature or old-growth conifer stands that provide protection from weather and human disturbance (Stalmaster and Newman 1978). Bald eagles are found in the Sandy River Delta as wintering/transient birds and use riparian trees for hunting and loafing perches. Migrant bald eagles also are expected to occur as transients in the Delta area. Bald eagle nesting territories are present at nearby Lady Island and Flag Island in the Columbia River.

Threatened and Endangered Species

Species under NMFS Jurisdiction

The ESA-listed Salmonid species under the jurisdiction of the National Marine Fisheries Service (NMFS) that may occur in the project area are shown in Table 8. In 2005, critical habitat was designated for all Columbia River steelhead and salmon Evolutionarily Significant Units (ESU), with the exception of coho salmon. Life history descriptions for the ESUs are provided below.

Snake River Spring/Summer Run Chinook Salmon. Fish from this ESU occur in the mainstem Snake River and subbasins including the Tucannon, Grande Ronde, Imnaha, and Salmon rivers. Adults migrate in late winter to spring and spawn from late August to November. Spawning occurs in tributaries to the Snake River. Juveniles remain in freshwater from 1-3 years and outmigrate from early spring to summer.

Snake River Fall Run Chinook Salmon. Fish from this ESU occur in the mainstem Snake River and subbasins including the Tucannon, Grande Ronde, Imnaha, and Salmon rivers. Adults migrate from mid-August to October and spawn from late August to November. Spawning occurs in the Snake River and lower reaches of tributaries to the Snake River. Juveniles rear in freshwater from 1-3 years and outmigrate from early spring to summer.

Table 7. ESA-listed Species under NMFS Jurisdiction

Evolutionarily Significant Units	Status	Life History Type	Federal Register (FR) Citation
Chinook Salmon (*Oncorhynchus tshawytscha*)			
Snake River spring/summer run	Threatened	Ocean	70 FR 37160; June 28, 2005
Snake River fall run	Threatened	Ocean	70 FR 37160; June 28, 2005
Lower Columbia River	Threatened	Stream	70 FR 37160; June 28, 2005
Upper Columbia River spring run	Endangered	Stream	
Coho Salmon *(Oncorhynchus kisutch)*			
Lower Columbia River	Threatened	Stream	70 FR 37160; June 28, 2005
Chum Salmon (*Oncorhynchus keta*)			
Columbia River	Threatened	Ocean	70 FR 37160; June 28, 2005
Sockeye Salmon (*Oncorhynchus nerka*)			
Snake River	Endangered	Stream	70 FR 37160; June 28, 2005
Steelhead (*Oncorhynchus mykiss*)			
Snake River Basin	Threatened	Stream	71 FR 834; January 1, 2006
Lower Columbia River	Threatened	Stream	71 FR 834; January 1, 2006
Middle Columbia River	Threatened	Stream	71 FR 834; January 1, 2006
Middle Columbia River	Threatened	Stream	71 FR 834; January 1, 2006
Eulachon (*Thaleichthys pacificus*)	Threatened	(Ocean)	74 FR 3178; May 18, 2010

Lower Columbia River Chinook Salmon. Fish from this ESU occur from the mouth of the Columbia River upstream to Little White Salmon River, Washington and Hood River, Oregon and including the Willamette River upstream to Willamette Falls. Adults migrate in mid-August through October (fall run) and late winter to spring (spring run). Spawning occurs from late August to November. Spawning occurs in the mainstem Columbia River to upper reaches of tributaries. Juveniles outmigrate from early spring to fall. Spawning areas for spring and fall runs include the Sandy River. Juveniles could utilize the Sandy River during their downstream migration.

Upper Columbia River Spring Run Chinook Salmon. Fish from this ESU occur in Columbia River tributaries upstream of the Rock Island Dam and downstream of Chief Joseph Dam in Washington, excluding the Okanogan River. Adults migrate from late winter to spring and spawn from late August to November. Spawning occurs in the mainstem Columbia River to upper reaches of tributaries. Juveniles outmigrate from early spring to summer. Juveniles could utilize the Sandy River during their downstream migration.

Lower Columbia River Coho Salmon. It is believed that the majority of fish from this ESU return to the lower Columbia River to spawn between early December and March. Spawning occurs in tributaries to the Columbia River. Young hatch in spring, rear in freshwater for one year, and outmigrate to the ocean the following spring. Most juveniles outmigrate from April to August, with a peak in May. Coho salmon occur in the Columbia River estuary as smolts and limited estuarine rearing occurs (more extensive estuarine rearing occurs in Puget Sound). Spawning areas include the Sandy River.

Columbia River Chum Salmon. Fish from this ESU are distributed from Bonneville Dam to the mouth of the Columbia River. Adults migrate from early October through November and spawning occurs in November and December. Spawning habitat includes lower portions of rivers just above tidewater and in the side channel near Hamilton Island below Bonneville Dam. Juveniles enter estuaries from March to mid-May and most chum salmon leave Oregon estuaries by mid-May. Most

juveniles spend little time in freshwater and rear extensively in estuaries. Chum are not known currently to use the Sandy River.

Snake River Sockeye Salmon. Fish from this ESU occur in the Salmon River, a tributary to the Snake River. This population migrates in spring and summer and spawning occurs in February and March. Spawning occurs in inlets or outlets of lakes or in river systems. Juveniles rear in freshwater and outmigrate in spring and early summer, outmigrating primarily between April and early June. They spend little time in estuaries as smolts and are guided to ocean waters by salinity gradients. Juveniles could utilize the Sandy River during their downstream migration.

Snake River Basin Steelhead. Fish from this ESU occur in all accessible tributaries of the Snake River. Upstream migration occurs in spring and summer and spawning occurs in February and March. Spawning habitat includes upper reaches of tributaries. Juveniles spend from 1-7 years (average 2 years) in freshwater and outmigrate during spring and early summer. Juveniles could utilize the Sandy River during their downstream migration.

Middle Columbia River Steelhead. Fish from this ESU are distributed from Wind River, Washington and Hood River, Oregon upstream to the Yakima River, Washington. These fish migrate in winter and summer and spawning occurs in February and March. Spawning habitat includes upper reaches of tributaries. Juveniles spend from 1 to 7 years (average 2 years) in freshwater and outmigrate during spring and early summer. Juveniles could utilize the Sandy River during their downstream migration.

Lower Columbia River Steelhead. Fish from this ESU are distributed from Wind River, Washington and Hood River, Oregon downstream to the mouth of the Columbia River. These fish migrate in winter and spring/summer and spawning occurs in February and March. Spawning habitat includes upper reaches of tributaries. Juveniles spend from 1-7 years (average 2 years) in freshwater and outmigrate during spring and early summer. Spawning areas include the Sandy River.

Upper Columbia River Steelhead. Fish from this ESU are distributed from the Yakima River upstream to the Canadian border. These fish migrate in spring and summer and spawning occurs in February and March. Spawning habitat includes upper reaches of tributaries. Juveniles spend from 1-7 years (average 2 years) in freshwater and outmigrate during spring and early summer. Juveniles could utilize the Sandy River during their downstream migration.

Eulachon. The southern Distinct Population Segment (DPS) of Pacific eulachon (smelt) was recently listed as threatened under ESA. This DPS consists of populations spawning in rivers south of the Nass River in British Columbia, Canada, to and including the Mad River in California. The Columbia River and its tributaries, including the Sandy River, support the largest known eulachon run. Most eulachon production originates in the Columbia River Basin; the major and most consistent spawning runs return to the mainstem Columbia River (just upstream of the estuary at RM 25 to immediately downstream of Bonneville Dam at RM 146) and in the Cowlitz River. Periodic spawning also occurs in the Grays, Skamokawa, Elochoman, Kalama, Lewis, and Sandy rivers (tributaries to the Columbia River). Eulachon typically spend 3-5 years in saltwater before returning to freshwater to spawn from late winter through early summer. In the Columbia River, spawning occurs from January to March over sand, coarse gravel, or detrital substrates at temperatures from about 4° to 10°C. Shortly after hatching, the larvae are carried downstream by currents to the estuary and ocean. Adults die after spawning.

Species under USFWS Jurisdiction

The ESA-listed species for Multnomah County, Oregon on the website for the Oregon Fish and Wildlife Office of the U.S. Fish and Wildlife Service (USFWS) was updated in December 2009. These species along with bull trout are listed in Table 8. Life history descriptions for the species are provided below.

Table 8. ESA-listed Species under USFWS Jurisdiction in Multnomah County, Oregon

Species	Scientific Name	Listing Status
Bull Trout	*Salvelinus confluentus*	Threatened - Critical Habitat to be proposed to include lower Columbia River
Columbian White-tailed Deer	*Odocoileus virginianus leucurus*	Endangered
Northern Spotted Owl	*Strix occidentalis caurina*	Threatened - Critical Habitat designated
Willamette Daisy	*Erigeron decumbens var. decumbens*	Endangered - Critical Habitat designated
Water Howellia	*Howellia aquatilis*	Threatened
Bradshaw's Desert Parsley	*Lomatium bradshawii*	Endangered
Kincaid's Lupine	*Lupinus sulphureus var. kincaidii*	Threatened - Critical Habitat designated
Nelson's Checker-mallow	*Sidalcea nelsoniana*	Threatened

Bull Trout. The occurrence of bull trout in the Columbia River below Bonneville Dam appears to be incidental and their occurrence above Bonneville Dam appears to be limited. High quality habitat is characterized by cold water temperatures; abundant cover (large wood), undercut banks, boulders, etc.; clean substrate for spawning; interstitial spaces large enough to conceal juvenile bull trout; and stable channels (USFWS 2000). Historically, bull trout likely ranged through much of the Columbia Basin with spawning and rearing occurring in the coldest creeks, often at higher elevations. Presently, bull trout are distributed in a more fragmented pattern in the basin with fewer adult migratory fish and fewer, more compressed spawning reaches than what historically occurred. Bull trout have been reported only several times in recent years downstream of Bonneville Dam, including in the Sandy River.

Columbian White-tailed Deer. The current lower Columbia River population of Columbian white-tailed deer is approximately 600 individuals and occurs from RM 32-50 (Joel David, Refuge Manager, personal communication). Columbian white-tailed deer have been transplanted to Crims Island (RM 57), Hump and Fisher islands (RM 60), and Lord and Walker islands (RM 63). The habitats used by this deer include riparian and floodplain areas on both sides of the Columbia River and islands within the river. The deer graze on herbaceous plants. The closest deer population to the Sandy River Delta is over 55 river miles downstream on Lord and Walker islands. Thus, the work is considered to be outside the range of this species; it does not occur at the Sandy River Delta.

Northern Spotted Owl. The northern spotted owl ranges from southern British Columbia south to Marion County, California and east to the shrub steppe of the Great Basin in Oregon and California. Most observations of spotted owls habitat use have been made in forests with a component of old growth and mature forests consisting of western hemlock (*Tsuga heterophylla*), Douglas fir, and western red cedar. Northern spotted owls preferentially use forests with greater complexity and structure. The most important habitat characteristic is an uneven-aged, multilayered canopy that offers moderate to high (65% to 80%) cover. Numerous large trees with broken tops, deformed limbs, and cavities are typically used as nest sites by spotted owls. Spotted owls are

primarily nocturnal and eat small mammals, birds, and insects. This species is not expected to occur at the Sandy River Delta, and there are no recent records of its occurrence there.

Willamette Daisy. The primary habitat for this plant is native prairie wetlands. The habitat is characterized by the seasonally wet tufted hairgrass (*Deschampsia caespitosa*) community that occurs in low, flat regions of the Willamette River Valley where flooding creates anaerobic and strongly reducing soil conditions. Atypically, two populations of Willamette daisy occur on top of a dry, stony butte in an upland prairie (65 FR 3875). There is no known population of Willamette daisy outside of the Willamette Valley and the wetland prairie habitat or the more atypical dry prairie habitat that the species requires does not occur in the vicinity of the Sandy River Delta. There is no evidence that this species occurs at the Sandy River Delta.

Water Howellia. This plant grows in firm consolidated clay and organic sediments that occur in wetlands associated with ephemeral glacial pothole ponds and former river oxbows (Shelly and Moseley 1988). This plant's microhabitats include shallow water and the edges of deep ponds where there is firm consolidated clay and organic sediments. Water howellia appears to be extirpated from Oregon. Although four sites were documented from northwestern Oregon (including Clackamas, Marion, and Multnomah counties), these have not been successfully relocated (USFWS 2002). Virtually all of the remaining water howellia are clustered in two populations, one near Spokane, Washington and the second in the Swan River drainage of northwestern Montana (USFWS 2007). There is no evidence that this species occurs at the Sandy River Delta.

Bradshaw's Desert Parsley. This plant is a member of the native lowland prairie community endemic to the Willamette Valley of Oregon. This includes Benton, Linn, Lane, Polk and Marion counties. Formerly, the plant occurred from Salem to Creswell, but it is now reduced to 11 populations scattered from Stayton to just south of Eugene. Over 90% of the known plants are located within a 10-mile radius of Eugene (53 FR 38448). There is no evidence that this species occurs at the Sandy River Delta.

Kincaid's Lupine. This plant is restricted primarily to native grassland habitats in the Willamette Valley of Oregon and is known currently from a few small remnants of a formerly widespread distribution. Kincaid's lupine is typically found in dry upland prairie where the dominant species are red fescue (*Festuca rubra*), and/or Idaho fescue (*Festuca idahoensis*) (65 FR 3875). There is no evidence that this species occurs at the Sandy River Delta.

Nelson's Checker-mallow. This perennial herb occurs in moist, open ground and thickets, as well as on occasion in areas where prairie or grassland remnants persist. It occurs in the Willamette Valley in Oregon and in the Coast Range in Oregon and Washington. Within the Willamette Valley, Nelson's checker-mallow most frequently occurs in swales and meadows with wet depressions, along streams, or in wetlands within remnant prairie grasslands (58 FR 8235). There is no evidence that this species occurs at the Sandy River Delta.

Cultural and Historic Resources

Section 106 of the National Historic Preservation Act requires that federally assisted or federally permitted undertakings account for the potential effects on sites, districts, buildings, structures, or objects that are included in or eligible for inclusion in the National Register of Historic Places. The Oregon State Historic Preservation Office (SHPO) letter dated August 11, 1992 concurred with the recommendation that the East Channel dam was eligible for listing on the National Register of Historic Places under criteria A (its associations with events that have made a significant

contribution to the broad patterns of our history) and C (its engineering characteristics), and because it retained integrity of those qualities and attributes that are the basis for its eligibility.

Both historic and archaeological resources were considered. Photographic documentation of the dam was completed by the Forest Service, which satisfied the SHPO as mitigation for dam removal. Archaeological survey work was completed by the Forest Service in the vicinity of the dam and no archaeological resources were found.

Socio-economic Resources

Population and Economic Conditions

The Sandy River Delta is located in eastern Multnomah County, Oregon, near the city of Troutdale. Population data for Multnomah County and Troutdale is shown in Table 9.

Table 9. Population Data

Data	Multnomah County*	City of Troutdale**
2008 Estimate	714,567	15,465
2000 Census	660,486	13,777
Percent Change 2000-2008	8.2%	12.3%

Sources: *U.S. Census Bureau QuickFacts **Portland State University March 2009.

According to the U.S. Census Bureau, the median household income in Multnomah County in 2007 was $48,876 and 15% of the county's population was below the poverty level (U.S. Census Bureau QuickFacts located at http://quickfacts.census.gov/qfd/states/41/41051.html). The September 2009 unemployment rate for the county was 11.2% as compared to Oregon's rate of 11.5% (Oregon Employment Department located at http://www.qualityinfo.org/olmisj/AllRates). According to 2000 Census data, the median household income in Troutdale was $56,593. Major industries in Troutdale included educational, health and social services; retail trade; and manufacturing.

Recreation and Scenic Resources

Recreation. Recreation use is moderate to high in the Sandy River Delta area as evidenced by vehicle parking near the present entrance gate. Anecdotal data suggest as many as 75-100 cars park in this area on a weekend of nice weather and 10-20 cars consistently during weekdays (before the recent construction of a new parking lot, however). The majority of use tends to be dog walkers. Other substantial uses include hiking, angling, waterfowl hunting, horseback riding, water play along the beaches and mountain biking. Most of the recreation use occurs in the southwest corner of the Delta. Use on Sundial Island is lower, but growing. Given the proximity of the Delta to the Portland/Vancouver Metro Area and coupled with the recent development of a new 100 car parking lot, accessible trail, and wildlife viewing blind as part of the Confluence Project, overall recreation use of the Delta area should increase.

The Confluence Project, an unrelated project that explores the intersection of environment, cultures and regional history that reaches back many years and also celebrates the bicentennial of the Lewis and Clark Expedition that resulted in construction of a bird blind at the Sandy/Columbia confluence, is expected to continue to draw additional use of the Sandy River Delta. Most recreationists would likely make the viewing blind of the Confluence Project their destination; it is located near the confluence of the East Channel and the Columbia River on the mainland (the dam is not used to access this area). In addition, the development of a regional trail plan that would provide a direct

connection with Troutdale via the Interstate 84 bridge would draw recreation use from the local area. Recreation use would continue to be heaviest in the southern area of the Delta near the amenities and where short loops opportunities are available; however the dam, if it were to remain in place, would continue to provide opportunities for recreationists trying to seek more solitude and physical activity on Sundial Island and also provide equestrians and mountain bikers the opportunity to access more areas/trails for longer riding opportunities. Trails that have been constructed on the "mainland" between the existing public parking lot and the East Channel, which separates the mainland from Sundial Island, include the Boundary Trail (1.5 miles), Confluence Trail (1.25 miles), Meadow Trail (2 miles), Meadow Road (0.5 mile), Ranch Dike Trail (1.25 miles), and Old Channel Trail (0.75 mile). Cumulatively, approximately 7.25 miles of trails are present on the mainland.

Scenic Resources. The following discussion on scenic resources is a requirement of the Revised Columbia River Gorge National Scenic Area Management Plan (Management Plan). The measurement for the effect to scenic resources is the degree to which the project activities are predicted to meet Management Plan scenic resource guidelines in the required timeframes from Key Viewing Areas (KVAs).

Figure 20 - East Channel dam, to be removed.

The Columbia River Gorge National Scenic Area land use designation is a Special Management Area (SMA) Open Space at the dam and sediment removal locations. The entire project area is in the River Bottomlands Landscape Setting.

The portions of the site visible from KVAs were obtained from the KVA Geographic Information System (GIS) layer developed by the Forest Service and Gorge Commission based on a 10-meter digital elevation model. The factors that influence potential visual impact of a proposed development listed in the Management Plan are the following:

- The amount of area of the building site exposed to KVAs.
- The degree of existing vegetation providing screening.
- The distance of the building site to the KVAs from which it is visible.
- The number of KVAs from which it is visible.
- The linear distance along the KVAs from which the building site is visible.

The subject parcel is topographically visible (considering landform only, not vegetative screening) from the following viewpoints:

- Foreground Distance Zone (0-1/2 mile): Sandy River
- Middleground Distance Zone (1/2-3 miles): I-84, Historic Columbia River Highway (HCRH) and the Columbia River.
- Background Distance Zone (3 miles or more): HCRH, SR-14, Larch Mtn. and Larch Mtn. Road, Crown Point, and Portland Women's Forum.

The required scenic standard for SMA Public Recreation in the River Bottomlands Landscape Setting must be "Visually Subordinate" from KVAs which is defined in the Management Plan as:

Visually subordinate: A description of the relative visibility of a structure or use where that structure or use does not noticeably contrast with the surrounding landscape, as viewed from a specified vantage point (generally a key viewing area, for the Management Plan). As opposed to structures that are fully screened, structures that are visually subordinate may be partially visible. They are not visually dominant in relation to their surroundings.

The required scenic standard for SMA Open Space in the River Bottomlands Landscape Setting must be "Not Visually Evident" from Key Viewing Areas which is defined in the Management Plan as:

Not visually evident (SMA): A visual quality standard that provides for development or uses that are not visually noticeable to the casual visitor. Developments or uses shall only repeat form, line, color, and texture that are frequently found in the natural landscape, while changes in their qualities of size, amount, intensity, direction, pattern, etc., shall not be noticeable.

Infrastructure and Land Use

The dam is owned by the ODFW and is located on lands owned by the State of Oregon and administered by the DSL. The DSL manages Oregon's waterways, and the dam lies on submerged and submersible land. The lands adjacent to the original Sandy River channel are National Forest lands administered by the Columbia River Gorge National Scenic Area of the U.S. Forest Service. Williams Northwest Pipeline Corporation acquired two small parcels on Sundial Island in 1960 for maintenance purposes.

A sand and gravel mining company is currently operating downstream of the confluence of the West Channel and the Columbia River. The material removed by the company is primarily medium-sized sand deposited from the Sandy River. In addition, three bridges cross the Sandy River upstream of the project area – two bridges for Interstate 84 and a railroad bridge.

4 ENVIRONMENTAL CONSEQUENCES

Physical Characteristics

Geology and Soils

In general, the action alternatives for habitat restoration would not change existing site geology or soils in the Sandy River Delta.

Activities on National Forest Land.

- Temporary Equipment Staging Areas. The two staging areas would be located in previously disturbed areas. There would be some additional compaction and destruction of existing grasses but these areas would be replanted after use. No erosion or loss of site productivity would result from project implementation due to the site location on flat ground and mitigation measures such as grass replanting after use.
- BPA helicopter landing areas and footpaths on Sundial Island. No erosion would result from project implementation due to no ground disturbance in the helicopter landing areas and footpaths. Some loss of site productivity would occur within the small areas where rock would cover soil at one of the 45-foot diameter areas, at the 100-foot diameter area, and along footpaths where existing vegetation would be removed.
- Temporary Use of the Existing Road System. Use of the existing road system by this project would actually improve soil conditions by including maintenance such as rocking and blading portions of the existing road system. This would improve current conditions associated with soil erosion, especially on the Meadow Road which has a number of potholes that collect water.
- Storage of Rock Material. Storage of rock material would decrease soil productivity in the small area underneath the storage area. This would still maintain overall soil productivity since the area of disturbance is so small.

Hydrology and Geomorphology

The Forest Service contracted with the U.S. Bureau of Reclamation to model hydraulics (volume of flow, velocity of flow), and sediment transport if the dam were removed. Their findings are summarized below (Bureau of Reclamation 2006).

- The flow volume and extent of erosion in the East Channel. The east channel would erode by no more than 7 feet, which is the same elevation as the Columbia River. The flow would slowly shift from the West Channel to the East Channel over time.
- A mining operation on the Columbia River, just downstream of the confluence of the Sandy and Columbia rivers. The sand deposits are primarily from the West Channel and as the flow changes to the East Channel, sand delivery to the mining area would decrease.
- Channel scour at upstream railroad bridge and two freeway bridges. The model showed no effects on the upstream scour at the bridges.
- Bank erosion along the right bank of the West Channel. Removal of the dam is not anticipated to accelerate bank erosion along right bank of the West Channel; conversely, it may marginally allay erosion of the West Channel.

Additional modeling was conducted to address the potential for stranding of aquatic organisms in the East Channel under low flow conditions. Two scenarios were simulated: (1) Removed Dam

scenario, which represents topographic conditions just after removal of the dam and sediment plug; and (2) Eroded East Channel scenario, which represents estimated topographic conditions several years (approximately 5 years) following dam removal. Results indicate that no consistent flow would be maintained through the East Channel under the Removed Dam scenario for all exit water surface elevations evaluated; this validates the need for excavation of a pilot channel within the East Channel. In addition, small isolated ponds would be present within the East Channel due to unsteady variations of flow conditions. Results of the Eroded East Channel scenario suggest that flow through the East Channel would be maintained several years following dam removal for all exit water surface elevations analyzed. However, the direction of flow in the East Channel is dependent on the exit water surface elevation being evaluated. Under average summer low flow conditions, flow in the East Channel may travel either direction (i.e., may become activated as a slough system) and is controlled by unsteady flow conditions of the Columbia River.

Because of uncertainties with modeling in general, the pilot channel within the East Channel was planned in order to provide assurance that a low flow connection between the Sandy River main stem and the Columbia River would exist through the East Channel immediately after project construction. The project does not aim to dredge in the Sandy River Delta to manage hydrology, but rather allow the river to behave as it will.

Various existing plans provide guidance for projects in the form of Standards and Guidelines (S&G) and recommended Best Management Practices (BMP) including the Management Plan for the Columbia River Gorge National Scenic Area. A summary of applicable water quality S&Gs and BMPs from this document are displayed below:

<u>Columbia River Gorge National Scenic Area (CRGNSA) Management Plan Requirements:</u>

Water Resources (Wetlands, Streams, Ponds, Lakes, and Riparian Areas)

1. The CRGNSA Management Plan, Chapter 3, Natural Resources, SMA Guidelines, states:

   A. All Water Resources shall, in part, be protected by establishing undisturbed buffer zones as specified in A.(2)(a) and 2(b) below. These buffer zones are measured horizontally from a wetland, stream, lake, or pond boundary as defined below.
      (1) All buffer zones shall be retained undisturbed and in their natural condition, except as permitted with a mitigation plan. The following buffer zone widths shall be required:
         (a) A minimum 200 foot buffer on each wetland, pond, lake, and each bank of a perennial or fish bearing stream, some of which can be intermittent.
         (b) A 50-foot buffer zone along each bank of intermittent (including ephemeral), non-fish bearing streams

      Northwest Forest Plan Riparian Reserves: Fish Bearing Streams, Lakes, Ponds: 300', Wetlands, perennial streams: 150', Intermittent Streams: 100'. The NWFP requires a watershed analysis before any activity takes place in a riparian reserve.

Summary: Almost the entire project area is within the 100-year floodplain of the Columbia River, Sandy River or both (as is most of the Sandy River Delta). The project has been designed to minimize impacts to water resources, as work would be limited to the smallest area possible and all upland areas of soil disturbed would be replanted with native grasses and/or forbs and shrubs within one year.

Soil Productivity

1. The Management Plan, Chapter 3, Natural Resources, SMA Guidelines, states:

A. Soil productivity shall be protected using the following guidelines:
(1) A description or illustration showing the mitigation measures to control soil erosion and stream sedimentation.
(2) New developments and land uses shall control all soil movement within the area shown on the site plan.
(3) The soil area disturbed by new development or land uses, except for new cultivation, shall not exceed 15 percent of the project area.
(4) Within 1 year of project completion, 80 percent of the project area with surface disturbance shall be established with effective native ground cover species or other soil-stabilizing methods to prevent soil erosion until the area has 80 percent vegetative cover.

Summary:

(1) The work would occur during summer. This timing would minimize sediment loads that could enter the Sandy River mainstem and the Columbia River. Erosion control practices would be in accord with the Oregon Department of Environmental Quality blanket Water Quality Permit that covers actions done under Nationwide Permit 27. Because the work would be done during a low flow period, it is expected that the dam removal and much of the pilot channel excavation would occur in the dry; there may be a minor amount of sediment that enters the Sandy River mainstem when the low-flow connection to the mainstem is made to the East Channel.

(2) Soil movement would occur on the site through natural erosion and deposition that would result from redirecting water in the Sandy River Delta to more natural conditions. Soil movement would also occur with construction of the project as material from the dam and the pilot channel would be deposited at a designated REA. This deposition soil would be planted with native species.

(3) Soil disturbance would not exceed 15% of the total project area.

(4) All disturbed areas would be re-vegetated within one year with native grasses, shrubs and trees.

(5) Use of the existing road system by this project would actually improve soil conditions by including maintenance such as rocking and blading portions of the existing road system. This would improve conditions especially on the Meadow Road which has a number of potholes that collect water.

Water and Sediment Quality

There would be turbidity caused by sediment that is flushed into the West Channel at the upstream end of the East Channel and in the Columbia River at the downstream end of the East Channel when the dam is partially or fully removed and the connections are made at both ends of the pilot channel; this may cause temporary disturbance to fish and other aquatic organisms. However, these connections would be made during a time of low flows in the West Channel and Columbia River would likely result in minimal turbidity impacts. Adherence with the Oregon Department of Environmental Quality Water Quality Certificate that covers actions taken under Nationwide Permit 27 would ameliorate impacts.

The pilings from the dam were analyzed for arsenic and creosote compounds and no contaminants were detected. Sediment samples taken in the East Channel (Corps 2009) yielded no evidence of elevated levels of toxins and were below screening levels for unconfined in-water disposal in accordance with the *Sediment Evaluation Framework* (SEF 2009).

The water quality of the East Channel would be greatly improved from existing conditions. Currently, the East Channel becomes ponded in the late summer, with lethal water temperatures present for salmonids. With removal of the dam and creation of the pilot channel, a permanent connection would exist in the East Channel with the current main stem Sandy River. Therefore, relatively cool water from the Sandy River would enter the East Channel even under low flow conditions. This is projected to eliminate ponding, which causes stranding of fish, and would improve (cool) water temperatures in the East Channel so it is viable and accessible to juveniles salmonids more often. Ability of water to always flush through the East Channel would also increase dissolved oxygen concentrations.

Activities on National Forest Land. Some of the effects discussions outlined above pertain to the portion of the project on National Forest land. In addition, the following effects apply:

- Temporary Equipment Staging Areas. The two staging areas would be located in previously disturbed areas. There would be some additional compaction and destruction of existing grasses but these areas would be replanted after use. As described above, no erosion would result from project implementation due to the site location on flat ground and mitigation measures such as replanting vegetation after use. Stream temperature and other water quality parameters would be maintained due to the location of the site on flat ground at least 800 feet away from the nearest surface water and implementation of mitigation measures that include securing and complying with all necessary permits.
- Helicopter Landing Areas and footpaths on Sundial Island. No erosion and sedimentation would result from project implementation due to no ground disturbance in the helicopter landing areas and footpaths. These sites are proposed at locations that are at least 500 feet away from the Sandy River and completely avoid wetlands.
- Temporary Use of the Existing Road System. Use of the existing road system by this project would actually improve soil conditions by including maintenance such as rocking and blading portions of the existing road system. This would improve current conditions associated with soil, especially on the Meadow Road which has a number of potholes that collect water.
- Storage of Rock Material. Storage of rock material would not decrease water quality due to the site locations on stable, flat ground away from any surface water. The material is coarse, riprap size and resistant to erosion. No new ground disturbance is expected from implementation of this portion of the project.

Aquatic Conservation Strategy Objectives

In order for a project to proceed, "a decision maker must find that the proposed management activity is consistent with the Aquatic Conservation Strategy objectives" of the Northwest Forest Plan, identified on page B-10 of the Record of Decision (ROD). The nine objectives are listed on page B-11 of the ROD. The Aquatic Conservation Strategy only applies to National Forest lands within the project area. The effects analysis has focused on key parameters or indicators that make up elements of the nine Aquatic Conservation Strategy objectives, to determine if implementation of the portion of the Sandy River Delta Section 536 Ecosystem Restoration Project that is on National Forest land would restore, maintain, or degrade these indicators.

As described above, the Aquatic Conservation Strategy Objectives (ACS) only apply to the portion of this project on National Forest land. Since very little project activity would occur on this Federal land and almost all of the activities except a portion of three rock storage sites and some road use would be outside the Riparian Reserves, the ACS Objectives would be maintained at the 7th field sub-watershed scale and larger. In addition, activities within the Riparian Reserve would occur on previously disturbed sites that have been graded and had trees removed. Some small, short-term changes may occur at the site scale, but mitigation would minimize or eliminate these changes.

Air Quality/Noise/Light

There would be a small, localized reduction in air quality due to emissions from construction equipment. There also would be localized increases in noise levels from construction equipment. These impacts would be minor and temporary in nature and would cease once construction is completed. Ambient noise in the area includes the sounds of human activities as exemplified by the adjacent Interstate 84, river traffic, the Troutdale Airport, and surrounding development.

Vegetation

The action alternatives include the removal of approximately 3.5 acres of existing invasive plant species such as thistle and blackberry. Native plants such as willow, hardhack, dogwood, and other water tolerant species would be planted over approximately 22 acres in areas disturbed by construction and along the toe (both sides) of the existing channel bank where native plants are scarce. In addition, construction of a pilot channel and removal of even an increment of the dam would improve flow in the East Channel and create a greater diversity of wetland habitats in the Sandy River Delta.

While no rare plants are located in the project area (Salix Associates 1992 and subsequent observations by the Forest Service), a rare plant, the Columbia rock cress (*Rorippa columbiae*), occurs on mudflats and gravel bars of the Columbia River, including in the vicinity of the Delta. It has been noted on a gravel bar in the Columbia River off the mouth of the East Channel (Salix and Assoc., 1992). This plant may be positively affected by increased sediment transport after dam removal.

The CRGNSA Management Plan, Chapter 3, Natural Resources, SMA Guidelines, states:

A. Protection of sensitive wildlife/plant areas and sites shall begin when proposed new developments or uses are within 1000 ft of a sensitive wildlife/plant site and/or area. The approximate locations of sensitive wildlife and/or plant areas and sites are shown in the wildlife and rare plant inventory.

Summary: The project area is not within 1000 feet of any rare plant, although there would beneficial effects to the Columbia rock cress habitat. Riparian areas and wetlands are priority habitats in the project area. As discussed in this document, there would be change in riparian and wetland habitat as the result of restoration of a more dynamic hydrological regime, but the impacts are not adverse.

Activities on National Forest Land. Some of the effects discussions outlined above pertain to the portion of the project on National Forest land. There are no direct or indirect effects for Alternatives 1-3. The direct and indirect effects for Alternatives 4 and 5 include the following:

- Temporary Equipment Staging Areas. The two staging areas would be located in previously disturbed areas. There would be some additional compaction and destruction of existing grasses but these areas would be replanted after use. No erosion or loss of site productivity would result from project implementation due to the site location on flat ground and mitigation measures to revegetated after use. Additional project design criteria including equipment washing and inspection prior to entering National Forest lands would reduce potential introduction of invasive plants.
- Helicopter Landing Areas and footpaths on Sundial Island. Approximately twenty existing small trees, all common native tree species and none larger than 18 inches in diameter and about 20 feet high, would need to be cut down to facilitate the helicopter landing areas. About ten small trees would need to be cut down for the 100-foot diameter primary helicopter landing area. One of the 45-foot diameter satellite helicopter landing areas near the easternmost transmission towers on Sundial Island would also require the removal of about ten trees. These trees would be flush-cut at the ground level therefore no erosion would result.. The number of trees that would need to be cut has been minimized by proposing sites that currently have sparse vegetation and low tree density. There would be some loss of site productivity within small areas where soils would be covered with rock in two of the helicopter landing areas and along footpaths with existing vegetation.
- Temporary Use of the Existing Road System. As noted above, use of the existing road system by this project would actually improve soil conditions by including maintenance such as rocking and blading portions of the existing road system. This would improve conditions especially on the Meadow Road which has a number of potholes that collect water. In addition, these areas are devoid of vegetation due to their use as roads. This would not change with this project.
- Storage of Rock Material. Storage of rock material would decrease soil productivity in the small area underneath the storage area. These areas are currently disturbed and have an infestation of invasive plants including Scotch Broom and blackberry. Besides the weedy species, the area is covered in non-native grasses and young black cottonwoods. Site productivity would be reduced while this material is stored at the sites.

Fish and Wildlife

Implementation of the preferred alternative would greatly enhance the Sandy River Delta to the benefit of native fish and wildlife by creating a greater diversity of wetland habitats and greatly improving fish access to the East Channel. Fish and wildlife species, other than ESA-listed species discussed in detail, that could benefit include red-legged frog, painted turtle, and Pacific lamprey. Oregon and California floaters (mussels) may also benefit. These species would benefit from a general increase in wetted areas of slow moving water in the Sandy River Delta. Rearing habitat for juvenile lamprey (ammocoetes) in the East Channel may benefit substantially as ponding in the channel now occurs during summer. Ammocoetes burrow into sediment, usually in shallower waters, and may remain there for up to 6 years.

The ODFW designated in-water work period for the Sandy River is July 15 through August 31. An in-water work extension has been coordinated with the NMFS and ODFW to extend the work period through October 15. The work is planned to be done during one year.

The CRGNSA Management Plan, Chapter 3, Natural Resources, SMA Guidelines, states:

A. Protection of sensitive wildlife/plant areas and sites shall begin when proposed new developments or uses are within 1000 ft of a sensitive wildlife/plant site and/or area.

Sensitive Wildlife Areas are those areas depicted in the wildlife inventory, including all Priority Habitats listed in this Chapter. The approximate locations of sensitive wildlife and/or plant areas and sites are shown in the wildlife and rare plant inventory.

The project area is within 1,000 feet of many sensitive, threatened, or endangered fish species. Per the effects discussion here, habitat is expected to improve for all of these species.

Threatened and Endangered Species

Species under NMFS Jurisdiction

Both partial and full removal of the dam (Alternatives 4 and 5) would benefit ESA-listed juvenile salmonids spawned in the Sandy River system by allowing access to the East Channel during a variety of flow conditions, by reducing stranding potential during summer months when ponding occurs in the East Channel, by providing cooler water to the East Channel from the Sandy River during summer, and by providing additional area that meets appropriate depths and velocities for juvenile salmonids. The addition of cooler water could also have benefits in that it could decrease use of the area by warm-water predators, including non-native species such as bass (*Micropterus* spp.) that are known to use the East Channel. By partially or fully removing the dam, more shallow water habitat would exist and allow the river to reestablish a more natural flow pattern.

There may be some minor turbidity caused by sediment that is flushed into the West Channel when the dam is partially or fully removed and the connection is made to the pilot channel; this may cause a minor and temporary disturbance to juveniles and migrating adults of steelhead, Chinook, and coho salmon. However, this connection would be made during a time of low flows in the West Channel and would likely result in minimal turbidity impacts. This increase in turbidity may have minor and temporary impacts on Salmonid Critical Habitat and Essential Fish Habitat (EFH). No redds (nests of spawning fish) would be present at the time when this connection is made.

Alternatives 2 and 3 would also reduce stranding potential, provide additional area that meets depth and velocity criteria for salmonids, and allow influx of water from the Columbia River, but would not improve access to the East Channel from the Sandy River. The East Channel offers good rearing habitat for juvenile salmonids, as this channel currently supports fairly well developed riparian habitat which contributes to shade, invertebrate production, and may provide additional woody debris, all of which are important components of juvenile rearing habitat. Conversely, these habitat components in the West Channel downstream of the inlet to the East Channel are not as well developed. Benefits would likely be greatest for juvenile salmonids with stream-type life histories (e.g., spring Chinook, coho, and steelhead), as they depend on shallow rearing and refugia waters more than those with ocean-type life histories (e.g., fall Chinook). Permanent water in the East Channel may promote chum salmon spawning.

Water conditions and wetted area for the West Channel may have a minor loss of habitat because of the diversion of flow into the East Channel during certain times of the year. Impacts to ESA-listed fish during construction are likely to be minimal since water temperatures of ponds in the East Channel are typically too high to support juvenile salmonids. Decreased adult fish attraction flow during upstream migration in the West Channel is not considered to be a negative factor because fish historically were presented with multiple potential entrance points at the Sandy River Delta.

Post-construction monitoring (see Appendix) would measure the response of juvenile salmonids to the restoration measures. The Corps would monitor changes in juvenile Salmonid habitat for 2 years after construction. After this period, additional monitoring may be conducted by the U.S. Forest Service. As a part of monitoring, photo documentation points would be established at locations that represent the entire project site. Photos would be taken periodically during the two year period and would be aimed at documenting water passage through the east channel.

Species under USFWS Jurisdiction

Columbia River Bull Trout. Although bull trout have been recorded on a few occasions in the Sandy River, waters in the Sandy River Delta do not typically achieve water temperatures or contain other high quality habitat characteristics that are suitable for bull trout. Because bull trout are not expected to occur in the Delta during time of work, implementation of the preferred alternative is not expected to affect bull trout. Bull trout Critical Habitat occurs in the lower Columbia River but not in the Sandy River. A small amount of turbidity may enter the West Channel of the Sandy River when the connection is made between the East and West Channels. This connection would be made at lower flows, which would minimize the amount of sediment entering the West Channel. Also, the requirements of the Water Quality Certificate issued for Nationwide Permit 27 would be adhered to. Any turbidity would be minor and temporary, and would likely dissipate before it enters the Columbia River from the West Channel. The preferred alternative would have No Effect on designated Critical Habitat for bull trout in the Columbia River.

Columbian White-tailed Deer. The closest deer population to the Sandy River Delta is over 55 Columbia river miles downstream on Lord and Walker islands. The historic range of the species included western Multnomah County. The Sandy River Delta is considered to be outside the range of this species and would not affect Columbian white-tailed deer.

Northern Spotted Owls. Spotted owls are not expected to occur in the Sandy River Delta, except perhaps as dispersing juveniles from other nesting areas, because the area does not contain suitable nesting habitat for the species. The remnant stands of riparian forest in the Delta area do not provide the habitat attributes of old growth coniferous forest habitat sought by nesting northern spotted owls. Although it is possible that transitory birds could occur occasionally in the Delta, they are not expected. Therefore, implementation of the preferred alternative is not expected to affect spotted owls. Designated Critical Habitat does not include the Sandy River Delta.

Plant Species. As discussed in Section 3.4.2, suitable habitat does not exist in the project area for the Willamette daisy, Bradshaw's desert parsley, Kincaid's lupine, and Nelson's checker-mallow. Although appropriate habitat for howellia occurs on-site, there are no known populations that persist in Oregon. Plant surveys conducted in 1991 (Salix Assoc. 1992) and subsequent observations by the Forest Service have yielded no records of these plants in the Delta. Therefore, implementation of the preferred alternative would not affect these species. Designated Critical Habitat for the Kincaid's lupine does not include Multnomah County.

Activities on National Forest Land. Some of the effects discussions outlined above pertain to the portion of the project on National Forest land. There are no direct or indirect effects for Alternatives 1-3. The direct and indirect effects for Alternatives 4 and 5 include the following:

- Temporary Equipment Staging Areas. The two staging areas would be located in previously disturbed areas. These areas would be used to park equipment and vehicles

during project implementation, and would be rehabilitated after project completion. There would be some additional compaction and destruction of existing grasses but these areas would be replanted after use. As described above, no erosion would result from project implementation due to the site location on flat ground, mitigation measures and location of the site at least 800 feet away from the nearest surface water. The total area of both sites is approximately 20 acres in size, and located just south of the dam site.

- Helicopter landing areas and footpaths on Sundial Island. Use of the helicopter landing areas and footpaths would be for routine maintenance checks of BPA lines. The main helicopter landing area would involve clearing vegetation in a circular 100-foot diameter area to facilitate helicopter access for the Bonneville Power Administration. This area is just north of the existing transmission line, and currently has sparse vegetation with a few small diameter trees. About twenty existing trees would need to be cut down to facilitate two of the helicopter landing areas. The area would be mowed before geotextile fabric and 3-inch minus rock would be placed over the area. No erosion and sedimentation would result from project implementation because no grading or ground disturbance would occur in the helicopter landing area. The site is approximately 1,000 feet away from the Sandy River. In addition, two other secondary helicopter landing areas about 45 feet in diameter would be created; one mowed only with no fabric or rock placed, while the other would have geotextile fabric and 3-inch minus rock applied. Two footpaths connecting one of the helicopter landing areas to existing paths would be constructed under BPA's transmission lines and towers, which would require limited vegetation removal and application of 3-inch minus rock.
- Temporary Use of the Existing Road System to facilitate work. Increased use of the existing road system may cause some temporary (2 months) increased disturbance to wildlife, but since the ambient disturbance is already high from recreation use, this project is not expected to result in measurable changes to wildlife disturbance.
- Storage of Rock Material. Some of the rock from the dam removal would be stored at four rock storage areas, one south and one north of the dam, one on the west side of Sundial Island, and one to the east of the dam on the mainland side. These rock storage areas would have soil placed over them, and planted with native vegetation.

Cultural and Historic Resources

Prehistoric resources were considered. As discussed in Section 3.6, the East Channel dam was eligible for listing on the National Register of Historic Places. Photographic documentation of the dam was completed by the Forest Service, which satisfied the SHPO as documentation of the dam. Archaeological testing was completed by the Forest Service in the vicinity of the dam and no archaeological resources were found.

The required CRGNSA cultural resources standard is that new developments or land uses shall not adversely affect significant cultural resources. Guidelines: 36 CFR Part 800 shall be used to assess potential effects to cultural resources and specific to the removal of the Diversion Dam, which include the following steps:

Step 4:

14. "For each significant (i.e., eligible for the National Register) cultural resource inventoried within the area of the proposed development or change in use, assessments

of effect shall be completed, using the criteria outlined in 36 CFR 800.9 ("Assessing Effects").

15. "If the proposed development or change in use would have an "Adverse Effect" [36 CFR 800.9(b)] to a significant cultural resource, the type and extent of "adverse effect" upon the qualities of the property that make it eligible for the National Register shall be documented. This documentation shall follow the process outlined under 36 CFR 800.5(e).

Step 5:

18. "If there would be an effect on cultural resources, mitigation measures shall be provided. Mitigation measures that shall be considered include avoidance of the property through project design or modification and subsequent protection, burial under fill, data recovery excavations, and other appropriate measures.

The Scenic Area Archaeologist has made a finding that "adverse effects would be resolved through mitigation."

Data recovery from the dam was coordinated among the Forest Service, the Oregon State Historic Preservation Office (SHPO), and the Oregon Department of State Lands through a Memorandum of Agreement (MOA). This MOA was submitted to the Advisory Council on Historic Preservation. Documentation of the historic dam is housed at three Oregon locations: the Forest Service in Hood River, the SHPO in Salem, and the Troutdale Library. This documentation has satisfied all SHPO requirements.

The helicopter landing areas, footpaths, and rock storage have been determined to have no potential to affect cultural or historic resources because no ground disturbing activities would be required.

Socio-economic Resources

Population and Economic Conditions

This habitat restoration project is not expected to cause changes in population, economics, or other indicators of social well-being. Implementation of the preferred alternative also would not result in a disproportionately high or adverse effect on minority or low-income populations.

Recreation and Scenic Resources

Access to Sundial Island would be lost with Alternatives 4 and 5, because removal of even a portion of the East Channel dam would reduce pedestrian access to the island for recreation. At times of low water, however, recreational users still may be tempted to cross the East Channel. The silty nature of the sediments in the East Channel could cause people to sink into the sediment. If this is deemed to be an issue, a warning sign would be posted at the south end of the East Channel, where the gravel/dirt road extending from the parking lot meets the East Channel. Trails that have been constructed on the "mainland" between the existing public parking lot and the East Channel, which separates the mainland from Sundial Island, include the Boundary Trail (1.5 miles), Confluence Trail (1.25 miles), Meadow Trail (2 miles), Meadow Road (0.5 mile), Ranch Dike Trail (1.25 miles), and Old Channel Trail (0.75 mile). Cumulatively, approximately 7.25 miles of trails are present on the

mainland. Although access to Sundial Island would be removed with implementation of the preferred alternative, mileage of trials outlined in the EIS (Forest Service 1995) would be met.

While implementation of the preferred alternative would remove access to Sundial Island, other recreational opportunities may be increased. For example, opportunities for canoeing or kayaking in the East Channel would benefit as there is predicted to be no ponding of water during the summer as a result of removal or even a part of the structure. The East Channel would provide excellent canoeing or kayaking opportunities as the existing riparian habitat offers nice scenery. The Delta currently supports a wide array of habitats that support a diversity of birds and provides excellent areas for bird watching. Implementation of the preferred alternative would add habitat diversity, as it is predicted to create more backwater channels in an area that is currently dominated primarily by upland habitats.

Implementation of the Preferred Alternative would meet the goals of the Columbia River Gorge National Scenic Area Management Plan. In general, an artificial rock/earth/piling structure would be removed and the East Channel of the Sandy River would support flow on a year-round basis. The rock storage areas would be planted with native species appropriate to site conditions. The CRGNSA Management Plan, Chapter 3, Natural Resources, SMA Guidelines, states:

All Water Resources shall, in part, be protected by establishing undisturbed buffer zones. These buffer zones are measured horizontally from a wetland, stream, lake, or pond boundary. All buffer zones shall be retained undisturbed and in their natural condition, except as permitted with a mitigation plan. The following buffer zone widths shall be required:

(a) A minimum 200 foot buffer on each wetland, pond, lake, and each bank of a perennial or fish bearing stream, some of which can be intermittent.
(b) A 50-foot buffer zone along each bank of intermittent (including ephemeral), non-fish bearing streams.

Activities on National Forest Land. Some of the effects discussions outlined above pertain to the portion of the project on National Forest land. There are no direct or indirect effects for Alternatives 1-3. The direct and indirect effects for Alternatives 4 and 5 include the following (rock storage, however, would not occur with Alternative 4):

- Temporary Equipment Staging Areas (see Figure 13). The two staging areas would be located in previously disturbed areas. Use in staging Area #1 would require some temporary (approximately 2 months) trail closures and reroutes to keep recreationists away from heavy equipment and work areas. This is a safety issue. Mitigation including notification requirements, signing, fencing and other methods of closure control would be implemented to reduce potential conflicts. There would be some potential short term conflicts between recreationists and vehicle traffic associated with use in the temporary staging areas. While the Sandy River Delta is close to urban development, it provides a surprisingly natural appearing environment protected from the noise of nearby development and I-84. Trail closures, fencing, construction noise, heavy construction equipment and vehicle traffic would have a short term effect to the recreation experience. Mitigation including notification requirements, signing and other methods of closure control would be implemented to reduce potential conflicts. **Scenic Resources** - The heavy equipment at these staging areas would be topographically visible from the background of multiple KVAs and the middle ground from I-84. These may be visible in the background from higher elevation Key Viewing Areas such as Crown Point and Portland Women's forum due to the high contrasting color typical of heavy equipment. During the time that equipment is stored

there it would not meet the scenic standard, however this effect would be minor as it would be seen in the background of only a few KVAs. The staging area would not visually change after equipment has left. There would be no effects to scenic resources from the staging areas after equipment has left.

- Helicopter Landing Areas and footpaths on Sundial Island (see Figure 13). There are no anticipated effects to recreation from clearing vegetation in the helicopter landing areas and footpaths. **Scenic Resources** - The three areas proposed for helicopter landing areas may be topographically visible from the background and middle ground of multiple KVAs as well as the foreground of the Sandy and Columbia Rivers. These areas are currently vegetated with some small trees and shrubs and are anticipated to maintain low vegetation coverage as they are predominantly within or near BPA's existing transmission line rights-of-way. Developing and maintaining these areas as helicopter landing areas would require minimal vegetation manipulation and as such would have negligible visible change. Surfacing two of the helicopter landing areas with rock would be of a natural color but could be discernible from the surrounding natural environment. Due to existing screening vegetation these spots would only be visible if viewed from above. Crown Point and Portland Women's Forum and the section of the HCRH between them are the only KVAs which would view the site from above, however, these vantage points are over 4 miles away. At this distance the gravel surface would not be discernible. These helicopter landing areas would meet Not Visually Evident/ Retention scenic standards from all Key Viewing Areas.
- Temporary Use of the Existing Road System (see Figure 13). Use of existing roads for project implementation would require some temporary (approximately 2 months) trail closures and reroutes to keep recreationists away from heavy equipment and work areas. This is a safety issue. The existing road system serves as part of the trail system for hikers, mountain bikers, equestrians, angler and duck hunting access. Temporary closure of these roads as well as heavy construction equipment, and vehicle traffic would have a short term effect to these users. There would be some potential short term conflicts between recreationists and vehicle traffic associated with use of the existing roads. The area of highest potential for conflict includes the Dike Road and the Meadow Road due to the amount of expected traffic from restoration activities. Mitigation including notification requirements, signing and other methods of closure control would be implemented to reduce potential conflicts. There are no anticipated effects to scenic resources from use of existing roads.
- Storage of Rock Material (see Figure 13). There are no anticipated effects to recreation from storage of rock material. The proposed storage sites are already disturbed and would not be on any trail or roads that would be accessible. They would not cut of access to any use areas. **Scenic Resources** - Southern Rock Storage Area -This would be topographically visible from the background of multiple KVAs and the middle ground from I-84. This would meet Visually Subordinate / Partial Retention scenic standards from all background views due to existing screening vegetation and the form, line, color and texture of the material that lends itself to being visually subordinate to the natural landscape. This would meet Visually Subordinate / Partial Retention scenic standard for middle ground views from I-84 due to existing screening vegetation and the angles from which the area would be viewed. This would result in no adverse effect to scenic resources. Northern Rock Storage Area - This would be topographically visible from the background of multiple KVAs and the middle ground from I-84, HCRH, Sandy River, and Columbia River KVAs. This would meet Not Visually Evident/ Retention scenic standards from all background views due to existing screening vegetation and the form, line, color and texture of the material that lends itself to blending with the natural landscape at this distance. This would meet Not Visually Evident/ Retention scenic standard for middle ground views from I-84, the Columbia River,

HCRH and the current route of the Sandy River due to existing screening vegetation and the angles from which the area would be viewed. Due to the uncertainty of the course of the Sandy River following implementation of the dam removal there is potential that this would be visible from it. Provided the rocks are piled low enough to not be visible from the old channel, the proposal would meet scenic standards as viewed from the potential new route of the Sandy River. This storage area, as mitigated, would have no adverse effect to scenic resources.

Infrastructure and Land Use

The emerging meander in the West Channel is threatening a BPA transmission tower (see Figures 14-16) and BPA has proposed to relocate the affected transmission towers inland from the bank with a separate action. With implementation of the preferred alternative, it is expected that less water would enter the West Channel and would reduce energy against the cut bank and likely alleviate some erosion in this area.

The source of sand to the mining area just downstream of the confluence of the Sandy and Columbia rivers is primarily the West Channel. Modeling conducted by the Bureau of Reclamation (2006) showed that if more flow is directed to the East Channel, more sand would be deposited in the east Delta area and the amount of sand deposited in the mining area would decrease (estimated range from 20% to 39% reduction). The Columbia River does not substantially contribute sand to the mining area. The sand in the east Delta area would not be transported to the mining area, even at Columbia River flood flows.

Landowners that may be impacted from the implementation of the preferred alternative include the U.S. Forest Service, DSL, ODFW, Bonneville Power Administration, and the Williams Northwest Pipeline Corporation. The majority landowner is the Forest Service, having acquired ownership in a purchase from the Trust for Public Land in 1991. The State of Oregon (State) asserts a sovereign right to the bed and banks of the Little Sandy River. Regarding the current flow of the river, a test of navigability under federal law has not been addressed. It is not believed that the State acquired fee title to the Little Sandy River channel by means of any conveyance deed. In addition to the Forest Service, four entities hold third-party rights to use of the project area including the potential use of the dam for access to Sundial Island: ODFW, Sandy Drainage Improvement Company, Williams Northwest Pipeline Corporation, and BPA.

During project planning, Williams Northwest Pipeline Corporation (Northwest Pipeline) raised a concern regarding Sundial Island accessibility. They own two parcels of lands on Sundial Island and also have a buried pipeline in the area. Overland access to the island, including their property, is only available via the dam. Implementing the preferred alternative eliminates any island access by vehicle. Northwest Pipeline periodically checks their lines for anomalies, and requires expedited maintenance if one is detected. Vehicle (including heavy equipment) access to Sundial Island would be required. Maintenance and Repair would also be required if a pipe blowout occurs. Currently, vehicle access across the dam is sometimes not available because of water over-topping the dam.

In a September 19, 2011 meeting, the Corps allayed Northwest Pipeline's concerns regarding access. A Corps Regulatory representative explained the emergency and expedited permit processes should the need to install a temporary bridge for vehicle and equipment access arise. Necessary permits would be obtained through the Corps' Regulatory Branch, who would coordinate with appropriate State and Federal agencies.

Cumulative Impacts

The area of consideration for the cumulative impacts analysis is the Sandy River Delta. Cumulative effects are caused by the aggregate of past, present, and reasonably foreseeable future actions. Over the past several years, the Corps and U.S. Forest Service have worked cooperatively under the Section 536 ecosystem restoration authority to enhance large areas of upland habitat by invasive plant removal followed by plantings of native plants. Implementation of the preferred alternative would add to the wildlife benefits already being realized by this previous work, as a diverse array of wetland habitats would result. Juvenile salmon habitat quality, area, and accessibility are predicted to increase greatly in the Sandy River Delta with implementation of the preferred alternative.

Even with implementation of the preferred alternative, however, the Sandy River Delta likely would not return to support the hydrologic diversity that characterized the area prior to dam construction on the Sandy River because of alterations to the Columbia River including the construction of dams that suppress spring freshets and pile dikes that collect sediment. Because of these factors, the Delta would not experience scouring from Columbia River flows as it did in the past. Scouring and backwater channel creation would result from implementation of the preferred alternative as Sandy River flow would be much less confined than it is at present.

Removal of Marmot Dam in 2007 and Little Sandy Dam in 2008 on the Sandy River upstream of the Delta was done for enhancing salmon populations. These dam removals should result in increased salmon production upstream on the Sandy River and may result in increased numbers of juvenile salmonids that would have the opportunity to use the improved habitat in the Delta with its increased area and better accessibility. Additionally, because of absence of these dams, increased flow in the Sandy River during freshets would aid in scouring of the Delta area in general. Absence of the dams will also result in additional sediment supply to the Delta in the future.

There is current work to replace the Interstate 84 bridges over the Sandy River upstream of the Delta at approximately Sandy RM 2.5. This work is scheduled to be completed in 2013, with in-water work scheduled to occur within the designated in-water work period for the Sandy River (July 15 through August 31). An extension has been granted by NMFS and ODFW through October 15. Fish passage will be maintained during the project and impacted aquatic habitat under the bridges will be restored. The volume of water entering the Delta downstream of the bridges would not be affected.

For activities proposed on National Forest Land the cumulative effect study area is the Sandy River Delta (~1500 acres of National Forest land north of I-84 identified as Sun Dial Island and Thousand Acres). Proposed activities include BPA's construction of helicopter landing areas and footpaths, , construction of rock storage areas, and the temporary use of the road system and two equipment storage areas. Since the Forest Service assumed ownership of this land, past activities have included transmission line maintenance, restoration projects, recreation use, and the development of recreation facilities such as trails and parking lot. Current activities have included paving the existing parking lot and the ongoing restoration projects. Transmission line maintenance has been continuous and BPA plans to relocate two transmission towers on Sundial Island away from the edge of the channel. This will occur prior to the proposed dam removal so that the dam access road may be used and equipment will not impact water ways. New projects in the reasonably foreseeable future include a restoration project in Thousand Acres to restore riparian and upland habitat and enhance fish access and periodic vegetative maintenance of helicopter landing areas and footpaths. Management of invasive weeds and recreation use will continue into the foreseeable future.

The activities on National Forest Land are a very small portion of the entire project and PDC and mitigation will minimize or eliminate detrimental effects associated with these activities. The future restoration project in the Thousand Acres is similar in nature to the proposed action and will use similar mitigations to address potential environmental effects. These activities, combined with past, present, and reasonably foreseeable future actions in the Sandy River Delta, will only have short-term minor incremental impacts to scenic, cultural, natural, and recreation resources. There are no cumulative impacts for Alternative 1. For activities on National Forest Land, Alternatives 2 – 5 will have no cumulative impact to soil; water and sediment quality; air quality/noise/light; vegetation; fish and wildlife; cultural; recreation; scenic resources; and infrastructure.

In conclusion, the 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 adjacent to the project site. The potential cumulative effects associated with the preferred alternative were evaluated with respect to each of the resource evaluation categories in this EA, and no cumulatively significant, adverse effects were identified.

5 COMPLIANCE WITH LAWS AND REGULATIONS

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. There would be minor intermittent, temporary reduction in air quality during construction of the preferred alternative due to emissions from construction equipment. There also would be an intermittent, temporary increase in noise levels from equipment used.

Clean Water Act

This Act requires certification from state or interstate water control agencies that a proposed water resources project is in compliance with established effluent limitations and water quality standards. Implementation of the preferred alternative is expected to be in compliance with the Act. The following permits will be obtained before construction can begin:

1. National Pollutant Discharge Elimination System (NPDES) construction permit
2. Oregon Division of State Lands (DSL) Fill/Removal General Authorization permit

The DSL permit application went through public review in 2012, and the permit was issued on May 6, 2013, after completion of the National Scenic Area Act compliance.

The Corps must comply with all provisions of Section 404 of the Clean Water Act. The work would be conducted under Nationwide Permit (NWP) 27 (Aquatic Habitat Restoration, Establishment, and Enhancement Activities) and the blanket Water Quality Certificate that includes actions under NWP 27 would be employed. Ability to use NWP 27 was coordinated with the Corps' Regulatory Branch and the Corps' Office of Counsel. The project fits under NWP 27 (Stream and Wetland Restoration

Activities) (FR 2007) because this NWP was developed for activities in Waters of the U.S. associated with the restoration, enhancement, and establishment of tidal and non-tidal wetlands and riparian areas and the restoration and enhancement of non-tidal streams and other non-tidal open waters, provided those activities result in net increases in aquatic resource functions and services.

This project qualifies as restoration of a non-tidal stream that would result in increases in aquatic resource functions and services by allowing juvenile salmon access to the East Channel from the Sandy River mainstem under a variety of flow conditions and would modify the east channel to eliminate the potential for stranding of juvenile salmon. Although the East Channel is tidally influenced from the Columbia River, as the Delta is located downstream of Bonneville Dam, it is considered non-tidal for regulatory purposes because of its location far upstream from the ocean.

Activities authorized by NWP 27 include removal of accumulated sediments, removal of small water control structures, and placement of in-stream habitat structures, among other actions. The proposed project also complies with the 28 points required under Nationwide Permit General Conditions (FR 2007). Coordination on use of NWP 27 has occurred with Portland District Counsel and Regulatory Branch. The Portland Water Bureau's removal of the remainder of the dam would require coverage under NWP 27 through the Corps' Regulatory Branch.

Fish and Wildlife Coordination Act

This Act states that federal agencies involved in water resource development are to consult with the USFWS concerning proposed actions or plans. Implementation of the preferred alternative has been coordinated with the USFWS in accordance with this Act. Specific aspects coordinated included turtle and fish salvalge from the East Channel prior to excavation, turtle nest monitoring at the staging area, and timing of tree removal to occur after July 15 to protect nesting birds. A field review of the project with USFWS was conducted on April 18, 2013.

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 fish and wildlife species and designated critical habitat is presented in this EA. For ESA compliance, a "No Effects" notification letter was sent to the USFWS dated January 14, 2010, and a Standard Local Operating Procedures for Endangered Species (SLOPES IV for restoration) form was sent to the NMFS for concurrence under the programmatic Biological Opinion for restoration projects on January 6, 2010. NMFS concurrence was received on January 26, 2010. SLOPES V supersedes SLOPES IV, which expired on February 25, 2013. It was coordinated with NMFS (via email and phone on December 21, 2012) that this project will fit under SLOPES V, which will also result in coverage for eulachon which was not covered under SLOPES IV (eulachon were federally listed after SLOPES IV was issued). The SLOPES V package was submitted to NMFS on May 2, 2013 and concurrence was received on the same day.

Magnuson-Stevens Fishery Conservation and Management Act

The Sustainable Fisheries Act of 1996 amended the Magnuson-Stevens Act and established requirements for essential fish habitat (EFH) for commercially important fish. Increase in turbidity may have minor and temporary impacts on Salmonid Essential Fish Habitat. No redds would be present at the time when this connection is made. Essential fish habitat was addressed for implementation of the preferred alternative as part of the SLOPES IV documentation submitted to NMFS. NMFS concurrence was received on January 26, 2010, and the project would operate under the programmatic Biological Opinion for SLOPES IV. As discussed in Section 6.4, SLOPES V will superced SLOPES IV.

Migratory Bird Treaty Act and Migratory Bird Conservation Act

These acts require that migratory birds not be harmed or harassed. Under the Migratory Bird Treaty Act, "migratory birds" essentially include all birds native to the U.S. and the Act pertains to any time of the year, not just during migration. The Migratory Bird Conservation Act aims to protect game and non-game birds. Impacts from construction could displace birds by causing flushing, altering flight patterns, or causing other behavioral changes. It is possible that nestlings could be harmed or killed during vegetation removal, but the majority of work would be conducted after the majority of nesting of most species is complete. At the recommendation of the Oregon Department of Fish & Wildlife, if tree removal is required to carry out the selected alternative, trees would be removed after the critical nesting season on Sundial Island concludes on July 15 and before April 1.

National Historic Preservation Act

Section 106 of this Act requires that federally assisted or federally permitted projects account for the potential effects on sites, districts, buildings, structures, or objects that are included in or eligible for inclusion in the National Register of Historic Places. Given the age of the dam and other factors discussed in Section 3.6, it may be considered eligible for the National Historic Register. Implementation of the preferred alternative was considered an Adverse Effect that was resolved through data recovery. This was coordinated among the Forest Service, the Oregon State Historic Preservation Office (SHPO), and the Oregon Department of State Lands through a Memorandum of Agreement (MOA). This MOA was submitted to the Advisory Council on Historic Preservation. Documentation of the historic dam is housed at three Oregon locations: the Forest Service in Hood River, the SHPO in Salem, and the Troutdale Library.

The remainder of cultural compliance for the newly identified actions to occur on Forest Service lands were covered under the 2004 Programmatic Agreement that the Forest Service has with the State Historical Preservation Office.

Native American Graves Protection and Repatriation Act

This Act provides for the repatriation or disposition of Native American (and Native Hawaiian) cultural items and human remains to Native Americans. It also establishes requirements for the treatment of Native American human remains and sacred or cultural objects found on federal land. This Act also provides for the protection, inventory, and repatriation of Native American cultural items, human remains, and associated funerary objects. There are no recorded historic properties within the immediate project area and the probability of locating human remains in this highly

disturbed area is low. However, if human remains are discovered during construction, the Corps and/or the Contractor would be responsible for following all requirements of the Act.

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 should shoulder a disproportionate share of the negative environmental impacts resulting from the execution of domestic and foreign policy programs. The preferred alternative is a habitat restoration project and is not expected to disproportionately affect low income and/or minority populations, and is in compliance with Executive Order 12898.

Executive Order 11988, Floodplain Management

Dam removal could alter the distribution of flood waters in the Delta that are influenced by the Sandy River. No residence occurs in the area of potential influence. Allowing flooding of existing backwater channels and creation of new ones would be environmentally beneficial.

Executive Order 11990, Protection of Wetlands

All activities in and near wetlands associated with the preferred alternative are designed to enhance the function and improve the value for fish and wildlife habitat. Seasonal wetlands present within the East Channel would be lost with excavation in the East Channel. These high spots become vegetated on a seasonal basis, during summer and early fall, as these areas become exposed during lower water. This aspect of environmental considerations was coordinated with the Corps' Regulatory Branch; restoration actions are considered self-mitigating because of the improvements to aquatic functions and values that would result from project implementation.

Prime and Unique Farmlands

Not applicable because no prime and unique farmlands exist within the project footprint.

Comprehensive Environmental Response, Compensation, and Liability Act and Resource Conservation and Recovery Act

The location of the project is not within the boundaries of a site designated by the EPA or the State of Oregon for a response action under Comprehensive and Environmental Response, Compensation and Liability Act, nor is it a part of a National Priority List site. Any presence of these types of wastes would be responded to within the requirements of the law.

Columbia River Gorge National Scenic Area Act and Management Plan

The project area is within two Land Use Designations, SMA Open Space and SMA Public Recreation. In each of these designations, the project is an allowed use as a "resource enhancement

project for the purpose of enhancing scenic, cultural, recreation and/or natural resources". The Management Plan requires resource enhancement projects to describe the goals and benefits of the proposed enhancement project, and to thoroughly document the condition of the resources before and after the proposed enhancement project. The EA provides the documentation of resource conditions before predicted resource conditions after the enhancement project.

The scenic resource standard in the Open Space designation requires a project to be 'not visually evident" from a Key Viewing Area (in this case, the Sandy River). The scenic resource standard in the public Recreation designation requires a project to be "visually subordinate".

Consistency with the resource protection guidelines of the CRGNSA Plan and Northwest Forest Plan was incorporated into the relevant sections of Chapter 3. For instance, consistency with scenic resource guidelines is found in the Scenic Resources section, consistency with recreation resource guidelines is found in the Recreation Resources section.

The Forest Service signed their Consistency Determination on March 29, 2013. There were no requests for administrative review during the 20-day review period that ended on April 18, 2013.

Mount Hood National Forest Land and Resource Management Plan (LRMP) as amended by the Northwest Forest Plan (NWFP)
Forest-wide standards and guidelines that are more protective than CRGNSA Plan guidelines apply.

This project is located within the following NWFP planning designations:
- Administratively Withdrawn
- Riparian Reserve of 300 feet designated along the Sandy River, Columbia River and original Sandy River channel.

6 COORDINATION AND RESPONSES TO COMMENTS

The U.S. Forest Service began general Sandy River Delta public involvement efforts in 2005. The dam removal concept was introduced to the public at a public meeting in November 2005 in Troutdale, Oregon. The Forest Service conducted a public site tour in April 2006. The Forest Service posted technical reports related to dam removal on its website.

On October 20, 2006, the Forest Service sent a notice about the dam removal proposal to over 240 interested parties for a 30-day comment period. Tribal governments, state, federal and local agencies, interest groups and Delta recreationists were contacted. The request was also posted to the Forest Service website. Twenty-one parties responded. Nine parties specifically supported the proposal, one party opposed it, and numerous parties raised specific issues concerning hydrology, fish and wildlife, recreation use, historic resources, scenic resources, economics, and land use regulations. A presentation was given by the Forest Service to the Sandy River Basin Partners on March 8, 2007. The Corps and Forest Service provided a status report to this group on the cooperative 536 project on November 12, 2009.

The Forest Service, ODFW, DSL, BPA, NMFS, Sandy River Basin Partners, Portland Water Bureau, and other resource agencies are supportive of the preferred alternative in the Sandy River Delta.

An earlier draft EA was issued for 30-day public review on October 27, 2011 under Public Notice Number CENWP-PM-E-11-06 and was extended through December 23, 2011 because of additional

public interest in commenting. A revised draft EA describing additional actions to occur of Forest Service land was issued for 30-day public review on December 21, 2012 under Public Notice Number CENWP-PM-E-12-09. Both EA's were provided to federal and state agencies, tribes, organizations and groups, and interested individuals. Some of the comments were similar in nature and focused on the interest in maintaining public access to Sundial Island. Comments similar in nature were grouped together into a single response. Comments on the 2011 draft EA (comments 1-68) and the 2012/13 revised draft EA (comments 69-77) follow:

Comment 1: Would public access to Sundial Island be maintained for people interested in using trails on the island for activities such as walking, dog walking, bicycling, and horseback riding?

Response to Comment 1: The project aims to remove the 1930's-era dam that provides access to Sundial Island. This dam, however, is currently overtopped during higher flows on the Sandy River, which can block access. There are no plans to provide public access to Sundial Island because a bridge would be required and be subject to flows and natural scouring in the East Channel. It is one aim of the project to allow natural hydrologic progression of the Sandy River Delta in general, which may result in substantial changes to the morphology of the East Channel. There are a number of naturally occurring safety hazards in the Sandy River ranging from unstable sandy sediments, high water, floating logs, etc. People that may decide to cross the West or East Channels to Sundial Island will have to exercise their own judgment when leaving established trails. There is a loop trail that was part of the preferred alternative selected by the Forest Service as a component of the Sandy River Delta Plan that is located on Sundial Island (USFS 1995b; 1996a; 1996b). The EIS and ROD identified 6-9 miles of trails to be constructed within the Sandy River Delta, approximately 2.8 of which were identified as occurring on Sundial Island. Trails that have been constructed on the "mainland" between the public parking lot and the East Channel, which separates the mainland from Sundial Island, include the Boundary Trail (1.5 miles), Confluence Trail (1.25 miles), Meadow Trail (2 miles), Meadow Road (0.5 mile), Ranch Dike Trail (1.25 miles), and Old Channel Trail (0.75 mile). Cumulatively, approximately 7.25 miles of trails are present on the mainland. Removal of Sundial Island from the trail system still meets the goals of the Sandy River Delta Plan with respect to trail mileage, although the greater solitude provided by Sundial Island will be lost. The scenery along the trails on the mainland is very similar to those on the island, and therefore removal of access to Sundial Island is not thought of as a substantial change to recreation opportunities. The newer parking lot at the Sandy River Delta provides the capacity (100 spaces) identified in the EIS, and therefore overcrowding of the existing 7.25 miles of trails on the mainland should not be an issue. Trails identified in the 1995 EIS to be present on Sundial Island, which would have been in forested areas as opposed to the more open areas of the mainland trails, have never been constructed (currently use occurs on existing roads on the island). Scenery along these existing roads is similar to that encountered on the mainland trails.

Comment 2: With implementation of the project, Sundial Island would reclaim its status as an island. The nature of the Sandy River Delta has been greatly altered by changes in hydrology, and removal of the dam would restore hydrology and greatly benefit salmon and steelhead.

Response to Comment 2: This project aims to restore some of the natural hydrology to the Sandy River Delta. The natural hydrology cannot be entirely restored because of operation of dams on the Columbia River, but removal of the dam is projected to greatly benefit native salmon and steelhead, all of which are on the Federal Endangered Species list.

Comment 3: In the event any archaeological or historic materials are encountered during project activity, work must stop and appropriate steps taken including implementing reasonable measures to

protect the discovery site, ensure the confidentiality of the discovery site, restrict access to the site of the discovery. If human remains are uncovered, appropriate law enforcement agencies shall be notified first and if the remains are determined to be Native, consultation with the affected Tribes would take place in order to mitigate the final disposition of the remains.

Response to Comment 3: These points will be complied with through adherence to the State Historic Preservation Act and the Native American Graves Protection and Repatriation Act.

Comment 4: Leaving part of the dam intact would provide an opportunity to educate the public about the history of the area, specifically the dam.

Response to Comment 4: Removal of the dam has been mitigated through coordination with the State Historic Preservation Office. This was done through documentation of the dam by the U.S. Forest Service. This report is available upon request and is on file at the Troutdale Public Library. There is interest from various natural resource agencies in removing the entire dam in order to allow the Sandy River Delta the maximum capability to return to a natural state by eliminating restrictions to direction of flow. The dam was built out of wood and rock. While historical photos of the dam exist and are available as noted above, the original building materials of the dam are not visible on-site as the dam has become entirely covered in sediment over the years.

Comment 5: The proposed restoration of the historic channel would help struggling salmonids and allow better egress of juveniles to the Columbia River from the Sandy River, and generally improve fish habitat.
Response to Comment 5: The project aims to accomplish these aspects, and also remove the risk of stranding of juveniles in the East Channel.

Comment 6: Losing access would prevent Northwest Pipe from a timely response in the event of a pipeline emergency on the island, which would delay repair and return to service work.

Response to Comment 6: The project will not proceed under Section 536 authority without the approval of Northwest Pipe. The Corps has coordinated with Northwest Pipeline to ensure adequate access to the pipeline located on the island.

Comment 7: Loss of vehicular access to Sundial Island causes risk for fire control.

Response to Comment 7: Many islands exist in the Columbia River that could be subject to fire, and fire on Sundial Island could damage recent planting of native trees and shrubs. The project would not proceed under Section 536 without the support of Bonneville Power Administration and Northwest Pipeline. Another means of access to the island for repairs and emergencies will be developed if all parties are in agreement with dam removal. The aspect of fire has been discussed with Bonneville Power Administration, and has not been identified as an issue. There are not a lot of fire fuels in the vicinity of the steel towers.

Comment 8: Has the option for a long bridge been changed. A long bridge would not be in keeping with the values of the Gorge.

Response to Comment 8: Dam removal and construction of a long bridge for vehicular access was earlier proposed by the U.S. Forest Service before requesting the project under Section 536 of the Water Resources Development Act with the Army Corps of Engineers. This is no longer being considered. The formerly proposed project would not have met National Scenic Area requirements

with the open space land use designation. The project is now being considered under Section 536 of the Water Resources Development Act, and is strictly intended for ecosystem restoration.

Comment 9: The proposed project would set the stage for potential further slough reconnection and restoration, which would build further habitat diversity that is impossible with the East Channel disconnected from the main stem Sandy River.

Response to Comment 9: While the hydrology of the Sandy River Delta cannot be entirely restored because of alteration of Columbia River flows with dams on the Columbia, removal of the dam in the delta is projected to greatly improve hydrology in the Delta and additional channel braiding and side channel development may occur.

Comment 10: How would pilot channel excavation and maintenance sustain scour of the new channel?

Response to Comment 10: A large sediment plug, likely partly due to disposal of dredged material from the main stem (West Channel) Sandy River, exists between the main stem and the dam. And the East Channel has largely silted in. No maintenance is planned for the pilot channel. Without the pilot channel, the sediment plug would act as a dam itself to some degree. The pilot channel is designed to provide a low water inlet from the main stem Sandy River into the East Channel and to allow a continuous water connection between the West Channel and the Columbia River. From hydrologic analysis, it is not expected that the pilot channel will silt in. The pilot channel will allow for a head start for hydrologic changes in the East Channel.

Comment 11: The estimate of maintenance costs for plantings appears to be low.

Response to Comment 11: Planting and plant maintenance costs will be based on previous work that the Corps did in cooperation with the Forest Service for planting that was done on Sundial Island, and experience with other Corps' projects.

Comment 12: Responsibilities for the Oregon Division of State Lands Fill/Removal Permit and the National Pollutant Discharge Elimination System (NPDES) Permit should be detailed in a Memorandum of Understanding of which the Forest Service and the Corps are signatories.

Response to Comment 12: The Corps has blanket coverage for the NPDES Permit in Oregon through the Oregon Department of Environmental Quality. Requirements of the NPDES are covered through the Corps' development of sediment and erosion control measures in the plans and specifications. The Corps has obtained the DSL Fill/Removal Permit.

Comment 13: Support of the proposed action because Alternative 5 has the highest habitat suitability and channel-specific habitat unit scores for the types of salmonids assessed.

Response to Comment 13: Alternative 4 was the Corps' chosen alternative from results of a cost-benefit analysis. Alternative 4 had lower costs than Alternative 5, but also lower environmental outputs. Strong interest in full dam removal was expressed by a number of natural resource agencies, including the owner of the dam, the Oregon Department of Fish and Wildlife. It was discovered that the City of Portland Water Bureau also had an interest in dam removal for mitigation for their operation of the Bull Run Reservoir. It was agreed by the National Marine Fisheries Service that both the Water Bureau and the Corps could obtain mitigation credits for dam removal. It is planned that the Water Bureau will fund a portion of the dam removal.

Comment 14: The EA states that "Anecdotal data suggest as many as 75-100 cars park in this area on a nice weekend and 10-20 cars consistently during weekdays (before the recent construction of a new parking lot, however)." Since more than 200 cars were documented in the parking lot on a winter weekend, then year-round use of the area is far higher than described in the EA, and effects to recreationists from the proposed project are significant.

Response to Comment 14: The particular weekend day when more than 200 cars were parked may not be representative of a typical weekend day; from the photos, the weather appeared clear that day. Many of these cars appeared to not be parked in designated parking spaces. The new parking area likely does attract more recreationalists in the Sandy River Delta now compared to before when parking was very limited. The parking lot was designed in part in concert with the mileage of trails outlined in the 1995 U.S. Forest Service EIS. The EIS and Record of Decision identified 6-9 miles of trails to be constructed within the Sandy River Delta and 100 parking spaces. Trails that have been constructed on the "mainland" between the existing public parking lot and the East Channel, which separates the mainland from Sundial Island, include the Boundary Trail (1.5 miles), Confluence Trail (1.25 miles), Meadow Trail (2 miles), Meadow Road (0.5 mile), Ranch Dike Trail (1.25 miles), and Old Channel Trail (0.75 mile). Cumulatively, approximately 7.25 miles of trails are present on the mainland.

Comment 15: The Draft EA failed to disclose the full impacts to recreationists, failed to gather appropriate data to assess the impacts to recreationists, and failed to fully disclose the economic and human impacts of the project.

Response to Comment 15: The Forest Service 1995 EIS and record of decision identified 6-9 miles of trails to be developed and mapped out locations. While trails have not been developed on Sundial Island as mapped in the EIS, the mileage of trails developed on the mainland meets the total mileage for the Delta described in the EIS. Therefore, while impacts to recreationists may occur, this impact is being viewed by the public with respect to the current condition and perhaps not with respect to how the area was designed for recreation.

Comment 16: Can access to Sundial Island be maintained with dam removal?

Response to Comment 16: With full dam removal, the East Channel will be subject to a more natural hydrologic regime. It is the intent of the project to allow the East Channel to develop under more natural hydrologic conditions. Building of a permanent foot crossing would be difficult because of the width of the East Channel and the unpredictability of how the East Channel may change in the future. Soils on-site are susceptible to scour since they are mainly sand and silt and a permanent crossing would be subject to flooding and scour. There are a number of naturally occurring safety hazards in the Sandy River ranging from unstable sandy sediments, high water, floating logs, etc. People that may decide to cross the West or East Channels to Sundial Island will have to exercise their own judgment when leaving established trails.

Comment 17: How would the power towers be accessed for maintenance.

Response to Comment 17: As described in the EA, BPA is proposing helicopter landing areas on Sundial Island to facilitate access by helicopter.

Comment 18: Removing access to Sundial Island would negatively affect habitat management on the island.

Response to Comment 18: The Forest Service and the Corps have been involved cooperatively on upland habitat restoration on Sundial Island. The restoration has gone well to date. Future need to access the island for vegetation management would likely be done by boat.

Comment 19: Removal of the dam should be the last part of the project because of timing of Chinook and coho salmon and possible effects of silt.

Response to Comment 19: Removal of the dam is not expected to generate much silt input into the East (or West) Channel because this would be done likely entirely in the dry. Excavation of the pilot channel is more likely to cause suspension of sediment. Adherence with the Oregon Department of Environmental Quality water quality certificate and the National Marine Fisheries Service biological opinion will assure that suspension of sediment will be minimized. Water in the East Channel may be too warm for juvenile salmonids during summer when work would take place.

Comment 20: A crossing to Sundial Island should be allowed for equestrian access.

Response to Comment 20: With full dam removal, the East Channel will be subject to a more natural hydrologic regime. It is the intent of the project to allow the East Channel to develop under more natural hydrologic conditions. Building of a permanent foot crossing would be difficult because of the width of the East Channel and the unpredictability of how the East Channel may change in the future. Soils on-site are susceptible to scour since they are mainly sand and silt and a permanent crossing would be subject to flooding and scour. There are a number of naturally occurring safety hazards in the Sandy River ranging from unstable sandy sediments, high water, floating logs, etc. People that may decide to cross the West or East Channels to Sundial Island will have to exercise their own judgement when leaving established trails. Equestrian use will be perhaps the most affected recreational aspect because of the more concentrated use of the mainland trails with walkers and dogs present.

Comment 21: How would dam removal affect wildlife species?

Response to Comment 21: Implementation of the proposed action would greatly enhance the Sandy River Delta to the benefit wildlife in general by creating a greater diversity of wetland habitats. No ESA-listed wildlife species occupy the Sandy River Delta. Rare species that occupy the area include bald eagle, painted turtle, red-legged frog, and Oregon and California floaters (mussels). These species would benefit from a general increase in wetted areas of slow moving water in the Sandy River Delta.

Comment 22: Why isn't Oregon Department of Fish and Wildlife participating in the cost of the project since they own the dam?

Response to Comment 22: Project cooperation with the Corps was requested by the Forest Service under Section 536 of the Water Resources Development Act. The City of Portland Water Bureau will be participating in the cost of dam removal also, since it is required by the National Marine Fisheries Service under the Biological Opinion that was issued to the City for their operation of the Bull Run Reservoir.

Comment 23: The description in the EA of the Confluence Project is too general.

Response to Comment 23: Language was added into the EA to more adequately describe the Confluence Project.

Comment 24: Request that the EA public review comment period be extended.

Response to Comment 24: It was extended per this request for an additional 15 days.

Comment 25: Potential problems with an unmanaged and undesirable user base on Sundial Island.

Response to Comment 25: It is unknown if the isolation of Sundial Island would attract an undesirable user base. If this occurs, necessary actions to alleviate problems would be taken by the property owner, the Forest Service.

Comment 26: Restricting access to Sundial Island would lead to deterioration of the accessible regions of the Delta.

Response to Comment 26: As noted above, trail mileage on the mainland meet the recreation needs as previously planned by Forest Service.

Comment 27: The two smaller channels may result in worse fish passage conditions.

Response to Comment 27: Currently there is potential for stranding of juvenile salmonids in the East Channel and mortality due to high temperatures; removal of the dam and creation of the pilot channel will eliminate this problem. A continuous year-round connection will exist between the Sandy River main stem and the Columbia River with presence of the pilot channel. The Sandy River produced good Salmonid runs before dam construction and is expected to continue. Recent removal of dams upstream in the watershed will provide for additional spawning grounds and may increase Salmonid production in the Sandy River basin.

Comment 28: "Hydrologic complexity" is used throughout the EA but is not defined. The West Channel and the East Channel still show extensive complexity.

Response to Comment 28: An area that is hydrologically complex would be characterized by braided channels and backwater areas. The East Channel has largely become in-filled with sediment and the majority of Sandy River water flows through the West Channel directly out into the Columbia River. Figure 3 of the EA (1935) shows the abundance of braided channels and backwater areas that existed in the Delta while Figure 4 (1995) shows how this complexity has been lost.

Comment 29: ODFW states that Sandy River juveniles do not usually rear in the Delta.

Response to Comment 29: Use is expected to increase with implementation of the project. Riparian habitat in the East Channel is much more well developed than in the West Channel; juveniles from the Sandy River now would mainly use the West Channel because of limited access to the East Channel and much of the West Channel downstream of the East/West split is rather poorly vegetated. The East Channel is also expected to provide good refuge habitat for juveniles entering from the Columbia River during higher flows in the Columbia River. ODFW is in full support of this project and it is expected to score relatively highly with respect to providing juvenile Salmonid survival benefits as part of the Expert Regional Technical Group (ERTG) scoring of habitat restoration projects.

Comment 30: Future annual channel maintenance would probably be required for all alternatives in order to protect the benefits of the project. Is there a commitment for annual funding?

Response to Comment 30: There is no commitment to funding channel maintenance. From hydrologic analysis, it is predicted that no dredging will be required in the pilot channel. The aim of this project is to restore flow largely to a natural condition, and it is projected that channel braiding and development of off-channel habitats will occur.

Comment 31: What is the cause of the loss of hydrologic complexity?

Response to Comment 31: Loss of hydrologic complexity is attributed to the dam on the East Channel and to alteration of flows on the Columbia River. Currently, the Sandy River overtops the dam on the East Channel only during higher flows in the Sandy River which has caused sedimentation in the East Channel. Removal of the dam will restore Sandy River flows to the East Channel. Recent removal of dams higher in the Sandy River watershed will aid in this also. Frequent floods affecting the area from the Columbia, of course, cannot be restored.

Comment 32: It would be helpful to include a life history summary of Sandy River juveniles from fry to smolt and where they rear.

Response to Comment 32: Any salmonids spawned in the Sandy River would have to move downstream to rear in the East Channel. Parr are expected to use the East Channel.

Comment 33: If the West Channel is too warm now, both channels would be too warm later. And, if flows in the West Channel are reduced, ponding would probably occur in both channels.

Response to Comment 33: With creation of the pilot channel in the East Channel, a continuous connection year-round connection will exist between the Sandy River main stem and the Columbia River through the East Channel. This will eliminate current stranding potential in the East Channel.

Comment 34: Is there an elevation plan for the East Channel? Is there a proposed design elevation plan for the East Channel after excavation?

Response to Comment 34: Yes, the invert elevation at the entrance to the East Channel at the Sandy River main stem will be 9.2 feet, and the mouth of the East Channel will be 8.0 feet.

Comment 35: A major loss of habitat may occur in the West Channel because of water diversion to the East Channel.

Response to Comment 35: The Corps' hydrologic analysis predicts that the wetted area of the West Channel won't change much initially. As the hydrology of the Delta develops over time, it is difficult to predict the response of the West Channel. Currently juvenile rearing habitat in the West Channel downstream of the East/West Channel split is deficient with respect to riparian vegetation. Riparian vegetation is much better developed in the East Channel. This provides shade, cooling of water, detrital and large wood input, and promotes greater invertebrate production; all of which are important to juvenile salmonids.

Comment 36: The junction of the East and West Channels needs to have an engineered design or it would not work.

Response to Comment 36: No in water diversion structures are part of the proposed action. It is desired to return the hydrology of the Sandy River to a more natural condition and allow the Delta to

change as it will. Excavation of the pilot channel within the East Channel will allow water from the Sandy River main stem into the East Channel even at low flows.

Comment 37: Are costs associated with removal of the sediment plug in the EA economic analysis?

Response to Comment 37: No, only the pilot channel through the sediment plug.

Comment 38: For the purposes of the benefits analysis, only the affected wetted areas within the East and West Channel were incorporated into the analysis. It is not clear what this means.

Response to Comment 38: This is the area occupied by the limits of the Ordinary High Water line.

Comment 39: The HSIs for the alternatives were assumed to be constant during the project life for the four types of juvenile salmonids that were assessed in the area. This is an unsupported assumption. And what is the life of the project? The HSI analysis is based on unproven assumptions.

Response to Comment 39: The project life for the purpose of benefits evaluation is 50 years. The Habitat Suitability Index scores were assumed to be constant for the life of the project. It is difficult to predict the long term hydrologic response of the Sandy River Delta, and would have been impractical to attempt to vary the scores over time.

Comment 40: The depth and velocity criteria for salmonids was provided for informational purposes but depth, velocity, as well as access, stranding potential, and water temperature were considered in a rather qualitative, predictive context. Either get the data and apply the criteria or just leave it out.

Response to Comment 40: The depth and velocity criteria are useful for the reader to get a sense of habitat preferences of juvenile salmonids. Obtaining extensive data on depth and velocity and how they vary through a particular year was considered initially. It was decided to view the project in a more general way because making predictions on area that would meet criteria over a 50-year period was considered difficult. The most important aspect of this project is to eliminate stranding potential in the East Channel and provide year-round access to the East Channel from the Sandy River main stem so that the excellent habitat associated with the East Channel may be used without issues with mortality due to stranding and water temperatures.

Comment 41: The data from the hydraulic engineering study did not fit the assumptions so the data was discarded. The engineering study should be included in the EA.

Response to Comment 41: A more general approach was utilized because it was difficult to quantify all factors that contributed to the cost/benefit analysis; i.e. we didn't want to have a mixture of quantified and qualified variables. No data was discarded because of lack of support of any assumptions. "Data" on predicted depth and velocities was useful in the qualitative assessment. And also it is difficult to predict how the hydrology may change in the Sandy River Delta over the 50-year project life, and a qualitative approach would be more suitable and realistic.

Comment 42: You cannot make the conclusion that the West Channel is a more common habitat type than the East Channel in the Columbia River system. Both channels may become rare off-channel habitat once flow is reestablished.

Response to Comment 42: Agreed. The East Channel presents a lot of value compared to the West Channel in that riparian development there is better.

Comment 43: Under all alternatives, during lower water in the Columbia River the access across the sand bars at the mouth for both channels would be difficult, and similar.

Response to comment 43: Agreed. Adult access will typically correspond to higher water in the Columbia, and fish can hold in the Columbia before entering on higher tides. There is about a 1.5-foot tidal influence at the mouth of the Sandy River. Juveniles entering from the Columbia River for refuge would be more apt to do so with higher flow in the Columbia.

Comment 44: The EA contains no construction cost estimates, no design costs, no construction administration costs, no annual costs for plant maintenance or channel maintenance, so it is impossible to review the economic analysis.

Response to Comment 44: This information is internal and not provided in the public review process.

Comment 45: The entire dam would be removed and under the same contract, but would not be a part of a Federal project.

Response to Comment 45: There will be one contract for dam removal. The Corps will be reimbursed by the Portland Water Bureau for their part of it which is required under a Federally-issued Biological Opinion.

Comment 46: Lahars are not necessarily associated with "eruptive activity". Lahars are associated with volcanic conditions.

Response to Comment 46: Noted.

Comment 47: Tidal waters do not enter the delta, there is no upstream-moving tidal surge, "tidal influenced" is sufficient.

Response to Comment 47: Noted.

Comment 48: "Excess stream energy" – excess of what?

Response to Comment 48: This is in context to the West Channel. There is more stream energy there now compared to before dam construction because most of the Sandy River flow gets funneled down the West Channel and is causing erosion in one particular area near a Bonneville Power Administration transmission tower.

Comment 49: Both the Marmot and Little Sandy Dams were run-of-the-river dams. Neither impounded significant water or sediment. Once steady state conditions were reached behind the dams (about a year) sediment from upstream flushed over the dams during high water events as if the dams were not there.

Response to Comment 49: There may be no data available that give good estimates of how much sediment was stored behind those dams. No speculation was made on how much sediment was stored.

Comment 50: Smallmouth bass also occur in the Sandy River Delta.

Response to Comment 50: Noted.

Comment 51: There does not appear to be any discussion in the EA of the impact of the project on eulachon.

Response to Comment 51: Eulachon run during higher waters in the Columbia River and larvae exit shortly after spawned. The presence of flow in two channels should not inhibit ingress or egress of eulachon.

Comment 52: The EA required better hard data on present and future recreational use of the Delta.

Response to Comment 52: The mileage of trails in the Delta and parking lot capacity meet what was detailed in the Forest Service's Master Plan for the area.

Comment 53: Major changes to the hydrology of the river are likely and would have the potential to significantly change the geology and soils in the Delta.

Response to Comment 53: The EA discussed geology and soils in a general sense. With implementation, water in the Delta will be allowed to meander and create new channels; geology will be changed that way.

Comment 54: Why would flow slowly shift from the West Channel to the East Channel over time.

Response to Comment 54: The Sandy River appears to turn in a way that indicates that it would naturally flow down the East Channel if given the opportunity. The pilot channel will encourage this. Without the pilot channel, the sediment plug would act as a dam itself limiting water flow to the East Channel.

Comment 55: Removal of the dam is not anticipated to accelerate bank erosion along the right bank of the West Channel. But the rate of erosion may increase.

Response to Comment 55: Noted. Without study of the soils in the area of erosion along the West Bank, this assumption cannot be made. The soils are likely fairly uniform in that area, and it is believed that having less water going down the West Channel will allay erosion. This is less of a concern now because Bonneville Power is intending to move their transmission tower that is currently very close to the banks of the West Channel because of erosion.

Comment 56: Who did the modeling? Where is the study and data? And the conclusion appears to state that there is no indication that the project would have any long-term benefit without long-term periodic East Channel excavation.

Response to Comment 56: See the following:

Bureau of Reclamation. March 2006. Analysis of Sediment Transport Following Removal of the Sandy River Delta Dam, Troutdale, Oregon. Technical Service Center, Denver, CO.

Bureau of Reclamation. August 2006. Addendum to Analysis of Sediment Transport Following Removal of the Sandy River Delta Dam. Technical Service Center, Denver, CO.

Comment 57: If both largemouth and smallmouth bass are regularly found all the way up the Sandy River in the West Channel to the freeway bridge, how would implementation of the project decrease use in the East Channel.

Response to Comment 57: Cooler water input from the Sandy River to the East Channel may improve conditions with respect to bass (predators on juveniles) as they prefer warmer waters, but it is not certain.

Comment 58: Do you think there would be no temperature problems associated with shallow water?

Response to Comment 58: There could be especially in late summer but the project aims to provide a low flow connection from the main stem Sandy River through the East Channel to the Columbia River so that fish occupying the East Channel will be able to move out in response to rising temperatures.

Comment 59: What is a "more natural flow pattern"?

Response to Comment 59: A flow pattern where water entering the Sandy River Delta has no major obstructions to flow.

Comment 60: No data exists characterizing the flow conditions prior to dam construction. Upstream migration might become a problem after dam removal.

Response to Comment 60: There is tidal influence in the area and runs typically correspond to higher flows in the Columbia. It is doubtful that upstream migration will be hindered by the presence of two channels.

Comment 61: Removing a significant portion of the land base available for, and currently used by recreationists, is not acceptable without some form of formal mitigation.

Response to Comment 61: A large amount of the land base will be removed from recreational use. Trail mileage on the "mainland" and parking capacity meet the Forest Service's Master Plan goals, although it is recognized that loss of Sundial Island will result in areas that provide more solitude for recreationalists.

Comment 62: What is the economic impact to the sand mining permittee?

Response to Comment 62: The source of sand to the mining area just downstream of the confluence of the Sandy and Columbia rivers is primarily the West Channel. Modeling conducted by the Bureau of Reclamation (2006) showed that if more flow is directed to the East Channel (proposed action), more sand would be deposited in the east Delta area and the amount of sand deposited in the mining area would decrease (estimated range from 20% to 39% reduction).

Comment 63: Backwater channel creation is hoped for but not certain.

Response to Comment 63: Large floods are expected to create backwater areas over time. The intention is to return hydrology in the Sandy River Delta to a more natural state but not to manage that hydrology over time.

Comment 64: You should consider the potential for significant future adverse unintended consequences including hunting and fishing, cycling, horseback, running, new users, potential for unregulated access, and undesirable users.

Response to Comment 64: It is believed that the Sandy River Delta will be at least partially restored to natural conditions. This will not create adverse unintended consequences.

Comment 65: A concrete box culvert through the dam should be considered.

Response to Comment 65: A concrete box culvert was discussed when the Corps initially looked at the project but was not considered further because of potentially large maintenance issues.

Comment 66: How can part of the dam be removed by non-Federal funding.

Response to Comment 66: The U.S. Forest Service and the Portland Water Bureau (City of Portland) have entered into an agreement which allows the Forest Service to accept the City's funds, which in turn, can be used to partially fund the cost of the construction contract.

Comment 67: Marmot and Little Sandy dams were run-of-the-river dams and neither impounded significant amounts of sediment that could affect the Sandy River Delta.

Response to Comment 67: Noted; the EA doesn't speculate on how much sediment was impounded.

Comment 68: An Environmental Impact Statement should be prepared.

Response to Comment 68: A purpose of an Environmental Assessment (EA) is to allow public comment and make a determination of whether or not the proposed action would constitute a "significant impact to the quality of the human environment." When making this determination, the *context* and *intensity* of the proposed action are taken into account. The *context* of an action refers to the affected environment in which a proposed action would take place while the *intensity* of an action refers to the severity of a proposed action's impact on the environment.

It is acknowledged that this project is unpopular with some of the public that uses the Sandy River Delta for activities such as walking, dog walking, and horseback riding, as evidenced by comments on this EA and the 2011 EA. Mileage of trails provided in the Sandy River Delta when excluding Sundial Island meet the trail mileage planned for in the area by the 1995 Forest Service Environmental Impact Statement (EIS), although it is acknowledged that use in the area has increased since 1995, but this EIS was developed as a long-term document. Many recreationists in the area don't travel as far as Sundial Island. It is likely that greater density of recreationists will use the mainland trails after dam removal. This will lessen the enjoyment of the Delta for users that would normally travel as far as Sundial Island and that prefer greater solitude in nature.

The *context* of the action is deemed low because it affects a relatively small geographic region, the Sandy River Delta, and affects only a portion of the Delta (that portion that requires farther travel from the parking lot), and because trail mileage after dam removal is still consistent with that

planned for the area as outlined in the 1995 Forest Service EIS. The *intensity*, or severity of the proposed action's impact on the environment, concerns a proportion of recreationalists in the Delta that travel as far as Sundial Island and that prefer more solitude in the excursions. The intensity in this case is deemed to be moderate because recreation opportunities, although lessened, will not be eliminated and because the action only affects a portion of users of the Delta.

Comment 69: Prefer that helicopter landing areas not be constructed so that the grounds be retained in their currently rehabilitated state.

Response to Comment 69: Most of the area associated with the helicopter landing areas consists of non-native herbaceous vegetation as they are located within the transmission line corridor. As noted in the EA, some tree plantings associated with a large restoration project on Sundial Island will be removed. Plantings to be removed consist of a very small portion of the overall restoration project on Sundial Island.

Comment 70: Sundial Island will be cut off from access for hunting.

Response to Comment 70: On Sundial Island, the area north of the Bonneville Power Administration transmission lines are open to waterfowl hunting (by shotgun). The area will still be open to hunting. Even currently though, overland access is difficult at times during waterfowl season because of over-topping of the dam .

Comment 71: Suggestion to do Columbia Yellow Cress surveys to insure that any unknown populations are not affected.

Response to Comment 71: The location of the Columbia Yellow Cress has been established and the proposed project will not effect this species. Suitable habitat for this species has not been identified in the proposed areas of ground disturbance. Forest Service staff will be monitoring project activities and work with Corps' staff and contractors to mitigate any potential impacts if new populations are identified.

Comment 72: There should be consultation with the Columbia River Gorge Commission's list of sensitive species and consider requirements of the National Scenic Area Management Plan.

Response to Comment 72: These species were reviewed during the Scenic Area Act consistency review after completion of NEPA public review.

Comment 73: There should be some discussion about impacts to scenic resources; areas should be screened from designated key viewing areas.

Response to Comment 73: Effects to scenic resources are discussed in the EA, including for each alternative. This project has undergone the required Scenic Area Act consistency review. This review discussed impacts to scenic resources and key viewing areas. The Forest Service signed a consistency determination on March 29, 2013. No appeals were received during the public appeals process of the Scenic Area Act Consistency Determination.

Comment 74: Concerns of prompt access for pipeline emergency; should have a well documented response plan.

Response to Comment 74: This has been coordinated with the Corps' Portland District Regulatory Branch. Prompt access would be allowed through emergency permitting. Rock will be stored on Sundial Island and the mainland in the Delta to aid in access to the island if needed. General concepts have been coordinated with Williams Northwest Pipeline but specifics will be decided if emergency access is ever needed due to the wide range of physical variables that may be present at any specific time in the future. Concern of Williams Northwest Pipeline have been addressed and they have formally expressed support for the project.

Comment 75: Provide a construction activity timeline.

Response to Comment 75: Construction is planned for 2013. Construction will occur within the designated in-water work period, including an extension that has been coordinated with the Oregon Department of Fish and Wildlife and the National Marine Fisheries Service. This timeframe is July 15 through October 15. Particulars regarding timing of specific work components won't be specified until after a construction contract has been awarded.

Comment 76: Safety concerns about crossing the West Channel to Sundial Island.

Response to Comment 76: There are a number of naturally occurring safety hazards in the Sandy River ranging from unstable sandy and silty sediments, high water, floating logs, etc. Members of the public that may decide to cross the West or East Channels to Sundial Island will have to exercise their own judgment when leaving established trails.

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